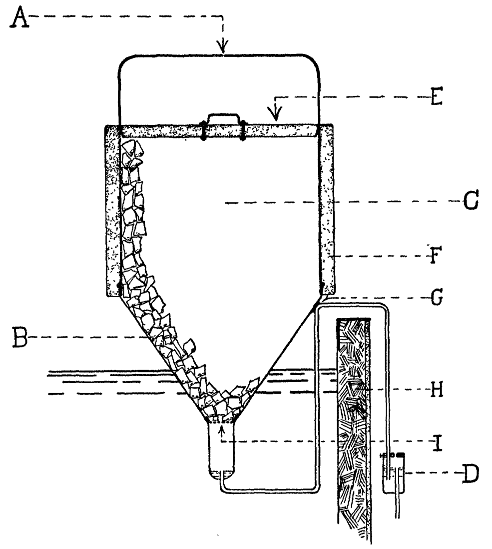

FIG. 1. *A*, cooling unit to be attached by its strap-iron handle to a system of pulleys or a heavy "ring stand"; *B*, copper funnel, 8 inches in diameter; *C*, hopper containing 20 pounds of cracked ice; *D*, constant level device, clamped to ¼-inch copper pipe which is soldered to the funnel at *G*; *E*, heavy linoleum lid; *F*, walls of hopper made of heavy linoleum; *H*, wall of thermostat, insulated by a layer of felt; *I*, removable brass sieve.

device, or by a suction line attached to a water aspirator.

By means of a pulley system and a counterweight the conical portion of the funnel is lowered into the water bath (or air thermostat) to different levels. A position is found, by trial, where the heat removed from the bath is roughly equal to the heat added from the air. Regulation of temperature within the body of the thermostat is obtained by setting the cooling unit so that it undercools the tank, constancy being maintained automatically by a large-capacity mercury thermoregulator actuating a relay-controlled bank of heating lamps (*cf.* Crozier and Stier, 1927, *ibid*).[2]

The following tests of this device were made in a well-insulated thermostat containing 10 gallons of water, adequately stirred by a motor-driven agitator. Fluctuations of temperature of the water were estimated to within 0.001° C. by a Beckmann thermometer.

Ice was not replaced more frequently than once every 1½ hours. The cooling unit could be made to function without attention for 12 hours if the storage space for ice were increased and if the ice were moved into the metal funnel at a uniform rate by a motor-driven agitator.

[2] A simple form of this device, involving regulation by manual control of the depth of immersion of the funnel, was made by the writer during 1929–30, in the Physiological Laboratory, Cambridge, England.

TABLE I

	Room temperature	Extreme variation of temperature within the thermostat	Constancy	Amount of ice used
	°C.	°C.	°C.	lbs.
Cu needle in thermo-regulator	16.1 to 19.6	5.946 to 5.914	± 0.016 for 5½ hrs.	10
	17.5 to 18.1	5.919 to 5.881	± 0.019 for 7½ hrs.	25
Nichrome needle in regulator	13.8 to 19.1	16.989 to 16.971	± 0.009 for 4½ hrs.	3
	16.6 to 20.3	4.007 to 3.993	± 0.007 for 4 hrs.	14

If a more sensitive system of thermoregulation were employed in conjunction with this cooling unit, one might obtain a constancy of temperature control even closer than ± 0.007° C.

T. J. B. STIER,
National Research Council Fellow
LABORATORY OF GENERAL PHYSIOLOGY,
HARVARD UNIVERSITY

A VACUUM TUBE METHOD OF TEMPERATURE CONTROL[1]

IT is customary to regulate the temperature in water baths used in biological and physical chemical work by arranging a competition between the cooling effect of water flowing through a copper coil, and the heating effect of the electric current passing through a submerged resistance unit. The flow of water is usually set at an arbitrary rate while the electric current is controlled by a platinum-mercury contact through an electromagnetic relay.

This relay system has been a source of considerable annoyance in the past owing to the pitting of the relay contacts and to the fouling of the mercury surface of the thermoregulator owing to the passage of relatively high currents, usually of the order of 0.1 ampere, which resulted in considerable temperature fluctuation. This was particularly objectionable in certain experiments on nerve metabolism where temperature fluctuations in over-night runs were sufficient to ruin a number of experiments. To eliminate this difficulty we have devised a vacuum tube relay which has proven so surprisingly superior in every respect to the electromagnetic relay that it was considered of sufficiently general interest to warrant brief description.

As stated, the chief objection to electromagnetic

[1] From the Department of Zoology, Washington University, St. Louis, Missouri.

relays is the relatively large current which passes across the contacts. This objection has been eliminated by the use of the new Thyratron regulator tube, type FG-27, made by the General Electric Company. This is a mercury vapor tube capable of controlling a peak current of five amperes by means of a grid in which a current of less than 0.1 milliampere may flow. Thus by inserting the toluol-mercury regulator in the grid circuit of the Thyratron unit the current passing across the mercury surface has been reduced over a thousand fold. The circuit is as shown in Fig. 1.

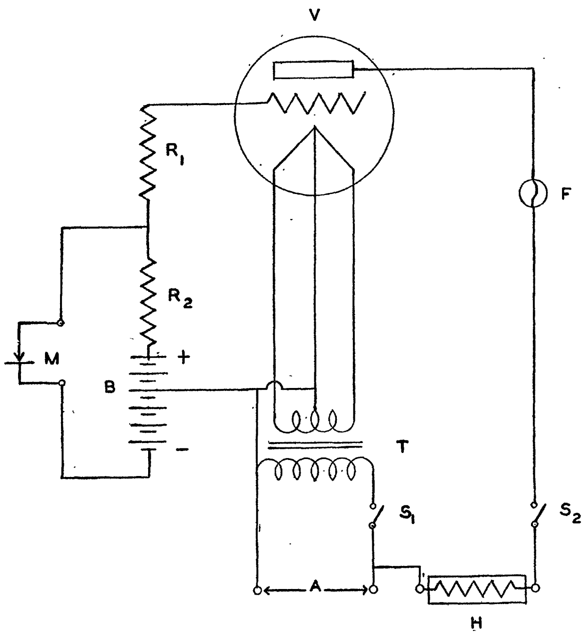

FIG. 1. *A,* 110-volt *alternating-current* source; *B,* two standard size 4½-volt "C" batteries; *M,* contacts of toluol-mercury thermoregulator; *F,* five-ampere, auto-type fuse; *H,* submerged heater resistance unit; R_1, one megohm cartridge resistor; R_2, 100,000 ohm cartridge resistor; S_1 and S_2, switches; *T,* five-volt, 25-watt center-tapped transformer; *V,* Thyratron tube, type FG-27.

It is recommended that resistance R_1 be at least one megohm to prevent the backing up of the plate current through the toluol thermoregulator. The value of R_2 should lie between 25,000 and 100,000 ohms; its purpose is to prevent the rapid discharge of the battery and the fouling of the mercury surface when the contact *M* is closed. The fuse *F* is inserted to project the Thyratron should the heater unit become grounded by water. The Thyratron is unique among thermionic tubes in that its filament is center tapped. The plate return must be made through this center tap to prevent the plate current adding itself to the filament current in one arm of the filament. The optimum position on the battery of the lead from the center tap varies from tube to tube but is usually about as represented. The filament switch S_1 *must* remain closed for at least five minutes before closing the switch S_2 in the plate circuit. Failure to observe this precaution may seriously decrease the useful life of the tube. Working at full load the efficiency of the entire unit is about 75 per cent.

In choosing a heater unit to be used in conjunction with the Thyratron relay one must bear in mind that only half of each cycle is utilized and that a 15-volt drop obtains across the tube. Hence, if 110 volts is being used, the value of the desired heater unit should be multiplied by a factor of about 2.3. Thus, if 200 watts must be dissipated, a unit of $200 \times 2.3 = 460$ watts rated capacity must be chosen.

Incidentally, we have found it very convenient to utilize the rectifying properties of the Thyratron to charge laboratory storage batteries. For this purpose it is only necessary to insert the batteries in the plate circuit in such a way that the battery cathode is connected to the plate. In this way as many as nine cells may be charged without interrupting experimentation, since the tube functions simultaneously as a relay and as a rectifier.

Our experience with the above described unit has been most gratifying. Using an ordinary large uninsulated metal water bath, temperature control to at least 0.005° C. has been maintained in experiments lasting over a period of days. For physical chemical experiments in which well insulated water baths are used, control to within 0.001° C. is easily realizable. Servicing of the unit consists solely in replacing the "C" batteries twice each year; the life of the Thyratron may be estimated to be at least a thousand hours of actual operation.

FRANCIS O. SCHMITT
OTTO H. A. SCHMITT
WASHINGTON UNIVERSITY,
ST. LOUIS, MISSOURI

SOCIETIES AND ACADEMIES

THE SPOKANE MEETING OF THE NORTHWEST SCIENTIFIC ASSOCIATION

THE seventh annual meeting of the Northwest Scientific Association was held at Spokane, Washington, in the Davenport Hotel on Monday and Tuesday, December 29 and 30, 1930. The meetings were presided over by the president, Francis A. Thomson, president of the State School of Mines, Butte, Montana.

At the opening general session, on December 29, an address was delivered by T. C. Spaulding, dean