remains thus tilted until the motor is again activated, the circuit being broken by the insulated strip when the rack has returned to the horizontal position. By this means the culture material can be maintained in contact with the nutrient medium for any given period.

The size and form of the growing chamber, B, can be made to conform to the requirements of the material to be cultured. Entire plants, such as sunflowers, require a vessel 35 × 200 mm. in diameter, containing quartz sand to a depth of 170 mm. For the culture of small fragments of plant tissue the upper tube, G, can be dispensed with, and the fragments cultured in a tube 25 × 200 mm. Molds also can be cultured by this means, provided that the fluid medium level is so arranged as to ensure the maintenance of a layer of liquid between the mycelium and the sintered glass disc, which must be of sufficient fineness to prevent spores from being washed back into the nutrient medium reservoir. Optimum frequency of immersion must be determined separately for each type of tissue. In general, plant tissues grow most satisfactorily if their immersion is infrequent. One immersion of 5 minutes duration in a period of 24 hours was sufficient for sunflower stem tissue if supported on quartz sand. The nutrient medium can be changed as often as is desired by emptying vessel A with a sterile pipette and introducing fresh nutrient to level L.

A High-Capacity Sensitive Relay

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A high-capacity relay is often needed for the control of heating elements in constant-temperature cabinets and water baths that will operate on a minimum amount of current. The sensitivity of most thermostats is usually affected by the arcing at the contact points. Such a relay has been developed to reduce this arcing to a minimum.

By using a solenoid instead of an electromagnet it is possible to operate an arm bearing a mercury contact tube with a minimum amount of current. Mercury contact tubes are available with rated capacities of 5–35 amperes.

The assembled relay is diagramed in Fig. 1. The base for the relay was constructed from seasoned oak (K). The mounting for the solenoid was made from a brass plate (A). Four small holes were drilled in the base for roundheaded brass screws. The holes were made slightly larger than the screws in order to permit final adjustments in the position of the solenoid in relation to the arc described by the end of the arm. A hole ¼ inch in diameter, of the same size as the brass casing of the solenoid (B), was drilled in the center of the brass mounting plate, to which the solenoid casing was then soldered. The bearing support (F) for the mercury tube was made by cutting a rectangular brass bar into three pieces, two pieces 2 inches long for uprights and one 3 inches long for the base, and soldering them together to form a U.

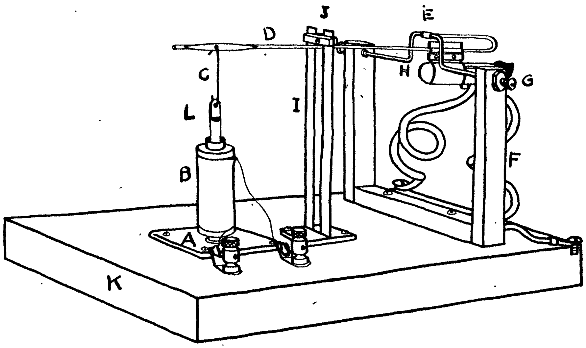

Fig. 1

It was necessary to make a wide support for the mercury tube to allow free movement of the connecting wire. Holes (G) ⅛ inch in diameter were drilled ½ inch from the top of the support and threaded with an 8–32 tap. Through these holes were screwed two ½-inch brass bolts (G), the ends of which were drilled to a depth of 1/16 inch to provide a bearing for the relay arm assembly. Each bearing was held in a fixed position by a hexagonal lock nut.

The arm (D) for the mercury tube was made from 12-gauge, galvanized-iron wire about 9 inches long and bent into the shape shown in the diagram. Both ends were flattened, one for drilling the hole for the link to suspend the soft-iron plunger and the other end to solder to E. A second piece of 12-gauge wire (E) was bent to form a U, 1 inch in width and height, with projections to be used as a shaft. The U wire was then soldered to the arm (D) 4 inches from the hole drilled for the iron plunger (L). The holder for the mercury tube was made from light-gauge tin plate. The mercury tube and holder (H) were then clamped to the arm by small machine bolts. This type of clamp provided a final adjustment of the instrument and made it possible to reverse the action of the tube for special requirements. The movement of the arm was controlled by means of an adjustable stop made of two small pieces of heavy brass (J) fastened with small machine bolts to two strips of brass (I) soldered to a brass base. The connecting link (C) for the soft-iron plunger was made from a piece of 16-gauge steel wire after assembly of the instrument. The soft-iron plunger was made from a piece of 6-gauge iron wire, this size allowing about 1/32 inch on all sides for free movement of the plunger. One end was flattened to drill the hole for the connecting link. Binding posts were then attached to the leads from the solenoid and the mercury tube.

In the heating circuit the tube was operated as a single-pole, single-throw switch. The current for the solenoid was supplied by an ordinary 6–8 volt a-c bell-ringing transformer. A 0.25-microfarad condenser was used across the terminals of mercury thermostats (not shown). The final adjustment of the stop (J) was made while the instrument was in operation. A 5/16-inch movement of the plunger would make and break the circuit, but to insure positive action of the mercury tube the stop was set for a ½-inch arc. The mercury contact tube used in the construction of the relay was a General Electric KON-NEC-TOR, 40KRI. Other types of mercury tubes would give the same results with the relay, but it would be necessary to change the length of the arm, depending on the tilting action.

This relay has been used with open and closed types of mercury thermostats with no failures. The relay may be used with direct current (4–7.5 volts), but it will be necessary to determine the direction of the lines of force through the solenoid before soldering to the base.

A Punched-Card Technique for Computing Means, Standard Deviations, and the Product-Moment Correlation Coefficient and for Listing Scattergrams

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Punched-card techniques are not familiar to the general scientific public. While laboratory workers are devoting hours to tedious calculations, machine facilities frequently have completed monthly routine reports and are lying idle in the accounting department. But with sketchy information at the level of this note the laboratory man should be able to speak the language of the punched-card specialist well enough to arrange basic computations and tabulations. Although the specialist will know punched cards and in all probability will be able to clear up at once any problems in planning the card, his knowledge is likely to be deficient in the special applications of cards to statistical studies.

The sorting and tabulating operations to obtain means, standard deviations, the product-moment coefficient, and the scattergram are detailed step by step below. Only two points must be grasped to understand these operations. The first is that, after two consecutive sortings of data, the individual groupings resulting from the second sort are in order according to the first sort. The second point is the theory underlying the method for computing sums of squares and sums of cross-products by progressive additions. Details can be found elsewhere (*1, 3*), but they can be reconstructed readily if one recalls that multiplication may be accomplished by adding the multiplicand as many times as the multiplier.

Machine Sorting and Tabulating Operations After Cards Are Punched

(1) Sort cards so that they are in order from largest to smallest according to one of the items (hereafter referred to as variable Y).

(2) With the cards in this order, next sort them so that they are in order from largest to smallest according to the second item (variable X). The cards are now in order with respect to both X and Y; that is, all cards with any given X digit are in order from large to small according to Y.

(3) Insert a blank card wherever any digit is missing in the X series in the range from the largest number in X through to zero. Then place the cards in the tabulator so that the card with the largest digit will go through first.

(4) Tabulate the following columns with a minor control on Y for a card count and intermediate control on X for sums:

X	Y	Card count	Sum of X	Sum of Y

(5) Tabulate the following progressive totals with an intermediate control on X, printing the following columns in this order:

X	Progressive card count	Progressive total of X	Progressive total of Y

(6) Remove the cards interpolated for missing X digits, sort a second time on variable Y, and insert blanks for any missing Y digits. Repeat step (5), but this time control on Y and print Y instead of X.

Subsequent Hand Computations

The following statistical data can then be computed. In step (4), N is the total card count, the tabulation being adjusted so as to omit blank cards; *mean* X is the final total *sum of* X divided by N; *mean* Y is the final total *sum of* Y divided by N; and a scattergram can be completed at once by copying from the several card counts to the corresponding spaces of the scattergram. In step (5) the sum of the *progressive totals of* X is the sum of squares for X, and the sum of the *progressive totals of* Y is the sum of the cross-