

## Note on a Modification of Bunsen's Calorimeter

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2. In some capillary tubes the liquid is not depressed, but disappears at the level of the liquid in which they are immersed on first heating. Once heated, long contact between liquid and tube is necessary to prevent the formation of the depression on again heating. For two tubes which were examined, this time was in each case about 20 hours; a shorter period merely sufficed to *diminish* the depression. The depression is the result of an action between the liquid and the inner glass surface of the capillary tube.

3. Indications that surfaces exercise a slight action in determining the position at which the liquid condenses in the external tube have been observed.

4. By reflecting a bright line of light from the apparently convex and well-defined surface of ether in a tube of 20 millims. diameter at a temperature near the critical, it may be inferred to remain concave until it loses the power of reflecting when it is plane. The apparent convexity is the result of refraction, or, perhaps, of an action resembling mirage.

5. The black ill-defined band which immediately succeeds the disappearance of the liquid surface is the result of too rapid heating, and possibly due to the mixing of liquid and vapour when they are of nearly equal density. When very slowly heated, as described, the defined concave surface is gradually obliterated, and is last seen as a fine and often waving line. Under this condition also the volume of the liquid at its disappearance is greater than when it is rapidly heated. When the liquid is vaporized by rapid heating, it has a higher temperature and larger volume at the time of disappearance than it has when first condensed by cooling; slowly heated and cooled, these volumes and temperatures are more nearly the same.

Royal Indian Engineering College,  
June 1880.

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## X. *Note on a Modification of Bunsen's Calorimeter.*

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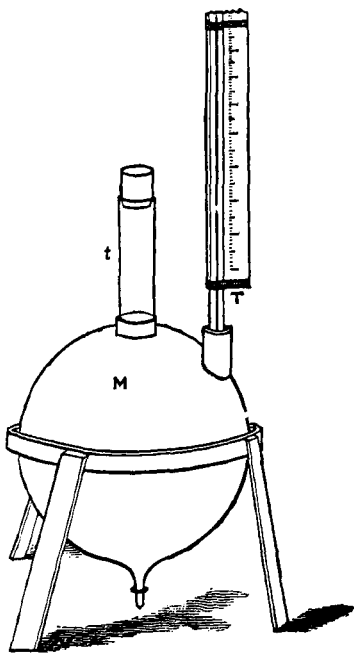
PROFESSOR STEWART described to the Manchester Literary

\* Read June 26.

and Philosophical Society, on March 4, 1879, a calorimeter devised with the purpose of obtaining the specific heat of a substance of small quantity with much readiness. It consists of a combination of part of Bunsen's arrangement with that of Favre and Silbermann. In it advantage is taken of the method employed by Bunsen—namely, that of dropping a small body, whose temperature does not differ much from that of the atmosphere, into ice-cold water contained in a small tube. In Bunsen's instrument the heat so given up by the body experimented with is measured by the change of volume produced by the melting of ice surrounding the tube. There being certain practical difficulties in the use of this method, it was thought that if the tube were surrounded by a large mass of mercury, forming the bulb of a delicate thermometer, after the manner of Favre and Silbermann, then the direct expansion of the mercury would indicate the amount of heat brought into the tube by the body, this mercury being in its turn surrounded by melting ice not in contact with it. The instrument figured was made by Casella. T is the graduated tube of a glass thermometer whose large bulb is encased in the copper chamber M, there being only a small air space between the two. In the centre of this large bulb a test-tube *t*, provided with a cork, is tightly inserted, so that its lower portion is completely surrounded by the mercury in the bulb.

Prof. Stewart intrusted the calorimeter to us, in order that we might determine its working conditions and ascertain how far it was reliable.

The following was the way in which the apparatus was tested. The test-tube was first filled with water to the level of the mercury inside the



bulb. The instrument being placed in its wooden case, the latter was then filled with pounded ice and then allowed to cool down until the column of mercury in the stem of the thermometer T was apparently stationary between two observations taken at an interval of about fifteen minutes.

After preliminary trials with various quantities of mercury dropped into the test-tube, it was found absolutely necessary to make some allowance for the loss of heat from the surface of the mercurial thermometer by radiation and convection; for although the rise produced by dropping in was almost immediate, yet during a comparatively long period of apparent maximum that followed, the heat received must have been equivalent to the heat lost by radiation and convection. (This prolonged stationary period, it was always observed, was followed by a comparatively rapid fall.) A curve of cooling, extending from  $0^{\circ}\cdot3$  to  $0^{\circ}\cdot0$  C., was accordingly obtained, with times as abscissæ and temperatures as ordinates. By aid of this curve the loss of heat was allowed for by a simple method of compensation.

Brass and mercury were selected for comparison. The results, after applying the correction above indicated, for 2 and 6 grams of mercury and 2 grams of brass are given below:—

2	grams mercury	at $15^{\circ}\cdot8$ C.	Corrected rise	15·6
2	„ brass	at $15^{\circ}\cdot9$ C.	„ „	46·0
6	„ mercury	at $15^{\circ}\cdot25$ C.	„ „	48·5

An inspection of these results, knowing that the specific heat of brass is about three times that of mercury, will show that the principle of the instrument is experimentally verified. The bore of the thermometer-tube being, unfortunately, large, necessitated a small rise; greater accuracy hence could not be expected. It is hoped shortly, however, to make further experiments with a new instrument having a much smaller bore, and with other needed improvements that could not in a first instrument be foreseen as wanting.