PART X

CIRCULAR SHEET METAL WORK

PATTERNS FOR SPHERES, LOUVRES, PANELS, FINIALS, DORMER AND BAY WINDOWS, CORNICES, AND SEGMENTAL PEDIMENTS

THE general principles underlying the development of patterns for all curved work are the same, yet there are well defined conditions to be observed. The intelligent mechanic will consider the nature of the curved object he is to make, before averaging the flare, in determining the blank or pattern. Most cornice moldings are stamped or pressed, providing there is enough of the work to pay for the making of the dies. When but a small amount of work is required, the molds are usually made by hand. This applies also to spheres, urns, finials, etc., which are usually spun on a lathe, from sheet zinc or copper in case a large quantity is required. On occasions only one large finial may require to be made, so that it would not be profitable to prepare dies or a set of chucks. In such cases it is more economical to hammer this work by hand. The procedure for determining the patterns for hand and for machine work varies, according to the methods following.

SPHERE OR BALL, HAVING HORIZONTAL ZONES

Solution 88

Spheres to be hammered by hand are usually made in two styles, as shown in Fig. 320. That illustrated in diagram A is made of horizontal zones, while that shown by B is made up in vertical gores. As an example there is shown in Fig. 321 the method of developing the patterns for a ball in eighteen pieces made up in horizontal zones. The principles set forth are alike applicable to any number of zones.

First draw a circle whose diameter corresponds to the size of ball required; divide half the circumference into ten spaces or such number of spaces as are required to form the ball, as indicated by A, B, C, D and E. Pattern A is merely a round piece of metal with enough stock added to allow for raising or bumping up and for laps. To obtain the pattern of the piece A, it is required to divide the arc A^1 A A^1 into a number of equal spaces, eight in this case. Extend the chord A^1 A^1 both ways outside of the circumference of the circle and set off on it these eight spaces. This will give the diameter at pattern A to which lap must be added.

Line *x y* divides the circle into halves, one half only being needed to develop the patterns. To get the remaining patterns, for instance that for C, draw a line tangent to the arc included between *a′* and *d′* intersecting the vertical center line in O^4. Divide the arc into three equal spaces as shown by *a b c d* and set off these spaces on the line just drawn from O^4 to *d′*. This will give the width of pattern C. With O^4 as a center and O^4 *d′* as a radius describe another arc. Divide the semicircle 1 5 *d* into a

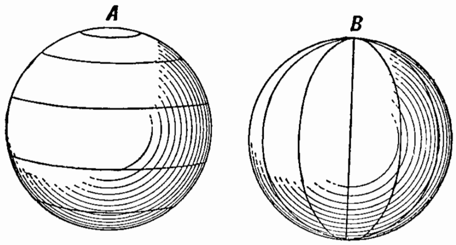

Fig. 320.—Sheet Metal Spheres

number of equal spaces, eight in this case, as shown by 1, 2, 3, 4, 5, 6, 7 and *d,* and transfer them to the arc, previously drawn from *d′* by corresponding numbers 1′, 2′, 3′, etc. This will give the half pattern for zone C. Repeat this operation with all the zones as B, D and E. This is classed under approximate pattern developments, as every pattern must undergo the raising or bumping up process.

For pattern A two pieces will be required. For patterns B, C, D and E, four pieces each are wanted, making in all eighteen pieces.

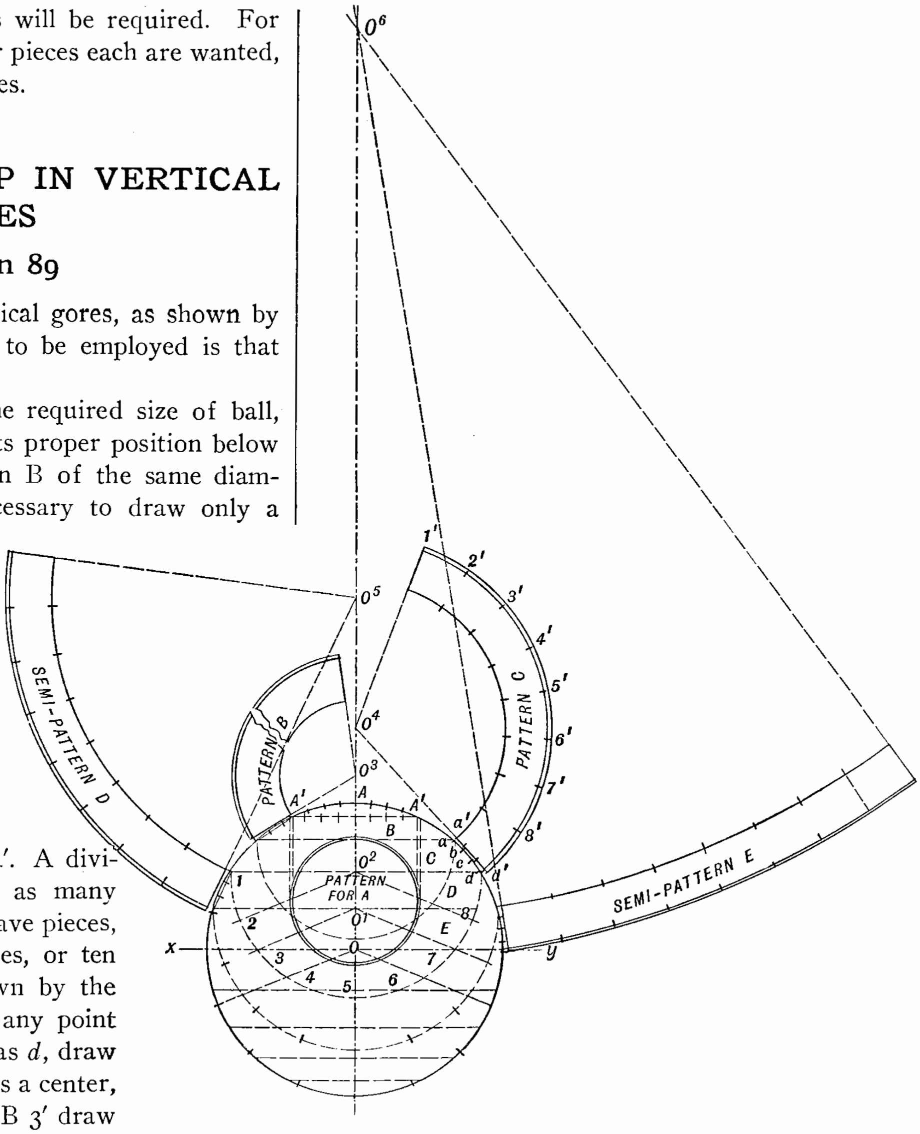

Fig. 321.—Patterns for a Ball in Eighteen Pieces. Made in Horizontal Zones

SPHERE MADE UP IN VERTICAL GORES

Solution 89

If a ball be made of vertical gores, as shown by B in Fig. 320, the method to be employed is that shown in Fig. 322.

Draw the elevation of the required size of ball, as indicated by A, and, in its proper position below the elevation, draw the plan B of the same diameter. In practice it is necessary to draw only a one-quarter elevation and a one-quarter plan. Divide the elevation into an equal number of spaces, as shown by the small figures 1 to 4. From these small figures drop perpendicular lines to cut the horizontal line drawn from the center B in plan, at 1′, 2′, 3′ and 4′. A division of the half plan into as many spaces as the half ball is to have pieces, gives in this case five spaces, or ten for the entire ball, as shown by the small letters *a* to *f*. From any point next to the center line B 4′, as *d*, draw the joint line *d* B. Using B as a center, with radii equal to B 2′ and B 3′ draw short arcs, cutting the joint line *d* B at 2″ and 3″.

The pattern for one of the sections may now be laid out as follows:

Draw any vertical line, as C D, upon which place the girth of the half elevation 1 to 1, as shown by similar figures 1 to 4 to 1 on C D. Through these small figures draw lines perpendicular to C D, as shown. Measuring from the center line B 4′ in plan step off the distances along the arcs 2′ to 2″, 3′ to 3″ and 4′ to 4″ (not straight across) and place them on similarly numbered lines in the pattern, measuring in each instance from and on either side of the line C D, thus obtaining points *h, i*, etc. Trace lines through points thus obtained, as shown; these will outline the desired pattern, of which ten will be required. These gores require to be raised on the block with a raising hammer, care being exercised that the curve in elevation is used as a profile along 1-1 in the pattern and that the curve in plan is used as a profile along *h i* in pattern. Allow edges for soldering.

CONSTRUCTION OF A BASEBALL

Solution 90

Fig. 323 shows four views of a baseball, each view representing a one-quarter revolution of the ball. The covering of the baseball has a peculiar cut, by which but two pieces of material are required. The seam line is shown by the illustration in four positions. The method of laying out an *approximate* pattern is indicated in Figs. 324 and

325. Some trimming will be required in joining the seam, since an accurate pattern cannot be developed, because the surface has a double curvature and more will depend upon the skill of the mechanic with the raising hammer than upon the pattern, which at best is only approximate, as stated. To develop the approximate pattern proceed as follows:

Let A in Fig. 325 represent the elevation of the ball. Using the radius with which the circle was

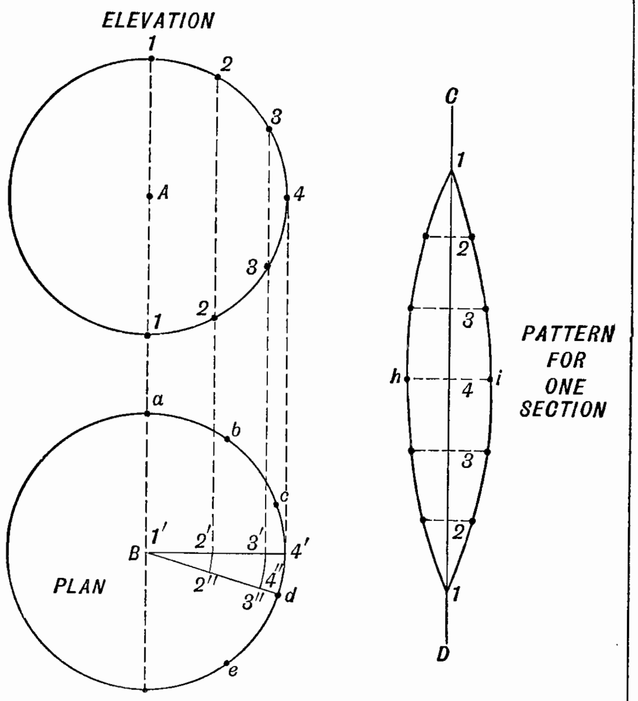

Fig. 322.—Pattern for Ball in Ten Pieces Made in Vertical Gores

drawn, step off the circumference of the circle, which will result in six divisions, as shown from 1 to 6 to 1. Next take the girth of five divisions from 1 to 6 and place them on any line as B-C, shown from 1 to 6. Bisect this length 1-6 and obtain point *a*, through which at right angles to 1-6 draw the line 1°-6°, making *a*-1° and *a*-6° equal respectively to the girth of *a*-1 and *a*-6 in elevation. Thus the distance from 1 to 6 in the pattern takes up the girth from 1 to 6 in the elevation, while the distance from 1° to 6° in the pattern takes the remainder of the girth from 1 to *a* to 6 in elevation. In practice it is necessary to obtain only a one-quarter pattern and then duplicate it by the method hereinafter described. Space the distance from *a* to 1 in the pattern in

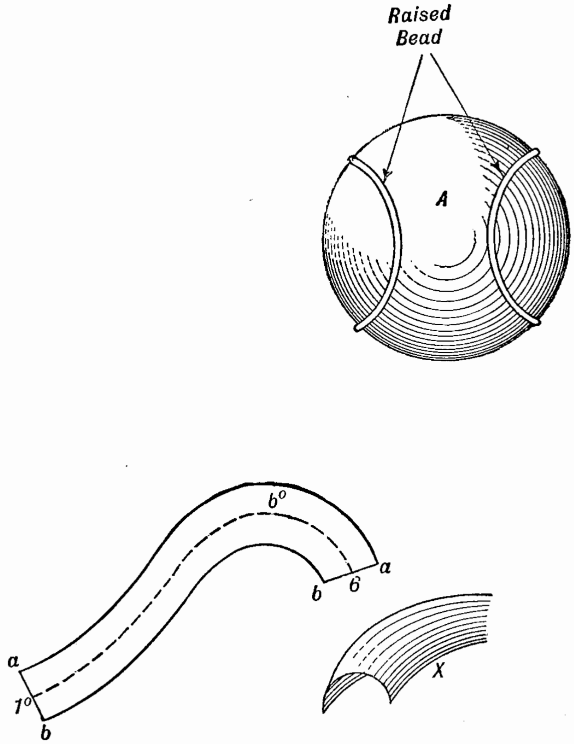

Fig. 324.—Method of Raising the Beaded Seam for Ornamental Purposes

three parts as shown by *a*-*b*-*c*-1 and through *b* and *c* draw perpendicular lines indefinitely. Make the distances *c*-*b′* and *c*-*b″* in the pattern equal to one of the spaces as *c*-*b*. From *b′* draw a line parallel to B-C, to meet the line erected through point *b* at X. In a corresponding manner draw from 1° a line to intersect *b*-X at Y. Bisect X-Y and obtain point *d*.

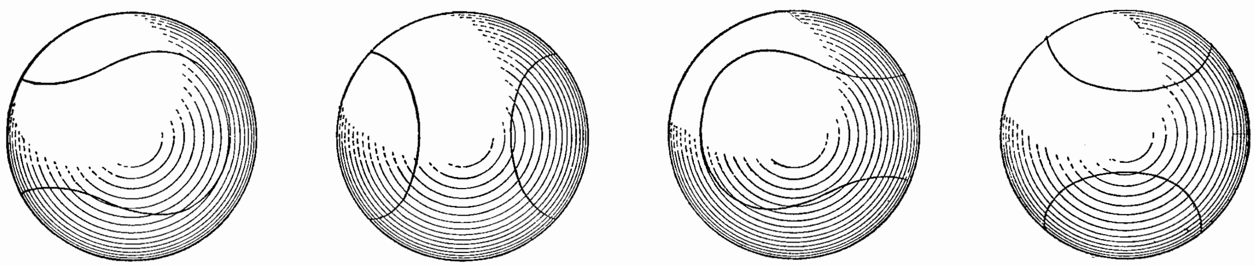

Fig. 323.—Four Views of a Baseball Showing the Seam Line Which Makes a Quarter Revolution in Each View

Next, from point 1, draw a symmetrical curve through points b'-d-l° as shown and trace this outline below the line 1-a as shown by 1-b''-d'-6°. Proceed to trace the half pattern opposite 1°-6° as shown by 1°-b°-6-b^x-6°. Then will 1-1°-6-6°-1 represent the approximate pattern shape, of which two will be required to make up the ball.

Care must be taken when raising the ball on the raising block to hammer up true to the circle shown in elevation. When joining the ball, the edges of the pattern must be trimmed for an accurate fit. It will be understood that in the process of manufacturing base balls, the leather covering of the ball can be moderately stretched to fit. In making a

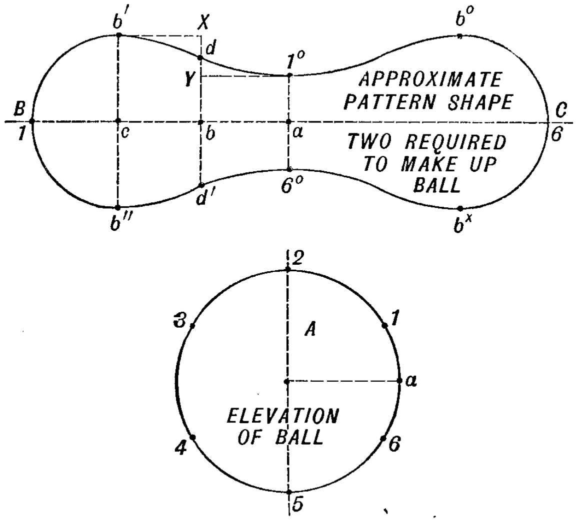

Fig. 325.—Elevation of Ball with Method of Obtaining an Approximate Pattern

ball of sheet metal constant care is required for hammering the material to the given profile, which must fit the sphere in whatever position the profile is placed as, of course, its spherical surface is always the same. The making of sheet metal base balls for ornamental purposes does not usually involve the use of the seam as shown in Fig. 323, but spun balls or those hammered in the usual manner are employed, and on the spheres the outline of the base ball seam is marked with a crayon when, on these lines, a raised bead is soldered, as shown in the illustration A in Fig. 324. Assuming that the outline 1°-b°-6 in the pattern in Fig. 325 has been transferred as shown by 1°-b°-6 in Fig. 324, simply add one-half the girth of the desired bead, on either side of and parallel to the line 1°-b°-6 as indicated by a-a and b-b at both ends. Lines are drawn as shown. Four of these patterns are required and the small raising hammer is employed for raising in a manner alike to diagram X. As previously stated, much depends upon skill with the hammer for obtaining satisfactory results.

CIRCULAR LOUVRES

Solution 91

In Fig. 293 is shown a view of a round ventilator containing circular louvres, which are marked A A. The method of striking the pattern is shown in Fig. 327. Here A B represents the center line of the ventilator. Using C as center, draw the half plan of the ventilator, also the location of the two

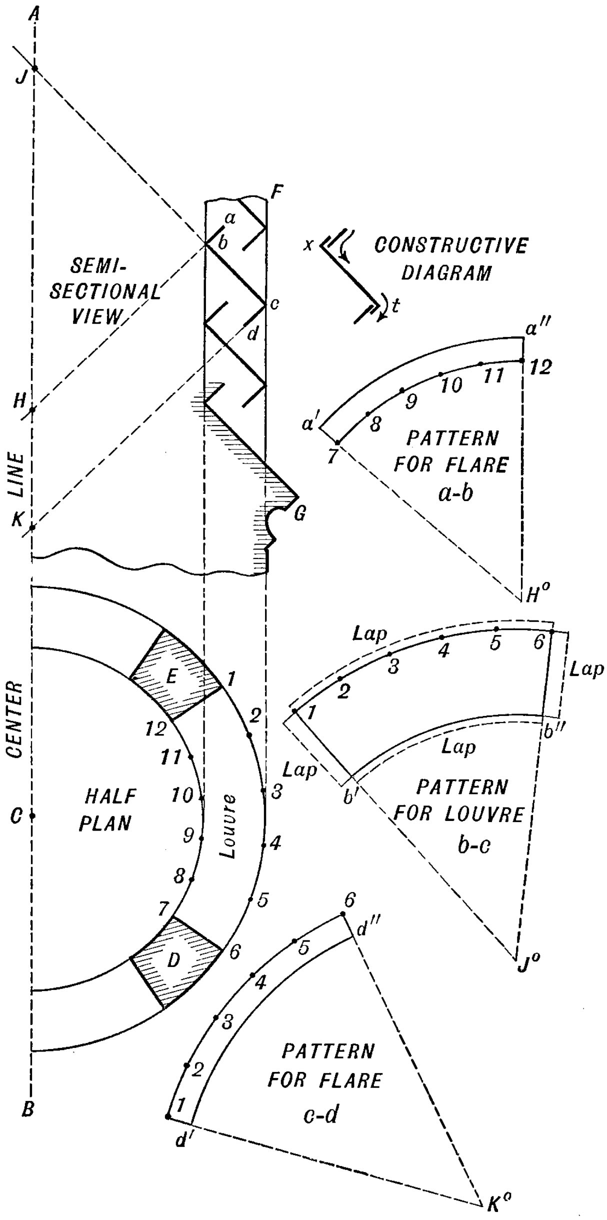

Fig. 327.—Patterns for Louvres in a Circular Ventilator

columns D and E, the full ventilator having four columns. Above the plan in its proper position draw part of the semi-sectional view showing one or more louvres, as indicated by one marked *a b c d*, since the pattern for one will serve for all. Now it is necessary only to extend the lines of the louvre *a b, b c* and *c d* until they intersect the center line A B at H, J and K respectively.

To obtain the pattern for the flare *a b*, use as radii H *b* and *H a* and, using H° as center describe the arcs 7-12 and *a′ a″*. Starting from 7 in the pattern, lay off the girth from 7 to 12 in plan, which is the plan view through the corner *b* of the louvre in the sectional view. All this procedure is shown by the corresponding numbers in the pattern. Draw radial lines from H° through 7 and 12, cutting the outer arc at a′ and a″, thus forming the desired pattern.

The pattern for the louvre b c is found by using J *b* and J *c* as radii and describing the arcs *b′ b″* and 1-6, using J° as center. The girth from 1 to 6 in the louvre pattern is obtained from 1 to 6 in the plan, which represents a section through the corner *c* of the louvre in the sectional view. In a similar manner is obtained the pattern for the flare *c d*, all as indicated by similar reference numbers. Laps are allowed on the louvre patterns, as shown by the dotted lines; this allows the water to pass over, as indicated in the constructive diagram *x t*.

COVE MOLD IN A CIRCULAR PANEL

Solution 92

A finished view of a circular panel having a cove mold is shown in Fig. 328. The rule here given

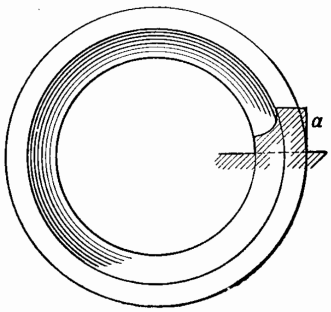

Fig. 328.—Front View of a Circular Panel with Section of Cove Mold

for developing the blank applies to panels made up by hand, when the cove is made separately and soldered in position, as shown in the view of construction diagram in Fig. 329. When it is desired to hammer up or raise this cove, in one full circle, a special method is required to determine the girth of the pattern, as follows:

First, draw any vertical line, as A B, and to the right, as shown, construct the half sectional view

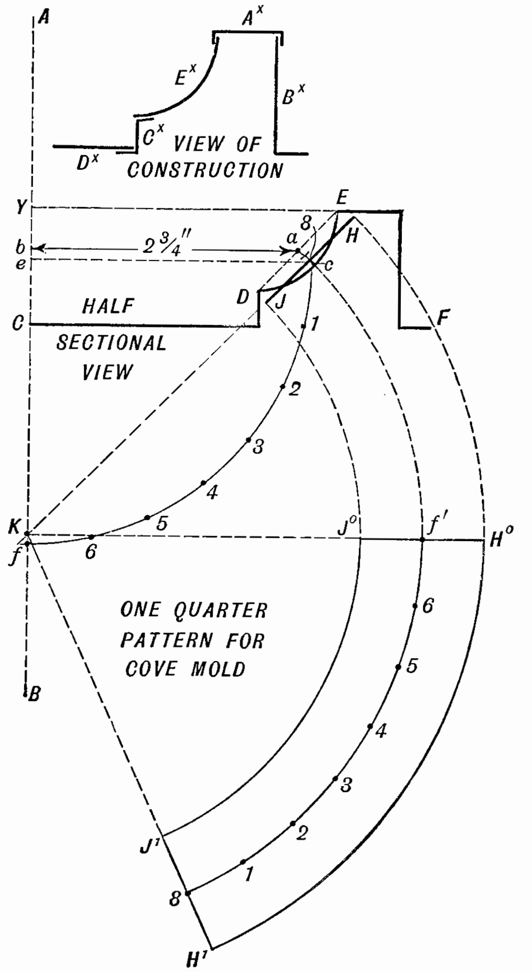

Fig. 329.—Pattern for Cove Mold in a Circular Panel

of the panel, as indicated by C D E F. Connect the corners of the cove by the line D E, which bisect and obtain *a*. From *a* draw a line at right angles to D E, meeting the cove at *c*. Divide the distance *a c* into as many parts as the semi-diameter *a b* has inches. It is assumed that the distance *a b* is 2¾ in., which represents 3. Any fraction less than one-half is not taken into account, while any fraction greater than one-half represents one. This rule applies to any diameter. Since *a b* counts as 3, simply divide the distance *a c* into 3 parts, as shown, and through the first part *nearest the mold,* marked 8, draw a line parallel to D E until it intersects the center line A B at K. From this first division 8 draw a horizontal line to intersect the center line A B at *e*; using *e* as a center, with *e*-8 as radius, draw the quadrant 8-*f*, as shown; divide this into equal spaces as shown from 8 to 6.

The one-quarter pattern may now be laid out as follows: Take the girth of the mold from *c* to E and from *c* to D and place it, as shown, from 8 to H and 8 to J. Using K as center, with radii equal to K J, K 8 and K H, draw arcs, as shown. Draw any radial line as H° K cutting the center and inner arc at *f′* and J° respectively. Take the girth of the quadrant 8 *f* and set it off on the center arc in the pattern from f′ to 8, as shown by similar numbers. From K draw a line through 8, intersecting the inner and outer arcs at J^1 and H^1 respectively. J° J^1 H^1 H° is then the desired quarter pattern. If preferred, this pattern may be made in one piece, by joining the four quarters, when the seam can be riveted and the blank raised to the required profile E *c* D. If this panel be made by hand, its construction is as follows: Referring to the view of construction, A^x is a circular ring whose inside radius is Y E in the sectional view, while D^x is a flat disc, whose radius is C D. B^x and C^x are straight strips, while E^x is the curved mold. Note where edges are allowed for soldering.

QUARTER ROUND MOLD IN A CIRCULAR PANEL

Solution 93

Fig. 330 shows the method of averaging the profile and developing the pattern for a quarter round mold in a circular panel. Draw the center line A B and in its proper position the outline of the panel indicated by C D E F G. The following method will provide for the stretching of the quarter round mold required in this case, as well as to the stretching of all molds of this shape:

Drawn a line from E to D, bisect it and obtain *a*. From *a* and at right angles to E D draw a line intersecting the mold at *b*. Through *b* and parallel to E D draw a line, until it meets the center line A B at H. Take the girth of the mold from *b* to E and from *b* to D and set it off from *b* to K and from b to J. From *b* draw a horizontal line to intersect the center line at *c*. Using *c* as center, with radius equal to *c b*, draw the quadrant *b* H; space this into equal divisions, as shown from 1 to 7. This quadrant then represents a quarter section on the line *b c*. Using H as center, with radii equal to H J, H b and H K, draw the arcs as shown. Starting from any point on the center arc, as b′, lay off the girth of the quadrant *b* 4 H as shown by similar numbers and letters in the pattern. From the center H draw radial lines through *b′* and H° cutting the inner and outer arcs as shown. J^1 K^1 K° J° then

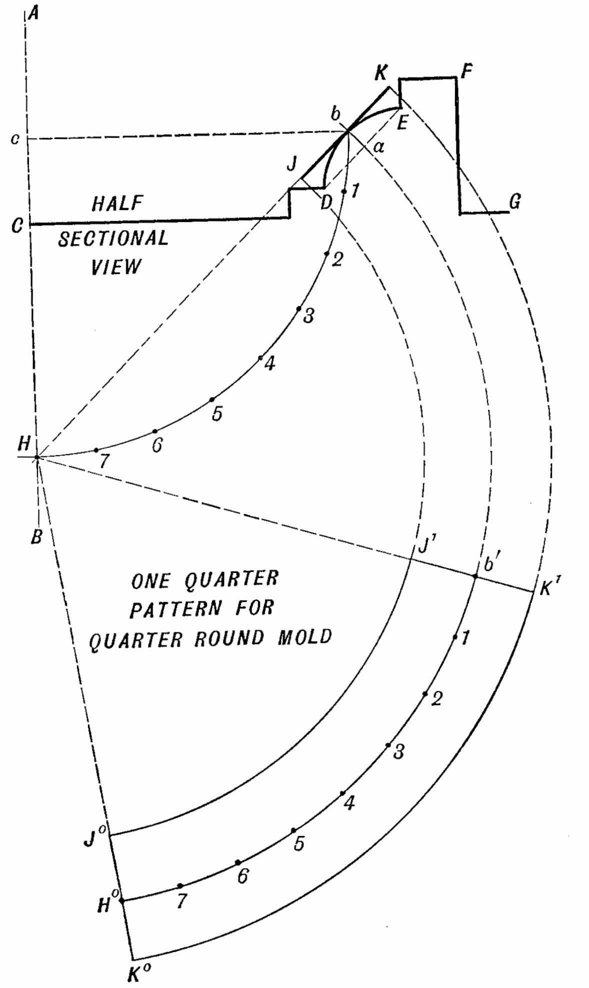

Fig. 330.—Pattern for Quarter Round Mold in a Circular Panel

represent a quarter pattern. In reference to the stretching of the mold, point *b* in the profile remains stationary, while *b* K and *b* J are stretched over the blow horn stake until it has the shape indicated by *b* E and by b D, respectively. The method of constructing the panel is alike to that explained in the preceding problem.

REVERSED OGEE IN A CIRCULAR PANEL

Solution 94

The pattern for an ogee or a reversed ogee in a circular panel is laid out as shown in Fig. 331. Here, as before, the center line A B is first drawn and to the right thereof the outline of the panel profile is drawn, as shown by C D E F. Through the flare of the reversed ogee D E draw the line H J, extending it until it meets the center line A B at G. Take the girth of the mold from *a* to E, and

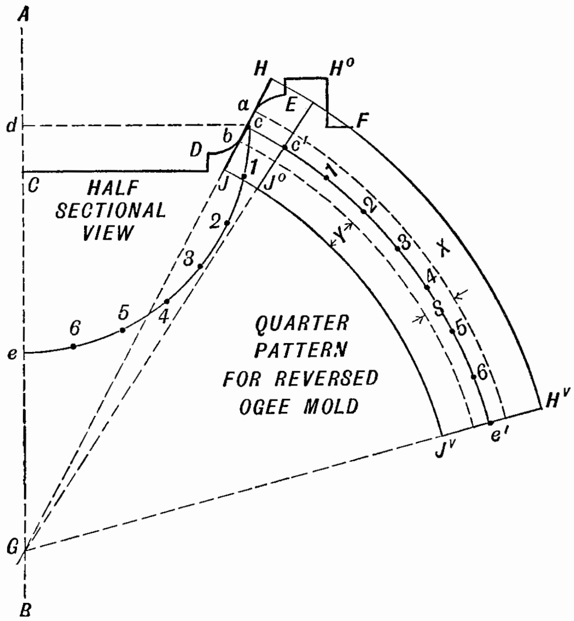

Fig. 331.—Pattern for Reversed Ogee Mold in a Circular Panel

from *b* to D and place it on the line H J, from *a* to H and from *b* to J. H J shows the girth of the mold E *c* D. Bisect *a b* and obtain *c* and from this draw the horizontal line *c d*. Using *d* as a center, with *d c* as radius, draw the quadrant *c e*; divide this into equal spaces, as shown from 1 to 6. Using G as center, with radii equal to G J, G *b*, G *c*, G *a* and G H, draw the arcs shown. From any point, as *c′*, on the center arc, lay off the girth of the quadrant *c e*, as shown by similar letters and numbers in the pattern. From G draw radial lines through *c′* and *e′* cutting the inner and outer arcs as shown. H° H^v J^v J° then represents the quarter pattern. That portion of the pattern indicated between the arrows or S remains stationary, while that part marked X will be stretched and the portion marked Y will be raised. Care should be taken when raising and stretching not to go inside the lines on either side of S. When the panel is small, the pattern can be made in one entire piece, riveting the seam; if the panel is large, the pattern can be made in halves or quarters.

ROUND FINIAL FOR CIRCULAR TOWER

Solution 95

In Fig. 332 is shown a photographic view of a round finial on a circular tower roof. The method of developing these various patterns is alike applicable to any profile or diameter of finial. Fig. 333 shows a front elevation of the finial, the numbers indicating the patterns, of which there are five. In order that one may proceed intelligently with the development of the patterns, it will be necessary to know just where and how the seams in the finial are to be made. For this purpose Fig. 334 has been

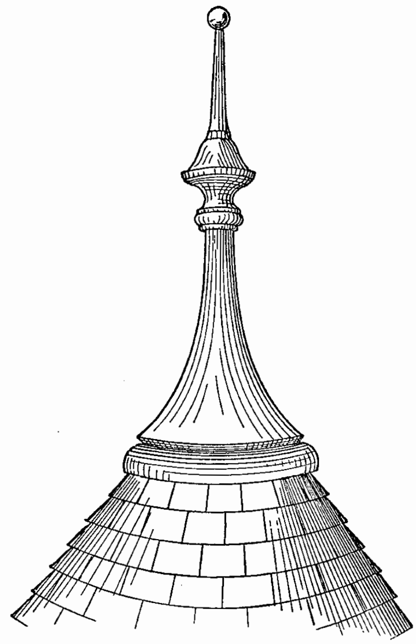

Fig. 332.—View of a Finial on a Circular Tower Roof

prepared. Note the flanges and joints from A to R; also that the bead J is soldered separately to the flat band H at *a* and *b*. The method of obtaining the pattern for the mold 1 between the arrow points in Fig. 333 is laid out as shown in Fig. 335. In this figure A B is the center line, on either side of which the profile of the mold is drawn, as shown. In practice only a one-half elevation is required.

Pattern for Flare

To obtain the pattern for the flare 1-2 simply extend this line until it meets the center line A-B at A. With *a* as center and *a* 2 as radius describe the quarter circle 2-10; divide this into parts as shown by the small figures 2 to 10. With radii equal to A 1 and A 2 and with A^1 as center describe the arcs $1'$-2° and $2'$-10. Starting from $2'$ set off the girth of the quarter circle 2-10, as shown by similar numbers in the pattern. From A^1 draw

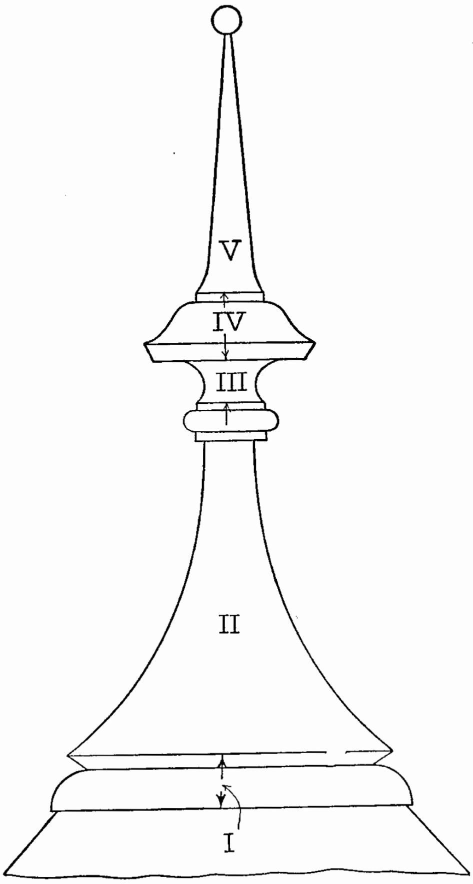

Fig. 333.—Front Elevation of Finial

radial lines through $2'$ and 10 intersecting the outer arc at $1'$ and 2° respectively. $1'$-$2'$-10-2° represents the one-quarter pattern for the flaring strip.

Pattern for Quarter Round

To obtain the correctly averaged line and pattern for the quarter round mold 2-*c*-11, the following rule gives accurate results:

Draw a line from 2 to 11, bisect it and obtain 12. From point 12 and at right angles to 2-11 draw a line meeting the mold at *c*. From 12 draw the horizontal line meeting the center line at *b*. Let us assume that this distance 12-*b* measures 6 in., and divide the line 12-*c* into six equal parts or, in other words, into as many parts as the semi-diameter 12-*b* measures in inches. Through the first part nearest the mold (as 13), and parallel to 2-11, draw a line until it intersects the center line A B at B. Space the mold 2-*c*-11 into equal divisions, as shown by the small dots, and take the girth from *c* to 2 and from *c* to 11, and place it on the averaged line just drawn, as indicated from 13 to 2^v and from 13 to 11^v, respectively. Using B-2^v, B-*c* and B-11^v as radii, with B^1 at the right as center, draw the arcs 2^{vv}-2^{vv}, $13'$-$21'$ and 11^{vv}-11^{vv}. From point 13 on the averaged line draw a horizontal line intersecting the center line A B at *d*. Using *d* as center and with *d*-13 as radius draw the quarter circle 13-21, and divide into equal parts, as shown. Take the girth of this quarter circle, and starting from any point on the center arc in the pattern, as $13'$, step off these divisions, as shown from $13'$ to $21'$. Draw lines from B^1 through $13'$ and $21'$ intersecting the inner and outer arcs, as shown. 2^{vv}-11^{vv}-11^{vv}-2^{vv} gives the quarter pattern for the quarter round mold, which must be raised on the raising block.

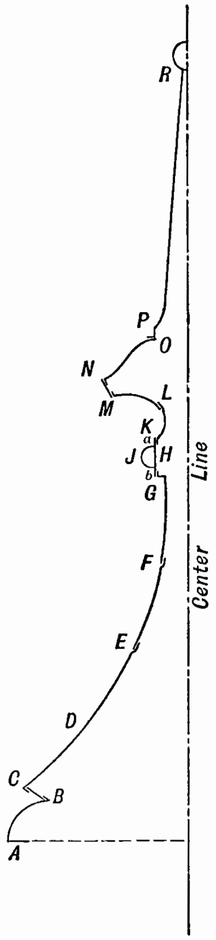

Fig. 334.—One Half Construction Drawing, Showing Location of Seams and Method of Lapping

Pattern for Curved Shaft on Bead

To obtain the pattern for the curved shaft and bead marked II, in Fig. 333, follow the method illustrated in Fig. 336. Here the full elevation is drawn but only a half elevation is required in practice. After the elevation of the shaft, fillet and bead has been drawn, erect the center line X Y, as shown, and space the shaft into as many parts as it is to contain pieces. In this case four parts are employed, as shown by I° to IV°, the dotted lines representing the seams. In laying out work of this nature it is preferable to introduce a few more seams, thus saving time and labor incident to stretching or hammering, for the more numerously seams are introduced, the nearer to a straight line will be the sections, thus necessitating but little hammering. In making up the bead a seam is introduced into its center, as shown, so that the pattern for one half can be used for either side. The method of laying out the raised bead, is similar to that employed in the preceding problem. Draw a line from 1 to 2 in the half bead, bisect it and obtain 3. From 3 draw the horizontal line meeting the center line X Y at 4. Assume that 3-4 measures 2 in., and divide the line 3-5, which is drawn at right angles to 1-2, in two parts as shown by *x*. Through *x* parallel to 1-2 draw the line to intersect the center line X Y at A. From *x* draw the horizontal line *x a*; using *a* as center and with *a x* as radius, draw the quadrant 5-10; space this into convenient parts, as shown. Take the girth of the half bead from 5 to 1 and from 5 to 2, and place it on the averaged line, shown from *x* to 1′ and *x* to 2′. 1′-2′ then

The pattern is obtained as follows: Using *b* as center and *b* 11 as radius, draw the quarter circle 11-15, and space this as desired. Space the curve or profile, as indicated by 16, 17, 18. Take four times the girth of the quarter circle 11-15 and set it off on the vertical line 11′-11^x at the left, and make the distance of 11′ to 16′ to 18° equal to 11 to 16 to 18 in elevation. Complete the rectangle in pattern for I°, as shown by 11′-18°-18^x-11^x. The part between 11′ and 16′ in pattern for I° remains straight, while that part from 16′ to 18° will be stretched to conform to the curve 16-17-18 in elevation.

The method hereinafter given to obtain the pat-

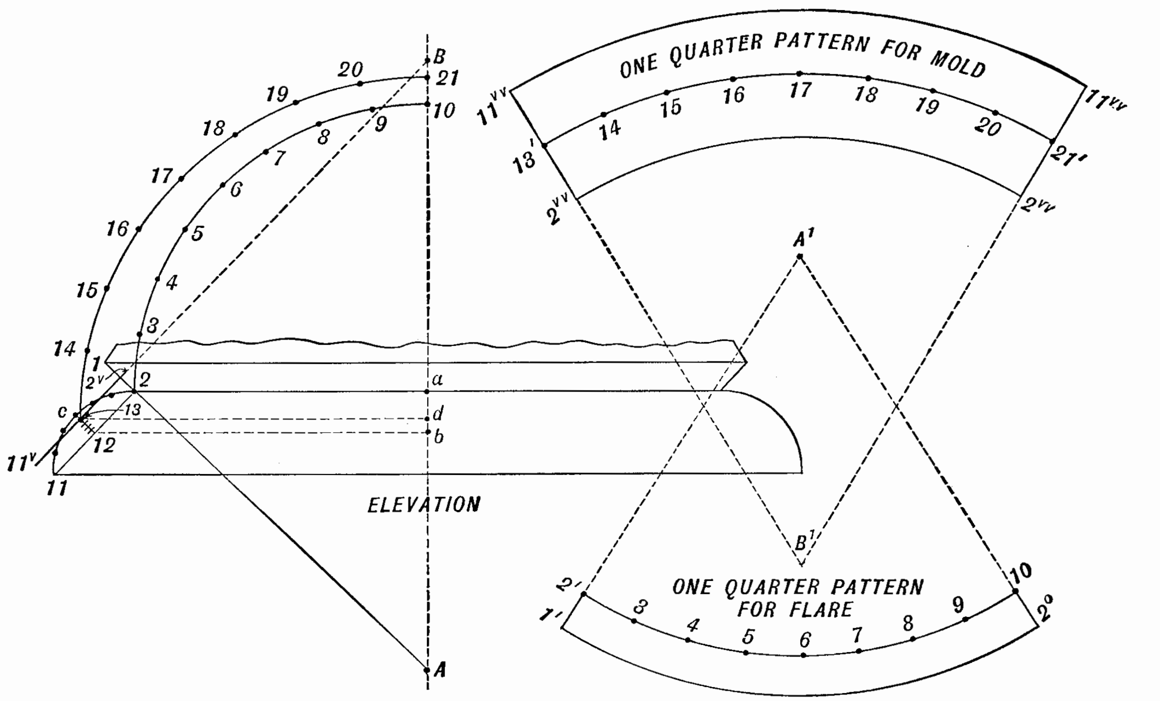

Fig. 335.—Patterns for Base Mold

shows the amount of material required to form up the half bead. With radii equal to A-1′, A-*x* and A-2′, and using A^1 as center, draw arcs as shown by similar numbers. Starting on the center arc at X°, lay off four times the girth of the quarter circle *x*-10 in elevation, as shown by similar numbers in the pattern. From A^1 draw radial lines through X° and X^x intersecting the inner and outer arcs as shown. 2° 2^x 1^x 1° then gives the full pattern for the half bead. Respecting the pattern for the upper part of the shaft marked 1°, note that a perfect cylinder occurs up to 16, when it gradually curves to meet the top of H°. In cases of this nature a cylinder is used, made up of number 24 iron, or copper and flanged at the bottom.

tern for II° will also apply to III° and IV°, so that care should be taken to follow each step carefully, as III° and IV° will be but briefly described. Draw a line from the extreme points in the mold II°, as shown from 18 to 19. Bisect the mold and obtain point 20. This represents the stationary point from which the true girth measurement can be obtained. Through point 20 and parallel to 18-19, draw a line until it intersects the center line at *b*. From 20 draw a horizontal line until it intersects the center line at *c*. Using *c* as center and with *c* 20 as radius, describe the quadrant *c*-20-25, which space up as desired. This quadrant represents the quarter section on the line 20 *c*. Take the girth of the mold 20 to 18 and 20 to 19 and place it on the averaged line, as shown from 20 to 18″ and from 20 to 19″. Using *b* 18″, *b* 20 and *b* 19″ as radii, with *b′* to the right as center, draw arcs as shown by similar numbers. Take twice the girth of the quadrant 20-25, and, starting on the center arc in the pattern at 20^x, set off the proper number of spaces, as shown from 20^x to 25 to 20^v. Draw lines from the center *b′* through 20^x and 20^v intersecting the inner and outer arcs, as shown. 19^x-19^v-18^v-18^x then gives the half pattern. To obtain the radii for III°, a line is drawn through 27 (the bisection of the curve 19-26), parallel to 19-26, until it meets the center line at B. The girth of the mold 27-19 and 27-26 is now placed as shown by 27-19″ and 27-26″. The quarter section on the line 27-*d* is struck by using *d* as center. Then B-19″, B-27 and B-26″ are used in striking the arcs of the pattern shown in Fig. 337, while the girth along 27-27 in this pattern is twice the girth of 27-33 in the elevation in Fig. 336. The pattern for the lower section IV° is obtained in precisely the manner specified in the preceding problems, all as shown by similar letters and figures in Fig. 338. Laps are to be allowed on all patterns for riveting and soldering.

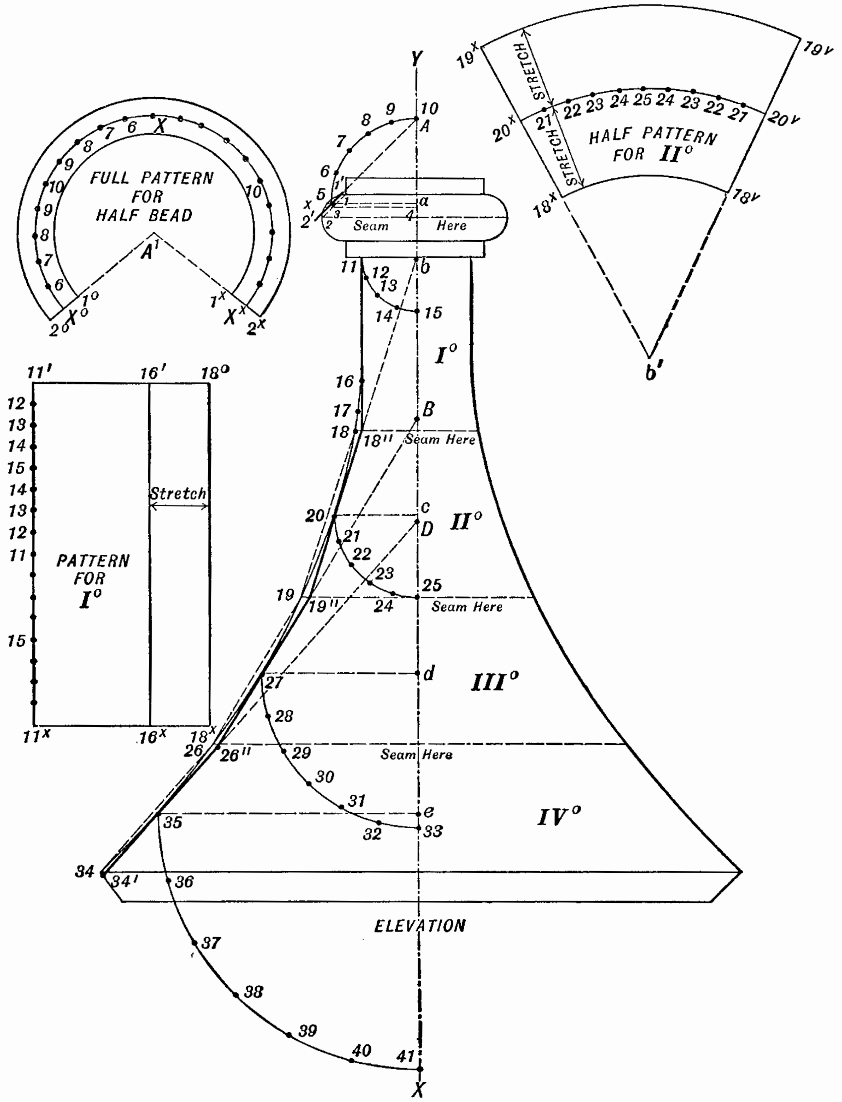

Fig. 336.—Obtaining Radii and Patterns for Bead and Shaft

Gothic Mold

For the pattern of the gothic mold marked III in Fig. 333, proceed as shown in Fig. 339. Draw the elevation of the mold and through it the center line. In this case it is assumed that the mold 2-3 is to be made in two pieces with a seam at 1. Should the mold be large, two or more seams can be made, the patterns being developed in a manner to be described. Since the mold is to embody two parts, with a seam at 1, draw a line from 2 to 1 to 3. Bisect the mold 2-1 at 4, and from 4 draw the horizontal line meeting the center line at *a*. Use *a* as a center with radius *a*-4 and draw the quadrant *a*-4-9 and divide this into equal parts, as shown. Through 4 and parallel to 2-1 draw a line cutting the center line at A. Take the girth of the mold

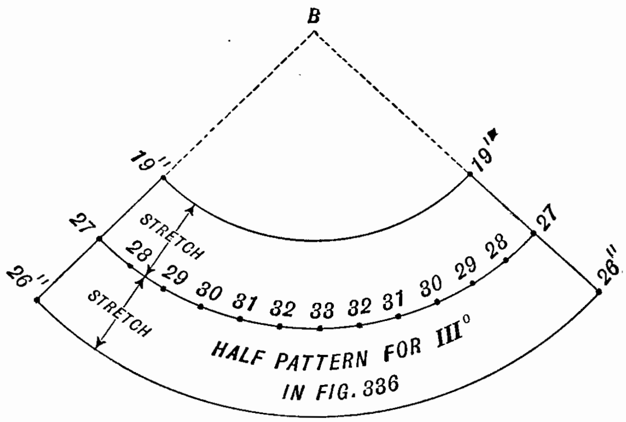

Fig. 337.—Half Pattern for Portion of Shaft III° in Fig. 336

from 4 to 2 and from 4 to 1 and place it on the averaged line, as shown from 4 to 2′ and 4 to 1′. With radii equal to A-1′, A-4 and A-2′ and using A^1 as center, describe the arcs, as shown by similar numbers. Take the girth of the quarter circle, shown from 4 to 9 in elevation, and step off four times the number of spaces (20), starting at 4° on the center arc in the pattern, as shown from 4° to 4^x. Draw radial lines from A^1 through 4° and 4^x intersecting the inner arc at 1° and 1^x and the outer arc at 2° and 2^x. 2°-2^x-1^x-1° is the full pattern for the upper part of the mold, which requires to be stretched. In other words, the point 4 in the elevation represents the stationary point, while that part from 4 to 2′ and from 4 to 1′ must be curved to the shape shown by 4-2 and by 4-1 in the profile.

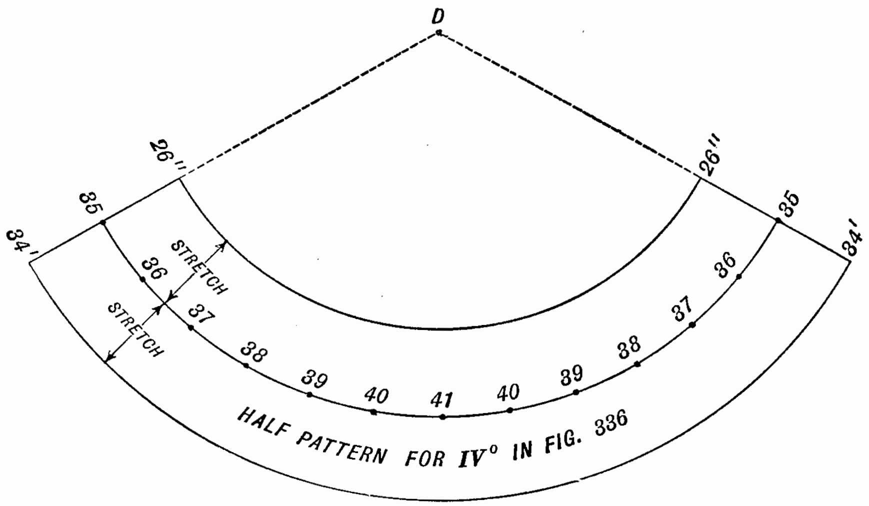

Fig. 338.—Half Pattern for Portion of Shaft IV° in Fig. 336

The pattern for the lower part of the mold is obtained in a similar manner. Draw a line from 1 to 3, then bisect the mold 1-3 and obtain point 12; through this point and parallel to 1-3 draw a line to intersect the center line at B. Take the girth of 12-14-3 and of 12-13-1 and place it on the averaged line, as shown by 12-14′-3′ and 12-13′-1″. From 12 draw the horizontal line 12-*b*, and, using *b* as center, draw the quarter section on the line 12-*b*, as shown by 12-18; space this, as shown. The pattern is now laid out, as shown to the left, using as radii B-1″, B-12 and B-3′, all as indicated by similar numbers in the pattern. The pattern is shown entire, by the use of four times the girth of the quadrant 12-18 in elevation. Laps are to be added to these net patterns.

Pattern for Reversed Ogee and Flare

For the pattern of the reversed ogee and flare, marked IV in Fig. 333, proceed as shown in Fig. 340. Draw the elevation of the ogee, and, in its proper position, draw the center line A B. Extend the flare 1-2 until it meets the center line at A. Using *a* as a center, with *a*-2 as radius, draw the quarter section 2-8; divide this into equal parts, as shown by the small figures. With A as center and with radii equal to A-1 and A-2 draw the arcs shown. From any point on the outer arc, as 1′, draw a radial line to A, intersecting the inner arc at 2′. Starting from 2′ lay off double the girth of the quarter section 2-8, as shown from 2′ to 8 to 2° in the pattern. From A draw a radial line through 2° cutting the outer arc at 1°. 1°-2°-2′-1′ then becomes the half pattern for the flare.

The pattern for the ogee, no matter what its

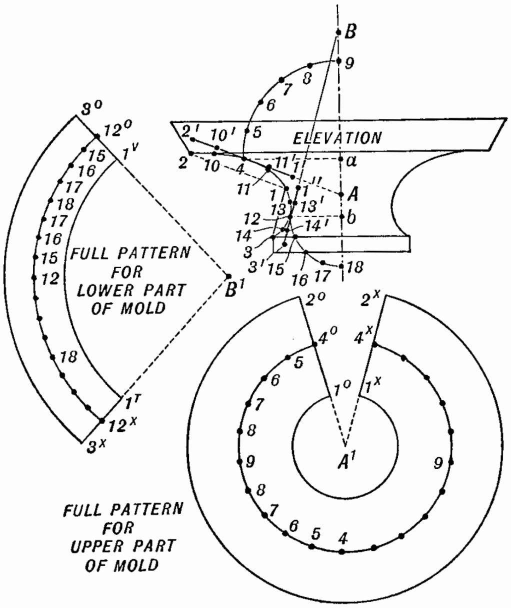

Fig. 339.—Patterns for Lower Part of Cap

position (reversed or otherwise), is developed as follows:

Divide the curved part of the ogee into equal spaces, as shown by 9-10-11 and by 12-13-14-15. Through the flaring part 12-11 draw a line intersecting the center line at B. From either point 11 or point 12, in this case from 11, draw a hori-

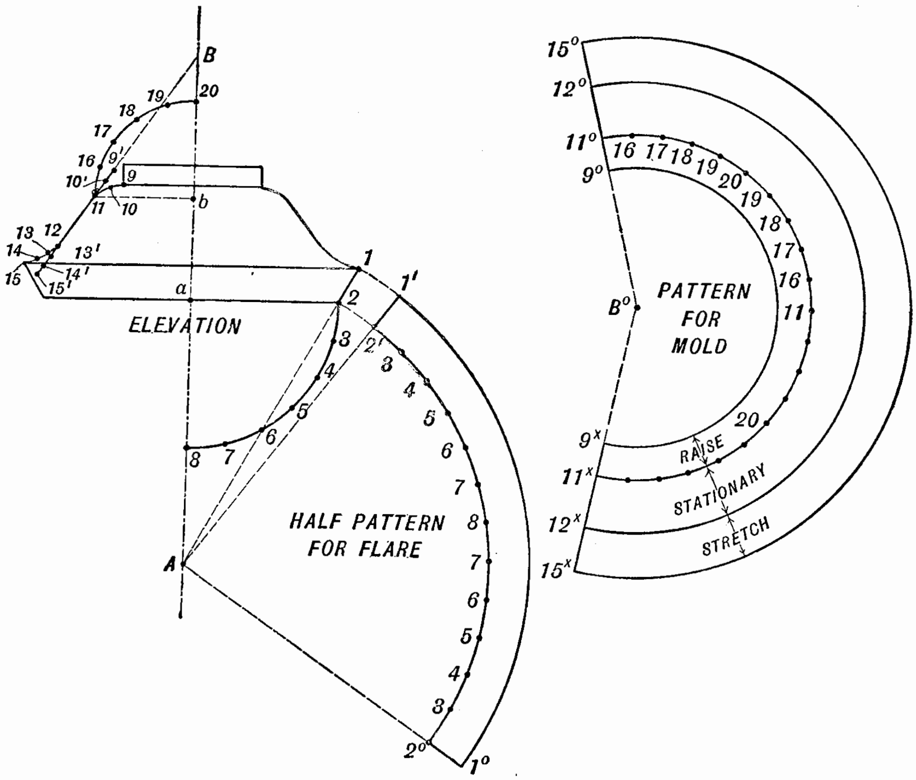

Fig. 340.—Patterns for Upper Part of Cap

zontal line intersecting the center line at *b*. With *b* as center and with *b*-11 as radius draw the quarter circle 11-20; space this at will. Take the girth of the mold from 11 to 9 and from 12 to 15 and place it on the averaged line from 11 to 9′ and from 12 to 15′, respectively. 9′-15′ then represents the amount of material required to form up the ogee. With radii equal to B-9′, B-11, B-12 and B-15′ and using B° as center, draw arcs to any length, as shown by similar numbers. As the quarter section 11-20 in elevation is taken from point 11 in the profile, then starting from any point on the arc 11° in the pattern, lay off four times the number of spaces contained in the quarter section 11-20 in elevation, as shown by similar numbers in the pattern. From B° draw radial lines through 11° and 11^x, cutting the arcs shown. 15°-15^x-9^x-9° is the full pattern for the ogee mold. That part of the pattern between 9^x and 11^x has to be raised, while the part between 12^x and 15^x requires to be stretched, 11^x-12^x remaining stationary. Laps are to be allowed for riveting and soldering.

Pattern for Spire

The pattern for the spire, indicated by V in Fig. 333, is laid out as shown in the final pattern in Fig. 341. Through the center of the elevation of the spire draw the center line shown and at A intersect it by the taper 4 B extended. As the curved part at its base will be added to the tapering spire pattern and stretched, divide the lower curve from 4 to 1 into any desired number of parts, as shown by the small figures. From 4 draw the horizontal line to intersect the center line at *a*. Use *a* as center and draw the quarter section on *a*-4, as shown; space this as desired. Using A as center and with radii equal to A B and A 4, draw arcs as shown. From any point, as 4′, on the lower arc, step off four times the number of spaces contained in the quarter section, as shown by similar numbers in the pattern. From A draw to any length radial lines through 4′ and 4°, cutting the

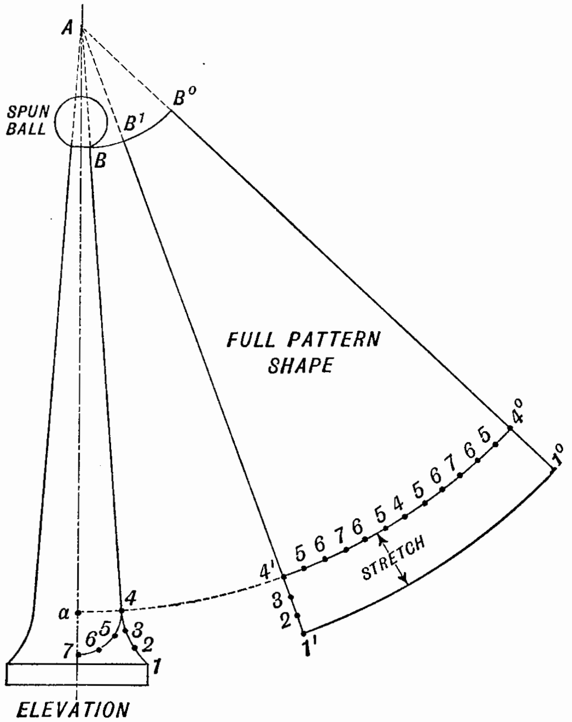

Fig. 341.—Pattern for Spire

upper arc at B^1 B° as shown. Take the girth of the curve from 4 to 1 in elevation and place it on the lines extended in the pattern from 4′ to 1′ and from 4° to 1°. Using A as center and with A-1′ as radius draw the outer arc 1′-1°. Allow laps for riveting and soldering. The ball shown at the top is usually spun.

Cases which Arise in Laying Out Circular Moldings Made by Machine

The method of averaging the profile of moldings made by machine differs from that just considered.

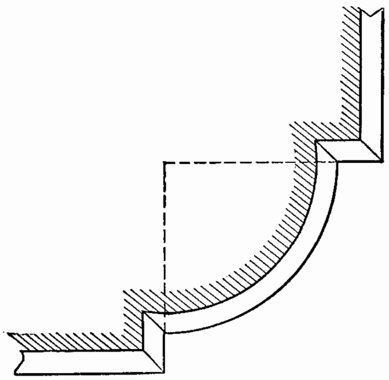

Fig. 342.—A Molding Curved in Plan, as Required when a Horizontal Cornice Sets Over the Rounded Corner of a Building

A circular molding may be concave or convex in plan, or it may be concave or convex in elevation. The significance of this is indicated in the four accompanying illustrations. In Fig. 342 is shown

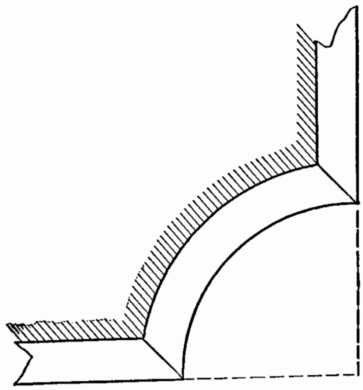

Fig. 343.—A Molding Curved in Plan, but in an Opposite Direction.

the plan of a molding such as is required when a horizontal cornice sets over the rounded corner of a building, which is convex, while Fig. 343 shows the same molding curved in plan, but in an opposite direction, which is concave. The method of proceeding with a development such as is shown in Fig. 342 is taken up in the course of this discussion. Corresponding principles would apply in the example of Fig. 343, simply reversing the averaged line. This statement applies also to curves made in

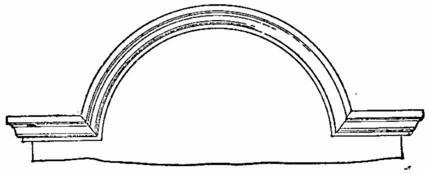

Fig. 344.—A Molding Curved in Elevation, as in a Circular Pediment

elevation. Fig. 344 shows a molding curved in elevation, as in a circular pediment, while Fig. 345 shows a molding, also curved in elevation but in an opposite direction.

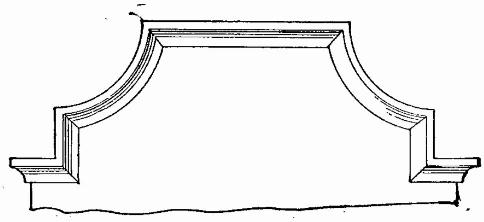

Fig. 345.—A Molding Curved in Elevation but in an Opposite Direction

Whatever the averaged line for the convex curve, in Fig. 344 may be, it should be reversed in averaging the profile in a concave molding as represented by Fig. 345.

AVERAGING PROFILE AND DETERMINING PATTERN IN THE CURVED MOLDING OF A DORMER WINDOW, MADE BY MACHINE

Solution 96

Fig. 346 presents a view of a dormer window,

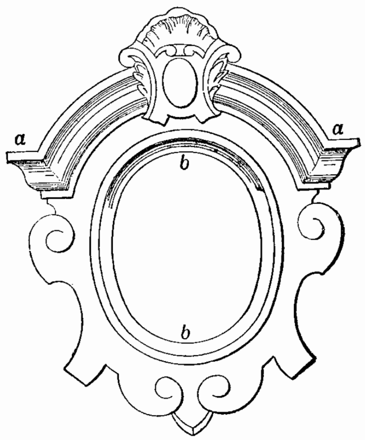

Fig. 346.—View of Dormer Window

having a segmental top mitering to the horizontal moldings at *a a*. The window opening is to be elliptical, as indicated at *b b*. The method of averaging the profiles for this dormer is shown in Fig. 347, where a one-half front elevation is shown by A C D B. The center from which the segmental curve is struck is indicated by E, while the curves of the elliptical window opening are struck from the various centers E, P and O. As the profiles of the horizontal and curved molds are alike, take a tracing of the profile C, and place it in its proper position to the right of the center line A B, as shown by the dotted lines and as indicated from F to G. Below G draw the profile of the elliptical mold, as shown by G H. In averaging profiles for molds to be hammered by machine, the following method has afforded excellent service. Referring to the engraving, diagram A^x gives an enlarged view of the ogee and fillet for the dormer in question:

First, draw a line touching the extreme points inside of the profile, as shown by *a b;* then draw a line touching the extreme points of the outside of the profile, as shown by *c d*. Bisect the distance between the two lines, as at *e* and *i*, and draw the averaged line *i e,* as shown. The girth of the profile from *b* to *a* is now laid off on the line *e i,* starting invariably from a point nearest the lowest member *b*, as *f*. Assuming that this has been done in the profile F G, extend the averaged line J G until it meets the horizontal line drawn from the center E, at right angles to A B, at L. Take the girth of the mold from *r* to *s* and place it, as hitherto described, and allow a lap at top and bottom for joining, all as shown from G to J. With radii equal to L G and L J and using L° as center draw the arcs 1-6 and J^1 J°, respectively. Space the lower member of the curve in elevation, as shown from 1 to 6, and place these divisions on the lower curve in the pattern, also shown by similar numbers. J°-J^1-1-6 is then the one-half pattern. In practice more material is added to the pattern as allowance for trimming the miters on the curved mold.

The method of developing the pattern for the

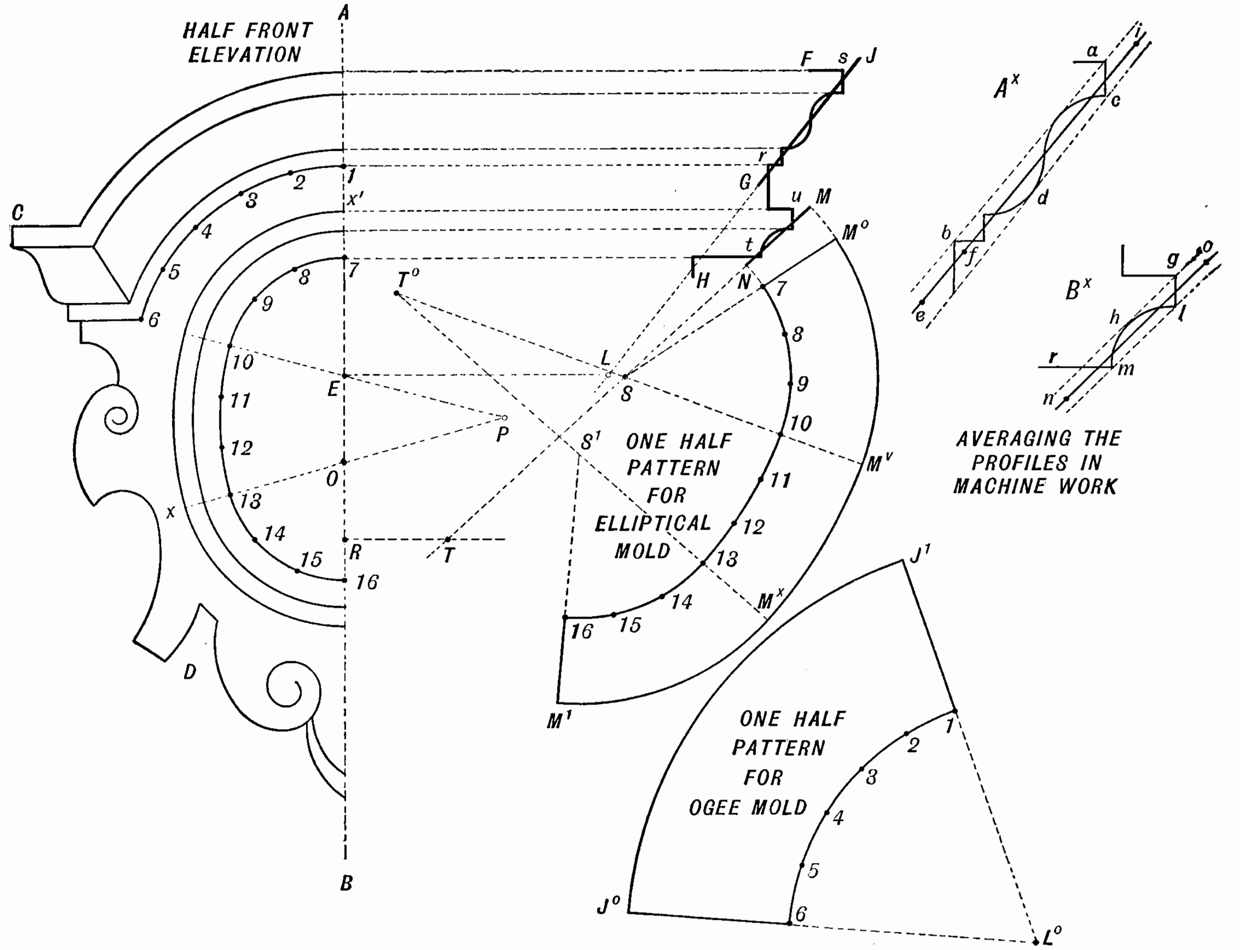

Fig. 347.—Averaging Profiles and Developing Patterns of Molds Made By Machine

horizontal mold C was previously explained. Let B^x represent the profile of the mold to go around the elliptical window frame; it is hammered up in one piece from *g* to *r*. In averaging this profile the method found in diagram A^x is followed. Draw the inner and outer extreme lines in B^x as *g h* and *l m*. Bisect the distance between these two lines, as *n* and *o*, through which the averaged line is drawn. In the same manner draw the averaged line M N through the profile *u t* in the elevation. As the half ellipse is struck from three centers, E, P and O, and as the radius E-7 is equal to O-16, take the distance of the radius *x* P and set it off on the center line, as shown from *x'* to R. From E and R and at right angles to A B draw to the right, lines of any length and intersect them by the averaged line M N extended at S and T respectively, which give the centers for striking the arcs in the pattern. Let N M represent the girth of the mold from *t* to *u*, obtained in the manner explained in connection with diagram B^x. Using S as a center and with S N and S M as radii, draw the arcs 7-10 and M° M^v, respectively. Space the curves of the inner elliptical arcs in elevation, as shown from 7 to 10, 10 to 13 and 13 to 16, having the points start and end on the radial lines there shown. Take the divisions from 7 to 10 and place them on the inner arc of the pattern, as shown by similar numbers. From the center S draw a line through 10, extending it to the right until it cuts the outer arc at M^v, and to the left to any length. Take the length of the radius from M to T and set it off from M^v to T° in the pattern; then, using T° as center and with T°-10 and T° M^v as radii, draw the arcs shown. Take the girth from 10 to 13 in elevation and place it in the pattern, as shown by similar numbers, and draw a line from T° through 13 until it meets the outer arc at M^x. Reproduce the pattern S M° M^v, as shown by S^1 M^x M^1, the distance from 13 to 16 on the inner arc being equal to 13 to 16 in the elevation. 7-16-M^1-M° then shows the half pattern for elliptical molding.

PATTERNS FOR CURVED MOLDINGS IN A CIRCULAR BAY WINDOW, MADE BY MACHINE

Solution 97

Fig. 348 is a view of a circular bay window in which the molds were hammered by machine. In this case we will take up only the method by which the patterns for the crown mold B are developed, as the principles are alike for laying out any other profile. In the previous solution the moldings were curved in elevation, while in this example they are curved in plan. Fig. 349 illustrates the method of procedure.

First, draw the wall line P-7 and at right angles thereto draw any line, as 12-D. On this line lay off the projection of the bay, as indicated from 1 to X, and, using the desired radius, as D 1, draw the arc 1-6. In its proper position above this plan draw the profile or sectional view A B C; project the points 7'-*a*-*e* to the plan and describe the arc 12-7 for measuring purposes. From D, the center from which the arcs in plan have been struck, erect the vertical line

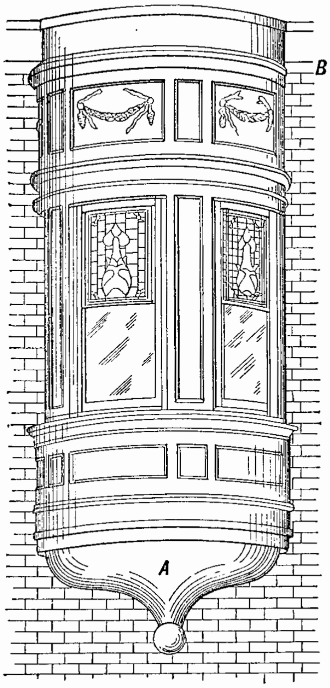

Fig. 348.—View of Circular Bay Window

D E. The mold A B C will be made up in three pieces, viz., the flare or wash A, the upper cove B and the lower cove C. These molds should be averaged in the way explained in connection with Fig. 347. When this procedure has been followed, refer to Fig. 349 and extend the flare A until it intersects the line D E at H. Using H as center and with radii equal to H *b* and H-7' draw the arcs to any length, as shown. Take the girth from 7 to 12 in plan and place it on the inner arc 7'-12 in the pattern, as shown. Draw a line from H through 12, intersecting the outer arc at M. M-*b*-7'-12 then shows the one-half pattern for the wash, to which laps are

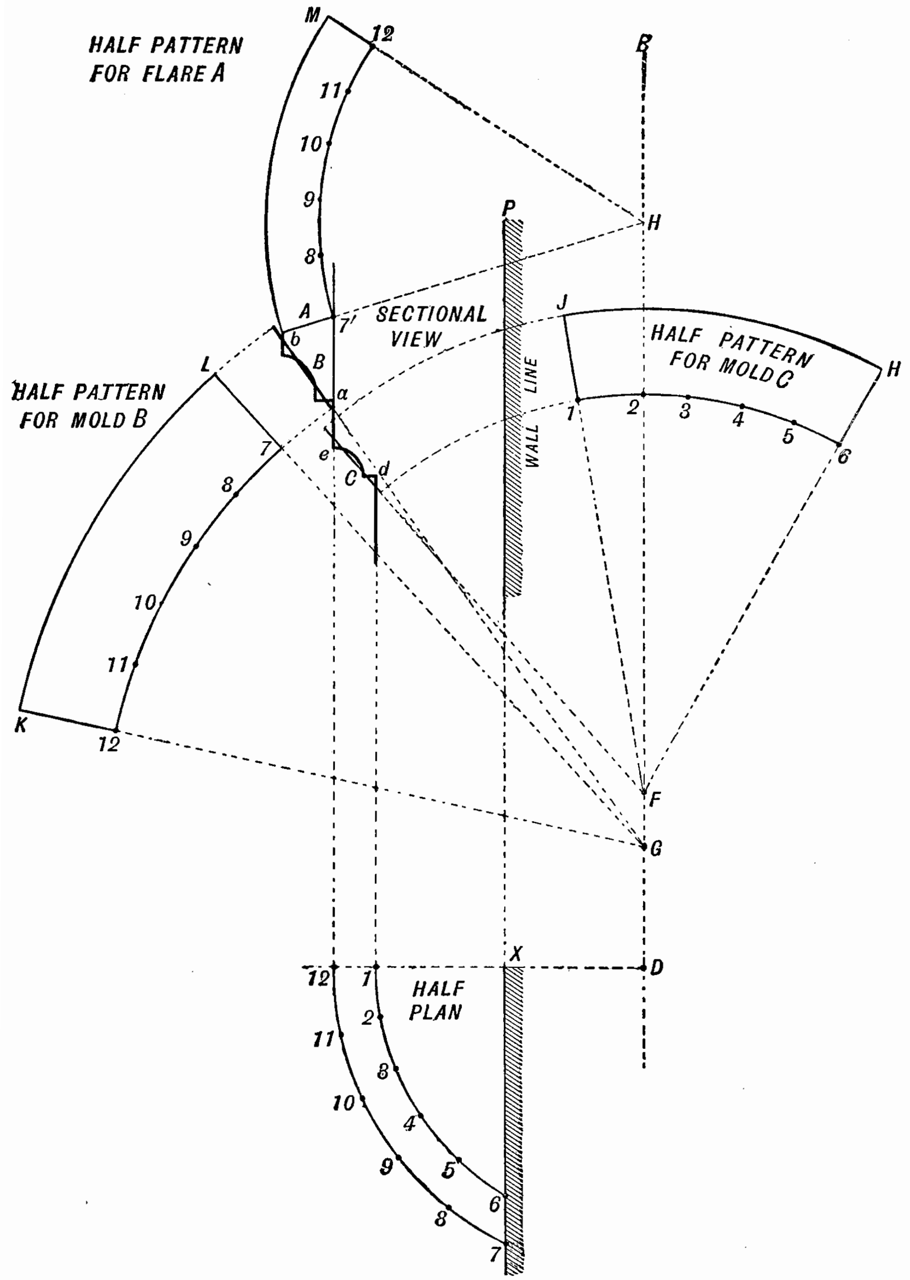

Fig. 349.—Patterns for Curved Molding in a Circular Bay Window Made by Machine.

for the mold C and is obtained by using F as center, with radii equal to F *d* and F *e,* averaging the line through the mold C, and obtaining the girth in the usual manner, as described in connection with mold B. Allow laps on all patterns for trimming, riveting and soldering.

MOLDED BASE IN A CIRCULAR BAY WINDOW

Solution 98

If the base of a circular bay window be molded, as shown by A in Fig. 348, the usual method is to hammer it up in horizontal sections, thus requiring flaring strips at various angles, as shown in Fig. 350.

In this illustration A represents the center from which the arcs in plan are struck, while the distance from X to B shows the extreme projection of the base. Through X the vertical line C K is drawn, representing the wall line both in plan and sectional view. In its proper position, as shown, draw the outline or profile of the base, and locate at will the

allowed. Draw the averaged line through the mold B until it intersects the line D E at G. Take the girth of the mold *a b* and set it off on the averaged line, as shown. Then, using as radii G *a* and G *b,* draw the arcs shown. Starting at 7 on the inner arc, lay of the girth of 7-12 in plan, as shown by similar numbers in the pattern. From G draw lines through 7 and 12 cutting the outer arc at L and K. 7-12-K-L then gives the one-half pattern for mold B in the sectional view. Allowance must be made at the ends of the pattern for trimming and fitting against the wall. J-H-6-1 shows the half pattern

horizontal seams in same, as shown by D, E, F, H, J. The spaces between these seams should not be made so wide that they may not be hammered with ease. Through A, the center from which the arcs in plan were struck, erect the line L M. From the various seam lines D, E, F and H drop lines in the plan to intersect the center line B X at *a, c, e* and *h.* Using A as center draw the various arcs *a b, c d, e f,* and *h i,* which we will use in obtaining the lengths of the several patterns. Extend the averaged lines through the profile until they intersect the line L M, as follows: Draw a line through D E until it intersects L M at L; through E F to intersect at P; through F H to intersect at N; and through H J to intersect at O. Using L as center, strike the pattern R, taking the girth of *a b* in plan and placing it along the outer arc in R. Using P as center, strike the pattern T, placing the girth of *c d* in plan along the outer arc in T. In like manner use N as center and strike the arc S, and take the girth along *e f* in plan and place it along the outer arc in S. O is used to strike the pattern M, taking the girth of *h i* in plan

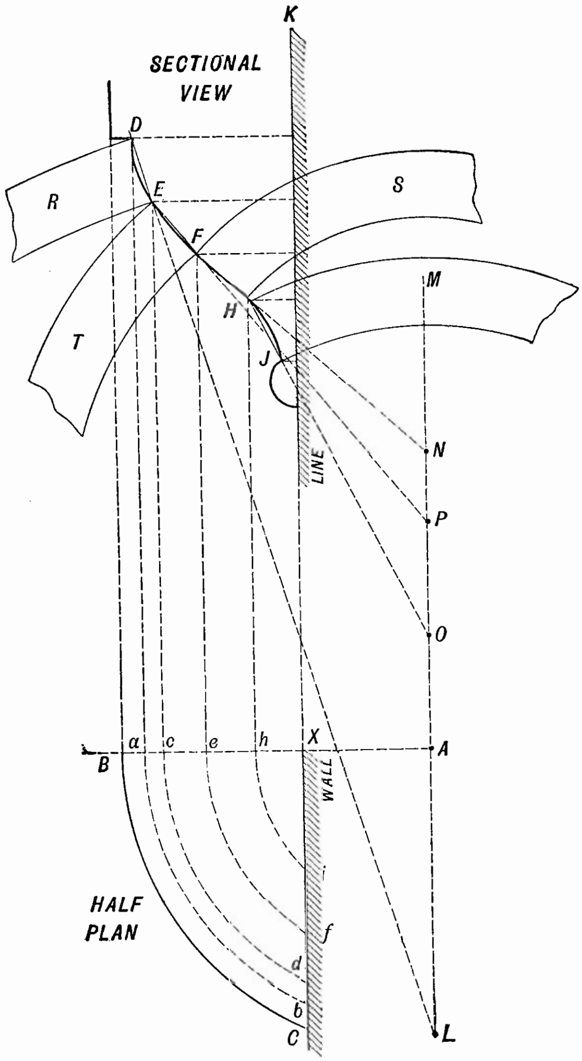

Fig. 350.—Patterns of the Flaring Strips for Bay Window Base

and placing it along the outer arc in M. When this has been accomplished net half patterns of the various flares are the result; to these laps are to be added for joining. Patterns R and T will be raised; pattern S remains flat, while pattern M must be slightly stretched. The lower ball is spun or hammered and the method of executing this work was previously given.

SEGMENTAL PEDIMENT MADE BY HAND

Solution 99

Fig. 351 is a view of a segmental pediment, in which the circular molded part is hammered by hand and the balance of the work is stripped. Fig. 352 represents the working drawing and the method of construction, as well as the methods used in developing the various patterns.

First, draw the one-half front elevation, the given profile of the horizontal return being shown from 1 to 28. Divide the molds in this profile into an equal number of parts, as shown by the small figures. Only the ogee mold, shown from 23′ to 28, will require to be raked or modified in the curved molding. Using X as the center, draw arcs from points 24 to 28, cutting the center line, as shown. From the various intersections of the arcs on the center line draw horizontal lines indefinitely to the right. Take the horizontal projections between points 22

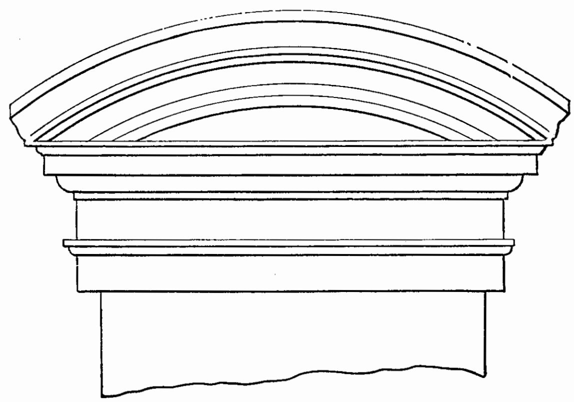

Fig. 351.—Front View of Segmental Pediment

and 28 in the normal profile, as shown on the line *r s*, and place them in a reversed position, as shown by similar numbers on *r′ s′*, to the right of the center line. From these points on *r′ s′* draw lines parallel to the center line until they intersect lines obtained from similar numbers, as shown from L to P. The profile from P to H in the vertical section can be made similar to the given profile from 23′ to 11 in the horizontal return. Care should be taken, in drawing the vertical section, that a vertical line, dropped from P, intersects a line drawn from 23′ in the given profile, as shown by 23° . From 23° down to 3° the profile is similar to 23′ to 3 in the half elevation. Lay off the projection of roof A B in the vertical section, and draw the wall line, shown by B *a′*. Draw the depth of the frame line, as *a′ 2′*. The half pattern for the horizontal front mold and

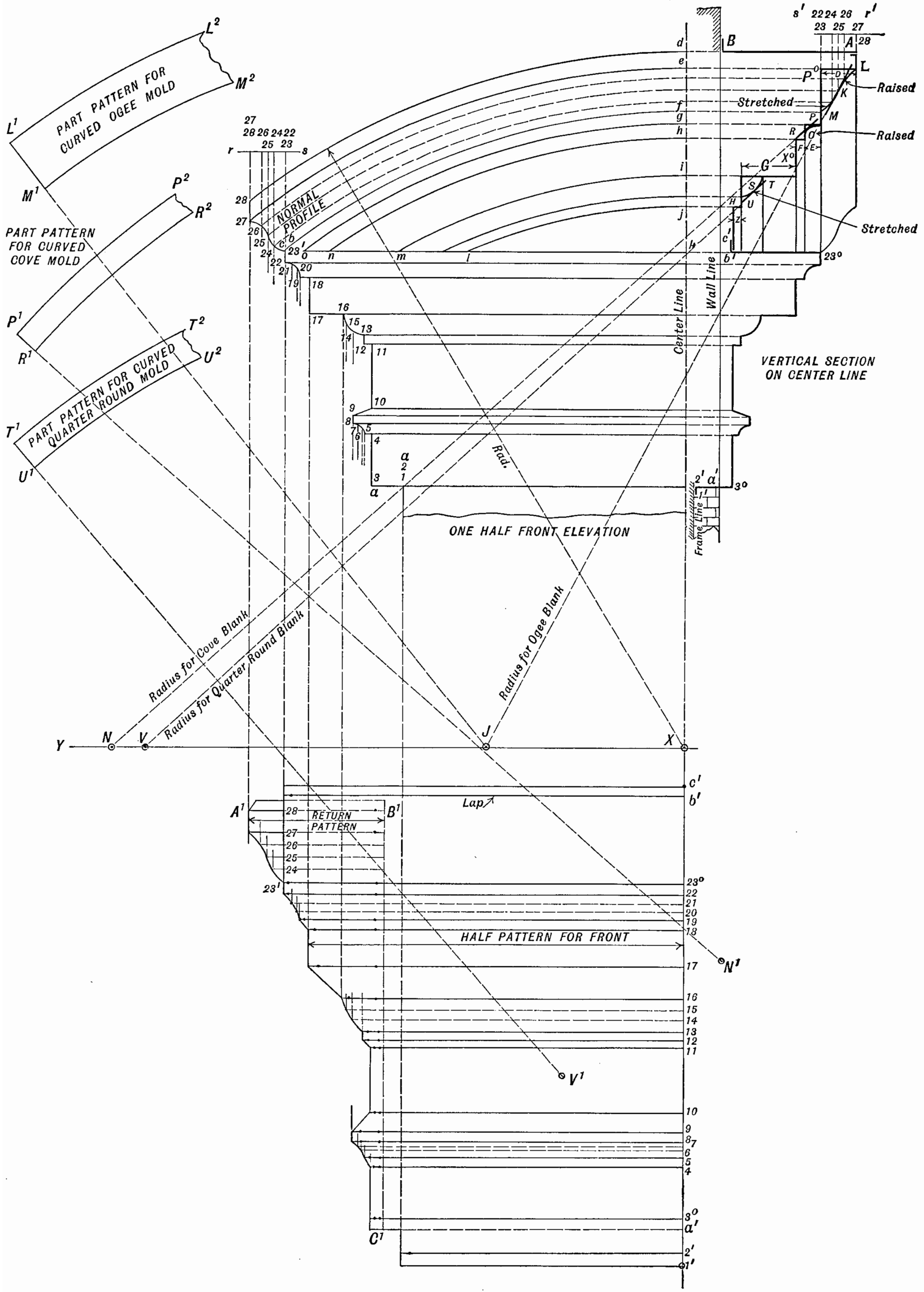

Fig. 352.—Working Drawing and Patterns for Segmental Pediment Made by Hand

the pattern for the horizontal returns are shown below the elevation; they are obtained by means of parallel lines, as shown by reference to similar letters and figures. A^1 B^1 C^1 represents the pattern for the lower horizontal returns. In making up the segmental pediment the various faces are stripped as follows:

The upper segment *d e* 27, 28 in elevation is shown in the section by L, which has a lap at L, to which is soldered the roof A B, with a flange added at B. To the lower part of L the straight strip D is soldered.

The next segment to be pricked from the elevation is shown by *e, g, o* 23'-27 and is indicated in section by P P°; it is soldered at the top to the straight strip D and at the bottom, the strip equal in width to E is soldered. The segment, shown in elevation by *g, h, n, o,* is shown in section by R, which joins the strip E at the top and the strip F at the bottom.

The next segment to be pricked from the elevation is shown by *h i m n* and is indicated by the line X° in the section; it is soldered to the straight strip F at the top and to G at the bottom.

i j l m is the last segment, shown in section by H; it is soldered to G at the top and to the strip, whose width is Z, at the bottom. The back ground shown by *j k l* in elevation completes the square angles in the segment. In these square angles at K, O and S the ogee, cove and quarter round, respectively, are soldered.

The method of obtaining the radii with which these flares are struck is now to be considered. The ogee K will be taken up first. At right angles to the center line and from the center X, from which the arcs in the segment were struck, draw a line to the left, as shown. Average a line through the modified profile of the ogee, as shown by L M in the vertical section, extending it downward until it meets the horizontal line drawn from X at J. Take the girth of the ogee in the sectional view and place it, as shown from L to M. Using J as center and with radii equal to J M and J L draw the arcs M^1 M^2 and L^1 L^2, as shown in the part pattern. The true length of the ogee pattern is found by measuring along the arc 27-*e* in the half elevation and placing it along the outer arc L^1 L^2 in the pattern. When these molds are hammered by hand, they are usually cut about 3 ft. long from sheets 36 in. wide. The averaged line for the cove mold O in the vertical section is drawn, as indicated by the line P R extended, until it meets the line at N. The girth of the mold O is now placed as shown from R to P. Using radii equal to N R and N P and from N^1 as center the arcs R^1 R^2 and P^1 P^2 are struck. Obtain the girth of the arc *o g* in elevation and place it along the outer arc P^1 P^2 in the pattern to obtain its length. The quarter round S in the vertical section is averaged by drawing the line in the direction of T U and extending it until it meets the line X Y at V. The girth of the quarter round S is then placed, as shown by U T, and using V U and V T as radii and V^1 as center the arcs U^1 U^2 and T^1 T^2 are struck. Along the outer arc T^1 T^2 the girth of *m i* in elevation is placed. Laps are to be allowed on all patterns to provide for soldering. Work of this kind, made by hand, should be scraped clean on completion.

CURVED DORMER WINDOW WITH CURVED ROOF AND ROOF FLANGE

Solution 100

Fig. 353 presents a view of a curved dormer window, usually designated as an "eye brow dormer." Since the roof of this dormer runs at an incline, the

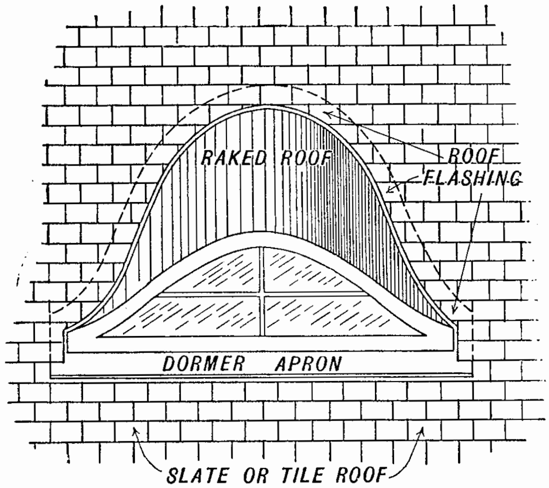

Fig. 353.—View of Curved Dormer Window, Requiring a Raked Roof and Roof Flashings

profile of the dormer roof requires a change of profile from that shown in the face. A roof flashing is also indicated by the dotted line, with an apron along the bottom of the dormer, as shown. The method of obtaining the patterns for the dormer roof and flange is illustrated in Fig. 354.

First, draw the center line A B, and construct the one-half elevation of the dormer face, shown by 7-2-1-V. In line with this half elevation, construct

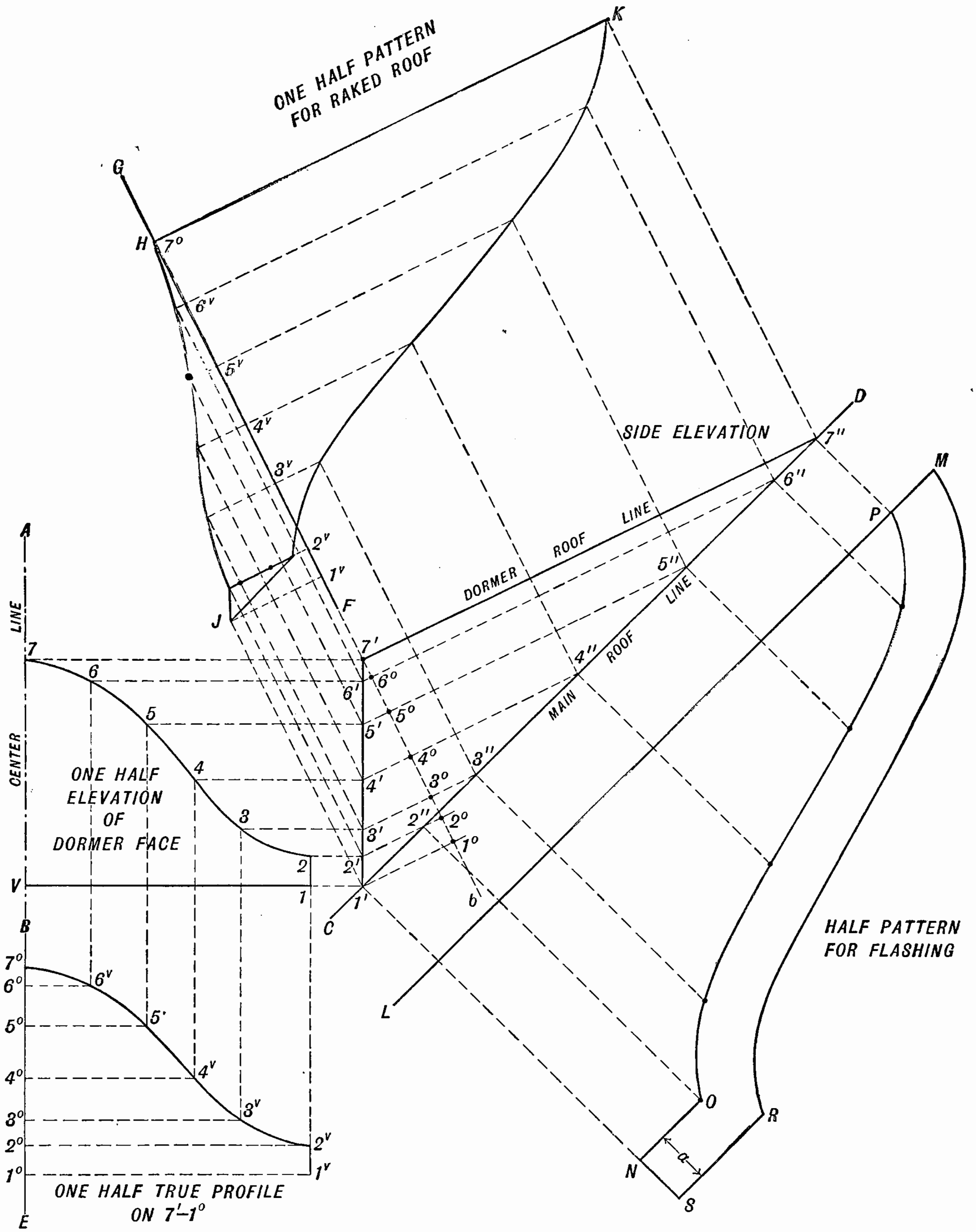

Fig. 354.—Patterns for Raked Roof and Flashings on a Curved Dormer

the side elevation, indicated by 7'-7"-1', D C representing the pitch of the main roof and 7'-7" the pitch of the dormer roof. Preparatory to laying out the roof pattern of the dormer, a true profile must first be found on the line 7'-*b*, drawn at right angles to 7'-7". This is obtained as follows: Divide the half elevation into an equal number of parts, as shown by the small figures 1 to 7, from which points and at right angles to A B, draw lines, cutting the vertical line 1'-7' in the side elevation, as shown from 1'-7'. From these intersections and parallel to the roof line 7'-7" draw lines crossing the line 7' *b* from 1° to 6°, and cutting the main roof line C D from 2" to 6". Take the various divisions from 1° to 7′ on the line 7′ *b* and place them on the line A B extended as B E, all as shown by similar figures 7° to 1°. From the small figures and at right angles to B E draw lines and intersect them by lines drawn parallel to B E from similar intersections in the half elevation. Trace a line through points thus obtained; the outline from 1^v to 2^v to 7° will be the half true profile on 7′-1° in the side elevation.

The pattern for the roof is next in order and may be developed as follows: At right angles to the dormer roof line 7′-7″ draw any line as F G, on which place the girth of the one-half true profile, as shown by similar numbers on F G. Through the small figures 1^v to 7° and at right angles to F G, draw lines and intersect them by lines drawn parallel to F G from similarly numbered intersections on the roof line 1′ to 7″ and on the face line 1′ to 7′. A line traced through points thus obtained, as shown by H J K, will be the one-half pattern for raked roof.

To obtain the pattern for the roof flange or flashing, indicated in Fig. 353, proceed as shown in Fig. 354. Parallel to the main roof line C D draw any line, as L M, and at right angles thereto, from the various divisions 1′, 2″, 3″ to 7″ on the main roof line, draw lines to any length, as shown. Measuring from the line A B in the half elevation, take the various projections to points 1 to 7 and place them on similarly numbered lines, measuring in each instance from the line L M in the flashing pattern, all as indicated by the heavy dots. Trace a line through these points, as shown by P O N, which represents the outline or opening in roof. Set the dividers to equal the desired width of flashing, as *a*, and describe a line parallel to P O N as shown by M R S. M R S N O P will be the one-half flashing pattern. The edge line along N O P will be equal in girth to the edge line J K in the raked roof pattern, while the edge line H J in the roof pattern will correspond to the outline 1-2-7 in the one-half elevation. Allow on all patterns laps for joining and soldering.