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DRAWINGS ATTACHED

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(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 injection into the well water for radioactive isotopes before measurements at a required depth and their uniform stirring.

There are known probes for estimating the characteristics of subsurface or ground water flow in a single well with the aid of radioactive isotopes wherein a casing houses a radioisotope radiation receiver and a cylindrical shield made of a material opaque to the kind of radioisotope radiation employed. There is provided means for registering pulses emitted from the radioisotope radiation receiver and conveying information relating to the characteristics of the subsurface or ground water flow under measurement.

In such known probes, the radioisotope radiation receiver is a crystal scintillation detector NaI(T1) disposed within a shield which has a narrow collimating slit for receiving radioactive radiation from the isotope used.

These known probes suffer from the disadvantages that in order to determine the direction of the water flow the probe must be oriented by rotation in the well so that the direction of the flow can be determined by the maximum intensity of radiation of the radioactive isotopes carried out of the well by subsurface or ground waters, and that in order to determine the filtration rate the probe must be mechanically pressed against the wall of the well in the direction of the flow that has been determined by probe rotation. Such rotation of the probe with subsequent pressing against the wall of the well may disturb the flow in the well and cause redistribution of the radioactive isotopes in the water, which will adversely affect the accuracy of the measuring of the characteristics of subsurface or ground water flow.

Another disadvantage of these known probes is that the actual measurement of the flow characteristic may only begin after a certain time period during which the radioactive isotopes, previously injected into the well, have been fully carried from the well. This time period may be unpredictably large or small, depending on the velocity of the subsurface or ground water flow.

On the other hand, to employ a mechanical device for pressing the probe against the wall of the well requires additional financial and labour expenditure.

The invention consists in a probe for estimating the characteristics of subsurface or ground water flow with the aid of radioactive isotopes, comprising a 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, and pulse registering means separately connected to or connectable to each gas-discharge counter for registering pulses emitting from the said counter and conveying information relating to the measured characteristics of the subsurface or ground water flow.

The shield may be solid and may have longitudinal slots formed in the outer

surface thereof, each slot accommodating one gas-discharge counter, which improves the accuracy of measuring the direction of the flow, filtration rate and water flow rate.

The probe enables reliable, simultaneous and relatively quick estimation 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 rotating the probe in the well and without its subsequently pressing the probe against the wall of the well, thereby making it possible to avoid disturbance of the flow in the well during measurements as well as redistribution of the radioactive isotopes in the well water, and permits more accurate measurement of the characteristics of the subsurface or ground water flow.

The probe may find use in hydrogeological, hydraulic engineering and hydromeliorative studies of subsurface or ground water flow. The probe can also be used to investigate the characteristics of any liquid medium by injecting radioisotope compounds soluble in the medium. The probe is simple in design, easy to operate, and requires low financial and labour expenditures.

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 1 (Figs. 1 and 2) housing a solid cylindrical lead shield 2; the shield 2 is made of a material opaque to the kind of radioisotope radiation employed.

The casing 1 further contains a radioisotope radiation receiver consisting of six gas-discharge counters 3, each of which are separately connected to means for registering pulses emitting from the counters and convey information relating to the characteristics of the subsurface or ground water flow being measured. The pulse registering means comprises cathode followers 4 (Fig. 1) for each gas-discharge counter 3 disposed in the casing 1 and coupled by a multi-core connecting cable 5 to a ground-based radiation counting scaler or radiometer 6.

The gas-discharge counters 3 (Fig. 2) are disposed equidistantly from each other in longitudinal slots 7 formed in the outer surface of the shield 2, so as to enable determination of the characteristics of subsurface or ground water flow at a preset depth with a required degree of accuracy without rotating the probe.

Immersion of the probe in a well and fixation of its gas-discharge counters 3 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 5.

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 1 of the probe, while the other end can be shifted to any place on the case 1, depending on the diameter of the well, and fastened in this place.

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

Before measurements, the radioactive isotope used in the probe is injected at a preset depth in the well and is uniformly mixed in the well water column. Then the probe is lowered to a given depth and the characteristics of the subsurface or ground water flow are measured by means of the ground-based radiation counting scaler or radiometer 6 (Fig. 1), the probe remaining stationary in the well. If the radiometer 6 incorporates one mechanical counter (not shown in the drawing), the activity of the radioisotopes is measured by alternate connection of the gas-discharge counters 3 by means of a switch (not shown in the drawing). On the other hand if the radiometer 6 has a number of mechanical counters equal to the number of the gas-discharge counters 3, such switching-over is not needed.

From the readings of the radiometer 6 corresponding to each of the numbered gas-discharge counters 3, a vector diagram (curve) of pulses is plotted which enables the direction of the water flow to be determined. The flow rate is determined by the decrease in the activity of the radioisotope used in a given time, which defines the entrainment of the radioactive isotope from the well by the water flow. The flow rate of the subsurface or ground water can then be determined if the size of the well and the filtration rate are known.

The probe described above provided simultaneous determination of the filtration rate, flow direction and water flow rate in one well.

The radioactive isotope used is radioactive iodine — 131_I. However, use can also be made of other radiosotopes possessing an appropriate half-life and

whose radiation energy permits the use of a small protective 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 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, and 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.

2. A probe as claimed in Claim 1 wherein the said shield is solid and has longitudinal slots formed in the outer surface thereof, the said gas-discharge counters being disposed in the said slots.

3. A probe as claimed in Claim 1 or 2 wherein there are at least three gas-discharge counters.

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 shield and the said gas-discharge counters are housed in a common casing.

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

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1321740 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

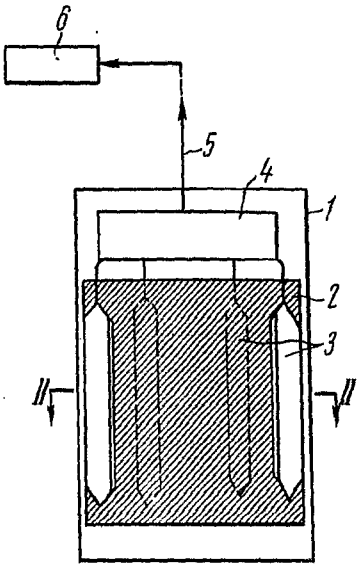

FIG.1

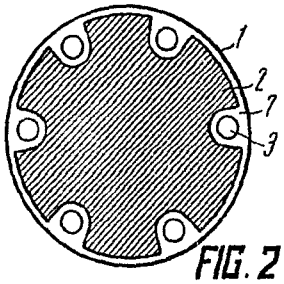

FIG. 2