producing a printed index to a body of documents on a monthly or quarterly schedule, closing the index at the end of the year with the printing of a cumulative index, and beginning a new index at the start of the next year. A schedule such as this, if feasible, keeps the index within manageable bounds and storage cabinets within reasonable limits. The unavailability of a storage cabinet with 8.5 × 11 in. or larger backings, however, is a disadvantage.

The new posting panel described in this paper has eliminated the serious disadvantages of the other two systems and offers the added advantage of using a card of dimensions suitable for a permanent card file, thus eliminating one typing operation. Acme and Chaindex cards are of no use after they have served the need for communicating a cumulative list.

We like the ease and speed of putting information into the Chaindex system. This advantage is realized in part with stock-size cards. Thus, in posting consecutive entries or several lines under a single heading, only one insertion of the card into the typewriter is required. We have posted up to 25 entries on an 8 × 5 inch card. In one file, we needed to use less than 700 8 × 5 inch cards for posting 4000 entries; the same file on Acme and Chaindex cards required 4000 cards, or one card per entry.

Assembling stock-size cards onto the new panel takes one-fourth to one-sixth the time of the Acme or Chaindex systems. Removing cards from the new panel takes less than one minute per panel, considerably less time than required for Acme or Chaindex cards which must be handled individually.

Stock-size cards may be stored on the panels or in stock cabinets. The new panel is one-half as thick as the Acme panel: a stack of 50 panels is approximately 6 in. high; the same number of Acme panels is approximately 12 in. high.

The major disadvantage is that the panel described in this paper is not commercially available and must be custom made. This shortcoming has not been particularly serious for us as we have had them made in our own and at a local sheet metal shop for between \$3.00 and \$4.00 per panel.

Graphic Symbols for Glass Systems*

By F. E. McKENNA
Information Center, Central Research Laboratories
Air Reduction Company, Incorporated, Murray Hill, New Jersey
Received March 8, 1962

Increased industrial use of glass components, in addition to the everyday use of glass in vacuum systems and laboratory apparatus, presents an ever-increasing need for standardized symbols to depict the components graphically.

The symbols for glass components which are proposed in this paper are compatible with the accepted symbols for the components of metal systems such as valves, elbows, *etc.* This consideration is important if it is necessary to depict equipment which may contain both glass and metal components.

Increasing uses for ceramics and cermets also can be accommodated by logical extensions of the proposed symbols.

Actual outline drawings for the individual glass parts of either laboratory or process installations are cumbersome, while much pertinent information is omitted when simplification is attempted by individual shorthand notations, such as the use of a cross with a circumscribed circle for a stopcock. Frequently, such makeshift symbols require additional extensive instructions, either oral or written, to the fabricator. For example, notations are necessary to indicate whether a stopcock is to be turned in the plane of the drawing or whether the cock is to be installed in a plane perpendicular to the plane of the paper. Additional notations also are required to define the type of cock: a solid or hollow plug, or an oblique or straight bore. A actual outline drawing of the components precludes a rapid freehand sketch by the designer,

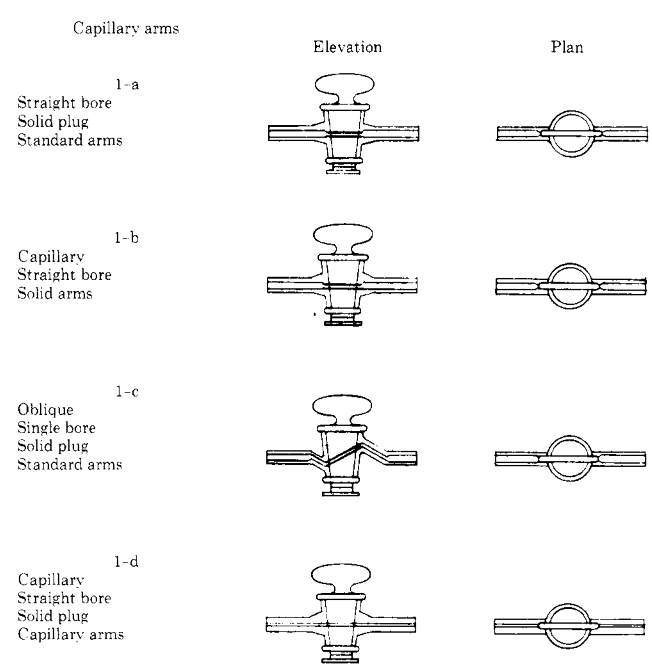

Fig. 1.–Conventional pictorial representation of stopcock types.

* Presented in part at the "Communication of Chemical Information Symposium," Division of Chemical Literature, American Chemical Society, Sept. 6, 1950, Chicago, Illinois.

is time-consuming for the draftsman, and may still be ambiguous for the fabricator.

Standardized and systematic symbols have been used for many years in other applications, for example, the components of electrical circuits, for construction materials, and for piping diagrams.[1,2] Apparently no attempt has been made by either the users or the fabricators of glass systems to employ uniform symbols, which can be sketched easily and which are also suggestive of the parts represented.

Stopcocks.—The type of bore in the plugs of different stopcocks cannot be differentiated in the plan views of the conventional drawings shown in Figs. 1a, 1b, and 1c. The figures illustrate three forms of straight-bore, solid-plug stopcocks. Fig. 1d shows a cock with capillary arms; here the capillary arms are apparent, but the construction of the plug itself is not defined from the plan view alone.

Symbols for seventeen kinds of stopcocks are in Fig. 2. Each symbol uniquely depicts the stopcock in both its plan and elevation views. Figs. 2a, 2b, 2c and 2d are the symbols for the same four kinds of cocks which are in the conventional drawings of Figs. 1a, 1b, 1c, and 1d, respectively.

The basic elements of the stopcock symbols are combinations of equilateral triangles, apex-to-apex. Elevation views are characterized by various *T* symbols to represent the handles of their plugs. The plan views are characterized by the addition of circular symbols.

A capillary bore in the plug is differentiated from larger bores by the use of a line through the cock symbol. If the stopcock has capillary arms, three parallel lines to indicate capillary tubing are added to the symbol for the stopcock (see Fig. 3 for the tubing symbols).

Symbols for oblique bore stopcocks are distinguished by a sloped line through the plug, while a double (or multiple) bore is depicted by two (or more) parallel lines through the plug.

Solid plugs are indicated by the addition of the simple *T*-symbols in the elevation views and by the open circles in the plan views. Hollow plug stopcocks are distinguished by the addition of an open rectangle to both views to suggest the hollow plug. As in the case of the solid plug stopcocks, a capillary bore is represented by a line through the body of the symbol.

Vacuum-type cocks are distinguished by shaded triangles in place of open triangles in the cock symbols. The angular nature of a right-angle vacuum-type stopcock is readily apparent from Figs. 2-l and 2-m. (Other angular components are developed in a similar manner in the depiction of tees and elbows in Fig. 4). Three triangular

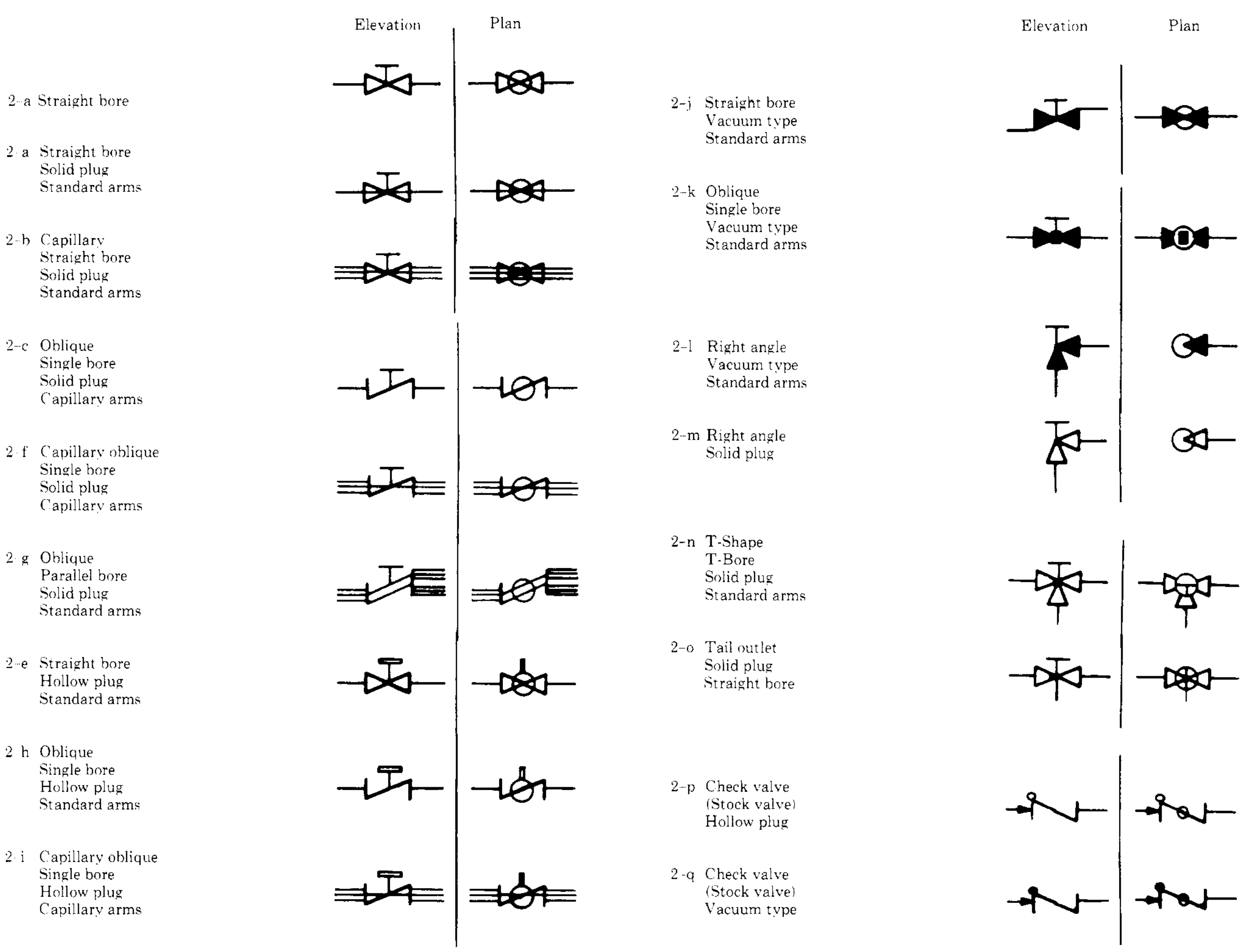

Fig. 2.—Graphic symbols for glass stopcocks.

members are used in the symbol for a T-bore stopcock (Fig. 2-n). If the stopcock has a tail-outlet rather than a true T-bore, the tail is represented by a straight line in place of the third triangle (Fig. 2-o). If the tail-outlet is a capillary, three parallel lines are used in place of the single line of Fig. 2-o.

The bore diameter for all stopcocks can be specified by placing the diameter in millimeters over the T of the symbol, which represents the handle of the cock.

Tubing.—Symbols for standard wall glass tubing, capillary bore tubing, solid glass cane, metal and rubber tubing are shown in Fig. 3. Often it is convenient to indicate a point where two glass tubes of either equal or different diameters are to be fused together. Such joints are indicated by the use of slanted lines at the junction point. If a glass tube is to be sealed by drawing out and rounding off, it can be distinguished from a plug of solid glass fused into a glass tube (as in the case of the closed end of the capillary of a McLeod gauge) by using the fusion symbol instead of the open cross.

When the type of glass used in a graded glass seal, or the metal of a glass-to-metal seal, is to be specified,

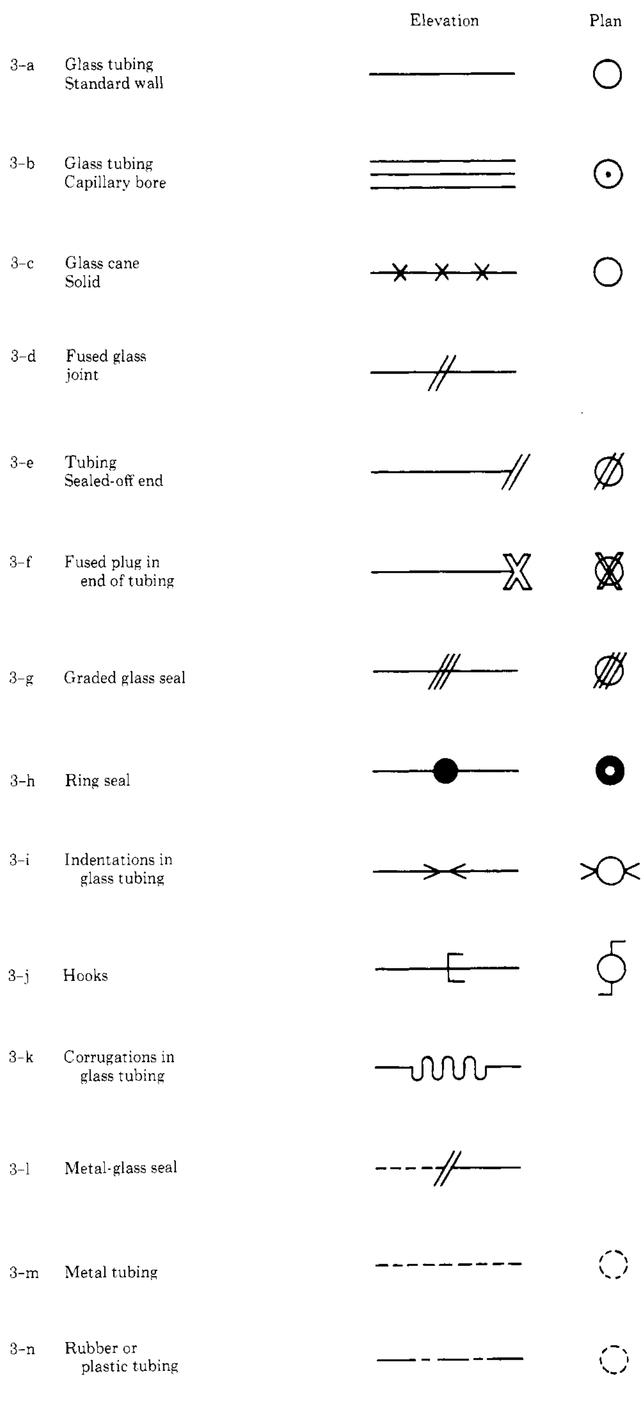

Fig. 3.—Graphic symbols for tubing.

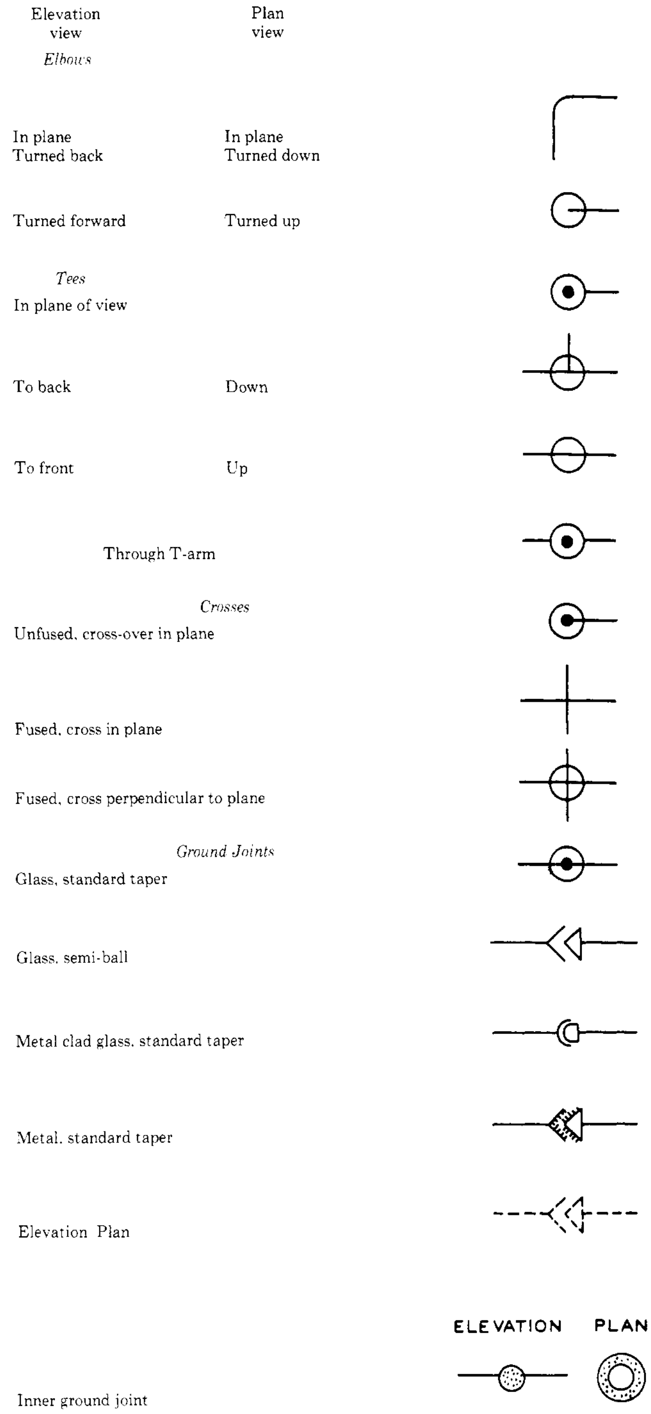

Fig. 4.—Elbows, tees, crosses and joints.

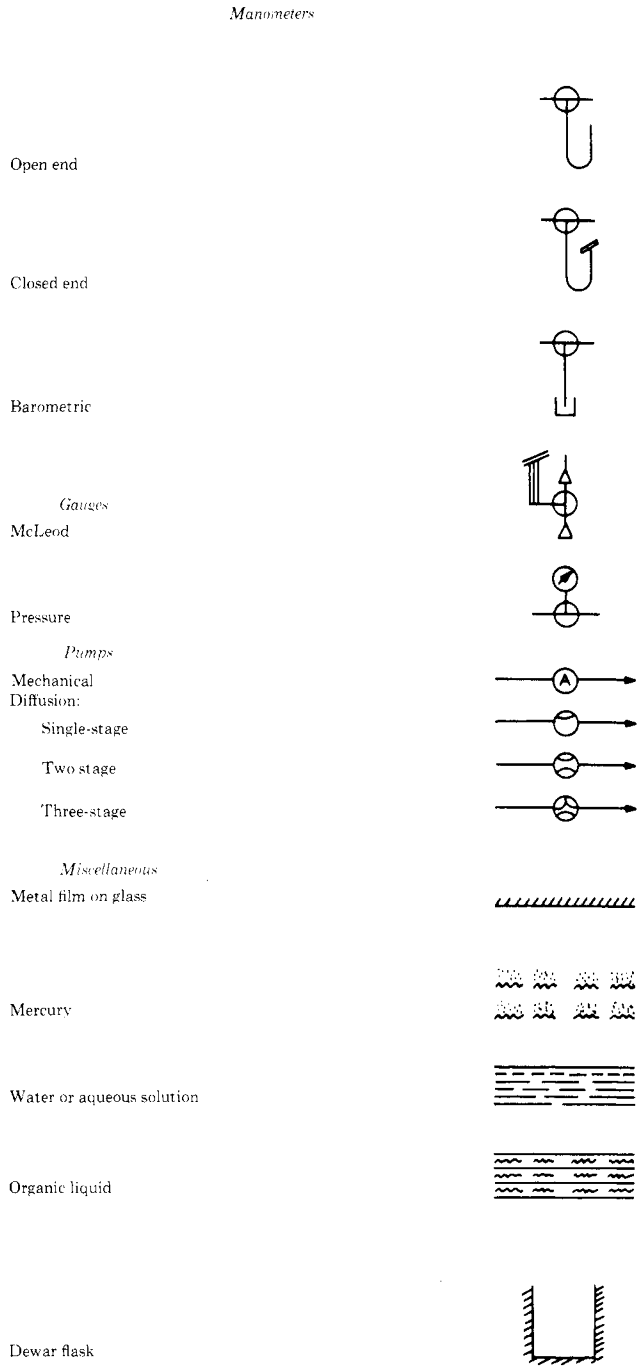

Fig. 5.—Manometers, gauges and pumps.

the number designating the type of glass can be added to the symbol, for example 774///172 or Cu///774. Similarly, if a change in tubing diameter occurs, it may be indicated as 10 mm. o.d./// 6 mm. o.d.

The use of metal components in conjunction with glass systems need not cause any confusion or ambiguity, since the metal components may be depicted by dotted lines instead of the solid lines used for the glass components.

Ring seals, indentations in the tubing or hooks on the tubing also are shown in Fig. 3.

Elbows, Tees and Crosses.—Ambiguity occurs when all the arms of elbows and tees are not in the plane of the paper; symbols for the possible views of elbows and tees in both plan and elevation views are in Fig. 4.

A source of particular annoyance when sketching glass systems is the representation of crosses. For example, it is difficult to distinguish between fused crosses and unjoined cross-overs, the arms of which are projected into the same plane. By encircling the cross of a fused joint this inherent ambiguity is eliminated.

Ground Joints.—Symbols for standard taper joints and semi-ball joints also are depicted in Fig. 4; these symbols can be adapted to glass, metal, or metal-clad glass joints. As in the case of stopcocks the tapers or sizes of these joints can be indicated next to their symbols. An inner ground joint such as is used for stirrers or thermometer wells is represented in Fig. 4. (Check valves are represented in Figs. 2-p and 2-q, where the arrow indicates the direction in which the inner member of the check valve is seated on the inner ground joint).

Manometers, Gauges, and Pumps.—Several manometers in Fig. 5 illustrate symbols mentioned earlier for fused tees and for closed ends of glass tubing. If it is necessary to define the liquid for manometer filling, gas burets, or levelling bulbs, the symbols of Fig. 5 may be added to indicate water, mercury, or an organic liquid. In many instances the use of a chemical symbol may be easier, but if a large area must be defined in the drawing, a definitive cross-hatching system becomes useful.

Mechanical pumps and diffusion pumps can be depicted as in Fig. 5; the arrow indicates the direction of gas flow. The substance being pumped is defined by a letter or chemical symbol within the pump symbol. Small arcs in the diffusion pump symbol define the number of stages in the pump.

Other components can be derived readily from the array of symbols presented. Thus, for example, the symbol for a metallic film on glass can be used to construct an illustration of a Dewar flask.

Composite Example.—An illustration from the literature[3] has been chosen as an example for the comparison of the apparatus as it appeared in print and as it would be depicted by the symbols suggested in this paper.

Fig. 6a includes all pertinent information in the drawing by the use of added notations. In simplified presentation of Fig. 6b, the vacuum-type stopcocks are immediately apparent without the use of added notes, and the standard taper and semi-ball joints are immediately distinguishable from one another (see p. 28).

Conclusions.—The symbols presented in this paper were useful in one laboratory, but they may not represent the ultimate form for general applications. However, this array of symbols can be a profitable starting point for the ultimate standardization of symbols for the components of glass systems.

BIBLIOGRAPHY

(1) American Standards Association, Z 32.2.3 (1949), and others.

(2) O. T. Zimmerman, and I. Lavine, "Scientific and Technical Abbreviations, Signs, and Symbols," Industrial Research Service, Dover, N. H., 1948.

(3) H.H. Sisler, J.D. Bush, and O.D. Accountius, *J. Am. Chem. Soc.* **70**, 3828 (1948).

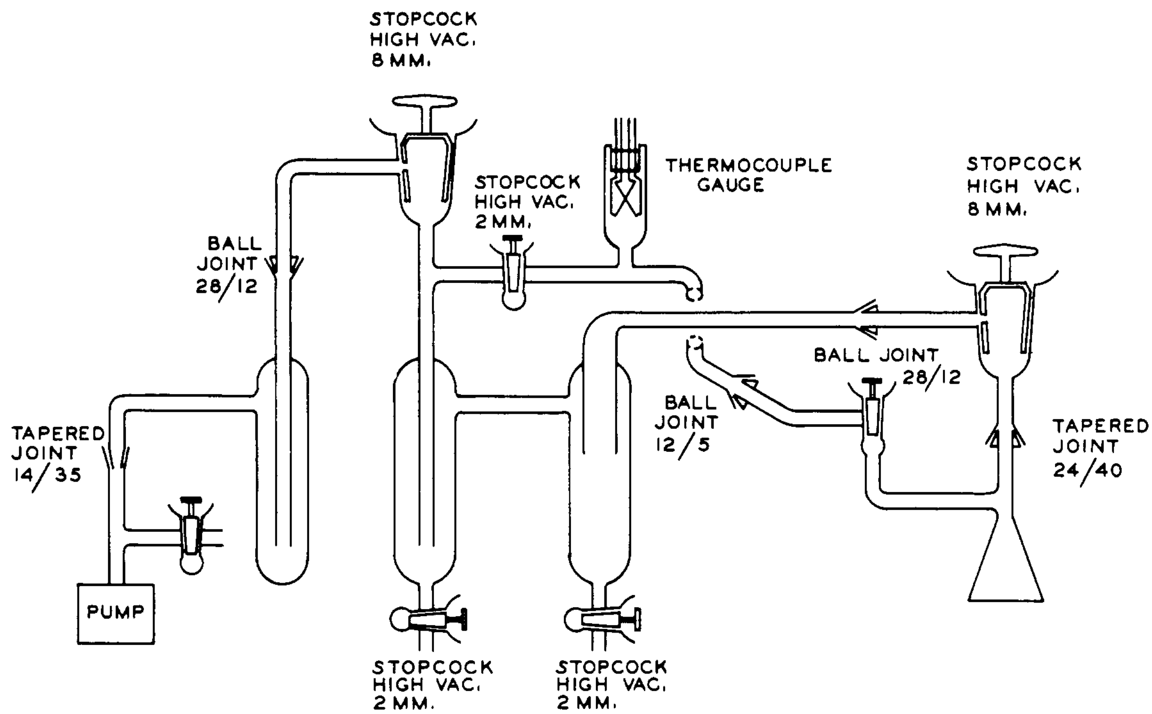

Fig. 6A.—Conventional representation.

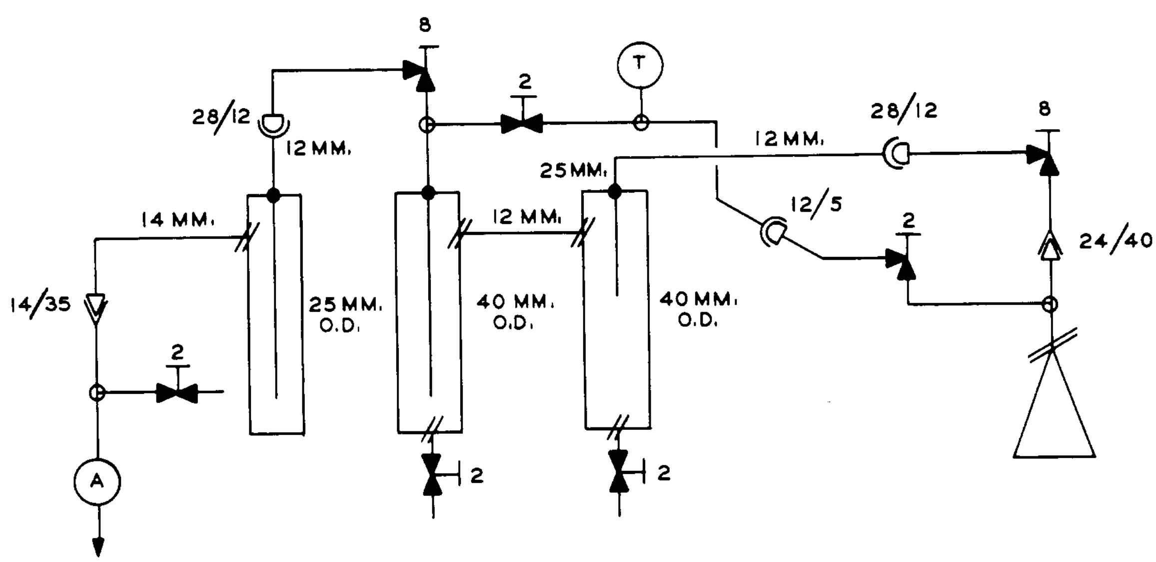

Fig. 6B.—Graphic representation with proposed symbols.