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Using wet and dry thermojunctions instead of wet and dry thermometers for measuring relative humidity is a rather obvious variation in experimental procedure. A. V. Hill (4) used thermopiles of fifty junctions for this kind of measurement but his sensitive elements were slow in response because of large thermal capacity and large thermal conduction between junctions. Lanning (2) and later Woodrow (3) successfully used single copper-constantan thermocouples for measuring relative humidity in restricted space. Baldes (1) and McCracken (7) have used thermocouples for measuring osmotic pressure by wetting one junction with the solution to be tested and placing the couple in a chamber where the aqueous vapor pressure was at equilibrium with a solution of known osmotic pressure.

To obtain moisture sorption isotherms for soils and other hygroscopic materials, it is desirable to be able to measure relative humidity with considerable precision in the neighborhood of saturation. The whole range of soil moisture contents permitting plant growth, i.e., from saturation to the wilting point, corresponds to a change in the relative humidity of only 1.18 per cent. This paper is a preliminary report of methods for making thermojunctions suitable for precise relative humidity measurements.

Among other methods, sputtering (3), electro evaporation in vacuo (2), and electro plating (5), have been used for obtaining thin metal conductors for thermocouples. Since an appartus for the evaporation of metals was available in the laboratory, this was the method first tried. Bismuth and antimony are well-suited for this method of deposition and single couples seem to give good sensitivity. Various arrangements have been tried for supporting and making electrical connection to the evaporated metal films. The following procedure appears to give satisfactory couples with a minimum of expense for time and materials.

Two lengths of No. 30 gauge or smaller enameled copper wire are twisted together and the ends are bent into the U-shaped form shown at Figure 1A. A thin freshly-cleaved plate of mica is then cemented across the sides of the U with bakelite lacquer as shown in the figure. The lacquer is also applied to the twisted part of the wires and, after drying for a few hours, is baked at 135°C for twenty minutes. The lacquer and enamel are then scraped off from the side of the lead wires opposite to the mica plate as indicated at B. Half of the plate is then covered with the two squares of

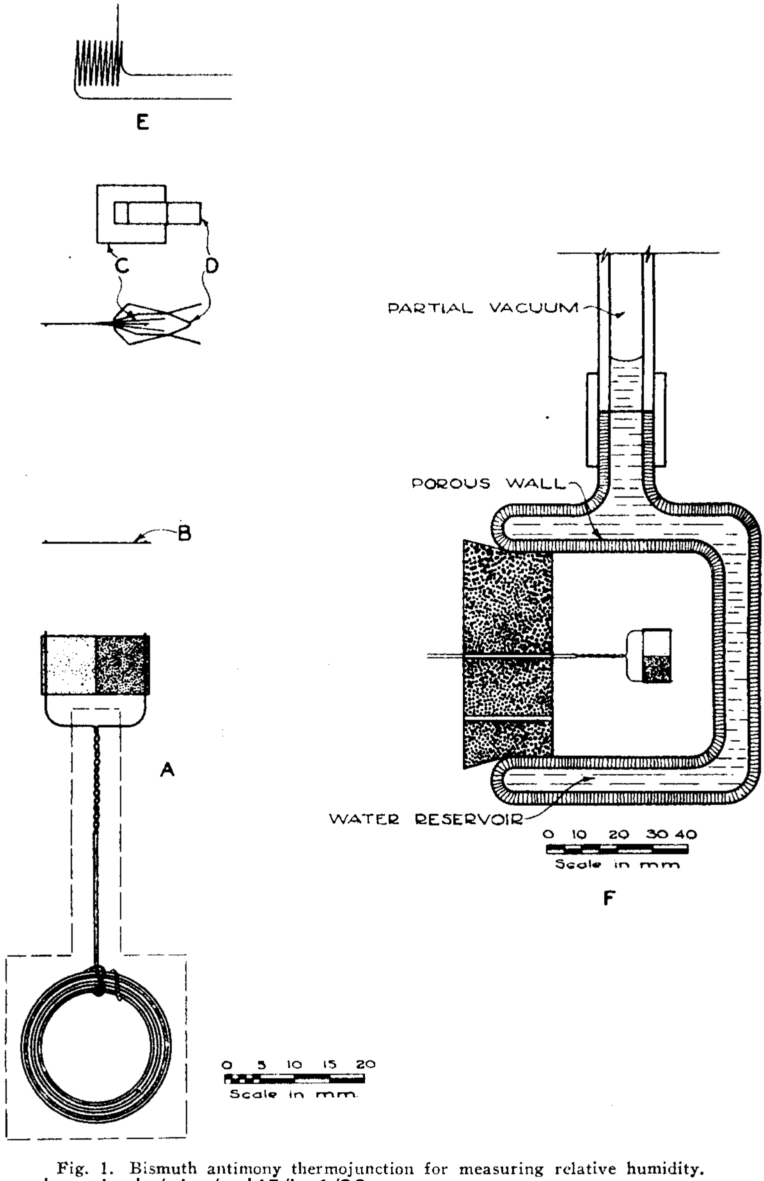

Fig. 1. Bismuth antimony thermojunction for measuring relative humidity.

mica C, which, for convenience, may be fastened to the spring clamp D with dekhotinsky cement. The remainder of the wires is then rolled up and covered with tin or aluminum foil as shown by the dotted lines for protection from the evaporated film. Half the plate is then coated with bismuth by the usual procedure (3). The metal to be evaporated was held in a closely wound helix of twenty mil tungsten which was slightly inclined to the horizontal and was closed at the lower end by a strip of mica as shown at Figure 1E. The thermojunction being formed was supported about 3.5 cm. in front of the filament.

After evaporating bismuth on one-half of the mica plate, the guard is transferred and antimony is deposited on the other half. A narrow overlap at center forms the bismuth-antimony junction which may be kept wet by a thin tissue or filter paper wick. The bakelite lacquer forms a continuous surface enabling the evaporated film to make good contact with the copper lead wire at the place where the insulation was removed. The resistance of the couple may be adjusted down to the desired value by repeated evaporation. Only a few minutes of evaporation was necessary to make a junction having a resistance of ten ohms.

Wet and dry thermojunctions for reading relative humidity may be calibrated by exposure in constant temperature chambers containing solutions having known vapor pressure. For calibration points in the neighborhood of saturation, it is possible to secure known vapor pressures and vapor pressure changes by physical means. The thermocouple is inserted in the inner chamber of a double walled ceramic pot, Figure 1, having an impermeable outer wall and a porous inner wall with an air entry value greater than one atmosphere. When the inter-wall cavity is filled with water, the inner porous wall quickly wets through and the inner chamber will begin to fill with water. If, however, the inter-wall reservoir of water is subjected to a partial vacuum pressure, all free water will be withdrawn from the thermocouple chamber which is maintained at atmospheric pressure. The curvature and hence the vapor pressure of the air-water interfaces or menisci in the porous wall exposed to the thermocouple will depend on the vacuum pressure maintained on the reservoir water. By this means, it is possible to vary the relative humidity from 100.00 to 99.927 at will.

With a thermojunction of the type shown in figure 1 and a Leeds and Northrup narrow coil galvanometer having a sensitivity of .045 u.v./mm., it was found that changing the relative humidity from 100.000 to 99.964 per cent gave a galvanometer deflection of

8.0 mm. at one meter. It thus appears that, with a single bismuth antimony junction, it may be possible to measure relative humidity near saturation with a precision of about one part in ten thousand.

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