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THERMOMETER FOR DEEP WELL MEASUREMENTS

Filed June 26, 1940

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FIG. 1.

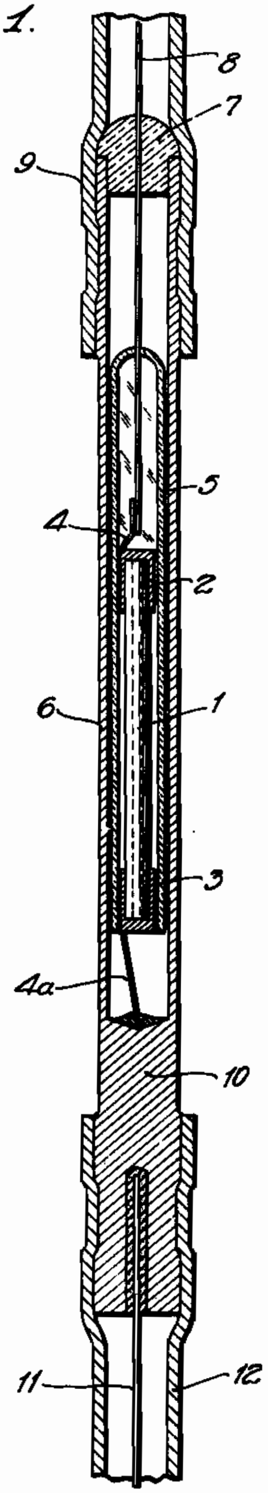
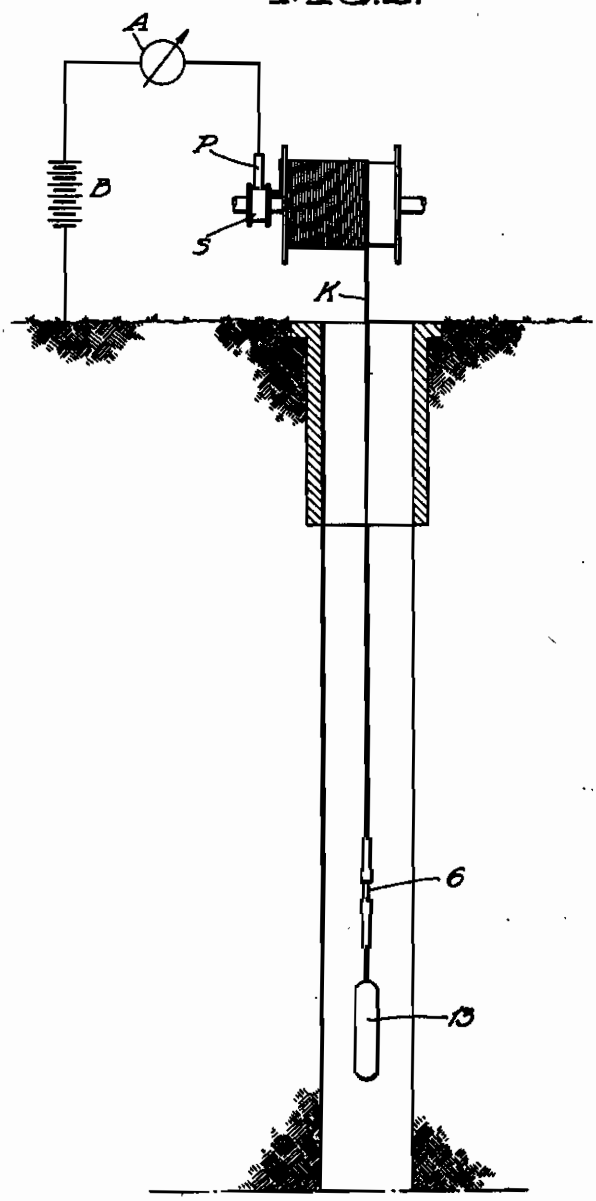


FIG. 2.



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ALIEN PROPERTY CUSTODIAN

THERMOMETER FOR DEEP WELL MEASUREMENTS

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In deep wells which are filled with water or a heavy flushing liquid, heretofore temperature measurements have been carried out with maximum or Kipp thermometers, if it was a matter of an individual measurement, or with electric resistance thermometers, if continuous measurements along the length of the well were required. For the latter measurements the usual thermometers constructed with metal wires—iron, nickel, or platinum, were used, the resistance of which was only increased by 1% for a rising temperature of about 3° C. These thermometers were weighted in suitable manner and lowered into the well by a cable and upon rising the changes in resistance in relation to depth were determined by a Wheatstone bridge connection. The thermometer had to be protected against high pressure in the well, up to 300 atmospheres, by means of a steel housing, into which the cable conductors had to be sealed to resist water pressure.

The use of these thermometers leads to difficulties. The small change in resistance of the metal makes it impossible to disregard the effect of the resistance of the conductor and, above all, the changes of this resistance. It was therefore necessary, with the connection customarily used with remote thermometers, to utilize three conductors. That required, with great depths, as compared with a single conductor cable, an increase of weight of several thousand kgs. for the whole measuring apparatus, because all parts, including the cable, the cable drum, the pay-out device, and the measuring carriage had to be correspondingly heavy.

Moreover, leading three conductors into the sealed housing caused such an increase in the mass of this housing as to cause the thermometer to respond to the surrounding temperature only slowly. In contrast to this the thermometer to be described herein requires only a single lead-in wire, which serves also as a load sustaining cable, and the thermometer itself is so small that it assumes the temperature of its surroundings in a few seconds.

According to the invention the thermometer consists of a semi-conductor having electronic conduction, such as a uranium dioxide or manganese-titanium-spinel resistor, such as is used as a series resistance in radio receiving sets under the name Urdox resistor.

These resistors can be produced in rod or tube form of not much more than 1 mm. diameter and 10 mm. length, with a resistance as desired between 20,000 and 100,000 ohms at 10° C. The resistance of such rods increases by several per cent with an increase of temperature of 1° C. This high resistance, coupled with a high temperature coefficient, makes it possible to work with a single conductor and an earth return, because their resistance and change in resistance is negligible. At the same time the dimensioning of the protective housing can be made smaller and lighter, so that the thermometer almost instantly assumes the temperature of its surroundings.

In the accompanying drawing there is shown one illustrative example of the invention.

Fig. 1 is an axial section of the thermometer unit and connections, in enlarged scale; and

Fig. 2 is a diagrammatic view showing the apparatus set up for temperature measurements in a well.

The Urdox resistor **1** is a small tube of about 1 mm. diameter and 0.2 mm. wall thickness. At the end of the little tube are soldered two caps **2** and **3**, which are provided with leads **4** and **4a** for electrical connection. Over the Urdox tube is placed a glass tube **5** with almost closed upper cap and having a wall thickness of about 0.2 mm., and encasing this is a silver protective tube **6** of only 2 mm. diameter and 0.2 mm. wall thickness. A glass pearl **7** closes the silver tube at the top and lets in a wire **8**, which is soldered to the lead **4**. The lead **4a**, on the other hand, is soldered to the closed bottom piece **10** of the silver tube **6**, which is connected by a wire **11** with a suspended lead sinker **13**. The latter serves for weighting the device in lowering and at the same time serves as an earthing electrode. The parts **9** and **12** are sheaths drawn over for insulation and protection of the connections.

Preferably the whole thermometer is surrounded by a wire cage (not shown), for protection against damage and for relieving the inner parts. The lead weight is then carried by this protective cage.

In Fig. 2 the complete measuring apparatus is shown diagrammatically. From the battery B having one pole earthed, and having an electrical pressure of at least 12 volts, the current flows through a milliammeter A and through a brush P and slip ring S to the cable K, thence to the Urdox resistor in the little silver tube **9**, and finally through the earthing electrode **13** to the ground.

If the temperature changes as the thermometer is lowered into or raised out of the well, the resistance of the thermometer also changes and thereby the deflection of the milliammeter needle. The latter may be graduated in a temperature scale. It is preferably constructed as a recording apparatus, in order to record the temperatures in relation to the depths upon a record strip.

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