One hesitates, however, to compare the heated crystals with a heat denatured protein because, despite many efforts, no denatured protein has been crystallized. And yet it can be shown that the heated, insoluble crystals are indeed crystals of denatured protein. The crystals, washed free of sodium sulfate by repeated centrifugation, readily dissolve in a pH 9.2 borate buffer. Crystals prepared from 0.3 ml of the serum albumin preparation mentioned above can be dissolved in 0.4 ml of a 0.1 M pH 9.2 borate buffer. If to this solution at 45° are added 5 ml of the sodium sulfate-acetate mixture used for crystallizing serum albumin, no crystals form. Instead all the protein immediately precipitates amorphously, and this precipitate does not dissolve when the salt solution is diluted with an equal volume of water. The albumin dissolved by placing crystals previously heated at 80° in the pH 9.2 borate buffer has the characteristic properties of a denatured protein. Denaturation is not caused by the pH 9.2 buffer, for if this buffer is added to native, unheated serum albumin, there is no difficulty in crystallizing the albumin and subsequently dissolving the crystals in water.

It is clear, then, that the heated crystals of serum albumin that are insoluble in water are crystals of denatured protein. Denaturation does not destroy the crystal pattern (although crystallographic analysis will probably show that it has been changed) but once the denatured albumin molecules are released from their confinement within the crystal by being dissolved in a pH 9.2 buffer it is impossible to replace them in the ordered pattern characteristic of a crystal of native protein. It is possible to obtain crystals of denatured protein by denaturing a protein while it is in the crystalline state, but it does not seem to be possible to crystallize a denatured protein.

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N^1-(β-AMINOETHYL)SULFANILAMIDE AND N^1-(β-DIETHYLAMINOETHYL) SULFANILAMIDE

THESE compounds were prepared from monoacetylethylenediamine[1] and β-diethylaminoethylamine,[2] respectively. The amine in an aqueous solution containing 1.5 molecular proportions of sodium bicarbonate was shaken for five hours (ten hours for the second compound) with a chloroform solution of 1.2 molecular proportions of acetylsulfanilyl chloride.[3] The insoluble material was separated by filtration (in the case of the second compound, after evaporating off most of the water and chloroform) and was hydrolyzed by boiling with 6 normal hydrochloric acid (8 cc per gram of the precipitate; in the case of the second compound, 4 cc per gram of the precipitate) under a reflux condenser for twelve hours. The compounds were isolated as the dihydrochlorides by evaporation of the solutions to dryness with a current of warm air and were purified by crystallization from ethyl alcohol-water mixtures (85 per cent. alcohol for the first compound; 95 per cent. for the second).

N^1-(β-Aminoethyl) sulfanilamide dihydrochloride. Yield (based on monoacetylethylenediamine): 90 per cent. Calculated for $C_8H_{15}O_2N_3SCl_2$: N, 14.58 per cent.; Cl, 24.61 per cent. Found: N, 14.37; Cl, 24.04. M.p. 217–220°[4].

N^1-(β-Diethylaminoethyl) sulfanilamide dihydrochloride. Yield (based on β-diethylaminoethylamine): 30 to 65 per cent. Calculated for $C_{12}H_{23}O_2N_3SCl_2$: N, 12.20 per cent.; Cl, 20.60 per cent. Found: N, 12.03; Cl, 20.59. M.p. 190–195°[4].

The synthesis of additional N^1-(β-dialkylaminoethyl) sulfanilamides is in progress. These compounds will be tested for chemotherapeutic activity.

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[1] Prepared by the method of Arthur J. Hill and Samuel R. Aspinall, *Jour. Am. Chem. Soc.*, 61: 822–5, 1939.

[2] Prepared as described by Lawrence H. Amundsen and Karl W. Krantz, *Jour. Am. Chem. Soc.*, 63: 305–7, 1941.

[3] Prepared by the method of S. Smiles and Jessie Stewart, "Organic Syntheses," collective vol. 1, edited by Henry Gilman, pp. 8–9. New York: John Wiley and Sons, 1932.

[4] Melting point ranges were somewhat indefinite. The compounds seemed to be undergoing decomposition, as gas appeared to be evolved.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ANOTHER CIRCUIT FOR TEMPERATURE CONTROLS

NUMEROUS articles have appeared in the literature recently describing circuits intended for use with thermostatic devices to control closely the temperature of ovens and chambers used for biological and chemical processes. Two of these have appeared within the last three months in SCIENCE.[1, 2]

Most of the circuits so far described require the use of one or more thermionic tubes to amplify the current passing through the control device. This greatly amplified current is caused to operate a commercial relay. The satisfactory use of these tubes often involves the use of transformers, condensers and numerous resistances. Occasionally it has been found that changes in atmospheric conditions alter the values of

[1] A. C. Hall and L. J. Heidt, SCIENCE, 92: 2380, 133, August 9, 1940 and SCIENCE, 92: 2400, 612, December 27, 1940.

[2] Charles Butt, SCIENCE, 92: 2389, 339, October 11, 1940.

grid leaks sufficiently to cause failure of operation. The use of improved high resistances now on the market may overcome this objection. It is obvious that a satisfactory arrangement which would operate a relay directly from the control device would greatly simplify the circuit and reduce the amount of equipment necessary.

The writer has had occasion within the past several years to accurately control temperature by using a mercurial thermometer into which platinum contact wires have been placed. When used with the ordinary relay and without an auxiliary circuit, the surface of the mercury is soon contaminated and separation of the column results. Thermionic tubes, as suggested by the papers to which reference has previously been made, eliminate this difficulty, but complicate the circuit and some technical supervision and maintenance are necessary.

A circuit has been developed which appears just as satisfactory and somewhat cheaper and easier to assemble. This circuit is shown in Fig. 1. The relay is

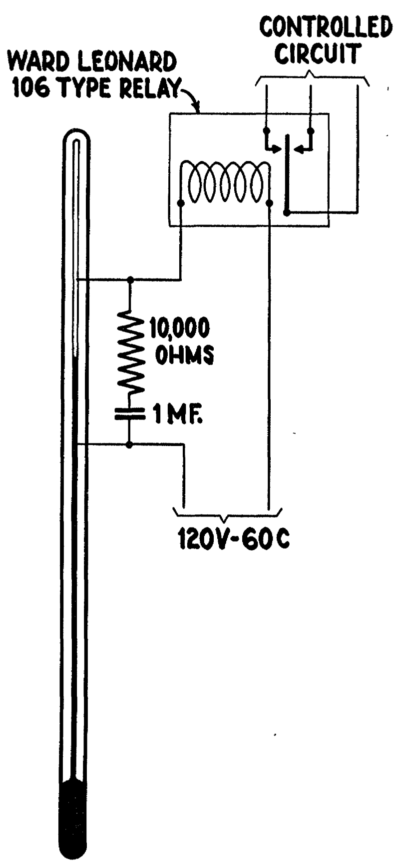

FIG. 1.

connected to the thermometer in the usual way, and in addition an auxiliary circuit, consisting of 10,000 ohms resistance in series with a one microfarad condenser, is placed across the terminals of the thermometer. This circuit absorbs the inductive energy stored in the magnetic field of the relay at the instant when the circuit is broken. The value of the constants given above applies only to the Ward-Leonard 106–662 type relay (120 volts), although many other relays would no doubt perform equally satisfactorily were the proper values for resistance and capacity determined. The type 106–662 was chosen for study because it is a double throw, double pole relay and thus is quite flexible.

The values of the resistance and the capacity are not critical, but should be held to within plus 5 per cent. The use of an electrolytic condenser is to be avoided. A telephone condenser manufactured by the Stromberg Carlson Company has been found most satisfactory. Suitable resistance may be purchased at any radio store for about ten cents. Observation of the mercury column at the time of make and break showed no spark in the thermometer tube, even though the tube was observed through a microscope and in a dark room. Sparking was very noticeable when the auxiliary circuit was not connected.

Attention is called to the fact that this circuit may be used only on 120 volts 60 cycles, A.C. Direct current might be used with a suitable relay, if sufficient capacity were installed, and in this case the resistance may be eliminated. Attempt has been made to find a suitable combination for use with 24 volts A.C., but thus far without success. It seems strange that it is possible to break 120 volts successfully and not be able to accomplish the same result on 24 volts, but it should be remembered that the 24-volt relay necessarily requires more current to operate than does a relay of higher voltage. The energy in the magnetic field is proportional to the square of the current. All visible sparks may be eliminated on the 120-volt break, but this condition has not been attained at the lower voltage.

Life of the thermometer depends on several factors and decreases rapidly as the size of the spark increases. The contamination mentioned above may be the result of amalgamation or chemical action of the mercury, or may be the result of a sputtering of the platinum. It is a well-known fact that mercury will amalgamate with platinum at temperatures of 200° C. and above. Any visible spark probably indicates a local temperature of 4,000° C. so that an actual melting and vaporization of a small amount of platinum is not without the realms of possibility. It may also be that the lead oxide in the glass reacts with either mercury or platinum at the elevated temperature of the arc.

Fortunately, it is not necessary to know the exact causes of the contamination in order to completely eliminate the difficulty. Thermometers properly made and used with the above circuit have a life far exceeding that of the relay. In fact, the writer has three thermometers which have made over 14,000,000 operations each, without failure, and continue to function perfectly. The original relays have been replaced. Much depends upon the proper design and construction of the thermometer.

The question often arises as to how accurately the temperature of a bath or oven may be controlled by an instrument of this type. Unfortunately, there is no simple answer. Too many factors must be considered, such as the time lag of the bath, its heat capacity and the manner of supplying energy. Suffice it to say, that for close control, lag of the bath should be as small as possible. Good thermal insulation is essential. Forced circulation is necessary; and finally, the energy should be supplied (or withdrawn) at as constant a rate as practical. "On" and "off" circuits are not desirable.

To illustrate, let it be assumed that a bath is to be held at 200° F. Assume that 200 watts is not sufficient to maintain this temperature, even when the environmental temperature is a maximum, and that 300 watts is more than enough to maintain the desired 200° F. temperature even when the external temperature is a minimum. The relay should control only the difference of 100 watts, 200 watts being supplied to the bath at all times.

A simple method of accomplishing this is to place a resistance of suitable size in series with the heating element, allowing 200 watts to pass to the bath at all times. The relay should be connected so that when the temperature of the bath is as high, or above the control temperature, the contact of the thermometer is closed and the resistance is in the circuit. When the bath is too cool and the contact through the thermometer is broken, the relay contacts short the resistance and energy supply to the bath is increased to the 300 watts. Such circuits are easily designed, particularly if a variable transformer such as the Variac, manufactured by the General Radio Company, is available.

The other factors mentioned are beyond the scope of this article.

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ANOTHER METHOD FOR RECORDING LOCALITIES FROM TOPOGRAPHICAL MAPS

THE method of indicating localities from topographical maps suggested by Clyde F. Reed[1] has certain disadvantages. Not only must one construct an elaborate grid in order to record the localities, but any one wishing to interpret the record must also construct a similar grid. Since topographical maps are now printed in two sizes, both the recorder and the interpreter must have two grids.

A much simpler method, and one which could be used on any map regardless of size or latitude, would be to use the lower left-hand corner of the map as origin, recording in centimeters the distances of the locality from the left-hand margin and the lower margin of the map. Decimals may be used if great accuracy is necessary. As an example, the summit of Taum Sauk Mountain, the highest point in Missouri, would be recorded as: "Edgehill (31.0, 12.4)." This method has the advantage of conforming with ordinary graphing methods.

If it is desired to cut the map in segments for convenience in the field it is only necessary to indicate on the margin of these segments the distances to the margin of the complete map and to add these to the measurements on the segment.

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[1] SCIENCE, 93: 68.

A CONVENIENT METHOD OF LABELING BOTTLES

IF labels are typewritten on ordinary paper and then applied on bottles under "Scotch cellulose transparent tape," they can be removed readily without soaking and placed on another bottle if desired. At the same time they are not affected by dilute acids, alkali, oil or organic solvents. The transparent tape should be larger than the label by about one quarter of an inch all around.

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BOOKS RECEIVED

Carnegie Institution of Washington Year Book No. 39, 1939–1940. Pp. xxxi + 326. The Institution, Washington.

RIDER, JOHN F. *Vacuum Tube Voltmeters.* Pp. xi + 179. Illustrated. Author, New York. $1.50.

RUHEMANN, M. *The Separation of Gases.* Pp. xiii + 283. 148 figures. Oxford University Press. $5.75.

SLAUGHTER, FRANK G. *That None Should Die.* (A medical novel.) Pp. 423. Doubleday, Doran. $2.75.

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