

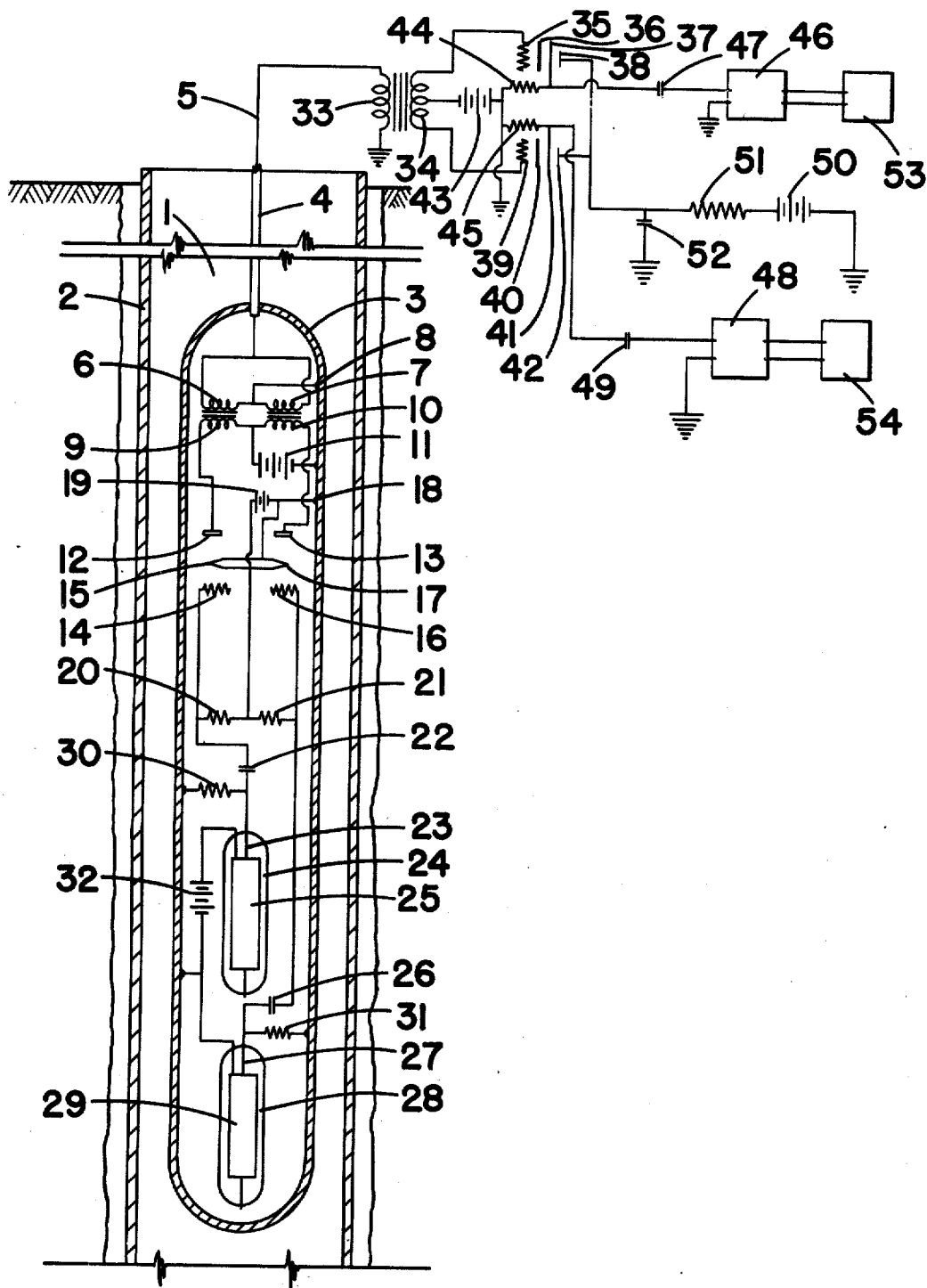
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WELL LOGGING

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WELL LOGGING

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The present invention is directed to a device for logging boreholes of the type in which the gamma-ray radiations from the material surrounding the borehole are utilized.

In the logging of wells by utilization of the gamma-ray radiations from the materials traversed by the borehole, statistical variations are encountered which may lead to errors in interpretation of the logs produced. For this reason, in making gamma-ray logs, it is frequently desirable to make check runs so as to ascertain the effect, if any, of the statistical variations. This has led to the utilization of two counters simultaneously.

The principal object of the present invention is the provision of a borehole logging bomb containing two Geiger-Muller counters connected with recording apparatus at the surface through a single conductor.

An additional object of the present invention is the provision in a device of the character described of two Geiger-Muller counters so connected to a single conductor that their responses are conveyed to the surface in a predetermined phase relation, and the provision at the surface of means for separating the responses of the counters and separately recording them.

Further objects and advantages of the present invention will appear from the following detailed description of the accompanying drawing in which the single figure is a vertical section, partly in diagrammatic form, of an apparatus according to the present invention, shown in place in a borehole.

Referring to the drawing in detail, numeral 1 designates a borehole provided with a metallic casing 2. Suspended in the casing is a bomb 3 made of steel or any other material transparent to gamma-rays and of sufficient mechanical strength to withstand the pressure encountered in practice. The bomb is suspended on a cable 4 carrying a single conductor 5 which terminates inside the bomb in the secondaries 6 and 7 of a pair of transformers which have a common ground 8. Numeral 9 designates the primary corresponding to secondary 6, and numeral 10 designates the primary corresponding to secondary 7. These primaries each have a common terminal connected to a battery 11 which provides the voltage for plates 12 and 13 of vacuum tube amplifiers. Plate 12 has a corresponding grid 14 and filament 15, while plate 13 has a corresponding grid 16 and filament 17. The filaments 15 and 17 have a common ground connection 18 and a common battery 19. The grid 14

is connected to ground through a resistance 20, while grid 16 is connected to ground through a resistance 21.

Grid 14 is connected through a condenser 22 to the anode of a Geiger-Muller tube 24 which is provided with the conventional cathode 25. Grid 16 is connected through a condenser 26 to anode 27 of a Geiger-Muller tube 28 having a conventional cathode 29. Anode 23 is connected to ground through a resistance 30, while anode 27 is connected to ground through resistance 31. A battery 32 supplies the necessary voltage to the cathodes 25 and 29.

At the surface the conductor 5 is connected to one terminal of a primary 33, the other terminal of which is grounded. It may be noted here that the primary winding 33 is a low impedance winding as well as the secondary windings 6 and 7. The secondary 34 corresponding to primary 33, like the primaries 9 and 10, is a high impedance winding. It has one of its terminals connected to the grid 35 of a thyatron having a filament 36, a cathode 37, and a plate 38, while its other terminal is connected to grid 39 of a similar thyatron having a filament 40, cathode 41, and plate 42. A bias battery 43 provides the necessary voltage for grids 35 and 39. Cathode 37 is connected to the ground through a resistance 44, while cathode 41 is connected to the ground through a resistance 45. Cathode 37 is also connected to one input terminal of a frequency meter 46 through a condenser 47, while cathode 41 is connected to a terminal of a frequency meter 48 through a condenser 49.

The plates 38 and 42 have a common source of power in battery 50, between which and each plate is a resistance 51. Between resistance 51 and each plate is a condenser 52 having one of its plates connected to ground.

The primaries 9 and 10 of the transformers in the casing 3 have their terminals so connected that the pulses taken off secondary 6 and resulting from the counter 24 are out of phase by 180° with the pulses taken off secondary 7 and resulting from the counter 28. These pulses then reach the surface 180° out of phase. In the secondary 34 of the transformer at the surface, the pulse from one counter will fire one thyatron, while the pulse from the other counter will fire the other thyatron. The functioning of a thyatron tube is well known in the art and is not described in detail here. It is important to note, however, that the resistance 51 and condenser 52 are so selected that the recovery time of the

electrical system is sufficiently long that any one pulse train has disappeared before the system is again ready to fire. It may be mentioned in explanation that, while the pulses from each Geiger counter are all on the same side of the zero axis, the transformers through which they are passed tend to convert them into pulses which cross the zero axis, whereby each pulse from a counter may be represented at the surface by a wave form simulating a decaying sine wave. Consequently, if the resistance 51 and condenser 52 were not provided and suitably selected a pulse resulting from a single Geiger counter might fire both thyatron tubes. Of course, the resistance 51 and the condenser 52 are necessary adjuncts to the thyatron tubes in any event.

The frequency meter 46 is connected to a recorder 53 which, as will be understood, is ordinarily of the photographic type in which a beam of light actuated by the frequency meter plays on a sensitized strip moved in synchronism with the movement of the casing 3 in the borehole whereby the deflections of the beam of light are correlated with the depth of the bomb 3 in the borehole. The frequency meter 46 is connected to a recording device 54 identical in nature and function with recorder 53. In practice it is desirable to use a single sensitized strip, on which is recorded simultaneously the deflections of the light beams caused by both frequency meters.

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

1. A method for logging boreholes which comprises passing along the borehole a plurality of Geiger-Muller counters, amplifying the output pulses of said counters continuously, combining said amplified pulses in a single conductor in out-of-phase relationship, conducting said pulses to the surface, separating said pulses at the surface, and separately recording values, each of which is a function of one of said pulses.

2. An apparatus for logging boreholes which comprises a bomb adapted to be lowered in the borehole, a plurality of Geiger-Muller counters arranged in said bomb, means for amplifying the output of each counter arranged in said bomb, means for combining the outputs of the various amplifiers in out-of-phase relationship, means for recording the output of the respective counters adapted to be arranged at the surface, means electrically interposed between said recording means and said pulse-combining means for separating said pulses according to their phase relationship, and means for delivering the output of said pulse-combining means to the input of said pulse separating means.

3. An apparatus according to claim 2 in which the means for delivering the output of the pulse-combining means to the input of the pulse-separating means is a single conductor carried by a cable capable of suspending the bomb in the borehole.

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