XLIX. A SIMPLE ELECTRIC THERMOREGULATOR.

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From the Science Museum, S.W. 7.

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A CONVENIENT, self-contained electric thermostat that will run with a minimum of attention for periods of three months or more has been described previously [Bradford, 1922, 1923]. The apparatus is now obtainable from Messrs Gallenkamp for the moderate sum of ten guineas, and needs merely to be connected to the continuous, or alternate current, supply to be ready for use. The high resistance magnetic cut-out for the heating circuit has unfoulable carbon contacts, and works with a feeble current tapped from the main circuit. During three years' work with several instruments of this type, a variety of thermoregulators has been tried. The ordinary spiral type of toluene regulator is cumbersome and not easy to change from one temperature to another. Perhaps the simplest regulator on the market is a metal one with platinum contacts obtainable from Messrs Gallenkamp. If a drop of heavy oil be placed on the contacts, and the depth of immersion kept constant, this regulator is capable of maintaining the temperature within one-hundredth of a degree for periods extending to six hours. Unfortunately, the apparatus proved subject to variations, due to changes in the humidity of the air or intensity of the current, causing temperature fluctuations of alarming magnitude.

It was, however, interesting to note that the great accuracy during short periods, of which this regulator was capable, was attained by movements of the contacts amounting to only 0.2 mm. per degree. This suggested that the comparatively enormous expansion, provided in thermoregulators with toluene or calcium chloride solution, is altogether unnecessary for electric apparatus, though it may be needed for gas regulation.

When the expansion was reduced to about 0.5 mm. per degree, by dispensing with the toluene, the total movement of the mercury thread in expanding from room temperature to the wished-for temperature was only a few centimetres, and it became possible to use a graduated wire-contact, which could be set instantly at any point desired.

The figure shows a suitable form of such a thermoregulator, two-thirds natural size. Mercury only is contained in the wider portion of the U-tube, which is made of thin-walled glass tubing about 0.6 cm. diameter internally. The closed end

of this tube carries a short piece of platinum wire to form one terminal. One connecting wire from the high resistance magnets of the relay is inserted through the separate capillary tube shown above and makes contact with the platinum wire through a drop of mercury contained in the short piece of rubber tube that serves to connect the capillary tube to the closed U-tube. The capillary tube must not be allowed to press against the end of the U-tube, or there is danger of cracking it. Instead of a rubber connection, the capillary tube may be made in one piece with the U-tube, and the platinum wire inserted through an internal seal.

The other end of the U-tube is joined to a capillary tube of from 1.0 to 1.1 mm. bore, which terminates in a cup, through which the mercury may be poured until it rises a few centimetres in the capillary tube. The other leading wire from the relay circuit is connected to the brass terminal carried by the rubber cork that fits the cup. The adjustable contact is made from No. 22 s.w.g. nichrome wire to slide friction-tight through the screw of the terminal.

The contact has a needle-point at one end, and a knob of vulcanised fibre at the other. It is graduated in millimetres, from within 2 cm. of the point to 1 cm. of the knob, every fifth division being marked with red paint or otherwise suitably distinguished. The top of the screw of the terminal is bevelled to facilitate reading the divisions of the wire.

The apparatus is calibrated by observing the change of temperature of the thermostat corresponding to a somewhat large movement of the wire. The number of degrees corresponding to a division of the wire may vary from about 1.5 to 3.0, according to the dimensions of the apparatus. With the aid of a lens, the wire may then be adjusted instantly so that the thermostat will settle down within 0.05° of any temperature desired and vary no more than 0.01° .

Since a movement of only 4 cm. corresponds to a temperature change of 60° or more, the mercury need never sink below the capillary tube. The extreme simplicity and ease of adjustment make the instrument particularly suitable for the use of students, or when a series of observations needs to be made at stated temperature intervals. It has the advantage of taking up very little space in the thermostat. It may be laid flat without the mercury running out. If the mercury becomes dirty the apparatus may be cleaned in a few moments by raking out the foul mercury from the capillary tube with a wire and cleansing the tube with cotton moistened with alcohol, followed by dry cotton, and pouring in fresh mercury. One disadvantage only must be mentioned, and this is common to every thermoregulator depending on a mercury contact. The continual sparking at the make and break gradually causes the top of the

mercury in the capillary tube to become foul. The evil is reduced to a minimum if only a small current is used in the relay circuit, as in the thermostat already described. In this case the apparatus will run without fouling for from two to three weeks. If a longer run is necessary, a condenser may be connected across the spark gap, or, if a single temperature variation of about 0.05° is permissible, a fresh thermoregulator may be substituted. These are so easy to make that several may be kept ready for use. Further improvement may be sought in the possibility of increasing still more the sensitiveness of the relay. The thermoregulator can be obtained from Messrs Gallenkamp.

REFERENCES.

- Bradford (1922). *Biochem. J.* **16**, 49.
—— (1923). *School Sc. Rev.* No. 17, 26.