

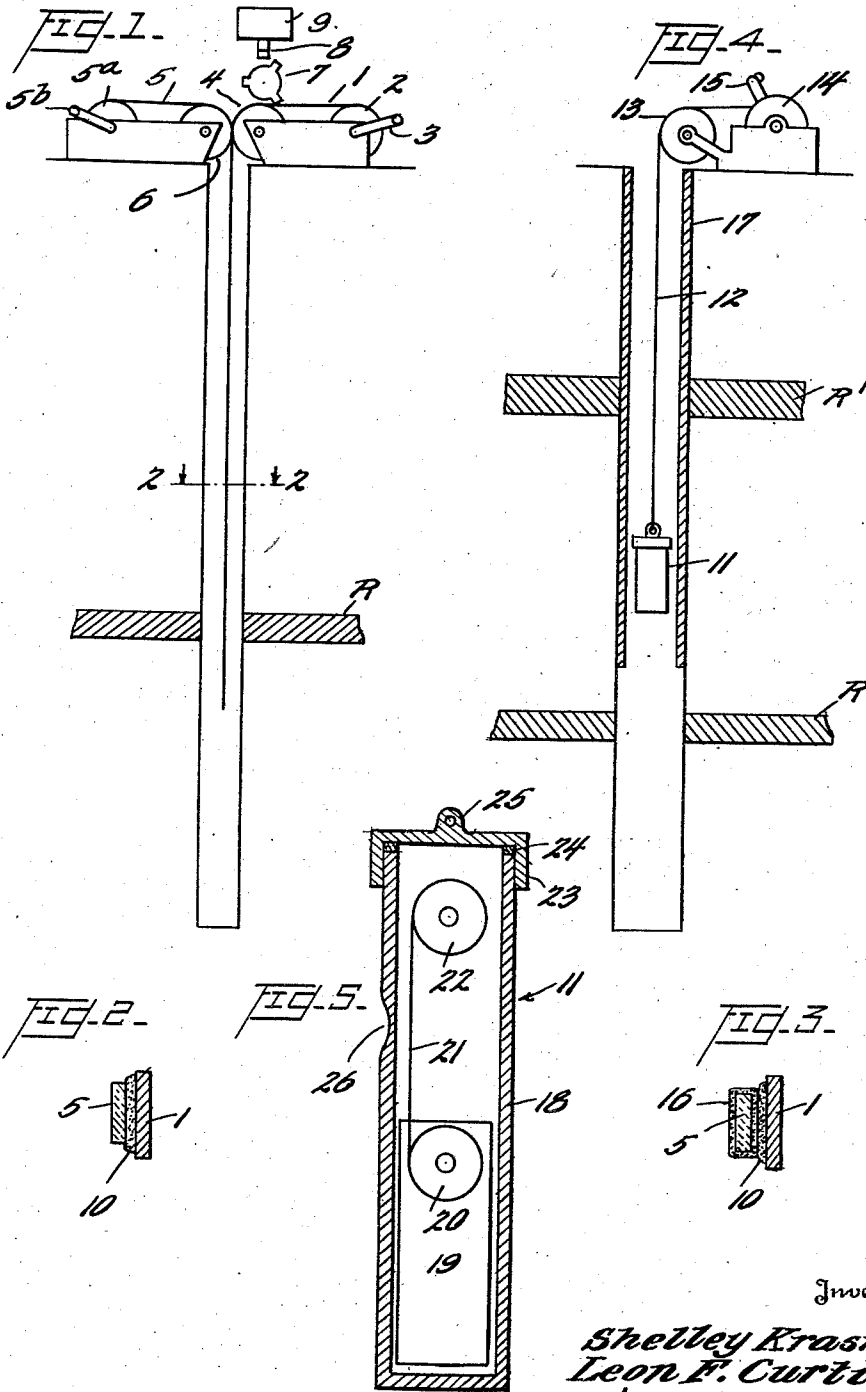
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METHOD AND APPARATUS FOR DIRECT RECORDING OF BOREHOLE RADIOACTIVITY

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METHOD AND APPARATUS FOR DIRECT RECORDING OF BOREHOLE RADIOACTIVITY

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1

This invention relates to an improved method and apparatus for measuring radioactivity and has particular reference to a method and apparatus for measuring radioactivity in inaccessible locations, such as in boreholes or at considerable depths in bodies of water.

One object of the invention is to provide a method and apparatus useful for locating deposits of minerals having radioactive properties. Another object of the invention is to provide an apparatus by which one may measure radioactive properties continuously from the top to the bottom of a borehole, and have both an immediate indication, and a permanent record, of the radioactivity at various depths.

In locating deposits of radioactive minerals it is often the custom to drill a number of boreholes in localities where such deposits might exist. It is further the practice to bring samples or cores of the drilled material to the surface of the earth, and there examine them for radioactivity by well known methods and apparatus. This method has several drawbacks. First, a deposit of ore may exist close to the borehole, but not be traversed by it, by which the deposit will be missed. Second, it is possible to make an error in ascertaining the exact depth from which a core or sample has been taken. Finally, it is rarely possible to bring all of the core to the surface, a certain percentage always being lost in the drilling or handling.

It is further known that deposits of petroleum are often markedly radioactive as compared with the surrounding rock material. This is believed to be due to the superior absorptive property of petroleum for radium emanation. Natural gas and ground water are also known to be somewhat more radioactive than their surrounding rock material. In drilling for either petroleum or natural gas, or ground water, it is desirable to know the exact level at which the strata having these are traversed by the drilled hole. This is often difficult to determine, particularly when drilling has been done by the "rotary" method, in which the use of mud under pressure tends to wall off the strata. Often, too, the drilled hole will be lined with a metallic casing, which casing by accident or intention may seal off strata having the desired fluid.

It is the intention in the present invention to provide an apparatus so sensitive, and a method appropriate to its use, that the relatively faint radioactivity of oil and ground water may be detected in place in a borehole. An apparatus sensitive enough to serve this function will by its nature differentiate between the different though faint radioactivities of the rock material.

2

Rock materials, dependent upon their origin and dependent upon the minerals contained in them, have different radioactivities. Thus, it has been found that granite, shales having organic materials embodied therein, sedimentary rocks containing zircon, and rock materials having mica associated with them, are all slightly more radioactive than for example limestone or chalk deposits. Sandstones will differ in their natural radioactivity, depending upon the minerals contaminating them. Organic deposits, such as coal, oil and natural gas, as mentioned above, petrified vegetable matter, etc., will show higher radioactivities than for instance limestone and chalk. Thus, with an apparatus as sensitive as that described herein it will be possible to differentiate between different layers of rock by the differences in their radioactivities. Each layer in an area will have a characteristic radioactivity, just as it has a characteristic chemical composition, and for the same reason. Thus, the radioactivity of a layer will serve as a variety of marker, serving to identify the layer wherever it might be in an area.

It thus becomes possible to identify rock layers in different boreholes drilled in an area and thus correlate the strata.

Further objects of the invention described are to obviate the difficulties mentioned and secure the advantages mentioned above.

Reference is had to the accompanying drawing in which:

Figure 1 represents a simplified form of apparatus for giving a continuous photographic record of radioactivity at various depths.

Figure 2 shows a cross-section of the members used in Figure 1, taken across the plane 2—2.

Figure 3 shows an alternate section similar to Figure 2, but with the addition of a coating constituting a filter element.

Figure 4 shows a schematic view indicating the lowering of an apparatus into a drill hole to measure radioactivity therein.

Figure 5 shows a vertical cross sectional view of another type of apparatus adapted to give a photographic record of radioactivity.

Referring now particularly to Figure 1, 1 shows a flexible band, preferably metallic, wound upon a reel 2 operated by a crank 3. The band passes over a measuring wheel 4 and into the borehole. A photographic film 5 is fed from a reel 5a operated by a crank 5b. A lobed member 7 serves to apply cement to the band 1 at regular intervals. This cement is fed by a brush 8 from tank 9.

In operation the band 1 and photographic film 5 are reeled together down into the borehole.

Because of the limited strength of the photographic film, it is found desirable to cement the latter to the band 1 at intervals and thus relieve it of tensile stress. As the film 5 and band 1 are reeled out together, the member 7 applies spots of cement 10 at intervals throughout the length of the band 1. This serves to cement the film and band together at intervals. The cement used may be of such nature that it will allow the ready separation of the two members when they are removed from the borehole. The band 1 serves as a holder, holding the film at the desired locality for the necessary length of time. It also acts as a mechanically protecting member, preventing injury to the film while it is being raised and lowered and while it is left dangling in the borehole. The photographic film reeled out is left in the borehole for a considerable period, which may be as much as several days. It is then wound upon the reel, removed and developed. If a markedly radioactive layer such as R exists, the film will be found to show a light spot. By measuring the length of film to this spot, the depth of the layer R may be determined. A film reinforced with strands of fiber or metal may be used and thus the necessity of using the band 1 obviated. It is further evident that the film may be coated with any of the standard intensifying materials commonly used in preparing medical X-ray films.

The film may also be coated with a substance to render it impervious to any harmful liquids which may exist in the borehole. An opaque coating may be applied to the film to allow its use in daylight. If the coating is properly chosen, it will not materially hinder the passage of rays from radioactive material.

Figure 3 shows an alternate cross sectional view similar to that shown in Figure 2, except that the opaque coating mentioned above is shown as 16, applied to the film 5. In other respects, the assemblage is the same as that shown in Figure 2. The impervious coating and intensifying materials mentioned above can be applied in a manner similar to the application of the coating 16 to the film 5.

The opaque coating 16 serves as a filter, filtering out for example visible light, yet admitting the rays from radioactive substances and allowing them to act upon the film. The coating 16 serves to shield the film from rays of visible light, and therefore constitutes a shielding means.

If desired, another type of apparatus may be lowered into the drill hole enclosed within a cartridge in order to enable measurements to be taken at any desired depth. This arrangement is shown schematically in Figure 4. This apparatus consists of a holder or cartridge 11, suspended by a cable 12, passing over a measuring wheel 13, and onto a reel 14 operated by a crank 15. By means of this crank 15, the required amount of cable may be paid out and the apparatus 11 lowered to any desired depth within the borehole. This may be done in boreholes which have been lined with metallic casing such as 17, making possible detection of layers such as R' or R when such layers have different radioactivities from their surroundings. The measuring wheel 13 allows one to tell the amount of cable which has been paid out and therefore the exact depth of the apparatus 11 within the borehole.

In the modification shown in vertical cross-section in Figure 5, a cartridge 18 is provided. In this is mounted a clock driven motor 19 which serves to wind photographic film 21 upon spool

20, the film originally being on spool 22. Cover 23 is removably fastened to container 18 by means of any suitable connection, preferably a threaded connection. A gasket 24 serves to make a fluid tight seal. The ring 25 serves for lowering and raising the apparatus in the borehole. The cartridge 18 is made of suitably heavy material to prevent collapse thereof under the high fluid pressure which may exist in a liquid-filled borehole. However, in order to reduce the absorption of radiation by the cartridge a thinned portion 26 is provided. Since this is of small area the material here may be made quite thin. In operation the clockwork 19 would be so set as to maintain the film 21 at a fixed position for a predetermined time, after which it would advance the film so as to expose a new portion thereof, and would serve to expose this new portion again for a predetermined period. The operator, knowing the length of these periods would maintain the cartridge at a fixed depth for each such period. Because of the slowness with which the film would be affected, it would not be necessary in most cases to provide any shield to protect the film from exposure while the apparatus is being raised and lowered.

The cartridge 11 may be run inside of the standard drill pipe used in rotary drilling and thus make measurements with a minimum of disturbance to drilling. Because of the limited absorptive power of the metals customarily used for drilling, it will be possible to detect radioactive rays through the thickness of metal in the drill pipe, or even through the several inch thickness of the drilling tools.

This application is a division of application Serial No. 301,078, filed October 24, 1939, entitled Method and apparatus for measuring radioactivity.

The scope of the invention is defined by the appended claims.

We claim:

1. In an apparatus for measuring radioactivity in a deep narrow borehole, a long narrow element sensitive to radioactivity, means to indicate the radioactive intensity of rays impinging on the element, and a filter, the filter serving to absorb a portion of the rays impinging upon the element sensitive to radioactivity.

2. In a method of measuring radioactivity within a borehole, the steps of measuring the radioactive intensity at one locality with an elongated measuring element, and of subsequently measuring the radioactive intensity at another locality with an elongated measuring element, at least one of the said measurements being made with the interposition of a filter element, the two measurements made being capable of intercomparison to evaluate the relative radioactive properties at the two localities, thereby serving as an indication of the conditions existing at the two localities.

3. In a method of examining geological formations, the steps of measuring radioactive intensity at one locality with an elongated measuring element, of measuring radioactive intensity at another locality with an elongated measuring element, at least one of the said measurements being made with the interposition of a filter element, the measurements thus made serving as an indication of the relative radioactive properties so measured serving further as an indication of the geological conditions existing at the two localities.

4. In a method of examining a borehole to determine conditions therein, the steps of measuring radioactive intensity with an elongated measuring element at different depths within the borehole, of measuring radioactive properties similarly with the interposition of a filter element, the two sets of measurements thus obtained being capable of intercomparison to evaluate the difference in radioactive properties at the two localities, the radioactive properties thus observed serving further as an index of conditions existing within the borehole.

5. In a method of investigating conditions existing within a deep narrow borehole, the steps of exposing a continuous sensitive member to at least a portion of the length of the borehole; at least a substantial portion of the sensitive member being sensitive to radioactive rays, of allowing the radioactive rays emitted by the substances in the borehole to affect the sensitive member in order to evaluate the relative radioactivity of the different portions of the borehole and to produce a permanent record directly on the said sensitive member, thereby obtaining an indication of conditions existing within the borehole.

6. In a method of investigating the radioactive properties of an extended source, the steps of placing a continuous sensitive member so that it is coextensive with at least a portion of the extended source, of allowing different portions of the extended source to act upon the sensitive member, thereby producing a permanent change in the condition of the sensitive member at different portions thereof, and of subsequently examining the sensitive member to determine the relative radioactive properties of the extended source.

7. In an apparatus for determining conditions within a deep narrow borehole, a continuous member sensitive to radioactivity, and means for lowering the said sensitive member so as to place different portions thereof in operative proximity to different portions of the borehole, the said sensitive member being permanently affected by radioactive intensity, and serving to indicate and record permanently the relative radioactive intensity at different parts of the borehole.

8. In an apparatus for the measurement of radioactive intensity within a borehole, a member sensitive to radioactivity adapted to be permanently changed upon exposure to radioactivity, the said change being in proportion to the strength thereof and adapted to be raised and lowered within the said borehole, means to lower and raise the said sensitive member so that it may be placed at a predetermined locality within the borehole, intensifying means mounted proximate to the sensitive member and being adapted to receive radioactive rays emanating within the borehole, and to intensify the effects thereon upon the sensitive member, thereby serving to give a heightened effect due to the radioactivity within the borehole.

9. In an apparatus for the measurement of radioactivity within a borehole, a sensitive member adapted to be lowered into the borehole so as to respond directly to radioactive rays emanating therein, means to protect the said sensitive member against mechanical injury, and means to raise and lower the said sensitive member within the borehole, the sensitive member being adapted after exposure to retain a permanent record indicative of radioactive intensity.

10. In a method of investigating radiant energy

emitted by substances within a borehole, the steps of placing an elongated sensitive member within the borehole, the said sensitive member being constituted so that exposure to radiant energy will produce a permanent and lasting record thereon, of exposing successive portions of the sensitive member to successive localities within the borehole, a portion of the said sensitive member thereby corresponding to a locality within the borehole, producing upon the said member by direct action of the radiant energy a lasting record, of removing the sensitive member from the borehole, and examining successive portions thereof for the effects of radiant energy thereon, thereby permitting correlation between the radiant energy emitting properties of substances within the borehole and locality within the borehole.

11. In a method for the investigation of the intensity of radiant energy within a borehole, the steps of placing at a predetermined point within the said borehole a chemical substance which is sensitive to and modifiable by radiant energy of the type emitted within the borehole so that a lasting record is produced thereon in proportion to the radiant energy, of allowing the chemical substance to remain at a locality within the borehole for a sufficient time to permit the modification chemically of the substance within the borehole due to the action of the radiant energy emitted thereby, of removing the substance from the borehole and subjecting it to examination, thereby obtaining an indication of the intensity of radiant energy at the selected locality within the borehole, the indication so obtained being capable of correlation with the depth or locality at which the indication was obtained.

12. In an apparatus for the measurement of radioactive intensity within a borehole, a sensitive member adapted to be acted upon directly by radioactive rays emanating within the borehole, and to leave a lasting record thereon due to the direct action of the said rays, means to lower the said sensitive member into the borehole so that it may be acted upon directly by the radioactive rays emanating therein, the said means including a protective holder to protect the sensitive member mechanically, and shielding means serving to exclude disturbing rays and to admit radioactive rays to the sensitive member.

13. In an apparatus for measuring radioactivity in a deep narrow borehole, a long narrow element sensitive to radioactivity to indicate the radioactive intensity of rays impinging on the element, and a filter, the filter serving to absorb a portion of the rays impinging upon the element sensitive to radioactivity.

14. In an apparatus for measuring radioactivity in a deep narrow borehole, a long narrow continuous member sensitive to radioactivity to indicate the radioactive intensity of rays impinging on the element, and a filter, the filter serving to absorb a portion of the rays impinging upon the element sensitive to radioactivity.

15. In a method of measuring radioactivity in a deep narrow borehole, the steps of lowering a long narrow measuring element sensitive to radioactivity to indicate the radioactive intensity of rays impinging on the element, within a deep narrow borehole, and absorbing by filter means a portion of the rays impinging upon the element sensitive to radioactivity.