PRACTICAL PROBLEMS IN SHEET-METAL WORK.

To describe a pattern for a square tapering article. The plan and vertical height or elevation are shown in Fig. 147. Draw the diagonals and take the distance from the center **a** to **b**, and mark off the same from **g** to **d**. Take the distance from **a** to **l** or **k**, and mark off the same from **h to e**. Draw a line through the points **d, e,** to cut the perpendicular line at **f**. Then draw the perpendicular line **af**, Fig. 148, and take the radius **fd**, Fig. 147, and with it

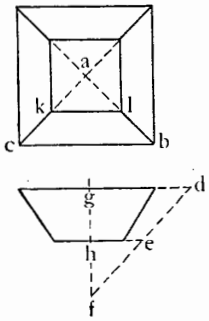


Fig. 147.

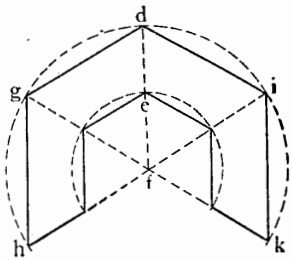


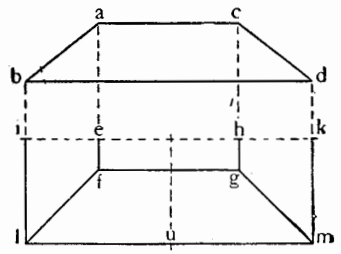
Fig. 148.

describe the arc of a circle **hdk**, Fig. 148. With the radius **fe** in Fig. 147, and with **f** in Fig. 148 as a center, draw the smaller arc **e**. Take the length of one side of the base from **c** to **b**, Fig. 147, and mark off the

same four times on the circle **hdk** at **h, g, d, i, k.** Draw through these points to the center **f,** join these points **hg, gd, di,** and **ik.** Also join the points on the smaller circle in the same manner, which will complete the pattern.

To describe the pattern for a rectangular taper-sided tray. The vertical height and one-half the plan are shown in Fig. 149. Draw the horizontal line **bd** and the perpendicular line **op** as in Fig. 150. Draw the

Fig. 149.



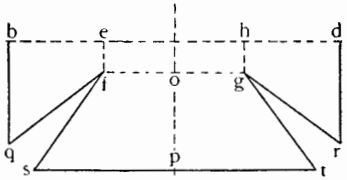


Fig. 150.

rectangle **efgh** the same size as **efgh** in Fig. 149. Take the length **ab** as in Fig. 149 and mark off a corresponding distance from **e** to **b, h** to **d,** and **o** to **p,** as in Fig. 150, and draw through the points **b, p,** and **d** the lines at right angles as **bq, st,** and **dr.** Transfer the length **il** to **bq** and to **dr,** also the length **ul** from **p** to **s,** and from **p** to **t.** Then draw the lines **qf, sf, tg,** and **rg,** which will complete one-half of the pattern.

To describe the pattern for a hexagon tray with tapering sides. The elevation and one-half the plan are shown in Fig. 151. To develop the pattern draw the perpendicular **bc**, Fig. 152, and draw the half-hexagon **efghi**, of the same size as **efghi** in Fig. 151. Divide the lines **hg** and **gf** into two equal parts and draw the lines **ak** and **am** through the points of bisection, then carry the length **ab**, Fig. 151, from **l** to **k** in Fig. 152. Draw through **k** the line **no** parallel to **hg**. Then take the **kl**, Fig. 151, and mark off the same from **k** to **n** and from **k** to **o**, and draw the lines **hn** and **go**. Proceed in the same manner to draw the remainder, which will complete one-half of the pattern.

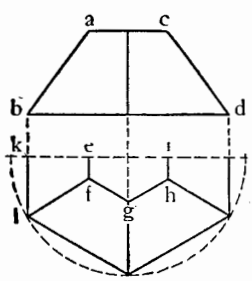


Fig. 151.

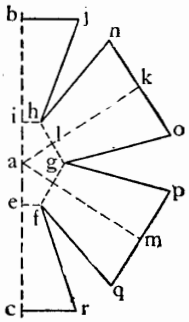


Fig. 152.

To describe the pattern for a diamond-shaped tapering body. The plan for the size and shape of top and bottom and the vertical height **fi** are shown in Fig. 153. Transfer the lengths **ac** and **ae** from **f** to **g** and **f** to **h** respectively, also the distances from **a** to **b** and **a** to **d**, to **il** and **ik**, and draw through **g** and **l** a line to cut the perpendicular at **m** and another line through **h** and

k to **m**. With the lengths **mg**, **mh**, **ml**, and **mk**, Fig. 153, as radii, describe the curves **g**, **h**, **l**, **k** from the center **m**, Fig. 154. Transfer the **ec**, Fig. 153, from **g** to **r** and from **g** to **n**, Fig. 154, also from **n** to **o** and **r** to **b**, and draw lines from **r**, **b**, **n**, and **o** to the center **m**. Connecting the points **br**, **rg**, **gn**, and **no**, also **ds**, **sl**, **lt**, and **tu** will complete the pattern.

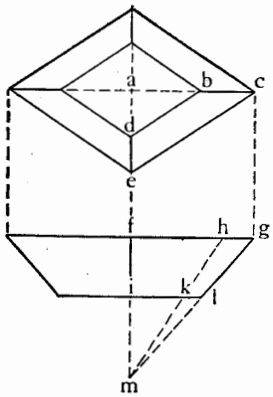


Fig. 153.

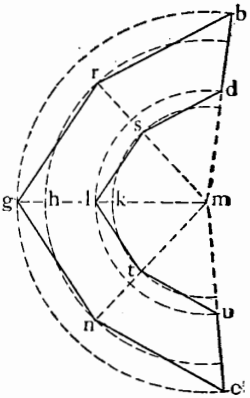


Fig. 154.

To describe the pattern for an oblique pyramid. The lengths of the sides are shown projected, **a′b** to **Cb′**, and **a′a** to **Cc′** giving for the true lengths **a′b′ and a′c′**. Take the length **a′c′** in Fig. 155, and with it strike the radius **a′c** in Fig. 156. With the length **a′b′** in Fig. 155, strike the radius **a′b** in Fig. 156. Take the length of one side as **ba** in Fig. 155, and set it off from **e** to **a**, and from **a** to **c**, from **c** to **b**, and from **b** to **e**. Connect the points of intersections of the arcs

by means of straight lines as **ae, ac, cb,** and **be.** Also **a′** with **e** and **e,** and the outline will be described.

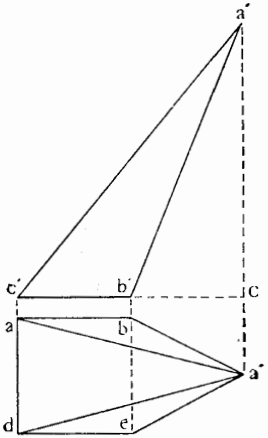


Fig. 155.

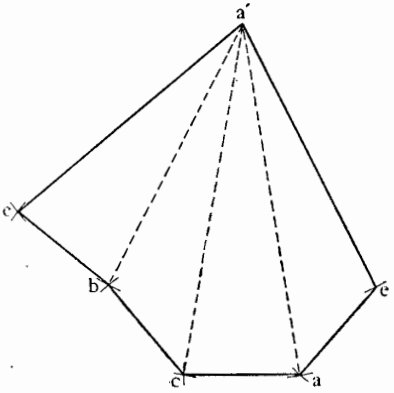


Fig. 156.

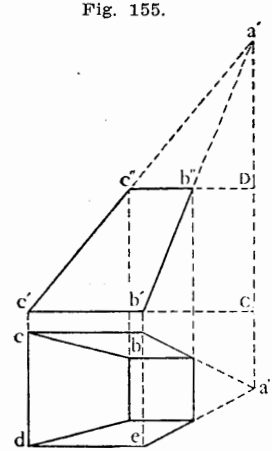


Fig. 157.

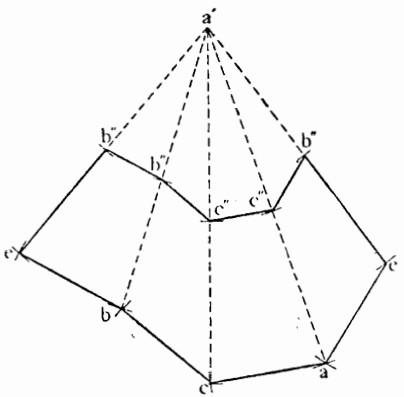


Fig. 158.

To describe the pattern for an oblique truncated pyramid. The correct lengths of the sides are shown projected in Fig. 157 as in the previous figure. The

lengths **ab″**, **ac″** on the plane **D**, are also the correct lengths for the sides of the small end of the pyramid. In Fig. 158 the outline of the base is developed precisely the same as in the previous example. To develop the top edge, the lengths **c′c″** in Fig. 157 are transferred to **ac″**, **cc″** in Fig. 158, and the lengths **b′b″** in Fig. 157 to **b′b″**, **eb″** in Fig. 158. Connecting these points with straight lines gives the outline of the pattern.

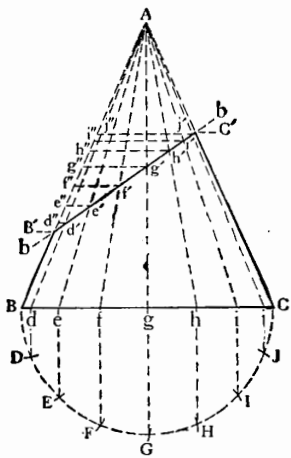


Fig. 159.

To describe the pattern for a cone cut in elliptical section. Fig. 159 shows the cone at **b-b**, the cut section forming or having the shape of an ellipse and Fig. 160 is the development of the lower part of the cone. Let **ABC**, Fig. 159, represent the outline of the cone. Strike a semicircle **BGC**, equal in radius to half the length of the base **BC**, and divide it into any num-

ber of equal parts as **B, D, E, F, G, H, I, J, C.** Carry perpendicular lines up to cut the line **BC** in **d, e, f, g, h, i, j,** and draw lines from these points to the apex at **A.** They will cut the diagonal **b-b** at **d′e′f′g′h′i′j′,** then carry horizontal lines from these points to meet the slant edge **B′A** in **d″, e″, f″, g″, h″, i″, j″.** Then the lengths **Bd″, Be″, Bf″, Bg″, Bh″, Bi″, Bj″,** will be the actual lengths of the lines **dd′, ee′, ff′, gg′,**

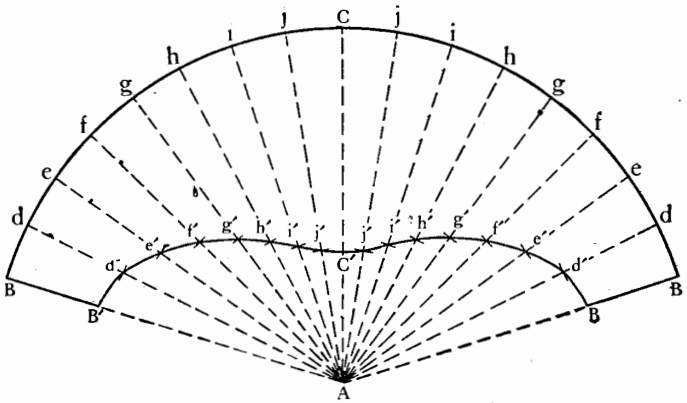


Fig. 160.

hh′, ii″, jj″ in Fig. 160. To describe the pattern take the length **AB** as a radius and strike an arc of a circle as **ABCD.** From the point **C** set off to the right and left the points **J, I, H, G, F, E, D, B,** using the lengths of the points of division in Fig. 159. Draw lines from the points of division to **A.** On these lines set off the projected lengths from Fig. 159 thus: Take the length **CC′** and set off from **C** to **C′** in Fig. 160. Take the length from **B** to **j′** and set it off from **j** to **j′** in Fig. 160. Take the length **B** to **i″** and set it off from **i** to **i′,** and so

on. A curve drawn through the points **c′, j′, i′, h′, g′, f′, e′,** and **d′** to right and left will give the shape of the pattern.

To describe the pattern of a round elbow at right angles. Draw **ABCFED,** which is the size of the elbow required. On the line **CF,** Fig. 161, strike a semicircle of the same diameter as the pipe. Divide the semicircle into any number of equal parts as **a, b, c,**

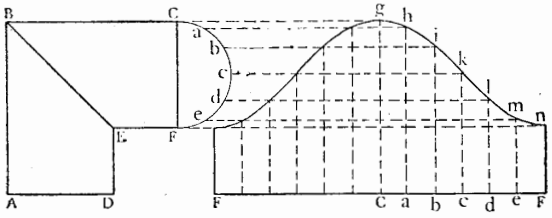


Fig. 161. Fig. 162.

d, e. Draw the line **FF** and make it equal to twice the length of the circumference of the semicircle in Fig. 161, by setting the parts **a, b, c, d, e** from **C** to **F** and **F** on each side, and draw the perpendicular lines **Fn, em, dl, ck, bi, ah, Cg.** Extend the line **BC** to cut the perpendicular **Cg,** and draw lines from the points **a, b, c, d,** and **e** in the semicircle to cut the perpendiculars at **h, i, k, l,** and **m.** Draw a curve through all the points of intersection, as **n, m, l, k, i, h,** and **g.** This will form the curve for half of the pattern.

To describe the patterns for two pipes which intersect at an angle. Let **DAEC** represent the larger pipe, and let **HFJG** be drawn to the required size of the pipe

that is to be connected with it at any desired angle. Draw the line **FG**, Fig. 163, at right angles with **FH**, on **FG** describe a semicircle, and divide into any number of equal parts, as **1, 2, 3, 4, 5**, draw lines through these points at right angles with **FH**. Then describe a semicircle **ABC** representing the diameter of the larger

Fig. 163.

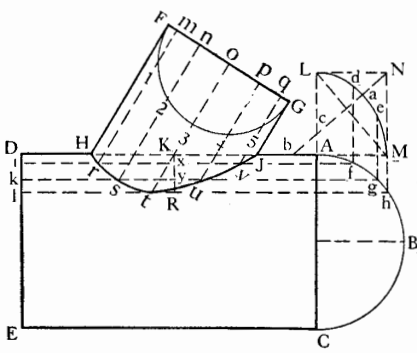
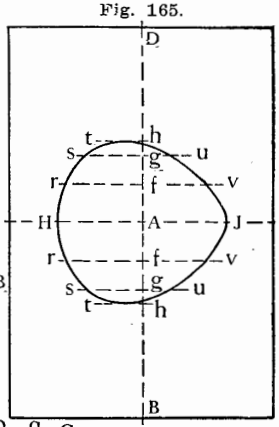


Fig. 165.



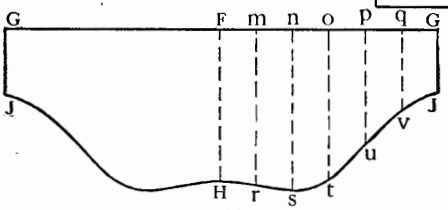


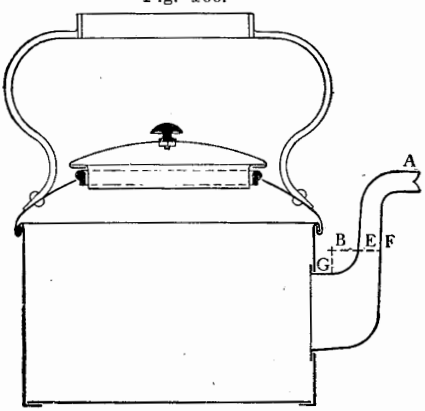
Fig. 164.

pipe, and extend the line **DA** to **M** and **CA** to **L**, take the radius **OF** of the smaller semicircle and from **A** mark off the same distance to **M**, then take the half length of the base of the smaller pipe as **K** to **H** or **H** to **J** and mark off a like distance from **A** to **L**. A quarter of an ellipse is required as shown from **L** to **M**, the

radius of which may be obtained in the following manner: Draw a line from **M** to **N**, also one from **L** to **N** at right angles, and draw the diagonal line **LM**; draw a line from the point **N** to cut the diagonal **LM** at right angles, producing the points **c** and **b**. With **c** as a center and radius **cL** draw a curve from **L** to **a**. With **b** as a center and radius **ba**, draw the remainder of the curve from **a** to **M**. Divide the curve from **L** to **M** into three equal parts, and then draw perpendicular lines from these points to intersect the semicircle **ABC**, as **df, eg, Mh**. Draw lines parallel to **AD** from **f** to **i, g** to **k**, and **h** to **l**. The points where these lines are intersected by the lines drawn from the semicircle on the smaller cylinder will be the points through which to draw the curve **r, s, t, w, v**. Draw the line **GG**, Fig. 164, equal to the circumference of the smaller pipe, or to twice the number of divisions in the small semicircle. Divide one-half of **GG** into six equal parts, as **Fm, mn, no, op, pq**, and **qG**. Draw perpendicular lines from **F, m, n, o, p, q**, and **G**. Take the length of the lines in Fig. 163, as **FH, mr, ns, ot, pu, qv**, and **GJ**, and transfer their lengths to the perpendicular lines marked by corresponding letters. Draw a curve through the points thus obtained, as **H, r, s, t, w, v**, and **J**. This will give the half-pattern for the smaller pipe. To obtain the curve for the hole in the large pipe. Draw **DB** and **HJ**, Fig. 165, at right angles, take the distances in Fig. 163, from **A to f, g** and **h**, and mark off like distances on each side of **A** in Fig. 165, on the line **DB**, as **f, g**, and **h**, and draw lines from these points parallel to **HJ**. Draw a perpendicular line from the point **K** to **R** in Fig. 163, and transfer the lengths **KH** and **KJ**, from **A** to **H** and **A** to **J** in Fig. 165, also the

distances **xr** and **xv** from **f** to **r** and **f** to **v** in Fig. 165, and the distances **y** to **s** and **y** to **u**, from **g** to **s** and **g** to **u**. Take the distance from **R** to **t** in Fig. 163 and mark off from **h** to **t** in Fig. 165. The curve drawn these

Fig. 166.



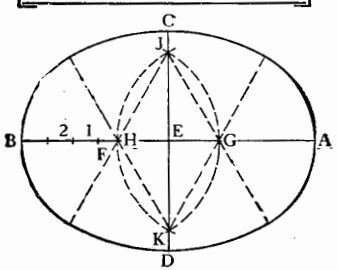


Fig. 167.

points will give the shape of the opening in the larger pipe.

To make a set of patterns for an oval tea-kettle. When getting out the patterns for an oval tea-kettle to hold 6 quarts. as shown in Fig. 166, first assume

a suitable length and width for the bottom, then a height suitable to the capacity required can be readily ascertained. As 6 quarts contains 346½ cubic inches, divide this quantity by the number of square inches in the bottom of the kettle and the quotient will be the height required. If the bottom of the kettle be 10 inches long and 7 inches wide, then

$$\frac{346.5}{10 \times 7 \times .7854} = 6.30 \text{ inches,}$$

the required height for the body of the kettle. Next determine the circumference of the kettle by first finding the circumference of a circle whose diameter is equal to half the sum of the length and width of the oval, thus

$$\frac{10 + 7}{2} = 8.5 \times 3.1416 = 26.70 \text{ inches,}$$

the circumference of the body of the kettle.

The body pattern shown in Fig. 168 is a rectangle 26.7 inches long and 6.3 inches wide, one-half an inch extra depth is allowed for forming cramps to hold the bottom in position while brazing, also one-half inch along the side for the seam. To draw the oval for the bottom, draw the axes **AB** and **CD** as in Fig. 167, intersecting at **E**, and mark the length and width of the oval upon them. Then mark the width **CD** from **A** along **AB**, as at **F**, and divide the difference between the length and width into three equal parts, as **1, 2, B.** From **E** mark a distance equal to two of these divisions on each side of the center line to the points **G** and **H.** Using the distance **GH** as a radius and **G** and **H** as alternate centers, describe the arcs **JHK** and **JGK** intersecting at **J** and **K.** Draw lines through **JG** and

JH, and **KG** and **KH**. With centers **H** and **G** and **BH** or **GA** describe the end arcs. With centers **J** and **K**, and radius **JD** or **KC**, describe the side arcs to join with the end arcs. This completes the oval.

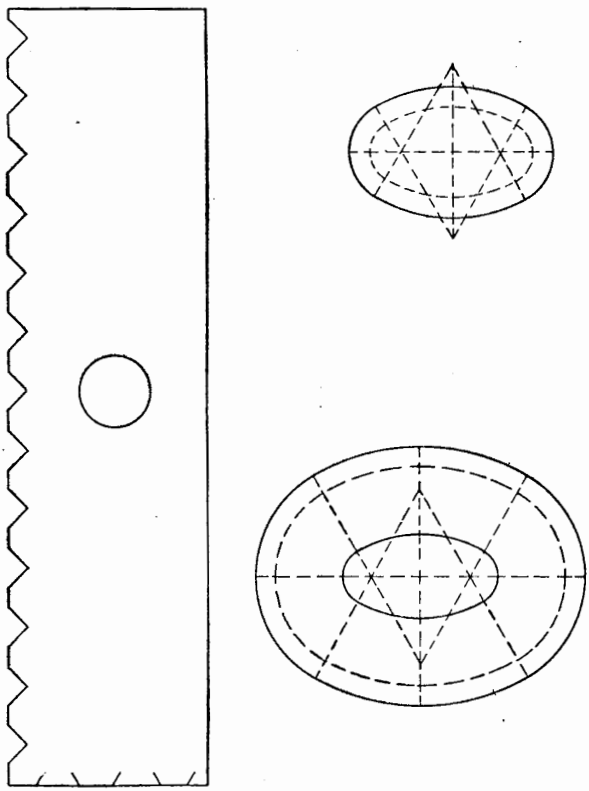


Fig. 168.

Lay out the pattern for the top shown in Fig. 168 in exactly the same manner, making due allowance for hollowing and edging, as indicated by the dotted lines.

Mark off the opening in the top for the cover, and using the same centers, describe the arcs required to form the cover opening. The pattern for the lid shown in Fig. 168 is also drawn in the same manner. The inner dotted lines are the same dimensions as the opening in the cover. Sufficient allowance should be made for the lap over the rim flange and also for hollowing.

To lay out the spout pattern approximately correct, draw a line as in Fig. 169, and set off **CD** equal in

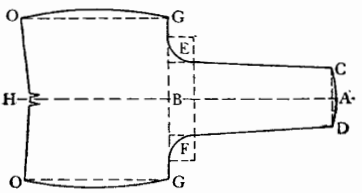


Fig. 169.

length to the circumference of the small end of the spout. From **A** to **B** mark a length equal to **AB** in Fig. 166, and through **B** draw a line at right angles. Make the length **EF** equal to the circumference **EF** in Fig. 166, and then draw the quarter circles at **E** and **F**, using the same radius as shown in Fig. 166. Draw **GC** equal to the straight length from the curve to the body on the inside of the spout at **G** in Fig. 166. From **GG** mark the lengths to **OO** equal to the circumference of the spout at the large end. Join these points to the center line at **H**, sloping them at the same angle as the base of the spout. Notch the center and cut a cramp at the top and bottom of the seam, as shown. The rim for the lid is a narrow strip of metal equal in length to the circumference of the hole, with a suitable allowance for lap at the seam.