CHAPTER IX.

SOME PRINCIPLES OF ORTHOGRAPHIC PROJECTION AS APPLIED TO TRIANGULATION.

To secure the pattern for an object whose ends are not in parallel planes demands a greater knowledge of orthographic projection. The reader will note that in foregoing examples a plan of the object, together with a knowledge of its vertical hight was sufficient to enable us to determine the true lengths of all lines presumed to be upon its surface and shown in plan. The reason for this is found in the fact that all points of the top are the same vertical distance from the plane of the base, or, all points of the base are at the same vertical distance from the plane of the top.

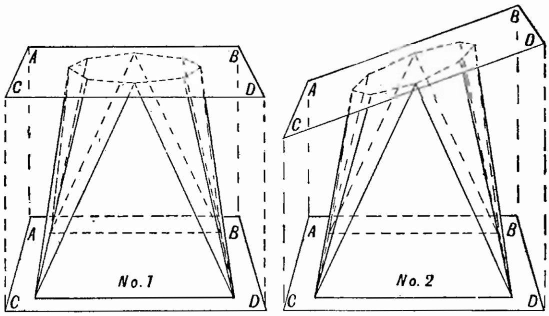

Fig. 45. A Pictorial View of Transition Pieces and the Planes Within which their Ends are Situated.

When the ends of the object are not parallel a more complicated problem is encountered, since there is variation in the distances between the planes of its ends. Therefore some method must be employed which will enable us to determine the distance between different points which may be conceived as being located within those planes. The above is clearly shown at Nos. 1 and 2, Fig. 45.

Fig. 45 shows, in a pictorial way, objects making a transition from square to octagonal, and the planes *A B C D*, within which the ends of those objects are situated. It is apparent upon examination of No. 2, that the perpendiculars of triangles employed to secure the true lengths of lines, must be of varying lengths. In an endeavor to convey to the reader an understanding of the principles involved to secure those lengths, some elementary discussion relating to the point, right line, and plane will be introduced.

On the Representation of a Point Upon the Vertical and Horizontal Planes of Projection.

Since the relative positions of points, lines and planes must be determined when the solution of the more complex problems in pattern development are attempted, we shall first consider the surfaces upon which they are represented. As has been previously explained, a plan is usually drawn upon a surface which is presumed to be horizontal. An elevation can be, and is many times, drawn upon the same surface, but intended to represent the object when viewed from positions which are at right angles to those assumed for the plan. Therefore if the object is to remain stationary, the surfaces upon which the plan and elevation are to be drawn must be presumed to be at right angles to each other. Thus we have what are known as the vertical and horizontal planes of projection.

As for example, the surface *A B C D*, No. 1, Fig. 46, represents the surface upon which a plan and an elevation may be drawn. A line, real or assumed as *I L*, divides this surface into convenient parts. The lower portion as *I L C D* remains in a horizontal position, while the upper portion as *A B I L* is looked upon as

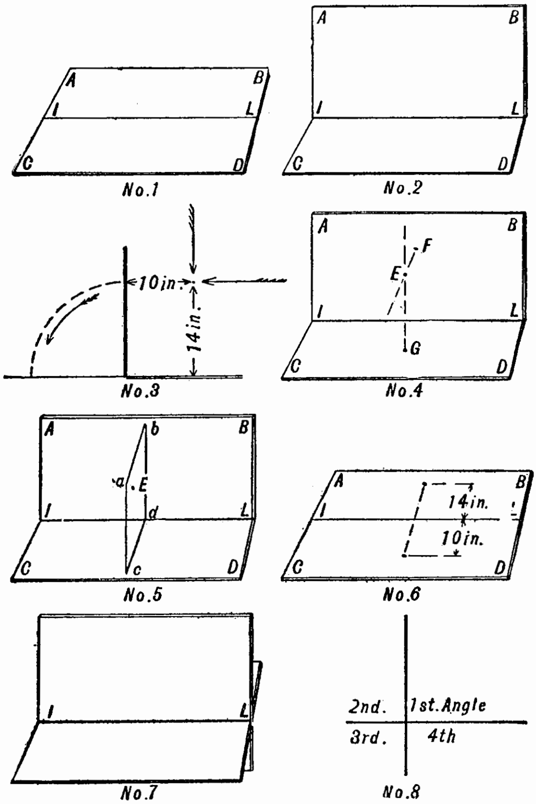

Fig. 46. *Illustrating the Principal Planes of Projection.*

being in a vertical position, as illustrated at No. 2, Fig. 46. That portion of the surface as shown at *I L C D* is known as the horizontal plane of projection, and that shown at *A B I L* as the vertical plane of projection. The line *I L* is the intersecting line between the two planes.

As these planes are presumed to be capable of indefinite extension there is no limit as to size.

The above spoken of planes, i.e., the vertical and horizontal, are known as the principal planes of projection, and are sufficient for many, but by no means all, of the ordinary operations of pattern development. In addition to the above there are the profile and oblique planes, which must be employed at times to secure desired results. However, since a knowledge of the first is essential to the study of the others, the author will for a time confine himself to the representation of the point, right line, and plane upon the vertical and horizontal planes of projection, and, as the work progresses, endeavor to explain the positions and value of the profile and oblique planes.

The object to be represented is presumed to occupy a position in space above the horizontal, and in front of the vertical plane. It may be here explained that space is unlimited extension in which all bodies are situated. The absolute position of bodies or objects cannot be designated except in a relative way, i.e., by referring them to each other, or to objects whose positions are assumed. In orthographic projection all objects are referred to the planes of projection.

Since representations of objects upon the planes of projection are composed of lines, and as lines are made up of points, we may direct our attention for the moment to the projection of a single point.

The point, which is the least of geometrical magnitudes, if considered as a visible particle, can be located in space by giving its distance from each of the two principal planes of projection.

Presuming a point is located 14 inches above the horizontal plane, and 10 inches in front of the vertical plane as shown at No. 3, Fig. 46, then a pictorial view of the planes and point as at *E* is shown at No. 4, Fig. 46. If from point *E* in space, a perpendicular line be let fall to the horizontal plane, the foot of the perpendicular as *G* is the horizontal projection or plan of the point. If in like manner, a perpendicular be drawn to the vertical plane, the point of intersection with that plane, as at *F,* is the vertical projection of the point, or its elevation. These perpendiculars are called the projecting lines of the point.

It will be noted that this places the plan of the point at the same distance from *I L* as said point is known to be from the vertical plane, and the position of its elevation is at the same distance from *I L* as the point is known to be above the horizontal plane. The converse of this may be assumed, i e., the location of the point in space is determined by its projection upon the vertical and horizontal planes, since its plan is 10 inches in front of the line *I L,* the point itself must be 10 inches in front of the vertical plane, and since the elevation of the point is 14 inches above *I L,* the point itself must be 14 inches above the horizontal plane. If a plane which is perpendicular to the two planes of projection be passed through point *E* in space, as shown at *a b c d,* No. 5, Fig. 46, said plane would cut a right line from each, i.e., the vertical and horizontal planes of projection, as illustrated by lines *b d* and *d c,* No. 5, Fig. 46, which are at right angles to *I L.* Therefore the elevation of a point will be found in a line drawn from the plan of said point perpendicular to *I L,* or the plan of a point will be found in a line let fall from the elevation of said point and perpendicular to *I L* when the vertical plane has been so revolved as to be parallel to the horizontal as shown at No. 6, Fig. 46.

In other words, the plan and elevation of a point are found in a right line drawn perpendicular to *I L.* Its distance above line $I\ L$ is equal to the distance said point is above the horizontal plane, and its distance below line $I\ L$ is equal to the distance said point is in front of the vertical plane. This, as will be noted, places the elevation above the plan in every instance. Thus we have what is commonly known as a first angle projection.

On the Relative Positions of the Plan and Elevation.

There is a tendency among draftsmen to place their elevation below the plan, or, in many cases, in what seems to be the most convenient position for them at the moment. This the writer believes is more likely to confuse than enlighten. Geometrical authorities state that the first angle is sufficient for all ordinary operations, and as it is by far the most simple of comprehension, the author will in every instance locate his object in the first angle. This is in line with the teachings of an English instructor in civil engineering, and a writer on orthographic projection who has always been held in high esteem.

In explanation of the above it may be stated that geometry teaches that the intersecting line is not a limiting line, but the line where two planes which are capable of indefinite extension intersect or cross one another, as shown at No. 7, Fig. 46. This forms four equal angles as shown at No. 8, Fig. 46, where an edge view of the planes is shown. The object may be looked upon as being situated within either of these angles. Thus when the vertical plane is presumed to be revolved into the plane of the paper, the elevation will occupy a position dependent upon the angle within which the object is situated. This then explains to some extent, the different positions taken for plans, elevations, and sections.

Geometrical authorities also state that the point of sight is always at an infinite distance above the horizontal and in front of the vertical plane, which is within the first angle, hence all objects situated within this angle can be seen. Objects situated within either of the other angles are concealed more or less by the planes of projection. Lines that are given or required are made full if they can be seen, but are dotted if concealed by other objects, or by the planes of projection. Auxiliary lines, or lines used to aid in the construction of a problem, are always dotted.

Many broken or dotted lines found in a pattern demonstration are included simply as an aid in conveying an understanding of the problem, although it must be admitted that in many instances said lines are erroneously looked upon by the novice as confusing the demonstration.