

IMPROVED GLASS-PLATE HEATER FOR PAPER CHROMATOGRAPHY

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Heating usually is the final step necessary for detecting carbohydrates and related substances that have been separated on paper by a developing solvent and treated with a suitable reagent for producing colored spots. The heating step may be as critical as the two preceding for producing an informative chromatogram, and requires more precise control than often is achieved. The advisability of controlled temperature and length of heating seems to be implied because these conditions are always included in any complete description of each detecting reagent.

Only one¹ of a number of excellent books and reviews covering paper chromatography of carbohydrates discusses devices for heating chromatograms to develop colored spots. Among devices recommended are the infrared lamp and radiating electric space heater¹, hot plate², and "oven"². ALBON AND GROSS³ described a specially designed oven, with glass doors, that controls temperature precisely and uniformly. The glass-plate heater of FETZER AND OUGH⁴ also offers the advantage of visibility of the paper during heating as well as simplicity and compactness of construction. Since we found no commercially available device which offered any of these features, we modified the FETZER-OUGH heater to improve control and uniformity of temperature as well as to provide greater convenience and facility for handling damp sheets of fragile paper.

DETAILS OF CONSTRUCTION AND USE

The improved heater as constructed at the Northern Regional Laboratory is pictured in Fig. 1. The box, which has an overall dimension of $10\frac{1}{2} \times 20 \times 26$ in. is made of $\frac{1}{2}$ -in. asbestos board, reinforced at the corners with galvanized sheet steel, and is lined with aluminum foil. The bottom is insulated with a 2-in. sheet of fiber glass. At the top stainless-steel rails support the full-width window of heat-resistant glass

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and form the channel in which the stainless-steel frame for chromatograms slides. A door 7-in. high forms the front side of the box and drops down horizontally to permit maintenance. Above the door is an open slit $\frac{3}{4}$ -in. wide for inserting the stainless-steel frame on which the paper chromatogram is supported.

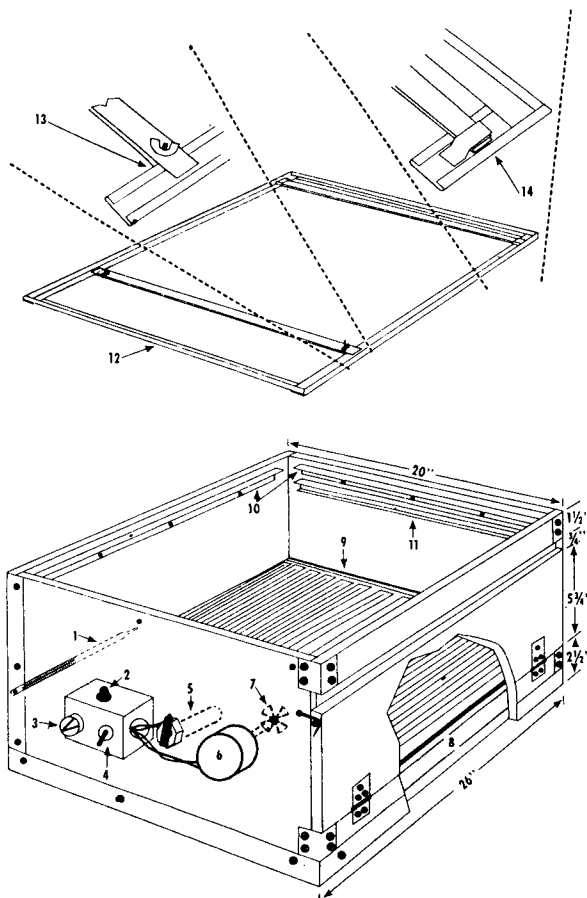


Fig. 1. Diagram of heater and frame for holding paper chromatograms. 1 = Thermometer. 2 = Fuse. 3 = Pilot light. 4 = Switch. 5 = Thermostat. 6 = Fan motor. 7 = Fan. 8 = Fiber glass insulation. 9 = Heater plate. 10 = Support for glass top. 11 = Track for frame. 12 = Frame for paper sheets or strips. 13 = Detail of adjustable support. 14 = Detail of stationary support.

The heating element is a Ra-Grid heater-plate*, Model K, $24 \times 12 \times 7/32$ in., for 115 V and 950 W. It rests on $\frac{1}{2}$ -in. fiber glass blocks and is controlled by a Fenwal Thermostat located about 3 in. above the plate. Any desired temperature up to 150° is readily obtained and maintained; the warm-up time is 15–20 min. A thermometer projects about 7 in. into the box at the left of the regulator and a small radio-tube cooling electric fan ($2\frac{1}{2}$ -in.-blade diameter) operated through a constant duty,

* A product of the Blue Ridge Glass Corporation, Kingsport, Tennessee. Trade names are given as part of the exact specifications, not as a recommendation or an endorsement of the products named over those of other manufacturers.

1/20 h.p. motor, projects into the box at the right of the regulator. When running, the fan reduces temperature lag in the box to about $\pm 2^\circ$.

The adjustable, stainless-steel frame (item 12 of Fig. 1) has overall dimensions of 62.8×48 cm. It is made of strips of light-weight stainless steel, with edges rolled to increase rigidity; the finished width is 2 cm. The crosspiece, shown at the left in the frame, usually is not removed from the frame but slides along the sides and is secured at any desired position by means of small wing nuts. The other crosspiece, shown at the right in the frame, is removable but occupies a fixed position. It is folded lengthwise through the center; a narrow opening extends lengthwise between the edges for inserting one end of the paper.

Any size paper strips or sheets may be used up to the maximum Whatman 46×57 -cm sheets. One end of the paper is inserted in the lengthwise opening in the stationary crosspiece and then rolled over the support before it is attached to the frame. The other end of the paper is secured by stainless-steel clips to the movable support, the position of which is then adjusted to make the paper taut before inserting the frame into the heated box. Since insertion and removal of the frame are accomplished quickly through a narrow slot, the temperature and heating time are uniform for all parts of the sheet.

The frame serves also as a convenient holder for the chromatogram while the developing solvent is being evaporated at room temperature in a fume hood. Last traces of solvents that would interfere with detecting reagents may be removed by

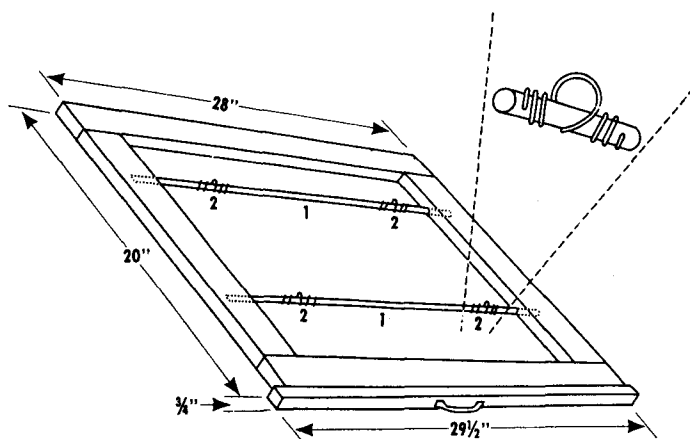


Fig. 2. Diagram of frame for heater fabricated with wood. 1 = Stainless-steel rod, $\frac{1}{4}$ -in. diameter
2 = Sliding fasteners.

placing the paper-filled frame briefly in the heater already slightly warmed. The paper can also be kept in the frame while the detecting reagent is being applied, as well as during washing and drying after color development.

When desired, humidity in the box can be increased by placing a narrow container of hot water between the heater plate and the front of the box.

Fumes from heating chromatograms may be removed by adaptation of a small vent and exhaust fan at the back of the box.

Alternatively, as constructed at the Clinton Corn Processing Company, the cabinet may be fabricated with wood from commercial 1-in. material; other features remained essentially the same, except the insulating liner of aluminum foil was omitted. In this case inside dimensions are 20×28 in. for breadth and length, respectively. The frame for holding sprayed chromatograms was made from $\frac{3}{4} \times 2$ in. wood strips (Fig. 2).

A diagram showing the construction and facilities for attaching sprayed chromatograms, 26×57 cm or smaller, also appears in Fig. 2. Two stainless-steels rods ($\frac{1}{4}$ in. diameter) are set flush with the lower face at the sides of the frame and centered about 27 cm apart. The sprayed chromatogram, clipped to glass rods, is held by sliding fasteners (Fig. 2) fashioned with copper wire (Brown and Sharpe gage No. 14).

DISCUSSION

This simple and easily constructed heater has met all our needs for bringing out color spots on chromatograms after treatment with reagents. In addition, it has several very advantageous features.

The main advantages result because the operator is able to heat the entire paper sheet uniformly while it remains clearly visible. This feature permits accurate control of heating time so that maximum contrast between spots and minimum background color is achieved. It also permits observation of the order of development of color which aids in differentiating closely related substances,^{2,5-8}. Transient colors may be observed before replacement by less distinctive final colors. It enables optimum length of heating to bring out the sensitive, differential colors produced by some of the most useful reagents⁹⁻¹¹ which aid greatly in distinguishing different types of sugars. Our observations are in agreement with those of others^{7,10,12} that overheating obliterates the differences in shade and color which are obtained from numerous reagents under optimum conditions.

Other advantages derive from excellent reproducibility of results and from ability to make valid comparisons on large sheets of paper for identification and for estimation or measurement of relative quantities.

Any temperature within the wide range necessary for carbohydrates can be obtained readily. Adaptation may be made for special requirements, such as increasing the humidity in the heating chamber¹³. Loss of time and of valuable materials through accident is precluded by the sureness and facility with which the fragile paper sheets are handled on the adjustable frame.

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SUMMARY

An easily made heater is described for bringing out colored spots on paper chromatograms after the detecting reagent has been applied. The device permits precise control of length and temperature of heating as well as heating the entire paper uniformly while it is clearly visible to the operator. The paper is supported on a versatile frame. Paper sheets or strips of different sizes can be accommodated.

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