CHAPTER XIX.

A Transitional Elbow from Round to Elliptical.

Herein will be discussed methods to secure the patterns for an elbow as shown in a pictorial way in Fig. 73, i.e., a four pieced elbow from round to elliptical.

This problem is closely related to others previously ex-

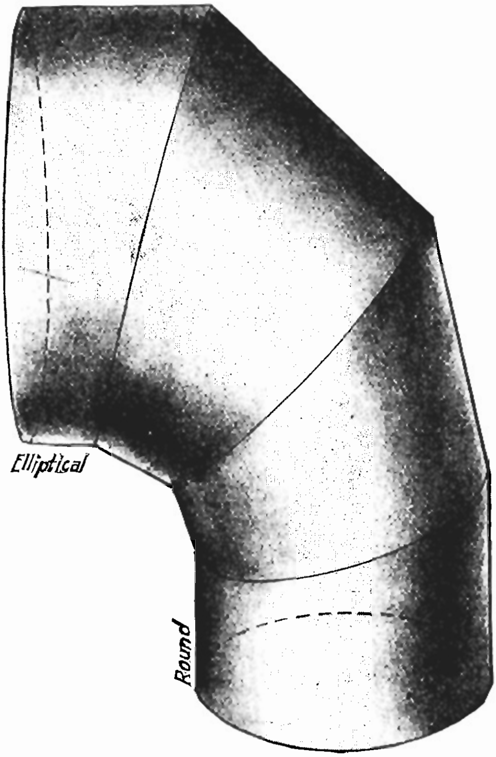

Fig. 73. Transitional Elbow from Round to Elliptical.

plained, although there are a few new features involved. The problem is not a difficult one beyond the fact that it is somewhat prolonged, since there are four separate and distinct patterns to produce.

It may be well to here explain that no doubt in practical work, the demand will be for an elbow made in five, six or seven pieces.

This work has been designed to illustrate and explain the principles involved. Therefore the illustrations have been reduced to as simple examples as are consistent with the problems in hand. The author's sole object being to enlighten rather than confuse.

Since the principles involved would be the same regardless of the number of pieces, he trusts that those principles may be best comprehended from the more simple examples. Moreover, if one succeeds in securing the patterns for an elbow of this class made in four pieces, he will have little difficulty in securing the patterns for the elbow made in a greater number of pieces.

In the following example, it has been presumed that the specification demands an elbow of 90 degrees to make connection between a 16-inch round pipe, and an elliptical pipe, whose major and minor diameters are 24 and 12 inches respectively. A scale has been appended in Fig. 74 to enable the reader to more readily follow the work by comparing measurements.

In a problem of this class, a complete plan of the elbow entails a considerable outlay of labor, and is unnecessary. Therefore it has been omitted. Beyond this, it has been presumed in this example that the axis of each piece is in one plane, or what is commonly known as "on center". Thus it is only necessary to draw one-half of each profile, as all semi-patterns may be duplicated for the other half.

As will be noted in Fig. 74, a semi-circle has been drawn as shown at *A*, the diameter of which is equal to the diameter of the round pipe, or 16 inches. At any convenient distance above the line *I L* draw a line as shown, or at a distance equal to the required length of the round collar as *B C*. Presuming the required radius of

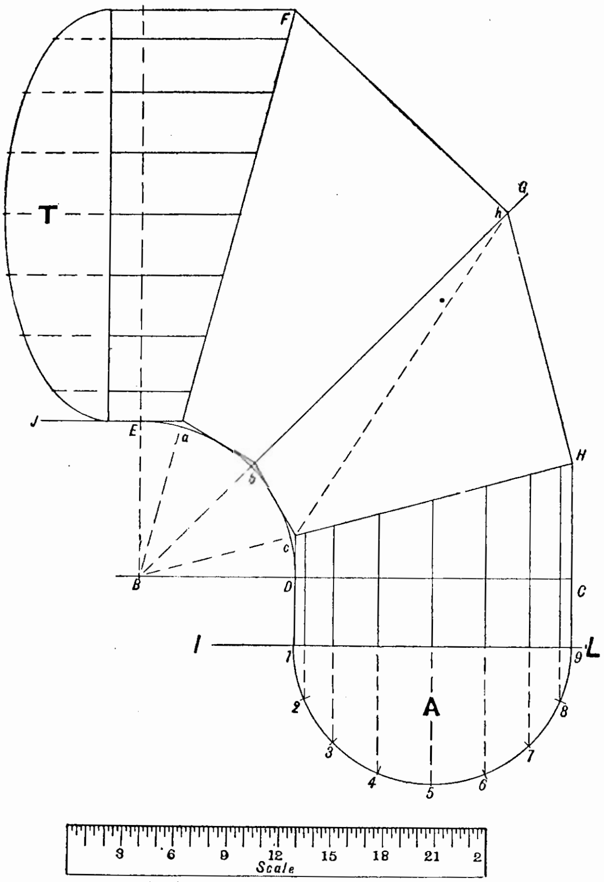

Fig. 74. Side Elevation and True Form of Ends of Elbow in Fig. 73.

throat is 9 inches, then point *B* is the center from which an arc is drawn, the radius of which is 9 inches, as shown at *E D*. We may now treat the arc *E D* in the same manner that a similar arc would be treated for an elbow of a constant diameter, as shown at *a, b* and *c,* i.e., locate points through which miter lines would be drawn presuming the elbow was to be a four-pieced elbow in 16-inch round pipe.

Through these points of division, draw lines as shown at *B a F, B b G,* and *B c H,* which will represent the miter lines of the elbow. From point *E* draw the line as shown at *E J*. Above this line draw a semi-profile of the elliptical end of the elbow with the major axis at right angles to line *E J* as shown at *T*.

The arc *1 9* is divided into an equal number of equal parts as shown at *1, 2, 3, 4,* etc., and lines projected from said points of division to intersect the miter line *c H,* thus securing an elevation of the round collar, or the true lengths of the rectilinear elements of the cylindrical surface. From this the pattern may be secured as for any elbow the diameter of which is constant. In like manner the semi-profile of the elliptical end is divided into an equal number of equal parts as shown at *T,* and lines projected to intersect the miter line *a F* as shown. This supplies two views of the elliptical collar, and the pattern for that portion may be secured as recommended for all parallel forms.

To Establish a Form for an Intermediate Section.

When following this mode of constructing an elbow, we have two cylinders, one circular and one elliptic, which have been cut obliquely, and forming two of its sections. Since the two intermediate sections are to connect these upon the miter lines *c H* and *a F* Fig. 74, it follows that one end of each must be of a suitable form and size to make said connections. Therefore in this example, the only unknown form is that upon the miter line *b G*.

This form can be arbitrarily established. However, it is not to be recommended, since it is a somewhat difficult undertaking to establish a form which will be productive of satisfactory results in the finished elbow. The author suggests that a form be found which will be in proportion to the two forms previously established upon the miter lines *a F* and *c H*.

The two diameters of this, the required ellipse for a suitable form of the elbow on line *b G,* may be secured by graphical methods as was explained for a similar example in the seventeenth chapter, or as it may be arrived at somewhat as follows:—We find that the ellipse which is the true form of the right circular cylinder upon line *c H,* will have dimensions of approximately 16½ and 16 inches as the major and minor diameters. In like manner we find that the ellipse which is the true form of the right elliptic cylinder upon miter line *a F,* has dimensions of approximately 12 and 24¼ inches. The difference then in the two major diameters is 8¼ inches. We may divide this difference in this case by 2 which gives us 4⅛ inches. This may be either added to 16½ or deducted from 24¾, which gives us 20⅝ inches as the major diameter of the required ellipse, which we shall presume to be the true form upon line *b G.*

In like manner we find that the difference between 12 and 16 is 4 inches. This divided by 2 is 2, which added to 12 or deducted from 16 equals 14 inches, the minor diameter of that ellipse. We can now definitely locate the point *h* as shown upon the miter line *B b h G,* since it will be 20⅝ inches from point *b* as shown at *h*. Since the forms for each end of the two intermediate sections are elliptical, and it is necessary that these forms be drawn to secure the patterns for these sections, we could employ any convenient method for securing them.

The Ellipse.

There are many ways of describing that curve known as the ellipse, and it makes no material difference how it is secured. It may be well to here explain that in the strictest sense, no part of an ellipse is a part of a circle. Therefore methods recommended for what is known as the false ellipse, i.e., those drawn from centers, will be somewhat in error, although the variation in many

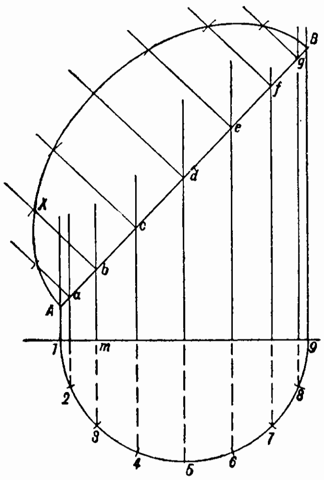

Fig. 75. Methods of Securing True Form of Oblique Section of Cylinder.

instances will be insignificant and may be consistently ignored. On the other hand, the author believes that the more accurate methods of securing that curve are to be desired.

As for example, the oblique section of a right circular cylinder is an ellipse, the diameters of which are dependent upon the diameter of the cylinder, and the angle at which said cylinder is presumed to be cut. By keeping this in mind, we are always prepared to locate points in an ellipse of given dimensions, as will be explained.

The true form upon miter line *b h,* Fig. 74, in this example, is an ellipse with diameters of 14 and 20⅝ inches. To secure this form we may draw a semi-circle, the diameter of which is *14* inches, as shown at Fig. 75, and divide said semi-circle into a convenient number of equal parts as shown at *1, 2, 3, 4,* etc. From these points of division project lines at right angles to line *1 9,* as also shown.

Thus we have before us the plan and elevation of a semi-cylinder which we shall presume to cut at a suitable angle to give us a length of 20⅝ inches for the section line, as *A B.* Points as *a, b, c, d,* etc., thus secured, are looked upon as the end elevations of lines which cross the semi-cylinder, and the horizontal projectors from points *2, 3, 4,* etc., i.e., from said points to the line *1 9,* are the plans of those lines, and are in this instance, their true lengths.

Draw lines from points *a, b, c,* etc., perpendicular to line *A B.* Set off distances upon said lines as found in plan, as for example, the distance from *m* to *3* is set off from *b* on line *b X,* and so on for all lines shown. We have thus secured points in the required ellipse. To facilitate our work, we may cut a templet from this, for the purpose of duplicating this curve whenever it becomes necessary in diagrams which must be drawn to secure the patterns for the two intermediate sections.

Since the semi-patterns for either intermediate section are secured by duplicate operations, but using somewhat different measurements, one only is discussed in this demonstration, i.e., that included between points *c, b, h, H,* Fig. 74. The form of one end of this section is elliptical, as shown at Fig. 75. Therefore in constructing the necessary diagrams to secure its pattern, we may first draw the semi-ellipse *1, 2, 3, 4,* etc., as shown at Fig. 76, and look upon this as a plan.

Above this as shown, we duplicate the elevation of section *c b h H,* Fig. 74, by first presuming the line *1 9* to be an elevation of what we may now term the base. To locate the remaining points, i.e., *e* and *H,* in their correct relative positions, we may divide our primitive elevation, Fig. 74, into triangles as shown by the broken line *c h*, and construct similar triangles at Fig. 76, thereby securing a duplicate elevation in a somewhat changed position.

The necessary form of the elbow upon line *c H*, Fig. 74, is also elliptical, and may be secured by determining the true form of the 16-inch round pipe upon line *c H*. This form drawn in a position as shown at *a e i,* Fig. 76, supplies a plan of the base, an elevation, and the true form of the top. The true form of the top as here represented, is presumed to be upon an oblique supplementary plane, and the line *a i* is the intersecting line between this, and the vertical plane.

Plan, Elevation and Diagram of Triangles.

An examination of the construction lines shown in Fig. 76 should render the work of drawing a complete plan and elevation of the semi-section a simple matter.

As will be noted, horizontal lines are drawn from points on line *a i,* which are at a distance from *I L* equal to the vertical hight for all triangles. From the base of some vertical line as at *Y*, we may set off distances as found in the lengths of full lines drawn in the usual manner between similar points in plan. From the base of some vertical line as at *X*, we also set off distances as found in the lengths of the indirect, or broken lines which have also been drawn in the usual manner. Lines are drawn from points thus located, to the respective intersections of horizontal lines and the lines extending from

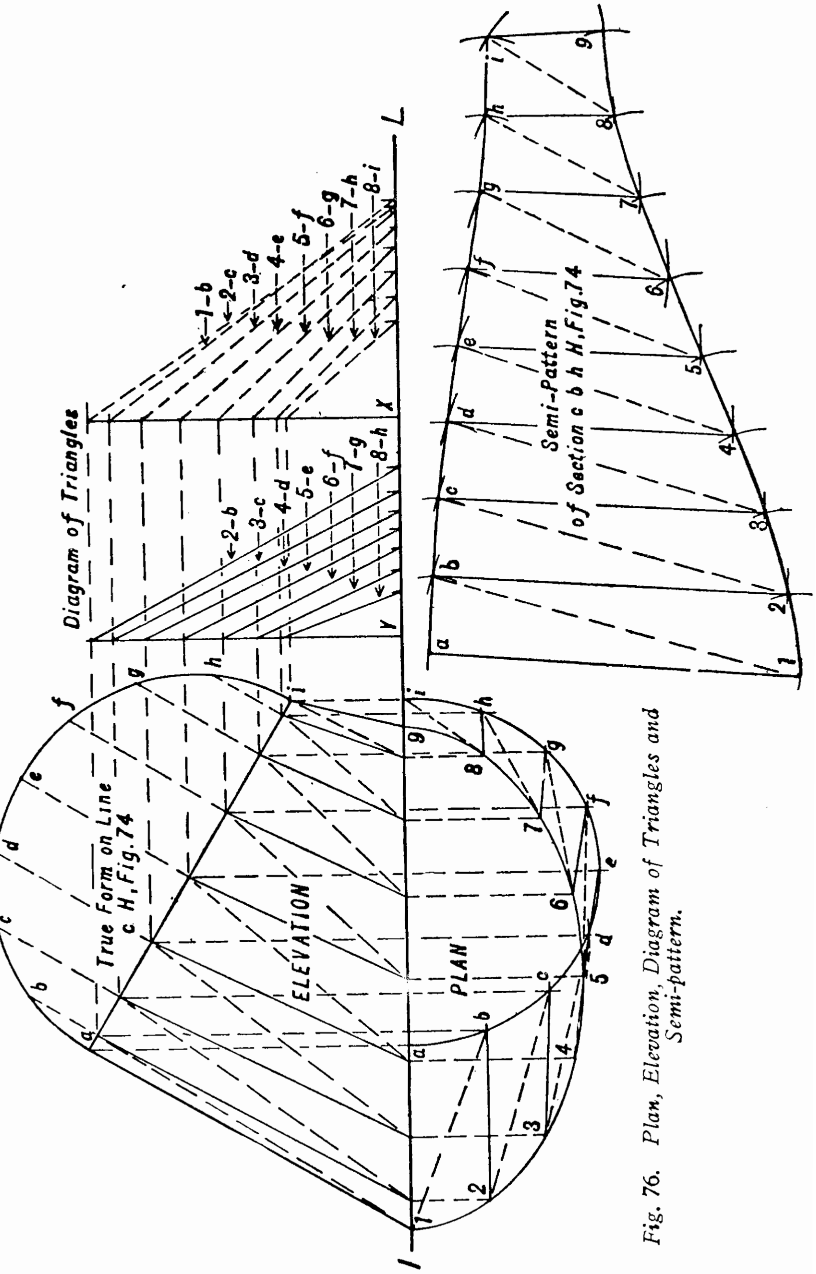

Fig. 76. Plan, Elevation, Diagram of Triangles and Semi-pattern.

Y and *X*, thereby determining the true lengths of lines shown in plan.

Thus in the diagram of triangles we have the full lengths of necessary lines shown in plan, and from the plan and the true form of the top, we determine the distances said lines are from each other at their extremities.

The Pattern.

To secure the pattern as shown, we draw a line in any convenient position upon the plane of development, the length of which is *a 1* of the elevation, as *a 1* of the pattern, Fig. 76. Line *2 b* is distant from *a 1* at the lower extremity equal to the distance between *1* and *2* of the plan, and at the upper extremity equal to the distance between *a* and *b* of the true form of the top.

To locate these points upon the plane of development, we use points *a* and *1* of the pattern to describe arcs, the radii of which are equal to the distances said lines are from each other; then the extremities of line *2 b* must lie in some points of these arcs. We find from the diagram of triangles that the true distance from *1* at the base to *b* at the top, is the length of the broken line *1 b* in the diagram of triangles.

Using this as radius and with point *1* of the pattern as center, we describe the second small arc as at *b*, thereby definitely locating the upper extremity of line *2 b* upon the plane of development. Since the true length of line *2 b* is also found in the diagram of triangles, we use that as radius, and with point *b* as center, describe the second small arc as at *2*, thereby completing what may be looked upon as one section of the semi-pattern. With these operations repeated for each section shown in plan, and using proper distances as found in the several diagrams, the pattern is completed as shown.

Should the student become interested in securing patterns for a form of this nature which is required to be "off center" or flat on one side, it may prove to his advantage to re-read Chapter XVII.

Application of the So-called Rule of Thumb.

It may at least be interesting to note that the so-called rule of thumb could have been introduced to secure the pattern by mechanical methods, by cutting from sheet metal a form as shown at Fig. 76, i.e., that bounded by line *1 a e i 9* and *5,* then bend upon lines *a i* and *1 9* to form an object as shown at Fig. *77.* If a piece of paper be wrapped about the curved face of this and marked, the

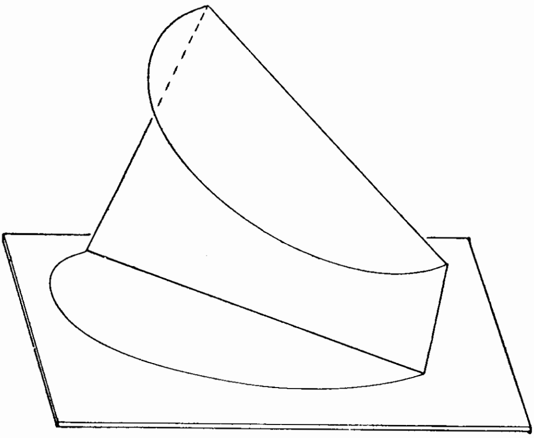

Fig. 77. Object from Which Pattern May Be Secured.

pattern sought is secured, providing of course, that the semi-elliptical forms are at right angles to what may now be termed the back.

This is explained in the fact that all sheet metal patterns are what may be looked upon as the envelope of a solid, the form of which is that of the required object.

Triangulation is but the process of measuring these surfaces, and applying these measurements to the plane of development for the purpose of locating points in the outline which bounds the pattern.