April 24, 1951 HENRI-GEORGES DOLL 2,550,004

METHOD OF ESTABLISHING MARKERS IN BOREHOLES

Filed Dec. 22, 1943

Fig. 1

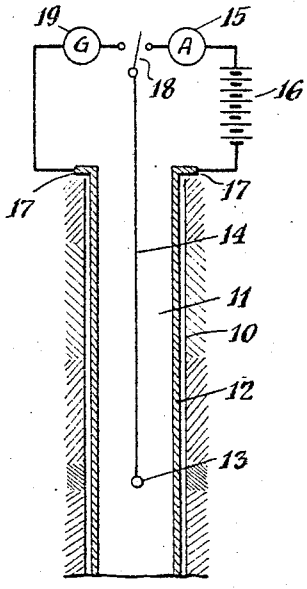


Fig. 2

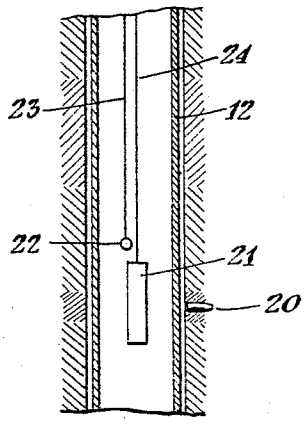


Fig. 3A Fig. 3B Fig. 3C Fig. 3D

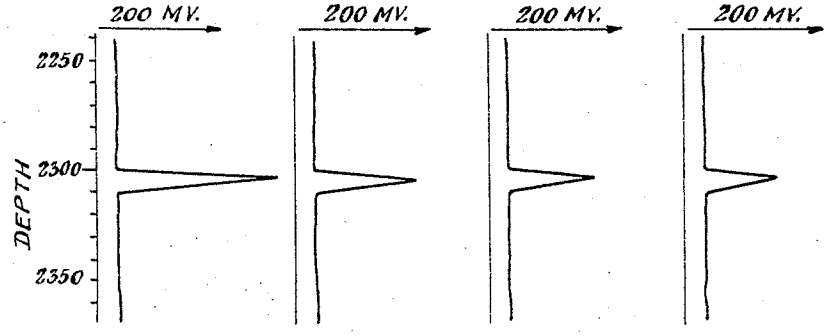
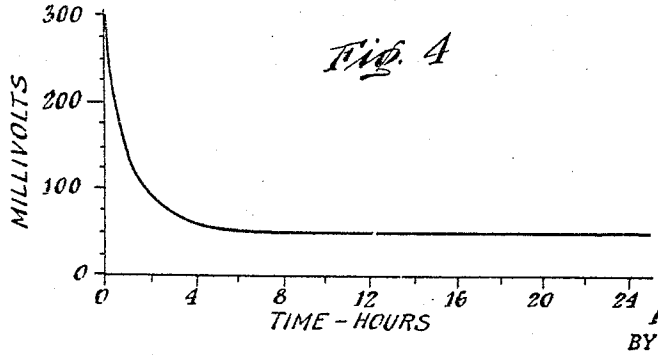


Fig. 4



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METHOD OF ESTABLISHING MARKERS IN BOREHOLES

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7 Claims. (Cl. 33—1)

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This invention relates to improved methods for establishing detectable reference points in the cased section of a bore hole in known relation to a formation or to another depth marker disposed outside the metallic case.

The desirability of establishing reference depth markers in bore holes is pointed out, and methods and apparatuses utilizing such markers are disclosed in the Doll application Serial No. 443,300, now Patent No. 2,476,137 granted July 12, 1949, filed May 16, 1942, and the Segesman application Serial No. 379,983, now Patent No. 2,350,832, granted June 6, 1944. The principal use of these markers is to facilitate the placing of a gun perforator in a bore hole very accurately with respect to a stratum, particularly one at greater depth.

In order to position the perforator accurately, it is necessary to lower the perforator and the marker detecting means into the bore hole simultaneously on the same cable. Gun perforators require relatively large powder charges to propel their projectiles through the steel casing and enormous shock and vibration, therefore, accompany the firing of a perforator.

The shock conditions during firing of the perforator are destructive and unless the marker locating device is especially constructed to withstand shock, it may be destroyed, or at least partially damaged. The economic factors involved preclude the use of a new marker locating device for each perforating operation and heretofore the locating devices have been constructed. at a very considerable expense, to withstand the shock encountered during firing of the gun perforator.

One of the least expensive and most reliable markers that can be precisely detected through the steel casing is a radio-active marker that spontaneously gives off gamma-rays, which rays easily penetrate the casing. Gamma-ray detecting apparatus is inherently delicate and costly and, accordingly, cannot be attached to a gun perforator unless special precautions, involving considerable expense, are taken to prevent damage to the apparatus. Similar difficulties are encountered in the use of other marker locating apparatuses.

It is an object of this invention to provide a method for establishing and locating a marker in the casing which can be detected by means of sturdy and inexpensive equipment.

Another object of the invention is to provide a method of establishing and locating a depth marker in a casing by means of equipment which is neither delicate nor expensive.

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A further object of the invention is to provide a method for marking the bore hole casing at any desired depth in such a manner that the marked portion of the casing can be readily detected by lowering a suitable apparatus into the casing either alone or in combination with a gun perforator.

Other objects of the invention will become apparent from the following detailed description of a typical embodiment of the present invention.

In accordance with the present invention, an easily detectable marker can be established in a cased bore hole by lowering an electrode into the casing and passing a rather high direct current between the casing and the electrode, thereby polarizing a short section of the casing.

The polarized section of the casing will retain its polarity for a considerable length of time, usually considerably longer than is required for relocating the marker for subsequent operations in the bore hole. The presence of the polarized marker can be readily detected by any one of a number of known types of apparatus which can be used alone or in combination with a gun perforator, whereby the gun perforator can be accurately positioned in the casing or other determinations made in the bore hole.

In establishing the electrical or polarized marker in the casing, a radio-active marker may be used as a reference point. This marker may be positioned in a formation of interest before the casing is inserted. By lowering a radiation-detecting device and the polarizing electrode, in known spatial relationship, into the casing until the detecting device is opposite to the radio-active marker, the polarized marker can be established in the casing in a known relation to the radio-active marker.

Sturdy and inexpensive equipment can then be utilized to locate the polarized marker and to position a perforating gun accurately with respect to the formation of interest.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

Figure 1 is a view in longitudinal section through a bore hole casing illustrating, schematically, apparatus for producing and detecting an electrical depth marker;

Figure 2 is a partial longitudinal section through the bore hole and apparatus illustrating the method of locating a marker positioned externally of the casing and then establishing an electrical marker within the casing in known depth relation thereto;

Figures 3A, 3B, 3C and 3D are reproductions

of the natural potential curves recorded at various time intervals after producing an electrical depth marker; and

Figure 4 is a curve showing the exponential decay as a function of time of the natural potentials produced by an electrical marker.

According to the present invention, an electrical depth marker may be established at any place in the cased portion of the bore hole by lowering an electrode into the hole on an insulated electric cable, such as a conventional well logging cable. When at the desired position, a relatively heavy direct current is caused to flow between the electrode and the casing for a short length of time. This produces a polarization along a short length of the casing at the depth of the electrode. This zone of polarization may then be very easily detected by conventional potential measurements. Apparatus such as that shown in Schlumberger Patent No. 1,913,293 is suitable for this purpose.

Referring to Figure 1, a bore hole 10 containing a column of liquid 11 is shown in longitudinal section. A conventional steel casing 12 is inserted in the bore hole. An electrode 13 is suspended in the bore hole on an insulated electrical conductor 14, the upper end of which is connected to a switch 18. When the switch is thrown to the right, the electrical conductor is connected through an ammeter 15 and a source of direct current 16 to the casing or ground as at 17. In the other position of switch 18, the electrical cable 14 is connected through a galvanometer or other potential measuring instrument 19 to the casing as at 17.

In operation the electrode 13 is lowered into the bore hole to the desired depth on a cable 14 by means of a winch or other suitable mechanism which is not shown. When the electrode is at the depth at which it is desired to establish an electrical marker, the switch 18 is thrown to the right which causes a direct current to flow from the battery 16, through ammeter 15, through electrical conductor 14 and from electrode 13 to the casing 12 through which the circuit is completed to the surface. As will be explained in more detail subsequently, it has been found in practice that a current of four or five amperes flowing for ten minutes is sufficient to establish an easily detectable marker which may be located several days after it is established.

Figure 2 is a section through a portion of a bore hole schematically illustrating the method for positioning an electrical marker in a known spatial relationship with a particular formation of interest, or a marker which has been placed outside the casing. Referring to Figure 2, a radio-active marker 20 is placed in known relation to a stratum of interest, for example, in a thin oil sand before the casing 12 is inserted in the bore hole. To create an electrical marker within the casing in known relation to the marker 20, a gamma-ray detecting apparatus 21 is lowered into the bore hole on an electrical cable 24. An electrode 22 is positioned on/or adjacent the assembly 21 and connected electrically to the surface by any suitable means, such as conductor 23. The assembly is raised or lowered in the bore hole until the position of marker 20 is definitely established by the assembly 21 by any of the methods well known in the art. Direct current is then caused to flow between the electrode 22 and the casing 12. By knowing the distance between the electrode 22 and the effective point of measurement of the gamma-ray detecting assembly 21, the relative depth of the electrical marker may be established.

Figures 3A, 3B, 3C and 3D are reproductions of natural potential logs which have been produced by conducting the method in a cased bore hole, the operations being conducted at the depth indicated on the graphs. In the particular field operation which has been here shown for the purpose of illustration, a direct current of four amperes was sent between the electrode and the casing for ten minutes and the curve of Figure 3A recorded five minutes after cutting off the current. Curves 3B, 3C and 3D were recorded thirty minutes, forty-five minutes and one and a half hours, respectively, after interrupting the current. It can thus be seen that the electrical anomaly produced is very sharp and persists for a reasonable length of time. It will also be noted that the indication of the presence of the marker is very great compared to the background or spurious potentials present in the casing.

Figure 4 is a curve plotted from the data of Figures 3A through 3D and additional data taken at longer intervals. As shown in Figure 4, the maximum natural potential adjacent the marker has been plotted against time and it will be noted that the maximum value decays exponentially with time. It may thus be seen that this type of electrical marker may be easily located several days after it is established. Should it be desired to have the marker persist for a longer interval, a greater current could be used for a greater length of time when producing the electrical marker.

Field tests have indicated that it is relatively unimportant which direction the current flows when producing the electrical marker A. Electrical markers have been successfully established by flowing the current in each direction. When the direction of current flow is reversed, the direction of the peak on the voltage curves, or its polarity, is reversed, but the marker indication remains sharp.

If desired, the body of the perforating gun, or part of the body, may be used as an electrode instead of providing an additional one. Most electrically fired gun perforating equipment is already provided with means for denoting the variations in potential as this is very useful in following the lowering of the perforator into the hole. While the spurious potentials present in the casing are not large, they are sufficient to check to see whether the gun perforator is moving. Thus it may be seen that this particular type of depth marker may be located by conventional electrically operated gun perforating equipment as it is used without any additions. The marker may be placed with conventional electrical logging equipment as it is used and does not require any additional expense for either positioning or locating the marker.

It will be apparent from the foregoing that the invention provides a simple, effective and fast method for positioning a gun perforator or other tool in a bore hole in known relation to a stratum of interest or other marker placed outside the casing or to locate a marker in the bore hole to permit making consistent depth measurements therein, the marker not necessarily being placed in any particular relation to a stratum or marker lying outside the casing.

Although this specific embodiment of the invention has been described in detail, the invention is not to be limited thereto, but is susceptible

of numerous changes within the scope of the appended claims.

I claim:

1. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to radioactive material outside the casing, comprising lowering into the bore hole a detector for said radioactive material outside said casing and an electrode in known spatial relationship to said detector, stopping said electrode in a predetermined relation to said radioactive material outside the casing, and passing a direct current between the casing and said electrode while said electrode is stopped in said predetermined relation to the radioactive material outside said casing.

2. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to a radiation-emitting marker outside said casing, comprising lowering into said bore hole a detector for said radiation-emitting marker and an electrode in known spatial relation to said detector, and passing a direct current between said casing and said electrode to polarize a portion of said casing while said detector and electrode are stopped.

3. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to radioactive material outside the casing, comprising locating said radioactive material by lowering a detector therefor into the casing, lowering an electrode into said casing, stopping the electrode adjacent a portion of the casing at a zone where a depth marker is to be established, passing a direct current between said electrode and said casing to polarize said casing portion, and determining the relative positions of said polarized casing portion and said radioactive material outside the casing.

4. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to a marker outside the casing, comprising locating said marker outside the casing by lowering a detector therefor into the casing, lowering an electrode into said casing, stopping the electrode adjacent a portion of the casing at a zone where a depth marker is to be established, passing a direct current at about 4 to 5 amperes value between said electrode and said casing to polarize said casing portion, and determining the relative positions of said polarized casing portion and said marker outside the casing.

5. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to a marker outside the casing, comprising locating said marker outside the casing by lowering a detector therefor into the casing, lowering an electrode into said casing, stopping the electrode adjacent a portion of the casing at a zone where a depth marker is to be established, passing a direct current at about 4 to 5 amperes value for about ten minutes between said electrode and said casing to polarize said casing portion, and determining the relative positions of said polarized casing portion and said marker outside the casing.

6. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to a marker outside the casing, comprising lowering into the bore hole a detector for said marker outside said casing and an electrode in known spatial relationship to said detector, stopping said electrode in a predetermined relation to said marker outside said casing, and passing a direct current at about 4 to 5 amperes value between the casing and said electrode while said electrode is stopped in said predetermined relation to the marker outside said casing.

7. A method of establishing a detectable depth marker in a casing in a bore hole in known relationship to a marker outside the casing, comprising lowering into the bore hole a detector for said marker outside said casing and an electrode in known spatial relationship to said detector, stopping said electrode in a predetermined relation to said marker outside said casing, and passing a direct current at about 4 to 5 amperes value for about ten minutes between the casing and said electrode while said electrode is stopped in said predetermined relation to the marker outside said casing.

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