An Electronic Actinometer for measurements in narrow spectral ranges

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ABSTRACT. This paper describes the use of capacitance bolometers for special measurements of the direct solar radiation. Electronic and optical design factors are outlined, followed by constructional and operational details. Indicating methods for capacitance bolometers are discussed with particular reference to this electronic actinometer.

1. Introduction

Measurements of solar radiation in specified spectral bands are of considerable importance, particularly for the determination of atmospheric water vapour by actinometric means. The use of ordinary actinometers is often unsatisfactory, because their radiation-sensitive elements consist of resistance bolometers or thermo-piles; both are not sufficiently sensitive if connected to normal indicators, e.g., pointer-type galvanometers. On the other hand, large sensitivity is required because of the small radiation intensities available in narrow spectral bands.

Adequate sensitivity may of course be obtained if a mirror-galvanometer, of portable or laboratory type, is used in conjunction with an ordinary actinometer. However, such indicators lack operational convenience under daylight conditions and are absolutely useless wherever physical vibrations are encountered (e.g., measurements in aircraft).

The only possible solution appears to be the use of the capacitance bolometer which was developed by the author sometime ago (Albrecht 1955). This bolometer's principle is based upon the temperature coefficient of the dielectric of ceramic condensers, and their measurement by means of a super-imposition of two frequencies, one being governed by an unexposed temperaturesensitive capacitor and the other by an identical element being exposed to the radiation to be measured. If both frequencies are selected and adjusted as suggested in the author's previous publication on this subject, the capacitance bolometer can be used for convenient measurements of all possible types of heat radiation, because the resultant frequency is automatically compensated for effects of the ambient temperature and thus gives an accurate and reliable indication of the actual radiation intensity.

2. Electronic Design

Fundamentally, the design of capacitance bolometers is based upon the selection of operating frequencies for both, the temperature-compensating and the radiation-sensitive oscillator. This is governed by the distance within which the readings are to be taken. In the case of actinometers, the indicator should either be housed in the cabinet of the actual actinometer, or be in a separate unit situated close to the actinometer for convenient operation by one observer. Thus the distance is extremely small and a low radio-frequency can be utilized.

To illustrate the importance of the above considerations, it may be mentioned that the author has designed and manufactured tele-apparatus, e.g., tele-pyranometers, with distances of more than thousand miles between the positions of detector and indicator (Albrecht 1955). In such cases, the resultant frequency has to be chosen with regard to the ionospheric propagation at the times of