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DRAWINGS ATTACHED

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(72) Inventor ABAKAR ABAKAROVICH ABDULLAEV

(19)

(54) PROBE FOR ESTIMATING THE CHARACTERISTICS OF SUBSURFACE OR GROUND WATER FLOW

(71) We, INSTITUT YADERNOI FIZIKI AKADEMII NAUK UZBEKSKOI SSR, of poselok Ulugbek, Ordzhonikidzevsky raion, Tashkentskaya oblast, Union of Soviet Socialist Republics, a Corporation organized and existing under the laws of the Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a probe for estimating the characteristics of subsurface or ground water flow, and in particular for determining the filtration rate, the direction of the subsurface or ground water flow and the water flow rate in a single well by immersing the probe to a required depth.

In our co-pending British patent application No. 54906/71 (Serial No. 1321740) there are described probes for estimating the characteristics of subsurface or ground water flow in a single well with the aid of radioactive isotopes enclosed in a shell wherein a casing houses a radioactive isotope radiation receiver in the form of at least three gas-discharge counters equally spaced apart from each other in longitudinal slots formed in the outer surface of a cylindrical shield made of a material opaque to the kind of radioisotope radiation employed. Each counter is individually connected to means for registering pulses emitted from the gas-discharge counters and conveying the information relating to the characteristics of the subsurface or ground water flow under measurement. In these probes, the shield is solid.

The use of such probes for measuring the characteristics of subsurface or ground water flow requires that, prior to taking measurements, radioactive isotopes be released into the well by special releasing means and be subsequently uniformly mixed in the water column.

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Since the releasing of radioactive isotopes, the uniform mixing and the subsequent immersion of the probe in the well requires a certain amount of time during which the isotopes may be carried far away from the well if the flow velocity is high, the probes of the above type are not suitable for measuring such relatively high-velocity flows of subsurface and ground waters.

The invention consists in a probe for estimating the characteristics of subsurface or ground water flow with the aid of radioactive isotopes, comprising a hollow cylindrical shield made of a material opaque to the kind of radioactive radiation employed, gas-discharge counters equidistantly spaced from each other around the outer surface of the said shield, the shield having open longitudinal grooves between the said gas-discharge counters, pulse registering means separately connected to or connectable to each gas-discharge counter for registering pulses emitting from the said counters and conveying information relating to the measured characteristics of the subsurface or ground water flow, and means for releasing radioactive isotopes within the shield, so that, in operation, the radioactive isotopes carried by subsurface or ground water flow through the open grooves act upon the said gas-discharge counters.

Preferably, the shield has longitudinal slots equidistantly spaced from each other formed in the outer surface thereof, the slots being arranged between the longitudinal grooves, and the gas-discharge counters being disposed in the longitudinal slots.

The probe enables reliable, simultaneous and quick determination of the characteristics of subsurface or ground water flow, in particular the rate of filtration, the direction of the flow and the water flow rate, in a single well without the preliminary introduction of radioactive isotopes and their mixing in a water column in the well, and without rotating the probe (to deter-

mine the direction of flow) and subsequently pressing the probe against the wall of the well (to determine the rate of filtration).

The present probe also permits more accurate measurement of the characteristics of subsurface or ground water flow at relatively high flow velocities and when using small amounts of radioactive isotopes. In addition, unobstructed passage of water through the open grooves reduces errors caused by the effects of the probe fitted with a solid shield on the water flow.

The probe may find use in hydrogeological, hydraulic engineering and hydromeliorative studies of subsurface or ground water flow.

The invention will be further described by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a vertical sectional view of a probe for estimating the characteristics of subsurface or ground water flow; and

Figure 2 is a sectional view taken along the line II—II in Figure 1.

The probe shown in the drawings will be considered in relation to the single-well method of measuring flow parameters by means of radioactive isotopes.

The probe comprises a hermetic casing consisting of a cover 1 (Fig. 1) and a support 2 to which are attached the opposite edges of a hollow cylindrical lead shield 3; the shield is made of a material opaque to the kind of radioisotope radiation employed.

The cover 1 and the support 2 also carry a radioisotope radiation receiver consisting of six gas-discharge counters 4 disposed equidistantly from each other in longitudinal slots 5 (Fig. 2) formed in the outer surface of the shield 3.

Each counter 4 (Fig. 1) is separately connected to means for registering pulses emitting from the counters, which means convey information relating to the characteristics of the sub-surface or ground water flow being measured. The pulse registering means comprises cathode followers 6 for each gas-discharge counter 4 disposed in the cover 1 of the hermetic casing, and coupled by a multi-core connecting cable 7 to a ground-based radiation counting scaler or radiometer 8.

The shield 3 (Fig. 2) has longitudinal open grooves 9 between the longitudinal slots 5 accommodating the gas-discharge counters 4.

A shell 10 (Figs. 1 and 2) containing radioactive isotopes 11 is housed within the shield 3 so that the radioactive isotopes 11 carried out of the well by subsurface or ground water flow through grooves 9, and act on the gas-discharge counters 4 disposed in slots 5 in the immediate vicinity of the well flow outlet. The shell 10 containing the radioactive isotopes may be water-soluble. Electromagnetic or other mechanical injectors mechanically linked with the cover 1 of the hermetic case may alternatively be used.

The gas-discharge counters 4 are each closed by a water-tight envelope 12. The stationary probe provides measurement of the characteristics of subsurface or ground water flow at a preset depth with a required degree of accuracy.

Immersion of the probe in a well and fixation of its gas-discharge counters 4 with respect to the cardinal points are effected by mechanically attaching the probe to rods (not shown in the drawing). The probe is immersed in a well and falls to the required depth under the effect of the weight of the connecting cable 7.

If, necessary, the probe can be centered in a well by means of three or four steel springs (not shown in the drawing). One end of each spring is secured to the casing of the probe, while the other end can be shifted in either direction along the casing depending on the diameter of the well, and fastened in this position.

The probe operates as follows to determine the characteristics of subsurface or ground water flow.

Before being released, the radioactive isotopes are placed into the water-soluble shell 10 which has a thickness such that it will not dissolve before the probe reaches a preset depth. After the gas-discharge counters have been oriented with respect to the cardinal points and fixed by means of rods, the probe is lowered into a well to a given depth, the radiometer 8 is switched on, and the radioactive isotope is released into the water as the shell 10 dissolves.

If the radiometer 8 incorporates one mechanical counter (not shown in the drawing), the activity of the radioisotopes is measured by alternate connection of the gas-discharge counters 4 by means of a switch (not shown in the drawing). On the other hand, if the radiometer 8 has a number of mechanical counters equal to the number of the gas-discharge counters 4, such switching-over is not needed.

From the readings of the radiometer 8 (Fig. 1) corresponding to each of the numbered gas-discharge counters 4, a vector diagram (curve) of pulses is plotted, which enables the direction of the flow to be determined. The rate of the flow is measured by the decrease in the activity of the radioisotope used in a given time, which defines the entrainment of the isotope from the well by the water flow. The flow rate of subsurface or ground water can then be determined if the size of the well and the rate of filtration are known.

The probe described above provides simultaneous, quick and accurate

measurement of high and low rates of filtration, and the direction of the flow and water flow rate in one well.

The radioactive isotope used in the probe is radioactive iodine-131. However, use can also be made of other radio-isotopes possessing an appropriate half-life and whose radiation energy would permit the use of a small shield suitable for use in conventional wells.

WHAT WE CLAIM IS:—

1. A probe for estimating the characteristics of subsurface or ground water flow with the aid of radioactive isotopes, comprising a hollow cylindrical shield made of a material opaque to the kind of radioactive radiation employed, gas-discharge counters equidistantly spaced from each other around the outer surface of the said shield, the shield having open longitudinal grooves between the said gas-discharge counters, pulse registering means separately connected to or connectable to each gas-discharge counter for registering pulses emitting from the said counters and conveying information relating to the measured characteristics of the subsurface or ground water flow, and means for releasing radioactive isotopes within the shield, so that, in operation, the radioactive isotopes carried by subsurface or ground water flow through the open grooves act upon the said gas-discharge counters.

2. A probe for estimating the characteristics of sub-surface or ground water flow with the aid of radioactive isotopes, comprising a hollow cylindrical shield made of a material opaque to the kind of radioactive radiation employed, the shield having longitudinal slots equidistantly spaced from each other in the outer surface thereof and open longitudinal grooves between the said longitudinal slots, gas-discharge counters disposed in the said longitudinal slots, pulse registering means separately connected to or connectable to each gas-discharge counter for registering pulses emitting from the said counters and conveying information relating to the measured characteristics of the subsurface or ground water flow, and means for releasing radioactive isotopes within the shield, so that in operation, the radioactive isotopes carried out by subsurface or ground water flow through the open grooves act upon the said gas-discharge counters.

3. A probe as claimed in Claim 2 wherein there are at least three gas-discharge counters each disposed in a said longitudinal slot.

4. A probe as claimed in any of Claims 1—3 wherein the said pulse registering means comprises a cathode follower associated with each gas-discharge counter, the said followers being connected by a multi-core cable to a ground-based radiation counter scaler or radiometer.

5. A probe as claimed in any of Claims 1—4 wherein the said radioactive isotopes are contained within a shell disposed within the said shield.

6. A probe as claimed in Claim 5 wherein the said shell is water-soluble.

7. A probe as claimed in any of Claims 1—6 wherein the radioactive isotope is iodine 131.

8. A probe as claimed in any of Claims 1—7 wherein the said shield and the said gas-discharge counters are housed in common casing.

9. A probe substantially as herein described with reference to, and as shown in, the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
57 & 58 Lincoln's Inn Fields,
London, WC2A 3LS,
Agents for the applicants.

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1321739 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

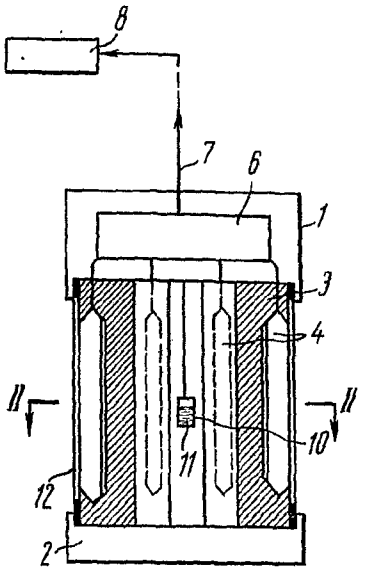

FIG. 1

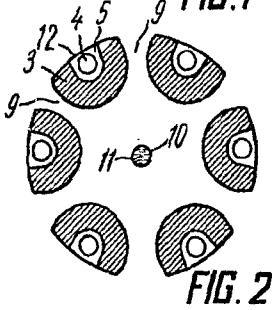

FIG. 2