

An Instruction Course for the Apprentice*

Seventh of a Series of Articles on Pattern Drafting for the Beginner—Intersections

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Sheet metal pattern drawing consists largely of the development of the surfaces of intersected solids, and since no pattern can be drawn until the line of intersection or "miter line" has been located and drawn in its proper position, the subject of intersections is of vital importance in the work of the pattern draftsman.

One of the most common intersections is that of the adjacent sides of a roof, "hip" being the term applied to the intersection of a projecting angle and "valley" to a re-entrant one. These are simple illustrations of the intersection of plane surfaces and are familiar to every one connected with the building industry.

The intersection of curved surfaces, however, presents some more difficult features and the drawing of the miter line quite often requires more labor than does the development of the pattern.

In Fig. 40 are shown the elevations of two fittings—a three-piece elbow, (a) and a Y, (b)—which are familiar to all sheet metal workers.

An examination of this figure will reveal: that when the intersecting solids have the same cross section the

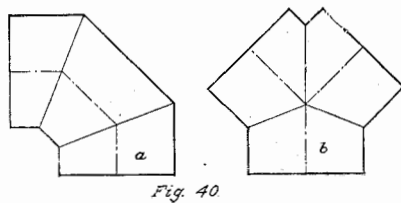


Fig. 40

miter line is represented by a straight line in any view which shows the axes in their true length; that the axes also intersect; that the miter line joins this point of intersection with that of the edge lines; and that it is a bisector of the angle formed by the axes and also by the edge lines. Locating the miter line in the case of solids of this class is therefore simply a matter of constructing a view in accordance with these principles.

When the two sections of a fitting make a right angle with each other, it is also possible to obtain a pattern from a view which shows one of the sections in plan. This is illustrated in Fig. 41, in which are shown at *a* a side elevation of a T, and at *c* a side elevation of a two-piece elbow. The view at *b* is an end elevation of both *a* and *c* and since the axis of the lower section is shown in its true length in each of the three views, it is evident that a pattern may be developed from any of them. Since at least a half-plan of this section must be drawn in order that developers may be located on its surface, the view at *b*, having this plan already drawn, will be the one chosen from which to draw the pattern.

It should be understood that, considered in reference to the two-piece elbow, the circle in the view at *b* represents a foreshortened view of the miter line, the full view of which is an ellipse; while as regards the T, the lower half of the circumference of this circle represents a view of the miter line *on edge*.

The fact that the miter line is always a bisector of the angle formed by the edge lines and axes in solids of the

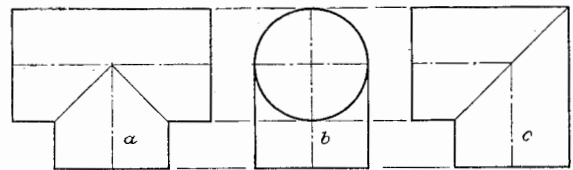


Fig. 41

same cross section is also true of the intersection of plane surfaces. Fig. 42 illustrates this feature, all the miter lines making an angle of 45 deg. with the axes. This being known, the point P in the intersection of the right-hand branch is automatically located by drawing the miter lines at this angle. Otherwise this point would have to be located by projecting it to the outline of the half-section in the upper view, transferring it to a like position in the lower view and finally projecting it back

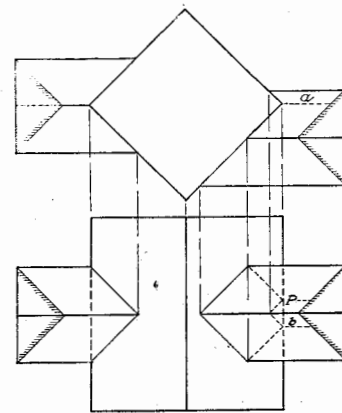


Fig. 42

to the edge line of the larger solid, as indicated by the dotted lines *a* and *b*.

Fig. 43 shows (above) an elevation of a square miter for flat-back moulded gutter and, as stated in the explanation of Fig. 41, the pattern for a square miter may be developed from this view, the profile being considered as a foreshortened view of the miter line.

For any angle other than 90 deg. a view must be drawn in which the miter line may be shown on edge and rep-

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resented by a straight line. This view may be projected as follows: disregarding that part of the elevation to the left of the vertical dotted line, consider the remaining portion as an end view of the gutter. It is evident, then, that if the end of the gutter nearest the observer were tipped downward until the bottom was parallel with the

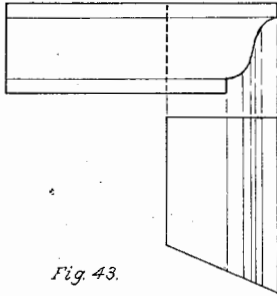


Fig. 43.

paper, a projection in this position would permit of a miter line being drawn at any required angle. The curved portion of the outline is therefore divided into any convenient number of equal parts, vertical projectors drawn from the division points thus established and the view constructed as shown, the miter line in this instance being drawn at the proper angle for a 45-deg. miter.

In the intersections heretofore described it has always been possible to show at least one view in which the miter line may be represented by a straight line, though this view is not always the most desirable for the development. There are many cases, however, in which it is impossible to show the miter line as straight in any view that may be drawn, but before considering the representative cases of this class of intersections, some explanation of the manner of treating curved surfaces is necessary.

It was shown in the article on Projection that to project the views of plane surfaces having curved outlines it is necessary to arbitrarily establish a number of points on these outlines. In the case of curved surfaces, this treatment is carried a step further and a series of lines are established on these surfaces, and these lines are assumed to proceed from the division points on the base, longitudinally across the curved surface. For example, consider the cylinder whose oblique section was shown in Fig. 35. For the projection of the plan of this cylinder, its circumference was divided into sixteen equal spaces, and for all purposes of projection it may be considered a polygon of sixteen sides instead of a circle. By this treatment of its base, the cylinder therefore becomes a prism having sixteen faces and lines drawn on its surface from the division points on its base may be considered as actual edge lines of the prism. This treatment of the cylinder is carried through all the work of projection, locating the miter line and until the final points have been established in the pattern. Then, instead of connecting these points by a number of straight lines, as would be done in the case of a real prism, a gradual curve is drawn through them and this has the effect of restoring the solid to its original circular form.

In a like manner, the cone is assumed to be transformed into a pyramid having as many faces as there are division points on its base, and since the lines which are drawn on the surfaces of both the cone and cylinder are assumed to represent *actual* edges of an *imaginary* solid, these edges are represented in the drawing by light solid lines which are referred to as *developers*.

It may be stated here that, while in all the figures previously illustrated, as well as those yet to follow, the

circumference of the base of each figure has been divided into a number of *equal* spaces, it is not absolutely necessary that they be so spaced. As regards the accuracy of the work, it is a matter of little consequence how the points are located, but since the same relative position must be maintained in each view and also in the pattern, and since these points may afterwards serve as the location of rivet holes (as will be shown later), it is preferable and usually customary to locate them an equal distance apart.

A typical case of intersections in which the miter line must be determined by the principles of projection is illustrated in Fig. 44. This figure represents two views of a cylinder intersected by two cylinders of smaller diameter, both of whose axes are inclined at an angle of 60 deg. The circle which represents the end view of the larger cylinder is first drawn, after which the outlines of the two branches may be drawn as shown in the figure—one tangent to the circle and the other in a position such that its axis passes through the center of the circle. Now, in order that developers may be drawn upon the surfaces of each of these branches, it is necessary to draw a half-plan of each branch and divide its semi-circumference into a convenient number of equal parts. This half-plan may be drawn anywhere in the length of the cylinder, provided, of course, that its center is located on the axis and it is usually constructed by drawing a semicircle upon the line which represents the edge view of the base, as is shown in the side view of this fitting. In this case, however, the view of the base is foreshortened and cannot be represented by a straight line, so both half-plans are constructed upon the diameter of the large circle. By spacing these half-plans, the position of the developers is established and they may be drawn as shown, though in practice it is necessary to locate only the point of their intersection with the circumference of the large cylinder.

From an inspection of the work so far constructed, it

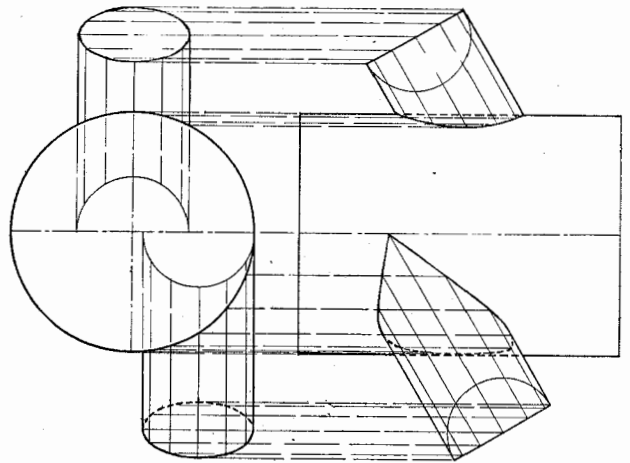


Fig. 44.

should be apparent that the two parts of the circumference of the circle included between the edge lines of the branches are views of the miter line *on edge*, and also that if the axes of the branches were shown in their true lengths, a pattern for either could be obtained from this view. Since the axis of the upper branch is inclined towards, and of the lower, away from the observer, and since both are vertical in the end view, it is evident that a side view will show both the axes and the developers in their true length.

This view is accordingly constructed by projection

from the end view and the edge lines and axes of the branches drawn at the required angle. The half-plan of each branch in the end view is then reproduced in the side view with the *same number* of division points, and developers drawn as shown. Now if the point at which each of these developers strikes the surface of the large cylinder can be established in this view, their length will be defined and the line of intersection

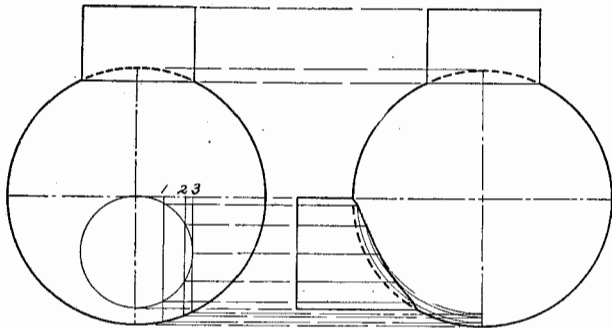


Fig. 45

may be drawn. These points have already been found in the end view so it is only necessary to draw horizontal projectors from them to the corresponding developers in the side view and to trace the miter line through these points of intersection. It should be noted that, in this view, the branches have been rotated one-quarter of a turn and consequently the developer which serves as an edge line in the end view coincides with the axis of the branch in the side view; also that since the upper branch is symmetrical about its axis in the end view, only one-

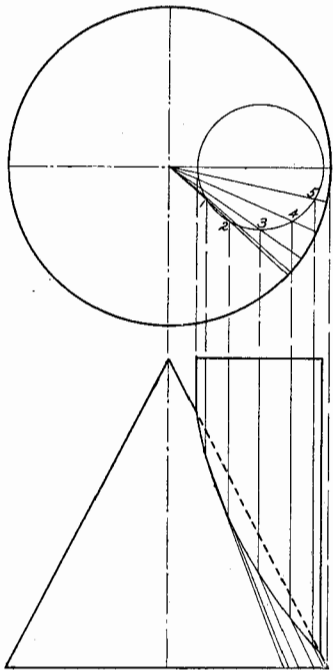


Fig. 46

half of the miter line need be drawn, the opposite side being a duplication of the part shown, while the miter line of the lower branch must be shown entire.

The foreshortened views of the bases of the branches, as shown in the end view in Fig. 44, are not necessary to the construction for the purpose of obtaining a pattern and they are never drawn in actual practice, but the method is apparent and they should be drawn by the

student merely for the practice afforded him in projection and in the use of the instruments.

The intersection of a cylinder and a sphere is illustrated in Fig. 45 and the upper branch needs no explanation as the miter line is straight in any view which shows the axis in its true length, in all cases where the axis passes through the center of the sphere. When it does not, the position of the miter line must be determined by projection, as shown in the lower half of the figure.

A circle equal in diameter to that of the sphere is first drawn and in the required position within this circle draw a half-plan of the cylindrical branch and divide its semicircumference into a convenient number of equal parts. The division points thus located are then *end views of the developers*, and if vertical lines (1, 2 and 3 in the figure) are drawn through these points and each of these lines is considered a cutting plane, it is evident that a full view of the sections thus produced will show the intersections of the developers with the surface of the sphere.

A side view of the sphere is therefore constructed at the right and a partial outline of each of these sections

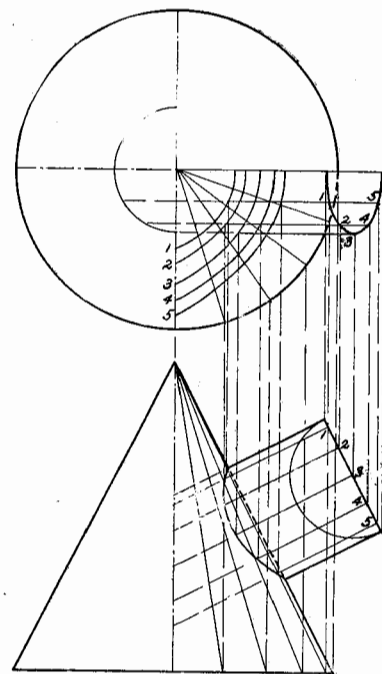


Fig. 47

drawn, using the lengths of the lines 1, 2 and 3 as radii. Developers on the surface of the cylinder intersect these arcs at points through which the miter line may be drawn.

The intersections of the cone shown in Fig. 46 and 47 are generally considered the most difficult problems in pattern work and the student who masters them will have little to fear in the way of intersections in future problems. In Fig. 46 the axis of the cone and of its intersecting cylinder are parallel and this feature simplifies the work to a great extent.

The plan and elevation of the cone may first be drawn and within the circumference of the base in the plan draw a half-plan of the cylinder and locate points on its outline as in the preceding problems. Through each of these points draw an element of the cone and project each point of intersection with the circumference of the

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base to the edge view of the base in the elevation and then draw these elements in the elevation. Developers drawn on the surface of the cylinder will intersect these elements in the elevation at points on the miter line and it may be drawn through them.

In Fig. 47 the axis of the cylinder is perpendicular to the element of the cone through which it passes and this feature necessitates drawing a partial section of the cone for each developer used. The construction is as follows:

First draw the plan and elevation of the cone and also the outline of the branch in the elevation. In this outline draw a half-plan of the cylinder, as shown, and reproduce it in any convenient position along the horizontal diameter of the plan. Then draw the developers on the surface of the cylinder in the elevation and produce them to the axis of the cone.

Each of these developers is considered an edge view of a cutting plane and a foreshortened view of each of these sections must be drawn in the plan. The intersection of developer 1 with each element in the elevation is projected to the plan and section 1 drawn and this operation is repeated for developers 2, 3, 4 and 5. These projectors are not shown in the figure, their use having been explained in drawing the sectional view in Fig. 37. Much of the confusion and liability to error incident to this problem will be eliminated if the student also omits them. The points through which the outline of the sections are to be drawn may be located by bringing the T square or triangle into the position for drawing the projector, and instead of drawing it, merely marking the radial line in the plan.

After these sections have been drawn the foreshortened view of the branch may be drawn in the plan, though as in the case of the cylinders in Fig. 44 the foreshortened view of the base is not necessary to construct either the miter line or the pattern. Developers are then drawn on the surface in this foreshortened view and the point at which each intersects the corresponding section is projected to its intersection with the same developer in the elevation. Thus, the intersection of developer 1 with section I in the plan is projected to the elevation and the intersection of the projector with developer 1 in this view is one of the points through which the miter line must pass. The other points being located in like manner, the miter line may be drawn and the work is ready for the development of the pattern, which subject will be treated in the following article.
