AN AUTOMATIC TEMPERATURE REGULATOR.

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DURING the past two years while conducting some experimental work it was necessary to maintain a piece of apparatus at constant temperatures for a day or more at a time. The range used was from room temperature to 380°C . The heating was by means of the electric current, the source of which was a 110-volt Edison dynamo. This current fluctuated under a varying load so that the heat from the coils was unsteady. Even if the current were steady some regulating device would be necessary if it were desired to keep the temperature constant for some time.

To this end an automatic regulator was devised. Two CuFe thermostats ab, ab' were clamped with their backs together as shown

Fig. 1.

in Fig. 1. MN , the main support, carried at its upper end an arm Ma from which at a the thermostat was suspended by pivots. The lower end of the arm ab' was fastened by pivoted connections directly to the support MN , thus leaving the lower end of ab free to

move in the plane of the paper, its motion being that due to both branches of the thermostat. This motion communicated by an aluminium rod xy to a system of pivoted aluminium levers mounted on a vertical board RS . The first lever had its fulcrum on a movable support at c which was capable of adjustment up and down by means of a thumb-screw at d . The motion of the lower end of this lever was communicated to another lever ef . This lever was mounted on a separate board rs , and both lever and board were pivoted concentrically at o to RS . The lower end of ef terminated in a platinum ring. Another lever supported on rs and pivoted at h was held lightly against a stop g by a delicate spring at k . The lever hg was flattened at its lower end and carried a platinum surface on which f played. All of the joints p were delicately pivoted needle points. The amount of motion at f could be varied through a considerable range by adjusting the length of the levers op and cp . Wires led from o and h to a relay which in turn operated an ordinary sounder that controlled a part of the heating current.

The heating coils were in two sections ; one to heat the oven to within 5 or 10 degrees of the temperature desired, and the other to furnish the heat that was needed to keep the temperature constant by means of the regulator. By swinging rs about o the two platinum contacts could be adjusted to correspond to any temperature.

The oven consisted of a sheet iron box lined both inside and out with $\frac{1}{4}$ -inch asbestos. To still further guard against radiation the oven was surrounded with an asbestos-lined wooden jacket, leaving an air-space of about two inches between the two. Windows of heavy plate glass were placed in the opposite walls of the oven and jacket. The thermostat was placed within the oven and about one inch from one of the walls. The rod xy extended through an opening in both walls, communicating the motion of the thermostat within to the system of levers without. Care was taken to have this opening as small as possible, yet to insure freedom of motion. The heating coils were placed at the bottom, and the bulb of the thermometer extended down to about the center of the oven. No attempt was made to screen the direct radiation from the coils. The windows enabled the coils to be seen and overheating was thus avoided.

Two curves were plotted. The first (Fig. 2) shows the variation of the temperature of the oven when the apparatus was adjusted

Fig. 2.

for 25, and the second (Fig. 3) when adjusted for 375 degrees centigrade. At the low temperature the first section of the heating coils was dispensed with, since the temperature was but a few degrees above that of the room. At first the variation in temperature was nearly $1\frac{1}{2}$ degrees, but in the course of fifteen or twenty minutes it reached a fairly steady condition, it being some less than .5 of a degree. By better adjustment, no doubt, a less variation could have been obtained. At the high temperature both sections

Fig. 3.

were used. The resulting curve is more broken (Fig. 3); it falls from a maximum in much less time than at the low temperature. Both curves are steeper while heating than while cooling, indicating that the regulating coil was too hot, *i. e.*, it took longer to cool through a given range of temperature than to heat through the same range. The regulation at the high temperature, after the lapse of some minutes, was within a half degree.

The essentials to success in this method of automatic temperature regulation are that the friction must be reduced to a minimum by using needle point bearings, and that the platinum contact be kept bright. An ordinary gravity cell with considerable resistance in the circuit will operate the relay.

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