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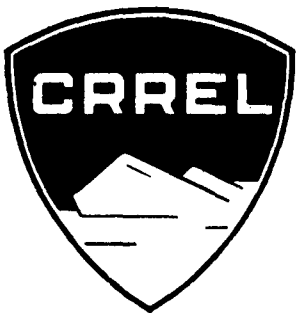

Draft Translation 373

Wired Probe for Measuring the Temperature Profile in Icecaps

K. Philberth

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CORPS OF ENGINEERS, U.S. ARMY
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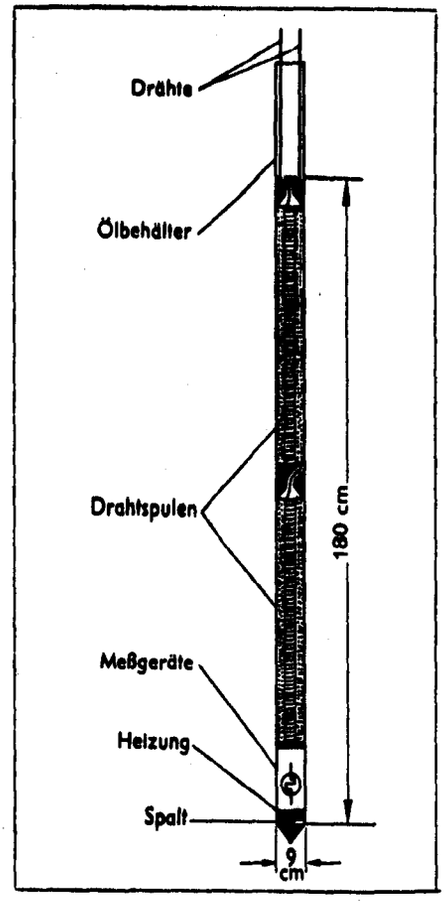
WIRED PROBE FOR MEASURING THE TEMPERATURE PROFILE IN ICECAPS

Sonderdruck aus: Umschau in Wissenschaft und Technik (Preprint from: Review of Science and Engineering), Frankfurt-am-Main, No 11, 1966, p 360

Dr. Karl Philberth
(Munich)

The Greenland icecap covers an area of about 1.6 million sq km; its depth reaches more than 3 km. This ice mass reveals a constant movement toward the coasts, from which the greater part drifts seaward in the form of icebergs. This ice creep is dependent on the configuration of the ice shield and the temperature-related viscosity of ice. The ice temperature near the rock base has the most influence on the ice motion. Mechanical drillings in the ice are useful. In themselves, thermal soundings are simple; however employing the conventional techniques, one fails to reach any great depths because the cable running from above to the hot water or electrical lead easily freezes in.

In recent years, I have developed a new thermal probe system which promises to reach depths of more than 3 km (see the illustration). Heating is provided electrically from above via a pair of copper wires insulated from each other. However, these wires are not delivered from above downward but initially they are wound within the probe and unwind from here outward. Soon after its exit from the probe, the wire pair freezes into the ice. This provides additional electrical insulation. The copper wires are flexible enough so that they do not become broken from the steady deformation of the ice. The probe is cylindrical, is about 10 cm in diameter and 2 m in length. The heating unit is located on the very bottom; above that is the chamber containing the measuring instruments (thermistors, geophone, manometer, inclinometer and so forth): both wire reels are mounted above this; they take up the most space. The heating current flowing through the wire reels develops resistive heat in them. This is proportioned in such a way that the side walls of the probe can not become frozen in. For measuring the ice temperature, at the desired depth, electric heating is cut off, after which the probe freezes in. Accordingly, the disturbed temperature approximates a hyperbolic function of the original ice temperature, which it in effect attains after a few days. Switching from the thermistors to temperature measurement and from the other measuring instruments occurs through a relay.



Schematic Section Through the Thermal Probe. Key: a) Wires; b) Oil tank; c) Wire reels; d) Measurement instruments; e) Heating element; and f) Aperture.

One must prevent the probe from tilting increasingly and thereby causing a curved path. A thermal control is used for this purpose: between the heating element and the probe bottom, an aperture partly filled with mercury is set perpendicularly to the axis; any tilting of the probe causes an asymmetrical displacement of the mercury serving as a heating bridge, whereby the probe is returned to the vertical position. This type of control has been tested successfully with the kind support of R. Haefeli at the High Alpine Research Station of Jungfraujoch (Switzerland).

The Greenland probes of the new type were completely designed and built by L. Hansen and H. Asmot in cooperation with the author at CRREL (Cold Regions Research and Engineering Laboratory, Hanover, U.S.). During last year's testing at Camp Century (Northern Greenland), the basic design proved successful; however, due to a shortage of material, a depth of only 90 m was reached. For this year in Greenland and for future years in the Antarctic as well, CRREL plans to put improved models into operation. The second International Glaciological Greenland Expedition (IGGE II) has planned the operation of the probes for drillings in Central Greenland in 1968.

Exploration of the polar ice masses may become of serious significance for mankind. It has been suggested by Bernhard Philberth that the radioactive wastes which result from the peaceful utilization of atomic power be disposed of in the large ice caps on Earth. Here plenty of space is available for all the atomic wastes from all nations for all the future. This disposal plan has gained many advocates; no other disposal method is known which could offer an equally great storage safety (DFG) [expansion unknown].

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13. ABSTRACT

In recent years, the author has developed a new thermal probe system which promises to reach depths of more than 3 km. Heating is provided electrically from above via a pair of copper wires insulated from each other. However, these wires are not delivered from above downward but initially they are wound within the the probe and unwind from here outward. Soon after its exit from the probe, the wire pair freezes into the ice. This provides additional electrical insulation. The copper wires are flexible enough so that they do not become broken from the steady deformation of the ice. The probe is cylindrical about 10 cm in diameter and 2 m in length. The heating unit is located on the very bottom; above that is the chamber containing the measuring instruments (thermistors, geophone, manometer, inclinometer and so forth): both wire reels are mounted above thi; they take up the most space. The heating current flowing through the wire reels develops resistive heat in them. This is proportioned in such a way that the side walls of the probe can not become frozen in. For measuring the ice temperature at the desired depth, electric heating is cut off, after which the probe freezes in. Accordingly, the disturbed temperature approximates a hyperbolic function of the original ice temperature, which it in effect attains after a few days. Switching from the thermistors to temperature measurement and from the other measuring instruments occurs through a relay.

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