CHAPTER X

RADIAL LINE DEVELOPMENTS

The problems in this chapter will teach in a simple, progressive manner the construction and method of developing the patterns for tapering forms that have for a base the circle, or any of the regular polygons in which lines drawn from the corners terminate in an apex over the center of the base.

Patterns for tapering forms are developed by the radial method, by means of radial lines converging to a common center. When developing such patterns, first draw an elevation showing the true length of the axis, and the true length of the radius with which to describe the stretch-out arc of the pattern. The stretch-out must be described with a radius equal to the length of the true edge of the solid, as shown by *AC*, Figure 91. Then a plan view must be drawn from which the length of the stretch-out can be obtained, as shown by *DEFG* in Figure 91.

The simplest forms of tapering article are the cone and pyramid, and these are applied in the construction of chimney caps, ventilator heads, pitched covers, etc.

The sheet metal worker is frequently required to construct an article in the form of a frustum, or plane section of a cone, and the method used in developing the pattern is simply to develop a pattern for the entire cone and then cut off the upper portion, leaving the desired frustum.

The bodies of well-known tapering articles, such as the furnace hood, funnel, dipper, coffee pot, strainer, bucket, pan, etc., are of this character, and when developing their

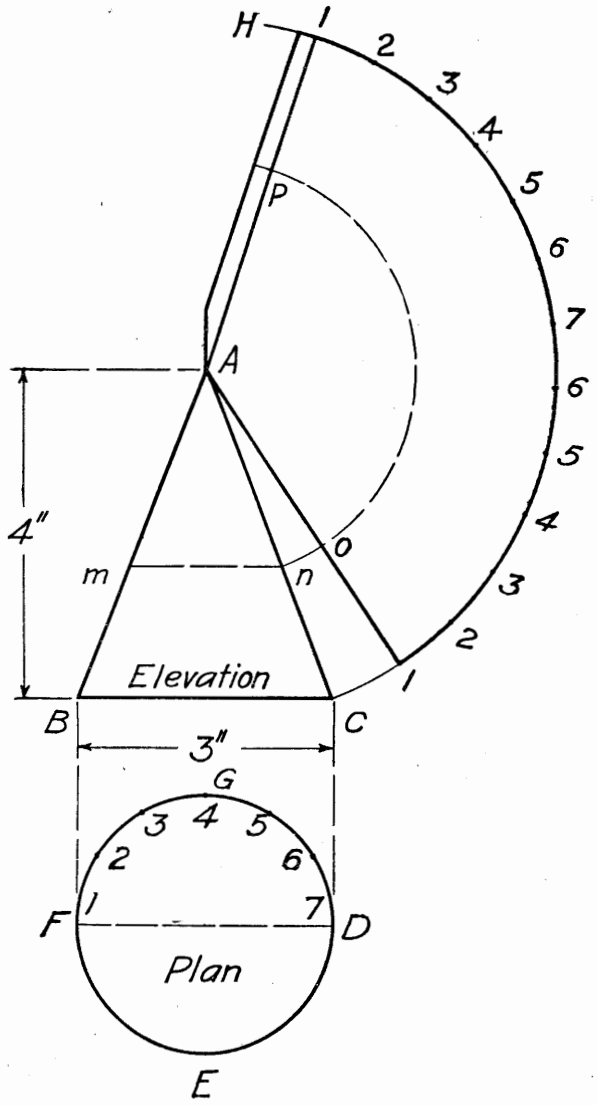


Figure 91.—Radial Method of Developing Pattern for a Right Cone.

patterns they are treated as the frustums of cones, as referred to above.

Pattern for Cone and Frustum.—In Figure 91 is shown the method of developing the pattern for a right cone, which contains the principles applicable to all frustums of pyramids and cones.

Draw the elevation *ABC*. Then describe a circle to represent a plan view of the base as shown by *DEFG*. Divide one-half of the outline of the base in the plan into a number of equal parts as shown by the figures 1 to 7; from the apex *A* of the cone as center, with a radius equal to the true length of the slant height of the cone as shown by *AC*, describe the stretch-out arc *CH*. On any convenient point on the stretch-out locate point *1* and draw a line from *1* to *A*.

Then set dividers equal to the length of one of the spaces in the plan, and starting at point *1*, mark off spaces equal to twice the number of those on the plan as shown by *1-7-1*, which will make the stretch-out equal in length to the circumference of the base of the cone. From the end point thus located draw a line to the apex *A*, and then add an allowance for seaming. This completes the pattern for the right cone. When adding allowances for seaming flaring work, care should be taken that the added lines are drawn parallel to the edge lines of the net pattern.

When the frustum of a cone is desired as shown by *mnBC*, Figure 91, then the diameter of the small end of the frustum will be equal to *mn*, and the radius to describe the upper edge of the pattern will be equal to *An*. With *A* as center and *an* as radius, describe the arc *op* as shown by the dotted line. Then *op 1-7-1* will be the pattern for the frustum of the cone.

Pattern for a Square Pyramid.—This development is shown in Figure 92 and the same principles used in developing the pattern for a conical-shaped object are ap-

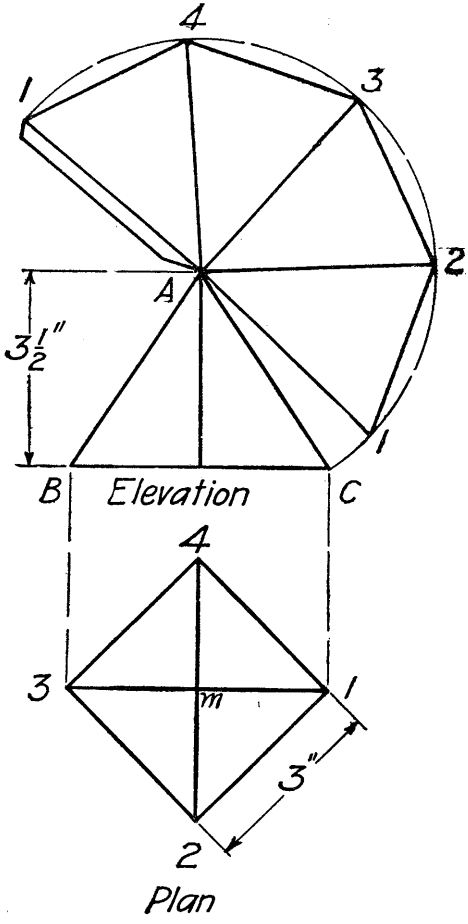


Figure 92.—Pattern for a Square Pyramid.

plicable to the developments of pyramids having a base with any number of sides. In this case we have a square pyramid.

Draw the elevation as shown by *ABC* and the plan view as shown by *1-2-3-4*, according to the dimensions given in the figure. Next draw the two diagonal lines *1-3* and *2-4*, intersecting in the center at *m*. When the plan view is placed in the position as shown, the line *AC* in the elevation represents the true length of one of the corners of the pyramid. With *A* as center and *AC* as radius the stretch-out arc is described in the same manner as in the case of the cone in the preceding problem. After setting the dividers to the width of one side of the base, as *1-2* in the plan, starting at *1*, mark off on the stretch-out line spaces equal to *1-2-3-4-1* in plan; connect these points by straight lines as shown, and draw lines from each point to the apex *A*, completing the development.

Pattern for a Hexagonal Pyramid.—The development of this problem, as shown in Figure 93, does not differ from that of the preceding problem, except that the line *AD* in the elevation is not the correct radius with which to strike the stretch-out arc, and it is therefore necessary to draw a line that will represent the true length in the elevation. This is found as follows:

First draw the plan and elevation according to the dimensions given in the drawing. From the center *m* draw the line *m-n* at right angles to *6-1* in the plan. From *m* as center with the radius *m-6* describe an arc intersecting line *m-n* at *a*. From *a* erect the perpendicular line intersecting the base line *BD* of the elevation extended at *g*. From *g* draw a line to the apex *A*, which will be the true length of *m-6* in the plan, and is also the radius with which to describe the stretch-out arc. With this radius and the apex *A* as center, describe the stretch-out line.

After setting the dividers to the width of one of the sides of the base which is shown in the plan, mark off six

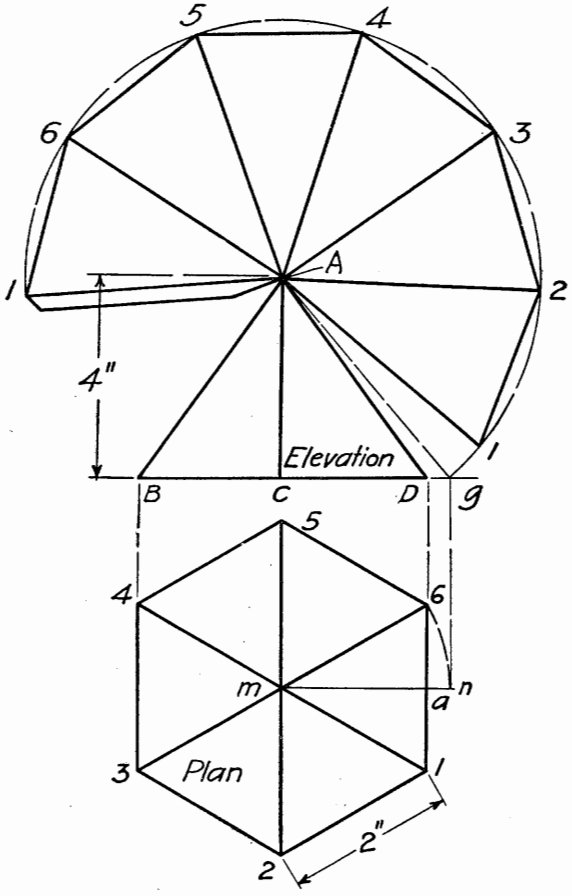


Figure 93.—Pattern for a Hexagonal Pyramid.

spaces on the stretch-out arc, and complete the pattern in the same manner as shown in the preceding problem.

Patterns for these problems should be developed, and models made from sheet metal, thus giving practice in construction. These models will at once show any error in the pattern which might otherwise be overlooked.

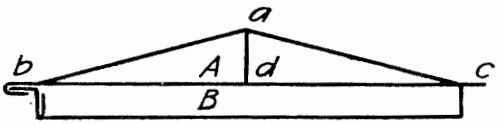
Rectangular Pitched Cover.—Sheet metal workers are frequently required to construct ornaments in cornice work, a hood, canopy, or a cover for an article square or rectangular in form. These articles are usually made in the form of a square or rectangular pyramid having a short height or rise to the apex.

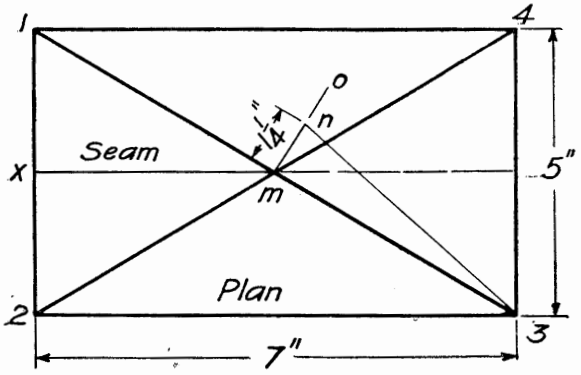
Patterns for work of this kind are usually laid out directly on the metal by a short method in which no elevation is required, as the true length of the radius for describing the stretch-out arc is found in the plan. Figure 94 shows the development of a pattern for a rectangular pitched cover by this method.

The half elevation and section can be omitted. They were drawn in this case to show the construction and method of connecting the hoop *B* to the cover shown at *A*. The hoop is a strip of metal of the required width, having a single hem on the lower edge and an edge turned to a right angle on the upper side for seaming, as shown in the section.

The length, width and height of cover being known, first draw a plan to the required size, as shown by *1-2-3-4*. Next draw the diagonal lines intersecting in the center at *m*, which lines represent the hips of the pitched cover in plan. Bisect the line *1-2* and locate the point *x*, then draw a line from *x* to the center *m*, showing the position of the seam. Before describing the stretch-out arc for the pattern, find the true length of one of the hip lines in the plan and use that dimension as the radius for describing the stretch-out.

To find the radius, draw the line *m-o* at right angles to the hip line *m-3* in the plan. The height of the cover as shown by *ad* in the elevation is marked on the line *m-o* at





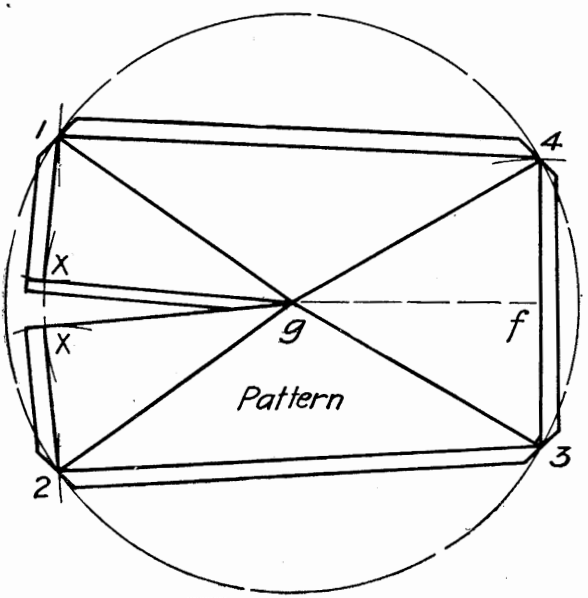


Figure 94.—Pattern for a Rectangular Pitched Cover.

n. Now draw a line from *n* to *3;* then *n-3* is the true length of the line *m-3* in the plan and is the radius for describing the stretch-out.

After setting the dividers equal to *n-3* in plan, with *g* as center describe a circle on the metal. Starting at any convenient point on the circle, as point *3*, space off the length of the end and sides of the cover as shown by *1-2-3-4* in the pattern. From *1-2* as centers, with a radius equal to one-half the width of the cover as shown by *1-x* in the plan, describe short arcs on the pattern as shown. The true length of the seam line is shown by the dotted line *g-f* in the pattern. Then with *g-f* as radius and *g* as center describe arcs at *x*. Connect all points by straight lines and draw lines from them to the center *g*. This completes the net pattern, to which allowances for seaming are added as shown.

After the pattern has been cut from metal, notch the corners and turn edges on the folder. The pattern is formed by placing the metal on the hatchet stake and bending on the hip lines to the required angle. The lap seam is riveted or soldered, and the hoop is attached to the cover as shown at *b* in the elevation. The edge is then closed down by means of the setting hammer, completing the construction.

Construction of a Flaring Pan.—In Figure 95 is shown a perspective view of a flaring pan, the form of which is seen to be the part or frustum of a cone. It is to be made of IC bright tin, according to the following dimensions:

Diameter of top, 6¼ inches.
Diameter of bottom, 4¾ inches.
Height, 2⅝ inches.

A No. 12 wire is inclosed in the top edge and the bottom is double seamed to the body. The body is made in two pieces cut from a 10x14 sheet of tin. The number of

pieces in which the body of an article in this form is made will depend upon its size and the material from which it is to be constructed.

In Figure 96 is shown a half elevation, also a half sectional view and the method of obtaining the pattern for a flaring pan made in two pieces. In developing the pattern, first draw the center line *GH*, upon which place the height of the pan, as shown by *AD*. Through these points draw lines at right angles to the center line. On

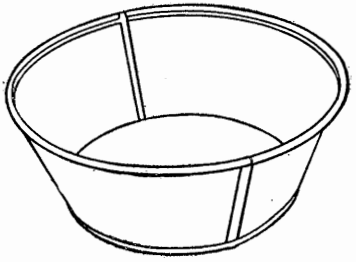


Figure 95.—Flaring Pan, Perspective View.

either side of the center line *GH*, from the points *AD*, place the half diameters *AB* of the top and *CD* of the bottom. Then *ABCD* shows the half elevation, while *AFDE* shows the half sectional view. Draw lines connecting *BC* and *EF* and extend them until they meet the center line at *K*, which is the center point with which to describe the pattern. With *CD* as radius and *D* as center, describe the quarter circle *CM*, and divide it into a number of equal spaces, as shown by the figures *1* to *7*. This quarter circle represents a one-quarter plan of the bottom of the pan.

The pattern is developed as follows: With *K* as center and the radii equal to *KB* and *KC*, draw the arcs *NO* and *RS* as shown. From *N* draw a line to the apex *K*, and starting from the point *R*, space off on the arc *RS*

the stretch-out of twice the number of spaces contained in the quarter plan, as shown by the figures *1-7-1* on the arc *RS*. From *K* draw a line through *S*, extending it until it intersects the arc *NO* at *O*. Add laps for seaming and wiring, as shown by the dotted lines. This completes the half pattern for the pan.

A one-half elevation and a quarter plan of the top or bottom is all that is required to find the stretch-out and

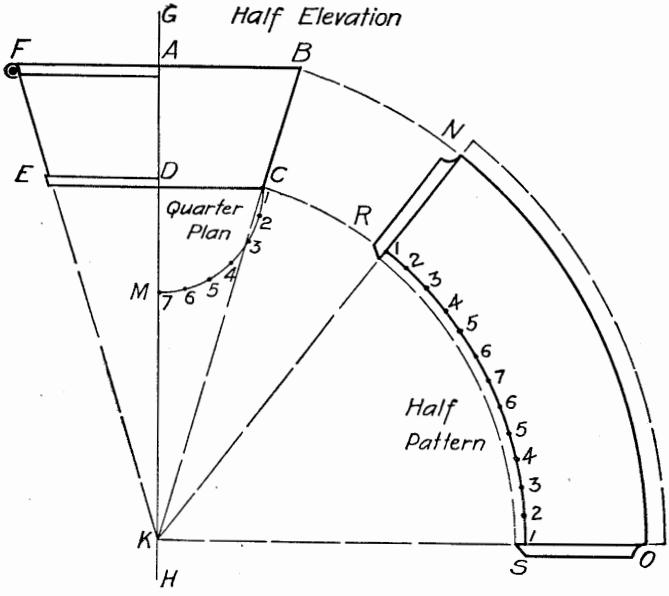


Figure 96.—Development of Pattern for a Flaring Pan.

radius for describing the pattern for the frustum of a cone. The allowances for seaming and wiring are made in the same manner as for the straight work described in previous chapters.

Wiring Flaring Articles.—Articles in the form of a frustum of a cone, such as a coffee pot or liquid measure,

which have a wire inserted in the edge of the small end or top of the body, are wired while in the flat before being formed into shape; while flaring articles such as pails, pans, etc., having a wire inclosed in the large end, are wired after the body has been formed up and seamed together. A flaring article is to be wired always before seaming the bottom to the body.

Turning a Wire Edge.—Having completed the pattern for the one quart pan, Figure 96, transfer it to metal and cut two pieces from a sheet of 10x14″ bright tin. Notch the upper corners for wiring and the lower corners for seaming, as described in Chapter VIII. Place the two pieces together and form them into a semicircle on

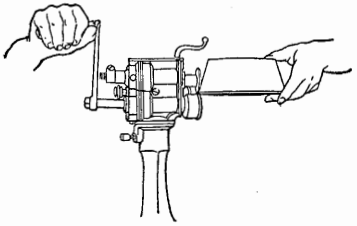


Figure 97.—Turning a Wire Edge on the Folding Machine.

the forming rolls (Figs. 24, 25). Next, turn the edge for the side seams on the folding machine (Figure 16), and then groove the seams and close them down by means of the mallet on the mandrel stake.

The next step will be to turn the edge for the wire. This is done on the small turning machine (Figure 86), in the following manner:

Having made an allowance of ¼ inch to the edge of the pattern for a No. 12 wire, set the gauge on the machine ¼ inch from the center of the depression in the lower roll. Then placing the upper edge of the pan against the gauge, bring down the upper roll and revolve the work in the machine, making a deep depression or bead on the metal.

Run the work through the machine several times, gradually raising the work until the edge is turned to the required angle, which will bring the side of the pan to a vertical position, almost touching the upper roll.

When turning a wire edge on the turning machine, it is often a difficult matter to keep the work circular in form; this difficulty can be overcome by pulling the work and rounding it into shape as it passes through the machine.

The edging operation and the position of the workman while operating the machine is shown in Figure 97.

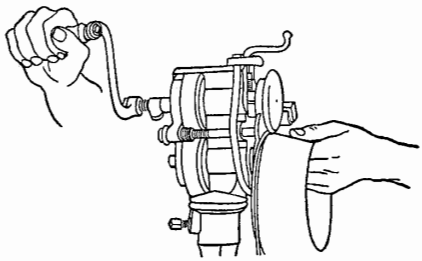


Figure 98.—Wiring a Flaring Article, Showing Correct Position of the Hands.

Use of Wiring Machine.—After turning the edge for wire, we are ready for the wiring process, which is the same as that described in Chapter VII, except that the wire is formed in the rolls before being inclosed in the edge of the article. First cut a piece of wire about ½ inch longer than the circumference of the top of the pan and form it circular in shape on the forming rolls (Figures 24, 25). Then placing one end of the wire at the side of a vertical seam and under the wire edge, close the metal over the wire for a short distance from the end by means of the hammer and the horn on the standard of the machine, or some suitable stake.

After setting the gauge on the wiring machine (Figure 57) to the required width, run the work through the rolls, wiring the top about three-fourths of its circumference. By stopping the operation at this point, the end of the wire can be held away from the edge of the metal and easily cut off to the required length by means of the wire cutters. The ends of the wire should fit close together. The work is then run through the rolls, completing the operation. In Figure 98 is shown a wiring machine and the correct position of the hands when wiring a flaring article.

The bottom is now double seamed to the body in the same manner as the bottom for the covered pail, and the process is fully described in Chapter IX. Using rosin as a flux, solder the bottom and the side seams on the inside of the pan, which completes the construction of the problem.

DIMENSIONS OF FLARING PANS

It is important that the student should know something of the standard sizes and dimensions of flaring pans that can be constructed with the least possible waste of material. For this purpose the following schedule of sizes and dimensions is presented:

Size	Diameter of Top	Diameter of Bottom	Height (Inches)
1 Pint	5¾	4	2⅜
1 Quart	6¼	4¾	2⅝
3 Pint	8⅛	6⅜	2½
2 Quart	8⅝	6⅛	3½
6 Quart	12¾	9	4
10 Quart	14¾	9⅜	4⅛

Making a Funnel.—A useful article in the form of a frustum of a cone is the common funnel shown in Figure 99. It is to be made from bright tin or No. 28 galvanized iron, having a No. 12 wire inclosed in the upper edge.

The vertical height is 3½ inches. The diameter of the top is 5 inches, and the lower opening in the body measures one inch in diameter. The spout is 2 inches long, having a ½-inch outlet, the seam being lapped and soldered. The body is made in one piece, having a ⅛-inch grooved seam on the side.

The body and spout are merely two frustums of cones and the patterns are developed in a similar manner by the radial method as shown in Figure 100. In this figure, the full elevation is drawn, but in actual practice

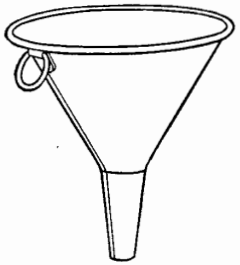


Figure 99.—Common Funnel, in Which Both Body and Spout Are Frustums of Cones.

much extra work can be avoided by drawing only one-half of the elevation, as shown, on one side of the center line *AB*. This is done to simplify the work and to avoid the drawing of unnecessary lines. To develop the patterns, extend the side lines of the body and spout until they intersect the center line at *M* and *G*. For the pattern for the body proceed as follows:

With *g* as center and radii equal to *GF* and *GE*, describe the arcs *ee* and *ff* of the pattern. On the arc *ee* step off four times the number of spaces contained in the quarter plan *C;* then draw lines to the center *g*. Add laps for seaming and wiring.

The pattern for the spout is developed in a similar

manner, with a lap added to the upper edge and side for soldering.

After the pattern has been cut from metal, notch the corners, and turn the edge for the side seam on the folding machine. When the outline of the pattern is a semi-

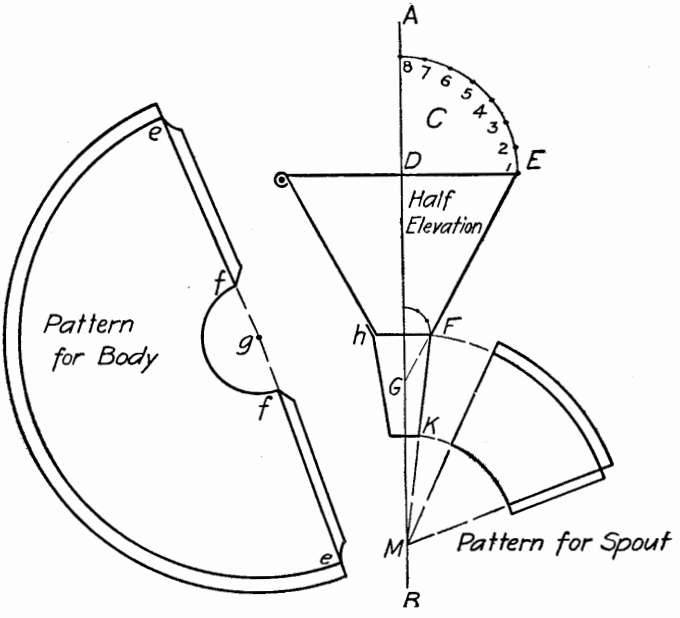


Figure 100.—Patterns for Funnel Body and Spout, Developed by the Radial Method.

circle or larger, place the work in the folder and bend the edge to a right angle, then finish the operation by means of the mallet on the hatchet stake. The patterns are now formed on the blowhorn stake, after which the side seam of the body is grooved and the upper edge is wired in the same manner as described in the preceding

problem. The spout is slipped over the lower end of the funnel and soldered in position, as shown at *h*.

Flaring Liquid Measure.—Another application of the processes of wiring and seaming of flaring articles is the construction of flaring measures. These measures are usually made from bright tin, having a wire inclosed in the upper edge, and the bottom double seamed to the body.

When constructing measures of small size, the upper edge of the lip and side edges of the handle are usually hemmed, in the same manner as the one-quart lipped measure described in Chapter VIII. For the larger measures, greater strength is obtained by wiring these edges. As they must hold a given quantity when completed, the greatest accuracy is required in developing the patterns and in making the allowances for wiring and seaming.

DIMENSIONS OF FLARING MEASURES

While there are various proportions used by different workmen and for different purposes, the following schedule is one that is commonly used by sheet metal workers in commercial shops. The table presented gives the height, bottom and top diameters for flaring liquid measures from ¼ pint to 5 gallons.

Size	Top Diameter	Bottom Diameter	Height
¼ Pint	$2\frac{1}{16}$ in.	2¼ in.	2¼ in.
½ Pint	2¼ "	2½ "	$2\frac{3}{8}$ "
1 Pint	$2\frac{11}{16}$ "	3 "	$4\frac{9}{16}$ "
1 Quart	$3\frac{1}{4}$ "	4 "	$5\frac{7}{16}$ "
½ Gallon	3½ "	$5\frac{3}{16}$ "	$7\frac{3}{4}$ "
1 "	5 "	6½ "	$8\frac{7}{8}$ "
2 "	$6\frac{3}{4}$ "	$8\frac{3}{4}$ "	$9\frac{3}{4}$ "
3 "	8 "	10½ "	$10\frac{1}{4}$ "
4 "	8½ "	11 "	$12\frac{5}{16}$ "
5 "	9½ "	12½ "	$12\frac{1}{16}$ "

One-Half Gallon Measure.—Assuming that a one-half gallon measure is to be made from IX bright tin, the pattern for the body is developed by the radial method, as

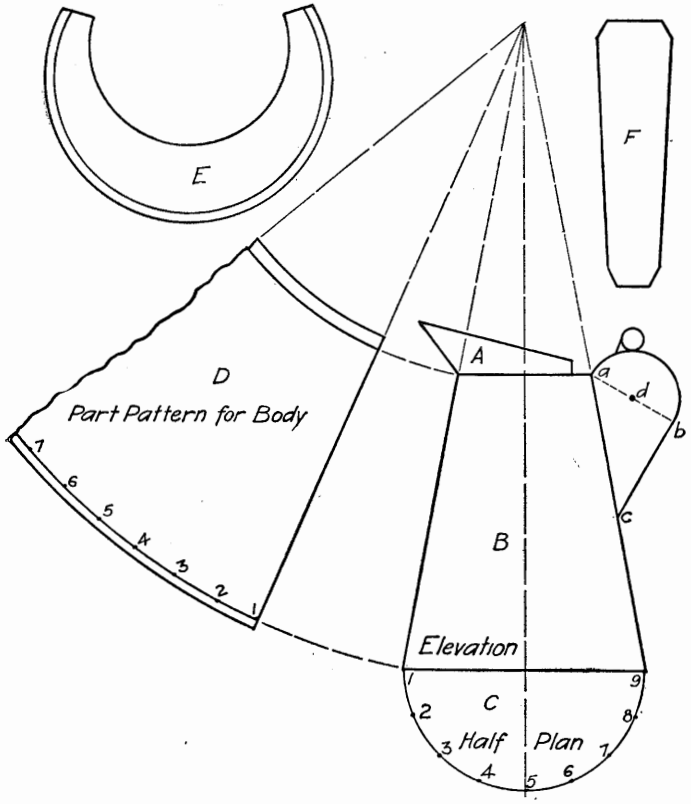


Figure 101.—Patterns for One-Half Gallon Measure, with Lip.

described in preceding problems. Using the dimensions given in the foregoing table, first draw the elevation and half plan as shown by *ABC* in Figure 101. Next lay out

the pattern for the body in the usual manner and add allowances for wiring and seaming, as shown by the part pattern *D*. The pattern *E* for the lip is laid out by the short method shown in Figure 71, an allowance for a No. 14 wire being added to the upper edge. The pattern for the handle is shown at *F*. The length of this pattern is found by spacing the outline of the handle, as shown by *abc* in the elevation; to this dimension add laps at each end for soldering.

The handle is strengthened by inclosing a No. 13 wire in the side edges. After the patterns have been cut from metal, notch the corners, and turn edges on the folding machine (Figure 16) for wiring the handle and seaming the body. The edge for wire is now turned on the upper edge of the body and lip by means of the small turning machine (Figure 86), and wired in the usual manner on the wiring machine (Figure 57).

Next form the body, lip and handle in the forming rolls (Figures 24, 25), but do not place the wired edges in the grooves on one end of the rolls when passing the work through the machine. The bottom is double-seamed to the body, the lip and handle soldered in position, completing the problem.

Flaring articles in the form of a frustum of a cone, such as measures, pans, tapering pipes, etc., can be easily shaped on the forming rolls.