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FROST DEPTHS IN THE GROUND

BY

WILLIAM C. MASON

ELECTRICAL ENGINEER, SLINGERLANDS, N.Y., U.S.A.

AND

FREDERICK H. RUGGLES, JR. ENGINEER

U.S. GEOLOGICAL SURVEY, ALBANY, N.Y., U.S.A.

# A UNIQUE METHOD OF MEASURING FROST DEPTHS IN THE GROUND

By WILLIAM C. MASON\* and FREDERICK H. RUGGLES, JR.\*\*

(This is a condensation of the original paper)

One of the most difficult problems in the study of snow, ice, and frost, is the measurement of frost depths in the ground. A number of devices have been tried, with varying success, but they have been of the single-reading type and they usually require a relatively large amount of handling. The time-honored pick and shovel method is, to say the least, not very satisfactory as a scientific procedure. This paper describes an instrument that not only indicates frost depth automatically, but also records the depth.

The ground unit consists of a thin-walled pipe with one end closed, set vertically in the ground with the closed end flush with the surface. The length is a little more than twice the probable frost depth. In the pipe is a slender rack, driven by a pinion gear on a horizontal shaft that intersects the pipe at the mid point. The horizontal shaft is driven by bevel gears from a vertical shaft that is driven through a worm and gear by a reversible motor at the recorder. The several moving elements are in pipes that form a rectangular lower-case "y". The pipes are kept full of water so that the ground pipe is under a constant low head, maintained by a small tank.

The first model of the frost-depth recorder is situated close-to and in a shop, such that part of the ground unit is in a basement. Thus the water in the vertical section under the recorder does not freeze.

The water in the outer ground unit freezes to the frost level. Periodically, as actuated by an electric clock, or on demand by a manual switch, the vertical rack moves slowly upward from its low (resting) position until it contacts the bottom of the slug of ice. The resistance to movement stalls the rack and connecting shafts, causing the worm to climb the stalled gear and close an electrical contact. The recorder pen also travels as the rack rises and as the contact is made, an electric magnet causes the pen to touch the chart momentarily and leave a trace of its position. At the same time, a relay closes and the motor reverses to make the rack retreat to its starting position; the pen also returns in parallel with that action, but not marking.

The action of the instrument is simple. The frost depth can be recorded as frequently as desired, such that an essentially continuous trace can be made. It was found near Albany that every six hours is sufficient.

The instrument, of course, requires a source of electricity, preferably alternating current so that the clock motor will keep accurate time. It needs an installation such that the recorder side of the U-tube will not be subject to sub-freezing temperatures. This makes it most useful at a laboratory and there would seem to be direct application at all of the research stations where frost depths are a part of the observations. It is conceivable, however, that unattended field installations could be designed.

\*Electrical Engineer and Inventor, Slingerlands, N.Y.

\*\*Hydraulic Engineer, U.S. Geological Survey, Albany, N.Y.