

PART X

LAYING OUT FULL SIZE PATTERNS BY MEANS OF REDUCED DRAWINGS

PATTERN cutters usually experience difficulty in connection with laying out large size details and patterns. A method employed under prevailing conditions, has been to draw a full size plan or elevation and then to develop the full size pattern in the customary manner. This method requires in some cases much space, time and labor. For the information of the cutters in various branches of the sheet metal trade, a plain rule is given for simplifying any of the operations in pattern drafting without regard to the size of the work that is being laid out. The following solutions are presented to illustrate the application of principles. In the first example, that of a large tapering joint, the length of radius is omitted from consideration, as its use is impracticable.

A FULL SIZE TAPER JOINT

Solution 199

Let us assume that a taper joint for round pipe is required, 30 in. long, 30 in. diameter at one end and 24 in. diameter at the other, and that the joint is to be made in two pieces, riveted. The rule to follow can also be applied to square or rectangular reducing or taper joints. Fig. 654 shows how this pattern may be developed without the aid of full size drawings, the measurements being simply obtained from any reduced drawing. The rule for determining the size of the reduced drawing is as follows: At pleasure select any number as a divisor. For the purpose of explanation we will say 4. Divide by 4 all the full size dimensions above given, thus obtaining the one fourth size reduced elevation having a diameter of one fourth of 24 in., or 6 in., at top, and one fourth of 30 in., or $7\frac{1}{2}$ inches, both in height and diameter, at the bottom. It will be understood that the selection of a greater or lesser number to serve as the factor of reduction is governed by the amount of room available for the reduced drawing. Having thus determined upon a one fourth size reduction, draw any center line as A B, upon which set off the height of $7\frac{1}{2}$ in., as shown. At right angles

to A B draw D C and H J, making D C, $7\frac{1}{2}$ in. and H J, 6 in., placing the half diameters on either side of the center line A B. In practice it is necessary to draw only the half elevation. Extend the line C J until it intersects the center line at A. On the base line D C, draw the semi-circle shown, and space one half of it into equal divisions, as indicated from 1 to 4. Using A as center, with radii equal to A J and A C, draw short arcs as shown. Starting at 1 on the lower arc, step off twice the girth of the quarter circle C 4, as shown from 1 to 4 to 1° in the pattern. Draw radial lines to the apex A, cutting the upper arc at $1'$ and $1''$. From the small figures 2 to 2 in the pattern, draw short radial lines towards the apex A, as shown. Draw a line from 1 to 1° and $1'$ to $1''$. This completes the net one fourth reduction of the one half pattern for the taper joint and gives the necessary data for laying out the full size pattern. Since the original dimensions were *reduced* to one fourth size this reduced pattern must be *enlarged* to four times that size, as follows: Take four times the length of F E in the reduced pattern and set it off on any horizontal line, as $F^\circ E^\circ$, which represents the center line of the enlarged half pattern. Now take four times the length of F- $1'$ and E-1 in the reduced pattern and place it on either side of F° and E° in the enlarged pattern, on lines drawn at right angles to $F^\circ E^\circ$, thus obtaining the points $1''-1''$ and $1^\circ-1^\circ$ respectively. Draw lines from $1''$ to 1° as shown. Where the radial lines in the reduced pattern intersect the lines $1-1^\circ$ and $1'-1''$, measure each of these intersections separately and place four times the amount of these distances on the lines $1^\circ-1^\circ$ and $1''-1''$ in the enlarged pattern. Through the intersections so obtained draw the dotted lines as shown. Measure from the line $1-1^\circ$ in the reduced pattern and take the various distances to points 2, 3 and 4 on the lower curve $1-4-1^\circ$. Enlarge them four times and set them off on corresponding radial lines in the enlarged pattern, measuring invariably from the line $1^\circ-1^\circ$, thus obtaining on both sides the intersections marked $2^\circ-3^\circ$ and 4° . Trace the curve $1^\circ-4^\circ-1^\circ$, which gives the lower cut. The upper curve

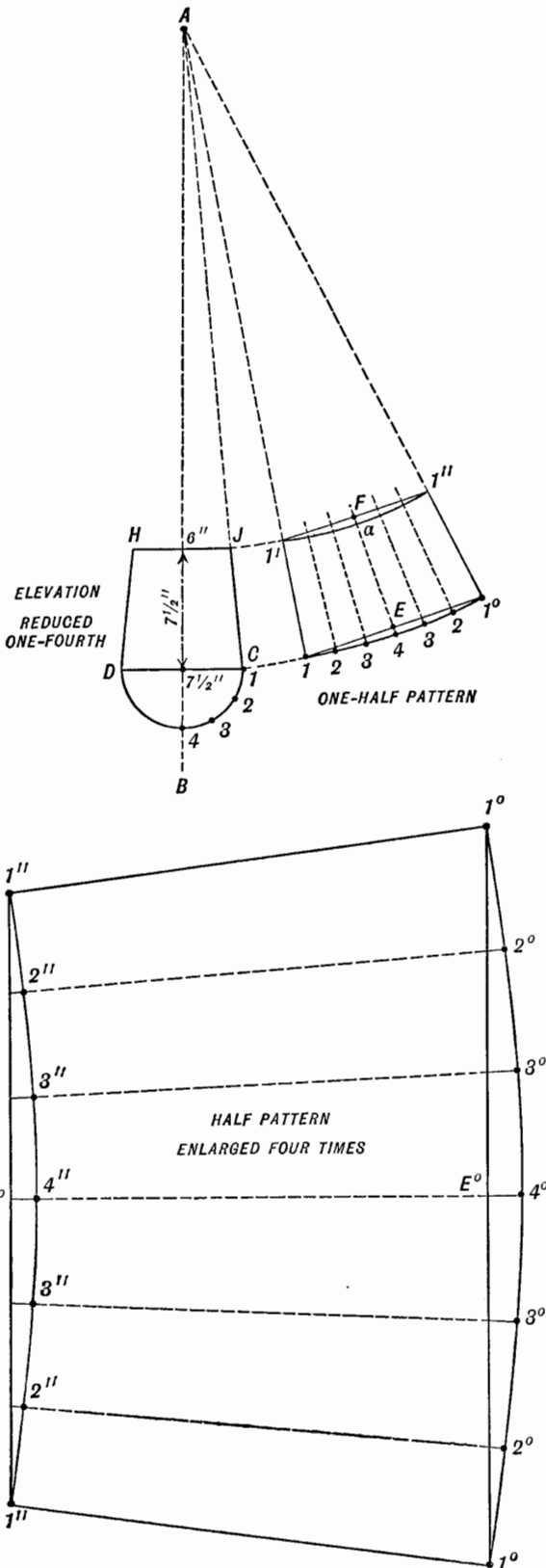


Fig. 654.—Finding Full Size Pattern for Reducer by Means of Reduced Drawings

1"-4"-1" may be obtained by drawing this line parallel to 1°-4°-1° to equal in width 1°-1", or the procedure heretofore presented may be employed, the measurements in each instance being taken from the line 1'-1" in the reduced pattern, to the various intersections on the upper curve 1'-a-1". 1"-1°-4°-1°-1"-4"-1" then shows the one half full size pattern, to which allowance is required for edges and laps. The foregoing rule applies successfully to any right or scalene cone, regardless of whether the profiles are round, square, rectangular, or of other formation.

OBTAINING FULL SIZE PATTERNS FOR TWISTED RECTANGULAR OFFSET

Solution 200

In Fig. 655 is shown a perspective of a twisted offset in rectangular pipe, which we will assume it is desired to lay out without making full size details.

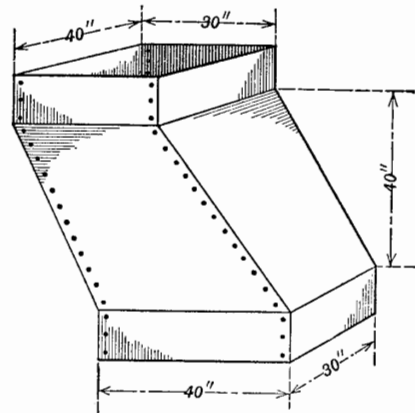


Fig. 655.—Twisted Offset in Rectangular Pipe

The method is illustrated in Fig. 656 where the specifications of the full size dimensions are indicated. We find that the offset has a corresponding size pipe at each end, namely 30 x 40 in. The vertical height calls for 40 in., the projection in the front view 20 in., and the projection in side view 5 in., on each side. In this case we will take five as the divisor in order to simplify the preparation of the drawings by omitting the full size section of the 30 x 40 in. pipe, and draw only the 6 x 8 in. section, shown by 1-1-4-4 in plan. Make the projections one fifth of 20 in. and 5 in., or 4 in. and 1 in., respectively, as shown in the plan and again draw the section of the 6 x 8 in. pipe in a reversed position, as shown by 2-2-3-3. Above the plan in their proper positions, draw the front and side views to one fifth of the 40 in. height, or 8 in.,

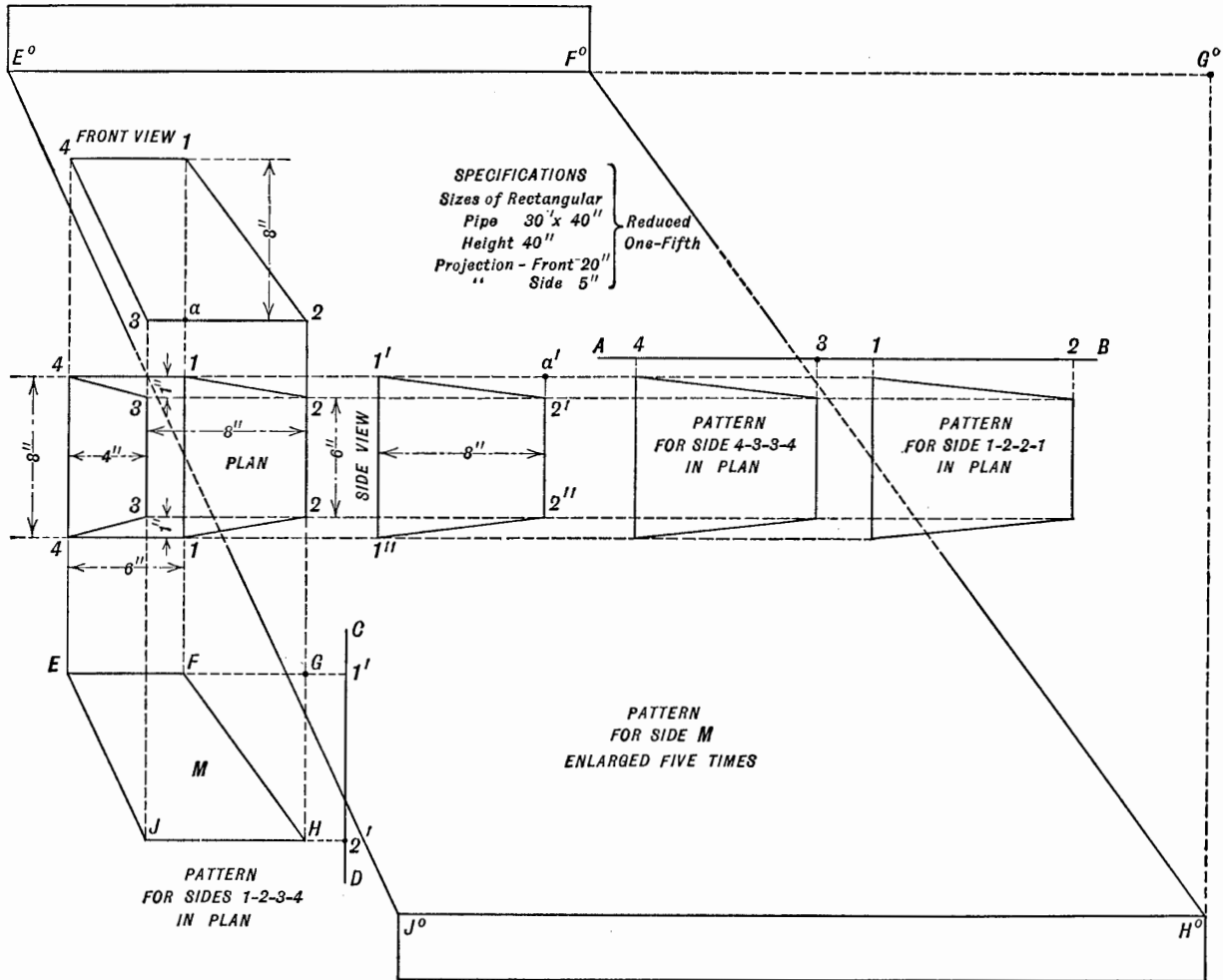


Fig. 656.—Full Size Patterns for Twisted Offset by Means of Reduced Drawings

as shown. The small drawing serves all requirements in obtaining the necessary data for developing the full size patterns. To obtain the one fifth reduced patterns, proceed as follows: Draw any horizontal line, as A-B, on which place the girth of the sides marked 1-2 and 3-4 in the front view, as shown by similar numbers on A B. Through these small figures, at right angles to A B, draw lines as shown, which intersect by lines drawn parallel to A B from the correspondingly numbered intersection in plan. Connect points by lines, as shown, resulting in the patterns for the right and left sides of the offset in front view. Since the two sides in the reduced plan have like projection, the one pattern serves for both. The pattern for one of the sides, indicated by M, is obtained as follows: Take the girth of either 1'-2' or 1''-2'' in the side view and place it on any vertical line, as C D, as shown by like numbers. At right angles to C D, draw the usual measuring lines, which intersect by lines drawn parallel to C D from similarly numbered

points in plan. E F H J then shows the pattern for either one of the sides marked 1'-2' or 1''-2'', in the side view. The enlargement of the pattern, only that for M is shown since the method is alike applicable to the remaining patterns. Since, as stated, 5 is taken as the divisor, we use this figure as multiplier in obtaining the full size pattern. To economize space, the enlarged pattern for M is located directly over the plan elevation and patterns in the reduced drawings. At pleasure, draw any right angle as E° G° H°. Make H° G° equal to five times the distance H G in pattern M. Take five times G F and five times F E and place it as shown from G° to F° and F° to E°. Take also five times the distance of H J in pattern M and place it from H° to J° which is located parallel to G° E°. Draw lines from E° to J° and H° to F° and allow for collars above E° F° and below J° H° as well as for riveting flanges along E° J° and H° F° (not shown). The remainder of the patterns may be enlarged in a corresponding manner.

OBTAINING PATTERNS FOR LARGE FULL SIZE ELBOWS FROM REDUCED DRAWINGS

Solution 201

Economy of labor and time may be effected in the development of elbows constructed of heavy material by omitting to lay out full size details. The procedure is, in principle, alike to that previ-

ously described, elbows of required size being laid out quickly by means of a reduced drawing.

Let us take as an example a six pieced elbow, to be made of 1/8 in. thick metal and with a 60 in. throat, having an angle of 60 degrees, the diameter of the pipe to be 56 in. all as shown in Fig. 657. To develop this pattern without reduction requires a space of 60 + 56 in. or 116 in. This alternative method is as follows: At pleasure select a given number as the divisor. In this case we will use the divisor 8. Thus, 116 divided by 8 = 14 1/2. 14 1/2 in. is then the space required in which to lay out the reduced pattern. We divide the 60 in. throat by 8, with the result of 7 1/2 in. Division of the 56 in. pipe by 8 = 7 in. Next referring to Fig. 658, draw any horizontal line, as A B, on which set off the distances A-1 to equal 7 1/2 in. and 1-7 to equal 7 in. As the elbow is to contain six pieces, divide the number of degrees of the elbow by 10 (as explained in previous problems on elbow work), thus obtaining 6 degrees as the rise of the first miter line. Draw an angle of 30 degrees from A, as shown by A b. For this purpose, if no protractor is readily at hand, the 30-60 triangle will serve. At pleasure, between the angle b a A, draw the arc a b, and divide this arc into five spaces. Then, a line drawn from the first space to the apex A will present an angle of six degrees, as required. On the line 1-7, place the half diameter as shown, and divide it into equal spaces. From these points, lines are carried vertically to intersect the miter line, as shown. This procedure comprises all requirement for laying out the full size pattern. Let it be understood that the semi-circle 1-4-7 represents the mean semi-diameter of the pipe. In other words it is the outside diameter of the small end and the inside diameter of the large end, all as shown in diagram X. As the divisor used was 8, we must now multiply by 8, to obtain the full size patterns. The several pieces of the elbow will lap toward the inside in the direction of the arrow, shown in Fig. 657. Therefore, will the lower part of piece A be the

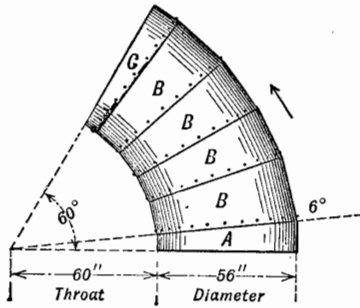


Fig. 657.—Six Pieced Riveted Elbow

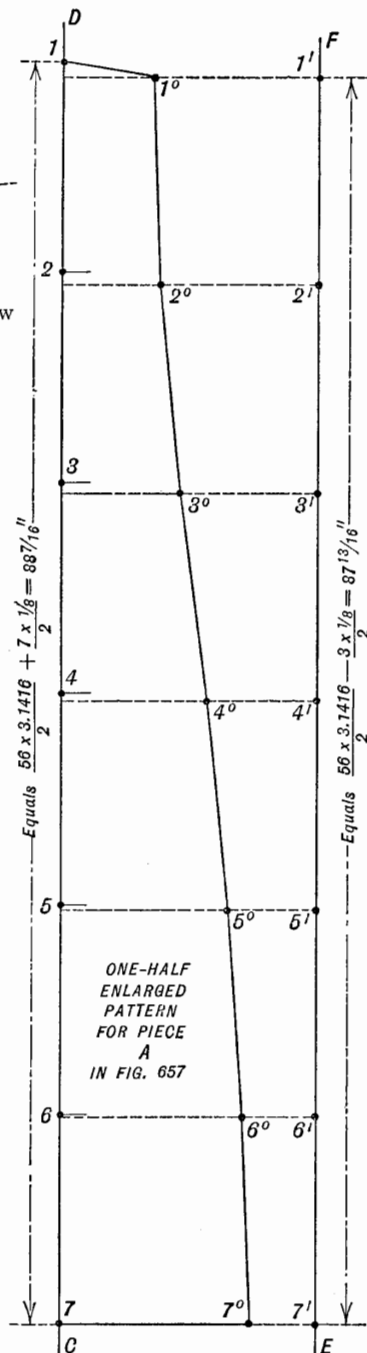
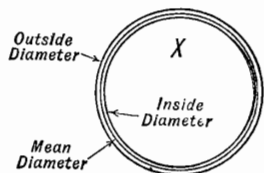
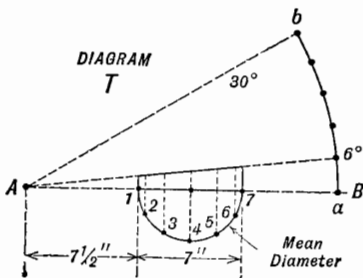


Fig. 658.—Developing Elbow Patterns from Reduced Drawings

wide end and the upper part of piece A along the miter, the small end, which latter must fit to the inside of B, etc. In Fig. 658 is shown the one half enlarged pattern for A. It is developed as follows: Draw any line on the metal, as D C, and find the one half circumference of the wide end including therein the necessary allowance for the use of the $\frac{1}{8}$ in. material, which is simply computed by taking $\frac{1}{2}$ of 56 (the mean diameter) \times 3.1416, plus $\frac{1}{2}$ of $7 \times \frac{1}{8}$ in., or $88\frac{7}{16}$ in., which provides for an easy slip joint. Set this amount as indicated from 1 to 7 on the line C D. At right angles to C D, from the point 7, draw the line C E and at any desired distance, as from E, draw the line E F parallel to C D. On this line E F, set off one half the circumference of the narrow or small end of the elbow, deducting the allowance for the thickness of the metal. This is computed thus: $\frac{1}{2}$ of 56 (the mean diameter) \times 3.1416 — $\frac{1}{2}$ of $3 \times \frac{1}{8}$ in. = $87\frac{13}{16}$ in., as shown from 1' to 7'. Divide the distance 1'—7' into as many parts as there are spaces in the semi-profile 1 to 7 in diagram T, as shown from 1' to 7' on the line E F. Through these small figures, at right angles to E F, draw lines indefinitely, as shown, to intersect the opposite line D C. Now, take measurements in every instance from the line 1—7 in diagram T, and obtain the various distances between the line 1—7 and the miter line A 6°, multiply them by 8, and place these enlarged distances on lines drawn from corresponding numbers 1' to 7'. In this case, measure in every instance from the line C D, thus obtaining the points of intersections marked 1° to 7°. Draw a line from 1° to 1, observing that this angle is exaggerated to more clearly show the procedure involved. 1—1°—7°—7 is then the one half enlarged pattern for piece A in Fig. 657. The patterns for the remainder of the pieces B and C are procured by the method set forth in Solution 189, where also is stated the rule employed in allowing for flanges and for punching the rivet holes.

LARGE TRANSFORMER, RECTANGLE TO ROUND. OBTAINING PATTERNS BY MEANS OF REDUCED DRAWINGS
Solution 202

Fig. 659 represents a large transformer whose rectangular base we will consider as measuring 30 x 60 in. and whose top round opening is presumed to have an area equal to its base, its height being 48 in. The construction is assumed to be of $\frac{1}{4}$ in. material.

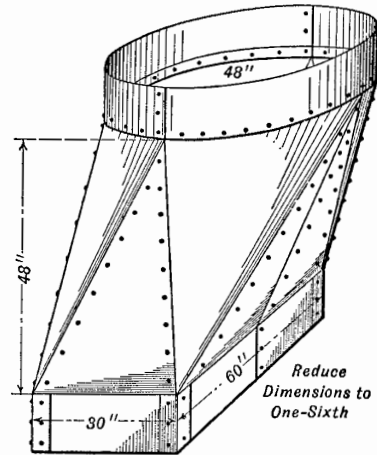


Fig. 659.—View of Riveted Transformer

Obtaining Areas

The base of 30 x 60 in. contains 30 \times 60 in., or 1800 sq. in. area. The ordinary method of finding the area of the round outlet is to divide 1800 by the decimal .7854 and extract the square root therefrom. A quicker resort is that provided by a table of Circumferences and Areas. Refer to the Area column on page 365 where will be found 1809.56 (the nearest number to 1800), and note that the diameter of a circle having such area is 48 in., which is the diameter for the top; see indication in the diagram. Now, as a selection of some given number to serve as a divisor, let us say 6, and divide all dimensions by this number, thus establishing the reduced size of the rectangle as 5 x 10 in., the height, as 8 in. and the diameter at the top, as 8 in., all as shown in the reduced drawing in Fig. 660, where a reduced plan is indicated, and the upper pipe as running tangent at one side, at point 1. Here A B C D is the base profile, and G is the center from which is struck the circle. Through G, draw the center line E F, dividing the plan in half, since only a one half plan is necessary in actual work. From G, draw the semi-diameter G—5 and then divide each quarter circle into an equal number of spaces, as shown from 1 to 5 and from 5 to 9. From points 1 to 5, draw lines to the corner B and from points 5 to 9, draw lines to the corner C. At pleasure, draw any right angle, as H J K, on which set off the reduced height (8 in.), as shown from J to H. Now, take the various divisions from B to 1, 2, 3, 4 and 5, also those from C to 5, 6, 7, 8 and 9, and set them off on the line J K. Measure in each instance from the corner J and obtain the points numbered 1 to 9, from which lines are drawn to the apex H. These lines represent the reduced true lengths. As the divisor was 6 we must now multiply by 6, to furnish the

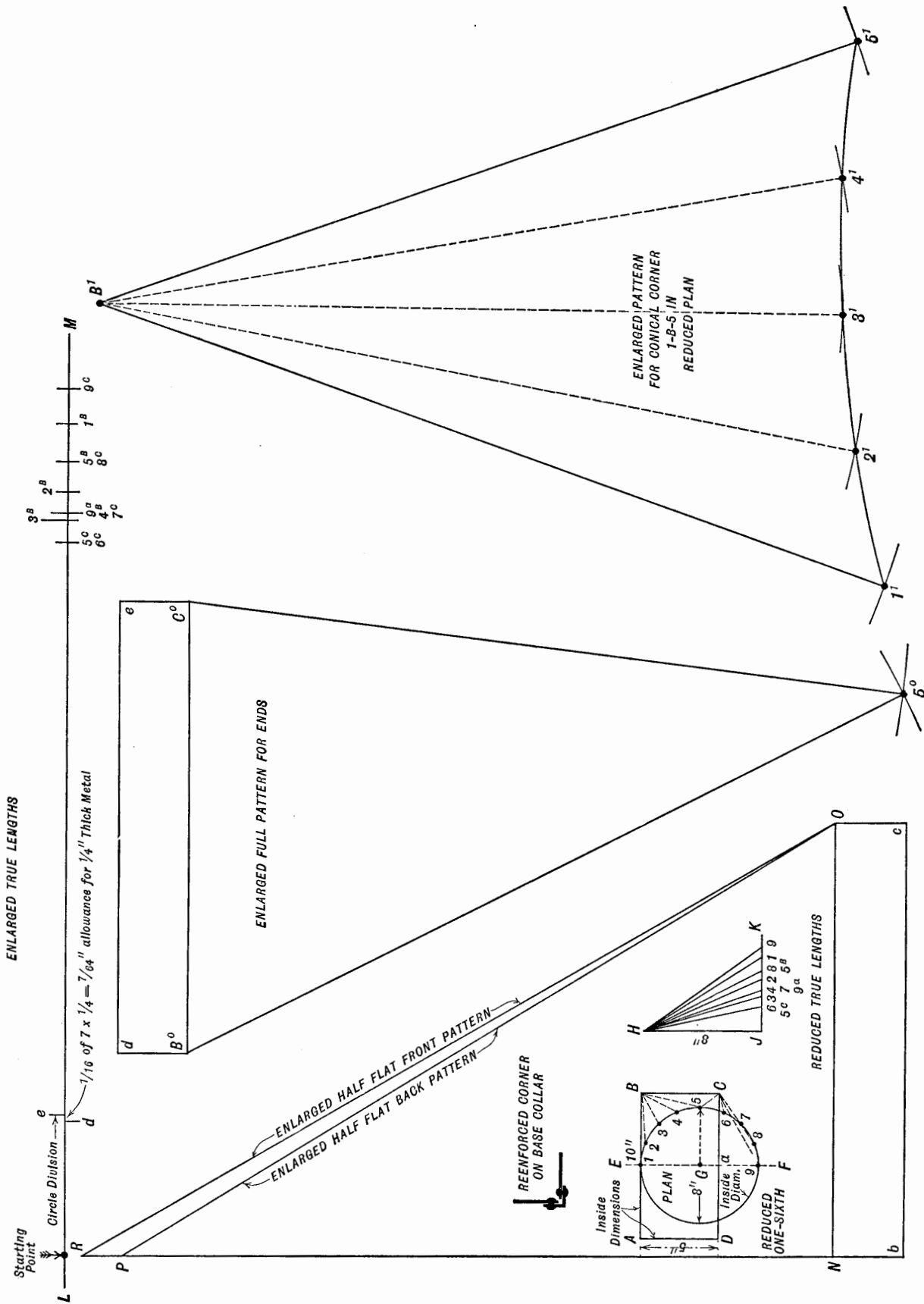


Fig. 660.—Development of Full Size Transition Piece from Reduced Drawings

basis of development for the full size patterns, which are now in order. Laying out large work of this nature demands precision in order that there shall be no waste of material or occurrence of unnecessary seams. Therefore the patterns are laid out here as indicated by the riveted seams, shown in Fig. 659, that is, each rounded corner is separated, the flat ends also are separate and the triangular flat back and front are made in halves, as shown. The reduced plan and true lengths, in Fig. 660, furnishes the basis of all of our enlarged measurements used in laying out the full size patterns.

To obtain the full size true lengths, draw any line, as L M, on which place six times the length of each line contained in the diagram of reduced true lengths, invariably measuring from the position indicated as "starting point" on the line L M. This results in obtaining the similarly numbered points shown at the right. Provide allowance for the quarter inch thick material along the upper circle. The allowance is made to only one space to serve the merely necessary requirements for enlarging the conical corners. Take the distance of one of the equal spaces in the semi-circle in the reduced plan and step it off six times, from the "starting point" on the line L M, thus obtaining the mark *d*. Since $\frac{1}{4}$ in. represents the thickness of the metal in use, this amount multiplied by seven is the required allowance for the full circle, and as the full circle is divided into 16 spaces, we add from *d* to *e*, one sixteenth of seven times one quarter inch, or $\frac{7}{64}$ in. That portion of the diagram marked "circle division" is used in laying out the full size conical corners. To obtain the half full size pattern for the back, proceed as follows: Draw any line, as N O, equal to six times the length of 1-B in the reduced plan. At right angles to N O, draw the line N P to equal six times the height of J H in the reduced true lengths. Draw a line from P to O and add the desired collar, *b c*. *P b c* is then the half pattern sought for the back. To obtain the enlarged pattern for the half flat front, take the enlarged true length R-9° and with O in the pattern as center, intersect the center line at R. *b c R* is then the half triangular pattern for the front of the transformer. The pattern for the flat ends, shown by B 5 C in the reduced plan, is obtained by taking six times the length of B C and placing it on the line B° C°. Now, with the enlarged true lengths R-5° and R-5°, as radii, and using B° and C° respectively as centers, intersect arcs at 5°. B°-5°-C° is then the pattern sought for the ends, to which the collar *d e* is added. To develop the pattern for the conical corner B-1-5 in the reduced plan, take the enlarged

true length R-1^B and place it on any line, as B¹-1¹. Now, using R-2^B, R-3^B, R-4^B and R-5^B in the enlarged true lengths as radii, and with B¹ in the pattern as center, draw the short arcs 2¹, 3¹, 4¹ and 5¹. Next, set the dividers to equal the circle division R *e* and starting from 1¹ in the pattern, step to arc 2¹, 3¹, 4¹ and 5¹ and draw a line from 5¹ to B¹. B¹, 1¹, 5¹ is then the pattern sought. In a corresponding manner the pattern is developed for the conical corner C-5-9 in the reduced plan. Allowance for laps and rivet holes is required according to the procedure previously described, in Solution 191 relating to the working of heavy gauge metal.

Y JOINT, RECTANGULAR TO ROUND. OBTAINING PATTERN FROM REDUCED DIMENSIONS

Solution 203

Fig. 661 shows a riveted Y branch, forming a transition from a rectangular base to two round

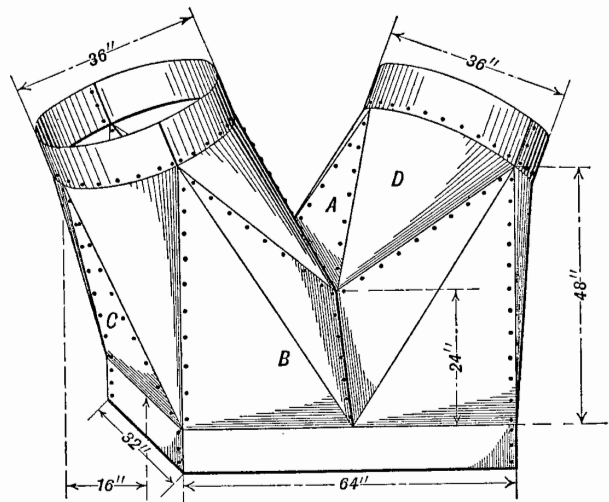


Fig. 661.—View of Riveted Transition Y with Full Size Dimensions Indicated

outlets having areas alike. We will assume that each round outlet is of 36 in. diameter and that it is required to make a rectangular base whose width will be 32 in. We will compute the length as indicated below. While the construction of the branch is usually from heavy metal, the method of allowing for its thickness will not be taken up in that solution, as it is similar to the rule explained in the next preceding solution.

Finding the Area of the Base

The area of the 36 in. outlet equals $36 \times 36 \times .7854 = 1017.878$ sq. in. This product multiplied

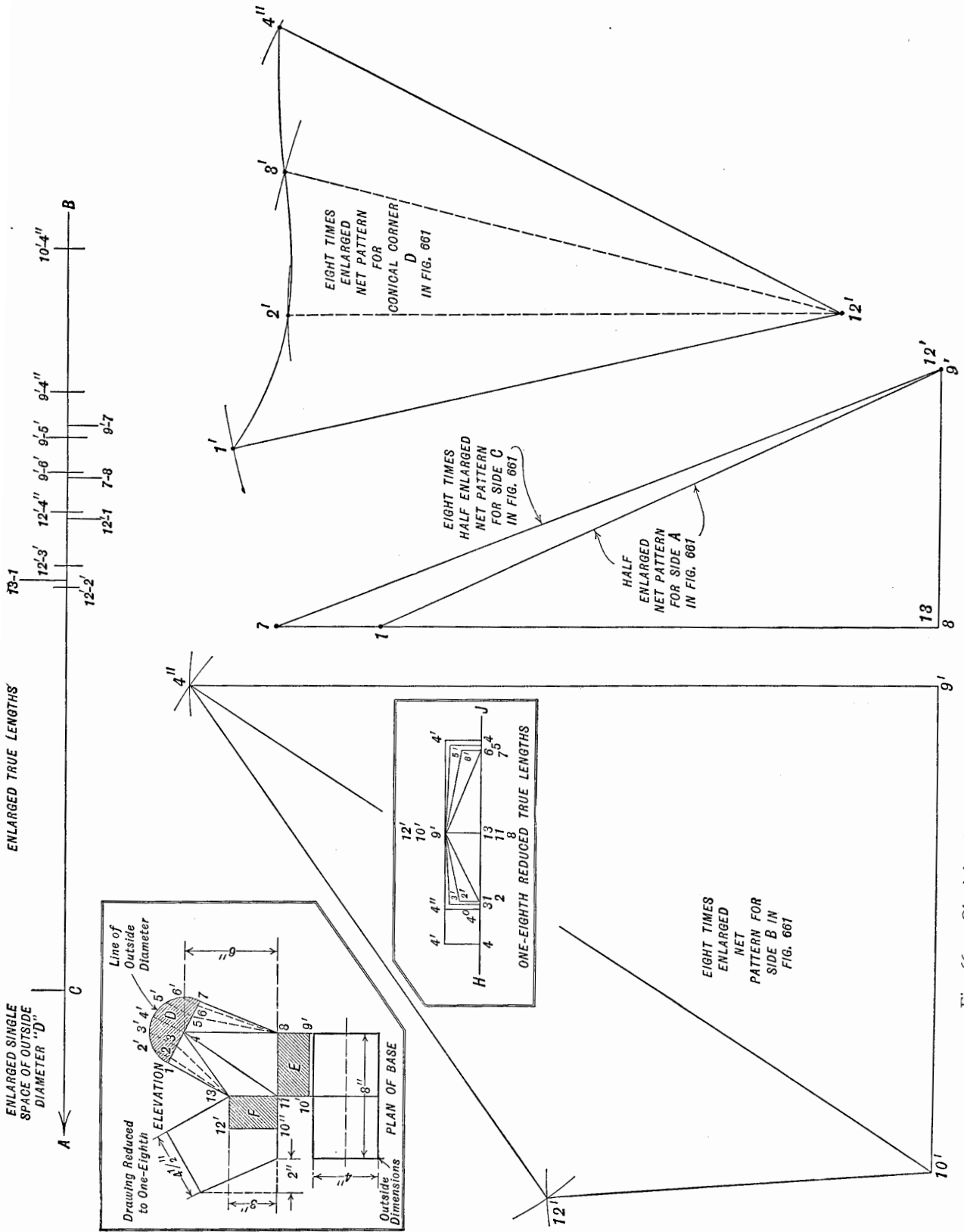


Fig. 662.—Obtaining Full Size Patterns of Large Y Transformer by Means of Reduced Drawings

by $2 = 2037.756$ or, say 2036 sq. in. area for the two 36 in. outlets. Since the one side of the base has a given width equal to 32 in., we compute simply as follows:

$$\frac{2036}{32} = 63 + \text{ or say } 64 \text{ in.}$$

The size obtained of the rectangular base is then 32×64 in., as indicated in the diagram. In the procedure of laying out the full size patterns, the dimensions are found so large as to require their being laid out in sections, as indicated by the riveted pieces shown. In other words, each conical corner is separated, as well as the triangular pieces of the ends, sides and top.

Constructing the Reduced Drawing

As a divisor, select any number that is capable of providing for the reduction of the drawings so that they will take up minimum space on the drawing board, as 8. Thus, the rectangular base reduces to 4×8 in., the full vertical height to 6 in., the vertical joint in the center to 3 in., the projection of each prong to 2 in., and the diameter of each outlet to $4\frac{1}{2}$ in., all as indicated in the reduced plan in Fig. 662. The two prongs of the Y being alike it is, in practice, necessary to draw only the one half reduced elevation. Having thus completed the elevation in its correct position in the reduced drawing, place the semi-profile of the round outlet as shown by D, and place one fourth of the plan of the base as shown by E, drawing the desired section on the joint line 11-13, as shown by F and making the distances 13-12' and 11-10'' equal to 2 in., representing one half of the narrow side of the base. The semi-section F is capable of being made elliptical or round, as desired. The profiles D, E and F placed in position, divide the semi-circle D into an equal number of spaces, as shown by the small figures 1 to 4' to 7, from which points, at right angles to 1-7, draw lines to intersect the line 1-7 from 2 to 6, as shown. From the points 2-3 and 4, draw lines to 13; from point 4, draw a line to 11, and from points 4, 5 and 6, draw lines to the corner 8. Number the one fourth profile E, 8, 9', 10' and 11; and the half profile F, 11, 10'', 12' and 13. The reduced true lengths, now in order, are shown in the lower diagram to the right of the plan. First draw any line as H J, upon which are constructed the various sections, as shown by diagrams having corresponding numbers. Thus, to find the true length of the line 13-4 in elevation, take that distance and place it on the line H J, as shown by 13-4°. From the points 13 and 4°, at right angles to H J, draw the lines 13-12' and 4°-4'', to equal respectively 13-12'

in the semi-profile F in elevation and 4-4' in the semi-profile D. Draw a line from 4'' to 12' in the reduced true lengths. This will show the reduced true length of the line 4-13 in elevation. All true lengths are found by the foregoing procedure, as shown by corresponding numbers, which constitute the basis for laying out the full size patterns. Now, with our divisor of 8 in mind we proceed to multiply all the reduced dimensions by that number, thus obtaining the dimensions of the full size pattern. At pleasure, draw any line as A-B. Take one of the equal spaces in the outside diameter of the semi-profile D and step it off eight times from A to C on the line A B. A C is then one of the enlarged spaces in the round outlet. In like manner obtain the enlarged true lengths. Thus: To obtain the enlarged true length A, 9'-4'', take the distance of 9'-4'' in the one eighth reduced true lengths, and starting from point A on the line A B, step off eight times this length, thus obtaining the point marked 9'-4''. A, 9'-4'' is then the length sought. The eight times enlargement of each reduced true length shown in the reduced drawing are made by the foregoing procedure, the measurements being taken invariably from the point A on the line A-B. The full size patterns are now in order. To obtain the half full size pattern for the flat triangular piece, shown by A in Fig. 661, proceed as shown in Fig. 662. Draw any right angle as 1-13-12', making 1-13 equal to eight times 1-13 in the reduced elevation and 13-12' in the pattern equal to eight times 13-12' in the semi-profile F. Draw a line from 12' to 1 in the pattern. Then is 1-12'-13 the half enlarged net pattern. To obtain the half enlarged pattern for C in Fig. 661, take eight times the length of 7-8 in the reduced elevation in Fig. 662 and place it on the line 8-7 in the enlarged pattern, as shown from 8 to 7. Now, take eight times the length of 8-9' in the profile E in the reduced elevation, set it off from 8 to 9' in the enlarged pattern and draw a line from 9' to 7. 7-8-9'-7 is then the half pattern sought. To obtain the pattern for the two triangular sections shown by B in Fig. 661, take eight times the distance of 9'-10' in the profile E in the reduced elevation in Fig. 662 and place it on any line, as 9'-10', in the enlarged pattern for B, as shown. Now, take the enlarged true length of 9'-4', shown from A to 9'-4'' and using 9' in the pattern as center, describe an arc near 4'', which intersect by an arc, struck from 10' in the pattern as center, with the enlarged true length A to 10'-4'', as radius. With the enlarged true length A to 12'-4'' as radius, and 4'' in the pattern as center, describe the arc near 12', which intersect by an arc

struck from 10' in the pattern as center, with eight times the length of 10''-12' in the profile F in the reduced elevation, as radius. Connect the intersections so obtained. Then will 4''-9'-10'-12'-4'' be the pattern sought. A developed enlargement of the pattern for the conical corner shown by D in Fig. 661 is presented in Fig. 662 by 1'-12'-4''. It is laid out as follows: Using as radii, the enlarged true lengths A to 12'-1, A to 12'-2', A to 12'-3' and A to 12'-4'' and, with any point, as 12' in the pattern for D as center, draw short arcs near 1', 2', 3' and 4''. Now set the dividers to the equivalent of the enlarged circle space shown from A to C, and, starting at 1 in the pattern, step to arcs 2', 3' and 4''. Trace the curved line from 1' to 4'' and draw lines from 1' and 4'' to 12', thus completing the net pattern. By the same procedure precisely obtain the

pattern for the opposite conical corner shown by 4-7-8 in the reduced elevation. Collars must be allowed to all flat pieced patterns and the corners require to be notched to an equivalent of the thickness of the metal since outside dimensions are given, as shown in the reduced plan. Laps and rivet holes must be added, marked and punched on all patterns preparatory to the rolling or bending, the method of which was explained in preceding solutions relating to heavy metal work. The present method of obtaining large full size patterns by means of reduced drawings effects important saving of labor, and the full size patterns may be laid out directly on the metal. The method is in fact generally serviceable, applying as it does, to large moulds, ornaments, ventilators, skylights and other articles made from sheet metal.