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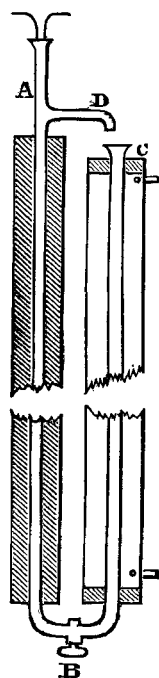
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III. *A Continuous Heat and Electrical-Current Measuring-Instrument.* By FREDERICK J. SMITH, M.A., *Millard Lecturer, Trinity College, Oxford, and Lecturer in the University in Experimental Mechanics and Physics\**.

WHEN a quantity of heat given to a known mass of liquid causes it to rise through a certain number of degrees of temperature, this quantity of heat can be determined ; but if heat be continuously applied, then the liquid would reach a temperature quite inconvenient for experimental purposes.

By means of the following device, which the author thinks might be perhaps of interest to those who may be working in the same direction, heat may be imparted to a mass of liquid, while the quantity of heated liquid may be measured, cooled, and reheated continuously. In the figure is shown a section through the middle of the instrument.

A B C is a U-shaped tube furnished with a branch at D. The leg, C, is surrounded with a large tube, through which water at any required temperature may flow when required. The leg, A, is surrounded with cotton-wool or any good nonconductor of heat ; at B there is a stopcock. Either two parallel wires or a coil of wire extend through nearly the whole length of the leg A. The instrument is used thus :—The stopcock B is opened, and the U-tube is filled with mineral oil up to about 5 millim. from the top of C. An electrical current sent through the coil or wires causes the liquid in A to be heated, and therefore to increase in length. When it reaches the branch D it runs over and drops into the leg C, which is always at a lower level than D, owing to its being at a lower temperature, and consequently having a greater density than the liquid in the leg A. The number of drops in a given time, under certain circumstances, becomes an index of the heat given to the liquid in A, and therefore of the current by which the heat is produced.



\* Communicated by the Author.

The author finds that, by making the leg A about 2 metres long, abundant length can be obtained between D and C to place a small fluid meter, by which means the weight of liquid which passes from D to C can be accurately measured. The instrument works either with a continuous or alternating current. The stopcock B is used to contract the cross section of the U-tube ; without some check a violent oscillation is set up between the two columns of liquid.

The first experimental instrument constructed by the author consisted of a continuous rectangular-shaped tube, one part of which was heated while the rest of the tube was kept cool. The liquid circulated, and its rate of circulation, when properly interpreted, would have been a measure of what was required ; but it was given up, as it appeared nearly impossible to cause the current of liquid to mechanically record its rate of flow with any amount of accuracy.

Several rather interesting results, which at present are not complete for publication, have cropt out of experiments made with the instrument. Of these, perhaps, the most promising was an illustration of the conversion of work into heat. The meter devised for determining the flow is one by which the weight of the oil is indicated, not the volume.

IV. *The General Solution of Maxwell's Electromagnetic Equations in a Homogeneous Isotropic Medium, especially in regard to the Derivation of special Solutions, and the Formulæ for Plane Waves.* By OLIVER HEAVISIDE\*.

1. **EQUATIONS of the Field.**—Although, from the difficulty of applying them to practical problems, general solutions frequently possess little practical value, yet they may be of sufficient importance to render their investigation desirable, and their applications examined as far as may be practicable. The first question here to be answered is this. Given the state of the whole electromagnetic field at a certain moment, in a homogeneous isotropic conducting dielectric medium, to deduce the state at any later time, arising from the initial state alone, without impressed forces.

The equations of the field are, if  $p$  stand for  $d/dt$ ,

$$\text{curl } \mathbf{H} = (4\pi k + cp) \mathbf{E}, \quad . \quad . \quad . \quad . \quad (1)$$

$$-\text{curl } \mathbf{E} = (4\pi g + \mu p) \mathbf{H}; \quad . \quad . \quad . \quad . \quad (2)$$

the first being Maxwell's well-known equation defining electric

\* Communicated by the Author.