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THE OCCURRENCE OF HAIL

EDITOR'S NOTE.—In response to the demand for more specific data on the occurrence of hail in the United States, the Weather Bureau began in the April number of this REVIEW the publication of reports on the occurrence of hailstorms as observed by its regular and cooperative observers, numbering approximately 5,200. Cooperative observers report directly to the Weather Bureau officials in charge of the several section centers and these officials in turn transmit the reports to the Central Office in Washington, D. C. The reports are incorporated in the table which hitherto has borne the title "Severe Local Storms." That table will be found on pages 324–325 of this REVIEW, and it will appear in approximately the same position hereafter.

ON A SIMPLE METHOD OF RECORDING THE TOTAL AND PARTIAL INTENSITIES OF SOLAR RADIATION

551.508.2

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(Washington, June 14, 1924)

Synopsis.—A simple form of recording pyrheliometer is obtained from the combination of a thermopile of the Moll type with a recording voltmeter of the Richard type. The large-surface thermopile is composed of 80 elements made from thin strips of manganin and constantan, which are placed in a circle nearly 2 cm. in diameter. These strips can be exposed to radiation over their whole length.

The thermopile is question affords a high degree of stability (absence of zero errors) and sensitivity, together with great quickness in action, namely, the time elapsing between the admission of radiation and the moment at which the full electro-motive force is reached, is less than two seconds. The radiation from a candle at one meter distance yields about 90 microvolts.

Other details and some historical data are given.

With a recording voltmeter (Richard type) the large-surface thermopile, properly diaphragmed and equatorially mounted (clock driven), gives a new form of thermoelectric pyrheliometer, very rugged, and simple in use even for inexperienced observers. A solar radiation intensity of one gram-calory per minute per square centimeter of surface normal to the incident rays develops a current having an electromotive force of about 16 millivolts; this voltage is very nearly proportional to the intensity of the solar radiation so that the pyrheliometric records can be directly calibrated in gram-calories/cm.^{2}/min.

An illustration of the new pyreheliometer is given, with three sample records from measurements made by the author in the Desert of Sahara. The method of obtaining the partial intensities by the use of colored glasses and liquid light filters is also indicated.

THERMOELECTRIC METHOD OF MEASURING RADIATION.

Independent of the ordinary thermometric method, the endeavors to apply the thermoelectric current to measurements of radiation date back several years. Special attention may be called to the old thermoelectric pyrheliometer constructed by Professor Crova and used at the University of Montpellier, France, in 1890. Among other forms we note especially the instrument of Féry, constructed in the beginning of the twentieth century. The difficulties met with in the application of thermopiles for measuring radiation are principally the following:

(1) *Constancy of the zero.*—The thermopile must be free from zero errors.

(2) *Quickness in action.*—The ordinary thermopile is a rather slow instrument; when exposed to radiation a constant temperature will be obtained only after a considerable time; for instance, even in the best Rubens thermopile more than 15 seconds elapse before the full electromotive force caused by constant radiation is reached.

(3) *High sensitivity.*—The sensitivity is generally not great enough to make possible the use of the ordinary millivoltmeters instead of the delicate mirror-galvanometers with the photographic recording. However, when great sensibility has been obtained, it has been at the expense of speed.

(4) *Rugged form of construction.*—The existing thermopiles were not sufficiently rugged for the comparatively rough handling they would meet with in practice for permanent solar radiation measurements.

Through the independent efforts in recent years of two distinguished physicists, excellent thermopiles have been constructed, which may be considered to have overcome generally the difficulties in the application of the thermoelectric methods to continuous measurements of solar radiation.

In consequence of these developments, on the one hand by Doctor Coblentz, of the United States Bureau of Standards, at Washington, and, on the other by Dr. W. J. Moll, lecturer on physics at the University of Utrecht, new forms of thermoelectric pyrheliometers have recently been constructed. To this group of recent instruments, based on the use of the new American thermopile, belongs the excellent thermoelectric pyrheliometer constructed at Washington by Prof. H. H. Kimball and Mr. H. E. Hobbs. On the other hand, on the basis of Doctor Moll's thermopile, a new form of thermoelectric recording pyrheliometer has recently been constructed in Europe and was used during my recent actinometric campaign in the Sahara Desert. I give below a short description of this recording pyrheliometer, which is free from zero error, quick in action, very rugged in construction, and easily worked.

It seems that in the future only the simple thermoelectric method will be in current use, with the restriction, of course, that for control purposes special standard instruments (as for instance the water-flow pyrheliometer of Doctor Abbot) must always be recommended in view of the necessity of controlling and comparing solar radiation measurements.