3. *Fifth Report of the Committee for considering the best methods of recording the direct Intensity of Solar Radiation.*—See Reports, p. 40.

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4. *On the Black Bulb Thermometer in Vacuo.*

By Professor HERBERT M'LEOD, *F.R.S.*

This instrument, which is generally employed for measuring solar radiation, does not appear to give universal satisfaction, for it is said that no two instruments give the same result when placed side by side. No doubt the imperfection of the vacuum may account for this in a great measure, but besides this there appear to be other causes.

When such an instrument is exposed to the rays of the sun a large proportion of the radiation passes through the enclosing case, and also traverses the opposite side of the globe. Some, however, is absorbed by the blackened thermometer bulb, and this then begins to radiate heat of low refrangibility which is incapable of passing through the enclosing case; as a consequence the latter becomes heated, so that the thermometer bulb is in a warmer enclosure than at first. The quantity of heat thus radiated will be diminished the smaller the bulb of the thermometer, and some years ago I suggested to Mr. Hicks to make a thermometer with a very small bulb. Such a one was made, and I am informed that it gave readings ten degrees *higher* than any other instrument. As this was exactly opposite to my expectation, perhaps I may be excused for not attempting any explanation. Some months ago I ordered two instruments with very small bulbs, one to be in a thick case and the other in a thin one. When the instruments came I found that one of the cases, which appeared the thicker, was devitrified and rough, and produced a very marked shadow when held before a screen exposed to sunshine, so I was not surprised to find that this thermometer always indicated a slightly lower temperature than the one with the clear glass. It was returned to the maker, and I was then informed that the bulb was a thin one, and the devitrification was caused by blowing the bulb before the lamp. This, therefore, supported the theory that I had formed on the subject. These two thermometers were used from May 20 to June 6. The mean of the readings of the instrument in the thick case was 119·2° F., and the mean obtained by the instrument in the thin case was 116·8°. I then had one of the thermometers enclosed in a case of very thick glass. The thermometers were then tested with a thermopile, to determine the quantity of radiant heat that would pass through the enclosing cases. The source of heat was an albo-carbon flame, and the cases of the thermometers were interposed in succession between the flame and the cone of the thermopile.

Case of thermometer with large bulb transmitted about 26 per cent. of the radiant heat.

Thin case of thermometer with small bulb transmitted about 23 per cent. of the radiant heat.

Thick case of thermometer with small bulb transmitted $11\frac{1}{4}$ per cent. of the radiant heat.

These thermometers were exposed to the sun's rays for the first 27 days of August, and the means of the readings are as follow:—

Large bulb instrument	125·7° F.
Small bulb with thin case	119·9 „
Small bulb with thick case	118·3 „

Although the case of the instrument with the large bulb allowed a larger percentage of the rays from a low temperature source to pass through, yet the amount of heat radiated from the large bulb was so great that the case was warmed sufficiently to cause the instrument to read, on the average, nearly 6° F. higher than the small bulb instrument. It should be noted, however, that the small bulbs are not so dead black as the large bulb, which is coated with lampblack, the small bulbs being made of black glass.

According to the theory enunciated above, the thermometer with the thick

case should have read higher than the one with the thin case; it, however, gave readings 1·6° F. lower. But it must be remembered that the thick case transmitted less than half as much of the radiation from the gas flame as passed through the thin case, so it must have stopped more of the radiation from the sun than the thin case, and notwithstanding this the temperature registered is very little less than that indicated by the other instrument.

The small bulb instrument has another advantage over the large bulb one, inasmuch as it is much more sensitive, and so reaches the maximum more quickly than when a large bulb is used. This is shown by the readings on August 4, when there were only some occasional gleams of sunshine, the large bulb registering 98·2° F. and the small bulb 101·8° F.

It seems to follow from these experiments that the black bulb should be as small as possible, and very little of the stem blackened; and also that the case should be as thin as is consistent with strength.

A series of experiments should be carried out with instruments of different sizes and with cases of different thickness in order to set the matter at rest. Some investigations on this subject have been carried on at the Kew Observatory, but I believe they have been only partially published. An accident to our old instruments gave me the opportunity of having fresh ones constructed, and it seemed advisable to put the above results on record.

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5. *Fifth Report of the Committee for considering the best means of Comparing and Reducing Magnetic Observations.*—See Reports, p. 49.

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6. *On Atmospheric Electricity.* *By* Professor Leonhard Weber.

The continuous currents obtained on clear days by flying kites and balloons were investigated, and deductions as to the rate of variation of potential with elevation were made.

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7. *Electrification of Air by Combustion.*[1]
By Magnus Maclean, *M.A.*, *F.R.S.E.*, *and* Makita Goto.

This was a description of a large series of experiments on natural atmospheric electricity carried on, under the instructions of Sir W. Thomson, in several of the rooms of the University of Glasgow. Their purpose was to find a relation between the electrification of the air within a room, and the potential of the air in its neighbourhood outside; and also the causes which produce or change the electrification of air within an enclosed space.

An insulated water-dropper and a Thomson's quadrant electrometer were used in the usual manner, but the deflections were observed by a telescope instead of by lamp. It was found that an enclosed mass of air is electrified negatively by the burning of a paraffin lamp, of coal gas, of sulphur, of magnesium, and of several other substances. On the other hand, the burning of charcoal electrified a room positively.

An arrangement was also described by means of which the burning substance was joined metallically to one of the quadrants of the electrometer, and precautions being taken to guard against the effect of the surrounding air, it was found that the substances which electrified the air negatively became positively electrified themselves. Thus burning charcoal was found to give a deflection equivalent to three volts in the negative direction, the other terminal of the electrometer being joined to the case of the instrument and to earth.

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[1] *lectrician*, September 20, 1889.