HOME INSTRUCTION

FOR

SHEET METAL WORKERS

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BASED ON A SERIES OF ARTICLES ORIGINALLY
PUBLISHED IN
METAL WORKER, PLUMBER AND STEAM FITTER

BY

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PREFACE

For the benefit of those who are using this work, it is well to give, at the outset, a general statement of the plan upon which it is written, together with some advice for the use and study of the same, being a Practical Instruction Manual for the Apprentice, Helper, and Mechanic. It includes Detailed Instructions on Cutting, Forming, Soldering, Preparing Full-Size Details from Architects' Blue Prints, Developing the Patterns, Laying Out the Work on Sheet Metal, Forming and Bending on the Brake and Assembling. It also covers forms of Architectural Cornice and Skylight work, including Instructions on Preparing Details, Developing the Patterns and constructing the work whether in the shop or on the building. A glance at the table of contents will give, at once, a clear idea of its scope and arrangement.

From this it will be seen that the book is for the most part composed of practical problems. The aim of the book is not only to assist the apprentice, helper, and the mechanic to understand the theory of the subject, but chiefly to help him master the practical side of sheet metal work. A student, who will study the problems and make up the models either at home or in the shop, where he is employed, will be as well off as if he had taken a course at a trade school.

The chapter on cutting curves and circles, and also the chapters on soldering are very important to the beginner, and must not be overlooked by him. These chapters make up the fundamentals of the practical side of sheet metal work. The student who thoroughly masters them will have a splendid foundation for the more advanced work which follows.

Chapters V and VI on drawing tools and their uses, and drawing geometrical problems have been prepared to enable the student to become familiar with certain geometrical problems. These will help him understand the underlying principles of sheet metal pattern drafting. The student will do well to study these chapters carefully, as they form the groundwork for the more advanced drawings, of which a good part of the book is composed.

Those problems, which call for detail and scale drawings, will be of special value to the sheet metal worker and pattern draftsman. They will familiarize him with the reading of original drawings, such as those received from architects, from which he is required in many cases to make new drawings adapted to his own peculiar wants.

To make it easier for the reader to follow out the details of the more complex drawings, large folders have been added to the book, which are bound separate in handy reference form. These enable him to follow out the smallest details with greater ease than if these drawings were reduced to page size and printed in the book.

Important features in the book are the chapters on skylight and louvre work, the subject being covered completely, including flat, hipped and pitched skylights, stationary and movable louvres, turret sash, gearing, etc. The student will find this work of especial interest, because it is a branch of the sheet metal trade which requires, in addition to skilful workmanship, considerable constructive knowledge.

The practical problems throughout the book have been arranged in sequential order according to their difficulty, and while each problem is complete in itself, some are necessarily carried farther into detail than others. References are made from one problem to another, pointing out the similarity of methods employed or of principle used.

THE EDITOR.

CONTENTS

Part I

ERRATA

(Home Instruction for Sheet Metal Workers.)

All references to Figure 2 *should read* Folder A.

Page 7: Index reference Page 475 *should read* Page 405.

Page 177: Figure 236—This illustration is upside down.

CHAPTER XXXI

CHAPTER XXXII

CHAPTER XXXIII

HOME INSTRUCTION FOR SHEET METAL WORKERS

CHAPTER I

Introductory

The aim in presenting this course of instruction on architectural sheet metal work is to benefit the apprentice, the helper, as well as the mechanic, and to give assistance to those who are unable to take a course at a trade school, no matter where they are located. At the present time when a boy is taken in the shop to learn a trade, neither the master mechanic nor the workman has the time to give him the practical and technical instruction he ought to receive, and therefore what he learns is only what he can pick up himself. With the instruction given in this course, which is similar to that at the New York Trade School, a young man by close application can master his trade with such shop help as will be given if he is worthy of it. Sometimes the mechanic with whom he is working is not as bright as he might be, and the information obtained is not any too intelligent. The boy will have to pick up a little here and there, and at the expiration of his apprenticeship is supposed to be a mechanic, to whom other apprentices will look for information, and it does not require very deep thinking as to the kind of mechanics we will have years hence. While a course in a trade school does not make a mechanic, it does give the student practical and technical knowledge which he would be unable to obtain in the shop, and this knowledge, gained through studying this course, he can apply to the practical every-day work arising in the shop, and it is only a matter of time when he will climb ahead of the boy who lacks this information.

The following from the catalogue of the New York Trade School will explain the position taken by that school:

"A comparison between the shop method of learning a trade and the trade school system clearly shows the advantages which the latter offers young men. Generally a young man is employed simply to make himself useful about the shop, and neither the master nor the workman has the time to give the young man the instruction he should receive. What knowledge is obtained the lad himself acquires by observation, and as a result of the neglect of proper teaching, his progress is slow, and he can get at best but a limited knowledge of his trade. In a trade school every endeavor is made to advance the student in the trade he is learning, and by reason of the care that is devoted to his instruction it is not long before he understands how to use his tools and is capable of doing work that makes him of value to his employer. An important feature of the trade school system, too, is that a young man can quickly determine whether he possesses an aptitude for mechanics and along what particular line he is gifted. In most trades little or no opportunity is afforded the beginner to work with tools or to practice, and it is frequently the case that a young man does not discover until after a long term of service, and when it is, perhaps, too late to make a change, that a mistake has been made in the selection of a trade."

This course, prepared for those who cannot attend a school, covers 21 exercises in practical shop work, starting with cutting curves and irregular figures, etc., so as to teach the use of the shears; then the use of the soldering copper is taught. The drawing of geometrical problems follows, showing the use of the drawing tools, and then the exercises mentioned, which are practical and technical, giving what no apprentice, helper or mechanic has a chance to obtain in the shop—namely, instructions to prepare details or shop drawings from scale drawings, develop the patterns, transfer the patterns to the metal, allow edges, cut, form up on the brake and solder the article at the bench. While the above gives a general outline of the course and the benefits to be derived the following shows the full course of instruction:

PART I

1. Cutting Curves and Circles.
2. Filing and Tinning the Soldering Copper.
3. Soldering Flat Seams.
4. Soldering Upright Seams.
5. Geometrical Drawings.

PART II

Drawing details, obtaining patterns from details, and setting together the following work:

1. Plain Capital.
2. Molded Gutter.

3. Square Leader Head.
4. Octagon Leader Head.
5. Plain Window Cap.
6. Ornamental Window Cap.
7. Raised Panel.
8. Plain Cornice.
9. Ornamental Cornice.
10. Square Turret.
11. Ornamental Finial.
12. Paneled Cross.
13. Pediment on a Wash.
14. Dormer Window.
15. Hexagon Ventilator.
16. Flat Skylight.
17. Hipped Skylight.
18. Bay Window.

PART III

Hammer Work by Hand

1. Ten-inch Ball.
2. Round Finial.
3. Center Piece.

Hammer Work by Machine

4. Circular Panel.
5. Circular Molding.
6. Segmental Pediment.

Before starting the work the home student should be in pocession of a full set of hand tools for the practical work, and a drawing outfit for the pattern and layout work, as follows:

HAND TOOLS.

Hammer	Shears
Soldering Coppers (pair)	Mallet
Dividers	File
Scratch Awl	Prick Punch
Rivet Punch	Rivet Set
Several Size Chisels	Flat Nose Pliers
Ruler	Straight Edge
Try Square	Hand Groover

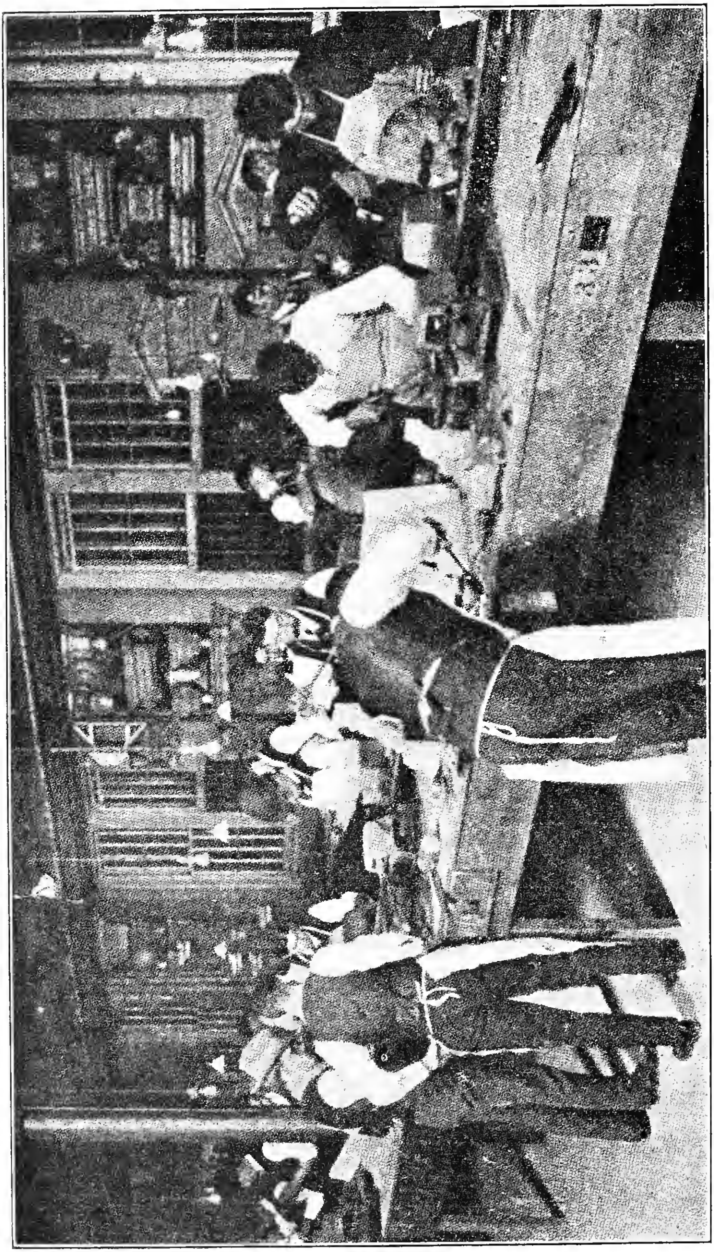


FIG. 1. View in Sheet Metal Instruction Shop

DRAWING OUTFIT.

Large Drawing Board	T Square
Set of Drawing Instruments	Drawing Pencil
45 Degree Triangle	30-60 Degree Triangle
Scale Ruler	Eraser
Detail Drawing Paper	Thumb Tacks

For the use of such machinery as the cornice brake, roll former, etc., the student will have to rely on the shop equipment in the shop where he is employed. With this enumeration of working and drawing tools any ambitious young man can take up this course and follow it in detail in the shop where he is employed just as if he attended a trade school, and his employer, the foreman, or some friendly workman can give him instructions on any points that might perplex him .

In Fig. 1 is shown one end of the sheet metal department of the New York Trade School.

CHAPTER II

Cutting Curves and Circles

Taking up the first work in the course, the home student should prick the set of full size patterns in Folder A upon thin sheet metal not heavier than No. 28 gauge, and use these patterns for cutting four of each piece. The way to prick these patterns on to the sheet metal is as follows: To obtain the pattern marked No. 1 set the wing dividers equal to 1½ in., or the distance from a' to b' using any scrap piece of metal, press one leg of the dividers slightly into the metal to keep it from slipping, and describe the circle with the other. Pattern No. 2 must be pricked through the paper pattern on to the metal, using a hammer and prick punch. A mistake often made is to use a center punch similar to that shown by A, while the prick punch should be forged long and pointed, as at B. Using the center punch A, the prick marks become too large, because the point at A spreads too quickly; but by using the prick punch B small prick marks give an accurate pattern. Lay pattern No. 2 on a piece of metal, not in the center, but in the corner, as indicated by the shaded portion, E, F, H, representing the metal, placing a weight on the pattern to keep it from moving, using the prick punch B and hammer, prick marks are made through the paper into the sheet metal by slightly tapping the punch with the hammer, the prick marks being indicated by the heavy dots. Remove the paper and, using a straightedge and prick punch, scribe lines on the metal from dot to dot, from L to M and N to O.

Where the curved line is pricked use a lead pencil to draw the curve over the dots in the metal. Care must be taken in pricking off any curved line not to place the dots too far apart, shown by *b, c, d, e, f, h, i*, pattern No. 3, for if this is done the student would be at a loss to know how to draw the proper curve or sweep, and the result would be an inaccurate pattern. The prick marks should be close, as from a to A°°. In pattern No. 4 it is not necessary to prick around the circle in the center; all that is required are the dots j and k; set one leg of the dividers in j and the other in k; describe the circle on the metal. This applies, as well, to j' and k', pattern No. 5. The heavy dots in No. 4 and No. 5 show where the prick marks should be made.

Pattern No. 6 shows the side of a modillion, to which laps are allowed, as at 8, 9 and 10. Note that the scroll from A° to B° has a double cut and is pricked on the outer curve from 1 to 2 and on the inner curve from 3 to 4, being careful to have the dots centered between each opposite pair. This double cut is only placed on the pattern to allow the prick punch or scribe awl to be inserted when scribing the line for the single cut on the four pieces to be cut. As in previous patterns, a lead pencil is used to draw the curves, while a straight-edge is for the straight lines. The small holes in the patterns are cut with the hollow punch, so that they can be hung on a small wire hook for use later on. With care the paper patterns may be preserved with the text for future reference.

The hollow punch used to punch these holes, as well as the larger circles in patterns No. 4 and No. 5, shown in Fig. 3, A and B, can be obtained from dealers in tinners' supplies. For accurate work the spring center hollow punch B is recommended, because when the centers *j* and *j'* in patterns No. 4 and No. 5, Fig. 2, are known, it is only necessary to place the spring point *a* of B, Fig. 3, in this center, and having the proper size punch, *b,* screwed to *c,* the hole is accurately punched where wanted; laying the sheet metal on a block of lead or on the trunk of a tree and hitting the punch with a heavy hammer. The shears for cutting the patterns and the pieces which will be cut after the patterns are as follows: The shears generally used is the left hand shears, illustration C. Note that when the shears are taken in the right hand they cut at the left side of the upper jaw *j,* so that the line on the material to be cut is in full view.

Another shears used to advantage in cutting curves, scrolls and irregular shapes is shown at D. The blades are shaped in a peculiar manner, which allows the material to pass freely when cutting curves or changing the direction of the cut. When a cut must be right handed, a right hand snips, or shears, is used. These snips have the handle shaped for the right hand, but they cut at the right side of the upper jaw the same as the bench shears at E. Note the difference of the upper blades in the left hand shears at C and the right hand shears at E. The bench shears, when in use, are fastened in the bench by inserting the prong at the end of the lower arm in a hole cut in the bench for the purpose. A circular snips, F, is used to cut moldings, curves, etc. Double cutting shears, H, is a labor saving tool for cutting pipes. A hole is punched into the pipe, and the point of the lower blade inserted, after which the cutting is done in the usual manner, giving a straight, smooth cut and having as waste the narrow strip, 1/8 in. wide or less and equal to the

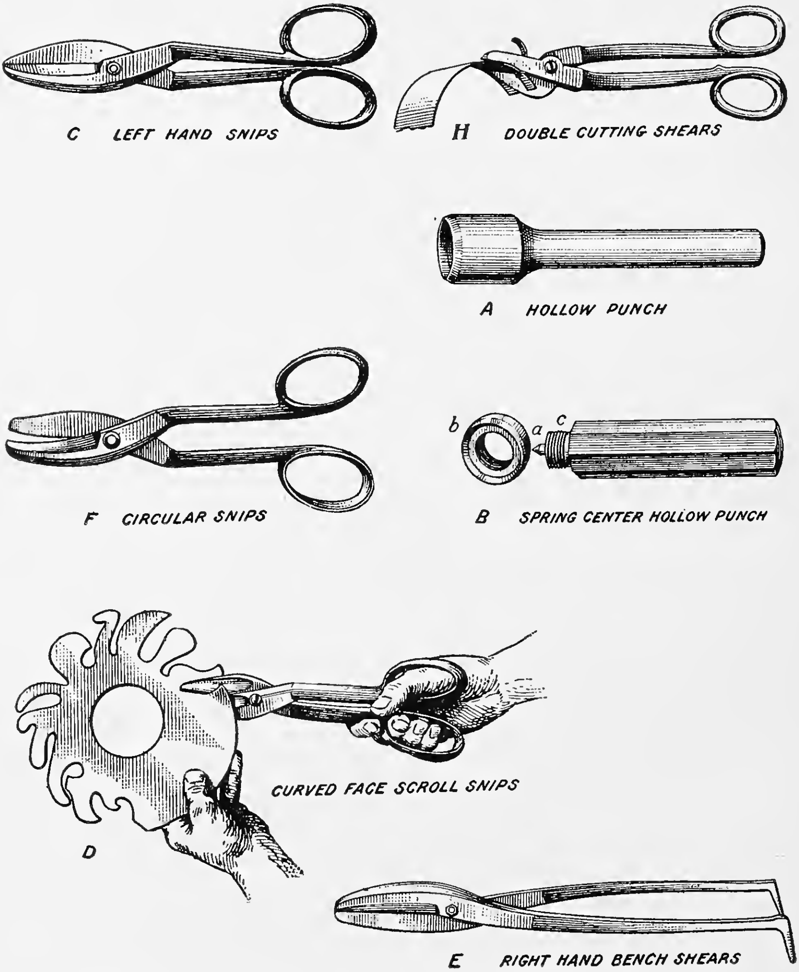


FIG. 3. Some of the Hand Tools Used in Working Sheet Metal.

thickness of the blade. Scrap pieces of metal should be used for cutting pattern No. 1, Fig. 2, four of which are required, and marked on the metal with the dividers. When large pieces of metal are used, care should be taken to avoid waste by scribing as in Fig. 4, X, and not as shown by A B C D. After the required number have been marked on the metal, X, cut through *a b* and *c d,* thus obtaining squares, after which, using the left hand

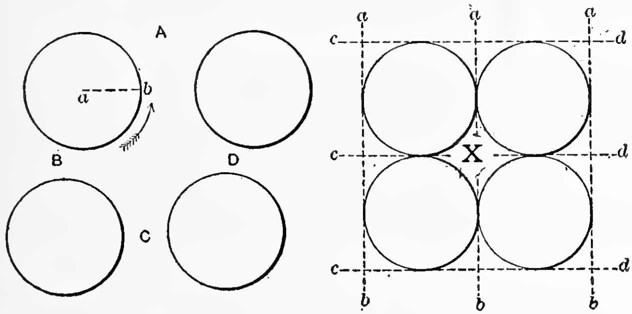


FIG. 4. Avoiding Waste in Material in Cutting Circles.

shears in the right hand and the square of metal in the left, a cut is made on the scribed line in the direction of the arrow *a b.*

A circle seems a very simple piece to cut, but it requires a little practice to get each piece true. Some students cut over a dozen before one is true and accurate, but as the school instructors insist that true circles must be furnished, no matter how many are cut, the home student must be an honest critic of his work in order to acquire accuracy and expertness.. The second templet or pattern, from which four are to be cut, is shown reduced in Fig. 5. When cutting this pattern the expert workman will cut in the direction of the arrows, and the student will

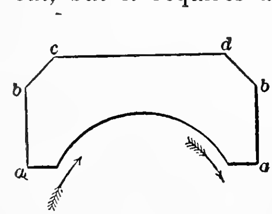


FIG. 5. The Second Templet.

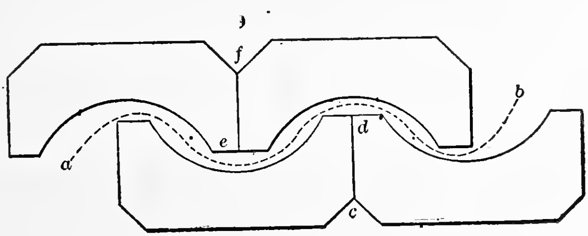


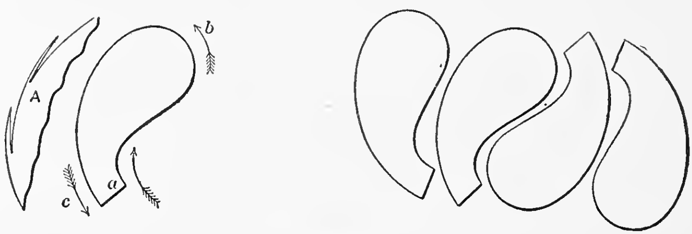
FIG. 6. Method of Cutting to Avoid Waste.

do well to follow this practice. When the straight cuts *a b, c d,* etc., are long, they are cut on the squaring shears, using foot power.

After this pattern has been cut true, the method used in scribing the rest on the sheet, no matter what pattern is used, is as follows:

Lay the pattern upon the metal; place a weight upon it to keep it from moving, and, using a scribe awl, scribe a line around the pattern. If the pattern is small, the weight can be omitted, holding the pattern with the thumb and first finger of the left hand and scribing with the right. Arrange the templet in various positions to have as little waste as possible, Fig. 6. When cutting this pattern, a rough cut is made along *a b,* then through *c d* and *e f,* after which the curves are cut as in Fig. 5.

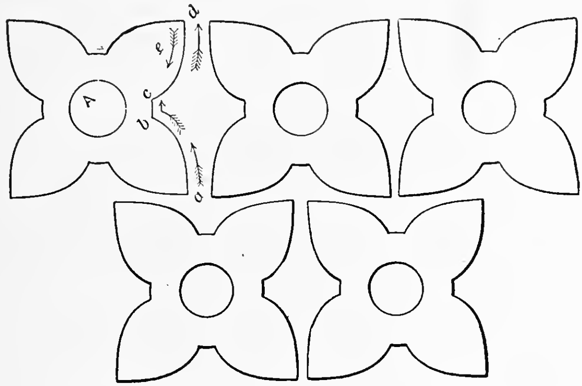
The third templet taken up by the student, Fig. 7, gives practice in cutting concave and convex curves. In scribing this pattern upon the sheet metal, waste is avoided by placing the pattern in the position in Fig. 8. When cutting, start at the concave curve *a,* Fig. 7, making one continuous cut around *b,* ending at *c.*



FIGS. 7 and 8. Third Templet and Method of Cutting.

When cutting curves of this kind, the cut should be continuous, for when the cutting is stopped, and started again, at different parts of the curve, there are apt to be small hooks or pins, shown enlarged at A, whereas the cut should be so smooth that the finger can be passed around the entire curve without cutting the skin. The fourth templet is Fig. 9, in which the center A is cut out, using a hollow punch. The templet is laid on the sheet and the pattern scribed as in Fig. 10, cut apart, the leaves then being cut in the direction of the arrow, Fig. 9. The cutting should be started at *a,* to *b,* to *c;* then starting at *d,* cut to *c,* in the direction of arrow *e.* While the cut could be made from *a* to *b* to *c* to *d,* the metal is liable to tear at *c,* when the shears is turned in the angle *c,* and the cut made from *c* to d. Sometimes instead of using the left hand shears, the circular shears, F, Fig. 3, is employed in cutting the curves in Figs. 9 and 11.

When scribing the templet No. 5 on the sheet, place it so as to avoid waste of material, as in Fig. 12; then when cutting the



FIGS. 9 and 10. Fourth Templet and Method of Cutting.

pieces separately cut, roughly along *a b* and *c d*, after which the circles A and A in Fig. 11 are cut out with the hollow punch, then cut the leaves in the direction of the arrows at *a* and *b*,

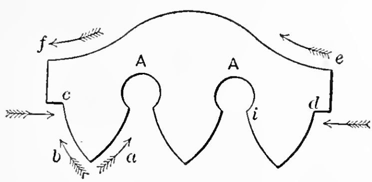


FIG. 11. Fifth Templet.

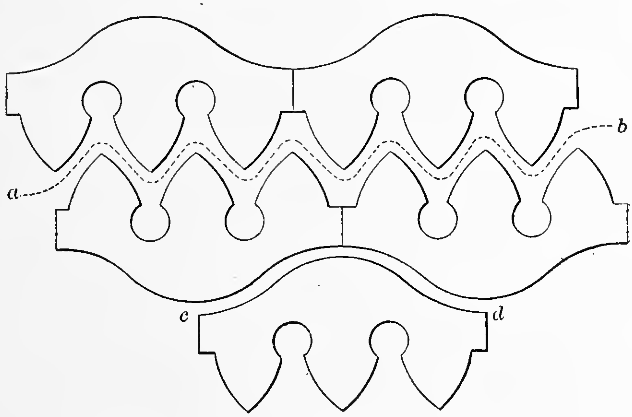
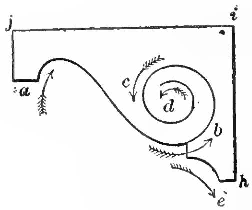
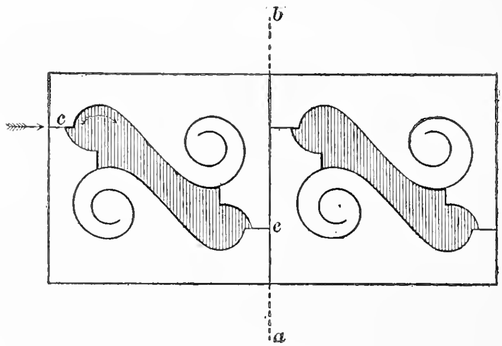


FIG. 12. Method of Cutting Fifth Templet.

notching at *c* and *d*, making one continuous cut, starting at *e* and ending at *f* on the upper curve. The last templet, No. 6, to be cut, Fig. 13, shows the side of a modillion with a scroll. The scroll has a double cut, as before described, or a slot wide enough to enable the scribe awl to pass in. These sides are scribed on the metal sheet, Fig. 14, to obtain two sides from one square. The shaded portion is waste, which can be used for small articles if cut out carefully. The cutting is accomplished as in Fig. 13, starting at *a*, making a continuous cut to *b* to *c* to *d*. The quarter round is cut in the direction of the arrow *e*. The straight cuts





FIGS. 13 and 14. Sixth Templet and Method of Cutting.

h i and *i j* are made on the squaring shears. To preserve the waste piece in Fig. 14, cut along *a b*, through *c* in the direction of the arrow and out at *e*. When the waste is small, a rough cut is made through the center and the scrolls cut as before described. The home student must keep on this cutting practice work until each piece is true to the templet, as the expertness which he gains is applied to the various pieces which he will cut throughout the course.

CHAPTER III

Tools and Preparations for Soldering

There are many ways of heating the soldering copper. Some shops employ charcoal pots, others gasoline or gas furnaces. These latter furnaces are a great convenience to the home student. When lighting the gas furnace a word of caution is given. Before turning on the stop cock have the lighted match ready and light from the bottom of the furnace. A mistake often made in lighting the gas in the gas furnace is to hold the match at the opening into which the coppers are placed. The gas usually ignites only when this chamber is full of gas and causes a little explosion, hence the lighting at the bottom is recommended. The soldering coppers are inserted after lighting, and when heated to a dark cherry color a rasp is used to remove all the dross and scales. In the larger shops an emery wheel is used, which saves time and copper, it only being necessary to hold the copper against the swiftly revolving wheel until the dross is removed. Some careless workmen fail to remove the dross and

Fig. 15. Copper Prepared for Soldering Small Ornaments.

forge the copper, thus driving the dross into the copper, with the result that the copper starts to "pit" or gets full of holes after being heated a number of times, the dross burning out and leaving the holes.

The dross being carefully removed by means of the emery wheel or file, the copper is forged on an iron block by means of a heavy hammer to a pointed shape, Fig. 15, which shape is always employed when soldering ornaments or other bench work. Having forged the coppers smooth, they are filed bright on four sides, not higher than about ¾ in., as indicated by the shaded portion A, and in filing no more should be filed off than enough to give a bright surface ready for tinning. A thoughtless mistake is often made in filing the copper as high as B, and then the filing is further continued without thinking that the copper is being wasted. If the material to be soldered is galvanized iron, zinc, copper or brass the coppers are tinned, using sal ammoniac, whereas, if the material were tin and also bright copper, they are tinned with rosin. The rosin, sal ammoniac or acid can be purchased in any drug store in 10-cent quantities. Using either rosin or sal ammoniac, the tinning is accomplished as follows: After the coppers have been heated sufficient to melt solder, a piece of sal ammoniac about 3 in. square is placed upon the bench, and, taking the solder in the left hand and the copper in the right, the point of the copper is rubbed gently on the sal ammoniac until the four sides of the copper show a clean surface; then a drop of solder is melted on the sal ammoniac from the bar in the left hand, and by gently rubbing the copper on the sal ammoniac it will become coated with solder or tinned and ready for soldering.

Whether using charcoal, gas or gasoline for the heating, the tinned part of the copper usually becomes discolored, and to clean it before soldering a dipping solution is made as follows: Using an old glass pot or large tumbler, mix a solution composed of one quart of water and one-half ounce of powdered sal ammoniac, and when dissolved it is ready for use. Then, when taking the coppers from the fire, they are first dipped quickly into this solution, which makes the tinned surface bright and clean and facilitates soldering. When the material to be soldered is galvanized iron or zinc the flux used is muriatic acid, or if the material is brass, copper or even zinc, "killed acid" is employed, which is prepared by putting zinc clippings into muriatic acid, until the acid stops boiling. When tin, bright copper or lead is to be soldered, rosin is used as a flux. As the materials used in this course are galvanized iron and zinc, muriatic acid is used as a flux. To transfer the flux from the glass tumbler to the work to be soldered a small brush is employed. These brushes are made from scrap strips of tin formed so that into one end some hair from an old brush can be placed and the tin rolled up over it and flattened at the end, Fig. 16, the brush being 4 or 5 in. long when completed. In this connection it is well to remark that soldering coppers can be obtained in any weight from 1 lb. to 10 lb. to the pair. Those used in the work under consideration are 4 lb. to the pair. The larger the coppers the more heat they will retain without being put into the furnace every few minutes to be reheated.

Having tinned the coppers and having dipping solution, acid, brush and solder in readiness, the first lesson in soldering is to strip the various pieces just cut from the full size patterns in Fig. 2. To cut the strips needed set the gauge on the squaring

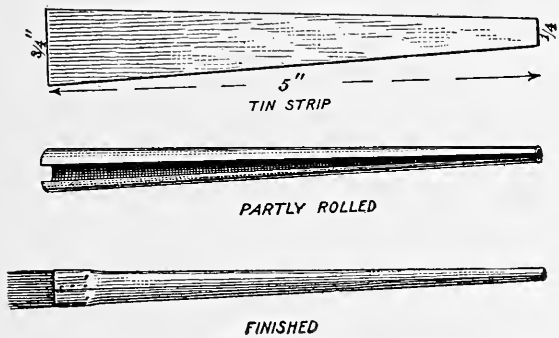


FIG. 16. Method of Making Acid Brush.

shears at ¾ in. from the blade and cut a sufficient number of strips from 30 in. wide iron, and for the work the ends of the strips must be cut perfectly square. Cut a strip equal in length to the circumference of the circle pattern No. 1 in Fig. 2, and,

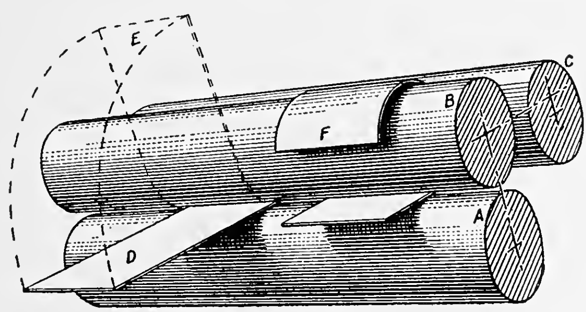


FIG. 17. Showing Forming Rolls and Their Use.

using this strip as a pattern, the required number are cut and formed up in the rolls or pipe former the same as any pipe or leader is formed into a circle, the operations being shown in Fig. 17, in which A represents the lower front roll, B the upper roll and C the rear or forming roll. This roll, C, can be raised or lowered, and gives the desired curve to the strip or pipe; the higher it is raised the smaller the diameter of the circle or pipe will be. The strip D is slightly caught between the rolls A and

B by slightly turning the handle, which is attached to the roll A, then strip D is pressed upward as at E, and by turning the handle the strip is formed until curve F is obtained, raising or lowering the rear roll as often as necessary to produce a circle the proper diameter.

Upon a piece of black sheet iron, glass or stone slab, place the ornament to be stripped, and solder the strips on the inside, so that they will set on top, as at A, Fig. 18, and not against the edge as at B, so that when viewed toward the face no strip edge

FIG. 18. Improper and Proper Methods of Stripping Ornaments.

will show. The piece of black sheet iron, marble or stone slab prevents discoloring the work when soldering, which would result if soldered on a wooden bench. When soldering hold the strip on top of the ornament with the left hand, transfer a little acid with the brush to the joint, and, using the copper, take a drop of solder from the bar and tack the strip. Make these tacks at intervals of 3/4 to 1 in. apart, then solder the entire joint, being careful not to open the tacks. A mistake often made in soldering after the work is tacked is to solder in one run, which loosens the entire joint, whereas the soldering should be done from tack to tack, waiting for the place just soldered to cool before new soldering is commenced.

When pattern No. 1 is stripped, pattern No. 2, Fig. 2, is next stripped. It is stripped in two pieces: One from L to M around the curve to N to O at the bottom, and from L to a° to b° to c° to d° to O at the top, making joints L and O, and the bends on the hatchet stake, with the pliers or on the small brake. Pattern No. 3 is stripped in one piece all around with a joint at *a*. In pattern No. 4 each leaf, as well as the circle, is stripped separately, making the small curves on the blow horn stake. The same applies to pattern No. 5. Stripping the scroll in pattern No. 6 or raising it to any desired hight is more difficult and requires a tapering strip (shown full size by Y), four of which must be cut. The straight side, *s u t*, should be soldered on the inside of the modillion side, on the inner curve 4 3 B°, the scroll then pressed outward until the curved part *s* Y *t* sets on the outside curve 1 2 B°. In the brake, laps 8 and 9 are bent outward, and lap 10 bent toward the inside all at right angles, bending two sets of sides, four in all, each set right and left, as at T.

After these 24 pieces have been stripped it is the custom at the school to mark them with the student's initial and class number for future examination and use. The marking solution is prepared by putting some copper filings in muriatic acid, which in a day or two will turn to a dark blue color, and is ready for use. It is applied with a piece of hard wood sharpened to a point, and dipped into the solution. The home student should be sure that his final work is as good as if made by a journeyman, and should keep it for future use in connection with more advanced work. The home worker is at a disadvantage in having no personal instruction and criticism, and in its absence must be a severe critic of his own work if no shopmate will do it for him.

CHAPTER IV

Soldering Flat and Upright Seams

Soldering flat seams is the next work in order. Pieces of galvanized iron are cut about 3 x 10 in. with which the student obtains practice in soldering and sweating flat seams having ½ to 1 in. lap. In soldering seams of this kind the flux must be placed directly between the metal strips the entire width of the lap, and not on the outside edges only, for it is a fact that although the soldering copper is good and hot the solder will fail to sweat all the way into the seam, because there is no flux

Fig. 19. Wedge Shaped Copper.

to aid the fusion of the metal, the acid being run only along the edges and not all the way into the space forming the seam. Bearing this in mind, the first step, is to forge the soldering copper to a wedge shape, as at A, Fig. 19, tinning only the under side and point. Knowing the amount that piece A, Fig. 20, will overlap B as at *a*, put acid over and between the seams and

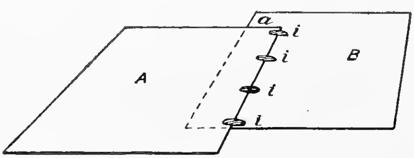


Fig. 20. Tacking the Flat Seams.

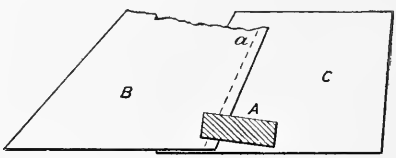


Fig. 21. Copper Improperly Placed to Sweat Seam.

tack at intervals with solder, as at *i*, *i*, etc. When soldering this seam throughout solder from tack to tack, let it cool, and so on until the entire seam is soldered. In this manner a tight seam is assured, whereas, if the tacks are opened in soldering and the seam is not held down well, an uneven and defective joint is the result. Special care should be taken in placing the soldering copper on the seam when soldering. In other words the soldering copper should be placed so as to cover the entire seam to insure the sweating, and to do this a hot iron is required. An improper way of placing the copper on the seam is shown in Fig. 21. It will be noticed that the copper A sets mostly on sheet C, while only a slight part sets on sheet B, hence most of the solder flows on sheet C, allowing but little to sweat into the seam and between the sheets or only as much as shown by dotted line *a*. Compare Fig. 22, where the soldering copper B

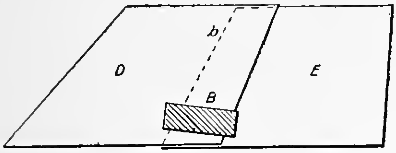


FIG. 22. Proper Position to Sweat Seam.

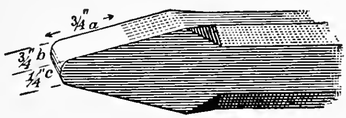


FIG. 23. Shape of Copper for Upright Seam Work.

is set directly over the seam, thereby drawing the solder between the seam formed by lapping sheets D and E, insuring a tight joint as wide as *b*. Some students have no trouble in grasping the idea and following this method, while those who do not must practice until proficient, and the home student must be sure he has acquired a proper mastery of this work before he takes up the next exercise.

The soldering of upright seams is the next work taken up and

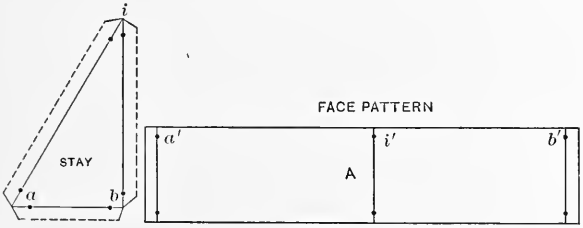


FIG. 24. Stay and Face Pattern for Upright Seam Work.

requires a little more skill than the flat seam. A wedge shaped copper is employed similar to that in Fig. 19, excepting that the point in Fig. 23 is more blunt, forging the wedge shape about ¾ in. wide and ¼ in. thick at the point, as shown by *b* and *c*. When soldering upright seams the copper is tinned on the top side about ¾ in. and on end only at *a*. The home student must now prepare from tin or galvanized iron the stay and face patterns arranged as in Fig. 24, the stay being about 8 in. high with edges all around, the angle at *a* being 60 and at *b* 90 degrees. The face is cut about 3 in. wide and of sufficient length to form *a i b* of the stay; the dots *a′ i′ b′* in A are made with the prick punch and hammer, indicating where the bends take place. These dots are the shee metal worker's marks for bending, the same as the pencil mark is the carpenter's for cutting or sawing. Four of each are cut, setting the squaring shears to cut the face strips.

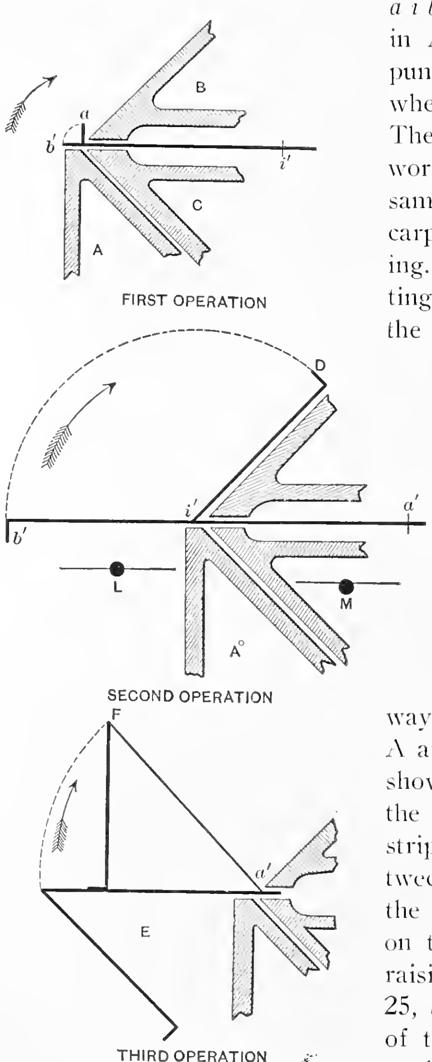


FIG. 25. Bending the Face Strip in the Brake.

Those who have had no experience in the use of the small cornice brake needed to bend the stay and face pieces, can get instruction from the shop foreman, who will superintend the bending of the stays and faces. The edges on the stay are all bent one way, while the bends in the face A are bent as in Fig. 25, which shows the three operations of the brake. The first shows the strip of metal *b′ i′* placed between the jaws B C of the brake, the top jaw or clamp B closed on the dot *b′*, Fig. 24, and by raising the bending leaf A, Fig. 25, *b′* is turned in the direction of the arrow, making the right angle *a i′*. The strip is now taken out of the machine, reversed and placed in the brake, in the position shown in the second operation, by *b′ a′* and the top clamped closed on *i′*, the bottom leaf A° swung all the way around in the arrow's direction until *b′* is brought over to D. This makes the angle at i' 45 degrees, while it ought to be 30 degrees, as at i, Fig. 24. This is accomplished by pressing together i' in the second operation in Fig. 25 until the proper angle is obtained. Then D i' a' is removed from the brake, reversed and placed in the position E in the third operation, the top clamp closed on dot a', the bending leaf raised to bring E in the position of F, which completes the bends. Particular care must be taken that the knife edge of the top clamp closes directly over the center of the dots, as indicated by L, and not to one side, as at M, Fig. 25, which is often the cause of inaccurate work, for if one end of the strip or

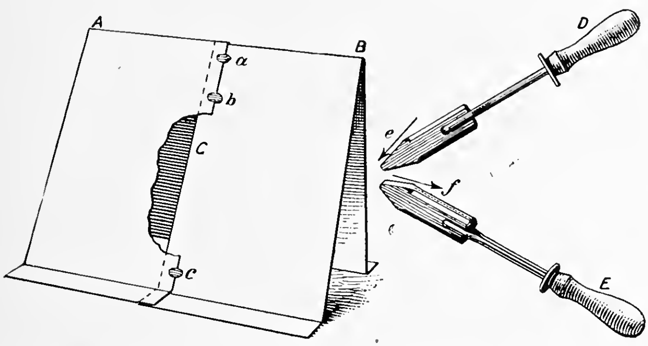


FIG. 26, The Lap of the Seam and Proper and Improper Position of Copper.

sheet is bent directly in the center of the dot and the other end away from the center the work is apt to be lopsided.

After the stays and faces are bent and have the shape shown in Fig. 26 a stay is tacked with solder near the ends, one at A and the other at B in each, and then, giving ¾-in. lap, C, two faces are tacked together at top and bottom on the side where the soldering of upright seams is to be practised. Pieces A and B are nailed to the bench with roofing nails through the lower flanges and placed between the laps forming the seam. The seam is then tacked with solder at intervals of 1½ in., as at *a, b, c,* etc. Using the hot copper and solder the seam is thoroughly sweated with solder, being careful not to open the tacks until the previous soldering has cooled, and to hold the soldering copper in the position D, which allows the solder to flow forward in the direction of the arrow at *e,* and not as shown by E, which would allow the solder to flow away from the seam toward *f*.

When soldering the seam the copper is held in the right hand, with the tinned surface upward, and the solder in the left; the solder is placed on the copper as often as required, or until the proper amount has been transferred to the seam. After it has been thoroughly sweated small ridges of solder are carried to the seam with the point of the copper, until it has the corrugated appearance in A, B, Fig. 27. In sweating and placing the ridges

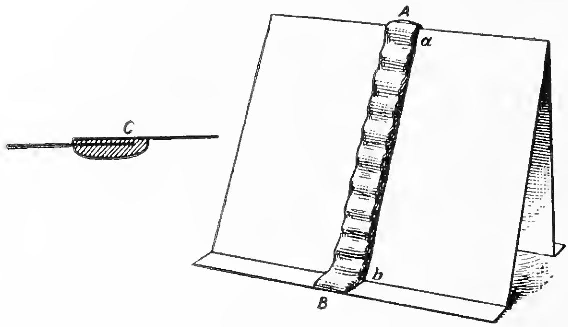


FIG. 27. The Appearance of the Solder on a Properly Soldered Upright Seam.

the solder should be placed on the seam as at C, bearing in mind what was said in connection with Figs. 21 and 22. To make a neat finish the copper is run down each side of the finished seam to make a straight line, as indicated by *a b*, Fig. 27. At the school in New York one of these seams is made by the instructor for a sample and other is made by the student until a perfect seam is produced. The home student must be careful to judge his work or have a competent workman do it for him to be sure it is properly done. At the school after this work has been passed and initials are marked on it, all working tools are put in the locker and preparations made to begin pattern drafting.

CHAPTER V.

Drawing Tools and Uses.

If the home student has no drawing instruments he should obtain those illustrated in Fig. 28, which shows the drafting tools required and the method of using them. The drawing board A should measure 24 x 36 in., be made of soft pine and well seasoned. The grain should run lengthwise of the board, and at the two ends, *s* and *t*, there should be pieces about 2 in. wide joined by tongue and groove to the board and fastened by screws; sometimes the ends are fastened by a glued matched joint and screwed. Two cleats, *M* and *N*, fastened on the bottom across the entire width of the board make it easier to move or raise it from the table and also prevent the board from warping. The entire board must be perfectly straight and true so that the T-square can be accurately used on it.

The T-square B consists of a thin straight edge called the blade, fastened at right angles to it is the head. The head is so formed that it fits against the edge of the board, while the blade extends over its surface, the blade being as long as the length of the board. The T-square having an adjustable head is frequently very convenient, as it is sometimes necessary to draw lines parallel to each other, not at right angles to the edge of the board. This form of T-square is similar to diagram B, excepting that the head is swiveled, so that it may be changed with a set screw to any desired angle. The ordinary T-square with a fixed head, however, is best adapted to most drawing work.

In diagram C and D are shown a 45, a 30, and a 60-degree triangle. They are usually made of wood or can be had of celluloid, which, being transparent, allows the draftsman to see the lines underneath, even when covered by the triangle. Their size should be about 10 or 12 in. from o to b, or o' to b'. The dividers F should be about 5 in. long. They are used for laying off distances, either from scales or other parts of the drawings, and are also employed when dividing a line into equal parts, or dividing a curve or mold into equal divisions, as in pattern drafting, about which more will be said farther along in the course.

When dividing a line or curve into equal parts with the

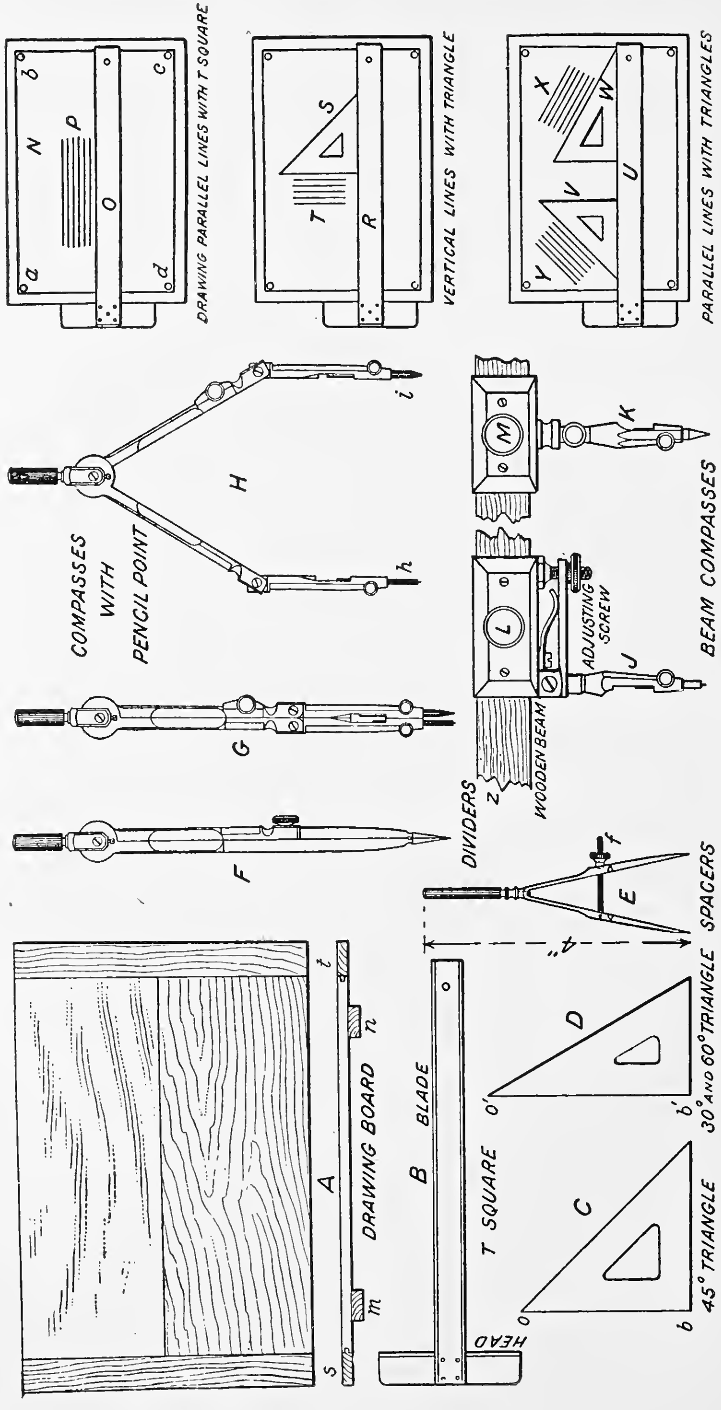


FIG. 28. Drawing Tools and Their Uses.

dividers they should be operated with the right hand, pressing them apart or together with the thumb and fingers, to do which will require a little practice to become proficient. The point of the dividers should be very sharp, so that the hole they make in the paper will be small; if large holes are made the distances between the points cannot be accurate. The "spacer" or bow spring dividers E, the entire length of which should be 4 in. is a handy little tool for spacing curves in pattern cutting. It has the advantage of being adjusted to a hair's width by turning the nut *f*. If the change in the width is considerable the two points should be pressed together, thus removing the pressure from the nut *f*, which can then be turned in either direction, with little wear on the threads.

The compasses G have pencil points, and the method of using them is shown in H, *h* being the needle point and *i* the pencil point. The length of the compasses should be about 5 in. The ordinary compasses are not large enough to draw circles having a greater diameter than 8 or 10 in., and a convenient instrument for larger circles is found in the beam compasses, J and K; J having the needle point and K the pencil point. The two parts, L and M, called the channels, are clamped to the wooden or steel rod Z, by set screws at L and M. The distance between the points J and K is equal to the desired radius. Accurate adjustment is obtained by means of the adjustment screw or nut. In addition to these articles a rubber pencil mark eraser, a No. 3 pencil, drawing paper and thumb tacks must be provided.

The sheet is tacked with thumb tacks upon the board, as in diagram N by *a b c d*, and the T-square used from the left side and bottom of the board, as at O. There are occasions when this cannot be done, but as a rule the T-square should be used as recommended. By holding the head of the T-square O against the left-hand side of the board, parallel lines can be drawn, as at P. The use of the triangle is shown in diagram R. Hold the T-square in position with the left hand, place the triangle S upon the edge of the blade R, and hold it with the left hand with the pencil in the right hand. Make the parallel lines T. The same method is applied in diagram U for drawing parallel angle lines Y and X at 45 and 30 degree angles, as shown by V and W.

CHAPTER VI

Drawing Geometrical Problems

The next step for the student who has become familiar with his drawing instruments is to put them to practical use by drawing 33 geometrical problems. The best size of drawing paper to use is 22 x 34 in. sheets. There is something added to the appearance of the work if an outline 20 x 30 in. is drawn as a border, and the inside space divided by lines into 5 in. squares within which the problems are drawn. The mastery of these problems will simplify much of the work of a sheet metal worker all through his life and particularly in pattern drafting.

The student should study each problem carefully till he under-

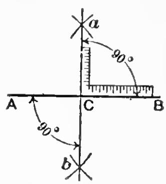


Fig. 29.

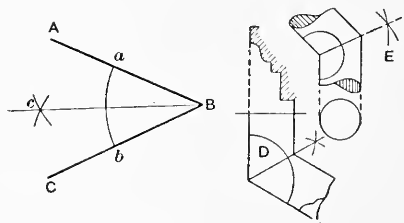


Fig. 30.

Fig. 29. Bisecting a Straight Line or Testing a Square. Fig. 30. Bisecting Any Given Angle or Drawing a Miter Line.

stands every question regarding any point which may come to his mind, and consult his shopmates on any problem he cannot master. The first to be drawn is to bisect a straight line as in Fig. 29. Let A B be the given line; using the compasses, place the point of one leg in A, and with a radius greater than one-half of A B, describe the arcs *a* and *b* with the pencil point in the other leg. In similar manner, with B as center, using the same radius, intersect arcs previously drawn at *a* and *b*. Draw a line from the exact point of the intersection of the arcs from *a* to *b*, which will bisect the line A B at C at a right angle, and divide it into two equal parts. As each of the four angles contains 90 degrees, the problem can be used in testing or constructing any right angle or square. Fig 30 shows how to bisect any given angle. This problem shows how to obtain the miter line or the line of intersection between the two parts of an elbow or a piece of cornice work. Draw the given angle, A B C; with B as center, and with any convenient radius describe arc *b a* and with *a* and *b* as centers, describe arcs intersecting each other at *c*. Draw a line from *c* to B, dividing A B C into two equal angles, and is known as the miter line in pattern drafting. The application of this rule is shown in D and E, the former being the miter line in part of a molding for a bay window, and the latter for an elbow.

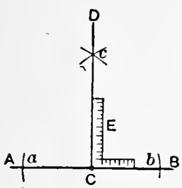


Fig. 31.

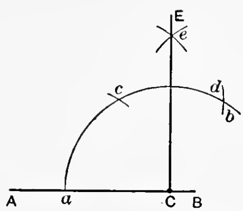


Fig. 32.

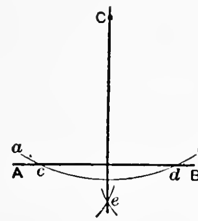


Fig. 33.

Fig. 31. Drawing a Perpendicular to a Given Line. Fig. 32. Drawing a Perpendicular Near End of Given Line. Fig. 33. Drawing a Perpendicular from a Point Outside Given Line.

When a perpendicular must be drawn from a point near the center of a given line, Fig. 31, in which A B is the given line and C the given point from which the perpendicular is to be erected, use C as center and with any convenient radius draw the arcs *a* and *b;* using *a* and *b* as centers with any radius, draw arcs intersecting at *c,* and through *c* draw the line C D, which proves the right angle shown by E. When the line to be erected is near the end of a given line, as at C on the line A B, Fig. 32, the method to use is as follows: With C as center and any convenient radius draw the arc *a b*; using the same radius, step off this distance from *a* to *c* and *c* to *d*. Using the same on any other radius, with *c* and *d* as center, describe arcs intersecting at *e*. Draw a line from C through *c* as shown by C E. This rule as well as the one in Fig. 31 shows how any perpendicular can be erected on a sheet of metal without using a square, or when out on a job with no square handy.

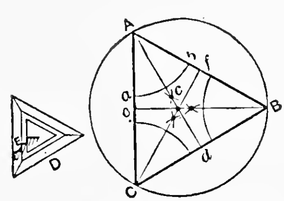


Fig. 34. Finding the Center of a Triangle.

Fig. 33 shows how a perpendicular is drawn from a point outside of a given line. Let A B be the given line and C the given point. With C as center and a radius large enough to bring the arc below the line A B, draw the arc *a b*, intersecting the given line at *c* and *d*. Then, with *c* and *d* as centers and any radius, describe arcs intersecting at *e*. Draw the desired perpendicular C *e*. Fig. 34 shows the method of finding the center and miter lines in a given triangle. Let A B C be the given triangle; bisect each of the angles A, B and C as follows: With A as center draw the arc *a b;* with *a* and *b* as centers intersect arcs at *c*. Draw the line A *c d*. In a similar manner bisect the angles B

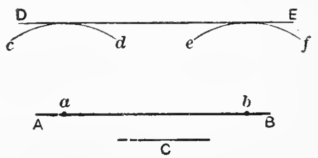


FIG. 35.

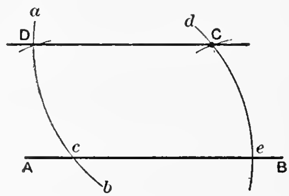


FIG. 36.

FIG. 35. Straight Line Drawn Parallel to and at Given Distance from Another Line.
FIG. 36. Drawing a Line Parallel to Another Line Through a Given Point.

and C by the lines B *e* and C *f*, and where they intersect or cross will be the center point from which the circle A B C can be drawn. This rule is applicable in finding the miter lines, when making up triangular panels in cornice work as in D, in which E shows the section of the mold. Fig. 35 shows how to draw a straight line parallel to a given straight line at a given distance from it. Let A B be the given line and C the given distance. With radius equal to C using *a* and *b* at pleasure, as centers, draw the arcs *c d* and *e f;* then tangent to these two arcs draw the desired line D E. This rule is used when parallel distances are to be laid off on sheet metal, using the compasses for spacing and then drawing lines tangent to the arcs.

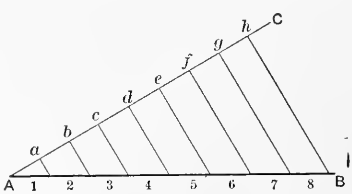


FIG. 37. Dividing a Line Into a Number of Equal Parts Without Spacing.

Another method of drawing parallel lines is shown in Fig. 36. When a line is to be drawn parallel to a given line through a given point, proceed with A B as the given line and C the given point. With C as center and any radius, draw the arc *a b* crossing A B at *c*, using the same radius and *c* as center, draw the arc *d e*. Take the distance *e* C and set it off from c to D on the arc b a and draw the line D C.

A method for dividing a given distance into any number of equal parts without spacing is given in Fig. 37. Let A B be the given length, which is to be divided into eight or any number of equal parts. From A draw the line A C at any angle, and on it mark eight equal spaces of any width by using the dividers or the rule and marking off the spaces, from a to h. From h draw h B and from the various points a to g draw lines parallel to h B, cutting the line A B, which it will be found is divided into eight equal parts. This applies when dividing any line on a

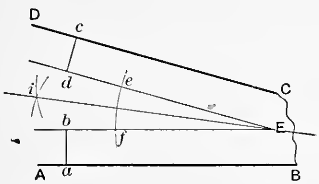


FIG. 38.

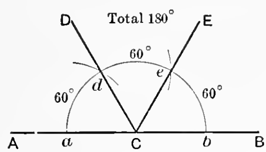
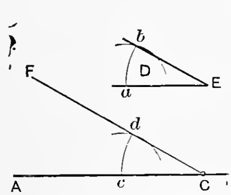


FIG. 39.

FIG. 38. Bisecting an Angle of Inaccessible Apex. FIG. 39. Drawing Three 60 Degree Angles from Any Point on a Line.

sheet of metal, no matter how many spaces are required in a given length.

A method for bisecting an angle whose apex is inaccessible is given in Fig. 38. Let A B C D be a portion of the given angle. At right angles to A B and C D draw the perpendiculars a b and c d, of any desired height, and through b and d draw lines parallel to A B and C D, until they meet at the apex E. With E as center and any radius draw the arc e f. With any other radius, using e and f as centers, intersect arcs at i. Draw a line through i E, which gives the desired bisection.



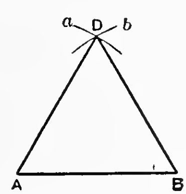


FIG. 40. Transferring Any Angle to a Given Point on a Line.
FIG. 41. Drawing a Triangle with Three Sides Equal to Given Side.

A method of drawing from any given point on a given line, three equal angles of 60 degrees each is given in Fig. 39. Let A B be the given line and C the given point. With C as center and any radius draw the arc a b; using the same radius step off on the semicircle from a to d and d to e, and draw the lines C D and C E. This method is used when constructing a semihexagonal figure, which would be obtained if lines were drawn from *a* to *d, d* to *e* and *e* to *b*.

The problem in Fig. 40 is from a point on a given straight line to transfer a given angle. Let A B be the given line, C the given point and D the given angle. With E in the given angle as center draw any arc as *a b;* using the same radius, and the given point C as center, describe the arc *c d*. Take the distance from *a* to *b* in D and place it from *c* to *d,* and draw a line from C through *d,* as shown by C F. Then F C A is equal to *b* E *a*. This method is employed in transferring any angle, whether acute or obtuse.

A method for constructing a triangle whose three sides are equal to a given side is given in Fig. 41. Let A B be the given side, which use as a radius and with A and B as centers, describe

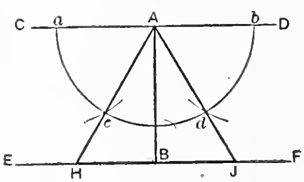


FIG. 42.

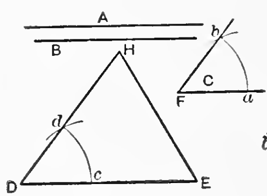


FIG. 43.

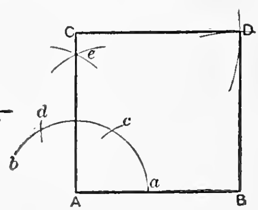


FIG. 44.

FIG. 42. Drawing Triangle with Vertical High Only Given. FIG. 43. Drawing Triangle When Angle and Lengths of Two Sides are Given. FIG. 44. Drawing a Square with Length of Side Given.

the arcs *a* and *b,* intersecting at D. Draw lines from A to D to B, which is the desired triangle. When a similar triangle is to be drawn whose three sides are equal, the vertical height A B, Fig. 42, only being given, proceed as follows: Across the ends of A and B draw the horizontal lines C D and E F. With A as center and any convenient radius, draw the semicircle *a b*. Using the same radius with *a* and *b* as centers intersect the semicircle at *c* and *d*. From A draw lines through *c* and *d* meeting the horizontal line through B at H and J, which completes the triangle A H J.

In Fig. 43 the explanation is given for drawing a triangle when the length of two sides and one angle are given. Let A and B represent the lengths of the two sides and C the angle. Draw D E equal to the length A. With F in the angle C as center; draw any arc as *a b* using this same radius, with D as center; draw similar arc, *c d,* making the distance from *c* to *d* equal to *a b* in C. Draw a line from D through *d,* as shown by

D H, which should be equal to the length of the line B. Then connect H to E, which completes the triangle.

When a square is to be drawn, the length of the side being given, by means of the compasses and straight edge, this is accomplished, as in Fig. 44, in which A B is the length of the side. With A as center draw any arc as *a b*. With the same radius, starting from *a*, step off to *c* to *d*. With *c* and *d* as centers, and any desired radius, draw arcs intersecting at *e*. Draw a line from A through *e*, making A C equal to A B. With A B as radius and B and C as centers, describe arcs, cutting each other at D. A line drawn from C to D to B completes the square.

A method for finding the center of a given circle is given in

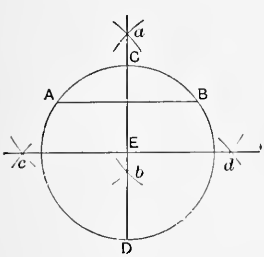


FIG. 45.

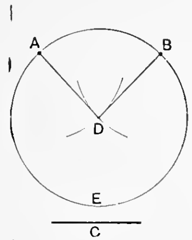


FIG. 46.

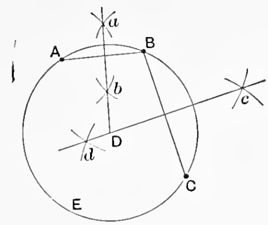


FIG. 47.

FIG. 45. Finding the Center of a Given Circle. FIG. 46. Drawing Circle of Given Radius Through Two Given Points. FIG. 47. Drawing Circle Through Three Points Not in a Straight Line.

Fig. 45. First, draw any chord as A B. Using A and B as centers, with any radius, intersect arcs at *a* and *b*, through which draw the line *a* D, cutting the circumference at C and D. Bisect C D by the arcs *c d*, through which draw a line crossing C D at E, which is the desired center. At this stage of the drawing the home student is reminded to keep the points on both pencil and compasses in good condition and resharpen when necessary, using a small whetstone for the steel and fine sandpaper for the pencil points.

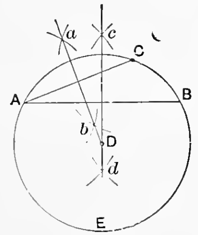


FIG. 48. Completing a Circle When Only Arc is Given

When a circle is to be drawn through two given points to a given radius, it can be done, as in Fig. 46, where A and B are the two given points and C the length of the radius. Simply use the radius C, and with A and B as centers, intersect arcs at D. Then

D is the center from which to draw a circle, passing through points A and B.

A method is given in Fig. 47 for finding the center from which to describe a circle passing through three given points not in a straight line. Let A, B and C be the three given points. Bisect

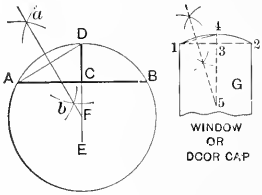


FIG. 49.

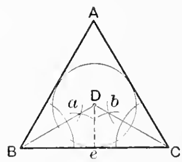


FIG. 50.

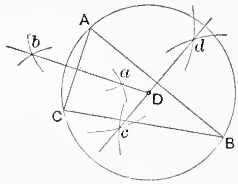


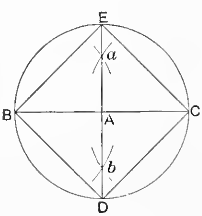
FIG. 51.

FIG. 49. Finding Center and Completing Arc When Only Chord and Height Are Given. FIG. 50. Drawing Circle Within Given Triangle. FIG. 51. Drawing Circle Outside of Given Triangle.

A B by the arcs *a* and *b* and B C by *c* and *d*. Draw lines through *a b* and *c d* intersecting at D, which is the desired center to describe the circle A B C E.

Fig. 48 shows how to complete a circle when only the arc A C B is given. Draw a line from A to B and establish at pleasure any point on the arc as C and draw A C. Bisect A B by the line *c d* and bisect A C by *a b*. From where these two lines *a b* and *c d* intersect, D, complete the circle A E B.

The rule in Fig. 49 is for obtaining the center to complete the arc, when the chord and height of a segment are given. Let A B be the chord and C D the height. Extend D C toward E, draw a line from A to D, and bisect this by the line *a b*, extending it until it meets D E at F. With F as center the arc A D B can be drawn. This rule is of value in taking measurements for metal windows or door caps, as in diagram G. Without a knowledge of this rule a stay would have to be cut to correspond to the arc 1 4 2. Knowing the rule, all that is required is to measure the distance from 1 to 2, and the height at the center line from 3 to 4 and proceed to find the center 5.



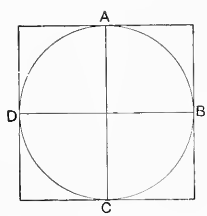


FIG. 52. Drawing a Square Within a Given Circle.
FIG. 53. Drawing a Square Outside of a Given Circle.

To draw a circle inside of a given triangle, Fig. 50, let A B C be the given triangle. Bisect angle B by line B *a* and the angle C by C *b*, extending the two lines until they meet at D, which is the desired center from which to describe the circle, using D *e* as radius.

When the circle is to be drawn around the outside of a given

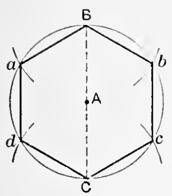


FIG. 54.

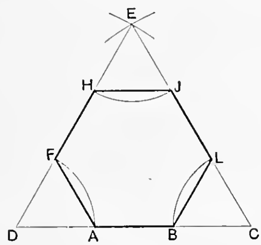


FIG. 55.

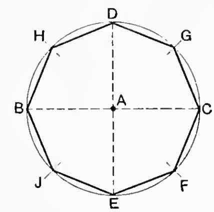


FIG. 56.

FIG. 54. Drawing a Hexagon Within a Circle. FIG. 55. Drawing a Hexagon Equal to a Given Side. FIG. 56. Drawing an Octogon Within a Circle.

triangle, let A B C in Fig. 51 be the given triangle. Bisect two sides, C A and A B, by the lines *b a* and *d c*, and where they intersect, D, is the center from which to draw the circle as shown.

Fig. 52 shows how to draw a square in a given circle. Through the center A draw diameter B C. Use B and C as centers and with any radius describe arcs intersecting at *a* and *b*, through which draw a line meeting the circumference at E and D. Draw lines from B to E to C to D to B, which completes the square. When the square is to be drawn outside of a given circle, Fig. 53, draw the two diameters as in Fig. 52, then in Fig. 53 draw lines through D and B parallel to C A, and through A and C parallel to D B. Where these lines meet at the corners the square will be complete.

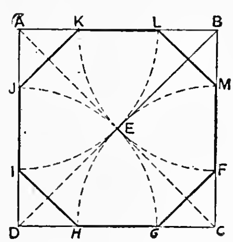


FIG. 57. Drawing an Octagon Within a Given Square.

A hexagon may be drawn within a given circle, as in Fig. 54, and the method is useful when laying out finials, etc. Let A be the center from which the given circle is struck. Through A draw the diameter B C. With a space equal to the radius of the circle using B and C as centers, draw arcs intersecting the circle at *a b* and *c d*. Connect the intersections by lines, which complete the figure. When a hexagon is to be drawn whose sides must be equal to a given side, this is accomplished as in Fig. 55, in which A B is the given length of one of the sides. Extend A B as C D, making A D and B C each equal to A B. With D and C as centers and D C as radius draw arcs intersecting at E and draw D E and C E. With D, E and C as centers and radius equal to A B, draw arcs meeting the triangle, as at F H J L. Draw A F, H J and L B to complete the figure.

An octagon is drawn within a given circle, as in Fig. 56. Through the center of the circle A draw diameters B C and D E and bisect the quarter circles B D, D C, C E, and E B at H, G, F and J. Connect the points by lines to complete the octagon. To draw an octagon within a given square, Fig. 57, draw the two diagonals A C and B D crossing each other at E. With each corner as center and one-half the diagonal as radius, describe arcs cutting the sides of the square at F, G, H, I, J, K, L and M. Connect intersections by lines to complete the octagon.

When one of the sides of the octagon is given, the figure can be drawn as in Fig. 58, in which A B is the given side. The

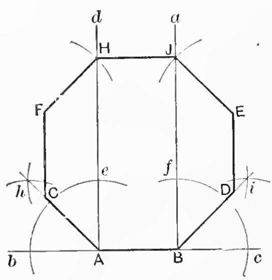


FIG. 58.

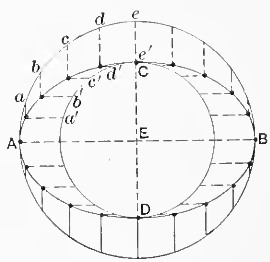


FIG. 59.

FIG. 58. Drawing an Octagon Equal to a Given Side. FIG 59. Drawing an Ellipse When Length and Width Are Given Without Using Centers.

side line may be extended indefinitely, as shown by *b c*. From A and B erect indefinite perpendiculars as A *d* and B *a*. With A and B as centers, using any radius, draw arcs *b e* and *f c*, and bisect the angles *b* A *e* and *f* B *c* by *h* A and B *i*. On these two lines set off A C and B D equal to A B. From C and D erect the perpendiculars C F and D E equal to A B. With F and E as centers and A B as radius draw arcs H and J intersecting the perpendiculars A *d* and B *a*. Connect F to H to J to E to complete the figure.

A method of drawing an ellipse, when the length and width are given without using centers, is shown in Fig. 59, and is of value when laying out heating and ventilation pipes. Let A B be the length, bisect and obtain E, through which draw the width

C D. With E as center and E C and E A as radii draw the inner and outer circles. Divide the one-quarter outer circle into any convenient number of spaces, in this case 5, as at *a, b, c, d, e;* also the one-quarter inner circle into the same number, from *a'* to *e'*. From the points on the outer circle drop vertical lines, which intersect by horizontal lines from similar lettered points on the inner circle, through which trace the one-quarter ellipse A C. If desired the four quarters can be drawn as shown, or each quarter can be traced separately, as at C B, B D and D A, completing the ellipse. In tracing this quarter ellipse or any other shape which will arise as the student proceeds with the course, tracing paper should be used to save time and labor. This is a transparent paper, placed over the drawing, and with a No. 3 pencil reproduces the outlines of the drawing. Then, reversing the tracing paper and laying it where a duplicate of the outline is to appear, go over the outlines of the drawing

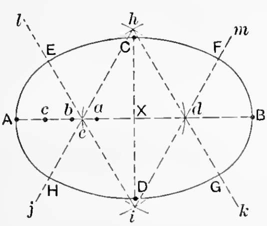


FIG. 60.

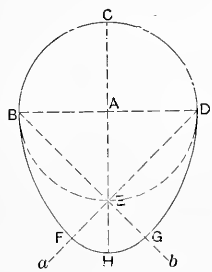


FIG. 61.

FIG. 60. Drawing an Ellipse When Length and Width Are Given, Using Centers.
FIG. 61. Drawing an Egg Shaped Oval.

again, and an impression of the drawing will be conveyed on the paper beneath. Over this impression a heavy line is drawn, as at C B D A. This is a simple method of reproducing any outline or shape. Tracing paper can be purchased or possibly would be furnished by the employer cut from the roll used in the shop.

A method for drawing an ellipse with the length and width given and when centers must be used, as in flaring pan or panel work is shown in Fig. 60. First draw the length A B, bisect same and obtain X, through which draw the width D C. Set off the width on the length from B to *a*, and divide he balancet A *a* into three parts, as shown by *a b c;* with two parts as radius and X as center draw arcs *d* and *e*. With *d e* as radius, and *d* and *e* as centers intersect arcs at *h* and *i*. Draw lines from *h* through *c* and *d* as *h j* and *h k* and through *c* and *d* from *i*, as *i l* and *i m*. With *h* and *i* as centers and *h* D and *i* C as radii draw the arcs H G and E F. In similar manner with *e* and *d* as centers and radii equal to *e* A and *d* B, draw arcs completing the ellipse, as shown by E A H and F B G.

The last problem in geometrical drawing, given in Fig. 61, is that of an egg shaped oval, when the width B D is given. Bisect B D and obtain A, which use as center and describe the circle B C D E. From B and D draw lines through E (the intersection of the circle and vertical line through A), as at B *b* and D *a*. With B and D as centers and B D as radius, draw the arcs D G and B F. With E as center and E F as radius draw the arc F H G, completing the figure.

At the New York Trade School on the completion of these drawings, the student's name, class number and date are put along the lower edge; the drawings are then rolled, put into a galvanized iron tube 4 inches in diameter and about 24 inches long and put away for future use. It may encourage the home student to know that both in the day and evening classes the students are allowed, during the season, to take their drawings home and redraw the problems so as to become more proficient. Many of the day students purchase a separate board, T-square, etc., in order to study up the patterns and problems in their evenings at home, a practice which is to be recommended.

PART II

DRAWING DETAILS, OBTAINING PATTERNS AND EXECUTING WORK

CHAPTER VII

Scale Drawings for Plain Capital

The student who has done all of his preliminary work correctly is now ready to start the first exercise of the course, which consists of drawing details from scale drawings, obtaining patterns from the details and putting together the work in sheet metal. Scale drawings are given to the pupil and he must study them so as to understand the various scales and how to use them. At the school boxwood scales are furnished, but they can be bought or drawn when not at hand, as in Fig. 62, if care is taken to make them correctly. Several scales are given in Fig. 62 on a basis of ½, 1, 2 and 3 in. to the foot. It will be noticed that whatever scale is used that amount is divided into 12 equal parts, each part representing a full inch. Thus with a 3-in. scale, 3 in. represents 12 in. on actual work or the detail; 1½-in. on the scale, 6 in.; ¾-in. on the scale, 3-in.; ⅜-in. on the scale, 1½-in., and so on, while each of the small subdivisions represents 1 in.

It will be noticed that whatever scale is used that amount is divided into 12 equal parts, when each one of these parts will represent a full inch on the full size detail or shop drawing. Thus, with a 3-in. scale, 3 in. on the scale drawing represents 12 in. in the full size detail.

The scale drawing of a plain capital is the first work for the student's consideration, and is drawn to a scale of 2 in. to the foot in Fig. 63, which gives the front and side elevations, and *a, b, c, d* and *e* indicate the center points in describing the various molds and circle, which will be explained when drawing the detail. On receiving the scale drawing the student measures off the heights of the members on the wall line, also their projections, recording them on a slip of paper, so that they can be proved or checked up by his foreman or some friendly workman in the absence of the school instructor, and after he becomes familiar with taking measurements with the scale rule the detail or shop drawing of the capital is laid out.

There are two ways of obtaining measurements from scale drawings: one is to use the dividers and the other a rule scale with bevel edges. When using the dividers, which perhaps is the best for the beginner to start with, spread the points equal

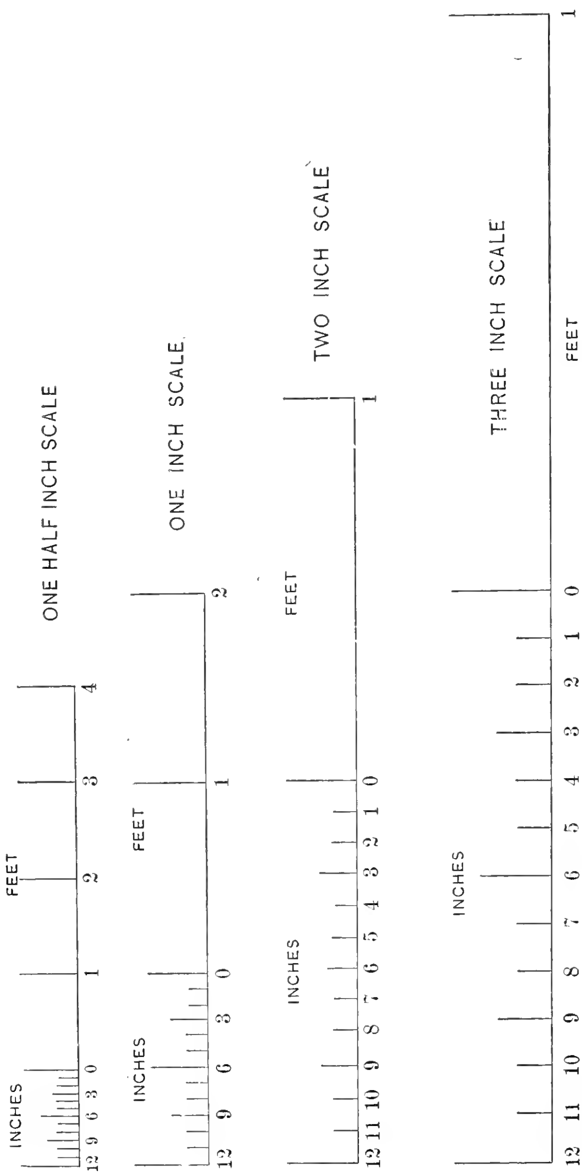


FIG. 62. Four Different Scale Rules.

to the distance from 1 to 2 on the wall line in the scale drawing; this being a 2-in. scale, set this distance on the 2-in. scale rule from O, Fig. 62, and it will measure 1¼ in. Again set the dividers from 2 to 3 on the wall line in Fig. 63, and placing this distance from O in the 2-in. scale in Fig. 62 it will also be found to measure 1¼ in. In similar manner the distances in Fig. 63 from 3 to 4 will measure 1½ in.; from 4 to 5, 4½ in.; 5 to 6, 1 in.; 6 to 7, ½ in., and 7 to 8, 2 in. Now measure the entire height of the capital, which measures 2 in. on the scale and indicates 12 in. in full size, and see whether the addition

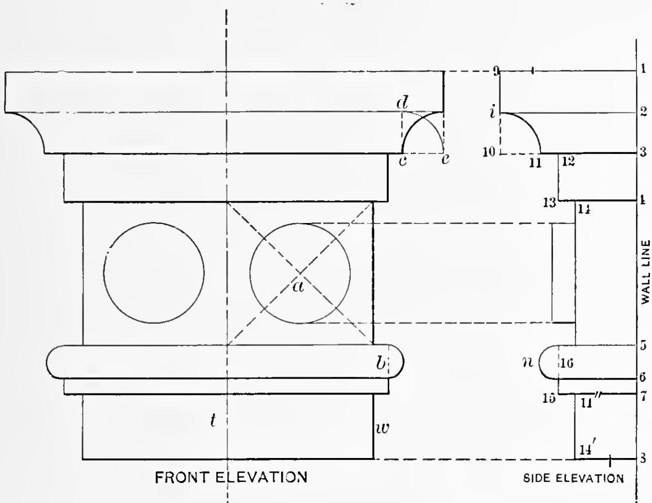


FIG. 63. Two inch scale drawing of Plain Capital.

of dimensions of all the members scaled amounts to 12 in., and, if so, this will prove it correct.

The projections are obtained in a similar manner: Take from 1 to 9, Fig. 63, with the dividers, and place this distance from O in the 2-in. scale in Fig. 62 and it will be found to measure 4¼ in. Point 10, Fig. 63, is the center from which to draw cove 11; no measurement is required for this as the center point 10 is obtained by drawing a vertical line from 9, intersecting the horizontal line from 3, shown by the dotted lines, making their intersection the point 10 and *i* as the radius, which is 1¼ in., or the height of 2 3, describe the curve which makes the cove. Obtain the projection from 11 to 12 and 13 to 14, which will be found to be ½ in. in each case. The point 14 also establishes the point 14″ as 14 and 14′ run, in one line. From 14″ to 15 will scale ½ in., and from 15 the vertical dotted line intersects line 5. Then one-half of the distance 5 6, or ½ in., on this dotted line becomes the radius to describe the semicircle from the center 16, which forms the bead *n*.

When recording these heights and projections on a slip of paper ready to lay off on the detail drawing, the following method is used: In this case the measures were taken from top to bottom, therefore make slip thus:

MEASURING SLIP FROM TOP TO BOTTOM

Numbers on scale	Projections in inches	Numbers on scale	Heights in inches
1 to 9	4¼	1 to 2	1¼
10 to 11	1¼ rad.	2 to 3	1¼
11 to 12	½	3 to 4	1½
13 to 14	½	4 to 5	4½
16	½	5 to 6	1
16 to n	½ rad.	6 to 7	½
15 to 14″	½	7 to 8	2
14′ to 8	2		
		1 to 8 =	Total 12

When the student becomes familiar with the scale measurements the dividers can be omitted, using the scale rule instead. The numbers on the slip can also be omitted when recording the heights and projections, it being done in this case to make each step clear. No mistake can occur in transferring these heights and projections on the detail, so long as it is known whether scaling is to be done from top toward bottom, or *vice versa*. When the student becomes familiar with scaling, this slip can be omitted, placing the measurements one after another on the full size detail. The student can readily see whether he has made any error in scaling his measurements from any of the scale drawings in the course by referring to the full size details, shown reduced herewith, but contain full size measurements on each and every detail.

CHAPTER VIII

Making Full-Size Drawings and Patterns for Capital.

The detail shown reduced in Fig. 64 is laid out as follows, and the student should carefully note each step, as a help in laying out other details which will follow: With a sheet of drawing paper of the required size tacked on the drawing board, using the T-square, a vertical line, which is the wall line A B, is first drawn, as shown at the right, upon which the heights of the various members are marked, and which were calculated from the scale drawing, Fig. 63, and given in the measuring slip. After these heights have been established on the line A B, Fig. 64, horizontal lines are drawn at right angle by means of the T-square indefinitely, or clear across the paper and upon which the projections of the members are placed, scaling the amount of each projection from the drawing in Fig. 63, or obtaining the proper measurement from the measuring slip. Thus the extreme projection is 4¼ in., as in side elevation, Fig. 64. Continuing work on the side elevation, with *a* as center, complete the cove, whose radius is 1¼ in. Note the amount of projection on each bend, and that *b* is the center from which to describe the semicircle forming the bead, the lower projection being 2 in. After the side elevation is completed start the front elevation by drawing the center line C D. Then scale the half face at the base of the capital in Fig. 63 from *t* to *w*, which is 4½ in., and place it on the front, elevation in Fig. 64, as shown by 4½ in., and with the T-square draw the vertical line 16 17. Continue up until a complete duplicate of the profile in the side elevation is made, as shown at the right from *o* to 18. Then draw the two arcs, using *a'* for the center for the cove, and *b'* for the bead. Draw the two diagonals *c d* and *e f*, and where they intersect at *h*, is the center from which to describe the 3-in. circle E, which is raised to the height E^2 in side elevation. The opposite or left hand of the front elevation is drawn in a similar manner; the centers being shown by *a''*, *b''* and *h'*.

The side and front elevations being completed, the next step is to develop the patterns. Provision for the metal to turn back at the top and bottom, is made as shown by 1 *o* and

17 18. Divide the cove a' and bead b' into equal spaces, numbering all the spaces and beads from a to 18. Extend the center line C D on the front elevation as D F upon the pattern below, and on it mark the dimensions of the upright, projecting and curved lines which give the girth or the amount of material required to form the capital, from o to 18 on D F. At right angles to D F with the T-square horizontal lines are drawn indefinitely through the small figures, intersected by vertical lines from similar numbered intersections in the front elevation. Note that a vertical line parallel to the center line C D in elevation from the point O intersects the horizontal line through O in the stretchout line D F at O′; that the vertical line through 1 2 in elevation intersects the horizontal lines 1 and 2 in the pattern at 1′ and 2′, and in this manner all the intersections from o'' to 18′ in the pattern are obtained.

The miter cut from H to G in the pattern is traced as follows: In tracing any miter cut in a pattern the student should bear in mind that where straight lines are shown in the profile O to 18 in elevation, straight lines must be drawn in the pattern, and where curved lines are shown in the profile in elevation, as in the coves, beads, etc., curved lines must be shown in the pattern. By referring to the numbers in elevation and pattern, the student will readily understand. Using a straight edge and pencil straight lines are drawn in the pattern, from O′ to 1′, 1′ to 2′, 5′ to 6′, 6′ to 7′ to 8′ to 9′ to 10′, and from 14′ to 15′, 16′ to 17′, 17′ to 18′, which corresponds to similar numbered straight lines in the profile in elevation. The curved lines from 2′ to 5′ and 10′ to 14′ are traced by taking a thin strip of metal about ¼ in. wide, rolled or bent with the fingers until it has the proper shape, so that when laid, say from 2′ to 5′, the metal curve will touch the intersections 2′, 3′, 4′ and 5′, and, holding the strip in this position, a pencil line is drawn. This applies to the curve 10′ to 14′, the curved lines corresponding to similar curves or molds in the profile in elevation.

Measuring from the center line D E, take the projections (either with dividers or a strip of paper) to the miter cut H G and transfer them on the opposite side of the center line D F, on lines previously drawn. Trace the miter cut J K, then J H G K is the pattern for the front. As the side elevation projects 4¼ in. at the top and 2 in. at the bottom, then measure off this distance in the pattern, and draw a line from L to M. Then L M G H is the pattern for the two sides.

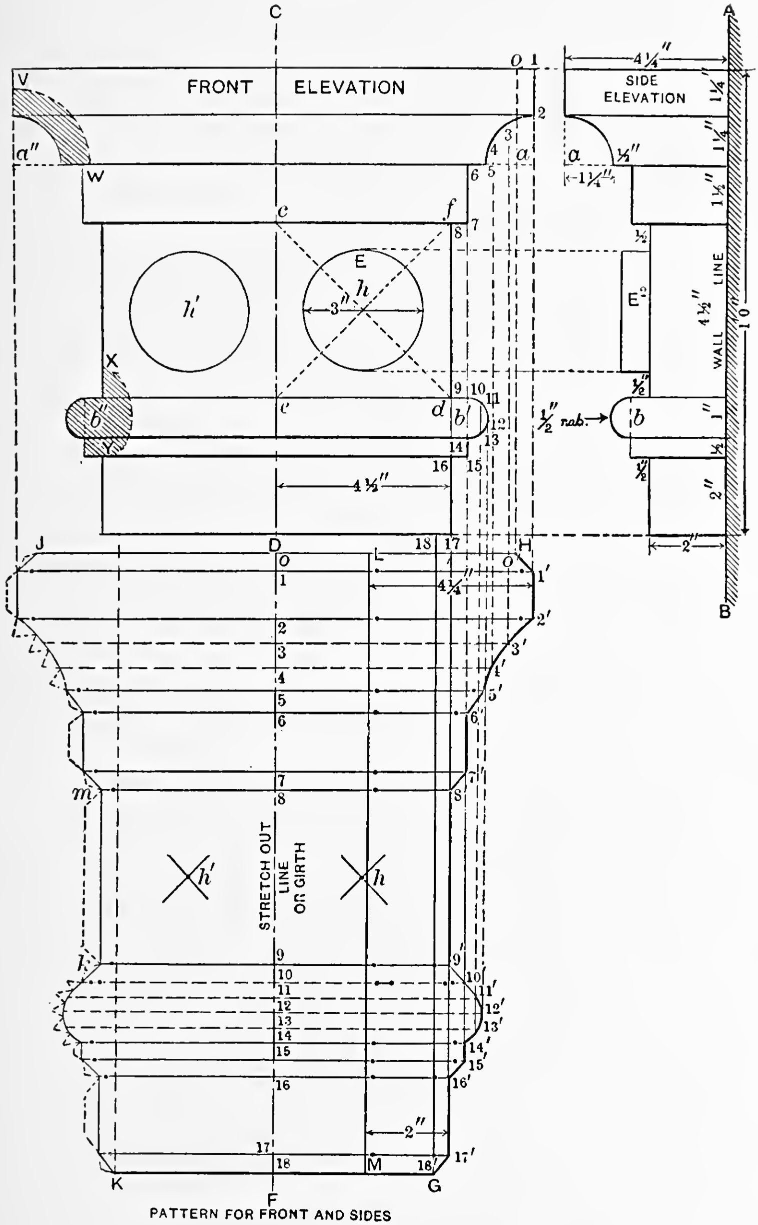


Fig. 64. Details and Developed Patterns of Plain Capital.

The intersections h and h' in the pattern for the front are obtained by drawing diagonals, m 9 and k 8, also 8 9′ and 9 8′. When allowing edges for soldering they are notched, as indicated, by the dotted lines on the left miter cut, making them about ½ in. wide, except in larger work laps are 1 in. wide to allow for riveting. Laps are allowed on the front piece on both cuts, the dots in the patterns indicating the bends; the double dots on line 10 show where the forming of the bead should stop, because the distance from 9 to 10 in the front elevation is flat.

The patterns being completed at the school, the student's name and number marked on the paper sheet, and the drawing tools put away, both he and the home student are ready to transfer the patterns to the sheet metal. This is done as follows, the student's attention being given to every step, because all work in transferring patterns will be similar in the entire course: Lay the paper pattern for the front upon the sheet of galvanized iron, placing the pattern in the corner of the sheet, so that there will be no waste, and lay a weight upon the paper to keep it from moving. Then with a sharp prick punch and a hammer put the point of the punch on each intersection of the lines and with a light tap prick the pattern on the metal. In other words, where a straight line occurs, as 8′ 9′, put a prick mark at 8′ and 9′; but where a curve occurs, as in the miter for the bead 9′ to 14′, a dot is made at 10′, 11′, 12′, 13′ and 14′.

When the outline has been prick marked, further marks are made right and left, shown by the black dots, indicating where the bends are to be made, as on 1, 2, 5, 6, 7, 8, 9, 14, 15, 16 and 17; also a double dot on line 10, indicating the finish of the bead mold. Dots are also made at h and h', indicating the centers of the raised circles. The weight is then removed, and using the paper pattern as a guide the outline is marked on the sheet metal, using a sharp awl and straight edge for the straight lines and a soft pencil for tracing over the prick marks for the curves.

Laps are allowed on the pattern, as indicated by J K, Fig. 64. When drawing the straight lines on the sheet metal, for lines that are not over 20 or 24 in. long, a straight edge can be made from No. 20 galvanized iron, such as shown in Fig. 65, following the measurements given. This sheet metal straight edge is light, and can be easily held by means of the V.shaped bend A.

In similar manner the pattern for the return or side G H L M is transferred to the metal. Cut the patterns from the metal, using the hand shears for the miter cuts, and, if desired, the squaring shears for the long cuts J H, L M and K G. There will be required in metal one piece from the front pattern and two from the side. Use the metal pattern of the side for the other piece by laying it upon the sheet metal, placing a weight upon it and then scribe off the pattern and dot off the bends.

A mistake often made, when two or more pieces are required, is to use the paper pattern for each piece. When one metal pattern is obtained from paper it should be used as a pattern, whether 2 or 200 pieces are required. When all are cut, flatten the burr, caused by cutting, on the square head stake with a mallet; never use a hammer. Before bending the pieces a stay must be cut, which is used in forming the capital. It is not necessary to waste metal and cut out the entire profile of the capital, as the square bends are obtained by using the stops on the brake.

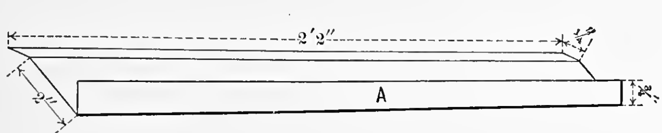


Fig. 65. Sheet Metal Straight Edged.

These stops are placed in the quadrant, fastened to the brake, and bends to any desired angle can be made by raising the handle of the bending leaf until it touches the top. Having a square bend to make the stop is set accordingly, hence all that is required in the way of a stay is from V to W and from X to Y, in elevation in Fig. 64, which can be pricked on any scrap piece of metal. The student is now ready to bend the first piece of work on the brake.

When starting on this piece of work, the instructor at the school bends the front piece of the capital to show how to open and close the brake, use the formers, the bending leaf, the stops, etc.; but the home student in most instances has never seen a brake used and should ask for assistance from some one in his shop. The school student usually finishes the two side pieces, formed right and left. When forming, start on bend 14, Fig. 64, and not on 9. By starting on bend 14, as in Fig. 66, A, the metal can be drawn over the former, leaving the flat part 10-9 as in the profile. When selecting the forming bar, it should be a trifle smaller than the mold to be made, because the metal springs slightly and the curve will be larger in size than the former selected. The next bend in order is on dot 9, shown bent in position from A° to B°.

The square bends are made up to bend 5, Fig. 67, then drawn out and a bend made on 2, as in Fig. 68, A; the proper size former B placed in position, and the metal drawn down, as shown by C, after which the square bends are completed to the desired

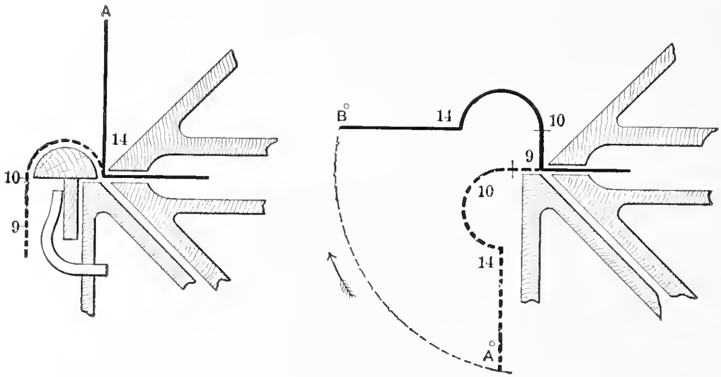


FIG. 66. Forming the Bead on a Plain Capital.

profile. In forming any mold care must be taken that each and every piece is accurate to the stay, otherwise failure will result when joining the miter, even though the pattern was accurately cut.

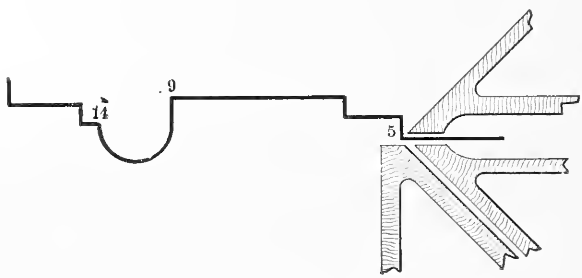


FIG. 67. First Operation in Forming Cove.

When forming the capital, students often make a mistake in placing the piece in the brake, Fig. 69, where in place of the profile being as shown by A, it was reversed in the brake on bend 8 and the result is shown at B. Of course these as well as other mistakes are liable to happen, and it is not altogether a loss when they do, because it puts the student on his guard against others. The pieces after being formed are ready to be put together. The small laps are turned over with a flat plyers, while the larger ones are bent upon the hatchet stake, with a small mallet. In putting together work of this kind, the miters should be sharp and the corners square, and as the steel square is too heavy for small work, cut a small try-square from number 24 iron, but it must be perfectly true, with one arm about 6 in. long and the

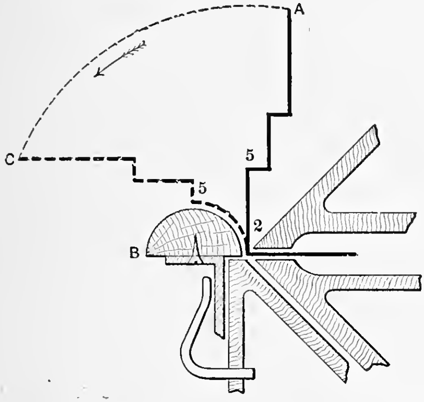


FIG. 68. Second Operation in Forming Cove.

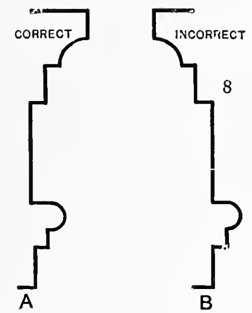


FIG. 69. Possible Error in Forming

other 4 in. This can be used for small work during the entire course.

Care must be taken to have the miters sharp as at A, Fig. 70, and not have one side above the other, as at B, and then hammer over the edge, as at C. Where possible all corners should be tacked and soldered on the inside, and any unnecessary filing should be avoided, for it only removes the galvanizing and the metal easily rusts.

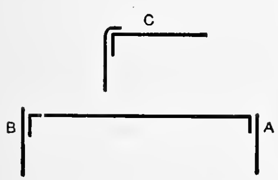


FIG. 70. Joining Miters.

In Fig. 71 are shown the various operations for joining the miter of the plain capital. The first operation in which the method of holding the upper flange of the capital together with the thumb and fingers of the left hand is shown by A, and the square *a b* is also shown, set over the outer angle to see if it is square. When the square is removed, hold it in this position, and with the soldering copper in the right hand, a small tack is made at *c*. The angle D e is again tested with the square *a b*, and if not quite true it can, by reason of only having a small tack at *c*, be turned in or out until angle D E is a right angle, when another tack is made at *d* in B. The capital is now reversed and set on the bench as at C and the cove miter dressed together from e to f, making a small tack at h. If angle F G is true, reverse it upon the edge of the bench, as indicated in B by i, and soldered at j. In this manner the balance of the miter from l to m in A

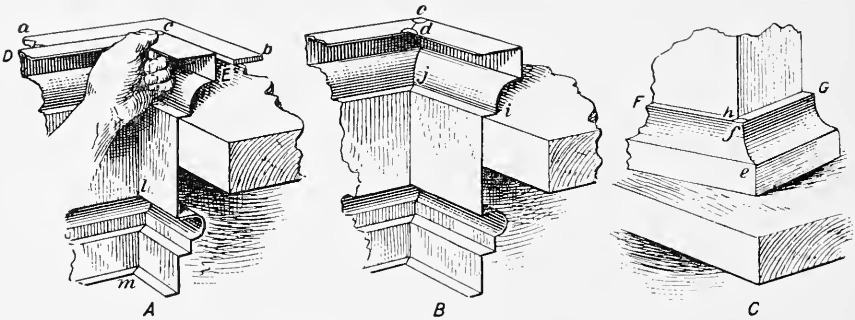


FIG. 71. Handling Miter on Bench in Making Joints.

is tacked together, dressing each member so as to have a sharp corner.

Of course, there is no given rule as to at which point fastening a miter should be started. This miter could be started at the bottom and still obtain good results. Experience will show what part of the work it should be started at when setting the miters together. In large work where the places cannot be handled alone, the mechanic and helper join the miters; the mechanic working the joint together and the helper making the necessary tacks. At the school two students generally help each other, and doubtless the home student can secure the aid of a shopmate or friend. After the two returns of the capital have been tacked true and square, they are soldered. Then solder the circles which were stripped in the earlier part of the course over th center dots on the capital. When the capital is completed scrape the surplus solder from the corners, and if done right will appear as in Fig. 72. When a piece of work does not turn out as it should, the student must try another until he is proficient.

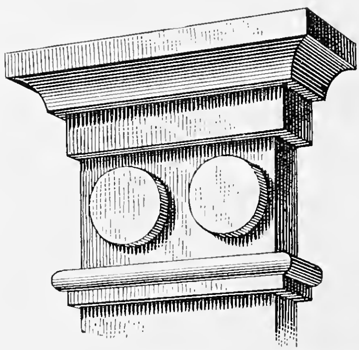


FIG. 72. Appearance of Finished Capital.

CHAPTER IX

Scale and Detail Drawings of Molded Gutter with a Miter

The second exercise is the molded gutter in Fig. 73, see Folder 1 which is also drawn to a scale of 2 in. to the foot. On the scale drawing for this exercise the section, plan and elevation of a molded gutter are given forming a miter joint at right angles in plan, with two flat heads on each end. For strength, the gutter, on the top edge, has the metal rolled into a cylinder called a bead, as shown in the section; the other ways of finishing the upper edge being explained as the student proceeds with the work. When drawing the detail the plan can be omitted.

Using the scale rule the first step is to obtain the heights of the various members in the gutter, which can be obtained from the elevation, and are placed upon the wall line, A B, in Fig. 74, see Folder 1 in the same manner as in the preceding exercise, indicated by 1 in., ½ in., 1½ in., and 1 in., making a total of 4 in. The projections of each member are scaled from the section, Fig. 73, measuring from the wall line to the profile, and the measurements placed full size on the detail in Fig. 74. Note that the bottom of the gutter is 2½ in., then a projection of ½ in., then 1½ in., which gives the center C from which to complete the cove 7 10, then another ½ in., making the extreme projection of the gutter 5 in. Make the bead the dimension on the scale drawing from 1 to 4, which completes the sectional view. The back of the gutter is turned up from 13 to 14, and in real shop practice this height is usually as high as the width of the metal sheet in stock will allow. Sometimes, the flange which turns on the roof is bent in the brake, if the amount which the gutter will overhang is known. If this is not known, the flange is turned over at the building.

Using the same profiles as that in the sectional view, draw the elevation of the gutter D E F G H making the distance D E equal to the length on the scale drawing in Fig. 73. Now, in Fig. 74, divide the bead and cove into equal spaces, and number all corners from 1 to 14 in the sectional view. Extend the line E F in elevation as E J, for the pattern, upon which place the girth of the gutter, from 1 to 14, on F J, at right angles to which draw the horizontal lines, intersected by vertical lines dropped from similar numbers in the sectional view, partly shown by 1, 2, 3, 4, 5, 11, 12, 13 and 14. Trace a line as explained in previous exercise, through points shown by K L M.

In laying out this or any other gutter the length should always be measured from the wall or hanging line K L in the pattern. In this case K 14 shows the length required and 1 14, K L M gives the desired pattern, two of which will be required, one without and one with laps, as indicated by the dotted lines at the left of the pattern. Note carefully how these laps are notched. The flat heads to close up the ends of the gutters can be pricked direct from the sectional view, allowing flanges or laps all around the profile; also allowing for a bead along the top edge 4 N, by taking a duplicate of the miter cut *a b c* and transferring it over the line 4 N, shown by *a′ b′ c′* N O, which completes the pattern for the flat heads, two of which are required.

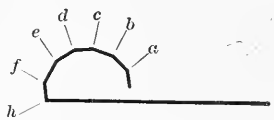


FIG. 75. Forming a Bead on the Brake

The patterns being developed, they are now pricked on the metal sheet, as previously described, cutting one of the gutter and another of the head and using them as the patterns for the balance, in this case one of each, being careful to avoid unnecessary waste by placing the patterns as indicated by X and Y. A stay is now cut for forming, all that is required being that from 6 to 11 in the sectional view. When forming the gutter on the brake the start is made on the bead, and if no beader is at hand when forming 8-ft. sheets in practice, the following method will show how the bead can be made on the brake: Place the sheet in the brake and turn up about ⅛ in.; repeat this, drawing the sheet out a short distance, being governed by the size bead to be formed. This is better shown in Fig. 75, where *a* is the first bend, *b* the second and *c, d, e* and *f* the next, while *h,* indicated by dot 4 in Fig. 74, is the square bend in Fig. 75. The bead is now placed in the brake in position A, Fig. 76, and the top clamp B closed until the bead lies close to the sheet at *a*. The student now proceeds to make the following square bends, forming the cove, as

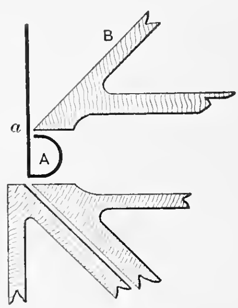


FIG. 76. Closing the Bead in the Brake

explained in the plain capital exercise, the gutter and heads to be bent right and left. In this work the student is taught how to wire the bead on the bench with the use of the hammer, mallet and rod, as explained in the four illustrations in Fig. 77. The first operation shows sheet A laid upon bench B and the required

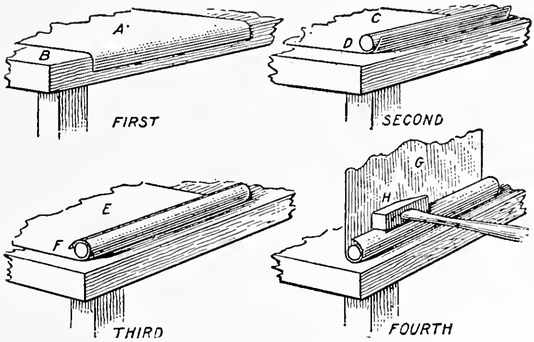


FIG. 77. Forming a Bead on a Bench.

amount turned over the edge with the mallet. The sheet is now reversed, as at C in the second operation, the rod D laid in position and the metal turned over it with the mallet, so that it will appear as in E at F in the third operation. Turn up the sheet, as G in the fourth turn, using the side of the hammer, H, and fit the bead close to the sheet.

FIG. 78. FIG. 79. FIG. 80.
Hollow Bead, Wired Bead, and Band and Angle Iron Edge.

There are several methods for making the upper edge of the gutter rigid. The hollow bead in Fig. 78 is made on the beader. Fig. 79 is a wired bead made on the brake or over the edge of a bench, having an iron rod or core, and Fig. 80 shows two methods in one example—a band iron placed in the upper edge and incased, after which a bolt or rivet is placed through at A; the other shows an angle iron edge incased and bolted or riveted at B. These can be made to suit any condition.

The student now proceeds to solder the gutter together, the flat heads being soldered at the square end of each piece first, which tends to keep the proper profile, after which the miter is joined true and square with sharp corners, sweating the laps well with solder.

The view in Fig. 81 shows part of the classroom in the New York Trade School, and two students joining the miters in the

Fig. 81. Trade School Students at Work Joining Molded Gutter.

molded gutter. The first student is dressing together the miter, clasping the upper part of the gutter in the left hand, and dressing the joint with the hammer in the right. The third student has his miter tacked and is soldering the joint. Note how they stand at ease; no awkward position is allowed in the classroom. The first student has his plain capital completed, shown standing against the gas furnace.

The water in the gutter is apt to freeze in winter, and when it expands it bursts the gutter if the joints and miters are not sweated well with solder. While a flange is not turned on the back of the gutter, the method of flanging under various roof coverings is explained in the following three illustrations. In Fig. 82, A shows the gutter flange for use under slate or shingle

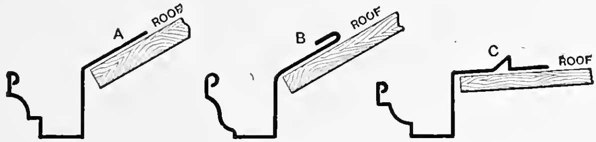


Fig. 82. Fig. 83. Fig. 84.
Roof Flanges for Shingle, Metal and Gravel Roofs.

roofing. At B, Fig. 83, a lock edge is shown for connecting with a tin roof, and in Fig. 84, C, a flange with attached guard for gravel or slag roofing.

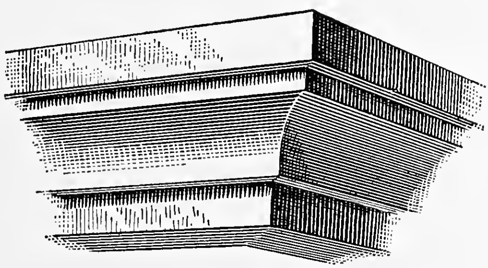


Fig. 85. Finished Molded Gutter Miter.

When the gutter is completed and the surplus solder scraped off, the student's initial and class number is put on with marking acid, and it is put up where directed in the classroom. The home student should take care of his work in some suitable place. The finished molded gutter is shown in Fig. 85 minus the roof flange.

CHAPTER X

Scale and Detail Drawings of Square Leader Head

The student now receives the 2-in. scale drawing of the square leader head in Fig. 86, which shows the front elevation, the inverted plan, or the plan of the head when viewing it from below, and the side elevation. In this case the head has molded face and sides with a flat back against the wall, as in the side elevation. A round tube is attached to the head, but a square or any other shaped tube could be used. When drawing the full size detail all that is required is the front elevation and a part plan, as will be explained as the student proceeds. First, determine the heights of the members from the front elevation on the scale drawing and place them on the center line A B on the detail in Fig. 87, as shown by ¾ in., 1¼, 2½, 1½, ½, 1½ and 3 in., making a total of 11 in. in height including the tube. Using the T-square, horizontal lines are drawn through these divisions, upon which the various projections are placed, after dimensions are taken from the scale drawing in Fig. 86. Thus the one-half projection of the top of the head measures 5¾ in., as in Fig. 87.

Note that *a* is the center from which the cove 4 7 is struck. Lay off 7 8 equal to ½ in.; 9 10 to ½ in. The center from which the quarter round 10 13 is struck is *b*, and 14 15 equals ½ in. and 15 16, 1¼ in. The half diameter of the tube is 1¼ in. Transfer these projections to the opposite side of the center line A B, so as to complete the front elevation. Find the center *d* and with ¾-in. radius describe the circle. Tangent to the circle at *e* draw the vertical line *f g*, and the diagonal lines *i g* and *h f*; where they intersect at *j* will be the center, from which to draw the second circle, it also having a ¾-in. radius as that for the circle in the center of the head. In similar manner find the center j^1 and draw the opposite circle. The height that these circles will be stripped is shown at each side by C and C^1. The entire plan being unnecessary a section through the outlet at *m n* is drawn as follows: Draw the wall line in plan, and with a radius equal to one-half the width of the tube, or 1¼ in., set off this distance from D to J and with J as center describe the circle shown.

From point 16 in elevation drop the vertical line 16 P indefinitely, as indicated on both sides by O P and R S, and set off the projection *t s*, or ¼ in., as indicated by *t′ s′*, and through *s′* draw the horizontal line S P. From the four corners R S P O draw lines to the center J cutting the circle at K L M and N. This divides the plan or soffit into sections which will be added to the various patterns as student proceeds. It will be noticed that the tube lies against the wall on the rear side, so that if the head were viewed from the side it would present a straight line on the wall side, as in the side elevation in Fig. 86. Therefore, in Fig. 87, erect a vertical line from the side of the tube E,

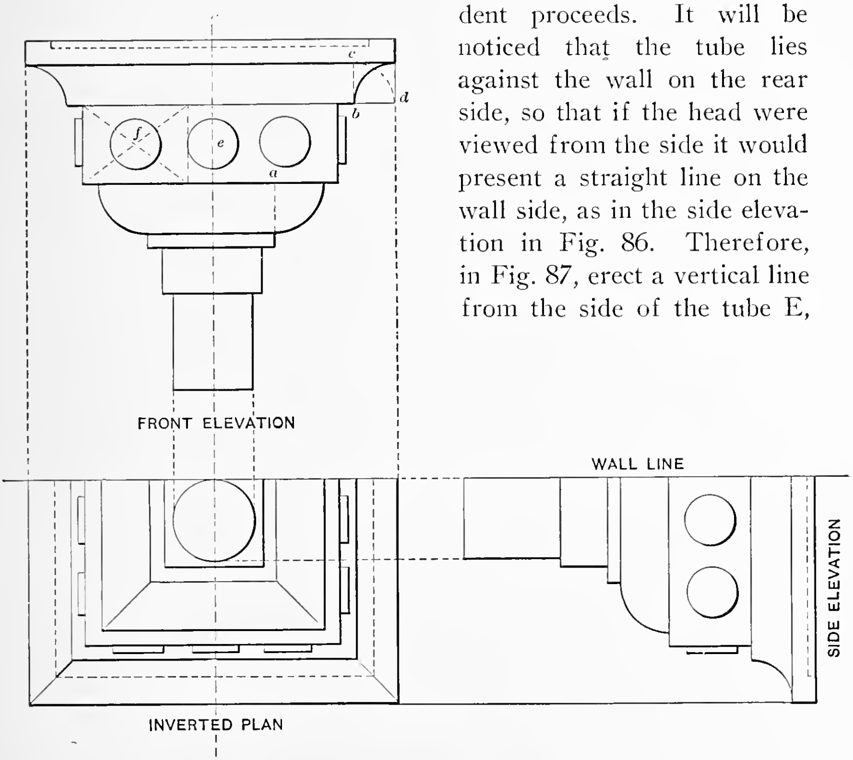


FIG. 86. Plan and Elevations of Square Leader Head

at E F; then E F G H at the left will represent a side elevation showing the two circles *j* and *d* in their proper position. Notice that the top edge of the head is turned inward to stiffen it, as at the right, 1, 2, 3, this edge being turned on all sides. Having laid out the detail accurately the patterns are developed as follows: Divide the profile of the head into equal spaces, from 1 to 16, and place this girth upon the center line A B, from 1 to 16.

With the T-square draw the usual horizontal or measuring lines, and intersect them by lines dropped from similar numbers

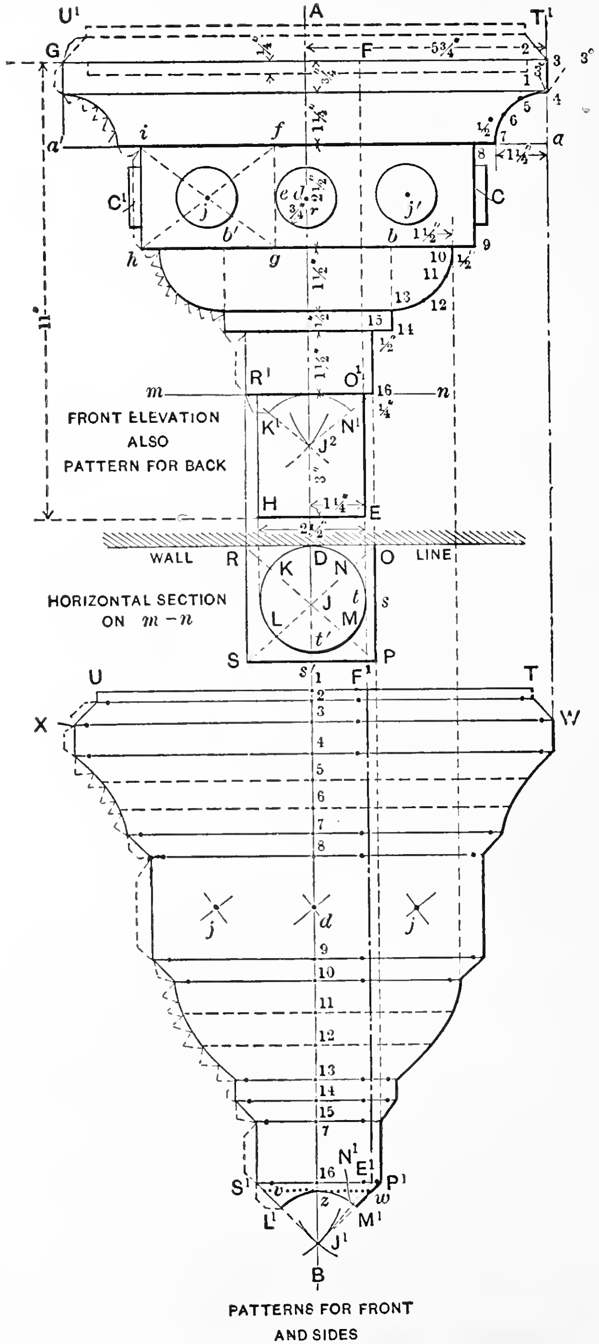


FIG. 87. Shop Detail of Square Leader Head with developed pattern.

in the elevation partly shown by 3 4, 10, and 15 16. Trace a line through points thus obtained, then T W P^1 will be the miter cut. Trace with tracing paper or transfer points with dividers or paper measurements opposite the center line, U X S^1. Then U T P^1 S^1 is the pattern for the front. The pattern for the sides is obtained by simply dropping the line F E in elevation, as shown by F^1 E^1. Then F^1 U S^1 E^1 is the pattern for the sides. It will now be necessary to add the quadrants in the horizontal section, to the patterns, which is done as follows: With P J in the horizontal section as radius and S^1 and P^1 in the pattern as centers, draw arcs intersecting each other at J^1. With radius equal to J M in the horizontal section, or one-half the diameter of the tube, and J^1 in pattern as center, draw the arc L^1 M^1, which intersect lines drawn from S^1 and P^1 toward the center J^1 at L^1 and M^1. In similar manner, from E^1 draw a line to J^1, cutting the arc at N^1. Then S^1 P^1 M^1 L^1 is that part added to the front and S^1 E^1 N^1 L^1 that part added to the sides.

Note that the cut E^1 N^1 is less than the opposite cut, because in the horizontal section the tube lies close against the wall line, making N O shorter than M P.

The rear quadrant R K N O in the horizontal section should be added to the lower part of the elevation R^1 K^1 N^1 O^1, the arc being struck from the center J^2, which is obtained from R J in the horizontal section. This completes the pattern for the three sides. If a square tube of the same size were to be placed in the head, then a line would be drawn tangent at *z* in the pattern, as shown by *v w*. As the rear side has a flat face, the front elevation answers for that pattern, adding the upper part T W X U of the front pattern to the upper part of the elevation, at the right and left, by T^1 3 G U^1. When allowing laps, place them on the front and rear piece, while no laps are allowed on the two sides. Notch the laps as indicated by the dotted lines on the front and rear patterns. The centers *j d j*, in the patterns, indicate the prick marks to be placed on the metal, to locate the soldering of the raised circles.

While these patterns are laid out for a head of a given style, it should be understood that this rule holds good in all square heads, no matter what style or profile is used. The patterns, checked off as correct, are now transferred to the sheet metal in a manner previously described, cutting one front and one back with laps, and two sides without laps. Stays are cut for forming purposes. Those required are to run from 3 to 8, and from

9 to 14 in the front elevation. A mistake often made by the student is to cut only the curve from 4 to 7, and then guess at the angle 3 4 5 and 6 7 8. The angles must always be added, or else a workman would not know whether to bend as shown by 5 4 3° or 5 4 3ᵛ. When forming make the first bend on dot 2, in the pattern, as shown in Fig. 88, then draw out to dot 3, at A, Fig. 89, and make the square bend B. Again draw out the metal and close on dot 4, in Fig. 90, A, and make another square bend B.

The metal is now drawn out to dot 5, A, Fig. 91, on which a square bend is made; when making this bend the first bend 2 will strike the top clamp at *a*, but the bending leaf should be raised until the bend at 5 is square at *b*, which will make *b c*

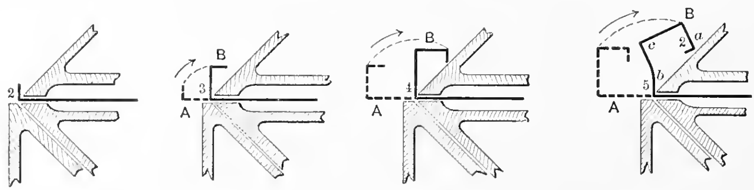


FIG. 88. FIG. 89. FIG. 90. FIG. 91.

FIG. 88. Bend in Forming Square Leader. FIG. 89. Second Operation. FIG. 90. Third Operation. FIG. 91. Fourth Operation.

slightly curved, and while in this position, as reproduced by A, Fig. 92, the proper size, former B, is placed in position and A pressed over in the position of C. The rest of the square bends are now made, and the quarter round, from 10 to 13 in the front elevation, Fig. 87, is formed in a manner similar to Fig. 92. The flanges or laps are now bent with the flat plyers, and the two sides tacked to the front perfectly square, as in the plain capital described in Chapter VIII, and the back tacked in position. If the head is true the lines of the molds run parallel, and if the four corners are well sweated with solder, the head will withstand the strain of expansion and contraction when filled with ice. Cut seven disks of the size shown by *j* in Fig. 87, and strip as high as indicated by C^1.

These are attached to the head, three on the front and two on each side in the position shown. The tube is now laid out, as in Fig. 93, in which A B shows the desired length (in this case 3 in.), and B C the circumference. Some students fail to understand the rule for obtaining the circumference of any size pipe, which is simply to multiply the diameter, in this instance 2½ in., by 3.1416, as follows:

	3.1416
Diameter of tube..................	2.5
	157080
	62832
Making the circumference..........	7.85400

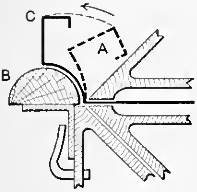


FIG. 92.

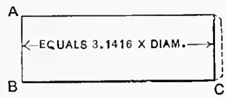


FIG. 93.

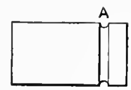


FIG. 94

FIG. 92. Forming the Cove. FIGS. 93-4. Pattern for Tube and Appearance After Beading for Flanging.

It will be noticed that the decimal point is before four figures on the first line and before one figure on the second, or a total of five; for that reason place the decimal point before five figures in the answer, which will read 7 and 85 hundredths, or nearly 7⅞ in. (7.875), the length from B to C, Fig 93.

A lap is allowed for grooving or soldering, after which the tube is rolled up and soldered, as explained in connection with Fig.

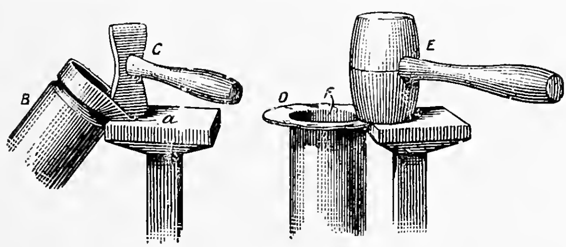


FIG. 95. Flanging the Tube.

17 on stripping. The tube is then ready to be flanged out ½ in. The gage is set on the small turning machine, and the tube passed through the machine a few times, when it will have the appearance enlarged at A, Fig. 94. This small groove acts as a guide when flanging, Fig. 95. Notice how this is done. The square head stake A is placed in the bench, the groove of the tube B placed on the corner of the stake, and holding the tube at an angle, the stretching hammer C is used to gradually stretch the metal in turning over the flange in the position shown by the dotted line *a*. It requires a little practice in using this hammer. Slight blows are given along the outer edge of the flange, so

as to expand the metal, which allows the flange to turn, until it has the position shown by D, after which the flange is dressed flat with mallet E.

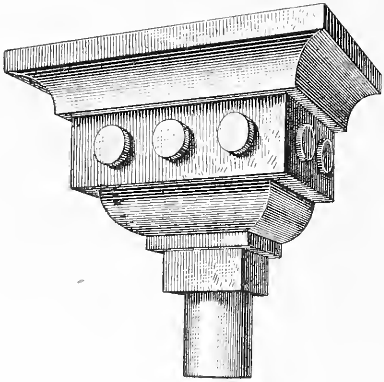


FIG. 96. View of the Finished Head.

As a rule when the beginner flanges any tube for the first time he is not apt to keep it in a true circle, but allows it to become elliptical, caused by striking light and heavy blows alternately, which stretches the metal unevenly. Light, steady uniform blows must be given to retain a true circle. To avoid elliptical shapes, a stay of the required diameter, as indicated by F, Fig. 95, is tacked with solder 2 or 3 in. below the flanging point, which will keep the pipe in proper shape and can be removed when flanging is completed. The expert does not need the stay F.

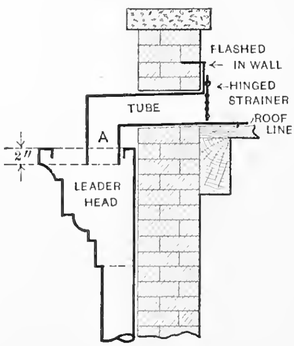


FIG. 97.

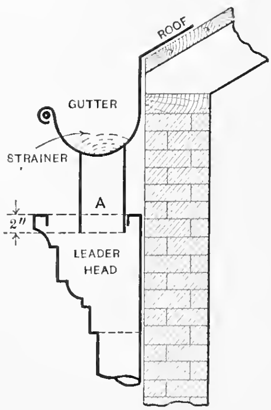


FIG. 98.

FIG. 97. Connecting Wall, Tube and Leader Head. FIG. 98. Connecting Gutter Tube to Leader Head.

The tube is now soldered into the head and finished as in Fig. 96. Fig. 97 shows a leader head with a roof tube through the wall. Fig. 98 shows a leader head connected to a hanging gutter. Note the depth the tubes enter the leader heads to prevent splashing.

CHAPTER XI

Octagon Leader Head

The method of making up octagon leader heads is the next lesson, and Fig. 99 shows the 2-in. scale drawing furnished to the student. In this drawing the front elevation, the inverted plan and the side elevation are given. When drawing the full size detail, the side elevation can be omitted. In this case the tube is made round but a square or any other shaped tube can be placed in, if desired.

The height of each member is scaled from the front elevation and placed in Fig. 100 on the center line A B, as

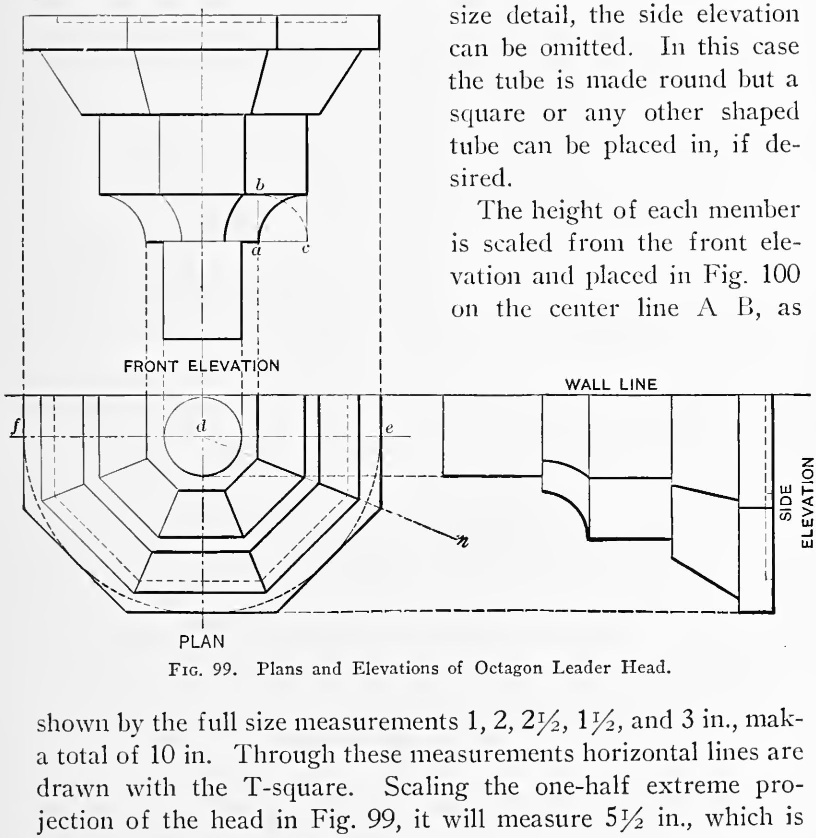


Fig. 99. Plans and Elevations of Octagon Leader Head.

shown by the full size measurements 1, 2, 2½, 1½, and 3 in., mak-a total of 10 in. Through these measurements horizontal lines are drawn with the T-square. Scaling the one-half extreme projection of the head in Fig. 99, it will measure 5½ in., which is placed to the left of the center line A B, Fig. 100, in which are shown the projections of each member by full size figures, the cove being struck from the center 0^1. Upon completion of this half elevation it is transferred to the opposite side, making the full elevation. As in the square leader head, the top edge is bent, as indicated by 1 2 3.

Having completed the outline of the elevation, the plan of the octagon leader head is drawn as follows: With radius equal to 1¼ in., or half the diameter of the tube, and with C on the line A B as center, describe the circle *a c f*. Tangent to *a*, with the T-square, draw a line representing the wall, against which the head is to be placed. Parallel to the wall line, through the center C, draw clear across the board the line D E. From the extreme projection of the head in elevation on each side drop lines intersecting D E at J and F. With C as center and C F as radius, describe the semicircle J H F. Draw tangent with the circle at J and F the vertical lines J L and F O and tangent to H the horizontal line M N; then using the 45° triangle, placed true against the T-square, draw lines tangent at I and G. Where these lines intersect at L M N and O, draw miter lines toward the center C intersecting the circle at *c, d, e* and *f*. Next divide the profile of the head into spaces from 1 to 11, from which points lines are dropped vertically until they intersect the miter line O *f*. From these intersections, parallel to O N lines are drawn intersecting the miter line N *e*, and are used for obtaining the miter line in elevation. The plan is completed by repeating this work on the left side.

From the intersections of the lines dropped from points 11 on the wall line at *j* and *i*, dotted lines are drawn toward the center C, cutting the circle at *b* and *h*, these lines being used to obtain the pattern for the back. The method of projecting the miter line N *e* in plan into the elevation will be shown, although not necessary in the development of the pattern. But when a completed front elevation is required it is well to understand how to project these points. From the intersections in elevation, from 1 to 11, horizontal lines are drawn, which in turn are intersected by vertical lines erected from similar numbers in the miter line N *e* in plan, partly shown in the front elevation by points 6′ and 9′. This explains how only two points are established, but is sufficient to show how all the numbered points can be established, and when the right side miter line has been drawn, the left is transferred to the opposite side of the center line with the dividers, and the drawing completed. The front elevation and plan being correctly drawn, the patterns are developed by placing the girth measurements of the profile 1 to 11 in front elevation on the line D E previously drawn, from 1 to 11.

Through these points at right angles to F E, draw the usual measuring lines, which are intersected by horizontal lines, drawn

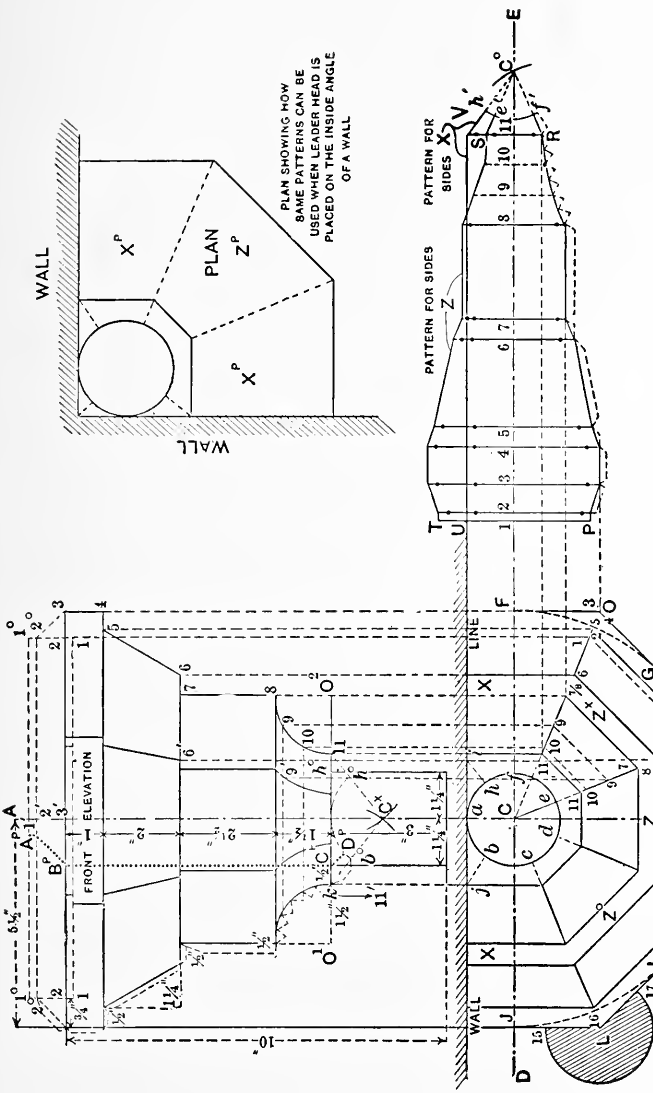


Fig. 100. Shop Detail of Octagon Leader Head with developed patterns.

parallel to F E from similar intersections on the miter line O f in plan, and resulting, when a line is traced through points thus obtained, in the miter cut P R. Measuring from the line F E, with the dividers, transfer the points in the miter cut P R opposite the line F E and obtain the miter cut S T. Then P R S T is the pattern for the three sides in plan marked Z°, Z Z^x. For the pattern for the sides marked X, simply extend the wall line U V. Then U V R P is the pattern for the two sides X. There are now patterns up to line 11, to which must be added the small segments in plan. With 11 C in plan as radius and R in pattern as center, describe an arc, cutting the line F E at C°; with C f in plan as radius and C° in the pattern as center, describe the arc h' f' indefinitely. As the miter lines in plan were drawn toward the center C, then from R, S and V in the patterns lines are drawn towards C°, cutting the arc previously drawn at f', c' and h'. Then S c' f' R is similar to f, c, 11 11 in plan; and V h' f' R in pattern, similar to h i 11 f in plan. The pattern for the back of the head is simply a reproduction of the front elevation to which the top and bottom is added as follows:

With C i in plan as radius, and 11 and k in elevation as centers, describe arcs intersecting each other in C^x. With C^x as center and C a in plan as radius, describe the arc b° h° in elevation, and from k and 11 draw lines to the center C^x intersecting the arc at b° and b°. Then K b° h° 11 is similar to j b h i in plan. To allow for the bends at the top place the girth of 3 2 1 in elevation upon the center line at 3′ 2′ 1′, through which horizontal lines are drawn, intersected by vertical lines from 1 and 2 in the profile on both sides, resulting in intersections 1° and 2°, through which a line should be traced. Then 1° 2° k b° h° 11 1° is the pattern for the flat back, to which edges are allowed on both sides from 2° to b°, as shown by the dotted lines on the left side. Laps are also allowed on both miter cuts of the sides Z° and Z^x in plan, as shown by the dotted lines in the pattern from P to f', but no laps are allowed on the front piece Z nor the sides X and X. The pattern for the tube is obtained as explained in chapter X on the square leader head.

If this octagon leader head were to be placed in the inside angle of a wall, the patterns for the sides Z and X could be used as indicated in the interior diagram by X^p, Z^p, X^p. The half pattern for the back for a leader head of this kind would be obtained by extending the line of the tube upward in the front elevation to B^p, as shown by the dotted line, and reversing the miter cut 3 2° 1° from B^p to A^p and drawing a radial line from C^p to the center C^x at the bottom, cutting the arc drawn at D^p, then 1° 2° 11 h° D^p C^p B^p A^p will be the desired half pattern.

After the pieces have been cut from metal, also the stays from 4 to 7 and 7 to h° in elevation, they are ready for forming; bending the upper ends, as explained in connection with the square leader head. After the pieces are bent the small flanges on Z° and Z^x shown from P to f' in the pattern are bent with the flat plyers, not square as in the previous work, but at an angle to form an octagon. The templet for this angle is obtained by pricking three points on a piece of scrap metal laid under 15 16 and 17 in plan, then cutting a templet stay as shown by the shaded part at L and using this for the bending of the flanges as well as in setting the work together.

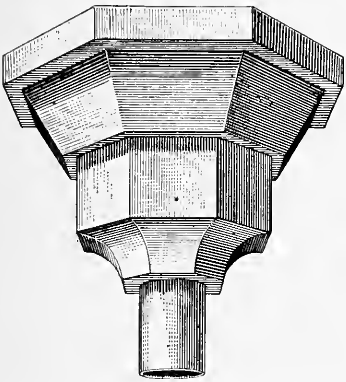


FIG. 101. View of finished Octagon Leader Head.

When putting the head together the same method is employed as in the plain capital excepting that the octagon stay L is used instead of a square, to insure the formation of a true octagon when joining the pieces X and Z° in the plan, then X and Z^x and finally the front Z, being careful to tack the miters true, so that the back will fit, after which the head can be soldered securely.

The tube is flanged and soldered in position, as explained in the previous exercise. What has been said about placing these heads in practice in reference to Figs. 97 and 98 also applies to the octagon heads. Fig. 101 shows the finished octagon leader head.

CHAPTER XII

Scale and Detail Drawings of Plain Window Cap

The fifth exercise gives more advanced work and takes up a plain window cap used on the fronts of buildings, etc. The 2-in. scale drawing in Fig. 102 shows the front and side elevation of the cap. When drawing the detail only one-half of the elevation is required. Note that the cap consists of molded dentils, C; sunk and raised panels, A and B, and corbels, D; the side of the dentil is shown by *b* and of the corbel by *c*. The dotted line inside of the wall line indicates the distance that the metal extends back against the window frame, as will be explained.

The various heights and projections are scaled from the drawing in Fig. 102, and placed on the wall line A B on the full size detail drawing in Fig. 103 see Folder 1. Note that the coves in the crown mold and detil block are struck from the centers *a* and *b*, while the quarter round in the side of the corbel is struck from the center, *c*.

The roof of the lintel has a rise of ½ in., to which is added a flange for nailing purposes, as indicated by the arrow point. The bottom of the cap or lintel returns against the frame line at point 19, returning against the wooden window frame at 21, with a flange added thereto for nailing, as indicated by 22. Before this distance from the wall to the frame line can be bent measurements are usually taken at the building from the wall to the window frame, so that the amount of material can be known. The dentil S is put in separate. The raised panel is shown by 15, 16, 17 and 18. After drawing the side elevation horizontal lines are projected with the T-square to the left and the detail of one-half of the front elevation is drawn. Scaling the width of the window from the drawing in Fig. 102, it will measure 18 in. between the inside of corbels, one-half of which, or 9 in., is placed as in Fig. 103. The face of the corbel, or 2½ in., is placed below and beyond this line, and a vertical line drawn to 14, making the profile from 14 to 1 similar to that in the side elevation. The centers of the cove in crown mold and dentil are shown by *d* and *e*, and the center of the raised panel is shown at *f*, *h* being the center for the semi-circular ends. All measurements are obtained from the scale drawing and enlarged to full size.

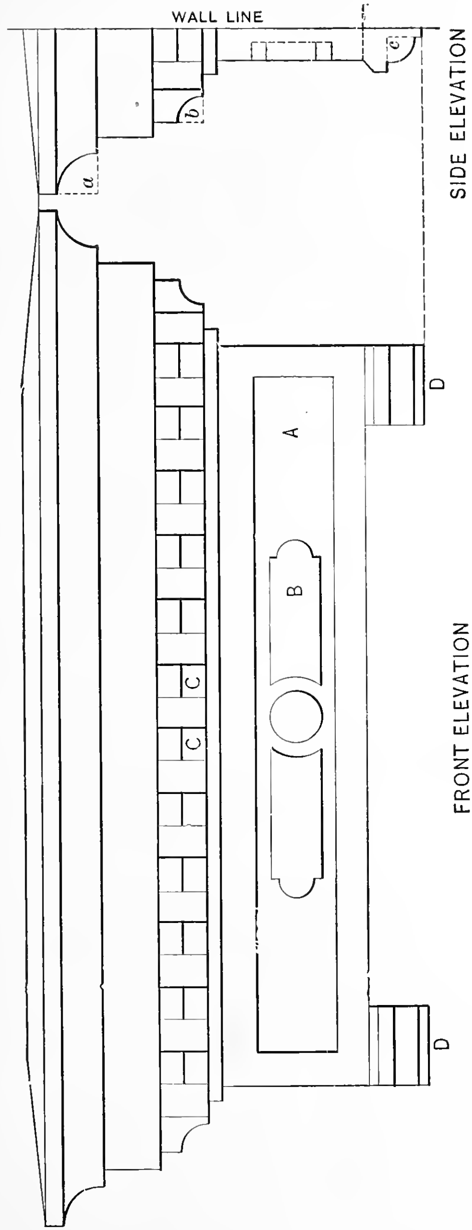


FIG. 102. Front and side elevation of plain window caps.

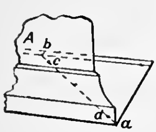
The dentils in both front and side elevations have 1-in. faces and the end dentils are placed in line with the panel face 14 19′ and 14^a 19, after which the others are spaced 1 in. apart. To develop the pattern for the one-half of the face of the window cap place the girth of the profile on the center line, C, D, shown from 1 to 14 in front elevation, and in the side elevation by 1^a to 14^a. Point 14 in the front elevation is indicated in the side elevation by 14^a. From this point, 14^a, take the girth from 14^a to 22 and place this on C. D. from 14 to 22. At right angles to C D from the small figures 1 to 22 draw horizontal lines indefinitely, intersected by lines dropped vertically from points of the same number in the profile at the right of the front elevation. Note that the horizontal dotted lines 15′ 16′, 17′ 18′, 19′ 20′ 21′ 22′ intersect or connect with points in the side elevation and the pattern having similar numbers. A line traced through points thus obtained, and partly shown by intersections 3° 4°, 8° 9°, 10° 11° and 20° 21° 22°, will be E, F, G, H, 22 and 1, which is one-half of the pattern for the front.

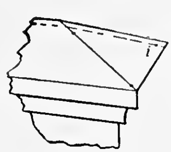
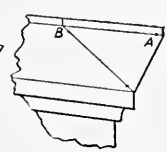
The miter cut on the roof is shown by T U F, but it is not cut on this line, a square cut being made, as indicated by T E F, and T U F is only drawn to show where the bend is to be made and the metal to be stretched, as will be explained. The pattern for the return of the cap mold is obtained by taking the distance of 5¼ in. in the side elevation and placing it from F to K in the pattern, and drawing a vertical line down to line 14, as K J. Then K F G J is the desired pattern, with a lap allowed at J G, which turns into the angle 14 in front elevation, and a lap along the top of the pattern at K F for soldering along F E when the cap is formed up.

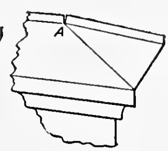
The object of cutting the notch L in the return pattern will be explained later. Laps are allowed on both miters of the front piece as indicated by the dotted lines along the edge of the pattern. The pattern for the dentil in one piece, shown below the side elevation, is obtained by taking a duplicate of the side of the dentil S, in the side elevation, and placing it at S^1. Extend the vertical line, *i m,* upon which place the girth of *i j k* found on S^1. Draw horizontal lines 1 in. wide, as in the front elevation, reverse S^1 to the opposite side, and draw S^2. The dots indicate where the bends are to be made. The circle *f,* in the front elevation, will be stripped ½ in., as indicated in the side elevation. Add ½ in. to the top and bottom of the pattern for the raised panel Z, on the front elevation, indicated by the dots around Z;

then all the stripping required on this panel will be the two curved ends. On the side elevation will be found the combined pattern of the panel miter and the outside of the corbel, which will show that the stile of the panel is 1 in. in front elevation, and which is added, as from 15 to R, in side elevation; add the depth of the panel 15, 16 or 17, 18, in side elevation, as indicated by P or R. Vertical lines are drawn from these points and intersected by horizontal lines from 15, 16 and 17, 18. The desired pattern is then M N O 19 P R 14^a, to which laps are added, as shown by M N, for turning on the inside, and another at R P for joining to *t u* on the front pattern.

The diagram V is a duplicate of 19, 21 *n p* in side elevation, with laps added, as shown by 19^1 21^1, 21^1 n^1 and n^1 p^1, and represents the pattern for the inside of the corbel a^v b^v, in front elevation, meeting the window frame. The pattern of the outsides of the corbels is obtained by taking a stretchout of the profile in V from 1 to 8, and place it below, making the face 2½ in. wide, as called for in front elevation. Laps are allowed on the corbel face pattern and completes all the patterns required. A templet for forming is required from 1 to 8 in front elevation, while diagram V is used for bending the corbel face. Only one-half of the pat-





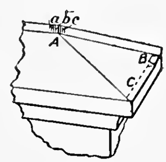


FIG. 104. FIG. 105. FIG. 106. FIG. 107. FIG. 108.

FIG. 104. Bending Miter on Roof Piece. FIG. 105. View After Bending. FIG. 106. Bending and Nailing Flange. FIG. 107. Wrong to Cut Flange at Bend. FIG. 108. Stretch Flange at Bend With Hammer.

tern for the front of the cap is shown. For obtaining the full pattern on the sheet metal, simply prick off this half, as previously described, and prick the two dots 1 and 22, on the center line C D, and on the metal, then turn the paper pattern, placing the dots 1 and 22 on the same dots in the metal and prick through the miter on the opposite side. This gives the complete pattern. Two returns will be required, right and left; 14 dentils; one circular panel *f;* two raised panels Z, and two outside and two inside pieces for corbel, and two corbel faces.

The student having obtained the patterns for the plain window cap, forming the patterns into the lintel or cap, requires no special instruction, excepting the bending of the miter on the roof piece, explained in connection with Figs. 104 to 108. The forming of the cap should be started on dot 4 in the pattern for cap in Fig. 103, and when the lower part of the cap is formed the bend on dot 3 should be formed to the angle indicated by 4 3 2 in the front elevation. Before bend 2 is made the cap is placed in the brake in the position shown by A in Fig. 104, and a slight bend made along the line *a b* on the dots *c d,* which represent similar dots in the half pattern in Fig. 103. When this slight bend in Fig. 104 is made it will look, when reversed, as in Fig. 105. A bend is now made on dot 1 to the proper angle, A, Fig. 106, and gives a straight line along A B. As this roof line should have an angle, as indicated by Z° 2 3 in elevation in Fig. 103, a mistake is often made in obtaining this angle by notching at the miter intersection B, Fig. 106, as at A, Fig. 107.

While the proper angle can be obtained in this way, a leak is the result, and to avoid this, flange A at the roof miter intersection should be slightly stretched—that is, laying the flange on the square head stake and striking light blows with the stretching hammer along *a b c,* Fig. 108, until the proper angle is obtained, shown by A. When this is completed the return miter in Fig. 103 is soldered in position, perfectly square to the face line, being careful to have the small lap K L and the large lap L F placed above and below the roof, as indicated by B and C, Fig. 108. This binds the laps and prevents the miter from breaking away from the roof.

When the miters are in position as partly shown by *a b c* in A, Fig. 109, the corbel is soldered together, B C D, B being the outside of the corbel with panel miter attached, C the face and D the inside, and is soldered in a manner similar to placing the flat head in the molded gutter. The corbels are now soldered on to the cap, the dentils placed in position, the raised panel soldered into the center of the sunk panel, being careful to avoid acid stains and blotches of solder, and if properly done the window cap will look as in Fig. 110.

When fastening the window cap to the building when the wall is of brick, the simplest way is shown in Fig. 111, in which nails are driven into the brick joints through the metal flange A, then covered with roofers' cement as indicated by the smooth finish B.

When a first-class job is desired the joint in the brick work is cut out to a depth of 1 in., and enough additional metal allowed on the roof edge to flange upward and into the brick work, shown by A, Fig. 112. When the window caps are to be fastened to a frame building having clapboards a 4 or 5 in. flange is bent from the roof at A, Fig. 113, nailed to the sheathing at *a,* and the clapboard B placed over the nail head and flashing.

When the flange is to be nailed to an outside wood surface and will not be covered with clapboards or metal covering, the

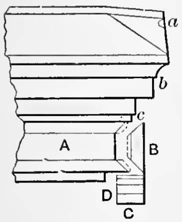


FIG. 109.

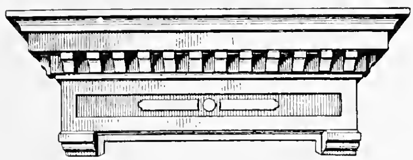


FIG. 110.

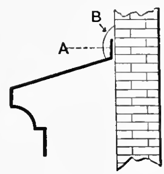


FIG. 111.

FIG. 109. Joining Corbel and Miter to Cap. FIG 110. View of Finished Window Cap. FIG. 111. Connection to Brick Wall with Cap.

flange is bent as indicated by B, Fig. 114, nailed at *c* and then turned down on the upper edge A so as to cover the nail heads at D. This prevents the nails drawing out by the heat of the sun. Care should be taken before nailing to have a good layer of white lead between the flange and woodwork, and after closing the flange over the nail heads to "paintskin" smooth over

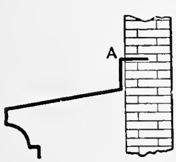


FIG. 112.

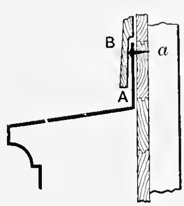


FIG. 113.

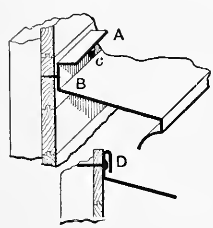


FIG. 114.

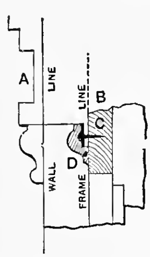


FIG. 115.

FIG. 112. Connection to Brick Wall with Recess Joint. FIG. 113. Finish under Clap Boards. FIG. 114. Protecting ails in Wood from Sun's Action. FIG. 115. Nailing Against Window Frame.

the flange, to prevent leaks. The method of finishing against the window frame at the bottom is shown in Fig. 115, in which A shows the window cap against the wall line, flanging against the frame line B and nailed at C. In most cases the flange remains in this manner; but where a neat appearance is wanted, with no nail heads to show, a wooden molding D is placed over the flange, mitering at the corners and extending along the sides of the frame.

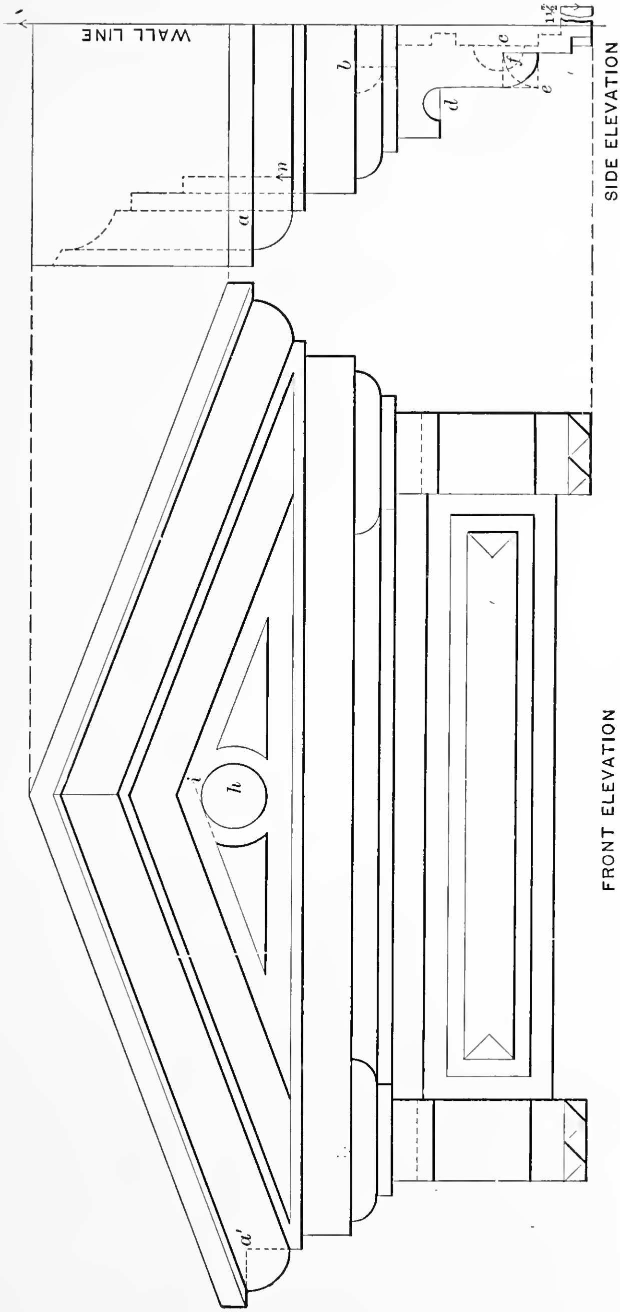
CHAPTER XIII

Scale and Detail Drawings for Making an Ornamental Window Cap

In proceeding with the course the exercises will become more difficult, the pattern drafting more complicated and, as a rule, the student becomes more interested in his work. The sixth lesson is the construction of an ornamental window cap or lintel, the blue print or lesson drawing as given to the student being drawn to a scale of 2 in. to the foot, and is reproduced in Fig. 116, in which the front and side elevations are shown, and on which are the small letters indicating the various centers from which the molds and arcs are struck. Note that the lines in the triangular panel in the pediment run tangent to the circle *h*, as indicated at *i*.

The roof of the fillet returns back the distance indicated by *n* to receive the back of the pediment mold. How this measurement is obtained will be explained when drawing the shop detail. It is assumed in this case that the window frame sets back 1½ in. from the face of the wall, although in practice this measurement is verified at the building. When drawing the detail only one-half of the front elevation is required, as in the previous exercise.

Having carefully studied the scale drawing and measured the heights and projections with the rule, lay them off full size on the wall line A B in the detail drawing in Fig. 117. See Folder 1. The total height of the window cap is 1 ft. 4¼ in., and the extreme projection 7½ in. The quarter round in the crown mold is struck from *a*, that in the cap mold from *b*. the bead in the panel from *c*, all in the side elevation. When the side elevation of the entire cap is drawn the bracket side is drawn in position and the extreme projection is 3½ in. The cap of the bracket is then drawn, being careful to have the same projections as in the profile 11-16, the quarter round being struck from the center *d*. The center *e* is for drawing the semicircle *t*, *u* and *f*, the center for the quarter round *v* in the bracket. The ¼-in. projection at the lower part of the bracket indicates the rise of the triangular dentil H in the front elevation.



Scale 2 in. = One Foot.

FIG. 116. Front and Side Elevations of an Ornamental Window Cap.

Having completed the side elevation, horizontal lines are drawn across the paper with the T-square through the various members, on which the one-half front elevation will be drawn. Draw the center line C D and lay off one-half of the window opening, in this case 9¼ in. Also lay off the face of the bracket 2½ in. and erect a vertical line to 16′ and place from 16′, the profile 16′ 10′ 1, which must be similar to *s* 10 *x* in side elevation; the distance 10′ 11″ in front elevation to be ½ in., which happens to be similar to 10 T° in the side elevation. Obtain 1^v, the apex of the pediment on the center line C D from the scale drawing, and draw a line from 1^v to 1. This gives the pitch of the pediment. From the corners 2, 3 and 7′ draw lines parallel to 1 1^v. As the heights 7′ 8′ and 9′ 10′ in the normal profile are ½ and 1½ in., place these distances at right angles to the pediment mold and draw parallel lines as shown by similar measurements.

Bisect *m n* on the center line and obtain *h*, which use as a center, and describe the 2-in. semicircle. Set off 5½ in., as at *o*, from which draw lines tangent to the semicircle. Complete G by drawing the arc at ½ in. from the semicircle. Draw the inside line of the bracket to 16″ and place a tracing of the cap mold. The quarter rounds are drawn from the centers *a′*, *b′*, *b″*. As the margin around the panel in front elevation should be equal, take the vertical heights on *r* 24′, in front elevation, and place them from *l* to 24′, and complete the panel, the miter lines 21′ 24′ and 24′ 27′ being drawn at angles of 45 degrees, because the panel head is square. Place the two dentils H on the face of the bracket, by dividing the upper line into two parts and the lower into four parts; then connect. From 1 to 10′ in the front elevation represents the normal profile of the horizontal return, from which a modified profile must be obtained for the pediment molding to admit the mitering of it with the return molding.

This is accomplished by dividing the quarter round into equal parts, from 3 to 7′, from which lines are drawn parallel to the raking molding intersecting the center line C D. Draw any horizontal line below the normal profile, as *i j*, upon which drop the various projections in the normal profile, shown by similar figures. Place these projections parallel with the pediment mold, *i′ j′*, and drop the perpendiculars to *i′ j′* until they intersect similar numbered lines in the pediment mold, shown by 1 to 10 in the modified profile. The distance from 10 to 11 can be made as deep as desired, in this case ½ in. Whatever distance is desired forms the basis for determining the depth of the roof of the fillet 7 x in side elevation. As the roof of the pediment is 7½ in. in side elevation, add this to the modified profile, from 1 to O; O X indicates the nailing flange. Then the shaded section, X O 1 11, is the true section on a line drawn at right angles to the rake, E F. This completes the elevations required for developing the patterns.

As the surface 7 8 in the pediment mold is to be flush with the surface 7′ 8′ in the front horizontal molding, indicated at 7′, 8°, 9°, and as the projections 8 9 and 10 11 in the modified profile are each ½ in., or a total of 1 in., place the 1 in. from 7 to x in the side elevation and allow the upright flange x y; then the partial shaded section, y, 7, 9, will give a true section through A^2 B^2 in the front elevation, and shows how deep the roof of the fillet, 7 8 in side, must return, as 7 x. The pattern for the lower part of the lintel will be developed by dividing the molds in the side elevation into equal spaces, as shown from 11 to 14 and 21 to 27.

Now, take the girth of all that part from y to 7 to 32 in the side elevation and place it on the center line C D, shown from y to 32, from which draw horizontal lines as shown. From the intersections in the side elevation from y to 32 draw horizontal lines cutting corresponding parts in the front elevation, shown by similar numbers. From these points vertical lines are dropped (partly shown) intersecting similar numbered horizontal lines from C D. A line traced through points R, S, T, U, Z, V, W, D, y, will be the one-half pattern for the lower front piece. If a vertical line is erected from the panel miter V, as V Y, and Y Z V traced opposite Y V, as Y V Z^1, then Z Z^1 V will be the pattern for the panel head 18′, 24′, 32′, in the front elevation, two of which are required. As S T represents the miter cut of the bracket cap, this can be used for obtaining the patterns for the inside, outside and face of the cap. Take the distance from s to c^v in the side elevation and place it from T to $c°$ in the pattern and erect the vertical line $c°$ $d°$; then $c°$, $d°$, S, T, is the outside cap pattern. Take the distance from s to 16 in the side elevation and place it from S to $a°$ and T to $b°$ in the pattern and trace the miter cut S T on $a°$ $b°$; then $a°$, $b°$, T, S, is the pattern for the inside of the cap. As the face of the cap is 2½ in., set off this distance from T to U in the pattern, reversing the cut T S from U to $e°$, being careful that the projection A^4 $c°$ is similar to A^3 S.

Then $e°$ S T U is the pattern for the face of the cap. A top and bottom lap is allowed, shown by the dotted line, two of each being required.

For the pattern for the return miter take the girth from $7'$ to 1 in the normal profile and add it above the point 7^p in the pattern from 7^p to 1^p. Draw the usual measuring lines and intersect them by vertical lines dropped from similar points in the normal profile, partly shown by $7'$, 2, 1. Trace the miter 7^p A^5, and make the distance A^5 E^5 equal to the depth of the return, or 7½ in. Allow a lap of ½ in. below B^5 D^5 and another along the top edge. Then A^5, B^5, D^5, E^5, is the return miter, two of which are required. The only laps required on the front pattern are indicated by the dotted lines.

In the front elevation G is reproduced by G^1 in the pattern, to which the rise of ½ in. is added at right angles to the sides, two of which are required, also a circle of 2 in. diameter indicated by *h*. The bracket dentil H is reproduced by H^1 immediately below it, to which the ¼ in. rise has been added at right angles to its sides, four of which are needed. The pattern for the two outsides of the brackets is pricked direct from the side elevation, as indicated by *s t u v w* J K c^v *s*, to which a lap is added as indicated by N P. The girth of the profile of the bracket *s t u v w* J K is then placed on the vertical line s' K' as shown by similar letters, and the face made 2½ in. wide, two of which are needed. Diagram L shows the pattern for the inside of the bracket, and is a reproduction shown by similar letters and figures in the side elevations. The dotted lines show where laps are allowed. Two of these sides are required. This completes the full set of patterns excepting the pediment molding, in Fig. 118.

Obtain the girth of the modified profile from X to 11, Fig. 117, and place it on the line E F, Fig. 118. At right angles to E F draw the usual measuring lines. Measuring from the line E F, Fig. 117, which is drawn at pleasure at right angles to the line of the pediment, take the various distances to similar numbered intersections on the miter line C *m* at the top and the intersections on the profile from 1 to $7'$ and along the horizontal line from $7'$ to $10°$, and place them on lines having similar numbers in Fig. 118, on either side of the line E F. Trace a line through points thus obtained, then X, 1, 7, $11°$, 11^v, 7^v, 1^v, X^v will be the desired pattern. To add the triangular piece of the pediment to the pattern use as radii, *m n* and *n* 11° in the front elevation in Fig. 117, using as centers in Fig. 118, points 11^v and 11° and intersect arcs at *n*. Then connect lines from 11^v to *n* to 11°. Two of these patterns are required, both with laps from 1 to 11°, and one with laps from X^v to *n* only. The paper patterns are now pricked on to

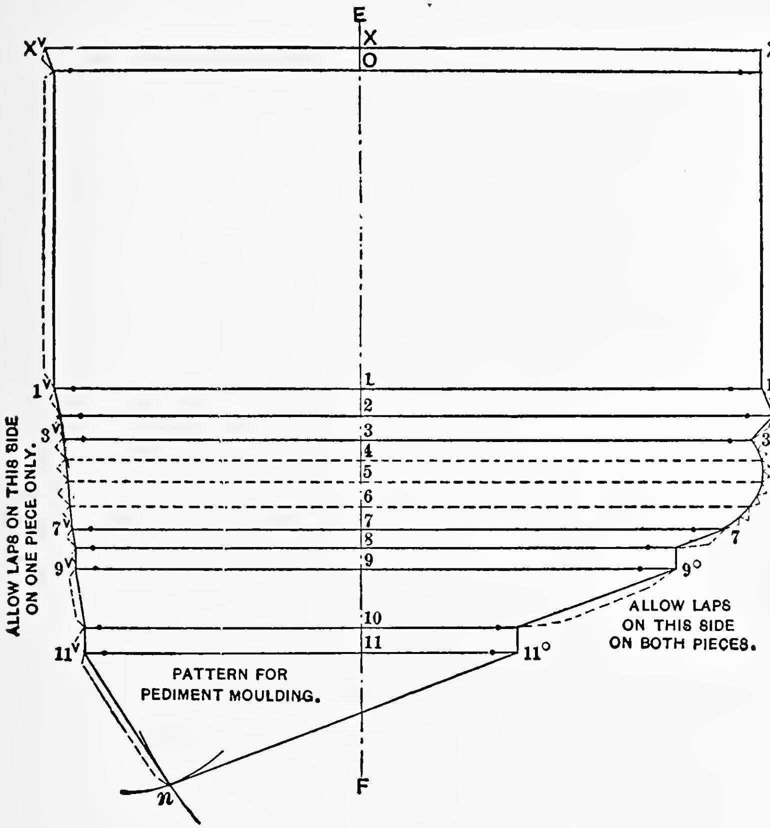


FIG. 118. Pattern for Raking Pediment Mold.

the metal as previously described, reversing the half pattern for the front in Fig. 117 on the dots *y* and D.

When cutting the caps for the bracket, time and material can be saved by marking the patterns on the metal as indicated in Fig. 119, where one cut is laid against the other; A representing the inside cap and B the outside. While but two of each are required, it is well to bear this in mind when large quantities are to be cut. Stays or templets for forming will be required as follows: From 2 to 8′ in the normal profile in Fig. 117; from

11 to 16 in the side elevation; from 20 to 28 for the panel, and from 1 to 9 in the modified profile for the pediment mold. The side of the bracket is used as a stay templet for bending the face. When bending the pediment mold start at dot 3 or 7, Fig. 118, and in forming the balance of the work always start at the mold.

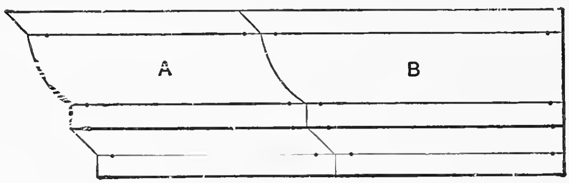


FIG. 119. Saving Time and Material In Cutting Caps.

When forming the bead in the panel in Fig. 117, start either on dot 21 or 27 and make a square bend, 21, shown by A, Fig. 120; use the former B and press down A in the position C. Then make a square bend on dot 27 at D, Fig. 121, and using the former E, press D in the position F. Proceed in the usual manner to complete the balance of the bends, using the templets to prove the profile of the work.

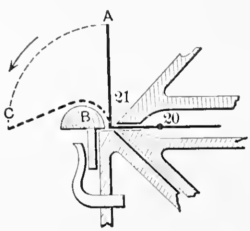


FIG. 120.

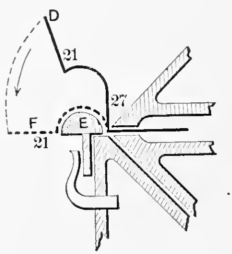


FIG. 121.

FIG. 120. First Position. FIG. 121. Bending the Bead.

A rough outline, Fig. 122, is given to show how the work is joined together. First set in the panel head A, and put in the return miter B, being careful to have them true and square. Set the bracket C together, joining the cap at *a* and tacking on the dentils *b*, being careful when soldering the face to the sides that the bends in the face run parallel to each other to avoid the bracket becoming lopsided. Should this happen, one side will have to be loosened and retacked until true. It will be noticed that the pattern for the window cap has been so developed that cap mold D runs behind the bracket and miters with the outside of the bracket cap *a* when the bracket C is joined to A, as in the plan D° at *d*. This makes a firm job and is the method employed on other work the student will take up. When the

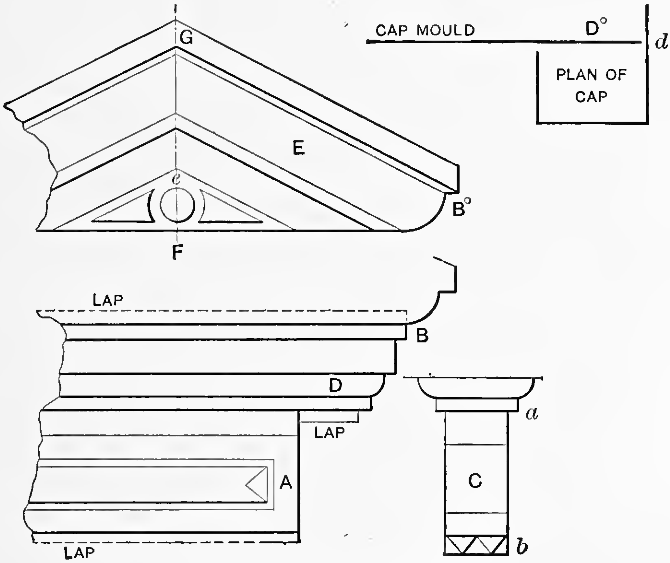


FIG. 122. Joining Various Parts of Window Cap.

lower part of the window cap is completed the pediment E is joined together, tacking the miter F G to suit the proper angle obtained from the detail. Then join B° to B. The small panels

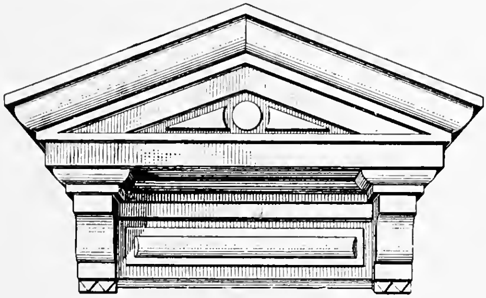


FIG. 123. View of Finished Window Cap.

are tacked into *e*, which completes the ornamental window cap shown finished in Fig. 123. What was said in reference to putting up the plain window cap on the building also applies to the ornamental window cap.

CHAPTER XIV

Making a Raised Panel

The seventh exercise is that of constructing a raised panel, Fig. 124, which is a reproduction of the 2-in. scale blue print (see Folder 1). A section is shown of the center panel, while the shaded section to the right in the front elevation shows the true section on the vertical line *i'*. The method of obtaining this section will be explained in the detail drawing. A in the upper part of the drawing is the development of the cone A in the front elevation. The various parts are designated by reference letters, and will be explained when laying out the shop detail. In the detail only one side need be drawn, as both halves are the same. In this piece of work the three methods of pattern drafting are employed—namely, the parallel line method for the straight sides, radial line for the cone, and triangulation for the flaring piece joining the straight sides. Take dimensions from the scale drawing, and draw the vertical line A B in the shop detail in Fig. 125 (see Folder 1), on which establish the center C, from which to describe the 6-in. circle representing the outside diameter of the center panel D E. Measure off a margin of ¾ in. and describe the inner circle F G, 4½ in. in diameter. Above this elevation draw the true section of the circular panel, J 1 6, the vertical heights being equal to ¾, ½ and 2 in. Tangent at E draw the horizontal line T M, and from E lay off 1 ft. 5¼ in. to M, and from M draw the line M U, having it tangent at V. Set off 1⅛ in. from H, and with C as center draw the arc *h i*. Then *h i* M is the outline of the triangular panel. Set off ¾ in. all around parallel to the outline, and obtain 7 7′ N.

From the center C draw the radial line C M, and lay off a distance from 10 to L equal to 2 in., and draw the miter lines 7 L, 7′ L and L N. This completes the front elevation, and it will be found that M *i* is the same length as M *h,* so that the pattern for one answers for the other. In this case it is desired that the heights of each member in the center and triangular panels should be the same as in the true section of the circular panel. As the distance from L to 5° in the triangular panel is only 1⅞ in., and from C to H in the circular panel is 3 in., then a true section on L 5° must be obtained from the true heights in the section of the circular panel as follows: From L in the elevation, representing the highest point, erect the vertical line L O, which intersects the horizontal line J K at *a*. Extend by means of horizontal lines the vertical heights from 1, 2, 3, 4, 5 and 6, in the true section of circular panel, shown on line O *a* by similar numbers. With *a* as center and the numbers as radii draw the arcs cutting J K, from 1 to 6, and from these points drop vertical lines cutting similar lines in the elevation, from 1° to 6°. Then 1° L 6°, or the shaded portion will be the true section for the triangular panel. This completes all that is required for developing the patterns. Now obtain the girth of the shaded section from 1° to 6°, and place it on the vertical line Q P. Draw the usual measuring lines, intersected by lines dropped from numbered points on the miter lines *h* L and L M. Trace a line through points thus obtained and W X Y will be the pattern for the straight sides of the triangular panel, four of which are required.

When that portion shown by *i* 7′ 7*h* is pricked on to the metal the pattern is complete for that part two of which are needed; the distance from *i* to *h* is stripped with a ¾-in. strip and from 7 to 7′ with a ½-in. strip, as in the section. The pattern for the flaring piece, 7 L 7′, is obtained by triangulations as follows: Divide the curve 7 7′ into equal spaces, shown from 7 to 10 to 7′. Take the distances from L to 7, to 8, to 9, to 10, and place them on the horizontal line in the diagram of triangles, from L° to 7, to 8, to 9 and 10, and draw the perpendicular L° L^1 equal to 2 in., or the height L^2 1° in the true section. With L^1 in the diagram of triangles as center and radii equal to L^1 7, 8, 9 and 10, draw arcs. Set the dividers equal to one of the spaces in 7 L 7′ and starting at R in the diagram of triangles step from arc 7 to 8 to 9 then to 10; reverse and step to arc 9, 8 and 7. Trace an arc from R to S and draw lines from S and R to L^1, which is the pattern for the flare 7 L 7′ in the elevation, two of which are required. The pattern for the cone of the center panel is obtained by using 1 2 in the true section as radius and with 1^v as center describe the arc G° G^x. Divide one-quarter of the proper circle in front elevation into equal spaces, as G *b c d e f*, and take four times this girth, and place it from G° to *f*, to G^1, to *f′*, to G^x. Allow a lap which completes this pattern, one of which is required. Prick on to the metal the semi-ring, D H E F *f* G, two of which are required. A mistake often made by the student in pricking work of this kind is to prick along the arcs, as at *b c d e*, etc., while all that is necessary is to prick the center C and E F G and D, and use the dividers to draw the arcs. As the angles in the panel are very acute no laps are allowed, excepting on the pattern for the cone.

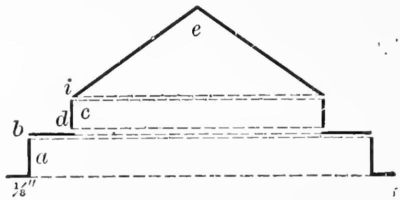


FIG. 126. Joining the Circular Panel.

The patterns are then pricked on to the metal in the usual manner, and the straight sides bent after the shaded profile. The pattern for the cone and for the flaring piece in the triangular panel are both formed on the blow horn stake, being careful to have the side smooth and round, avoiding kinks and dents in

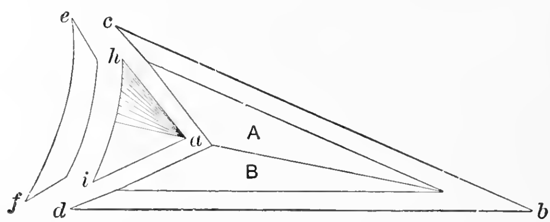


FIG. 127. Joining Triangular Panel.

forming. When joining the circular panel the strips are soldered on the inside, under and above the circular pieces, as in the sectional view, Fig. 126, in which *a* is soldered to the bottom of the circular piece *d* on the inside of *b*. Solder *c* to the cone *e* at *i*, on the inside, then to the circular piece at *d*, also on the inside The strip *a* is to be ¾ in. high, but is cut ⅞ in. and soldered in position, and when the entire center panel is completed, the ⅛ in. is turned outward on the small turning machine. When joining the triangular panel, shown in Fig. 127, pieces A and B are tacked along the miter *a b*, being careful that the distance from *c* to *d* is equal to *e f* of the curve. The curve *e f* is now stripped as high as *a*, Fig. 126, or ½ in. After this is done the flaring piece *h i a* in Fig. 127 is soldered in position on the inside. Care should be taken to solder all joints on the inside, where possible, so as to make neat, sharp corners. When soldering the

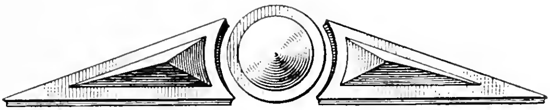


Fig. 128. View of Finished Raised Panel.

three parts of the panel in one, lay a straight edge along the bottom as indicated by the line T M, Fig. 125, making the distance between the end panels and center 1⅛ in. When this has been done the panel is complete and will look as in Fig. 128.

CHAPTER XV

Making a Plain Cornice

The first study in practical cornice construction is given in the eighth exercise, Fig. 129, which is a reproduction of the 2-in. scale blue print or lesson drawing furnished to the student. The object of this exercise is to explain how to draw, as well as how to apply the wrought iron braces or lookouts to the cornice, showing how the cornice is fastened to the beam whether wood or iron, and how the anchors are bolted to the cornice brace, which secures the cornice when the wall is built behind it. The letters *a, b, c, d* and *e* indicate the centers for drawing the curves in the molds. The lesson drawing shows a plain cornice with modillions, sunk panel, a drip on the foot mold and a lock on the upper flange of the crown mold, for locking the metal roofing. The iron brace has two anchors, one resting on the wall and the other bolted to the brace ready to be built in the wall, which will be erected by the mason. The small dots in the brace represent the bolts. When laying out the shop detail the vertical heights of the members are measured from the front elevation in the scale drawing, while the projections are obtained from the sectional view, measuring from the dotted line, erected from the drip in the foot mold to the various members. Although a perspective view is given, the profile shows a true section of the cornice and modillion.

Having checked off the heights and projections of the members in the cornice proceed to lay out the detail, as in Fig. 130 (see Folder 2), where the wall line is indicated by A B, and upon which line the various dimensions are clearly shown. From these points horizontal lines are drawn across the sheet, upon which the projections are measured. The center points for drawing the various quarter rounds and coves are indicated by *a, b* and *c*. A lock is allowed at the top, 1 2, into which the metal roofing is locked, and a drip is allowed at the bottom, 33 34, to prevent water from flowing into the joint and causing a damp wall, as it would do if the flange at the bottom of the foot mold were bent, as in diagram A° at *x*. By having the drip formed to the foot mold, the water, if any, flows down the face of the wall, as in the sectional view. After the outline of the cornice is drawn, put in the modillion, as indicated by the full size

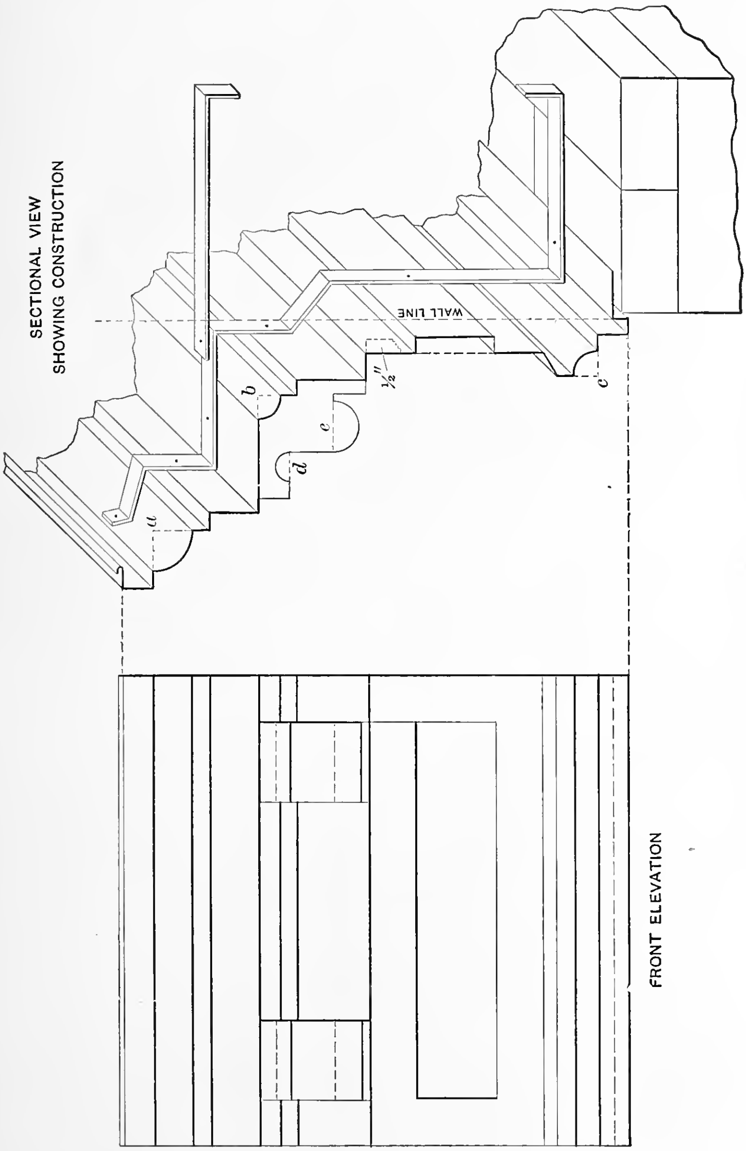


FIG. 129. Front Elevation and View of a Plain Cornice.

measurements, *c* and *d* representing the centers for describing the semicircles. This completes the sectional view of the cornice, whose total height is 1 ft. 4⅛ in. and extreme projection 8½ in. The front elevation is then drawn, 1 ft. 3 in. in length, and the face of the modillions 2½ in. As the panel stile is 1½ in., as in the sectional view, set off this distance, in the front elevation on the right and left sides. Set off the modillion a similar distance.

The drawing of this front elevation could be omitted in practice, as the home student could easily find the information of spacing the modillions from the blue print in Fig. 129, from which the measurements in Fig. 130 were obtained. The section of the iron brace or lookout is next drawn. There is no given rule for drawing this brace, except that it should lie against flat surfaces, where a bolt can be inserted, being careful to use good judgment in regard to obtaining the angles, D E F G H J. While the corners or bends in the brace are sharp in the detail, this is only a matter of drawing, and it is not necessary to make them so in practice. For example, the bend at F, when made in the brace bender, will look like diagram F°, and is sharp enough for the purpose required. K L shows an anchor bolted to the main brace, its purpose being explained later. These braces are usually made from soft steel, so as to allow them to be bent cold. The usual thickness used is 3-16 × 1¼ in., although lighter or heavier may be used, according to the size cornice to be made. These braces are bolted to the cornice with flat head stove bolts, ¼ × ¾ in. In this case bolts would be inserted at *f, g, h, i, j, k, l* and *m,* the hole in the brace at *m* being countersunk on the under side C, so as to make a smooth surface where it sets on the wall. When the cornice is made of copper all holes in the braces are countersunk so that when brass bolts are passed through, the outside will be smooth and flat. While these holes can be countersunk in the iron braces, when the cornice is to be of galvanized iron, as a rule it is not done.

For the patterns proceed as follows: Divide the profile of the main cornice into spaces as shown from 1 to 35. Take the girth of the main cornice and place it on line M N shown by similar numbers, the dots representing the bends. The cornice being small in this case, the entire profile is bent in one piece, and consequently no joints are made. But when joints are made, as in the next exercise, the method of construction, to save time in soldering and riveting, will be explained. The pattern for the face of the modillion is obtained by taking the girth along the profile from P to R to 19, and placing it at P^1 R^1 19′, making the pattern 2½ in. wide. The double dots at R^x and R^1 in the pattern do not indicate bends, but show where the forming of the semicircles end, as at R° and R in the profile in the sectional view. The pattern for the side of the modillion is pricked direct from the sectional view, allowing a lap for fastening, as indicated by the dotted lines. As the depth of the panel is ½ in., add this, as shown in the front elevation, when S T U V is the pattern for the panel head, to which laps are allowed. This

completes the patterns for the plain cornice; two panel heads,

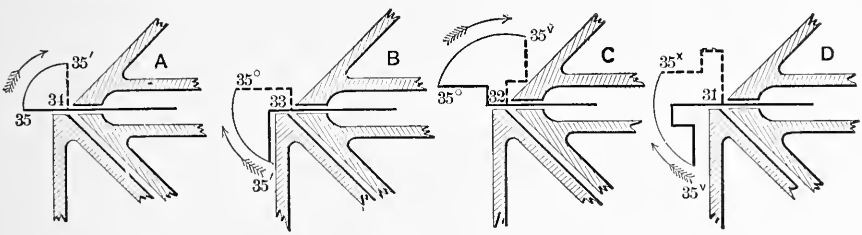


FIG. 131. Forming Drips on the Front Mold.

two modillion faces and four modillion sides are required. In getting out the main cornice, a square piece of metal is cut whose length equals the girth M N, and whose width will be 1 ft. 3 in.

No panel miter need be cut on the main cornice, as it will continue in one piece, as shown by *n o* and *r s* in the front elevation, and the panel miters set over it.

In this case, when forming the cornice, start at the drip or on dot 34 as A, Fig. 131, where a square bend has been made from 35 to 35′. Reverse the sheet by 35′ in B and make a bend on dot 33 from 35′ to 35°. Leaving the sheet in the brake, draw out same to dot 32 in C and make a square bend from 35° to 35^v. Reverse the sheet D and make a square bend on dot 31 from 35^v to 35^x. This forms the drip, from 35 to 31 in the sectional view in Fig. 130, the balance of the cornice being formed in the usual manner. The face of the modillion is formed as in Fig. 132. It is bent as *a b c,* making them square bends in the brake; the semicircles can be bent over any bar or gas pipe in a vise or elsewhere. Assuming that D is the proper size pipe to correspond to *e* in the sectional view in Fig. 130, the face A, Fig. 132,

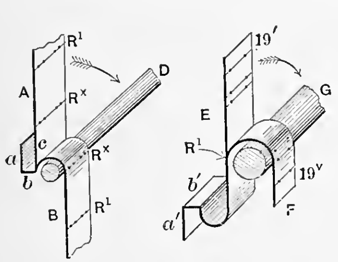


FIG. 132. Forming the Modillion Face.

is placed in the position shown, when A is pressed down in the direction of the arrow until it looks like B, thus bringing the double dots R^x and R^1 in A to R^x and R^1 in B. The letters and figures in diagrams D and G are similar to those on pattern for the face of modillion in Fig. 130. Reverse the face B, Fig. 132, a' b' in E, being careful to have the double dot R^1 against the side of the proper size pipe G and turn down E, in the position shown by F, bringing 19′ to 19^v. The balance of the bends are made

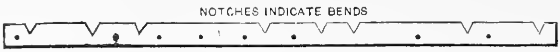


FIG. 133. Method of Obtaining Girth for Iron Base or Lockout.

to correspond to the side of the modillion in Fig. 130. The panel miters are bent and soldered in the cornice; then the modillions are soldered together, being careful to avoid any twist in them, and also soldered in their proper position in the cornice.

This being done, the iron brace must be made as follows: Take a strip of sheet metal about ½ in. wide and of sufficient length, and using a flat pliers obtain the girth (or amount of material required to bend the brace) from the sectional view, putting a prick mark in the strip to represent the hole in Fig. 133, and notch out the strip where a bend is to be. Cut as many braces as required into which 5-16-in. holes are punched, which allows for the burr of the metal and for the ¼-in. thick bolt to pass through. After the holes are punched the braces are bent in the bender shown in Fig. 134. The bender in practice is fastened by means of bolts to the bench at *a* and *b*, and when the brace is put into the slot at A the required bend can be made by raising the handle B. When bending the brace, the angles must correspond to the shaded section of the brace in the sectional view in Fig. 130. In practice one brace is bent accurately, according to this shaded section, then the balance are made after the finished templet. When inserting the brace in the cornice, slight prick marks are made through the holes from the inside, so that the impression shows on the outside of the cornice; then holes are punched from the outside through which flat headed stove bolts are placed and fastened with square nuts on the inside.

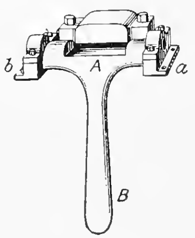


FIG 134. The Brace Bender.

When a cornice braced in this manner is to be set on a wall and fastened to wooden beams it is done as follows: Let A B, Fig. 135, represent the cornice with the brace *a b c* in position, set upon the wall C, and let E show the wooden beam. While the cornice is being held in position temporarily by the guy ropes, a wire is fastened to the anchor at D, and with a wall or flashing hook is nailed to the beam at E. Then a piece of rod or pipe is placed between the doubled wire at F and turned, until the wire is taut and the drip B is drawn tight against the wall. Another doubled wire is fastened at G and nailed to the beam at H; a rod is placed at J, and turned until the wire G H becomes taut, bringing the cornice in a plumb position, which is proven

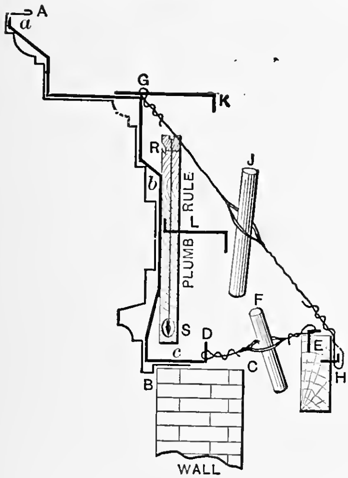


FIG. 135. Fastening Cornice to Wooden Beams.

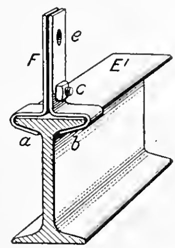


FIG. 136. Method of Fastening to Iron Beams.

by using the plumb rule R S. After the cornice is fastened, the guy ropes are removed and the anchor K bolted in position, after which the wall is built up, thus securing the cornice. When the cornice is high, extra anchors are bolted to the brace at L; the wall built around these anchors secures them, and allows the wires to be cut if in the way of the wood framer. Where the beam E is of iron, as in fireproof construction, the cornice is fastened temporarily to the iron beam, as in Fig. 136, by band iron clamps made from the same material as the braces. The iron beam is E^1, and F, the clamp, is made in two parts to fit the flange of the beam at *a* and *b*. When used in practice they are bolted together at *c*, with a hole punched at *e* to admit the wire to be fastened. After the cornice is secured to the wall, the clamps can be loosened and used on any other job.

A brick wall is usually built in the classroom at the New York Trade School with beam attached, to show the practical way

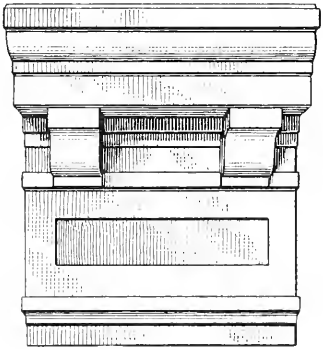


Fig. 137. View of Finished Cornice.

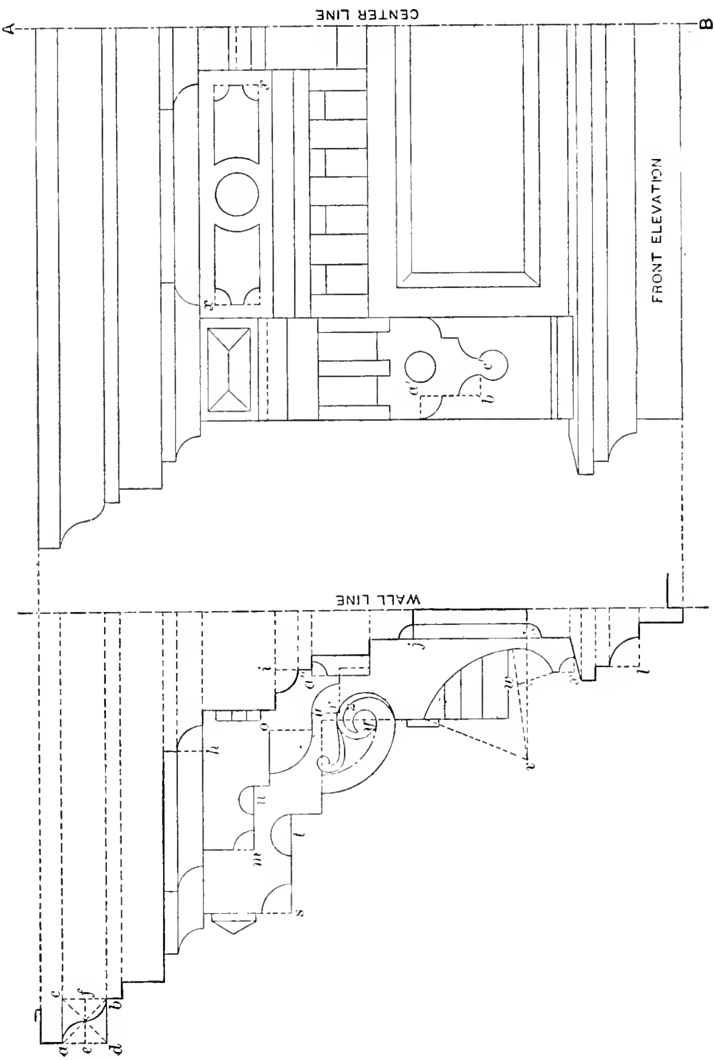
of fastening the cornice, and make it clear to the students. A view of the finished plain cornice is given in Fig. 137, the brace not being shown.

CHAPTER XVI

Making an Ornamental Cornice

The ninth exercise when completed in sheet metal is a fine piece of work, and the student is cautioned to be accurate in laying out the detail as well as the patterns. The blueprint given to the student is drawn to a scale of 2 in. to the foot and is reproduced in Fig. 138, in which one-half of the front elevation is shown, as well as the side elevation of the brackets and a section through A B in the front elevation. As will be seen, the cornice consists of ornamental brackets, plain modillion molded panel and dentils. The sides of the brackets have incised work and the fronts have diamond shaped panels and ornamental drops. In the main panel the student's initials and date are placed, using block letters, as described in the working detail. The small letters on the drawing indicate the centers for drawing the molds, semicircles, arcs, scroll, etc., which will be explained when drawing the detail.

The first step, as in the previous exercises, is to obtain the accurate heights of the members in the cornice, measuring from the wall line in the side elevation and placing them on the wall line A B in Fig. 139 (see Folder 2), making the total height of the cornice 1 ft. 10¼ in. Scale carefully the projection of each member from the drawing in Fig. 138 and place them, as shown by full size measurements in Fig. 139. Having located the point of each projection, the outline of the body of the cornice is drawn as follows: Starting at the top, a lock is allowed for the roofing; then the ogee is drawn by completing the square *a b c d*. Draw the two diagonals, and where they intersect draw the horizontal line *e f*. Then *e* and *f* are the centers for describing the arcs *a* 7 and 7 *c*. Next comes the fillet of ½ in., then the planceer of 8 in. Complete the mold 14 to 28, *j* being the center point for describing the cove in the cap mold and *k* for the quarter round in the dentil course. Complete the sunk panel, *l* and *m* being the centers for drawing the coves. The foot mold is then drawn, *n* being the center for the cove. A drip is added, but no brace or lookout is drawn, as this was covered in the previous problem.



Scale 2 in. = 1 ft.

FIG. 138. Side Elevation, Showing Brackets and Section on Line A B in Front Elevation.

The side view of the dentil is now drawn, as shown by O^1, v being the center for the cove, having a ½-in. radius. The side view of the raised panel on surface 19 20 is drawn 1½ in. wide and ⅜ in. deep. Draw the side of the modillion from P^1 to R^1, as shown by full size measurements, r being the center for the cove, s for the semicircle, t for the quarter round and u for the cove. The side of the bracket is next drawn, from M^1 to N^1. Care must be taken in scaling the lower part of the bracket (in Fig. 138) to obtain the location of the centers. Note that G is the center for the cove at the top, H for the semicircle, J the center point for the quarter round K L and sink strip K° L°. After the point M has been established at 3⅞ in. from the wall line, extend the line 7 *m* of the panel section to N, this point being 5⅜ in. from the wall line. Then N is the center and N M the radius from which to strike the arc M O, having O ⅜ in. above the line 7 N. Draw a line from O to N, on which set off 1¼ in. from O to P; then P is the center from which to draw the arc O R, meeting the vertical line drawn 1¼ in. from 11 Q. Complete the balance of the side, T being the center for drawing the cove. Complete the side view of the modillion and bracket caps, the coves being struck from *o* and *p*. Draw the side view of the diamond panel at the top of the bracket shown by H°, and the raised disk at Y, to the right of H°. In drawing the scroll in the side of the bracket, *g* is the center for drawing the arcs S L° and *v* L and *h* for drawing the semicircle *v* V L°. The balance of the scroll, as *u* X L and W, are drawn free hand. This completes the sectional view from which the one-half front elevation is drawn.

A mistake often made is to scale the measurements from the front elevation in Fig. 138 and transfer them on the line A^1 B^1, Fig. 139A (see Folder 2). This is not necessary, as the heights are obtained from the sectional view, Fig. 139, as partly shown by the horizontal lines D, E, F, and C, in both Figs. 139 and 139A. As the scale drawing calls for the cornice 3 ft. long, the half elevation is made 1 ft. 6 in. It should be understood that while the cornice will be 3 ft. long and 1 ft. 10¼ in. high, having 1 ft. 3 in. projection, the work covers everything that might arise in a cornice of 20, 40 or 100 ft. long, more brackets and modillions being necessary only in a longer cornice. The next step is to reproduce in the front elevation similar molds as in the sectional view, *a′* and *b′* being the centers for drawing the ogee and *e′* for the cove, making the distance from c' to d' 1 in., as in the scale or architect's drawing. The face of the bracket is drawn 3½ in. wide, and in drawing the foot mold, have the line &¹ 10 come in line with the outside of the bracket, shown by the dotted line 10 C^1. Reproduce the profile of the foot mold from 2 to 11 in sectional view, as shown from 2 to 11 in the front elevation, and let the line 2 to C^1 be horizontal as in the front elevation in Fig. 138. Complete the drop in the face of the bracket in the detail in Fig. 139A, in which full size measurements are shown, using $a°$ $b°$ and $c°$ as centers. The face of the diamond panel is then drawn, shown by H^2, it being projected from the side view. H°, Fig. 139, the miter lines being angles of 45 degrees.

Refer to the scale drawing in Fig. 138 and note that the modillion sets over the center line and is 3 in. wide. Between the bracket and modillion, raised panels and dentils are placed. The measurements are carefully scaled and placed full size, as in the detail in Fig. 139A. The centers f' and g' are for completing the coves in the bracket and modillion caps, and h' and i' for completing the curves in the raised panels. Complete the main panel by making the panel stile 1 in. This completes the detail of the ornamental cornice, which gives good, solid, practical study in cornice drafting. Should the student fail to master the first cornice drawing he must try another. When the cornice is completed in sheet metal, the student's initial and the date is placed in the panel, the date in the center and an initial on each side, using block letters.

In order that the student may become proficient in drawing the letters and numerals used in sheet metal sign work a chart is reproduced in Fig. 140, from which various letters and numerals are drawn. Note that the rule employed in drawing these block letters is to divide the given height into five equal spaces and then construct squares whose sides equal one-fifth the width of the letter. Thus if a letter 15 in. high were desired, the squares would be one-fifth, or 3 in. This rule applies to letters and numerals, but differs slightly on some of the letters in the small alphabet. In the ornamental cornice the initial is to be 3 in. high and the date 2 in. high, and in drawing the detail in Fig. 139A note that the 3 in. in T. F. and the 2 in. in date space have been divided into five equal parts, following the method given in Fig. 140.

The next step in the work of the student is to develop the patterns, and in doing so he will begin at the top of the cornice

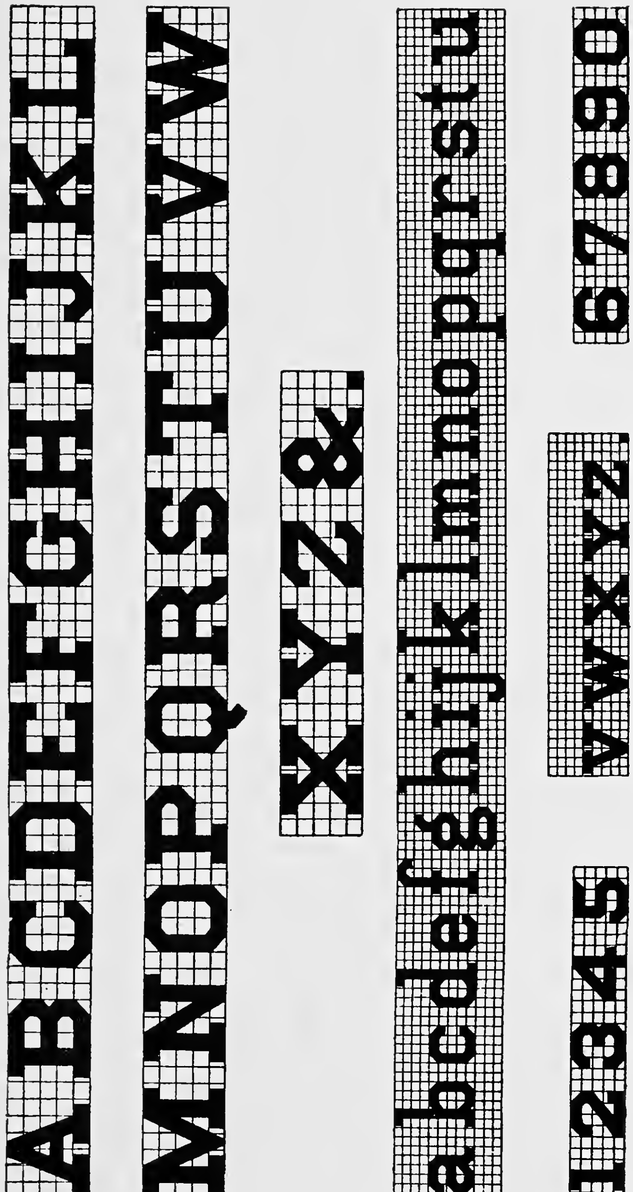


FIG. 140. Chart of Letters and Numerals.

in Fig. 139. The cornice will be joined in three parts, the joints at 28, 29 and at Q, as indicated in the sectional view. While the joints in this case are lapped and soldered, the various methods of making different seams and joints will be explained as the student proceeds.

To obtain the patterns for the upper part of the cornice, its return, and the bracket and modillion caps, proceed as follows: Obtain the girth of the upper part of the cornice from 1 to 29, Fig. 139, and place it on the line A B, as shown in Fig. 141 (see Folder 2). From these points draw the usual measuring lines indefinitely. As the one-half length of the cornice in Fig. 139A measures 1 ft. 6 in., make the distance from 3 to 3′, Fig. 141, equal to 1 ft. 6 in., so that the one-half pattern for front can be obtained. It is done in this case because the piece of cornice is to be but 3 ft. in length. When the cornice is longer, as is the case in practical building work, where one may be from 25 to a couple of hundred feet long, then a similar short piece containing the miter cut is developed, and used to mark out the miters on the full sheets, no matter what the length of the cornice may be. Thus it will be seen that the piece of miter which the student is about to develop will be the half pattern for the front, but can also be used for marking the miters in a longer cornice.

Take the projection from T^1 to 3 in the sectional view, Fig. 139, and place it from 3′ to T, Fig. 141, and through T draw the vertical line C *a*. Measuring from the line T^1 13, Fig. 139, take the projections to points 1 to 13 in the profile and place them on similar numbered lines in Fig. 141, measuring from the line C *a*, and resulting in the miter from 1′ to 13′. As the distance from *c*′ to *d*′ in the front elevation in Fig. 139A equals 1 in., set off 1 in. from *a* to 14′, Fig. 141. Take the projection of the cap mold in the sectional view in Fig. 139 from 14 to S^1 and place it from 14′ to S, Fig. 141, and extend a vertical line from S meeting line 29 at D. Measuring from the line S^1 19 in Fig. 139, take the projections with the dividers or a strip of paper to points 14 to 19 and place them on similar numbered lines in Fig. 141, measuring from the line S E, resulting in the miter cut. 14′ E. From E to D remains a straight cut, as all the molding from points 19 to 29 butts against the outside of the bracket in the front elevation in Fig. 139A. In Fig. 141, 1 1′ *a* E D 29 represents the one-half pattern for the upper part of the cornice, to which laps are allowed as shown by the dotted lines. Transfer pattern to metal by reversing on dots 1 and 29.

By referring to the sectional view in Fig. 139, it is found that the projection of the return is 1 ft. 3 in. Therefore measure 1 ft. 3 in. from the line 3′ 4′, Fig. 141, and draw the vertical line T° S, allowing a 1-in. lap below the line 13 13′, which is the lap that turns under at *c′ d′* in the front elevation in Fig. 139A. Then T° S 13′ 1′, Fig. 141, minus the laps on the miter, is the pattern for the return of the crown mold, two of which are required, the small dots indicating the bends.

The patterns for the caps for the bracket and modillion are the next work. For the patterns for the inside and outside caps for the bracket, take the distance in the sectional view in Fig. 139 from M^1 to 19 and from M^1 to P^x and place it in Fig. 141 from E to N and from E to P. From P draw the vertical line P R and from N trace the miter cut E 14′, shown by N O, being careful that the distance from 14′ to O is the same as E N. Then 14′ O N E is the inside return cap for the bracket and 14′ R P E the outside return cap.

As the face of the bracket is 3½ in., as in the elevation in Fig. 139A, measure 3½ in. from E to K in Fig. 141, and trace the miter cut E 14′, from K to L, being careful that when a vertical line is erected from K that the projection from J to L is similar to the projection S 14′. Then 14′ L K E is the cap pattern for the front of the bracket. Measure the projection of the modillion in Fig. 139 from P^1 to 19 in the sectional view, and place it at E to M and from 14′ to J, Fig. 141, and trace the miter cut J M similar to 14′ E. Then 14′ J M E is the pattern for the return cap of the modillion. As the face of the modillion is 3 in. wide, make the distance from E to F similar and draw the miter F H, being careful that the projection from G to H is similar to S 14′. No laps are allowed on these caps except along the top and bottom, as shown by the dotted line. The number of pieces required are indicated above the patterns. And it will be seen that seven distinct patterns are shown on one sheet in Fig. 141.

The student will next consider the patterns required for the face of the bracket. Referring to Fig. 139, take the girth from M^1 in the sectional view along the outline of the bracket to the arrow point W, which is a trifle inside of K° and allows for a lap, and place it from M^2 to W^2, Fig. 139A, making the face 3½ in. wide, which forms the patterns for the upper part of the bracket face. In similar manner on M^3 N^3, place the girth of the lower part of the bracket shown in sectional view in Fig. 139, from M to N^1, also making this face 3½ in. wide, Fig. 139A, allowing a lap at the bottom. Two of each are required. The face for the drop in front elevation is pricked directly on to the metal from D^1 E^1 F^1, Fig. 139A, being careful not to prick through the points in the coves, but to use the centers a° b° and c°, and then with the dividers describe the arcs. Two faces are required, as well as two disks marked A^4, which are stripped ¼ in. or as high as shown by Y in sectional view, Fig. 139.

The pattern for the return on drop is obtained as follows: Divide one-half the face of the drop in elevation, Fig. 139A, as far as F^1, from points 1 to 12, from which carry horizontal lines into the sectional view, Fig. 139 (as partly shown by lines drawn from points 2 and 10) until they intersect the profile of the bracket M O, as shown by similar numbers 1 to 12, and extend the lines until they intersect the vertical line M Z, dropped from M, thus making M Z O the side view of the return of the drop. Draw any line on any part of the sheet as K^2 L^2, upon which place double the girth of the profile of the drop in elevation, Fig. 139A, from 1 to 12 to 1 on K^2 L^2, Fig. 139. From these points at right angles to K^2 L^2 draw horizontal lines indefinitely. Measuring from the line M Z in the sectional view, take the various distances to points 1 12 on the curve M O and place them on similar numbered lines, measuring from the girth line K^2 L^2 in the pattern. A line traced through these points will be the pattern for the return on drop, two of which are required.

The pattern for the sink strip is shown by K^x L^x L^1 K^1 and is struck from the center J^1, and is a reproduction of K L L° K°, struck from center J. Eight of these sink strips will be required, four on each bracket, as shown by the shaded section D^1 E^1 in the elevation of the bracket, Fig. 139A. The pattern for the raised diamond shown by H^2 in elevation and by H° in sectional view, Fig. 139, is developed by taking the girth of 1 2 3 2 1 in H° and placing it on any vertical line below the face of the diamond as G^1 H^1, Fig. 139A, from 1 to 3 to 1, through which horizontal lines are drawn and intersected by vertical lines (partly shown) dropped from the intersections 1 to 3 in H^2, these intersections being obtained from 1 to 3 in H° in the sectional view, Fig. 139 (connecting lines not being shown). Trace a line through points thus obtained in the pattern, Fig. 139A, then J^1 is the pattern for the front of the diamond panel. From 3° erect the vertical line 3° A^T and trace the miter cut 3° 2° 1 on the opposite side of 3° A^T as shown by 3° 2 1. Then 1° 3° 1 is the pattern for the head of the panel, four heads and two fronts being required.

The patterns for the inside and the outside of the bracket are pricked directly from the sectional view in the detail drawing,

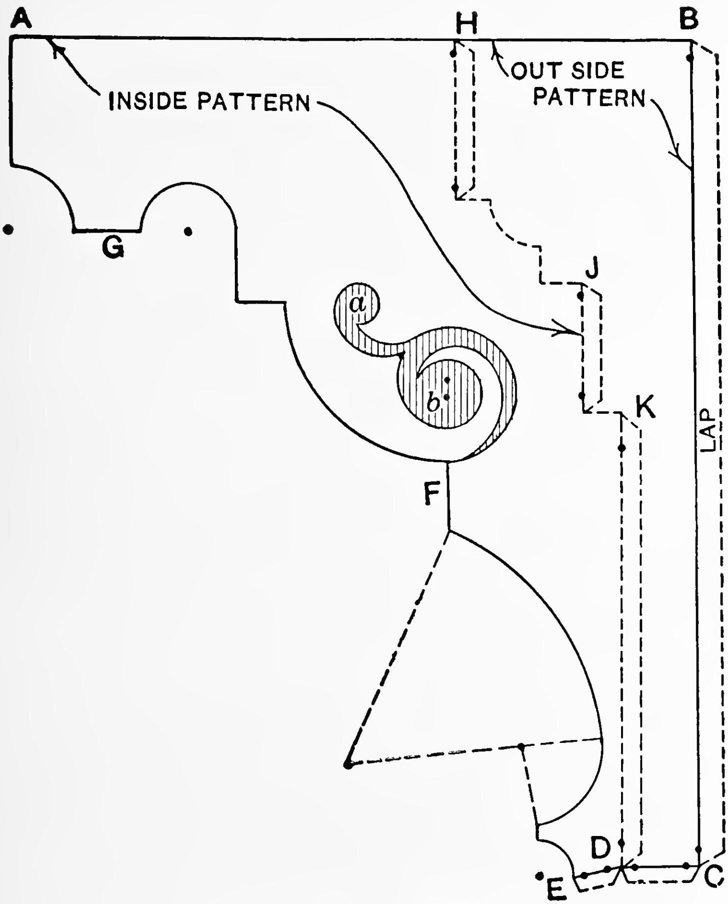


Fig. 142. Pattern for Bracket Sides.

Fig. 139 being reproduced in Fig. 142, in which A B C D E F G is the pattern for the outside and A H J K D E F G for the inside, the dotted lines indicating where laps should be placed for soldering. The method of pricking off one pattern on the metal and using it for the two sides will be explained later, as well as cutting out the shaded incised work. This completes the full set of patterns for the bracket. The pattern for the raised panel between the bracket and modillion in the elevation in Fig. 139a is obtained by adding the ⅜-in. projection in the sectional view, Fig. 139, and placing it at right angles to the top, side and bottom of panel shown by the dotted lines in Fig. 139A. Four of these will be required, stripping the curved parts with ⅜-in. strips. Two disks shown by i^1 will be needed, also stripped ⅜ in. For the pattern for the dentil O^1, Fig. 139, in sectional view, take a tracing of this side and place it at O^2. At right angles to *a d* add the 1-in. face in elevation, Fig. 139A, and trace O^2 in the position O^3, Fig. 139. Take the stretchout of *a b c* and *d c* and place it as

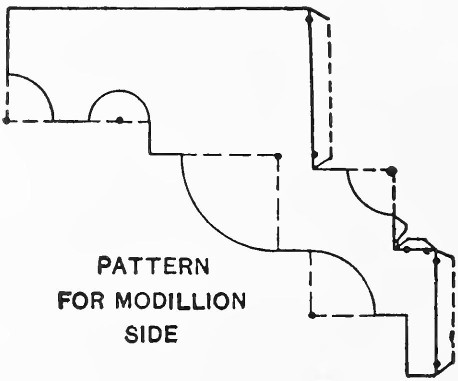


FIG. 143. Pattern Side of Modillion.

shown by *a b' c'* and *d' c'*, which completes the pattern for the dentil, eight of which are required.

The next work is to develop the pattern for the modillion face. This is obtained by taking the girth of the profile of the modillion in the sectional view in Fig. 139, from P^1 to R^1, and placing it on the line P^2 R^2, making the face 3 in. wide. The side of the modillion is pricked directly to the metal from the detail section, a reproduction with the necessary laps being shown in Fig. 143. Note in pricking this pattern on to the metal the centers are only used as shown by the dots, using the dividers to complete the arcs.

The pattern for the main panel in Fig. 139A is developed as follows: Find the center between 6 and 7 in the profile of the panel in Fig. 139 and draw a short line, as U^1 V^1. Take the stretchout of the entire panel from 1 to 12, and place it upon any line, U V, Fig. 144. In this case the line U V is placed in a different diagram, but in actual work a sheet of paper is tacked to the right of the wall line in Fig. 139 and the pattern developed with the T-square, instead of taking measurements with the dividers as in this case. At right angles to U V, Fig. 144, the usual measuring lines are drawn indefinitely. Measuring from the line U^1 V^1 in Fig. 139, take the distances to points 1 to 6 or 7 to 12 (only one side being necessary because U^1 V^1 is the center line), and place them on one side of the line U V in Fig. 144, thus obtaining the miter in L M N O. Take the

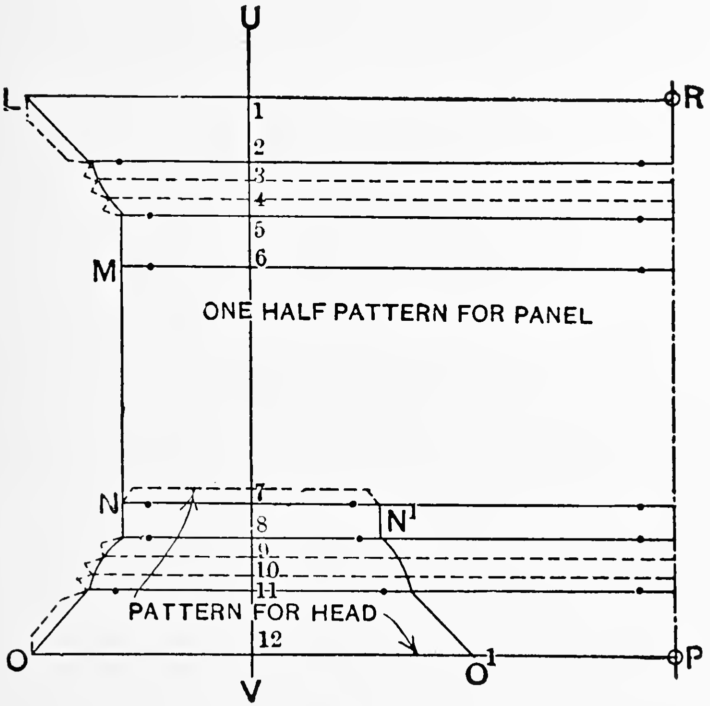


FIG. 144. Pattern for Panel and Head.

half length of the panel from E^1 to E^3, Fig. 139A, and place it, from L to R and O to P in Fig. 144, thus completing the half pattern of the panel, this half pattern being reversed on the dots R and P in transferring the pattern on the metal, and laps allowed on both sides of the miter cuts, as indicated by the dotted lines.

While in this piece of cornice the half length of the panel can be obtained from the detail, this would not be so if a long cornice were constructed, as the length of the panels would have to be computed from measurements obtained from the building. How these measurements are figured will be explained in connection with another diagram. Whatever the length of the panel may be a short miter cut, say, about 6 or 8 in. is usually developed as described in Fig. 144, and the panel made as long as desired. For the pattern for the panel head it is only necessary to trace the miter cut N O on the opposite side of the line U V, making the distance from 7 to N^1 the same as from 7 to N, because U V represents the center line shown in the sectional view in Fig. 139 by U^1 V^1. Then N O O^1 N^1, Fig. 144, is the pattern for the head, allowing a lap at 7, which sets under M N on the panel proper.

The last pattern required for the cornice is that of the foot molding. Divide the profile into equal spaces, from 1 to 14 in the sectional view in Fig. 139. Obtain corresponding spaces in the front elevation. Then on any line, as A B in Fig. 145, place the stretchout of the profile 1 to 14 in sectional view in Fig. 139, as shown by similar numbers in Fig. 145. At right angles to A B draw measuring lines. Take the distance from $\&^2$ to $\&^1$ in the front elevation in Fig. 139A and place it from 11 to & in Fig. 145, and erect the vertical line & C^3. In actual work this would not be necessary, as the pattern could be developed with the T-square directly below the elevation in Fig. 139A, which has been omitted here for want of space. Measuring from line $\&^1$ C^1 in elevation take the projections to points 1 to 14 and place them on similar numbered lines to the left of the line & C^3 in Fig 145, resulting in the miter cut & to 2′. Then 1 14 14° & 4° 2′ will be the half pattern for the foot molding to be reversed on dots 1 and 14 when pricking on the sheet metal, laps to be allowed as shown by dotted lines. The pattern for the return is obtained by taking the projection from 4 to 4^T in Fig. 139 and placing it from 4° to 4^T, Fig. 145, and through 4^T, drawing a vertical line down to line 12, meeting it at D, and upward as far as C, making the distance from 2′ to C^1 equal to 2 C^1 in elevation in Fig. 139A. Then C C^1 4° & D C, Fig. 145, will be the pattern for the return of the foot mold, two of which are required. A notch is cut from *a* to *b* in lap 2′ 2 so as to allow that part from C^3 to C^4 to turn upward vertically under the panel of the cornice, and allow the shaded part from 2′ to *a* to turn in a horizontal position to meet 2′ C^1 of the return miter in Fig. 139A.

This completes all the patterns for the cornice, and before giving the description of the constructive parts the reader is asked to examine carefully Fig. 146, which shows a photograph of the finished cornice which was made at the New York Trade

School by a student. After a study of the finished cornice the student will have a better idea of the various parts to be formed

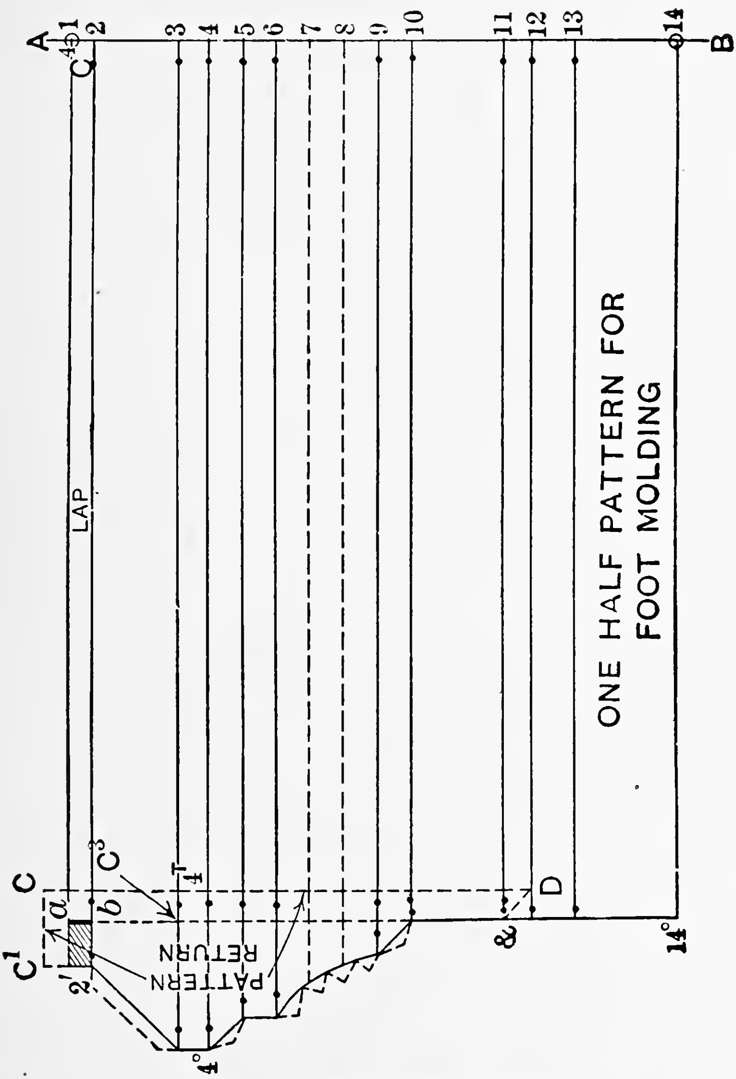


FIG. 145. Pattern for Foot Molding.

and set together. Note the crown, the panel, the foot mold, the bracket with its diamond panel, sink strips, ornamental drop, etc.

The patterns having all been developed are now pricked and cut from the metal in the usual manner, but special instruction is necessary in reference to some of the cutting to be done in connection with the bracket. When the sink strip shown in the sectional view in Fig. 139 is cut complete and flattened with the mallet on the stake it has a tendency to stretch, as shown by the dotted curved line C B, Fig. 147, while it should have the

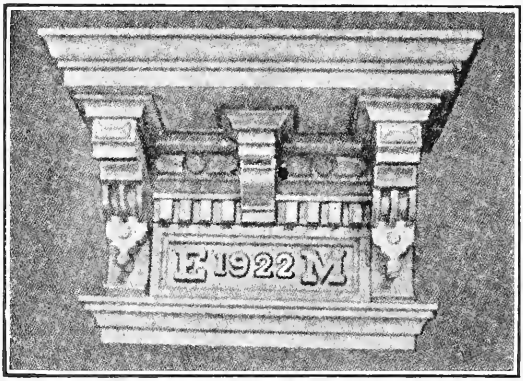


FIG. 146. View of Finished Cornice.

proper curve shown by the solid lines A B. To avoid this stretching the sink strip should be cut as follows: Let D represent a piece of metal, on which the required number of strips have been scribed to avoid waste, as indicated by E and H. The inner curve is first cut away, as shown by the shaded part, F, and then, before cutting the outer curve *a b,* the inner curve is flattened, and by having the large amount of metal behind the inner curve no stretching can take place. The outer curve *a b* is then cut and flattened, when the true shape is the result. Cut along *c d,* flatten the same, then cut the outer curve *e f,* and so on, being careful always to start to cut and flatten on the inner curve.

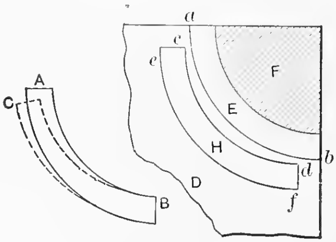


FIG. 147. The Way to Cut Sink Strip to Avoid Stretching.

When transferring the bracket sides, Fig. 142, on to the sheet metal, the outside pattern is pricked, as well as the outline of the molding shown by the dotted line from H to D. The center dots should be used, employing the dividers for drawing the various curves. As two outsides and two insides are required in this case, cut the outside pattern, and, using this as the pattern, cut two more. Cut along the molded outline shown from H to D, allowing laps as shown, and, using this as the pattern, cut one more. This method saves the trouble of pricking off two separate patterns.

The cutting of the scroll shown by the shaded part can be done by using a hollow punch and shears or a small chisel on a block of lead. In the former case the proper size hollow punches are used for *a* and *b*, then the balance cut out with the hand shears. When the scroll is small it is hard to turn the shears and the chisel is used, Fig. 148, in which A represents a block of lead, B the chisel and C the hammer. When cutting the scroll the chisel is tilted at an angle, using only the corner, *a*, giving slight quick blows with the hammer and moving the chisel along

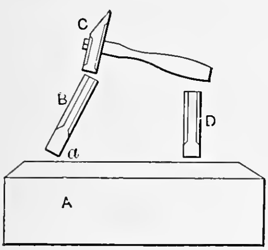


FIG. 148.

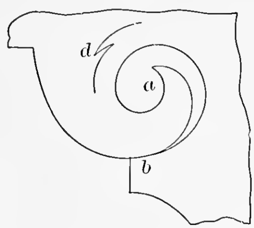


FIG. 149.

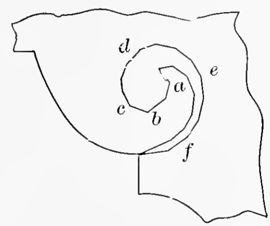


FIG. 150.

FIG. 148. Correct and Incorrect Way to Hold Chisel to Make Interior Cuts. FIG. 149. Appearance of Cut Made with Corner of Chisel. FIG. 150. Cut Made with Full Blade of Chisel.

the outline of the figure to be cut. If properly done an even cut should be the result, as shown from *a* to *b*, Fig. 149, and not uneven edges as at *d*, which results from allowing the chisel to slip off the line and making a new cut. The cut should be even and continuous, starting from *a* to *b*. The student very often makes a mistake and holds the chisel as shown at D, Fig. 148, which results in an uneven or cornered cut, *a b c d e f*, Fig. 150. When cutting the initial T F and the date shown in Fig. 139A, a sufficient number of strips should be cut for stripping same equal to one-fifth the height of the letter or numeral, or as wide as the face of the letter, one-fifth of 3 in., or 3-5 in., for the letters, and one-fifth of 2 in., or 3-5 in., for the numerals.

Having cut all the work and flattened the burrs, the various stays must then be cut ready for forming on the brake. Referring to Fig. 139, the student will need a stay, or templet, from 3 to 11 in the sectional view for the ogee, 14 to 19 for the cap mold, 20 to 26 for the quarter round, 1 to 6 for the panel and 1 to 14 for the foot mold. The bracket, modillion and dentil fronts are formed after their respective sides. The diamond panel on the face of the bracket is bent after the profile H° in Fig. 139, and the return for the drop on face of bracket is bent to correspond to the face F^1 in elevation, Fig. 139A.

The various coves, quarter rounds, drip, etc., are formed as in preceding exercises, and it will be necessary to give attention only to the forming of the ogee in the crown mold, also the panel and the return on the drop on the face of the bracket. When forming the ogee, start on either dot 4 or 10, as in Fig. 151, where a square bend has been made on dot 4, as shown by A 1. Place the proper size former, B, in position and press down A, as shown by C 4, or until C lies in a horizontal position, so that the mold will conform to the templet. Now loosen the former B and remove C 1 from the brake and reverse same, and make

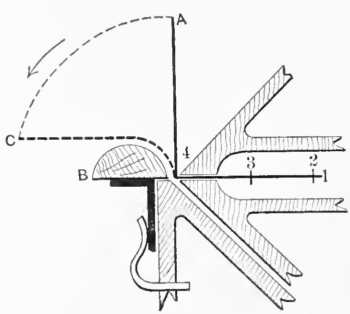


FIG. 151. First Operation in Forming Ogee.

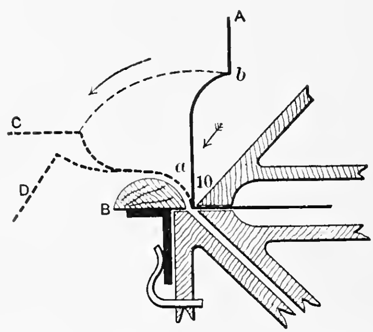


FIG. 152. Second Operation in Forming Ogee.

a square bend on dot 10, as A, Fig. 152. Place the former B again in position and press down A until it has the position shown by C. In pressing down A pressure must be exerted in the direction of the arrow *a*, so as not to get the upper curve out of shape, for if the pressure were exerted at *b* the upper mold would be pressed out of shape and result in the shape shown by the dotted line D when pressed down. Having the ogee true to the templet, the balance of the bends are made as described in previous exercises.

The forming of the panel is shown in Figs. 153 to 156, inclusive When forming, the start can be made at either dots, 2, 5, 8 or 11, Fig. 144. In Fig. 153 the start has been made by a square bend on dot 2, shown by A 1. The proper size former is placed in position at B and A drawn over, shown by C, or until C is in a level position. The former is removed and the sheet reversed, as A in Fig. 154, the brake closed on dot 5 and a square bend made, at B. The

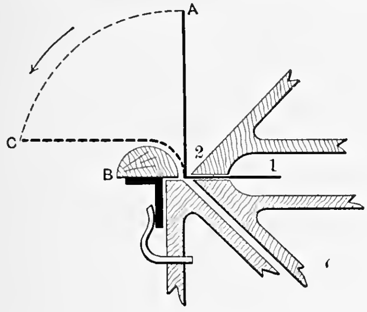


Fig. 153.

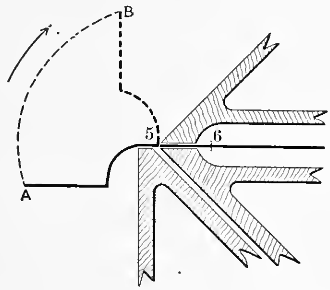


Fig. 154.

Fig. 153. First Operation in Forming Panel. Fig. 154. Second Operation in Forming Panel.

balance of the square bends are now made until the bend 8, Fig. 155, is made. The sheet is then drawn out, the brake closed on dot 11, at A, and a square bend made, at B, which is reproduced in Fig. 156. The proper former, E, is now put in position; B is pressed down over E, completing panel C. The two heads for the panel are formed in the same manner.

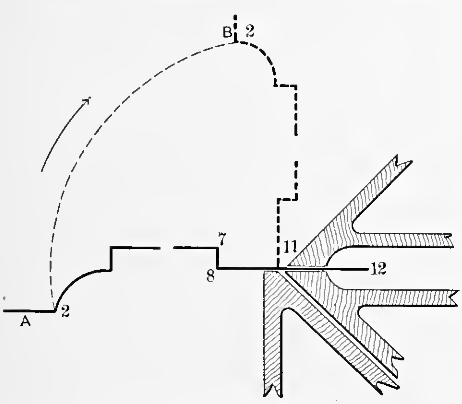


Fig. 155. Third Operation in Forming Panel.

When bending the return on drop, shown by K^2 L^2, Fig. 139, bends at the proper angle are made on dots 8 and 8, shown by B C, Fig. 157, and placed over the proper size rod or pipe A in the position shown and pressed down over the rod until it has the shape shown by D E. The pattern D E is then removed and, using one of the iron formers from the brake, which can be fastened in a vise, D E is placed against the lower edge of the former, A, Fig. 158, and D turned over to F, or until dot touches former A at 5′. The opposite cove on E is bent in the same manner, placing *b* against the former at *e*.

The balance of the square bends are now made in the brake to conform with the face until the shape B C D, Fig. 159, is obtained. Bend 4, having been placed against the proper size

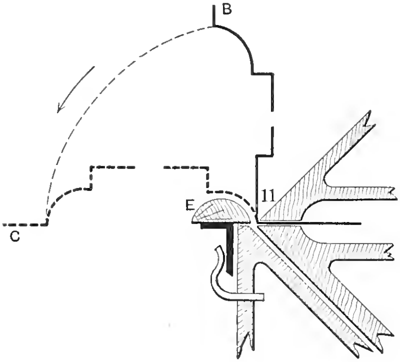


Fig. 156.

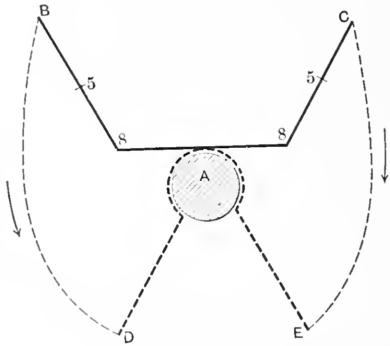


Fig. 157.

Fig. 156. Fourth Operation in Forming Panel.. Fig. 157. First Operation in Forming the Return.

rod A, B is turned over in the direction of the arrow, 1°. The opposite side, D, is formed by placing 4° against the rod A at 4v. The flanges on the modillion sides and insides of brackets are

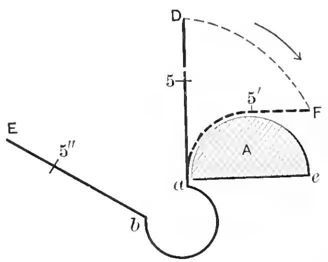


Fig. 158.

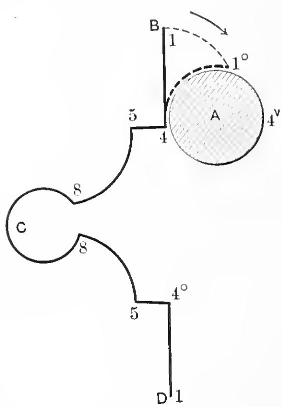


Fig. 159.

Fig. 158. Second Operation in Forming the Return. Fig. 159. Third Operation in Forming the Return.

turned toward the outside, while the lap on the outside of the bracket, B C, Fig. 142, is turned toward the inside.

Having all forming work completed, the small laps are turned with the flat pliers, and the soldering work begun. The scroll *a b* Fig 142 is first stripped on the inside with ½-in. strips, soldering back the shaded part of the scroll on to the strips, thus sinking the scroll ½ in.

Referring to the finished cornice, Fig. 146, it will be seen that the raised panels between the bracket and modillion, the dentils, the letters and numerals must be completed next, then the modillion, being careful to have the bends in the face run parallel to avoid the modillion becoming lopsided. The heads of the panel are soldered square in each end and the student's initial and date placed in it. The right angle returns are then soldered to the foot molding and the bracket and modillion caps set together. When setting together the bracket tack the joints only, and do no finished soldering until the bracket is true and plumb. Should the bracket be lopsided, it is easy to straighten it by opening a few tacks, whereas if all is soldered the entire bracket would

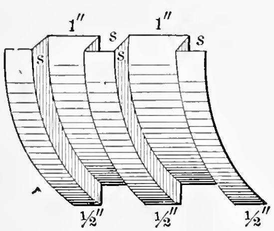


FIG. 160.

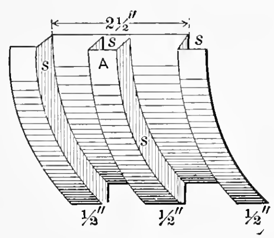


FIG. 161.

FIGS. 160-1. Different Methods of Finishing the Curved Sink Strips.

have to be taken apart. Therefore it is always best to tack the work first, then solder out when all is true. Tack first the upper and lower faces to the bracket sides, and after the return of the drop has been soldered to the face, tack on the drop; then tack in the curved sink strips, the diamond panel and molded cap.

When the faces run parallel to each other and the sides are plumb, solder the entire joints. There are two ways to strip the curved sink strips, shown in Figs. 160 and 161, in which the letter *s* indicates the sink strips, and the measurements the sizes of the face strips. Thus in Fig. 160 there are three ½-in. and two 1-in. face strips, while in Fig. 161 there are three ½-in. and one 2½-in. face strips, in which the center rib A is soldered. Whichever method is used, the strips must be cut square at the ends, so as to insure a straight line along the top and bottom of the finished curved sink.

When all the various pieces are assembled the cornice is set together as follows: Set the planceer of the cornice upon the bench, as in Fig. 162, and solder on the return miter of the crown mold, B. Set in the bracket C as well as the modillion D, being careful to have all angles square. Turn the cornice over in the position A, Fig. 163, and join the foot mold B to the brackets and set in panel C. Solder all joints clean and smooth and avoid acid stains; for while the galvanized iron cornices are usually painted, a little care will keep the work clean. The method of joining the iron lookouts is similar to that explained in the eighth exercise. When the entire cornice is completed, and the joints and miters scraped smooth, the piece of work will look as in Fig. 146.

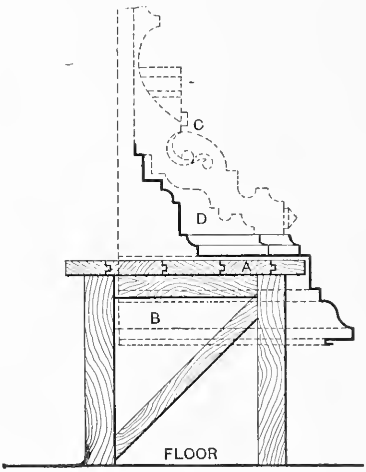


Fig. 162.

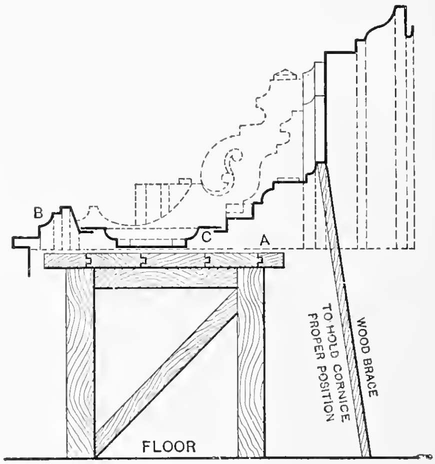


Fig. 163.

Figs. 162-3. First and Second Operations in Putting Cornice Together.

When the cornice is constructed of copper or even of galvanized iron very little soldering need be done if the cross joints in the moldings are first tacked and then riveted. This also applies to the brackets, modillions, panels, etc. The long joints or those running the length of the cornice can be locked as in Figs. 164 and 165, where the same profile of a cornice is shown, but with different joints at different places as will be noted by comparing the two figures. Rivets can be placed at intervals, as at *a b*, etc., to avoid slipping of the lock. Care must be taken before tacking the locks to have the proper distances, as A and B, Fig. 164 or C, D and E, Fig. 165.

Computing the Division in Cornice Work.

Some mechanics do not know how divisions between brackets, modillions, length of panels, molds, etc., are computed, when cornices of long lengths are made, and to help them diagrams are given by the instructor similar to Fig. 166, showing how these shop sketches and measurements are laid out. It will be noticed that the outline of the cornice only is shown, being all that is required to locate the various sizes. These measurements are used in the shop by the cutter to lay out the various pieces and by the bench hand to mark off and locate the positions of the brackets, modillions and panels when setting the cornice together. Assume that a cornice on a building is to be 25 ft. long, with four windows across the front, the measurements

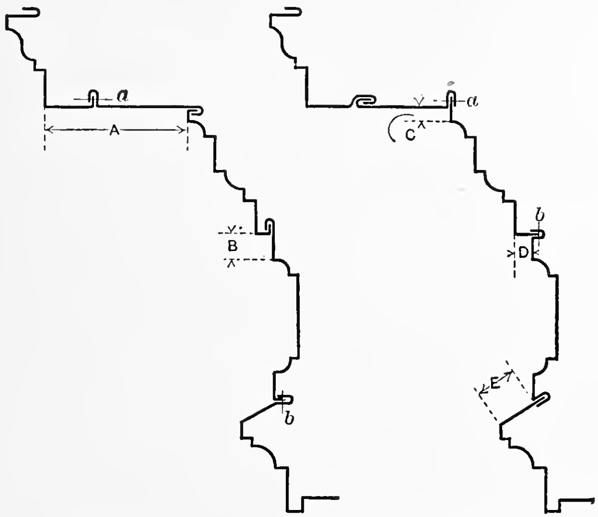


FIG. 164. FIG. 165.

FIGS. 164-5. Different Methods of Locking Seams.

having been obtained at the building. It will be noticed that a bracket is on each end, and one over the center of each pier.

The first step in getting the dimensions for the cornice is to add together the widths of the piers and windows, which in this case amount to 25 ft. As the three brackets are to come over the center of the piers, add together the width of the end pier, the window and one-half of the next pier, as 2 + 3 + 1 ft. 6 in. = 6 ft. 6 in. Then 1 ft. 6 in. + 3 + 1 ft. 6 in. = 6 ft. These measurements answer for the opposite side also. Prove these figures by adding 6 ft. 6 in. + 6 ft. + 6 ft. + 6 ft. 6 in. = 25 ft. Now locate and mark the face of the brackets and modillions by 10 and 6 in. In this case it is assumed that the distance from

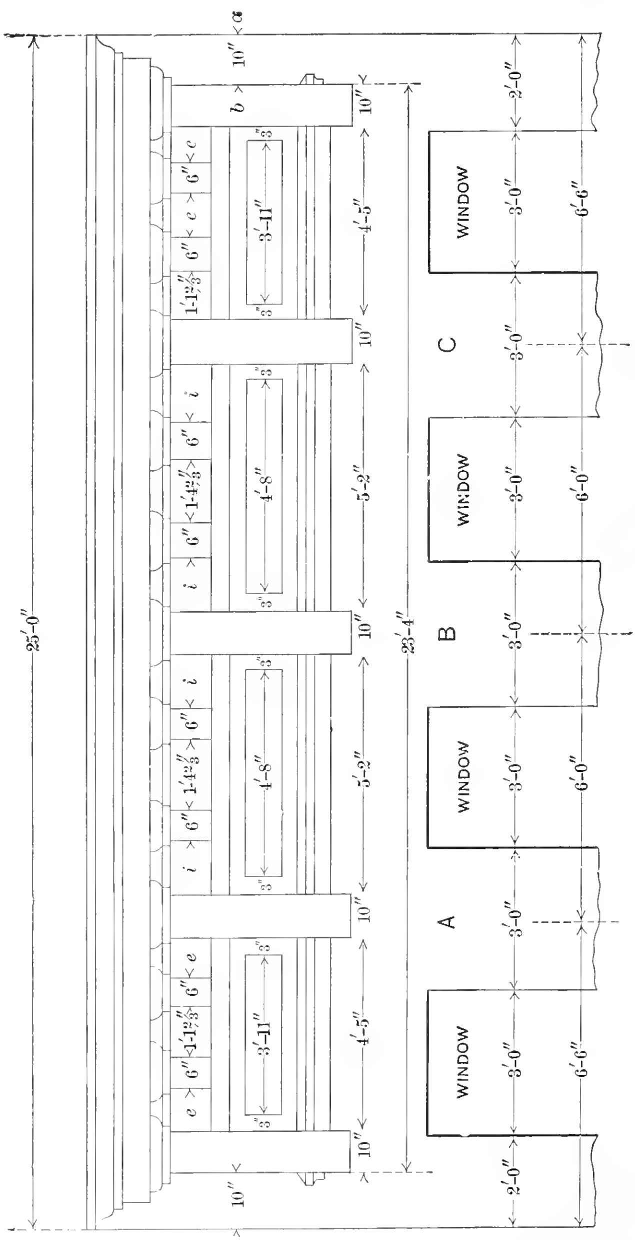


FIG. 166. Complete Cornice with Divisions Showing Method of Taking Various Dimensions.

the building line to the outside of the bracket is 10 in., and that the panel stile or the space between the panel and bracket is 3 in. To obtain the length of the two end panels add the projection 10 in., the bracket 10 in. and one-half of the bracket setting over the pier A or C, which would be 5 in., or a total of 25 in., or 2 ft. 1 in. Deduct this 2 ft. 1 in. from 6 ft. 6 in., which leaves 4 ft. 5 in., or the distance between the brackets. From 4 ft. 5 in. deduct twice the width of the stile, or 6 in., which leaves 3 ft. 11 in. the length of the end panels. Add one-half of brackets A and B, which amounts to 10 in. and is deducted from 6 ft., leaving 5 ft. 2 in., the distance between the brackets in the center. From this amount deduct 6 in., the width of two stiles, which leaves the length of the panel 4 ft. 8 in. Next deduct twice the projection from *a* to *b*, or 20 in., from 25 ft. leaving 23 ft. 4 in., the length from outside to outside of bracket. Prove these measurements by adding 10 in. + 4 ft. 5 in. + 10 in. + 5 ft. 2 in. + 10 in. + 5 ft. 2 in. + 10 in. + 4 ft. 5 in. + 10 in. = 23 ft. 4 in. To prove the lengths of the panels add together 3 in. + 3 ft. 11 in. + 3 in. = 4 ft. 5 in., and 3 in. + 4 ft. 8 in. + 3 in. = 5 ft. 2 in.

To obtain the divisions between the modillions add together the two faces, which amount to 1 ft., deduct this from 4 ft. 5 in., leaving 3 ft. 5 in. Divide this by 3 and each space will be 1 ft. $1^2/_3$ in. In a similar manner deduct 12 in. from 5 ft. 2 in. and divide the remainder by 3, leaving each division 1 ft. 4 2-3 in. The student is advised to make rough sketches having different measurements so as to become proficient in computing the various divisions and lengths.

CHAPTER XVII

Making a Square Turret

This exercise is devoted to making a square turret of four gables joined together at right angles in plan. The blue print given to the student is drawn to a scale of 2 in. to the foot, which requires a 2-in. scale, and is reproduced in Fig. 167. As the scale rules seldom have a 2-in. scale one can be made by dividing a space of 2 in. into 12 equal parts, as explained in the first part of this book, or the 1-in. scale can be used by considering each 1 in. space as ½ in. and thus using it as a 2-in. scale; or, in other words, taking one-half of the measurements of a 1-in. scale for a 2-in. scale, as in Fig. 168, in which a full size 1-in. scale is shown, the upper measurements being the 1-in. scale and the lower figures the 2-in. scale.

In Fig. 167 the front elevation and plan view is shown. As the angles in plan are right angles the plan can be omitted when drawing the detail. In the plan *c* shows the depth of the panel at *c* and *d* in elevation, as well as the projection of wash *e'*. Similar profiles are R and R, and the various small letters and figures will be explained in connection with the detail.

Using the 2-in. scale rule, the first step is to obtain the heights of the various members in the elevation up to the apex of the panel face and place them in full size on the center line A B, as shown in Fig. 169 (see Folder 3). Set off the half projection of the shaft, 4 in., and complete the outline of the base, using *a* as center to draw the cove 11 16. Complete the opposite half and draw the outline A^2 9′ D, 7^v 7′ 9 19. Draw the gothic panel, using full-size measurements obtained from the scale drawing and using *c* and *d* as centers and radius equal to *c d* to describe the arcs intersecting at *e*. In this panel face, the horizontal section H I J K L M, shows the panel sunk ½ in., as in plan in Fig. 167. This depth of ½ in. in Fig. 169 being known, a section of the lower part of the panel or wash is shown whose projection will also be ½ in. The gable mold is then drawn, by placing any line as E F at right angles to 7^v 7′, upon which the heights 1½ and 1 in. are shown, through which lines are drawn parallel to 7^v 7′ indefinitely. Draw the normal profile of the gable mold,

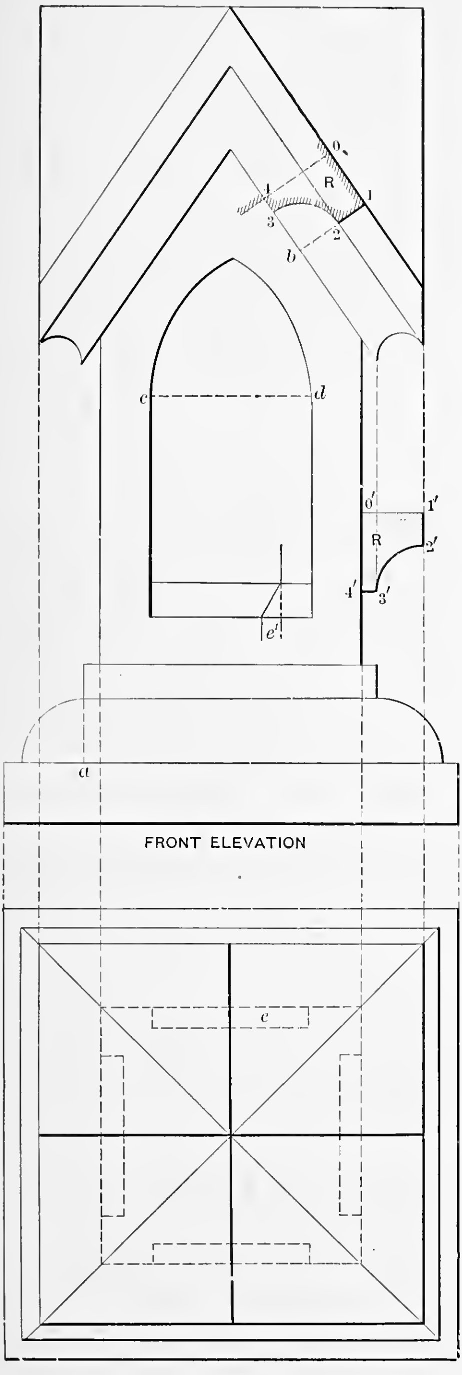


FIG. 167. Plan and Elevation of Square Turret.

R, using b as center to describe the quarter round. Before the elevation of the gable mold can be completed it will be necessary to find the miter line, or line of intersection, between the gables, as follows: Take a tracing of the normal profile R and place it in the position R^1, being careful to have the line F E in R placed on the shaft line F^1 E^1. Divide both profiles into a similar number of parts and draw lines parallel to the lines of the molding from points in R, and vertical lines from points in R^1 until they intersect each other from 1′ to 7′, which is the miter line. From the points in R, draw lines until the center line A B is intersected. Trace miter line on opposite side and extend 2° 1° and 2′ 1′ until they meet the ridge line of the gables drawn through 1^v at O and P, which completes the elevation of the gable roof. While the full front elevation is shown, one-half is all that is required.

The elevation having been completed, the patterns are developed as follows: For the pattern for the base extend the center line A B as B C, upon which place the stretchout of the base mold spaced from 8 to 19 in S°, by similar numbers on B C, through which horizontal lines are drawn, and intersected by vertical lines dropped from similar points in S°, and resulting when a line is traced through points thus obtained in the miter cut Y Z. By means of the dividers or tracing paper transfer the miter Y Z opposite the center line B C, shown by Y^1 Z^1. Then Y Z Z^1 Y^1 is the pattern for the base, to which laps are allowed, as on the left side. Of this pattern four duplicates are required in sheet metal.

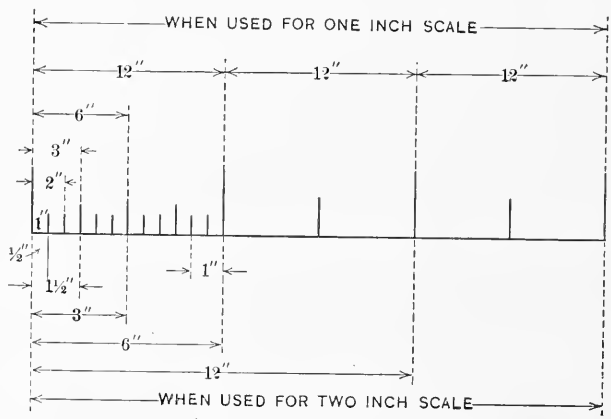


FIG. 168. Method of Using 1 In. Scale for 2 In. Scale.

For the pattern for the wash N, take the girth of *h i j l* (*h i* and *j l* representing laps) and place it at the right by *h′ i′ j′ l′*, and complete the rectangle *h′ h° l° l′*, making the length 5 in. or the width of the sunk panel, of which four pieces are also required. The pattern for the panel face forming the shaft is pricked direct from the detail, through points 9′ D 7^v 7′ 9 for the outline, and through points *c° b° d c c a° d°* for the panel allowing a lap along D 9′ and another partly shown at the bottom by 9′ *n*. This edge 9′ *n* is used to prevent any buckles, which would occur if the edge were omitted and the shaft soldered, as shown at the right in diagram B°. By having this small edge, 8 9 in S°, buckles are avoided. In this connection it is proper to say that in all work where joints are to be made, as B°, the edge 8 9 in S°, should be added, for in soldering a raw edge as in B°, the hot iron expands the metal, causing a succession of buckles, which make a bad and uneven surface. Four shaft or panel faces are required.

At right angles to the gable mold, draw any line as T S, upon which place the girth of the normal profile R, shown by the small figures 1 to 7 on T S. Through these points at right angles to T S draw lines, which intersect by lines drawn from similar numbers in the miter line 1′ 7¹ and 1^v 7^v in elevation, at right angles to 7^v 7′. Trace a line through points thus obtained; then P W U V will be the pattern for the gable mold. When these gables are of small size, the gable roof is usually added to the pattern, as in this case as follows: At right angles to W U draw W X, equal in length to 1^v P or 1^v O in elevation, and draw a line from X to U in the pattern. Then P X V is the full pattern, four duplicates of which are required without laps and four with laps all around, as indicated by the dotted lines. This completes all the patterns required.

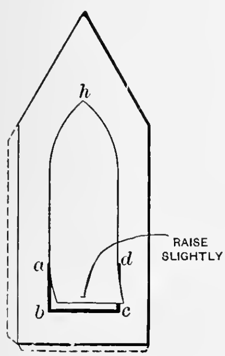


FIG. 170. Method of Cutting Sunk Panel.

The required number are now cut from metal. When cutting the panel or shaft face, all that part *a*° *b*° *c*° *d*° is cut away, and in its place will be soldered the wash *h*′ *h*° *l*° *l*′; but that part forming the sink face of the panel, *b*° *d e c a*°, must be saved, and, therefore, in cutting out this part cut as in Fig. 170, using the chisel on a block of lead to cut the slot *a b c d*, making the distance *a b* and *c d* about 4 in. Part *a b c d* is now slightly raised, which allows the right and left handed shears to be used to cut to *h*, the left hand, shears from *d* to *h* and the right handed from *a* to *h*.

The next step is to provide stays for forming. The stay for the gable mold is shown by R or R¹, Fig. 169, for the base mold from 10 to 17 in S°. For the wash at the foot of the panel prick off on metal *h i j l* in N. The molds, being simple, no explanations are necessary for forming, which will be done as previously described. When forming work on which laps have been allowed on one side only, as in the pattern for the base, the pieces should be bent so that the laps all come to one side, A, Fig. 171, which brings the laps in their proper corners; whereas, if the pieces were bent right and left, as shown by B, there would be two raw edges and two double laps.

After the forming has been completed the laps are bent at their proper angles with the pliers or on the hatchet stake, and the various parts of the turret put together as follows: Starting at the base solder together two sides so as to form a right angle, A B C, Fig. 172, and join the two angles at *a* and *b*. By having both angles A B C right angles, the two angles at *a* and *b* become

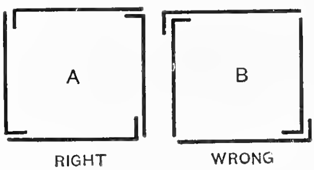


FIG. 171.

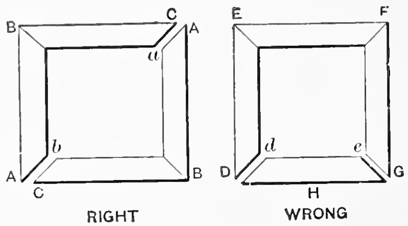


FIG. 172.

FIG. 171. Right and Wrong Method of Bending Laps. FIG. 172. Right and Wrong Way of Putting Square Article Together.

true without using the square. This rule applies to any article having a square plan. A mistake often made by students is to solder together three sides, as D E F G, and set in the fourth side H, soldering at *d* and *e*. It is better practice to join as explained in the first diagram.

The sink strip is now soldered to the gothic panel as in Fig. 173, in which A shows the face and B the portion of the panel

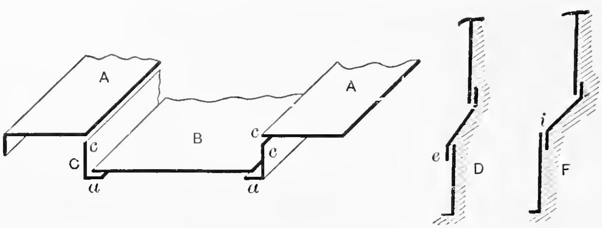


FIG. 173. Method of Stripping the Gothic Panel.

to be sunk. The proper width sink strip is shown by C, to which has been added an edge *a*, a little more than 1-16 in. wide. This small edge is turned to conform to the gothic curve without notching. These strips are cut off the proper length, bent to the proper curve and soldered raw edge at *c* to face A, after which B is dropped on to the edge *a* and soldered from the inside. When soldering the wash at the bottom it should be soldered as at the right of Fig. 173 in diagram D at *e*, which allows the water to flow over the face, and not as is sometimes done, as in diagram

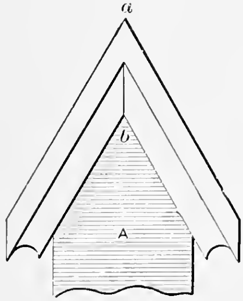


Fig. 174.

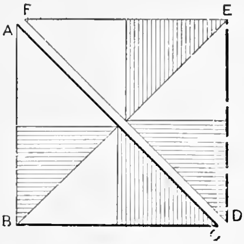


Fig. 175.

Fig. 174. Method of Using Templet to Keep Gable True. Fig. 175. Method of Joining Gable and Roof Pieces.

F at *i*, which is liable to cause a leak and rust the edge of the metal. The shaft is now soldered together in two halves, as explained in Fig. 172, and also soldered on to the base. The next work is to join the gables, for which a gage or templet is cut, as A, Fig. 174, tacked to the lap of the gable mold and the joint *a b* soldered together. The templet A is then removed and used for the next gable, and so on until all the gables are put together. They are then joined in two halves, A B C and D E F, Fig. 175, after which they are joined along A C and soldered to the upper part of the shaft. The miter joints at the lower end of the gables should be neatly put together, scraping all joints so as to make a smooth finish, being careful to keep the metal free from acid stains. When this has been done the turret will appear as shown in Fig. 176, which is a view of the finished square turret.

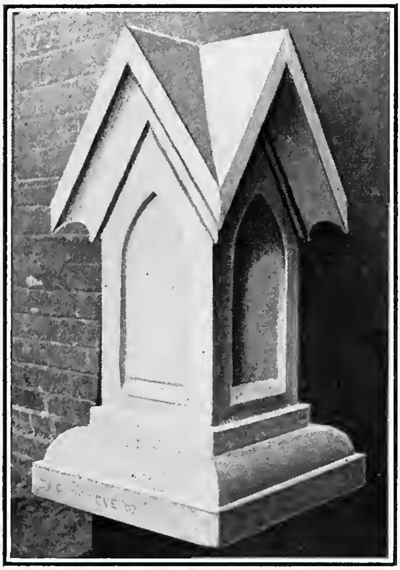


Fig. 176. Square Turret.

CHAPTER XVIII

Making an Ornamental Finial

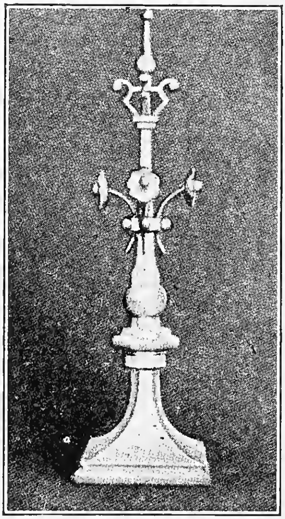


Fig. 177. An Ornamental Finial.

Before starting the eleventh exercise in drawing, the student is requested to examine Fig. 177, which shows a finished ornamental finial and gives a good idea of what the student is to construct. Note that the lower part of the base is perfectly square and a transition is made from square to octagonal in the neck of the base. Then comes a true octagon cap, joined to a sphere. On this sphere is a square shaft enriched with stems and rosettes with imitation bent iron-work. The small balls are of zinc, and are spun, but not made at the school.

The home student, having in mind what will be done, is referred to Fig. 178, which shows a reproduction of a 2-in. scale blue print. This scale drawing shows the front elevation of the finial in two parts, the center *d* of the sphere V being placed upon the center *a* of a similar sphere V. A plan view is also presented, which clearly shows the gores forming the transition from square to octagon. In the front elevation of the base *a, b, c* and *d* indicate the centers for striking the various molds, while the lower angle at the base is 45 degrees. In the front elevation of the finial *a, b, c* and *d* indicate the operations required in finding the intersection between the square shaft and sphere, and will be explained in detail when drawing the shop detail. The center for describing the curve at the foot of the spire is at *e,* the radial line from *e* being drawn at 90 degrees to the side of the spire. The centers for drawing the scroll are at *f* and *h,* the lower line being at an angle of 45 degrees from the intersection of the spire and the top line of the band. The distance from *i* to *j* is required to find the center *k* to describe the curve of

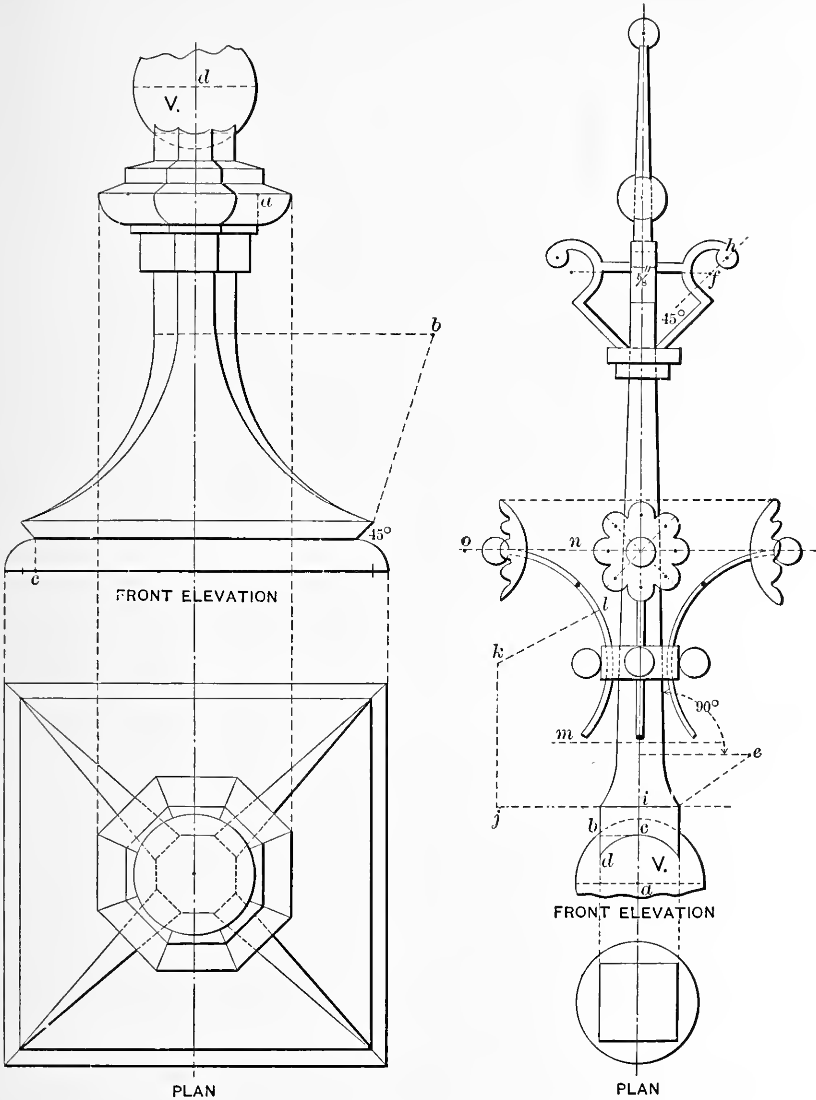


FIG. 178. Plan and Elevation of Ornamental Finial.

the stem *l m*. The height of the center of the rosettes is shown at *n* and the sections are struck from *o* and *r*.

All of these points will be described as the student proceeds with the shop detail. In drawing the shop detail, the base and one-half of its plan will be taken up first. Therefore, starting from the lower line in the base of the finial scale the various heights of the members up to the center d of the sphere, and place them full size on the center line A B of Fig. 179, (see Folder 3). Through the various points on this center line draw horizontal lines. Scale the projections on one side of the center line in Fig. 178 and place the full size measurements on both sides of the center line, as in Fig. 179, to the left of the center line. While the full elevation and half plan are shown, one-half elevation and one-quarter plan would ans wer the purpose. The small letters a^x, b^x, c^x and d^x are the centers for describing the curves and are similar to the letters in the scale drawing in Fig. 178.

The outline of the elevation in Fig. 179 having been completed, the next step is to draw the half plan, which must be carefully done, and that this may be more easily followed an enlargement twice the size of the quarter plan is given in the upper right hand corner. Below the elevation draw a horizontal line as O K, intersecting the center line previously drawn through the elevation at C. Then from the extreme point of the cap molding 5 in elevation drop a vertical line, intersecting M K in plan at G. With C as center and C G as radius describe the semicircle G H J. Then tangent to the circle at G and J draw vertical lines; at R and R° draw lines at 45 degrees, and at H draw a horizontal line. Where these lines intersect connect lines, thus forming the semioctagon, and from 5 and 5° lines are drawn to the center C, which become the miter lines of the cap. Then from the extreme point in the base, as l in the elevation, draw the vertical line l K, extending it and making the distance K l' in plan equal to one-half the width of the base in elevation, or 6 in. From l' in plan draw miter line l' C, which will be an angle of 45 degrees. Complete the outline of plan K l L M, and from h in elevation, the point from which the transition takes place from square to octagonal, drop a vertical line cutting the miter line at h. From the point 12 in elevation, the end of the transition from square to octagonal, drop a vertical line cutting the miter line 5 C in plan at 12. From this point, at an angle of 45 degrees, or parallel to 5 5°, draw a line meeting the miter line 5° C at 12^x, the point just above 10^x as in enlarged plan view, and from this point complete the semioctagon. From points 12 and 12^x draw lines to the corner h. Then h 12 12^x represents the plan of the gore piece forming the transition from the square base to the octagonal cap.

Note that the one-quarter plan to the left indicates the plan of the finished base, while to the right are shown the miter lines used in developing the patterns. The method of obtaining the miter lines in elevation will now be explained. While these miter lines are not necessary in obtaining the patterns, excepting the upper part of the cap, where the octagon shaft intersects the sphere, it is well to know how to project the various points from the plan should it be desirable to make a finished drawing.

The student will first take up the cap. Divide the profile of the cap mold into equal spaces, shown by the small figures 1 to 12, from which points draw horizontal lines across the elevation. From similar points drop vertical lines into the plan, cutting the miter line 5 C at the intersections numbered 1 to 12, from which points, parallel to 5 5°, draw lines cutting the miter line 5° C, the intersections being partly numbered on the miter line 5° C at 10, 11, 12 and 2 1 (enlarged plan view). From the intersection on 5° C vertical lines are erected into the elevation intersecting horizontal lines drawn from similar numbers in the profile 1 12 and partly shown by points, 2°, 5^T, 10°, 11°, 12°. Trace a line through points thus obtained and trace this miter line in its proper position opposite the center line 1^x 12^x.

It will now be necessary to find the intersections between the octagon shaft and sphere. Where the side of the shaft intersects the ball at D draw a horizontal line meeting the center line of the sphere at E. Then, using d^x as center and d^x E as radius, describe an arc, and intersect it by a vertical line erected from 2°, as at 1°. Obtain 1^x on the opposite side in a similar manner. From the points 1° and 1^x draw horizontal lines, intersecting the sides of the shaft at 1 and 1^a. A free hand curve can be drawn from 1^a to 1^x and from 1° to 1, the curve not to go below the horizontal line drawn from D. To obtain the miter line in the elevation forming the transition from square to octagonal, divide the profile of the base from 12 to *m* into equal spaces, as shown by the small letters *a* to *m*. From the various points in the curve 12 to *h* draw horizontal lines across the elevation, and drop vertical lines into the plan cutting the miter line of the gore *h a* in plan (see enlarged plan view), shown by similar letters. From these points parallel to 5 5°, or at an angle of 45 degrees, draw lines cutting the miter line *h* 12^x, partly shown by f^x *a* 12. From the intersections on this line *h* 12^x vertical lines are erected into the elevation, intersecting similar lettered horizontal lines drawn from points 12 to *h* in the profile, partly shown by the intersections *a*°, *f*° and *g*°. Trace a line through these points, which is then traced opposite the center line. This completes a carefully worked elevation and half plan, from which the patterns are obtained.

In constructing the base of the finial a seam will be most convenient at the angle 12 in elevation, as shown on the opposite side of the line A B. This allows the various parts to be formed with ease, and soldered together. To obtain the pattern for the base, obtain the girth of the profile 12 to *m* in elevation and place it on the center line O K in plan, extended as S P, shown by similar letters and figures. At right angles to S P and through the small letters draw lines, which intersect lines at right angles to K *l′* in plan from similar lettered intersections on the miter line *a h* and *i l′*, better shown in enlarged plan view, those points on *i l′* being used to obtain the square miter cut for that part of the base from *m* to *h* in elevation and those points on *h a* in plan for obtaining the miter cut to join with the gore, forming the transition from square to octagonal. Trace a line through points thus obtained. Then 12 A^3 *m* will be the half pattern. Trace this half by means of the dividers or tracing paper opposite the line K P, as shown by 12 A^4, which completes the pattern for the base, four of which will be required. Laps are allowed from *n* to *o*.

The pattern for the octagon cap is obtained by taking the girth from 1 to 12 in elevation and placing it on the center line S P from 1 to 12, through which horizontal lines are drawn, and intersected by lines drawn parallel to S P from similar numbered intersections on the miter line 5 C in plan. A line traced through these points will give the half pattern, 1 B^3 *s* 12, which is traced opposite the center line B^4 *r*. A lap is allowed at *r s* for joining to 12 on the pattern for the base, and a curve must be cut from B^3 to B^4 on the pattern for the cap, to which the sphere is soldered. This is done by using d^x 1^x in elevation as radius, and with B^3 and B^4 in the pattern for cap as centers intersect arcs at *d″*. Using *d″* as center, with the same radius, draw the arc B^3 B^4. Eight of this pattern are required for the cap, no laps being allowed owing to the small bends; though, on a larger size finial laps are allowed.

Before the pattern for the gore can be developed, it will be necessary to find the true profile on the line C *h* in plan, which is at right angles to the lines of the gore. Therefore, where the lines drawn from the various intersections, 12, *a, b, c, d, e, f, g* and *h,* cross the center line C *h,* shown by the heavy dots, and to better advantage in the enlarged plan view, take these divisions and place them on the horizontal line dots drawn from point *h* in elevation, as *h* T, and letter them as shown by 12, *a*, *b*, *c*, *d*, *e*, *f*, *g* and *h′*, to correspond to those in plan. At right angles to *h* T from the small letters erect vertical lines, and intersect them by horizontal lines drawn from similar letters in the profile in elevation. A line traced through these points, from 12′ to *h′*, will be the desired section. Take the girth of this section and place it on any line, as U V, at the bottom to the right, using similar letters, being careful to measure each space separately, because they are all unequal. Through the letters, at right angles to U V, draw lines indefinitely. Measuring from the center line C *h* in plan, take the various distances to similar points on the miter line *a h* and place them on similar lettered lines, measuring in each instance on both sides of the line U V. A line traced through points thus obtained will be the desired pattern, and four of these gores will be required. This completes all the patterns required for the base, which are transferred and cut from the sheet metal in the usual manner.

Templets will be required for forming, as follows: From 1 to 12 in elevation, for the cap mold; 12 to *m* for the base mold, and 12′ to *h′* in the true section, for the gore pieces. The cap mold is formed in the usual manner and requires no special mention, excepting that care should be taken to have the angles at the upper washes, 1 to 5 in elevation, true and accurate, so that true parallel lines will be the result when the cap is soldered together. In forming the gore care should be taken not to reverse the templets, but have the apex *h* of the pattern at *h′* on the templets.

The forming of the base mold for the finial shown in detail from 12 to *m* in elevation in Fig. 179 requires special attention, and assistance will be found in Figs. 180 to 184. When forming start at dot *i* in the pattern for the base in Fig. 179 and make a square bend at *i*, Fig. 180. Place the proper former in position and turn down *i l* at *l′*. Leaving *l′* in this position, raise the bending leaf B, Fig. 181, until the angle *l′ i h* conforms to the templet. Then reverse sheet A B, Fig. 182, and close the brake on dot *h*, making a bend at the proper angle in the direction of the arrow C. Again reverse the sheet A, Fig. 183. Close the brake on dot *l* and make a square bend, as at B. This completes the forming of the lower mold excepting the neck, which is rolled over a piece of pipe, Fig. 184, in which A represents a piece of steam pipe and B C the base just formed. The mold is held firmly at B and C turned over the proper size pipe in the direction shown, to D, which completes the forming of the base X Y.

Before starting to set these pieces together an angle templet is pricked from G 5 5° in plan in Fig. 179, shown by G in Fig. 185. This templet is used to insure true angles

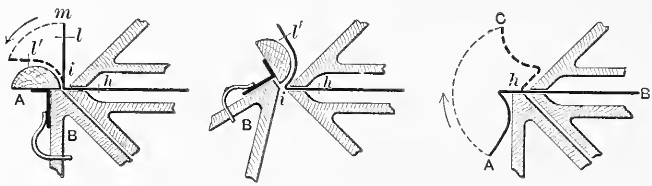


FIG. 180. FIG. 181. FIG. 182.

FIG. 180. First Operation. FIG. 181. Second Operation. FIG. 182. Third Operation.

in setting together the cap and base. First tack the cap with solder in pairs, as at A. Then join two pairs in one four, joining A^1 and A^2 at B. Next join two fours in one octagon, connecting B^1 and B^2 at C and C^1. When the entire cap is tacked together, solder out. This rule of joining together applies to any polygon. The same method applies in joining

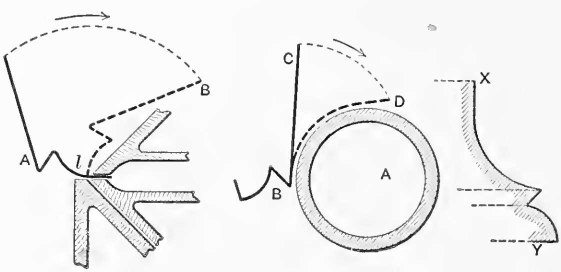
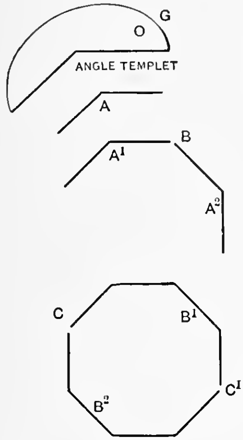


FIG. 183. FIG. 184.

FIG. 183. Fourth Operation. FIG. 184. Forming the Neck.

the gore pieces of the neck, as in the top diagram of Fig. 186, in which B shows the gore piece tacked to the neck piece A. If the gore is tacked to the right of the neck, then all four gores must be tacked to the right, so that when joined together as in C, no misfit will result. In the diagram C, A and B represent the neck and gore pieces. Two sides, $a\ b$ and $b\ c$, are joined at b, then $c\ d$ and $d\ a$ joined at d, after which a joint is made at c and a.

The sphere is obtained in two halves and the seam is joined as in Fig. 187. These spheres are not made at the school nor



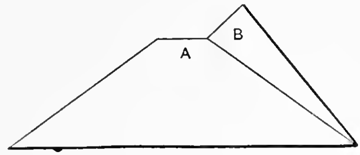


Fig. 186.

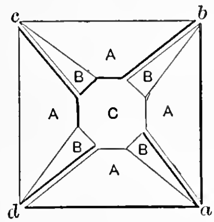


Fig. 185.

Fig. 185. Assembling Side of Cap. Fig. 186. Assembling Base.

can they be readily made by the home student, but are spun from zinc and purchased from dealers in pressed zinc work. A ¼-in. strip is tacked to the inside of the half sphere A, at *a*, after which the other half, B, is slipped over the strip *a* and the joint soldered very lightly all around. The entire base is now joined as in Fig. 188, the ball being first joined at *b*, and care should be taken that the seam *e f* is in a horizontal position, after which the cap is joined to the neck at *a*. When joining the cap to the neck care must be taken that the bend *c* runs parallel to the base at *d*, for the cap has a tendency to turn and throw the bend *c* out of parallel to the bend *d*, indicated by the line *a b*, Fig. 189, which shows the appearance, in plan view, when the cap is not set parallel to the base.

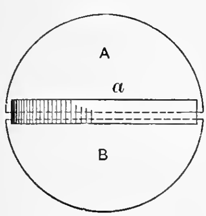


Fig. 187.

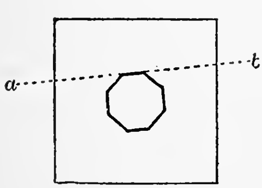


Fig. 189.

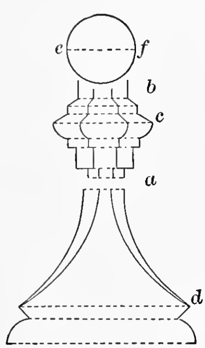


Fig. 188. Completing Base.

Fig. 187. Joining the Sphere.
Fig. 189. Cap Not Parallel With Base.

The base having been completed, the student will now lay out the shop detail of the upper part of the finial. Referring to Fig. 178, in which the front elevation of the upper part of the finial is shown, note that *a* is the center of the sphere and that *b, c, d* indicate the points of intersection in mitering the square shaft *i* upon the ball, as will be explained when laying out the full size detail. The center *c* is for drawing the curve on the base of the shaft, while *k, o* and *p* are the centers for drawing the profiles of the stem and rosettes. Points *f* and *h* are used in drawing the scroll. With the scale rule take the heights on the center line from the center *a* to *i* to *m* to *n,* and the various other ornaments, and place these measurements full size on the center line A B, as in Fig. 190 (see Folder 3). The point C on the line A B is established at pleasure, it being the center for describing the sphere. At a distance of ½ in. above the sphere the base line *d d* of the spire is drawn. From this line, *d d*, the vertical heights are placed, shown by full size measurements, through which horizontal lines are drawn and upon which the horizontal distance from the drawing in Fig. 178 are placed as scaled. Put the horizontal distances full size on the working detail, as in Fig. 190. The intersection between the square shaft and sphere is obtained by drawing a vertical line downward from *d* indefinitely, and where this line intersects the sphere at *c,* draw a horizontal line, cutting the center line at *f*. Using C as center and C *f* as radius, describe the arc *h f h′*, meeting the vertical lines dropped from points *d* and *d* at *h* and *h′*. This face, *d, h′ h d,* represents one side of the pattern.

After the height *c c* has been drawn place half the horizontal distance of 13-16 in. each side of the center line, and measure from the center C a distance of 2 ft. 3½ in., and at the top draw the 1-in. circle G. Place half the horizontal width 6, or ⅛ in., on each side of the center line and draw the shaft line 6 to *c.* From *c,* at right angles to 6 *c,* draw *c b* equal to 2¾ in., and, with *b* as center and *b c* as radius, draw the arc *c d,* meeting *d.* Next draw the bands D and E, also the sphere F.

The intersections between the shaft and the spheres F and G are obtained in precisely the same manner as for the sphere C. Extend the line *d d,* making the distance from the center line to *i* 4½ in. From *i* erect a vertical line, also 4½ in. in length, shown by *j,* which is the center for describing the stem, and use a radius equal to 3¾ in. and make the stem ¼ in. thick. Notice that the lower part of the stem meets a line drawn ½ in. above *c c,* and the center of the stem at its top meets the rosette at a distance of 3½ in. from the center line. Extend this 3½-in. line to *l* another 2 in., and, using *l* as center, with *l* 17 as radius, describe the arc *m n*, 3¼ in. wide. The student is not to copy these measurements but should scale them from the drawing. From *l* measure back 1 in. and obtain *l′*, which is the center for describing the 1-in. ball, to which the top of the stem is joined.

The front view of the rosette is obtained by using B° as center and B° A° as radius, or 1⅝ in., and describe the circle. Divide this circle into eight parts, or as many spaces as the rosette is to have petals, and draw the inner arc with a radius ⅜-in. smaller than the outer one. Where this inner arc cuts the eight radial lines use these intersections as centers and draw the eight small semicircles, which completes the face view.

To obtain an accurate side view of the rosette, proceed as follows: Establish at will on the center line drawn through B°, between the inner and outer circles, any number of spaces, in this case two, and number these points 1, 2 and 3. From these intersections draw horizontal lines, cutting the profile of the rosette *m n* at 1, 2 and 3, from which points vertical lines are drawn, through the side view. Using B° as center, with radii equal to B° 3, 2 and 1, draw circles intersecting the eight petals, shown by the heavy dots and indicated on one petal by 1′, 2′, 3′ and 3″. From these points horizontal lines are drawn, cutting similar numbered vertical lines in the side view, indicated by 1°, 2°, 3° and 3^{v}. A line traced from 1° to 3^{v} is the side view of the petal from 1′ to 3″ in the front. In this manner all of the intersections in the side view are obtained.

The scroll over the band E is drawn as follows: From *o,* at an angle of 45 degrees, draw *o p,* 2⅛ in. long, and at right angles to this line draw *p r* ½ in. distant. Through *r,* parallel to *o p,* draw the line *r s,* and set off from *r* a distance of 1 in. to *t.* Use *t* as center and *t r* as radius and describe the semicircle *r x.* Set off from *x* to *u* ⅜ in. and, with *u* as center and *u x* as radius, draw the arc until it meets the arc drawn parallel and at a distance of ¼ in. from the arc *r x* as shown at *y.* From *t* draw a horizontal line, cutting the shaft at *z* and joining the scroll. Above this line draw a parallel line ¼ in. distant. It is only necessary to draw one-half elevation, but in this case, to give practice for the student, the entire elevation should be drawn.

The elevation having been completed, the patterns are next developed, the pattern for the shaft being taken up first. Divide the profile d c into equal parts, shown by 4 5. Upon any vertical line, as H C^1 set off the girth of 6, 20, 16, 10, c, 5, 4, d and h in elevation, shown by similar numbered and lettered points on H C^1, through which horizontal lines are drawn. Then, measuring from the center line A B in elevation take the various projections to 6, c 5, 4, d and h and place them on each side of the line H C^1 on similar numbered or lettered lines shown on the pattern to the right. Through these intersections trace a line, 6 h° h°, which will be the pattern for one side of the shaft, four of which wili be required Laps tapering as at d are allowed on one side as shown by the dotted lines. The points 10^v, 16^v and 20^v are used to indicate where the bands D and E and the ball F in elevation are placed. To obtain the lower curve on the pattern for shaft K use h C in elevation as radius and with h° and h° in the pattern as centers, draw arcs intersecting each other at C^1. Using C^1 as center, with the same radius, describe the arc h° h°.

The pattern for the band D in elevation is obtained by taking the girth of 7 8 9 10 and placing it on any line, as L M, shown by similar numbers, through which perpendiculars are drawn. Measure from the center line A B in elevation and take the horizontal projections to points 7, 8, 9 and 10 and place them on similar lines, measuring from and on each side of the line L M. A line traced through points thus obtained, N O P R, will be one side of the pattern.

Between the spaces 7 8, 8 9 and 9 10 holes are punched, shown shaded, the one between 8 9 being used so that the ball A^P in elevation can be soldered on the inside of the band, and the holes between 7 8 and 9 10 in the pattern are to allow the stem of the rosette to pass through the band. When laying out the pattern N O P R it is well to make the width from a^T to b^T about 1-16 in. more than called for from a^T to 9 in elevation, so as to allow the band to slip over the shaft down to 10, to overcome the additional thicknesses of the metal when joining the shaft together. Four of these patterns, N O P R, are joined together on the lines v w, w' v' and v'' w''. Then h^v j^v l^v i^v is the full pattern for the lower band D.

The pattern for the upper hand E is obtained by taking the girth of 11, 12, 13, 14, 15 and 16 and placing it on the vertical line T S shown by similar numbers, through which horizontal lines are drawn. Measure from the center line A B in elevation and take off the various projections to 11 to 16 in the band E and place them on similar numbered lines on each side of the line T S, being careful to allow slightly in the width of the pattern for the band to slip over the shaft, down to point 16. When a line is traced through points thus obtained U V will be the desired pattern, four of which will be required.

The pattern for the scroll is pricked direct from the elevation, shown by A° B° C° D° E° F°; 20 and 21 being used as centers. Eight of these patterns will be required.

The pattern for the zinc stems are simply strips of zinc with a width equal to the circumference of a ¼-in. circle and a length of 12 in. to allow a firm hold at each end, so that the stem can be bent with ease. Four zinc strips will be required.

The pattern for the raised rosette is obtained by taking the girth from 17 to 3 to 2 to 1 in the curve *m n* in the side view of the rosette and placing it, from 17 to 3 to 2 to 1 on the line W X. Using 17 as center, with radii equal to 17 3, 17 2 and 17 1, draw circles. Through the center 17 draw the four diameters W X, a° b°, a^{v} b^{v} and a^{x} b^{x}, dividing the circles into eight equal spaces. Measure from the line A° B° in the elevation of the rosette and take the distances along the curves to the outline of one petal, as to 2′ and 3′, and place the dimensions on similar numbered circles in the pattern for the rosette, measuring on each side of the eight radial lines, and the result will be the shape indicated by one petal numbered 2^{x} and 3^{x}. Four of these patterns will be required, through the center of which at 17 a hole will be punched with the hollow punch to allow the stem to pass through.

After the required number are cut from sheet metal, templets must be cut to insure the true formation of the various parts; the part shown by *c d h* for forming the base of the shaft, the curve *m n* for raising the rosette and the templet 22, 23, 24 for soldering the rosette to the stem at the proper angle. No stays are required for the bands D and E, because the bends are all square. When forming the shaft pattern J K a square bend is made along the lap line d^{v} e^{v}, allowing the bend to pass through the lower part of the shaft at f^{v}. That portion i^{v} to f^{v} is then flattened and formed after the templet *c d e* in elevation. This allows a straight bend through the corner.

The setting together of the finial begins with the shaft, which is set together in two halves, A and B, Fig. 191. A and B are soldered together as shown by A^1 and B^1, the corner C being soldered and the corner *a* left open, which allows the shaft to be twisted in any direction. The base of the shaft is held firmly, and the apex turned until the sides run parallel to each other, as in diagram A, Fig. 192, when the corner *a* in Fig. 191 can be tacked and soldered. If care is not taken the shaft will have a tendency to twist, as in B, Fig. 192, in which *a b* does not run parallel to the base line.

After the pattern for the lower band in Fig. 190 has been bent along the lines h^v i^v and l^v j^v at right angles, it will look as shown by A B, Fig. 193. The black circles, *a*, *b* and *c* represent the openings for the stem to pass through and for soldering the ball. While in this position the 1-in. balls are soldered to the face of the band as in Fig. 194, in which A is the band and B the zinc ball laid against the punched hole *c d* and soldered from the inside, shown by the arrow. This method of soldering makes a neat appearance on the outside and avoids unsightly lumps of solder. The stem *a b* is shown passing through the upper and lower holes in the band. When these balls are soldered in position, it is only necessary to make the

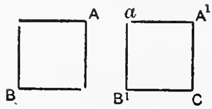


FIG. 191. Method of Joining Shaft.

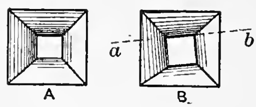


FIG. 192. Avoiding Twist on Shaft.

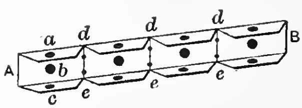


FIG. 193. Bending Lower Band.

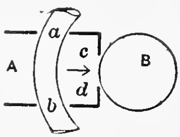


FIG. 194. Soldering Balls to Band.

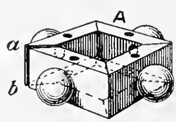


FIG. 195. Completing Lower Band.

corner bends with the hands, along the lines in Fig. 193 by *d e*, which will give the appearance shown by A, Fig. 195. Then all that remains to be soldered is the one corner *a b*.

The raising of the rosette is briefly shown in Fig. 196, because this hand-hammer work will be taken up in detail when hammer work is reached in the course. A lead block is shown at A, which is hammered out to the required profile by means of the raising hammer D. The blank B C is then laid over *a* and light blows struck with the raising hammer until the desired shape is obtained. Care must be taken not to strike the blows too hard at first, otherwise the metal has a tendency to overlap, shown by *b c*. The blows when struck lightly will cause the metal to form corrugations, indicated by *d e f h i*, and these are easily dressed out so as to have the smooth, round surface *j k l*.

The zinc stems are bent slightly in the brake, then formed over an iron rod by means of the mallet on the square head stake. When the stem has a true circle the seam is soldered, then dressed again to a true circle, if necessary. When a quantity of stems are to be made it is cheaper to purchase seamless brass or zinc tubing. As the stem used is but ¼ in. in diameter it can be bent without filling, by simply heating the zinc slightly and having the proper size pipe to fit curve, shown by A, Fig. 197; the tube B C being held firmly at B, with gloves or pieces of rag to prevent burning the hands, the end C is turned slowly but firmly over the shape until the position D is reached. Note that the two ends B and D remain straight, and for this reason 4 or even 8 in. are added to the girth of the length of the stem, as it is impossible to bend the curve to the ends.

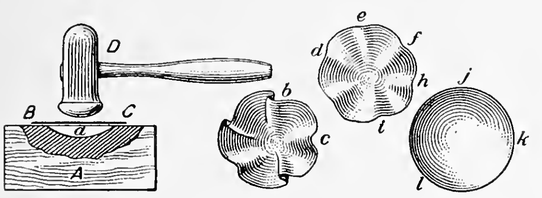


Fig. 196. Raising the Rosette.

When bending the stem, the seam is placed on the outside of the curve, which allows the seam to stretch as it is bent. If the seam is placed on the inside it has a tendency to buckle. A mistake often made by the student when forming the stem is to grasp each end of the tube and give a quick turn. This usually results in a bent, broken tube. The pressure must be inch by inch. When all the stems are bent lay them upon the detail drawing and mark to proper size and cut off with a three-cornered file. On one end a 1-in. ball is soldered and the other end is plugged up with paper and the end filled with solder and filed to a point or cone shape. The paper plug is used to prevent the solder from falling inside the stem.

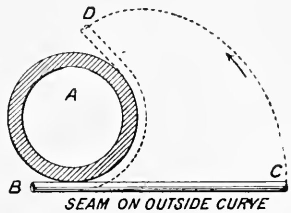


Fig. 197. Bending the Zinc Stems.

The rosette is soldered in its proper position and the templet indicated by 22, 23, 24, Fig. 190, being used, care must be taken when the rosette is being soldered to the stem that the petals run in a vertical line, as in the front view of the rosette. The stems are now soldered to the band just completed in Fig. 195 at their proper distance, as in the elevation in Fig. 190. The band D is then slipped over the shaft pattern so that the bottom of the band meets the point marked 10^v.

When the tubes or stems are larger than ¼ in. in diameter, plug up one end and fill with melted rosin or hot white sand. If a number of stems are required a templet could be made from wood or metal as in Fig. 198, in which A represents a piece of wood having a groove the size of the tube cut out at the end *a b* and throughout the curve and the desired profile of the stem cut as *c d*. A band iron strap is screwed fast at one end of the templet as at *c f*. By inserting the plugged end of the tube, while still warm, under the strap as at B and turning slowly a large amount of labor can be saved. Remove the sand or rosin from the stem, and cut it to the required length.

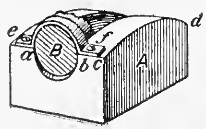


FIG. 198.

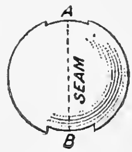


FIG. 199.

FIG. 198. Template for Bending Tubes. FIG. 199. Fitting Upper Sphere on Shaft.

The upper band E in Fig. 190 is next set together and slipped down on the shaft to point 16^v. The scrolls are stripped ⅝ in. in width, and one soldered on each side of the shaft. When the ball F is being soldered in position, the seam is placed vertically, shown by A B, Fig. 199, which allows the ball to be notched out before the seam is joined, until it slips down to point 20^v on the shaft pattern, Fig. 190. The shaft is capped with the 1-in. ball G, completing the upper part of the finial. Then set it over the 4-in. ball on the lower part of the finial and it will have the appearance shown in Fig. 177. Care must be taken that the lower part of the shaft runs parallel to the lower part of the base.

When these finials are set up on the ridge of a roof or over a tower, provision must be made to withstand wind and storm pressure. Probably the best, cheapest and quickest connection, whether the roof is constructed of wood or of iron framing, is to use heavy steam pipe as in Fig. 200, in which A B represents the ridge beam through which a hole is bored to allow the pipe or rod C to enter. A thread is cut a few inches above the ridge beam as high as E and down to the end D. The nut is screwed in position *a* in F, and F set down on to the ridge beam until the nut rests on it at a^1. The nut *b* is then fastened from below, which secures the pipe. The finial G H is set over the rod and the open spaces at *c* and *d* covered with metal collars. In iron

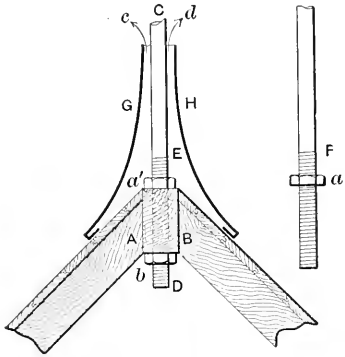


Fig. 200. Method of Fastening Large Finial.

frame construction this rod is made of angle or T iron, which answers the purpose just as well.

CHAPTER XIX

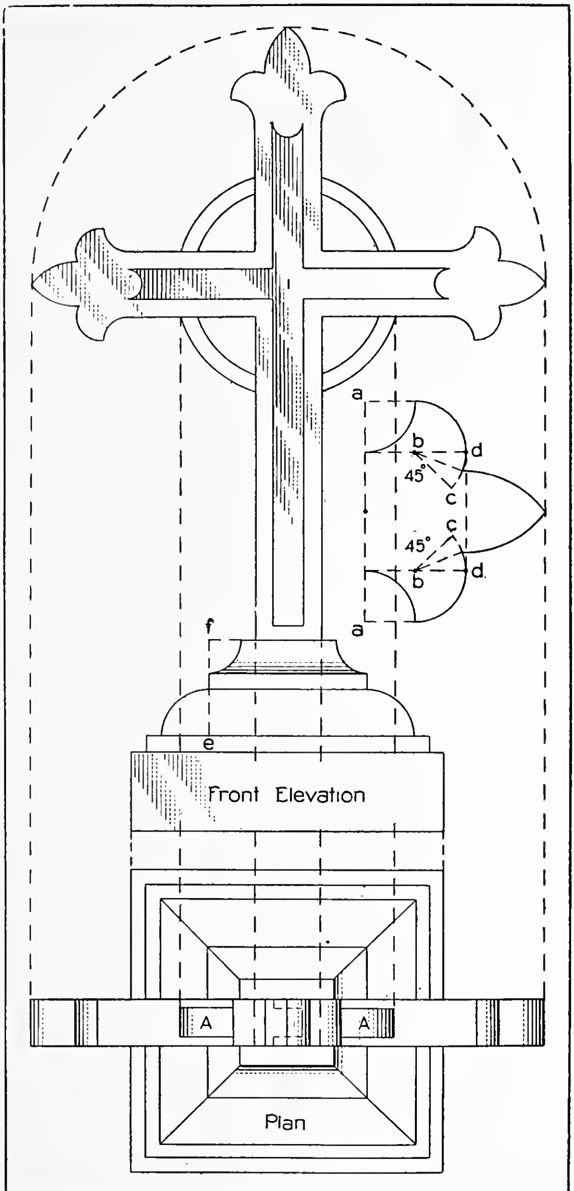
Making a Paneled Cross

The twelfth exercise, to which the attention of the student at home is directed, is the making of the paneled cross, Fig. 201. The drawing, reproduced for the student, is drawn to a scale of 2 in. to the foot and shows a front elevation and plan. Work of this kind is usually made of 20 oz. cold rolled copper, when placed upon spires or church towers, and is also constructed of heavy galvanized iron, to withstand the action of the weather. When a cross is to be gilded, it is always better to make it of copper, so as to withstand any corrosion which might occur from the inside or the outside.

The method of drawing the gothic leaf is indicated by the small letters, but explanations are avoided here, as similar letters are placed on the detail drawing, one-fourth of the full size, and in connection with it each step is explained in detail as the work proceeds. Note that the plan view gives, in the center, the section of the arms of the cross and that the circle in the elevation has its width indicated in the plan by A A. This plan view is not necessary when laying out the shop detail.

The first step, as in preceding problems, is to scale the vertical heights of the base and cross and place the full size measurements on the shop detail, as indicated in Fig. 202 (see Folder 4). Through these points on the center line A B horizontal lines are drawn, upon which the various projections are placed, shown by full size measurements. The lower part of the cross is allowed to enter the base as far as C D, where it is soldered to a flat bottom, which in turn is soldered at the corners 6 and 6°, as explained later. A true section through the cross proper is shown at E, which has a sunk panel of ¼ in. At the base, *f* and *e* are the centers for describing the cove and quarter round. The point where the arms of the cross meet in the center at H becomes the center, from which to describe the various arcs used in drawing the ring and establishing the length of the arms and end leaves. The various radii are obtained from the scale drawing in Fig. 201.

The gothic leaf at the end of the arms in Fig. 202 is drawn



Scale 2 in. = 1 ft.
Fig. 201. Plan and Elevation of Paneled Cross.

as follows: After establishing the length of the arm at *h* with the 5⅜-in. radius struck from H, draw the vertical line at *a′*

Make the distance from 1′ to *a* ¾ in., as in the scale drawing, and complete the square 1′ *a* 4′ *b*. Using *a* as center, draw the quarter circle 1′ 4′ and, using *b* as center, draw the arc 4′ *c* and intersect it at *c* by a line drawn from *b* at an angle of 45 degrees. Extend line 1′ *b* until the arc is intersected at *d*. Bisect *c d* and obtain 7′. In a similar manner draw the opposite side shown by *a′ b′ c′ d′*. Then using *d* and *d′* as centers, with a radius equal to *d* 7″, draw arcs intersecting each other at 12′, which completes the leaf. In practice the three leaves shown need not be drawn, as one answers the purpose for all.

The ring is represented by the section F taken on the radial line *j* H. As a rule, most students make a mistake when drawing this section. To avoid this an explanation is given of how sections are drawn when the elevation shows curved lines and whether the section is square, rectangular, molded or otherwise. Always draw the radial line as H *j* first, at right angles to which draw *i m* and *j n* equal to the required depth or 1 in. Then join *m n* and *i j*; F is then the required section. The rule to remember is, that all lines in the section must be drawn at right angles to the radial line *j* H. This completes the drawing of the front elevation.

No side elevation or plan of the cross is required, for section E shows that the side width of the cross is 1½ in. or ½ in. less than the face and that the pattern for the sides of the base will be ½ in. less than the front.

The student is now ready to develop the patterns and will take up the pattern for the base first. Divide the profile of the base from 1 to 17 into equal parts, and take this girth and place it below the elevation on the center line A B shown by similar numbers. Through these points, at right angles to A B, lines are drawn and intersected by vertical lines from the various intersections in the profile in elevation, partly shown by the intersections on the lines 1, 6, 7, 12, 13, 14, 15, 16 and 17. A line traced through points thus obtained, shown by L M, will be the miter cut. Measuring from the center line, transfer the various intersections on L M to the left of the center line, N O, using the dividers or tracing paper. Then L M N O will be the pattern for the front and back of the base. The pattern for the sides is obtained by taking the difference between the side and front in section E or ½ in., and setting it off on the horizontal lines in the pattern, indicated by J K, and obtaining the miter cuts shown by the dotted line L° M°. Laps are allowed on both cuts of the front and back pieces, but not on the side pieces. Two of each are to be cut.

When making the section E, a seam is made at 18 and 24, which allows the parts to be bent with ease and takes out the twist when soldering them together. Therefore number the corners in E, from 18 to 24 being one-half, and place this girth on any horizontal line as P R, shown by similar figures. At right angles to P R draw the usual measuring lines through the small figures, intersected by lines drawn parallel to P R from similar numbered intersections on the miter lines 19′ H and H 24′ in elevation.

After the points 21^v and 22^v in the pattern have been obtained draw lines from these two points at angles of 45 degrees, thus obtaining point H^1 corresponding to H in front elevation. As the cross is to extend into the base as far as C D, then from these points draw a line parallel to P R into the pattern, thus establishing S T. Then S T V H^1 U will be the pattern for the long arm of the cross, of which two are required, with a lap along S U and U H^1 V.

As the three upper arms are equal, as indicated by H° in elevation, take this distance and set it off in the pattern, X^1, and draw a line parallel to P R, shown by W X. Then W X V H^1 U will be the pattern for the short arms, six of which will be required, with a lap on all six from W to U, and a lap on two only from U to V, the other four receiving no lap on cut U V. The line carried across from S^x in elevation, shown by the dots s' and s'', indicate the position for soldering the outer curve of the ring.

The pattern for the gothic leaf is pricked direct from the detail and is indicated by A° B° C° D° E° F° G° H° J° K°, care being taken to use the various heavy dots as centers to describe the arcs. Six of these leaves will be required stripped from A° to H° to E° with a strip 1½ in. wide as in section E. The girth of this strip is obtained from the gothic leaf to the right, one-half of which has been spaced from 1′ to 12′ and double the number of these spaces, placed on the vertical line S^2 T^2. From S^2 and T^2 a rectangle is drawn 1½ in. wide which completes the pattern for strip around the gothic leaf, three of which are required. The heavy lines in the pattern indicate the bends. The semicircle on the pothic leaf B° C° D° will be stripped ¼ in. as in section E, showing the depth of the panel.

The pattern for the ring is obtained by pricking through the four heavy dots in the lower left quarter ring in elevation, using H as center for describing the arcs. Eight of these arcs are required, stripped 1 in. wide, as indicated in section F.

The pattern for the panel head forming a finish where the cross joins the base is obtained by transferring *r s t u* in elevation to a convenient place shown by *r′ s′ t′ u′*, and parallel to and at right angles to *s′ t′*, adding ¼ in. or the depth of the panel in section E. A small lap is allowed along *r′ u′* for soldering purposes. Two of these heads are needed.

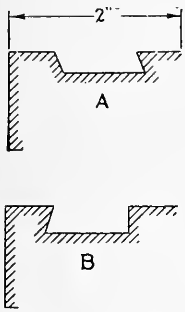
The pattern for inside head through 6 6° in elevation, to which the bottom end of the cross is fastened to keep it rigid, is shown by 6^p 6^v 6^t 6^a, being rectangular in shape, 6^p 6^v and 6^v 6^t being equal to 6^p 6^v and 6^p 6^t in the pattern for base.

The pattern for opening in E° is a reproduction of section E in elevation, but slightly enlarged in E°, to allow the cross to pass easily, care being taken to have E° at equal distance all around as indicated by a^t. Only one head is required.

All the patterns being developed the various pieces are cut from sheet metal in the usual manner, care being taken when cutting the rings to cut the inner curve first and flatten before cutting the outer curve so as to avoid stretching, as explained in cutting the sink strips in the ornamental cornice in Fig. 147. The opening E° in the pattern for the head in Fig. 202 is cut out on the lead block, using a hammer and sharp chisel. All the work being cut and the burrs flattened out on the square-head stake with the mallet, everything is ready for the various parts to be bent.

A templet will be required from 1 to 14 in elevation for forming the base, and the pattern for the gothic leaf can be used as a templet for forming the strip. Bend each piece accurately to avoid trouble when assembling the work. It is better to spend a little more time in forming and save three or four times as much time in setting the work together. Even if the patterns are accurate, if the forming is not done accurately the workman will, in setting the joint together, press, push and hammer, trying to make a neat miter, which cannot be done, because each piece has a different profile on account of the templet or the profile not having been followed. Even in the larger shops many a workman has been dismissed for being too slow in setting the work together, and it has been found later that the fault was not his, but was really in forming, which did not correspond to the templets, and therefore the miters failed to join properly.

No special mention is necessary for forming the parts of the cross except to say that care should be taken when bending the cross standard shown in section E. While these square bends look simple, a slight bend more or less than a right angle will cause a twist in the cross. When bending on the brake, each



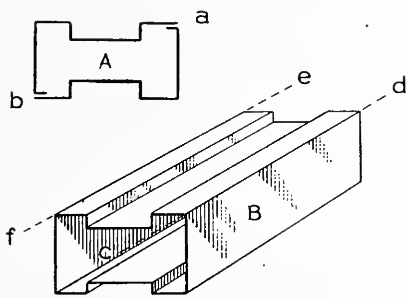
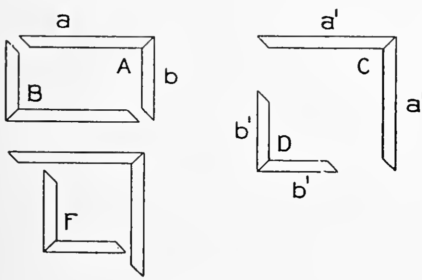


FIG. 203. FIG. 204.

FIG. 203. Errors to Avoid in Bending Cross Panels. FIG. 204. Methods of Avoiding Twist and Cross.

bend must be exactly at a right angle and not as shown by A and B, Fig. 203. Some students make this mistake and only measure the face width, which, as will be seen in diagram A, can be made to measure the required width or 2 in. and still have no right angles.



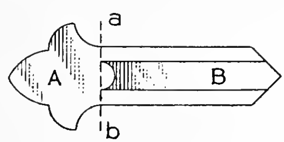


FIG. 205. FIG. 206.

FIGS. 205-6. Joining Leaf to Cross and Errors to be Avoided in Assembling Rectangular Bases.

When soldering the work together, strip the gothic leaves, being careful to have the bends run parallel to each other so as to avoid any twist. Strip the arcs for the ring and set together the arm of the cross as in A, Fig. 204, being careful when tacking together at *a* and *b* that the bends *c d* and *e f* in diagram B run parallel to each other, otherwise a twist will result. The gothic leaf A is then soldered to the arm B, Fig. 205. on the joint line *a b*, care being taken to soak the solder well into the joint, so that it can be scraped smooth, to give the appearance of being pressed from one piece of metal.

The base is put together in two halves and in all rectangular forms the wide side *a* and narrow side *b*, Fig. 206, are joined at A and B, then soldered together at opposite corners. A mistake is often made by joining the wide sides *a′* and *a′* in C and the narrow sides *b′* and *b′* in D, the workman being none the wiser until he tries to join the two halves and finds the corners or miters do not meet as in F. A little forethought will avoid unnecessary labor and time, as the corners must be taken apart and cleaned of surplus solder, and an opened joint never makes as neat an appearance as a new one.

The various parts are now assembled as in Fig. 207. The arms A and B are joined together square and the arc C soldered in position on the dots *s′* and *s″* in the pattern, Fig. 202. In a

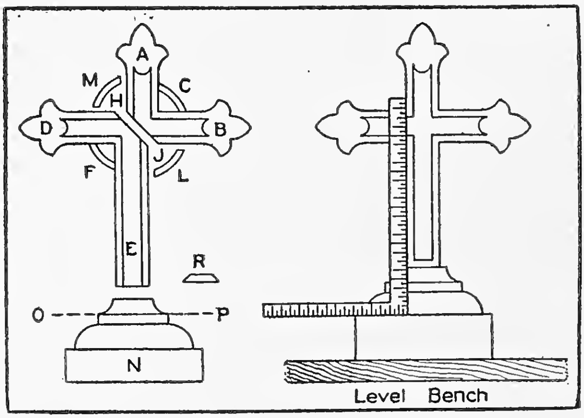


FIG. 207. FIG. 208.

FIGS. 207-8. Assembling Parts of Cross.

similar manner the arms D and E, Fig. 207, are joined and the arc F soldered in position. These two halves are laid on a flat bench or level board and soldered along the miter line H J. The arcs M and L are then placed in position. In the base N the head O P is soldered as shown in diagram Y°, Fig. 202. A^3 A^3 represents part of the base, in which the pattern for head E° is tacked as shown by B^3 B^3. The cross Y° is then slipped into the base A^3 as far as Z° or abount 1/8 in. below the head B^3, and a slight tack made to prevent the cross from sliding any farther when the base is set down. When the base is set on a level surface, and the cross is plumb when viewed from both sides or when squared, Fig. 208, a tack is made at a^{L} in diagram Y°, in Fig. 202. The joints are soldered tight along a^{L}, a^{x} and a^{p}, after

Fig. 209. Paneled Cross.

which the panel head R, Fig. 207, is soldered in place, which completes the cross.

All joints should be scraped smooth and sandpapered, when the cross will appear as in Fig. 209. When fastening the cross to the spire or ridge of a roof the method is similar to that explained in fastening the ornamental finial in Fig. 200.

CHAPTER XX

Scale and Detail Drawings for Making a Pediment on a Wash

The thirteenth exercise, known as the pediment on a wash, is presented in a 2-in. scale drawing in Fig. 210. If the student will turn back to the exercise on the Ornamental Window Cap, he will find that the pattern for a pediment was developed, the lower part of which was mitered with a horizontal molding, and the roof was on a horizontal plane. In this case the lower part of the pediment miters with a horizontal molding the roof of which is inclined or has what is known as a "wash"—that is, an inclined plane to shed water, A°, Fig. 210. This allows rain or snow to drip off, while if the wash were omitted and a horizontal surface were put in its place some of the water is likely to remain, causing the galvanized iron to rust. A wash is only placed where the depth of the pediment mold has great projection.

This 2-in. scale drawing contains the front elevation, showing the profile A in the pediment mold, and the side elevation in which the profile A is presented. The center points for describing the quarter rounds are indicated in *a* and *b*, while the method of obtaining the miter line 1° 6° in elevation between the pediment mold and the wash is shown by similar figures, and will be explained in the detail drawing. The scale drawing shows the full profile of the pediment mold mitering on the wash.

In some cases only part of the profile of the mold miters on the wash, as in Fig. 211, where only that part of the pediment mold marked A miters with the wash at *a*° *b*°. The wash is indicated by *a d* and the profile of the pediment mold by B. The projection from *c* to *d* must be equal to the projection from *c'* to *d'* in B.

Take the measurements from drawing Fig. 210 and place them on a vertical line, as A B, Fig. 212 (see Folder 4) which is one-quarter full size, it should be understood that the student is to make his drawing and work full size. At right angles to A B draw the line J C equal to one-half size, or 14 in., as only one-half elevation will be required. Place the heights of the horizontal molding, including, the height to the top of the pediment in Fig. 210, on the detail in Fig. 212 on the center line A B. Thus the total height of the horizontal mold to the top

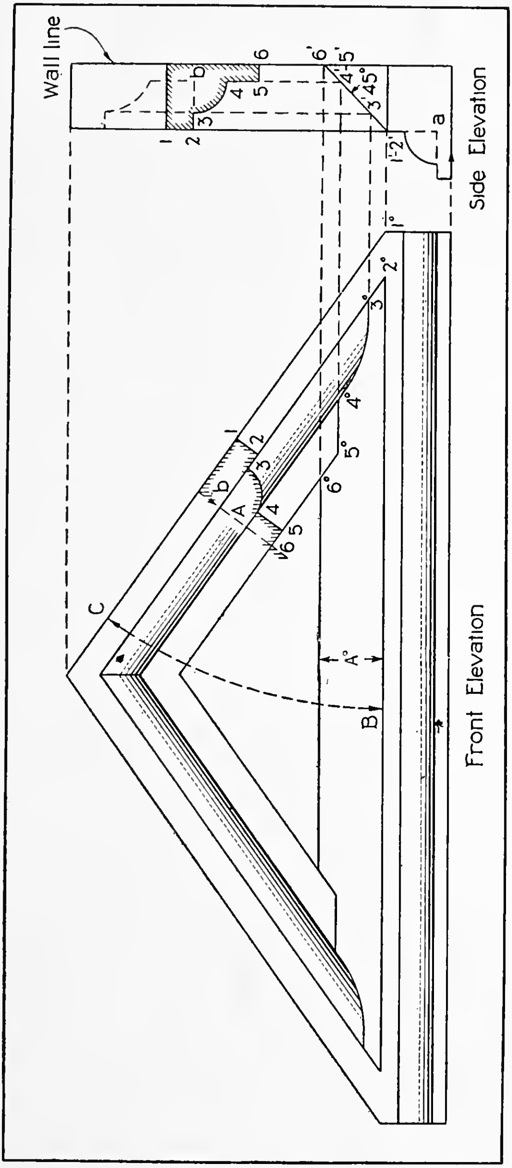


Fig. 210. Front and Side Elevation of Pediment on a Wash.

of the wash from J to H is 4⅛ in., while the height from H to the apex of the pediment E is 8 in., making a total of 12⅛ in.

From C in the front elevation erect a line to the fourth line or bottom of the wash and draw the slant line D E, which gives the pitch or rake of the pediment. This pitch or rake can be further proved by using 1°, Fig. 210, as center and drawing the arc B C. Using this same radius with D, Fig. 212, as center, draw the arc B^2 C^2, and if the angle is true the distance from B^2 to C^2 must equal that from B to C, Fig. 210.

Draw the profile F^1 below and at right angles to E D, Fig. 212, by placing the heights of the various members of the pediment mold at points ¾, 1 and 1¼ in. below the line, through which draw lines indefinitely. First draw the line *b* 9 at right angles to the pediment mold, setting off the 2-in. projection *b* 1, the ½-in. member, the 1-in. radius, with a^x as center for the quarter round, and again the ½-in. projection. The shaded section then repre-

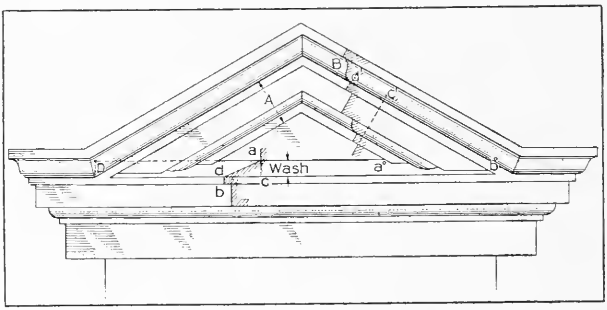


FIG. 211. Another Form of Pediment on a Wash.

sents the true profile, an edge *b a* being turned toward the inside. Divide the quarter round in F^1 into equal spaces from 3 to 7, through which lines are drawn indefinitely, parallel to the lines of the molding, cutting the center line A B.

At the right draw the side elevation, showing the profile of the horizontal molding, the extreme projection of which at the bottom is 3½ in., *h* to *g* ½ in. and the quarter round *g c* struck with a 1-in. radius from the center *a*°, leaving the distance 2′ L equal to 2 in. or the extreme projection of the profile F^1 in front elevation. From 2′ and L in the side elevation erect vertical lines, and intersect them by a horizontal line from the apex of the pediment, thus completing the side elevation of the top of the pediment mold.

From 2′ in the side elevation draw the line of the wash at an angle of 45 degrees, as in scale drawing, shown by 2′ 9′. Take a tracing of the profile F^1, with its various intersections in the front elevation, and place it at F in the side elevation, it being immaterial at what point it may be placed, so long as 1 2 in F faces the outside line.

From the various intersections in F vertical lines are drawn, intersecting the wash line 2′ 9′, shown by similar figures. From these figures 1′ to 9′ on the line of the wash, horizontal lines are carried in the front elevation, intersecting similar numbered lines previously drawn through points in the profile F^1 parallel to E D at 1^x, 2^x, 3^x, 4^x to 9^x. A line traced through these points will be the miter line or intersection between the wash and pediment molding.

The elevations being completed, the pattern for the pediment molding will be developed first. Therefore, at right angles to E D, draw the line F G, upon which place the girth of either the profile F in the side elevation or the profile F^1 in the front elevation, shown by similar letters and figures on F G. Through these small figures at right angles to F G draw the usual measuring lines, intersected by lines drawn at right angles to E D from similar numbered intersections on the miter line 1^x 9^x at the bottom, and from similar numbered intersections on the center line A B at the top, shown in the pattern by dotted lines. A line traced through the points N 9^v 9^t W will be the pattern desired.

If the pediment is of such size that the triangular piece H 9^x 9 in the front elevation can be added to it, then use as radii 9^x H and 9 H, and 9^v and 9^t in the pattern as centers, draw arcs cutting each other at H^1. Draw lines from 9^t to H^1 to 9^v, which completes the pattern, two of which pieces are to be cut without laps along the bottom, but with laps along the top cut, as shown, on one piece only.

If the pediment is of such size that the triangular piece 9^t H^1 9^v can not be added or the width of the metal sheet or length of the mold will not allow it, a lap would be added to the mold pattern from O to P and the triangular piece joined to it.

The next pattern to be obtained from the drawing is the pattern for the horizontal molding, with the miter cut in the wash to admit the joining of the lower part of the pediment mold, and is accomplished as follows:

Allow the metal to turn under, in the side elevation, as much as is shown by *i j*, and allow a lap from 9′ to *x* to admit the joining of the lower part of the triangular piece along the line H 9^x in front elevation. Take the girth of *x* 9′, also the various intersections on the wash line 9′ 1′, and to *c d e*, etc., to *j* in the side elevation, and place this girth, shown by similar letters and figures, on the center line A B. At right angles to A B through these small figures draw the measuring lines, intersected by lines drawn parallel to the center line A B from similar numbered intersections in the miter line 1^x to 9^x in the front elevation, shown by points of intersections in the pattern from $1°$ to $9°$.

As C 1^x in the front elevation is a vertical line and represents a flat head, then all the divisions from $2'$ to j in the side elevation, which cut this line C I^x are transferred to the line A B, from $2'$ to j, will be intersected by the line 1^x C extended in the pattern, as $1°$ $j°$. A line traced through points thus obtained, x $x°$ $1°$ $j°$ j, will be the half pattern for the horizontal mold with wash attached, and when traced on the metal will be turned over on the dots x and j on the center line. Laps are allowed as on the miter cut $x°$ $1°$.

When a pediment joins a wash and the material used is galvanized iron, the miter cut from $1°$ to $x°$ need not be cut in the pattern, it only being necessary to make a square cut from $x°$ to U to $1°$, thus allowing the wash to run through to D, Fig. 211, because the labor required to cut the miter $1°$ to $x°$, Fig. 212, is worth more than the piece of galvanized iron which could be saved. But if the material is of copper it pays to cut the miter $x°$ to $1°$, as the copper saved can be used for other small work. The miter line, however, should be marked on the galvanized iron to assist in joining the pediment to the wash.

The pattern T is for the head on the end of the horizontal molding, two of which are required, with laps all around, and is a reproduction of similar figures and letters in the side elevation.

This completes all the patterns required for the pediment on a wash. The patterns are now cut from the sheet metal and templets obtained for forming the various pieces in the brake. The true profile F or F^1 is used as a templet to form the pediment molding, one of which is formed right and the other left, and the pattern for the head is used as a templet for forming the horizontal molding. No explanations are necessary for forming these moldings, as they are similar to previous work.

The pieces having been formed they are set together as in Fig. 213. The flat heads A and B are first soldered to the ends of the horizontal molding, care being taken that they are perfectly square. Use the flat pliers and turn up the laps on the miter cut in the wash from a to b and c to d. The two pieces of pediment molding C and H are tacked together on the line *e f*, care being taken that the distance from D to E is the same as

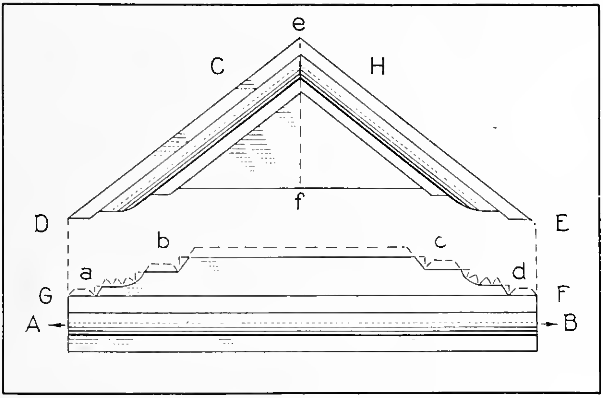


FIG. 213. Details of Assembling Parts.

from G to F. Set the pediment molding on the wash, tack carefully with all laps on the inside and if the joints fit snug, solder

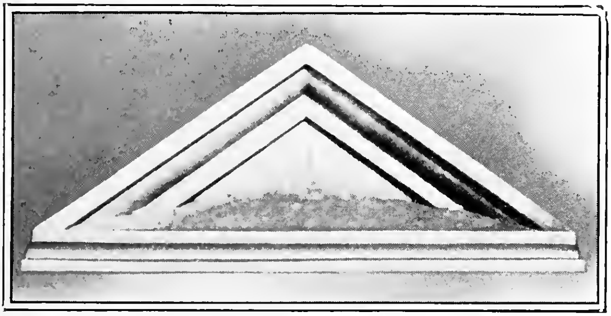


FIG. 214. Finished Pediment on a Wash.

on the inside. Scrape off any surplus solder on the outside, and if properly done it will look as in Fig. 214.

CHAPTER XXI

Constructing a Dormer Window

The fourteenth exercise is the dormer window drawn in Fig. 215, to a scale of 2 in. to the foot (see Folder 4). The front and side elevations and the pitch of the main roof line are given. The small letter indicate the center points for drawing the various arcs in the moldings and will be reproduced in the detail having similar parts, in which explanations will be made.

The dormer consists of mullions, the section of which is represented by A, with molded cap, ornamented with dentils and a molded base. The projection of the return of the sill molding, or rather, the molded base in the front elevation is greater than the projection of the front of the sill in the side elevation; the method of obtaining miter cuts for them will prove interesting as the student proceeds. The part indicated by the lines dotted on the side in the front elevation, marked "Roof Flashing," is the flashing strip which is soldered to the return of the dormer, making a water-tight joint between the dormer and the main roof, whether the covering of the main roof is metal, slate, tile or shingles, as will be explained in regular order, also, how the dormer will be made tight against the wooden window frame will be explained as the student proceeds.

With the 2-in. scale rule the student will proceed to measure the heights of the various members of the dormer, obtaining them from the line E D in the side elevation, or the center line in the front elevation, and place them full size on the center line A B in Fig. 216, which is drawn one quarter full size (see Folder 4). In the full size detail the total height from the top of the crown mold to the bottom of the sill is 2 ft. 6 in. When drawing the full size detail it is only necessary to draw one-half of the front elevation.

At right angles to A B, through these measured points, draw horizontal lines indefinitely across the sheet. At right angles to these horizontal lines, or parallel to A B, draw the vertical line E D of sufficient distance from the center line A B as called for in the scale drawing, Fig. 215, to make a side elevation. various projections in the crown mold and place them in the detail in Fig. 216, also measuring from the vertical line E D, shown, by the extreme projection of 10 in. at the top. Also, beginning at the top, place the projection of each member in the molding ½ in. between 3 and 4; 1½ in. radius for drawing the quarter round from the center *a'*; ½ in. between 9 and 10; 5 in. between 11 and 12, and 1 in. between 13 and 14, thus leaving a 1½ in. space between the window frame line and the vertical line E D.

Scale the projections of the different members in the sill molding from the line E D, Fig. 215, and place them full size on similar lines in Fig. 216, measuring from the line E D, the extreme projection being 4½ in., *b'* being the center for describing the cove 4 7 and *j* and *k* the centers for completing the ogee. A flange is allowed at the top of the sill 3 2, shown by 2 1, which is nailed to the back of the wooden sill to avoid the water from soaking on the inside.

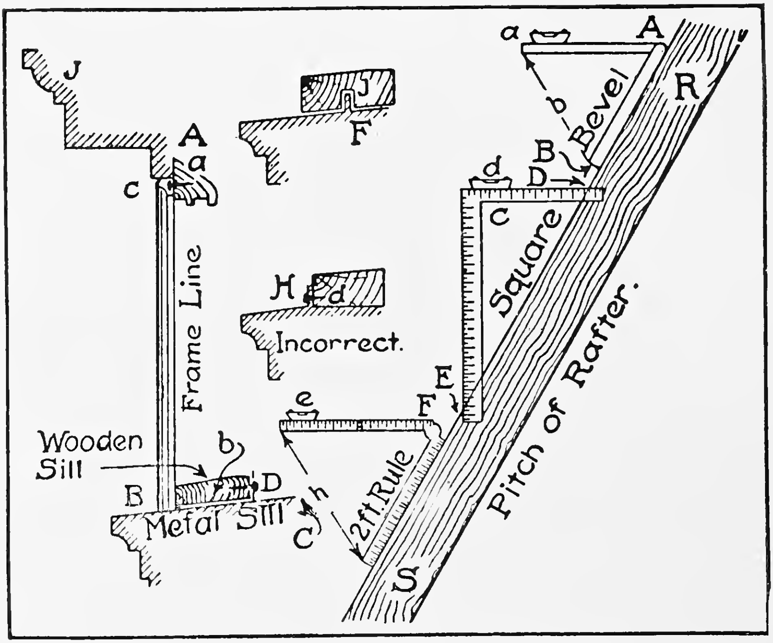
In this case it is assumed that the distance A^6 is the width of the wooden window sill, which, of course, would be wider in practice. At the top, on the frame line, A^7 represents the flange for nailing against the frame work. It is seldom that the distance A^6 is known and therefore the flange 1 2 of the sill connot be bent in the shop, but must be turned up behind the wooden sill at the building after the window frame is in position. Therefore it is well to know at the start when drawing the detail just what form of construction is desired.

In the lesson drawing, Fig. 215, the metal sill is flanged up behind the wooden sill. Sometimes the architect desires the sill bent as in diagram F, Fig. 217, in which the various methods of joining the metal dormer to the window frame is shown, for the form of construction desired must be known so that the detail can be made accordingly. The crown mold, J^1, is shown in Fig. 217, with the flange nailed against the upper part of the window frame A at *a*, and then covered with the small wood molding *c* to hide the joint and nail heads, the same as was described in the plain window cap in a previous exercise.

When the depth of the wooden sill B is not known, the metal sill C leaves the shop as shown, C being turned up at the building after the wooden sill is in position, as shown by D, and is nailed against the woodwork at *b*. Of course, it is understood that the metal sill must have sufficient pitch to shed the water and the wooden sill must fit this pitch.

When it is desired to bend the sill with a double standing edge as at F, it can be formed in the shop and sent to the building complete, where the carpenter must cut a groove in the bottom of the sill, J, which sets over the edge F, thus insuring a tight joint and avoiding any nailing at the back of the wooden sill. In this connection the students at the New York Trade School are told what joint to avoid, one being shown in diagram H.

Sometimes a joint is made in this manner, the flange being



FIGS. 217-8. Details of Construction of Dormer Window.

nailed against the front edge of the wooden sill at *d*, which not only causes a leak, but allows the water to get on the inside and rust the metal.

Having the various methods of joining in mind, the student can proceed intelligently with the detail. Measuring from the line E D in the scale drawing, Fig. 215, obtain the projection at the top from E to the roof line, and it will be found to measure 8 in. This 8 in. is set off on the detail in Fig. 216, measuring to the right of the line E D, and a line drawn from F to D, which gives the pitch of the roof line. It is seldom that the accurate pitch of the roof can be scaled from the blue print, it being usual to obtain the bevel direct from the rafters on the building before the detail is completed. For this reason the student is instructed how to obtain these bevels at the building, and three methods are shown in Fig. 218, and the pitch of the rafter by R. S.

One method of obtaining the pitch is to use a bevel, A, which can be obtained in any hardware store or made with two strips of metal riveted at one end. One leg of the bevel is placed on the line of the rafter A B, and the other raised to a horizontal or level position—a small spirit level *a* being used to prove it. When the spirit level *a* shows the arm or upper leg to be level, the distance between the inner corners of the bevel *b* is noted, the bevel closed and opened again to the measured distance when the pitch is put on the drawing. If no bevel is at hand the carpenter's square C can be used, by placing it firmly against the side of the rafter, D E, and making the upper arm level, by the spirit level *d,* noting the distance on each arm as at D and E.

When neither bevels nor square are handy an ordinary 2-ft. rule can be used in the same manner as the bevel A, shown by F. In this case F *e* of the rule is raised until level, as proved by the spirit level *e,* after which the distance *h* is noted.

The student, having learned how to obtain the bevel at the building by either one of the methods explained in the foregoing, and knowing the location of the point D in the detail drawing, Fig. 216, the outside of the lower leg of the bevel is placed against D, shown by Y^4 U^4, and the upper leg raised to its proper distance as before noted, so that the upper leg will form a right angle with the vertical line D E, shown by Y^4 U^4 X^4, when the roof line D F is drawn by extending the outside line of the bevel Y^4 U^4. If the bevel is to be placed with the steel square, then place the proper point of the square on D of the detail, shown by the annexed diagram D^6, and have the short arm D^7 D^8 at right angles to the vertical line D E, when the proper pitch of the roof can be obtained by drawing a line from D^6 through the point D^8 on the short arm, as indicated by D^6 D^9.

The proper bevel of the roof having been obtained, indicated by D F, by either scaling the measurements or obtaining the bevel at the building, the drawing of the detail of the one-half front elevation is now in order. Measuring with the 2-in. scale rule from the center line in the front elevation in Fig. 215, obtain the distances of the various members in the crown mold, mullion and sill mold, and place them full size, in the detail drawing in Fig.

216, shown by full size measurements. The half projection at the top is 10¾ in.; the half window opening, 4¼ in., and the mullion members 1, 2 and ½ in.

The profile of the crown mold at the top is similar to the profile in the side elevation, *a* being the center from which the quarter round 4′ 8′ is struck.

The half projection of the sill mold is 8¾ in., *b* being the center from which the cove 4 7 is struck.

After locating the points *c* and *d,* the ogee is struck as follows: Draw a line from *c* to *d,* bisect and obtain *e*. Using *c* and *d* as centers and *c e* or *d e* as radius, describe the arcs *e f* and *e h*. With *e* as center and *e d* or *e c* as radius, describe an arc, cutting the arcs previously drawn at *f* and *h*. Using the same radius, with *f* and *h* as centers, draw the arcs *c e* and *e d,* completing the ogee. The center *i* is for drawing half the semicircle.

In any part of the front elevation, draw the section of the mullion X obtaining the projections 1 in. and 1⅛ in. from the side elevation in Fig. 215. Take a tracing of section X, Fig. 216, and place it in its proper position anywhere upon the line extended through 12 13 in the crown mold in the detailed side elevation, as X°, and through the corners 7, 6, 4 draw vertical lines cutting the crown mold at the top and the wash of the sill at the bottom. Where these lines cut the sill line at 7^{oo} 6^{oo} and 4^{oo} lines are projected into the front elevation intersecting similar numbered lines in the mullion drawn from the section X, one point being 6^s. Draw the side view of the base of the mullion, *s t u* H in the side elevation, and project this to the front elevation, H^v, obtaining the measurements from the scale drawing. In a similar manner place the heights of the mullion cap in the front elevation in the detail, 1, 1½ and 1½ in., and project these into the side elevation, the full size projections being there noted; *n* being the center point for drawing the cove. The center *o* is for drawing the curve in the dentils, which are spaced as shown in the front elevation.

The home student is advised to scale carefully his measurements from Fig. 215 and compare them when drawing his detail, with the full size measurements in Fig. 216, and not copy from the measurements given in the detail. When a point is in doubt, follow the dotted lines from one elevation to the other and see how the points of intersections are obtained.

Note that the point *a* in the wash of the sill in the front elevation is obtained by projecting the intersection of the corner 1, in the section of the mullion X° in the side elevation, with the sill line a^s.

The detail of the front and side elevations having been completed, the patterns for the sill moldings will first be developed. When two different profiles are to be mitered together, as in this case, the method of obtaining the patterns is as follows: Divide the curves in either one of the profiles into an equal number of spaces, in this case the profile of the front, shown in the side elevation by the small figures from 1 to 20. Through these small figures draw horizontal lines cutting the roof line, shown by similar numbered intersections, also cutting the profile of the return in the front elevation by intersections also numbered 1 to 20. Divide one-half the semicircle in the front elevation into equal spaces, from 20 to 24, through which draw horizontal lines, in the side elevation cutting the roof line shown by similar numbers.

To obtain the pattern for one half of the front of the sill, obtain the girth from 1, including the intersection a^s, down to 24 in the side elevation, and place it as shown by similar numbers on the center line B C below the front elevation. Through these points with the T-square, draw horizontal lines, and then intersect with lines drawn parallel to B C from similar numbered intersections in the front elevation, partly shown by 1°, 2°, a°, 3°, 4°, 8°, 9°, 14°, 18°, 19°. Trace a line through points thus obtained, then using 20 in the pattern as center and 20 24 as radius, describe the quarter circle, which completes the one-half pattern for the sill of the dormer.

When pricking this pattern on the metal, turn over on dots 1 and 24 to obtain the opposite half. Allow laps on this pattern from a° to 20°.

For the pattern for the return of the sill mold, draw any vertical line below the side elevation N O, on which place the girth of the return mold, in the front elevation from a to 3 to 4 down to 24, being careful to measure each space between 9 and 18 separately, as they are unequal, as shown by similar numbers on N O. Through these small figures, at right angles to N O, draw lines indefinitely, and intersect with lines drawn parallel to N O from similar numbered intersections in the profile in the side elevation and from the intersections on the roof line D F, partly shown on the left side of the pattern by a^t, 3^t, 4^t, 8^t, 9^t, 13^t, 14^t, 24^t, and on the right side by a^v, 7^v, 8^v, 14^v, 19^v, 24^v. A line traced through points thus obtained will be the pattern for the sill return.

Laps are allowed on the roof cut from a^v to 24^v, to solder to the roof flashing. Two of these returns will be required.

The next pattern in order is that of the crown molding. As the profiles in both front and return are similar, as T^3 and T^4, divide the curve in both, in similar number of spaces, from 1 to 11, through which draw lines indefinitely, cutting the vertical line

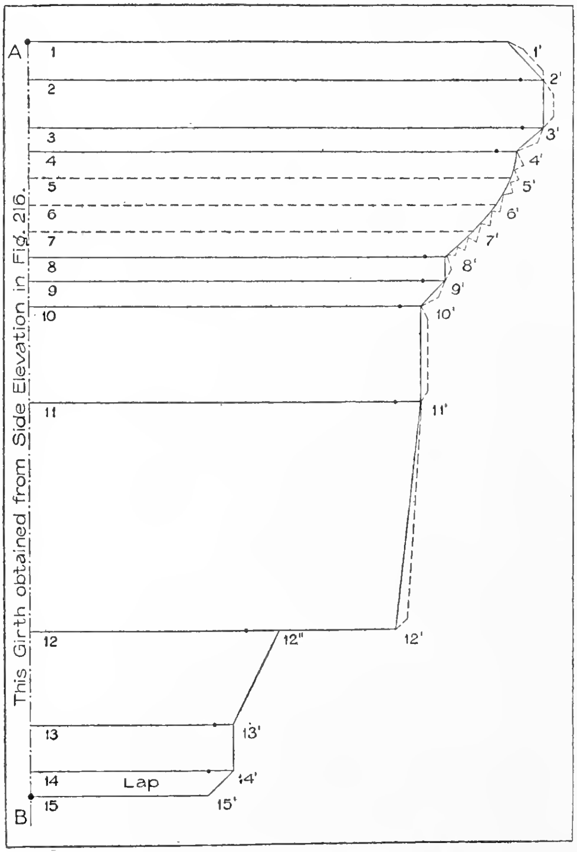


FIG. 219. Half Pattern for Crown Mold.

U 12′ in the front and extending into the side until the roof line is intersected by similar numbers. Thus the profile of the return mold T^3 in the front elevation is spaced from 1′ to 12′, while the profile of the front mold T^4 in the side elevation is spaced from 1 to 15; so that correct measuring points may be known in the front elevation when obtaining the pattern, horizontal lines are drawn to the front elevation from points 11, 12, 13, 14 and 15 in the side elevation until the joint line is intersected in the front by 11′, 12′, 12″, 13′, 14′ and 15′.

When drawing the patterns, they can be developed directly below the elevation, the same as the sill patterns, by simply tacking a sheet of paper over the detail and using the T-square in the

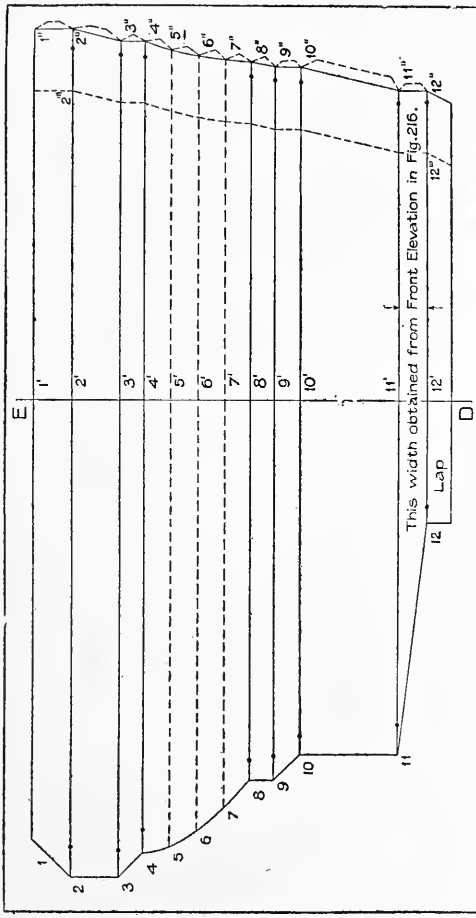


Fig. 220. Pattern for Return on Crown Mold.

usual manner. In this case, for want of space, the two patterns have been developed in Figs. 219 and 220 as follows:

For the pattern for the front, obtain the girth of the profile T^4, Fig. 216, in the side elevation from 1 to 15, and place it on the vertical line A B, Fig. 219, as shown by similar numbers. Through these small figures, at right angles to A B, draw lines as shown. Measuring from the center line A B, in the front elevation, Fig. 216, obtain the distances to points 1′ to 12′ to 12″ to 13′ and 14′ to 15′ and place them on similar numbered lines in Fig. 219, measuring each from the line A B. A line traced through points thus obtained, from 1 to 1′ to 15′ to 15, will be the half pattern for the front crown mold to which laps are allowed from 1′ to 12′. When obtaining the full pattern on the metal, turn over the paper pattern on dots 1 and 15, as was explained in previous exercise.

For the pattern for the return, the girth of T^3, Fig. 216, in the front elevation from 1′ to 12′ is taken (which is the same as T^4 from 1 up to 11) and placed on any vertical line E D, Fig. 220, shown by similar figures 1′ to 12′. Through these small figures, at right angles to E D, lines are drawn indefinitely. Measuring from the line E D in the side elevation, Fig. 216, take the distances to similar numbered points 1 to 12 in the profile T^4 and place them on similar numbered lines in Fig. 220, measuring each from the line E D on the left side, so that when a line is traced through points thus obtained the miter cut from 1 to 12 will result. In a similar manner, measuring from line E D in the side elevation, Fig. 216, obtain the various distances to similar numbered intersections on the roof line F Y from 1″ to 12″ and place them on similar numbered lines in Fig. 220, to the right of line E D. Trace a line through the points thus obtained, from 1″ to 12″; then 1 1″, 12″, 12 will be the pattern for the return, two of which will be required, laps being allowed for soldering to the cheek of the dormer window along 12 12″ and roof flashing.

The dormer under consideration by the student is of such size that the cheek and mullion can be developed in one piece. The method of proceeding will be explained, before the close of this exercise, for a dormer of such size that this could not be done.

To obtain the pattern for the mullion and cheek combined, take a tracing of the cheek, Fig. 216, shown in the side elevation by 12 Y a^2 a^s and place it as shown by similar letters and figures in Fig. 221, allowing a lap along Y W, on which the roof flashing will be soldered. Draw any line as P R, Fig. 216, at right angles to 12 a^s intersecting the line 12 a^s at P^2. Take the distance from 12 to P^2 and place it from 12 to P^2, Fig. 221, and through P^2 at right angles to 12 a^s draw the line P R, representing the line P R in the side elevation, Fig. 216. Starting at the point 1, on the line P R, Fig. 221, place the girth of the section X or X° from 1 to 8, Fig. 216, shown by similar numbers on the girth line

P R, Fig. 221. Through these points, at right angles to P R, draw lines indefinitely.

Lines drawn through numbers 1 to 8, in the mullion section, X°, Fig. 216, intersect the sill line from 1°° to 8°°; and intersect and show their proper location with the crown mold at the top, by the figures 1° to 5° to 6° to 7° to 8°.

Measuring from the line P R, take the distances to the inter-

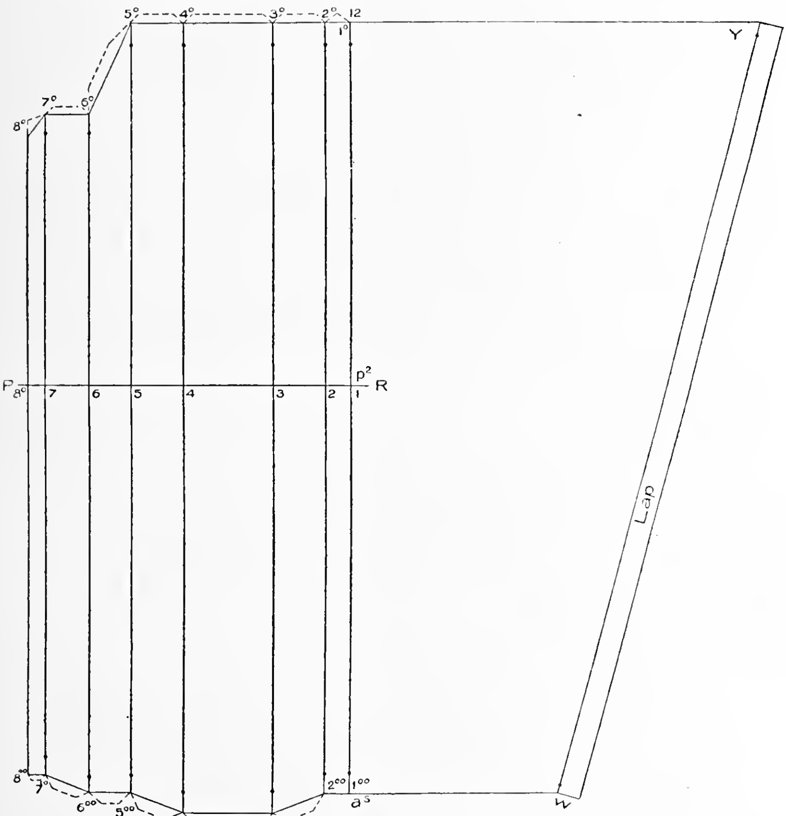


FIG. 221. Full Pattern for Mullion and Check Combined.

sections 1° to 8° at the top and 1°° to 8°° at the bottom, and place them on lines having similar numbers in Fig. 221 measuring above and below the line P R, as shown by the intersections 1° to 8° at the top and 1°° to 8°° at the bottom. Trace lines through points thus obtained and allow laps as shown by the dotted lines. Then 8° Y W 8°° will be the pattern for cheek and mullion combined, of which two are required.

It will be noticed in the side elevation in Fig. 216 that the mullion cap 1^x r 12^x and the mullion base s t u H are soldered to the mullion separately, along the seam line, because the mullion proper is bent in one piece and meets the sill and crown mold at u and r. To obtain these patterns, proceed as follows:

The pattern for the side of the cap or bracket K is a reproduction of similar figures in the side elevation. Laps are allowed to pattern K as shown by the dotted lines. The pattern for the face of this cap or bracket is shown by J. Obtain the girth of the side from 1^x to 12^x and place it on any vertical line in J, shown by similar numbers. Complete the rectangle, making it 2 in. in width, as in the front elevation. The heavy dots in J show where the prick marks must be made in the metal. Two of J and four of K will be required.

For the pattern for the base or lower wash of the mullion, take a tracing of s t u H and place it in L, shown by s° t° u° H°. At right angles to s° H° draw the lines s° s^2 and H° H^2 2 in. wide as required and trace s° t° u° H° as shown by s^2 t^v u^v H^2. Add to the line s^2 s° the rectangle s^2 s° t^x t^2, making the distance s° t^x equal to s° t°, which completes the pattern two of which are required.

The dentil block is developed in one piece by taking a tracing of v w 12 in the side elevation and placing it as shown by v° w° 12 in M. Extend the line w° X, as shown by w° v^x, making the distance X v^x equal to the girth of the curve X v°. Complete the rectangle v^x w° w' v'', making its width 1 in., as in the face of the dentils in the front elevation. Trace the side v° 12 w° X in M on the opposite side, X′ W′ 12′ V′, which completes the pattern, five of which are required.

The next and last pattern is for the roof flashing, shown in the section of the mullion X° in side elevation by T S, with a water lock S attached. This lock can be used to lock in the metal roofing and also to catch the drip when slate, tile or shingles are used as a roof covering, about which more will be said as the student proceeds. The pattern for the roof flashing is obtained by taking the various intersections on the roof line F D, in the side elevation, from 1″ to 12″ to a^2 down to 24^2 and placing them on vertical line U V in Fig. 222, as shown by similar numbered figures. At right angles to U V and through these small figures draw lines indefinitely. Extend the line U V of the cheek of the dormer in the front elevation in Fig. 216, and measuring from this line take the projections to points 2′ to 12′ in the crown mold and to points *a* to 3 to 24 in the sill mold, measuring right and left, and place these distances on similar numbered lines shown in both cuts in Fig. 222 (see Folder 6), measuring to the right and left of the line U V, shown by points of intersections having similar numbers. A line traced through points thus obtained, from 2′ to 12′ to *a* to 7 8 to E, will be the cut of the roof flashing mitering against the return crown mold, cheek and sill mold of the dormer.

Knowing the width that the flashing is to have (usually 6 or 8 in.) measure off 6 in. and draw a vertical line, B C, drawing a curved outline, approximately parallel to the upper and lower molds, shown by the solid line A B and C D, allowing a lap at E for joining. This solid outline from A to B to C to D is used when the covering on the main roof is of slate, tile or shingle, and in this case a water lock is allowed from A to B to C only, turning it upward, as at R. This lock is used so that when the slates, tiles or shingles are laid over it, as at N, and drippings from snow or rain should follow under the covering at *a b,* this drip would flow along the flashing and be caught by the water lock R′, and following this lock would run over the roof covering at C, the end of the lock. No lock is allowed from C to D, as this part overlaps the slate, tile or shingle.

If, however, the roof covering is of metal, laid flat seam, as at M, then the lock should be extended as shown by the dotted line from C to F to D and B to H. Enough material should be allowed to the pattern so that the lock along D F can be placed to meet the lock in the metal plates laid on the roof, bending the lock along D F downward, as at O. Enough material should be allowed at the top J to meet the seam lines in the roofing, bending the lock upward, as at P. When the roof is laid standing seam, as at T, then enough material must be allowed along H F of the pattern to make one side of the standing lock, so as to meet the standing lock on the main roof.

When the flashing, the pattern of which is Fig. 222, is soldered in position it will look as in Fig. 223, and necessitates, where slate tile or shingle is used, the cutting of the slate or tile, as shown by the shaded part A, from *a* to *b*. This cutting takes time, is likely to break a number of slates, tile or shingles, before a proper cut is obtained, and it makes a bad appearance.

The roofer, as well as the architect and owner, desires to avoid any unsightly appearance on any part of a building and sometimes require the sheet metal worker to form a pocket behind the crown mold in line with the check as in Fig. 224, which shows the pocket formed on to the flashing and allows for three thicknesses of slate, tile or shingle to pass behind the projecting crown mold in line with the cheek of the dormer and avoids any cutting of the slates, tile or shingles.

It is necessary to know before patterns are laid out for the roof flashing and crown mold return if this form of pocket is to be used. Then the changes must be made in the patterns as follows: Assuming that slates $\frac{1}{4}$ in. thick are employed, then $3 \times \frac{1}{4} = \frac{3}{4} + \frac{1}{2}$-in. playroom $= 1\frac{1}{4}$ in., which should be laid off at right angles to the roof line in the side elevation in

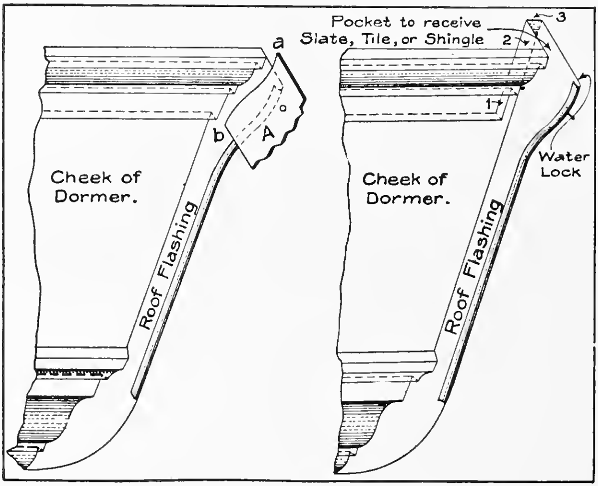


FIG. 223. FIG. 224.

FIG. 223. Flashing Soldered in Position. FIG. 224. Pocket Behind Crown Mold.

Fig. 216, and the line A^2 B^2 drawn, which represents the end of the crown mold return. Take a tracing of 2‴′ 2″ 12″ 12‴′ in the side elevation and place it in the pattern, Fig. 222, as shown by 2″ 2‴ 12″ 12‴ and trace the cut 2″, 2′, 12′, 12″, as on the line 2‴′ 12‴, shown by 2‴′ 2^{v}, 3^{v}, 12‴, allowing laps to solder to the end of the crown mold return, shown by the dotted lines. Then if a pocket, Fig. 224, is to be used the pattern for the roof flashing would be similar to that in Fig. 222, minus the heavy outline of the crown mold, from 2′ to 12′. The distance from 2″ to 2‴ in the side elevation, Fig. 216, would have to be deducted from the pattern in Fig. 220, shown from 2″ to 2‴ by the dotted miter line 2‴ 12‴. No laps would be allowed on cut 2‴ 12‴, as they have been allowed on the head from 2^{v} to 12‴, Fig. 222.

As before mentioned, sometimes the dormer windows are of such size that the cheek and mullion cannot be formed in one piece, making a seam necessary in the cheek, and can be made in three ways, which must be known, so that a workman can proceed intelligently when preparing the patterns.

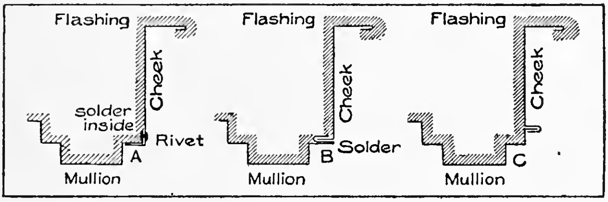


FIG. 225. FIG. 226. FIG. 227.
FIGS. 225-6-7. Different Methods of Joining Cheek and Mullion.

The first and simplest method is shown in Fig. 225, in which laps are allowed on the mullion as well as on the cheek at A, and riveted and soldered on the inside. The second method is shown

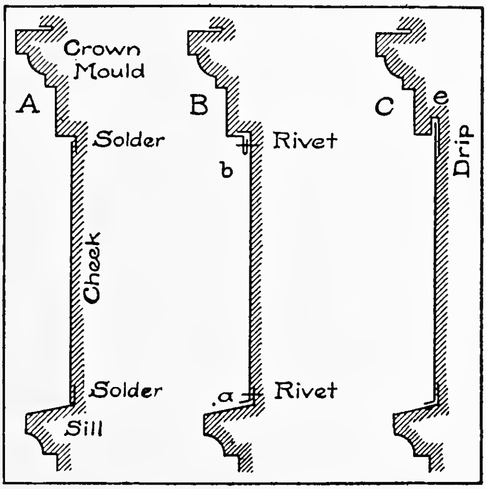


FIG. 228. Joining Cheek to Crown Mold.

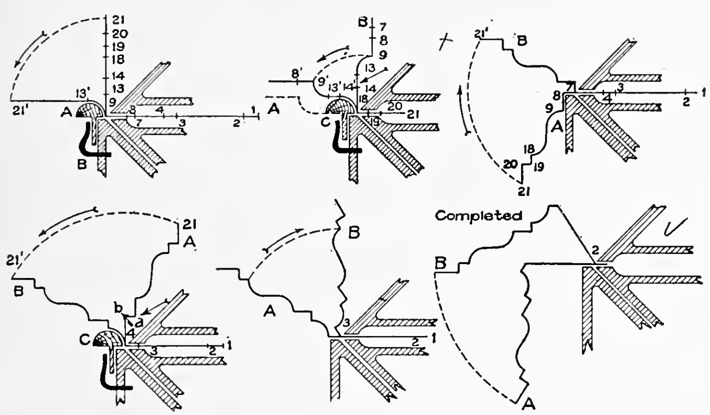
in Fig. 226, in which a hidden lock is formed on the mullion and a single lap on the cheek, then both are joined at B and sweated with solder on the outside. This method gives a neat, strong seam, which can be scraped clean and smooth. If there is no objection to a standing lock, the seam can be made as in C, Fig. 227, which explains itself.

In this connection the student is shown three ways of joining the cheek to the crown and sill molds. In Fig. 228, A shows the first method, in which the cheek is soldered to the crown and sill mold. The second method, B, shows an edge bent to the top and bottom of the cheek, riveting at the sill mold at *a,* allowing a hem edge at *b,* so as to have the flange lie close and rigid when riveted at *b.* In the third method, C, a drip is formed to the crown mold and then turned down to form the groove *e,* into which the cheek is placed, avoiding riveting or soldering.

As the student knows how to proceed with the seams, the patterns for the mullion and cheek can be laid out single or combined as required. All the patterns being developed, they are cut from sheet metal in the usual manner, and the work is ready for forming. Templets, stays or profiles must be cut from Fig. 216 as follows: T^3 or T^4 in the crown mold can be used for forming the front and side. The profile 2 to 24 in the sill mold in the front elevation is for bending the returns of the sill, while the profile 1 to 20 in the side elevation is for bending the front of the sill. The mullion and cheek are bent according to section X° in the side elevation, all bends being square. The face of the mullion cap or bracket is formed after the pattern K. The laps on the pattern K are both bent to the inside, so as to obtain a flush surface when soldering them on the mullion, as shown by the dotted line at 3 and 4, in section X° in the side elevation. The bends in the pattern L are all bent one way in the form of a pan, which completes the base S *t u* H in the side elevation. The dentil M is also formed square, bending the 1-in. face with the thumb and finger to the required curve.

When forming the crown molding, the same methods are employed as in the preceding work, the only molding in this exercise requiring attention being the sill mold. Forming the front of the sill mold will be explained, which will also be applicable to the return of the sill mold. When forming the front sill mold, start on dot 9 or 18, shown on the half pattern for sill in Fig. 216, using the profile in the side elevation as the templet or stay, and make a square bend if the start is on dot 9, Fig. 229. Place the proper size former A, in position, in the brake, fasten with clamp B, and press down the upper part of the sheet, so that dot 21 will be in a horizontal position, shown by 21′, or that dot 13 will touch former A at 13′. Reverse the sheet and place it in the brake, Fig. 230, in the position shown by the dotted line A 21, closing the brake on dot 18 and make a square bend, as shown by B 21. Fasten the former C in position, and press B down until it has the position shown by 8′, being careful to exert the most pressure between 13 and 14, so as not to press the upper curve 13-9 out of shape. This completes the ogee 8′ 18 and leaves a straight surface between 13′ and 14′.

The square bends are now made on dots 19 and 20, also on dot 8, after which it is placed in the brake A, Fig. 231, the brake closed on dot 7 and a square bend made, bringing the molding in position B. Leaving the sheet in the brake, draw it out to dot 4 and make a square bend, A, Fig. 232. Now place proper size former C in position and press A down, exerting the pres-



Figs. 229-30-31-32-33-34. Operations in Forming Window Sill.

Top row, left to right, 229, 230, 231.
Bottom row, left to right, 232, 233, 234.

sure at *a,* which should bring A in the position B, being careful not to press the angle *b* out of square. The sheet remains in the brake, drawing it out and closing the brake on dot 3, shown by A, Fig. 233, and making a bend to the desired angle B, using the stay previously cut to test the accuracy of the angle. Reverse the sheet in the position A, Fig. 234, close the brake on dot 2, and make a bend at the proper angle B, which completes the forming of the front of the sill molding.

Care should be taken, in forming the balance of the work, to bend it accurately to the various stays, it being better to spend a little more time to get all the bends accurate, saving time and labor when setting the work together.

Having formed all the work, bend the laps and set the work together as shown by line diagrams in Fig. 235. Let the returns be soldered on the sill A, being careful to have them true and square, then solder the joint on the inside, so as to have a clean, sharp corner on the outside. Next, set the crown mold in the reversed position B, slipping it over a bench or board as wide as X and tack the two returns on the outside. When the miters fit snugly, reverse it and solder on the inside. Placing it again

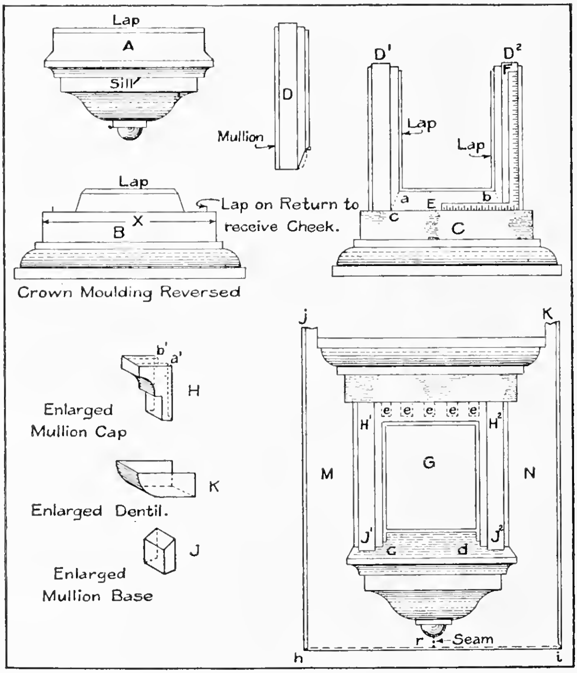


FIG. 235. Assembling Parts of Dormer Window.

in the reverse position C, take the right and left mullion, one of which is shown by D, and tack it with solder to the crown molding, D¹ and D²; make a smooth, clean seam at *a* and *b*, using the steel square to obtain the true right angle, E F. It is best to make a small tack at first at *c*, pressing the miter cut of the mullion tight against the miter cut of the crown mold. This small tack acts as a pivot and allows the mullion to be bent inward or outward until it is true to the square E F, after which additional tacks are made. Before soldering out this much of the window, it is reversed in position G and the mullions soldered to the sill at *c* and *d*, and if perfectly true and square the seams and joints in the entire dormer are soldered. All that now remains to be done is to solder the mullion cap, base and dentils in position.

The mullion cap shown enlarged at H, is soldered to the mullions at H^1 and H^2, in G. The mullion base, shown enlarged at J, is soldered to the mullions at J^1 and J^2, in G. The dentil, shown enlarged at K, is soldered to the positions shown in G by *c, c,* etc. The roof flashing M and N is soldered in position, with

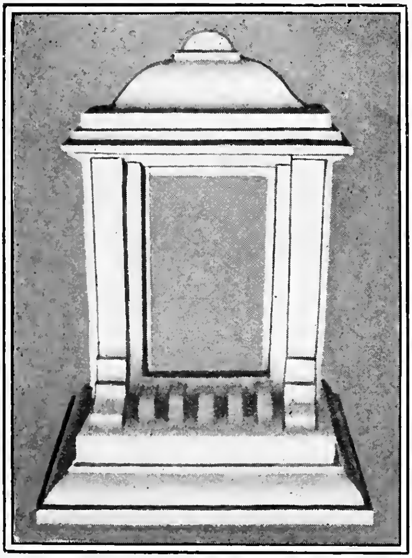


FIG. 236. Finished Dormer Window.

a seam at *r*. This flashing represents the one which would be used if the roof was laid with standing seam, in which case the cross lock *h i* and standing locks *h j* and *i k* would have to be bent to meet the seams of the roofing on the main roof. Above *j* and *k* the flashing is of indefinite length, to be trimmed as desired, so as to break joints with the cross seam line of the metal roofing.

When all is completed and soldered, the surplus solder is scraped off the front, and Fig. 236 gives the appearance of the finished dormer, minus the roof flashing.

CHAPTER XXII

Making a Hexagonal Ventilator

The student is now ready to take up the fifteenth exercise, which is ventilator work, Fig. 237 shows the 2-in. scale drawing from which all dimensions are taken for the patterns to be developed. While this exercise shows a hexagonal, or six-sided, ventilator, the methods which will be shown are applicable to any ventilator, no matter how many sides it may present. This lesson drawing represents the front elevation of a hexagonal ventilator when viewed toward one of the corners as shown in plan.

The base of the ventilator sets on the ridge of a roof. In this case the braces to uphold the hood on the ventilator are laid crosswise, as indicated by the dotted lines in plan A B and C D. As this manner of placing the braces is sometimes objected to, owing to reducing the area of the ventilator, other methods will be shown. The lower flange of the hood is ornamented by semicircles 1 in. in diameter. The method of constructing the base will be explained as the student proceeds with the detail drawing. The points at which 45 degree angles are to be drawn are indicated in the elevation.

Using the scale rule, obtain the vertical heights of the members on the center line in the front elevation and place them on the center line A B as shown in Fig. 238, making the total height from top to bottom 1 ft. 3¼ in. (see Folder 5). In a similar manner obtain the projections of the various members, measuring from the center line in the front elevation, Fig. 237, and place them on the left side of the front elevation in the detail in Fig. 238. Transfer these measurements on the opposite side and complete the outline of the ventilator and pitched roof.

Notice that the shaft of the ventilator goes under the hood, shown by 8 7 6 5, and forms a catch at 5 6 7 to prevent snow from blowing into the ventilator. On some ventilators the entire opening between 3 and 6 is covered with perforated sheet brass or, better still, fine mesh brass wire, which not only catches the snowflakes, but keeps out birds and insects which are likely to go inside when the ventilator is large.

The U-shaped brace on the left side in the elevation rests upon the top flange of the shaft and is bent as indicated by 1 2 3 4.

The half plan is all that is required in developing the pattern and is drawn as follows: Draw any center line in plan as H J intersecting the center line A B of elevation at 1°. Using 1° as center with any radius, describe the semi-circle D F E, intersecting the center line A B in F. Using the same radius with one leg of the compass in F intersect the semicircle on either side at *c′* and *d′*. This method, continued around an entire circle, produces a hexagon, while in this case it will produce a semi-hexagon. Draw lines from 1° through *c′* and *d′* extending them until they intersect the vertical lines projected, from the extreme point 2 and 4″ in elevations at 2° and 2^v in plan. Take the length from 1° to 2^v and set it off from 1° to 2^x on the line A B and draw the semi-hexagon *u* 2^v 2^x 2° *r*. Then 1° 2^v, 1° 2^x and 1° 2° represent the miter lines in plan.

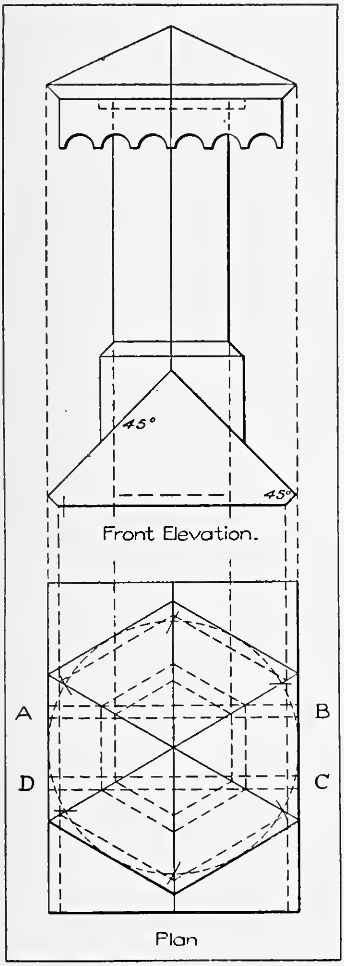


FIG. 237. Hexagonal Ventilator.

Make the semi-length of the roof piece from *r* to *s*, 5 in., as in the scale drawing and complete the semi-plan *r s t u*. Number the corners in the hood in elevation from 1 to 4, that of the shaft from 5 to 10, and from these points project vertical lines in the plan, cutting the miter line 1° to 2°, shown by similar numbers 1° to 10°. Complete the half plan from these intersections, drawing the lines parallel to 2°, 2^x until they cut the miter line 1° 2°; from these intersections lines are drawn parallel to 2^x 2^v, cutting the miter line 2^v 1°, from which they are drawn parallel to 2^v *u* until the center line is intersected.

As ornamentations are to be cut in flange 3 4 of the hood in elevation, refer to the flange line, represented in plan on one side by 4° 4^x which measures 4 in., and as the semicircles in the flange are to be 1 in. wide, then space this line 4° 4^x, so that 4^x *e*, *f h*, *i j* and *k* 4° will be each ¼ in. and *e f*, *h i* and *j k* each 1 in., making the total of 4 in.

Sometimes it becomes necessary to make a complete view of the elevation of the ventilator, showing the ornamental cuts in position, when the small semicircles must be projected in the elevation from the plan as follows:

Take any one of the spaces *h i*, in plan, parallel to which draw the line 1 5 in V, upon which draw the semicircle 1 in. wide; space section V in equal spaces, in this case four, from which lines are drawn at right angles to 2^x 2° until they cut 4° 4^x between *h* and *i*. Take a tracing of V and place it in line with the bottom of the hood as at V^1, in elevation. This is divided into the same number of parts as was section V, and from the various points in V^1 horizontal lines are drawn, and intersected by vertical lines erected from similar intersections obtained between the points *h* and *i* in plan, resulting in the intersections $1^{\circ\circ}$ to $5^{\circ\circ}$ in elevation, which gives the form of a semi-ellipse. From the points *e f j* and *k* on the line 4° 4^x in plan, lines are erected into the elevation, cutting the base line of the hood at *e′ f′ j′* and *k′*. Then on *e′ f′* and *j′ k′* trace the semi-ellipses. In a similar manner trace these semi-ellipses to the left of the center line, which completes the elevation.

Some students make the mistake of placing semicircles in the elevation, instead of projecting them from plan, as was just done, forgetting that the line 4^x 4° in plan does not lie in a horizontal position, but runs off at an angle, giving a foreshortened view of these semicircles. As the corner 2^x in plan or, rather, the miter line 1° 2^x lies in a vertical line, then the miter line in elevation, on 1° 2^x in plan, will be a straight line.

Instead of placing the brace as in the plan, Fig. 237, it will be placed as in the detailed plan, Fig. 238, which will not interfere with the area of the ventilator, as it will be placed along the top of the shaft. As brace X in elevation sets upon that part of the shaft indicated by 6 7 on the right side, take a tracing of section X and place it at pleasure upon lines 6^v and 7^v in plan, shown by X^1, numbering the corners 1 2 3 4 as in X.

The plan and elevation having been completed the development of the patterns is now taken up. The first pattern to be developed is that of the hood. Therefore take the stretchout of 1 2 3 4 in elevation and place it on the line H J extended in plan, at the right, from 1 to 4. Through these small figures at right angles to H J draw lines, and intersect with lines drawn parallel to H J from similarly numbered intersections 1° to 4° on the miter line 1° 2° in plan. Trace a line through points thus obtained from 1 to M, which gives the half pattern for one side. Trace this half opposite the line 1 4 and obtain 1 L. Then 1 L M is the pattern for one side.

On the lower line L M describe the three 1-in. semicircles struck from the centers *l m* and *n*, spacing same as on line 4° 4^x in plan. Six of these patterns are to be cut, with a lap allowed on one side of each, as shown by the dotted lines from 1 to L.

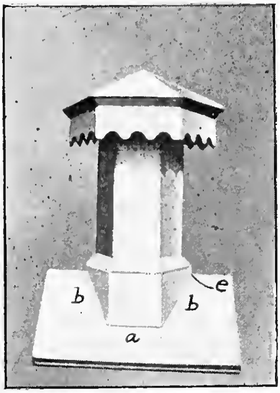


FIG. 239. Finished Hexagonal Ventilator.

The pattern for the shaft is obtained by taking the girth of 5 6 7 8 9 10 in elevation and placing it on the line H J, from 5 to 10. Through these points at right angles to H J draw lines, and intersect with lines drawn parallel to H J, from intersections 5° to 10° on the miter line 2° 1° in plan. Trace a line through points thus obtained. Then 5 N S^v R will be the half pattern for one side. Trace this half opposite the center line 5 10, shown by O P. Then N O P R will be the full pattern for the side indicated by *a* in the view of the finished ventilator, Fig. 239, two of which will be required.

To obtain the pitch on the sides *b*, Fig. 239, take the distance from the horizontal line 9 in the front elevation in Fig. 238, marked S°, to the apex of the roof *a* and place this distance S° *a* from line 9 in the pattern, on line N R from S^v to a^T and draw a line from a^T to P. Then N O P a^T S^v N will be the desired pattern, four of which will be required. A lap is allowed on the bottom of the patterns at P R and P a^T. A lap will also be required on one side of each piece from O to P as will be illustrated as the student proceeds.

The pattern for the roof piece, over which the ventilator is to set, is obtained by taking the girth of *d c b* 10 *a* in the front elevation and placing it on any horizontal line, at the right of the elevation, shown by *d, c, b,* 10 *a,* and then reversing and placing similar girth from *a* to 10 to *b, c* and *d* on the right.

Then the distance from d to d gives the full girth of the roof piece. At right angles to d d through these small letters, draw perpendiculars, making d t' and d t'' each equal to 5 in., as in plan from s to r. Complete the rectangle t' s' s'' t''.

As two sides of the ventilator shaft meet the roof piece at a, on each side, Fig. 239, the intersections being shown by 10 in the front elevation, Fig. 238, then point 10 will meet the miter line in plan at 10°, which represents the intersection between the roof piece and shaft. Take the half distance from 10° to 10^{2} and place it on the lines 10 in the roof pattern, measuring from the center line d d, and obtain the four intersections 10^{v}. Two miter joints of the ventilator meet the ridge line of the roof piece at e, Fig. 239, and are shown in the front elevation in Fig. 238 by a. The intersection between this point a and the roof piece in plan is obtained by extending the center line through a in elevation until it is intersected by a line parallel to 2° 2^{x} in plan from 10°, resulting in the desired point at a°. Take the distance from a° to 1° and place it in the roof pattern on the line drawn through a, measuring from the center line d d and obtain a^{v} a^{v}. Connect the points thus obtained. Then will 10, 10^{v}, a^{v} 10^{v} 10 on both sides of the center line be the part to be cut out to receive the ventilator. Laps are allowed toward the inside.

This method of obtaining the opening would be employed if the sheet metal worker had to furnish the carpenter with a templet, giving the shape of the opening to be cut in the roof over which a curb would be placed to receive the ventilator. This method would also be employed to obtain the pattern for a roof flashing to be placed on the bottom of the ventilator. After the cut a^{v} 10^{v} 10^{v} a^{v} is obtained, and knowing the width of the flange or flashing, which in this case is the width of 10 X, indicated on the horizontal line d d, then this distance must be laid off parallel to a^{v} 10^{v}, 10^{v} 10^{v} and 10^{v} a^{v} and the lines a^{r} 10^{r} 10^{r} a^{r} drawn. Then a^{r} 10^{r} 10^{r} a^{r} a^{v} 10^{v} 10^{v} a^{v} would be the flashings for one side, to which laps are allowed for riveting or soldering. The use of these flashing pieces in practical work will be explained to the student. The pattern for the head to close up the end of this roof piece can be pricked direct from the front elevation shown by a b c c' b'' a, to which laps are allowed as shown by the dotted lines, two of which will be cut.

The last pattern required is that of the brace to uphold the hood in the ventilator, shown in elevation by X, and in plan by X^{1}, and is obtained as follows: Obtain the girth of 1, 2, 3, 4 in either section X or X^1 and place it at the left on the line H *u* in plan by similar numbers. Through these points draw lines at right angles to H *u* indefinitely. As 1 and 4 in section X in elevation intersect the outer edge of the hood at 1″ and 4″, and as this outer edge is represented by the line 2^v 2^x, shown by the dotted lines in plan, then project lines through 1 and 4 in X^1 until pattern. In a similar manner points 2 and 3 in section X in elevation intersect the hood at 2″ and 3″; and as the line of the hood is shown by dotted lines in plan by 4^x 4^v, then draw lines through points 2 and 3 in X^1 until they meet this line at 2′ and 3′, from which points horizontal lines are projected into the pattern cutting similar numbered lines, V W then represents the cut. they meet the outer edge of the hood at 1′ and 4′, and from these points parallel to H *u* draw lines intersecting lines 1 and 4 in the Trace 4 W V 1 opposite H *u* and obtain T U. Then T U V W is the pattern for the brace, two of which are required.

The next work of the student after developing the patterns for the various pieces is to cut them from sheet metal, in the usual manner, cutting out the opening in the roof piece with a hammer and chisel on a wood or lead block. When allowing laps on each of the six sides of the shaft, be careful to place the laps as in Fig. 240 on the same side of each piece as shown by *a b c d e* and *f*, to form them all one way, so that when the work is soldered together the laps will appear as in Fig. 241. The best way to avoid a mistake in forming is to mark the various pieces *a b c*, etc., Fig. 240, with marking acid with the word "in," meaning that the sides marked will be bent to the inside.

After all the work has been cut, templets for bending are required as follows: From 1 to 4 in elevation, Fig. 238, for bending the hood; from Z to 10 for bending the base of the shaft, and the pattern for the head can be used for bending the roof piece. The method of bending the hood, the upper part of the shaft and the roof piece will be explained, as difficulties are likely to arise.

When bending the hood, start on dot 3 and make a bend to the required angle A, Fig. 242. Reverse the piece in the position A, Fig. 243, close the brake on dot 2, and make a square bend from A to B; then B 1 completes the hood piece. The bending of the shaft, shown from 5 to 10 in the front elevation, Fig. 238, should be started on dot 6; for if started at a different point the last bend 7 6 5 could not be made without disturbing the angle 6 7 8.

The bending of the roof piece should be done as in Fig. 244, in which *d* C *b* is bent, care being taken to start the first bend at C. The jaws of the brake are then opened as far as possible and it will be found that there is a depression in the lower table of the brake at D and one in the upper leaf at B, so that *d* C *b*

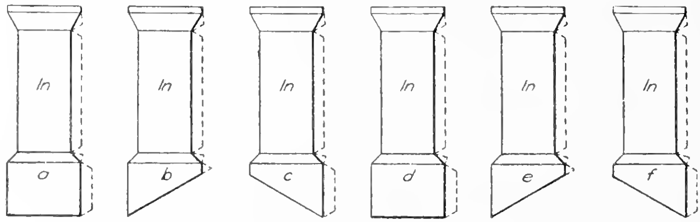


Fig. 240. Placing and Joining Laps on Ventilator Shaft Slides.

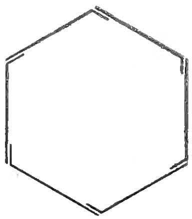
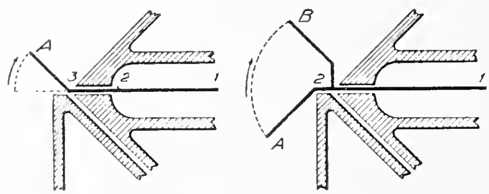


Fig. 241. Placing and Joining Laps on Ventilator Shaft Sides.



Figs. 242-3. Operations in Bending Hood and Roof Piece Joining Miters.

can be reversed and placed in this depression B D as shown by *d′ c′ b′*, and *d* C *b* bent on the other end of the roof piece, again starting at C. When this is done, the roof piece remains in the brake and the upper leaf closed on dot *a*, making a square bend, as indicated by A. Then A *a d′* completes the bending of the roof piece.

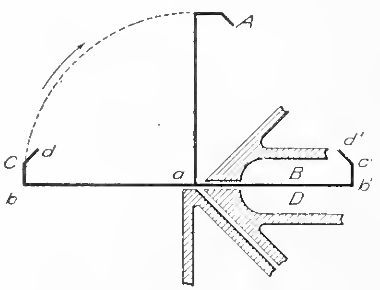


Fig. 244. Operations in Bending Hood and Roof Piece Joining Miters.

All the sides having been formed, the laps are bent at hexagonal angles, a templet similar to D, in Fig. 245 being used. This templet may be obtained from any one of the angles shown in plan, Fig. 238, *u* 2^v 2^x. As work having hexagonal angles will arise, a hole is punched in this templet in Fig. 245 at *f*, which allows it to be hung on a nail for future use. At the school in

New York the hexagonal, octagon and right angle templet are placed in each student's drawer for future use.

When the work is being set together, two sides are tacked at a time, as indicated by A B and C, Fig. 245, after which they are joined in one hexagon at *a* *b* and *c*. In no case should the joints be soldered through until the entire hexagon is tacked together, and, if true, it can be soldered complete. In a small ventilator of this kind the laps, braces and other parts are only soldered together, but when a large ventilator is to be constructed the parts are joined by solder and rivets, which fastens all in a more substantial manner, especially the hood to the ventilator to withstand the force of wind and storm. The method of securing the ventilator to the roof construction will be explained later.

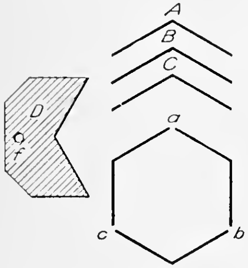


FIG. 245. Operations in Bending Hood and Roof Piece Joining Miters.

When riveting the seams they are first tacked with solder in sections, shown by A B and C, Fig. 245, then with a solid or rivet punch, Fig. 246, holes are punched the required size. Care must be taken to have the punch sufficiently large, so that the sheet iron will not be torn when the punch is being used to obtain the proper size hole. The punch should be of such size that the rivet will slip in snugly, as in diagram A. When punching use a piece of hard wood or a block of lead, held by the helper on the inside, at at *m*, and then punch from the outside, as at *n*, from which side the rivet is placed. When the punching on these sections of ventilators is done, they are riveted on the bench plate, X, or on the square head stake, a rivet set, Y, being used, in which *e* is the setter and *d* the header, a hole being drilled at *f*, which connects with *e* to allow any burr or surplus metal to pass out. The setter is now used and the rivet well drawn, after which the rivet is struck with the hammer in position B, until the hole punched in the metal is filled out.

A mistake often made is to keep on riveting with the hammer in a vertical position, resulting, if light-gage metal is used, in tearing the holes in the metal, as indicated in C, which shows the metal tearing around the rivet at *b*. After the hole in the metal is filled tight the hammer should be tilted as at E, which brings the rivet over the metal, diagram F. The header, *d* in Y, is then placed over F and with one or two blows a smooth, round button head is placed on the rivet H.

After all the parts of the ventilator have been soldered together in A C and D, Fig. 247, the various pieces are assembled as follows: The heads B and B are soldered in the roof piece, also the two braces soldered into the hood as indicated by *a a*. The surfaces *c* and *d* in the shaft C are soldered to the braces in hood D, after which the ventilator is soldered to roof piece A. The joints should be neatly soldered so that when completed it will look as in Fig. 239. The roof piece is only soldered in position to give the student an idea how the ventilator is connected

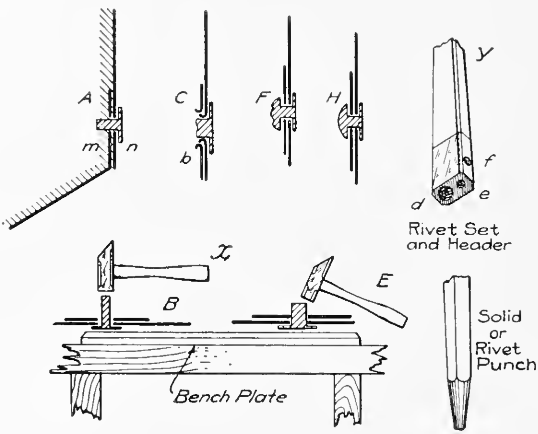


FIG. 246.

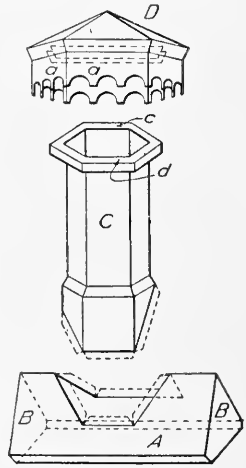


FIG. 247.

FIG. 246. Method of Riveting. FIG. 247. Assembling Parts and Secured Ventilator to Roof. Exhaust Ventilator.

to a pitched roof, also how the opening in the roof and a roof flange are obtained.

While soldering the shaft to the hood is proper for a small ventilator over a show window or flat part of a roof, for a large ventilator, on the ridge of a steep roof, more substantial provisions would have to be made to secure it against wind and storm. This is accomplished as in Fig. 248, in which A A shows the wooden frame or curb, flashed with metal around the main roof and curb, B B the flashing extending to the top of the curb and nailed. Over this flashed curb the ventilator is set, having a flange with a doubled edge drip around the bottom, C. Brass wood screws are inserted at *a* and lead washers between the head of the screw and the metal to insure against leaks. The lead washer being soft adjusts itself firmly between the screw head and metal. Wrought iron braces, made from ¼ x 1½-in. band iron, are formed as indicated by the hatched lines D D and bolted to each side of the shaft by bolts *d d*, etc., the hood being fastened by bolts, *b b*, etc. Over these bolt heads on the outside raised buttons are soldered *c c*, etc., which prevent leaks around the bolts. The buttons are made by using scrap pieces of metal and a hollow punch ¼ in. wider than the diameter of the bolt head; disks are punched on lead or wood, and it will be found that by punching the disks they become slightly concave, in which position they are soldered as at *c* and *c*. These braces prevent storms from dislodging the hood.

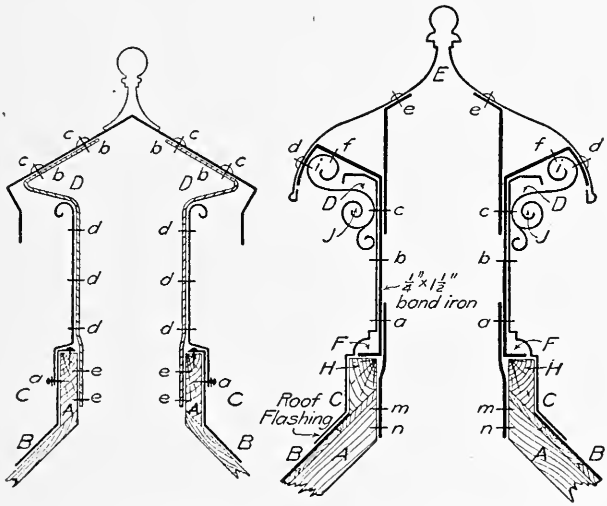


FIG. 248. FIG. 249.

FIGS. 248-9. Assembling Parts and Securing Ventilator to Roof.

To prevent storms from blowing off the ventilator it will be noticed that in making the brace D sufficient material is allowed for it to be bent to suit the thickness of curb A, and holes are punched at *e e*, etc., into which large wood screws are placed, securing the entire ventilator. If the roof framing were of iron construction the same method would be employed, holes being drilled in the angle or T-iron to which to secure the braces, bolts being used instead of wood screws.

To make a finish at the top, a finial E, Fig. 249, is sometimes employed. The student must bear in mind that it makes no difference how large the ventilator may be, or what its shape or outline, the principles shown in Fig. 238 are applicable in the development of the patterns as well as the constructive features.

Sometimes the hood over the ventilator is of such size that the wind causes the metal to loosen about the holes, making it dangerous to those below. This can be overcome by extra bracing, Fig. 249, in which a ventilator is shown, having the roof flashing, a^r 10^r 10^r a^r a^v 10^v 10^v a^v in the pattern for roof piece in Fig. 238, attached to the lower base, C, Fig. 249. This roof flashing is only employed when the main roof covering B is of slate, tile or shingle, and the roof flashing acts as a cap flashing. In this case A A shows the rafters, B B the sheathing over which the roof covering is laid, and then the ventilator with roof flashing attached is set over the covering. The sheet metal ventilator shaft is bent as indicated from C to D, while the hood E is formed as shown. The base of the shaft is molded, and if the entire weight of the ventilator rested upon it the weight would crush the mold and burst the soldered corners. To overcome this the wrought iron brace is bent with an angle, F, which rests upon curb H, whether of angle iron or wood, and bolted to the shaft at *a b* and *c*, the brace extending to the hood and bolted at *d*. An extra anchor *c e* extends to the hood, bolted to the main brace at *c* and to the hood at *e*. All the bolt heads on the hood are capped as before described. An anchor to secure the ventilator to the rafter is bolted to the main brace at *a* and nailed to the beams with anchor nails or bolted to angle iron construction at *m* and *n*. To keep the hood from wobbling a scroll made from band iron is bolted to the main brace at *i f* and *j*. This makes a tight, firm job.

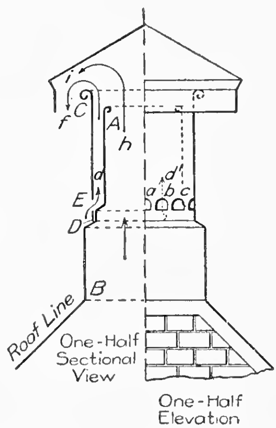


FIG. 250. Exhaust Ventilator.

While the ventilators just described depend for operation on the heated air rising from the inside, perhaps from steam coils placed inside of the shaft or in a drum below the shaft, it may not be out of place to show the student another form of ventilator which gives good results and is shown in Fig. 250. In the half section view, the inner shaft is formed from A to B and over this, on the lower member D, an outer shaft is placed, with semicircular openings cut into the base, *a b* and *c* in the half exterior view; these openings are shown in the sectional view by E. This allows the wind to enter at E through the opening *d* or *d′* and rush out at *f*, carrying with it the air from the shaft *h* to the outside at *i*.

It is seldom that in practice the sheet metal worker must design the ventilator. These designs are usually made by the architect, but the sheet metal worker must know the various ways of constructing and fastening, as he is held responsible for any defect; hence the foregoing hints on fastening.

CHAPTER XXIII

Construction of Flat Skylights

The student has now reached that part of the course which covers skylight work and will doubtless find it a study of much interest, and rightly so, because it is a branch of the sheet metal trade which requires, in addition to skillful workmanship a considerable constructive knowledge. This exercise will cover the flat skylight on a pitched roof; the doubled pitched skylight when placed on the ridge of a roof; the flat skylight on a flat roof, the curb having the required pitch; the double pitched skylight on a flat roof, the curb having the required pitch; also where an extension skylight is used, which is simply a flat skylight in which, if necessary, provision is made in the construction to allow some of the sashes to be raised by worm gearings. The method of constructing these sashes, obtaining their patterns, applying the gearings and the constructive features of the various skylights just mentioned are explained to the student in regular order.

In the sixteenth exercise, Fig. 251, it will be noticed that the plate contains no scale drawing but shows half-size sections. In the upper left-hand corner is a view of a flat skylight placed on a steep roof. In the right-hand corner the wood curb is shown with the dimensions. The student is to construct a flat skylight, 1 ft. x 1 ft. 6 in., the bars running the 1 ft. way. In the half size sections A shows the section for the sides and top of the curb A A A in the perspective view, and B the section of the lower part of the curb B in the perspective view. C shows the common bar shown in the perspective view by C C C, while D shows the cross bar or clip D D D in the perspective view. This cross clip is used in large skylights where more than one length of glass must be used, the edges of the glass being protected and leakage prevented by the cross gutter D, which conducts the condensation from the inside or leakage from the outside, into the gutters of the skylight bar C, from which it is drained into the gutter of curb B to the outside, as indicated by the small arrows. An illustration clearly showing this construction, similar to the finished model provided for examination by the students at the New York Trade School, will be given later.

While the sectional shapes of the bars and curbs are simple, they are true to the general principle followed in skylight construction for strength and to take care of the condensation and leakage; there are various other shapes of curbs and bars used in

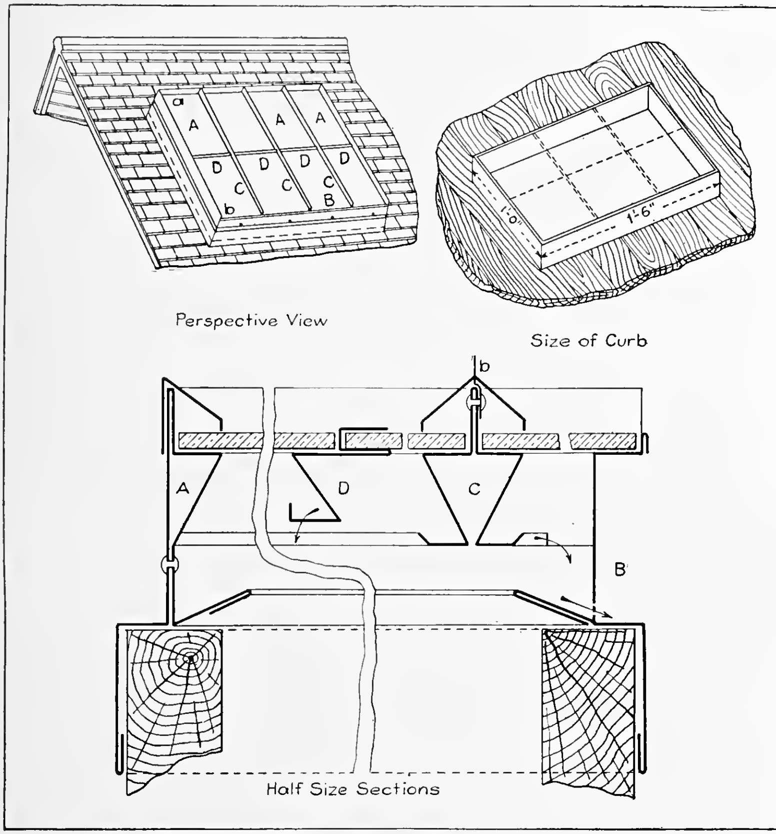


FIG. 251. Different Views and Detail of Flat Skylight.

large skylights, many of which will be explained and illustrated.

Some beginners do not understand what is meant by condensation in skylight work. The student has probably noticed on a cold day when the room is heated that the glass in the windows, sweat on the inside, and when there is much moisture in the air the sweat or condensed moisture collects and runs to the bottom of the sash. This condensation is caused by the warm air striking the cold surface and is exactly what happens when a skylight is placed over the roof of a warm building. If no provision was made to catch this condensation it would follow the pitch of the glass and drop into the room below or soil the ceiling or decorations; hence the use of the condensation gutter on all modern skylights.

Over bar C a V-shaped cap is placed, which makes a finish over the glazed surface, and is fastened by means of the copper clip *b* riveted to the doubled edge of bar C. The use of copper for the clip *b*, also the various ways of forming the caps and fastening them will be explained in detail.

In the sections the glass rests or rabbets of the bars run in one line, which is necessary in obtaining true surface, and is important when developing the patterns. As the width of the skylight to be made is to be 12 in. and the bars are to run parallel to the sides, refer to the half-size sections and draw them full size in position, as shown in Fig. 252 (see Folder 6), where they are lettered similar to the half-size sections in Fig. 251, the distance from outside to outside of the wooden curb in Fig. 252 being 12¼ in., allowing ¼-in. for the flashing which will be put around the curb as will be described later.

The student will see that it is not necessary to make a sectional view of the various bars of the full width of the skylight to be made, as the entire patterns can be obtained from the sections placed in a short space, Fig. 251, and after having the miter cuts the skylight can be made any size. The full width is placed in the detail in Fig. 252 because of its small distance, and the patterns obtained from it can be used for any size.

Having drawn the section A at the top left corner so that the rabbet or glass line 6 7 is in line with rabbet line 6′ 7′ in section B at the right, make the distance *u t* equal to the thickness of the glass used, so as to allow the water to run off over *u t*. Section C and D can be placed in any position between sections A and B, care being taken that the rabbet *c b c* in C and *l j* in D are in line with the rabbets in sections A and B. Connect sections A and B by lines, as shown.

Having placed section C in its proper or desired position, draw horizontal lines through bends *a* to *f*, intersecting the upper curb section A from *a′* to *f* and the lower curb section B also from *a′* to *f′*, notching the gutter of bar C at the bottom at the right at *d′ e′ f′*, which allows the drip or condensation to drop into the curb gutter below, as shown by the arrow. In a similar manner through bends h to o in the clip section D, draw horizontal lines, cutting the bar section C from h' to o', notching the gutter of the clip D at m' n' o' to allow the drip to flow into the condensation gutter of bar C. Of course the notches at c' f' and n' o' should be at a distance equal to about one-half the width of the lower gutters into which the drip is to flow. Thus any leakage or condensation occurring in cross clip D is led into the gutter of bar C, as shown by the arrow o' n', from which it is led into the lower curb gutter at f' e, thence to the outside through the small tube r s.

Caps of V-shape are placed over the sections A and C. This as well as other forms of caps and the methods of fastening will be explained. The curb sections A and B are so formed as to have a shoulder to rest on curbs D^3 and D^4.

The sectional view having been completed, the development of the patterns is now in order. The pattern for the sides will be developed first. Number the various bends in the curb section A, from 1 to 11, and place this girth A on any vertical line as E F, by similar numbers 1 to 11. Through these small figures at right angles to E F, draw lines indefinitely, intersected by lines drawn parallel to E F from similar numbered intersections in section A. A line traced through points thus obtained as shown at the right by R U will be the miter cut at the upper end of the side curb, joining the upper curb at a in the perspective view in Fig. 251.

To obtain the miter cut at the lower end of the side curb to join with the lower curb, at b, proceed as shown at the right in Fig. 252. As the lower curb B is of a different profile than A, project points 1 to 11 in A until they intersect section B, shown by 1′, 2′, 3′, 4′, a'', a''', 5′ 6′, 1′, 8′, 9′, 10′ and 11′. From these points, parallel to E F, lines are projected, cutting similar lines drawn through similar numbered and lettered points on and at right angles to E F. A line traced at the right through these points, S to T, will be the miter cut on the lower end of the side pattern. Then R S T U represents the pattern for the sides of the curb, two of which are required, with laps as indicated by the dotted lines.

As section A in the sectional view is the same for both side and upper curbs, the miter cut R U in the pattern for the sides will also answer for the miter cut for the top curb. As the upper curb is to be 1 ft. 6 in., it is only necessary to measure 9⅛ in. from 12 to 13 in the side curb pattern, Fig. 252, and through 13 parallel to E F draw the line V W. Then R V W U is the half pattern for the upper part of the curb, and when prick marked on to the metal is reversed on dots V and W, which will make the full length 18¼ in., thus making ¼-in. allowance in length to slip over the flashed curb or frame in the roof. One piece like this is required, minus laps.

To obtain the pattern for the lower curb B joining the side curb at *b*, in the perspective view in Fig. 251, take the girth of section B, Fig. 252, as 1′, 2′, 3′, 4′, 10′, 9′, 7′, 6′ *u t*, these intersections being numbered to correspond to the points projected from section A, and place them as shown by similar numbered and lettered points on the vertical line J K. Through these points at right angles to J K draw lines indefinitely. To the right of section A in the sectional view, erect any vertical line as E^3 E^4, and in a similar manner parallel to the line J K in the pattern erect at pleasure the line E^5 E^6. Measuring from the line E^3 E^4 in the sectional view, take the various projections to points, 1, 2, 3, 4, 10 and 9 and place them on similar numbered lines in the pattern, measuring to the right of the line E^5 E^6. After obtaining the point 9″, erect the vertical line 9″ A^2, meeting the rest of the lines drawn through 7′ 6′ *u* and *t*. The reason for drawing line 9″ A^2 straight is that this part meets the flush side of the side curb from 4 to 5, section A, also shown from 9^v to t^v in diagram X°.

As the length of the skylight is to be 18 in., make the distance from B^2 to Y in the pattern 9⅛ in. and erect the vertical line Y X, meeting the line drawn through *t*. Connect lines from 9″ to B^2. Then A^2 B^2 Y X represents the half pattern for the lower end of the curb marked B in the sectional view.

As the bottom of the condensation tube *r s* in sectional view meets the bend 9′, ¼-in. holes must be punched above the line 9′ in the half pattern for the lower end of the curb at *r*′. These condensation holes are usually placed between the lights of glass, as indicated by the small dots along the lower curb B, in the perspective view, Fig. 251.

When pricking this half pattern A^2 B^2 Y X, Fig. 252, on the metal, it is reversed on the dots Y X making the pattern 18¼ in. long, or ¼ in. allowance to slip over the flashed curb. One piece is required without laps.

For the pattern for common bar C, take the girth from *f* to *a* to *f* and place it on any vertical line G H from *f* to *a* to *f*. At right angles to G H through these small letters draw lines indefinitely, intersected by lines drawn parallel to G F from similar lettered intersections a' to f' in both sections A and B, these points being obtained by drawing horizontal lines through points a to f in bar section C. Trace a line through points thus obtained in the pattern from W to X and V to Y. Then V W X Y will be the pattern for the common bar C, two of which are required with laps, as shown by the dotted lines.

The last pattern required is that of cross clip D in sectional view. Note how this clip is formed; the lower sheet of glass X^T enters the groove $h\ i\ j\ k$ and is bedded in putty, $i\ h$ forming a cap to shed the water over the glass. The upper sheet of glass X^t lies on the rabbet $j\ l$ and is well bedded in putty to prevent leakage, allowing the water to pass over the cap $i\ h$. Should any leakage occur at the joint X^T it flows into the gutter $m\ n\ o$. The distance i to j should always be made to suit the thickness of glass.

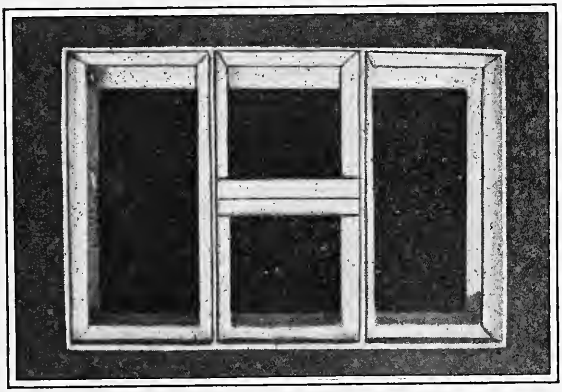


FIG. 253. Finished Flat Skylight.

Take the girth of D and place it on the vertical line L M, as shown by similar letters, through which at right angles to L M draw lines indefinitely. At pleasure in the sectional view draw any vertical line as O P. In a similar manner, parallel to L. M in the pattern, draw the line $O^1\ P^1$. Measuring from O P in the sectional view, take the distances to points h' to o' in C, which were obtained by drawing horizontal lines through points in D until they cut C, and place them to the right of $O^1\ P^1$ in the pattern. Through these points draw lines resulting in the miter cut $C^2\ d^v$.

Before transferring this cut to the opposite side $C^3\ d^x$, it is necessary to know what length the bar is to have and is obtained as follows: Referring to Fig. 253, which shows the finished flat skylight, notice that only one cross clip is placed between the two common bars, and as the length of the skylight is to be 18 in., and the metal curb sets inward ½ in. on each side, as in the sectional view in Fig. 252, then 18 — 1 = 17; 17 ÷ 3 = 5 2/3 in., the length of the cross clip from C^2 to C^3 in the pattern.

From C^3, transfer the miter cut C^2 d^v as shown by C^3 d^x, being careful to have the cut C^3 d^x placed in its proper position, so that when a vertical line is erected from d^x as d^x a^x the distance C^3 a^x will be similar to the distance a^v C^2 when a vertical line is erected from d^v. This completes the pattern for the cross bar or clip, one of which is required without laps.

No patterns are shown for the caps covering the glass, as they are usually bent in long lengths and cut off as required. This completes the patterns required for the skylight under consideration. The same patterns can be used for a larger size skylight, and, for an example, assume that a flat skylight is to be laid out, say 3 ft. x 5 ft., the bars to run the 3 ft. way, as in diagram Y^a, Fig. 252, which is usually laid out so as to obtain the number of bars required and other essential data. The top and bottom of the curb being 5 ft. long, the pattern for the upper end of curb would be used, measuring 5 ft. from point 12 in the pattern for the curb side, and then reversing the cut R U on the 5-ft. mark for the opposite side. In a similar manner, measure from point 18 in the pattern for the lower end of curb, reversing the cut A^2 B^2 on the 5-ft. mark for the opposite side. As the side of the skylight is 3 ft. wide, make the distance from 14 to 15 in the pattern for the sides, 3 ft. wide, assuming that the ¼ in. allowance for the metal flashing has been allowed in the roof curb.

In this case five lights of glass of equal width have been divided in the 5-ft. curb, *a,* thus requiring 4 common bars. These bars would be measured from points 16 to 17′ in the common bar pattern and be made ½ in. less than the length of the side curb, or 2 ft. 11½ inches, because the distance from 3 to 4 in the curb section A sets inside of the curb line ½ in. The length of the cross bar, if required, measured from 19 to 20 in the cross bar pattern, would be 60 — 1 = 59 ÷ 5, or 11 4/5 in.

Returning to the lesson, the various patterns are cut from sheet metal, punching the condensation holes *r′* in the lower curb pattern with a ¼-in. hollow punch before forming up on the brake. After all the pieces are cut, stays or templates are cut as follows: The entire section A for bending the top and sides of the curb; section B for the lower part of the curb; section C for the common bar, and section D for the cross bar or clip. The girth required for forming the V-shaped cap over the bar C is given in C^v. The method of forming the various bars and curbs will be explained in detail, for it is very important to know how to make the bends so that the bars and curbs will spring together at 4 in section A; at *j* in section D; at *d* in section C, and at 4′ in section B.

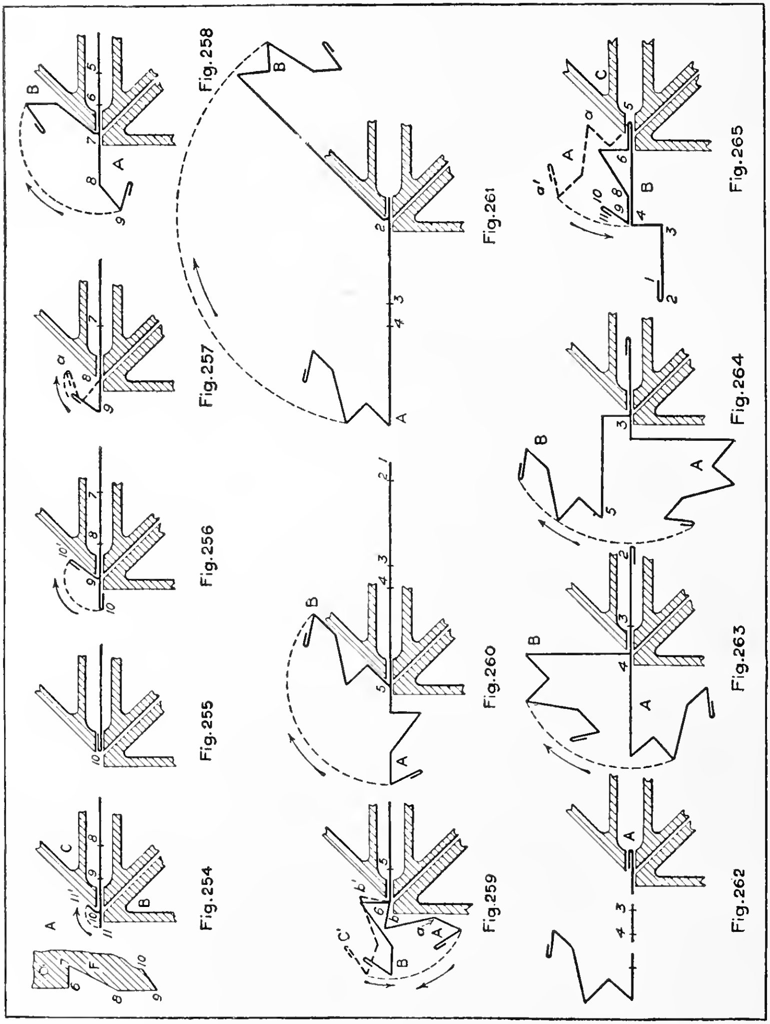
The patterns having been developed and the material cut out and marked with the prick punch at the proper points for the bends, the student is ready for the important work of forming the bars on the brake, and he will pay dearly for any carelessness or negligence, if he fails to form every piece right on the dot and at the proper angle.

The section of curb A used for the back and sides of the curb will be formed first, and all that is required is the stay F, shown in Fig. 254; where the bends are square no stay is needed as the stops in the brake are set for right angle bends. Start the forming on bend 10, A, raising the bending leaf B until it meets the upper leaf C, bringing 11 to 11′. Open the jaw of the brake as far as possible, place 11′ between the jaws, close the top leaf C, thus making the hem edge as in Fig. 255.

Take out the sheet, reverse it as in Fig. 256, and close the brake on dot 9, making a bend to the required angle called for by the stay. Open the brake and draw out the sheet to dot 8, Fig. 257. Close the brake on this dot and make a bend to the required angle indicated by *a*.

Reverse the sheet in the position A, Fig. 258, and make a bend on dot 7 to the required angle, bringing A in the position B. Reverse B and place it in the brake A, Fig. 259, where it must be forced into the brake so that the upper leaf can be closed on dot 6, in doing so *a* strikes against the lower leaf and makes a slight curve in the rabbet of the bar at *b*. Make bend on dot 6 at right angles, bringing A in the position shown by the dotted outline C′ *b*′. The angle *b*′ is now pressed together with the thumb and finger, bringing C′ into its proper position, as shown by the solid outline B.

The sheet is now reversed on dot 5, Fig. 260, A, and A bent around as far as it will go, as indicated by B. Leaving the sheet in the brake, draw out to dot 2, Fig. 261, A, and make a bend on dot 2, as far as possible, as indicated by B. Open full the jaws of the brake, insert the bend just made and close to a hem edge, Fig. 262. Reverse the sheet in the position A, Fig. 263,



FIGS. 254-265. Bending Operation on Brake in Making Finished Curb for Top and Sides of Skylight.

and make a square bend on dot 4, as shown by B. Again reverse the sheet, A, Fig. 264, and make another square bend on dot 3, bringing the sheet into the position B.

Open the jaws of the brake as far as possible and place angle 5 into them, as shown by A, 5, 2, Fig. 265. Close the upper leaf slowly until bend 9, shown on the dotted lines, almost reaches the bend 4 in B, when it can be seen whether the joint 9 4 will spring together tight. If there is any doubt that 9 and 4 in B will not meet, simply press together the angle at *a* and close the upper leaf C with a quick motion on bend 5, which will cause bends 9 and 4 to spring together.

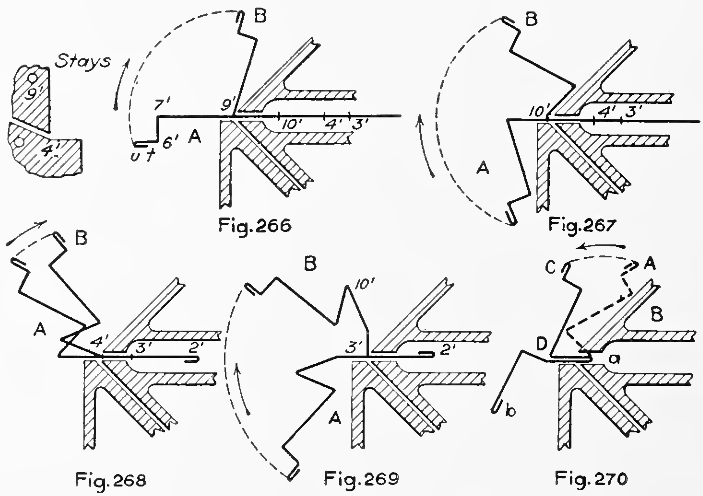
It will probably be necessary for the student to try these bending operations a number of times before he becomes proficient, and it is well to cut short pieces of curbs, about 3 or 4 in. long, to practice with. In Fig. 265, B represents the finished curb for the top and sides of the skylight.

The method of forming the lower part of the curb is shown in Figs. 266 to 270. The stays required are shown by 4′ and 9′ being reproductions of similar angles marked 4′ and 9′ in section B in the shop detail in Fig. 252. The first four operations, bending and closing the hem edge *t u* in Fig. 266 and making the square bends 6′ and 7′, are omitted. After bend 7′ has been made, place the sheet in the position A, and make a bend on dot 9′ to the required angle called for by 9′ in the stays as shown by B. Now reverse B in the position A, Fig. 267, and make a bend on dot 10′, turning it as far as it will go, as shown by B. Draw out the sheet and close the brake on dot 4′, A, Fig. 268, make a bend to the required angle, as shown by B, and finish the hem edge at 2′, after which reverse the sheet to the position A, Fig. 269, and make a square bend on dot 3′, as shown by B. Open the paws of the brake and insert bend 10′ in B, as shown by A *a b,* Fig. 270. Close the upper leaf B until A is brought into the position C, springing the joint at D. This completes the bending of the lower curb.

The forming of the common bar is next in order. In Fig. 271 A is the stay, showing what angles are actually necessary for forming purposes. The first bend is made on dot *e,* bringing *f* to the position *f′*, as called for by the stay. The sheet is now drawn out and the brake closed on dot *d,* Fig. 272, and a bend made to the required angle, as shown by A. The sheet is now reversed in the brake, A, Fig. 273, and the proper angle bent on dot *c,* shown by B. Again reversing B, place it in the brake, B, Fig. 274, and make a square bend on dot *b*, shown by C. Reverse the sheet C and place it in the brake, A, Fig. 275, and make a bend on dot *a* as far as it will go, as indicated by B.

Reverse B and place it in the brake in the position B, Fig. 276, where, in forcing B to close the brake on dot *b*, the lower part of B will strike the bending leaf at 1, thereby causing a slight curve at 2, which will spring out again when a square bend is made on dot *b*, shown by C. The bar is now reversed, A, Fig. 277, the brake closed on dot *c*, and a bend made to the angle B.

Again reverse B, Fig. 278, and make the proper bend on dot *d*, shown by C. Draw out sheet C and close brake on dot *e*, C, Fig. 279, and make a bend to the angle shown by D. Now open the



FIGS. 266-67-68-69-70. Bending Operations in Forming Lower Curb on Brake.

jaws of the brake as wide as possible and insert the angle *a*, shown by D *a*, Fig. 280. Close the brake firmly, causing the two condensation gutters 1 and 2 to spring together tightly at *b*.

The student is cautioned to be very careful to have each and every bend formed exactly on the dot and to its true angle, otherwise the result will be different from that shown by E.

The last part to be bent is the cross bar or clip shown in section by D, Fig. 252. In Fig. 281, B shows the only angle or stay required. Start this cross bar by placing sheet *h l* in the brake and make a square bend on dot *i*, shown by A. Leaving the sheet in the brake, draw it outward and close the top clamp on dot *j*, Fig. 282, and make a square bend. In making this square bend the edge *h* is forced against the top clamp at *a* and presses the right angle *i* out of square, shown by *i'*. Leave the sheet in this position, reverse it and place it in the brake, A, Fig. 283, and make a bend on dot *k* to the required angle, shown by B.

Place B *l* in the jaws of the brake in the position A *l*, Fig. 284, and clamp the bend *k*, shown by B. Leaving B in this position

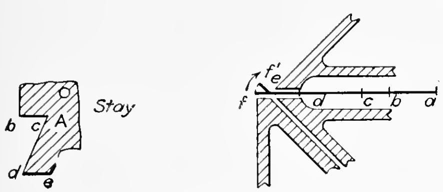


Fig. 271

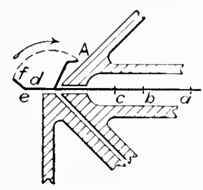


Fig. 272

Bending Operation on Brake in Forming Common Bar for Skylight.

with the brake closed, as A, Fig. 285, use the hammer C and with light blows against the corner 1 bring A 1 into the position B 2. Now take a piece of band iron, slightly thicker than the thickness of glass used, place the band iron A, Fig. 286, in the groove 1, 2, 3, and with the top clamp B squeeze 1 down. This makes an even, uniform groove to receive the glass. The rest of the

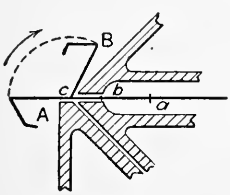


Fig 273

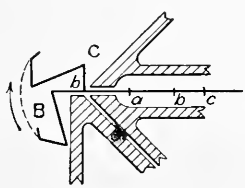


Fig. 274

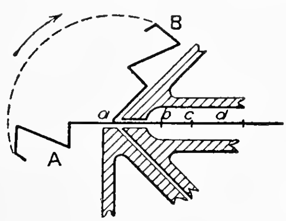


Fig. 275

Bending Operation on Brake in Forming Common Bar for Skylight.

bends on *l*, *m* and *n* in diagram X are made as explained in Figs. 277, 278 and 279.

Having bent the various parts the student is ready to put the skylight together, Fig. 287. The back and one side of the skylight should be joined square at A, then the front and opposite side at B. These corners should only be tacked and remain so until the opposite corners are joined at C and D. As the distance between the bars in this case measures $5\frac{2}{3}$ in. as before explained, mark off the distances on the back and front curb and tack in position the common bars E and F, after which cross bar G is tacked in the center between the common bars. If the skylight lies perfectly level, solder all the joints complete, when it will have the appearance shown in Fig. 253.

In the construction of large flat skylights, 50 or 100 ft. long, they are usually set together at the building, fitting all work at

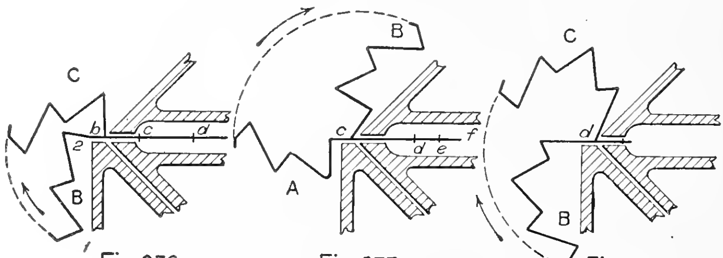


Fig. 276 Fig. 277 Fig. 278

Bending Operation on Brake in Forming Common Bar for Skylight.

the shop, and to speed the work at the job, instead of marking off the dimensions between the bars as in Fig. 287, a V-shaped stay is bent as in diagram X, which has the required length or distance between the bars and is used in spacing the bars, instead of the 2 ft. rule.

After the model skylight is completed at the school, instruc-

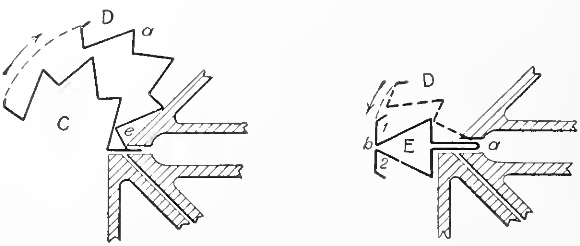


Fig. 279 Fig. 280

Bending Operation on Brake in Forming Common Bar for Skylight.

tion is given how to fasten the metal curbs to the wood or angle iron frames, how to glaze the skylight, and secure the capping over the joint between the bar and glass.

The first thing to be considered is the fastening of the metal curb on the wooden frame, Fig. 288. W shows the roof sheathing and V the wooden curb, which are flashed with tin, galvanized iron or copper and nailed to the top of the curb by wire nails at *a*. Over this flashing the metal curb A is set, the shoulder of the metal curb C resting on the wood curb. Through the cap flange A, the wood screw *b* is placed, having a lead washer between the screw head and cap flange to make a tight joint. These screws are placed about 2 ft. apart. Brass screws should be used when the skylights are made of copper, and they should not be driven in with the hammer, a screw driver should be used.

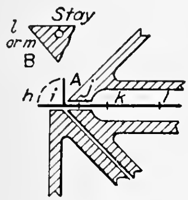


Fig. 281

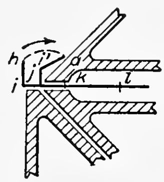


Fig. 282

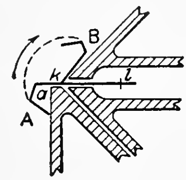


Fig. 283

Bending Operations for Cross Bar.

On fireproof structures where the framing is of iron, the curb of the skylight is bolted to the angle or T as in Fig. 289. In this case the flashing is carried up, and turned at *a;* over this flashing, resting on the angle iron, curb A is set, and a bolt *b* passed through the cap flange and angle through holes previously punched or drilled by the iron constructor. When the skylight

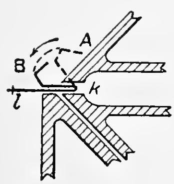


Fig. 284

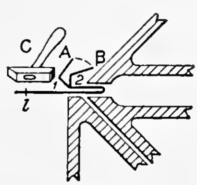


Fig. 285

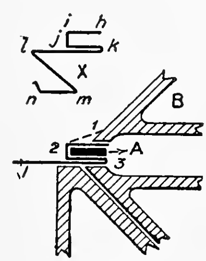


Fig. 286

Bending Operations for Cross Bar.

is being fastened in this manner the fireproof blocks F P B should not be in place until the skylight is secured. Sometimes these are already in position before the skylights are set, in which case the blocks are drilled and the metal curb fastened by long bolts passed through F with a washer on the inside made of band iron about 3 or 4 in. long and a nut placed on the inside of the fireproofing. A better job is obtained by tapping the holes in the angle iron, so that the curb can be fastened or removed at will, without disturbing the fireproof blocks.

When the curbs are in position and the bars in place, the skylight can be glazed in three ways. When the skylight is very steep the glass can be laid directly on the bars, Fig. 290, in which case ribbed glass is employed having a section similar to that shown by F. These ribs carry off the water and prevent it from running sidewise to the bar, which is an advantage when putty is not to be used. Its disadvantage, however, is that by having the ribs on the outside the depressions fill with dirt, which is hard to clean, and darkens the space below.

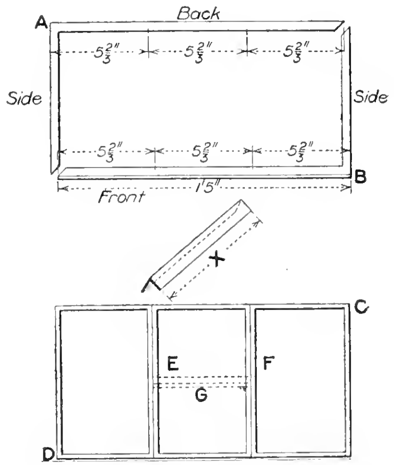


Fig. 287. Assembling Parts of Flat Skylight.

The second way of glazing when the skylight is not steep is to lay the glass directly on to the bar A and set the putty over the joint *a*. In this case, if ribbed glass is employed, the ribs may be placed downward, which acts similar to a prism light.

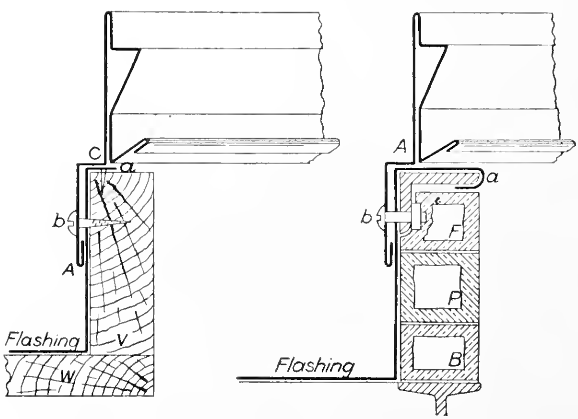


Fig. 288. Fig. 289.

Figs. 288-9. Fastening Skylight to Wooden and Angle Iron Curb.

The third and best method is to bed the glass in the putty as shown to the left of A. Soft putty is first laid on the rabbet of bar A, then glass G imbedded in it, which causes the putty to squeeze out of the joint at *b* and *c*. The surplus putty is cleaned off with the putty knife, leaving a layer as thick as *c*, while at the bottom it is cut off in line with the bend *e'*. When cutting off this putty, *b*, care must be taken to keep the gutter, *e*, of bar A clear of the putty, which would clog the gutter of the bar.

When all the glass has been laid a metal capping is placed over the joint to make a clean finish, as in Figs. 291 and 292. These cappings are secured to the bars by soft copper clips or wire fastened to the top of the bar, as will be understood by referring to Fig. 290. These clips are secured to the bars at the shop before being sent to the building and placed about 18 in. apart. Soft copper is used so that in case of breakage of glass the clip or wire can be raised, the cap removed, new glass and cap inserted, when the clip is again ready for use. Being of soft copper, it is pliable and will not break. If galvanized iron were used it would be likely to break when being rebent, which would necessitate new wire or clips and require the same work to be done over again, as will now be described.

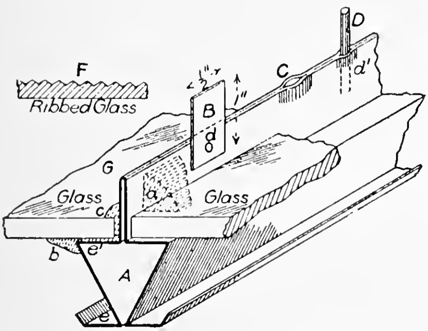


Fig. 290. Fastening Clip to Secure Cap Bar.

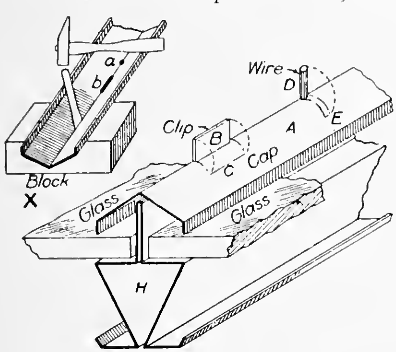


Fig. 291.

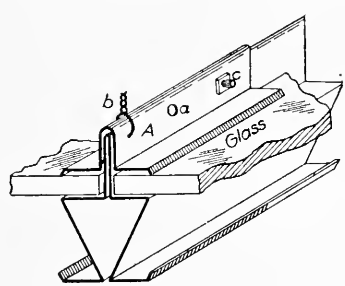


Fig. 292.

Fig. 291. Fastening Inverted V-Cap. Fig. 292. Fastening Another Form of Cap.

When clip B, which is cut ½ in. wide by 1 in. long, is to be fastened, it is riveted to the bar at *d* Fig. 290, holes having previously been punched in clip B as well as in the upper part of bar A and 1-lb. tinned rivets employed. When a wire clip is used a hole is punched through the doubled metal, as at C, with a prick punch and hammer until the hole is large enough to receive 1/16-in. thick wire. The wire D is then inserted about ½ in. inside as at *d′*, Fig. 290, and soldered to the bar, the joint being sweated well so that the wire will not loosen when turned over.

If a V-shaped cap is to be fastened as in Fig. 291, by clip B, a slot is cut from the inside, in the top of the cap in its proper position by a hammer and small chisel, diagram X, where the cap is laid on a block of wood or lead, *b* showing the cut slot. The cap A is now set over the bar H, and the clip B allowed to pass through the slot previously cut and B turned over as at C. When the wire is used as a fastener, a rivet punch of the required size is used to punch the hole *a* in X. When the wire D is passed through the cap, it is turned over as shown by E. Before the clips are dressed down with the hammer, cap A is pressed firmly on the glass and, while held in this position, clip B or D is turned down and dressed lightly with the hammer. Where the caps intersect one another they are mitered and soldered.

Another form of capping is shown at A, Fig. 292. This form can be fastened by small brass bolts *c* or copper wire *b* twisted at the top, either of which is passed through the proper size hole punched at *a*. A mistake often made is to use iron instead of brass bolts, and, in case of breakage and when the cap must be removed, it is a hard job to remove the iron bolt, as it is thoroughly rusted by the weather.

The method of forming the capping A is explained in connection with Fig. 293, in which A shows the capping when bent in a manner similar to that explained in connection with the skylight bars. A is placed in the jaws of the brake at B, and a piece of band iron C having the proper thickness is placed in B, the top clamp closed, bringing the cap in the desired position indicated by D. When the caps have been fastened and their intersections soldered the outside work at the building is complete.

While the patterns, in Fig. 252, were developed for a flat skylight, they could also be used, with a few minor adjustments of some of the miter cuts, for a double-pitch skylight on a flat roof, Fig. 294, or for a double-pitch or ridge skylight on the ridge of a roof, Fig. 295. That is, the bottom pattern cut S to T of the side curb A, of Fig. 252, and the bottom cut W to X of the pattern of bar C remain as shown. In addition a pattern is wanted for the gable miter on the side curb and a pattern for a ridge bar. This gable miter on the side curb is to be obtained from the shop detail as follows: First obtain the bevel of the gable in either Figs. 294 or 295, as A, Fig. 295, and place it as shown by A^a B^a C^a in the sectional view, Fig. 252. Bisect this angle by using B^a as center, and with any convenient radius draw arcs intersecting lines A^a B^a and B^a C^a at D^a and C^a. With the same or any other radius and D^a and C^a as centers draw arcs intersecting each other at E^a. Draw a line from B^a to E^a, which represents the miter line. As the side curb is represented by section A, then from intersections 1 to 11 in A, draw lines parallel to B^a C^a until they intersect the miter or joint line B^a E^a, as shown by the intersecting dots numbered 1 to 11, from

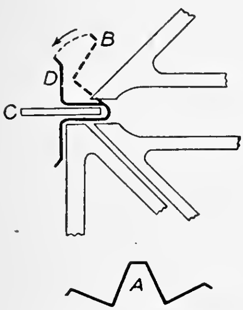


FIG. 293. Forming the T-Shaped Cap

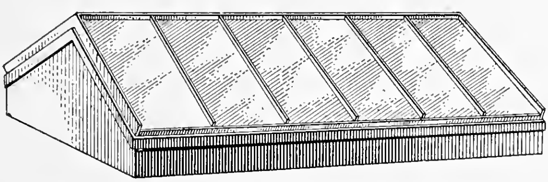


FIG. 294. Double Pitch Skylights for Flat Roofs.

which points, at right angles to B^a C^a, draw lines intersecting similar numbered lines in the pattern for sides of curb, shown by

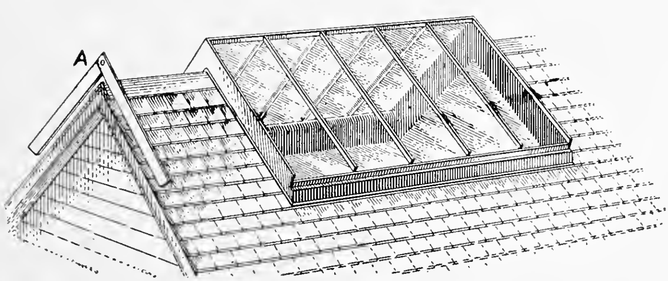


FIG. 295 Double Pitch or Ridge Skylight.

the dotted lines. A line traced through points thus obtained, H^a L^a N^2 J^a, will be the miter cut for the side curb to fit over the ridge of the roof at the required angle. Allow laps on one side from H^a to J^a.

To obtain the true section of the ridge bar, take the distance from 6 to 7 or the width of the rabbet in section A and place it, from 6 to 7^a, measuring from the miter line B^a E^a, and draw a line from 7^a to 8, corresponding to the line from 7 to 8 in section A. Take a tracing of B^a, 6, 7^a, 8, 10 and place it, as shown, by similar numbers in X. Reverse it by similar numbers in Y, and add the condensation gutters F^a F^a. Then X Y shows the true section of the ridge bar which will pass above the gutter line 10 in section A.

For the pattern for the ridge bar X Y, take the girth of X Y and place it on any line O^a P^a, shown by similar numbers, through which draw lines at right angles to O^a P^a, and draw the line O^b P^b parallel to O^a P^a at any convenient distance from it. As this ridge bar must miter with the side curb, take the distance of the rabbet 6 7 in section A and place it in the pattern

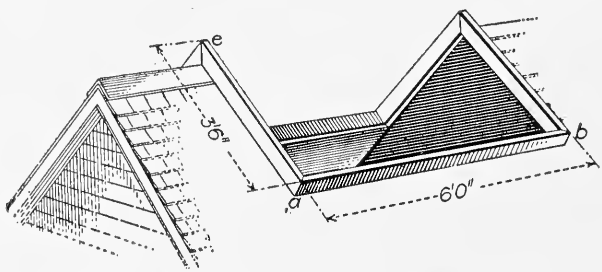


FIG. 296. Measurements for Frame for Ridge Skylight.

for the ridge bar on the lines drawn through 7^a, measuring from the line O^b P^b, thus obtaining the points 7^b 7^b, from which lines are drawn to 6^b and 8^b on both sides, which completes the pattern. The pattern of the top cut of the bar, C, with this ridge bar, would be obtained by projecting lines down to the pattern from points, on line B^a E^a, as B^a 6 7^a and 8.

When measuring the wood curb for the ridge skylight, the extreme outer upper edges should be measured from *e* to *a*, Fig. 296, which, assume will, measure say, 3 ft. 6 in., and from *a* to *b*, which measures 6 ft. To these measurements, ¼-in. should be added when measuring the metal curb to allow for the flashing turning up against the wood curb. Then, when laying out the metal curb, measure 6 ft. ¼ in. from point 18 in the pattern for lower end of curb, Fig. 252, to a similar point on the opposite side of the pattern when reversing the cut, and when laying out the metal gable curb for *a c*, Fig. 296, measure on the pattern for sides of curb in Fig. 252 from the arrow points L^a to M^a, making this distance 3 ft. 6¼ in.

When laying out the full pattern for the ridge bar, measure from B^b, reversing the cut on the opposite side to a distance of 6 ft. ¼ in., as in Fig. 296. Laps should be allowed to the ridge pattern in Fig. 252, as shown by the dotted lines.

The forming of the ridge bar is the same as for the common bar already explained. The ridge bar is capped in a manner indicated in section X Y.

Sometimes a flat skylight is placed on a flat roof, Fig. 297, the wood curb having the required pitch. The patterns developed in the shop detail, Fig. 252, for a flat skylight, can be used for this style of skylight, Fig. 297. The student will readily understand that the set of patterns developed in Fig. 252 can be used for flat or double pitch skylights, whether on level or steep roofs. Also this type of skylight would be used for a curb like in Fig. 251, for skylight like Fig. 294 and Fig. 297 by simply filling out the triangular cheek or sides with sheet metal.

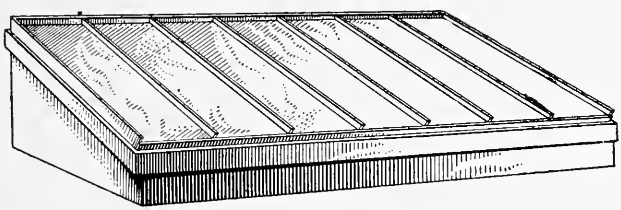


FIG. 297. Single Pitch Skylight for Flat Roof.

The size section of the bars shown in Fig. 252 should not be used for bars longer than 6 ft., as the weight of the glass, the exposure presented to catch snow, sleet and ice would be too great a strain on the bar. When the span of the skylight is wide and the run of the bar long, provision must be made in the construction of the bars and curbs to withstand wind pressure as well as dead loads of snow and ice. The strength of the bars of different sizes made from various gages of sheet metal, can only be determined by actual tests; that is, pieces of bars are formed of different sizes to given lengths, the ends placed upon supports and the center weighted until a deflection or bend is noted, which shows the weight it cannot sustain. A trial is again made until the safe load is obtained. In many cases of skylights of large size, the architect furnishes full size sections of bar and curb, or the construction is of angle iron made by the iron constructor, and covered by the sheet metal worker.

To give the student practical forms of skylight bars, Figs. 298 to 308 inclusive have been prepared. A reinforced bar is shown in Fig. 298, the general shape of which is similar to that already

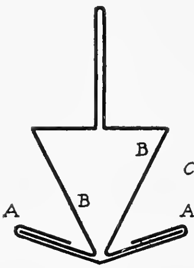


FIG. 298.

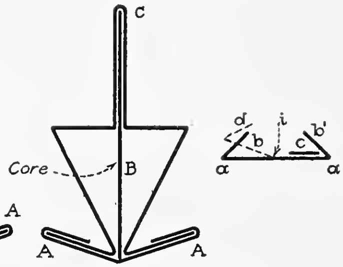


FIG. 299.

FIG. 298. Reinforced Bar. FIG. 299. Bar With Sheet Metal Core.

described, excepting that a reinforcing strip is placed at A A, which locks over the lower part of the bar, holding walls B and B together, imparting great rigidity to the bar.

A similar bar is shown in Fig. 299 which, in addition to the reinforcing strip A A, has a sheet metal core B extending through

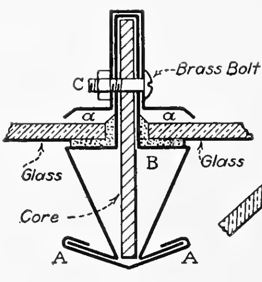


FIG. 300.

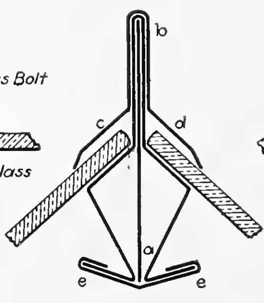


FIG. 301.

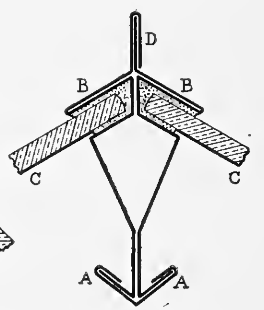


FIG. 302.

FIG. 300. Bar With Steel Core. FIG. 301. Ridge Bar With Sheet Metal Core. FIG. 302. Ridge Bar and Cap Combined.

the entire width of the bar, and clamped tight at C. This core B is cut from 22 gage iron and is inserted before the bar is clamped at C. After C has been clamped the reinforcing strip A A is slipped over the lower part of the bar and clamped in the jaws of the brake at A and A. When the reinforcing strip A A is being formed, it is bent in the hand brake as shown by the solid line *b' a a b,* a strip of iron 1/16 in. thick is placed at *c*, and *a b′* closed over it, which prevents the upper clamp from closing this edge entirely when making the slight bend at *i*. The strip *c* is now removed and *d i b′* slipped over the lower part of bar A A and the edges clamped in the brake, thus completing the bar.

In Fig. 300 a larger size bar is shown with a central core plate B added for wide spans. Modifications of this bar are made by increasing its depth and varying the thickness of the core plate. Note that the reinforcing strip A A is added to keep the walls of the bar in rigid position. With this style of bar holes are punched in the core plate, about 30 in. apart, through which the brass bolt, C, is passed to hold down the cap, *a a*, as well as to form a rigid construction between the core plate and metal bar.

The size of the core plate should be regulated according to the span of the skylight. To find the safe uniformly distributed load that the core plates will carry, the student is advised to consult any engineers' pocket book or the schedules furnished by rolling mills producing these core plates, which will give the safe strength of the skylight bar. When finding the safe load, the span of the skylight, the distance the bars are placed apart and the exposure presented for wind pressure, snow, sleet and ice, must be considered.

A ridge bar reinforced at *e e* is shown in Fig. 301 with a sheet metal core *a*. The joint between the glass and bar is protected from leakage by the cap *c b d* fastened as previously described. If desired the bar and cap may be made in one piece, Fig. 302. Note carefully how this bar is bent. The walls of the bar are held firmly by the reinforcing strip A A with caps formed at B B, then closed with a standing seam at D. Soft putty is inserted between the cap and rabbet of the bars and the glass C C pressed in, which will make a tight job.

In the five illustrations next shown, the various shapes of curbs which may be modified to suit the pitch as occasion may demand. The simplest form for small size skylights is shown in Fig. 303, and is bent in one piece from A to B, with a cap flange resting over the wooden curb C, through which screws are inserted at D. Holes for the escape of the condensation are punched at E, allowing the drip to run to the outside.

Note that bar F miters to the curb from A to G, as shown by the dotted lines, and gutter *b* in bar F is notched at *c* to allow the drip from the bar to flow into the gutter of the curb as shown by the arrow. When this style of curb is used and the doubled metal at *a* is not soldered, it is well to make a few notches, as at *f*, to allow any drip running between the folded metal at *a*, to escape at *e*.

Another simple form for small size lights is shown in Fig. 304.

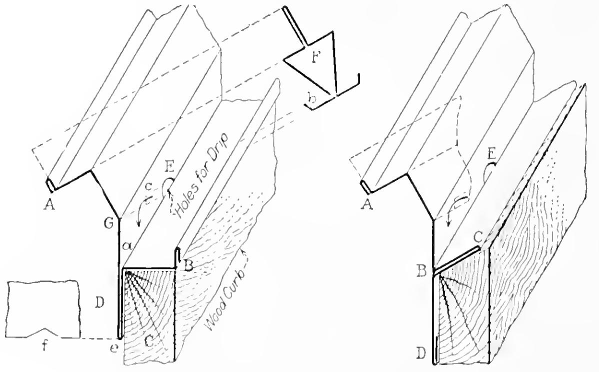


FIG. 303. FIG. 304.

FIGS. 303-4. Two Simple Forms of Curb for Flat Skylight.

This curb is bent in one piece from A to B to C to D with drip holes at E. Note that the wood curb is beveled at the top to suit the pitch of gutter B C, and that no joint is presented in the gutter to catch any drip as was the case at *a*, Fig. 303.

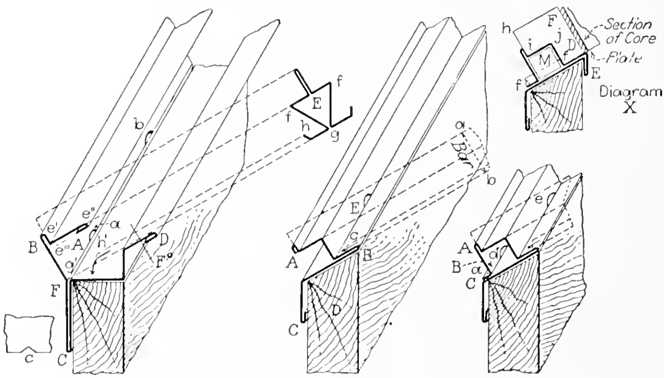


FIG. 305. FIG. 306. FIG. 307.

FIG. 305. Hollow Curb for Flat Skylight. FIG. 306-7. Two Forms of Curb for Larger Skylight.

A hollow form of curb is shown in Fig. 305, bent in one piece from A to B to C to D, with condensation holes punched at *a* and *b*. If the joint at F is not soldered on the inside notches should be made at the lower end of flange C at *c*, to allow the moisture to escape, which may enter at top of F.

In joining bar E to this style curb the corners f of bar E are notched as e' e'' e''' to allow the rabbet of the bar to rest upon the rabbet of the curb. The gutter h g of bar E is notched at the bottom, a distance indicated by h' g', allowing the drip from the bar to enter the gutter of the curb, as shown by the arrow. If desired flange h g of bar E may be riveted to flange D of the curb as indicated by F°.

A section of a curb is shown in Fig. 306 that is used for larger skylights and has the advantage of being easily bent; the weight of the skylight rests directly upon the main curb D, which must be cut to suit the bevel of the skylight. The curb is bent in one piece from A to B to C, with drip holes punched at intervals at E. The elevation of the bar is shown by the dotted lines a to b, the lower part of the bar resting directly upon flange B to which it is riveted, bringing the direct weight upon the curb D. The notch c indicated in the bar is for condensation outlet into the gutter of the curb.

A similar form of metal curb for heavy skylights is shown with Fig. 307 in which A B C is added, flange B C being riveted at a. In this case drip holes are punched at d, e, etc. When the skylight is of great span, provision is made to keep the metal curb from spreading by adding the double bend D E in diagram X. This is so bent that the metal curb slips over the flashed lower curb. Should the bars in the skylight contain a core as in Fig. 300, and as indicated by F D, Fig. 307, the metal curb is reinforced by the wood core M, and the core plate F D cut out so as to rest firmly on the metal curb, the cut being indicated by h i j f. In this case, where the wood core M is employed, holes are bored through M to admit the condensation tube f f. These tubes are made of soft copper to avoid rusting. The form of construction in diagram X is for skylights having great spans and long runs, and if wooden curbs are used as a base, they should not be less than 3 in. in thickness and well braced to prevent spreading.

A view is given in Fig. 308 of the various parts of a double pitched skylight using the bars and curb previously described. A is the ridge bar. B the cross bar or clip to support the glass in large skylights, where more than one length of glass is required. Leakage is prevented by means of the cross gutter, which conducts the condensation or rain into the gutters of the skylight bar; D is the common bar; the metal curb is set over the wood curb C as shown the curb C, of course, is first flashed.

With this form of construction, which gives great rigidity, any length of skylight can be constructed, similar to the one shown in Fig. 309, which is a double-pitched skylight with cross clips, 177 ft. long, 16 ft. 16 in. span.

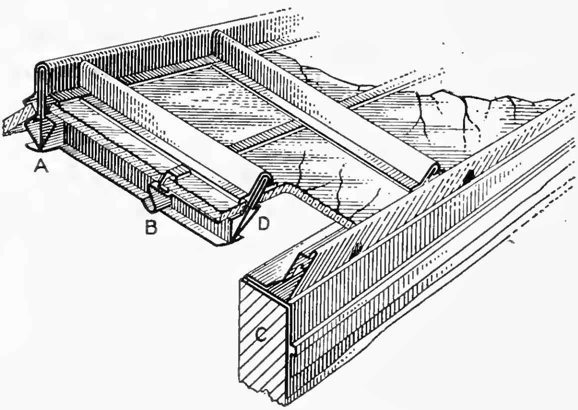


FIG. 308. Sectional View of Double Pitch Skylight.

When flat skylights are laid on steep roofs where no base curbs are employed and the line of the glass is to run flush with the line of the roof, the construction of the metal curb is the same as in Fig. 310, which shows a section taken through A B,

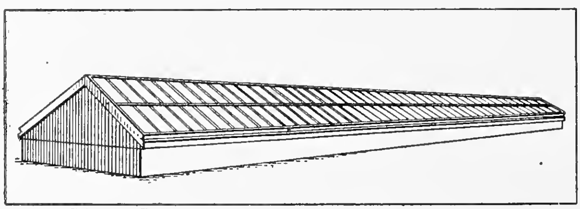


FIG. 309. Double Pitched Skylight With Cross Clips.

Fig. 311. Note how curb A, Fig. 310, is constructed. It is formed in one piece with a condensation gutter at B and riveted together at C. The metal capping over the glass is bent directly to the curb, as at D, and a lock attached at E on which to join the roofing.

The size of the curb is measured from the arrow point A to suit the opening in the roof. This curb rests upon the roof line F. The common bars are formed as indicated by H, allowing the top to pass under the metal capping of the top curb which is similar to D. Over the bar H a flat cap J is secured by copper cleats as previously explained. Cap J should also pass underneath the metal cap of the top curb. The condensation gutter of the bar H passes above the gutter of top curb A, Fig. 312, which makes a neat job and avoids mitering or notching the gutter of curb A.

As the water of the main roof flows over the glass, great care must be taken to solder all joints and cleats watertight. The glazing must also be carefully done, with the glass well bedded in white lead putty to avoid leakage.

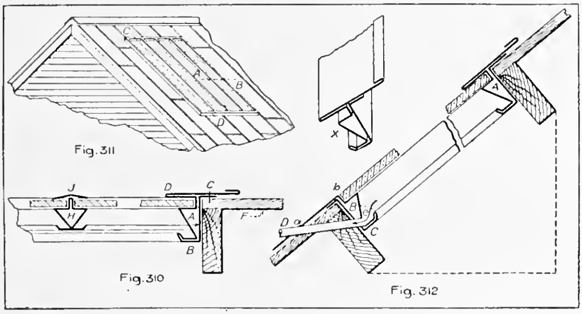


FIG. 310. Section Through A-B in Figure 311. FIG. 311. Flat Skylight Flush With Roof Line. FIG. 312. Section Through C-B Figure 311.

A section through C D, Fig. 311, is shown in Fig. 312, which also shows the top and bottom of the curb. The top curb A is similar in construction to the side curb A, Fig. 310, but the bottom curb B, Fig. 312, has the condensation gutter C as well as the glass stop *b* formed in one piece. When glazing at *b*, care should be taken to have a tight joint. Should any leakage occur it is taken care of by the condensation tube D, which is joined to the gutter at C, passing through the header and roof at D at a pitch to carry off the water. Care should be taken to solder tight around the roof at *a*.

When the condensation tubes are being put in the skylight is set and the holes marked, after which the curb is raised and holes bored at the proper angle through the roof, the curb reset and the tube, which should be made of copper, passed through from the outside and soldered at *e* and *a*. Should there be any danger of snow entering these tubes a small shield[1] can be placed over each outlet as shown by the dotted line *e*. A view of the top and side curb is shown in X. The patterns for a skylight of this kind are developed in similar manner, as already explained.

With the information given for forming the bars and curbs in the brake, the student should have no difficulty in forming the various shaped bars and curbs described. Practice is best obtained by cutting strips of metal about 2 or 3 in. wide having the required girth, and forming them in the brake until proficiency is attained.

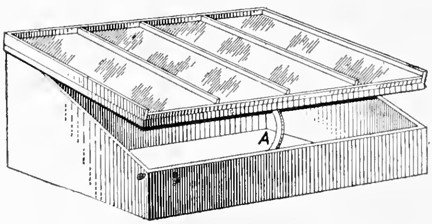


FIG. 313. Raising Small Flat Skylight.

CONSTRUCTION OF RAISING GEAR FOR SMALL FLAT SKYLIGHTS

When small flat skylights are to be used for light and ventilation, provision for raising them may be made similar to that in Fig. 313, in which a ratchet, A, is secured to the center part of

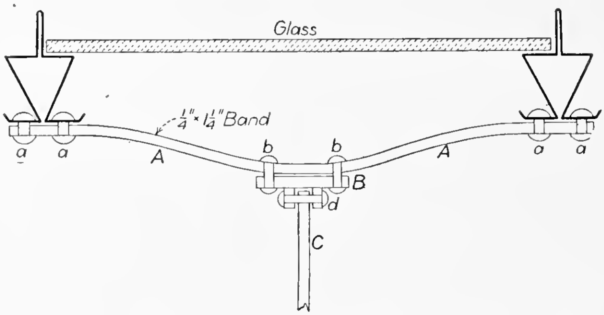


FIG. 314. Truss, Hinge and Raising Rod for Small Skylight.

the skylight bar as in Fig. 314, in which A A shows a truss shaped band made from ¼ x 1¼-in. band iron riveted to the two center bars at the lower flange at *a*, *a*, *a*, and *a*. In the center of A A a cast iron hinge, B, is riveted at *b* and *b*. These hinges may be obtained from dealers in skylight gearings. To hinge B a ratchet or raising rod C is pivoted at *d*, and while it can be made by hand it may be obtained cheaper from dealers or manufacturers, who call them skylight lifts. Such ratchets allow any small flat skylight to be opened and closed and locked automatically either way.

For these raising skylights a special hinge is required and may be made cheaply and quickly with a few pieces of band iron and rivets. Fig. 315 shows the parts of the hinge quarter size.

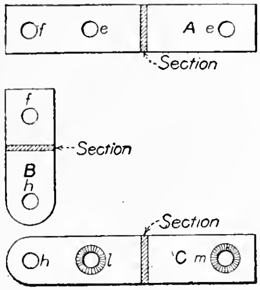


FIG. 315. Parts of Skylight Hinge and Details of Operations.

The band iron should be 1 in. wide by 3/16 in. thick and made in sections. The holes should be punched in the exact position shown. In the upper part A, two holes are punched at *e* and *e* to admit rivets ¼ in. in diameter. Hole *f* will correspond to *f*

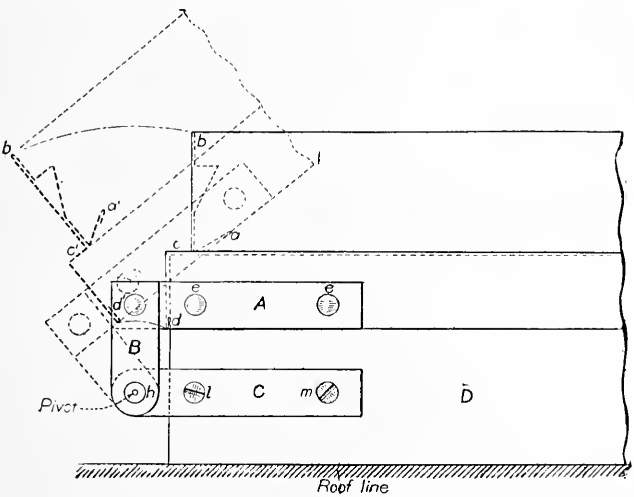


FIG. 316. Parts of Skylight Hinge and Details of Operations.

in the middle piece B; *f* in B is placed on *f* in A and riveted tight and rigid to form a right angle. The hole *h* in B corresponds to the hole *h* in C, and *h* in B is laid over *h* in C and riveted so as to allow *h* to act as a pivot in the hinge. In piece C the holes *l* and *m* are punched and countersunk on the outer side, to allow the heads of wood screws to be flush with the hinge surface.

Applying the hinge to the skylight and curb and the method of operation are shown in Fig. 316, in which D represents the that the upper part of hinge A is riveted to the flange *d* of the metal curb at *e* and *e* with flat head rivets inserted from the inside so as to have a smooth surface where flange *d* sets over curb D. A hinge being riveted at each side, the skylight is set over the base curb and screwed to the base curb at *l* and *m*. When raising the skylight *h* becomes the pivot upon which the hinge turns. The solid lines show the skylight closed and the

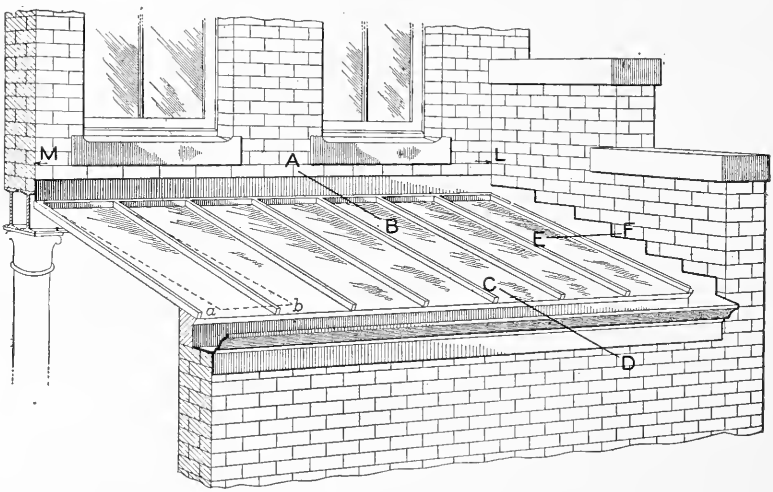


FIG. 317. Perspective View of Flat Extension Skylight.

dotted lines show the skylight open. Note how the metal curb *a b c d* is thrown away from the base curb, at *a' b'' c' d'*, the sweep being indicated by the dots and dashes. By using the patterns, Fig. 315, these hinges may easily be made by the student from scrap bands and punching the ¼-in. holes on the punch machine.

CONSTRUCTION OF EXTENSION SKYLIGHTS

A view of a flat extension skylight at the rear of a store or other building is presented in Fig. 317. The upper sides and the ends are flashed into the brick walls and pointed with waterproof cement, the lower side resting on the rear wall, to which it is securely anchored. The water flows into a molded gutter and a leader carries it to the ground or sewer connection. It is usually advisable to erect a wire guard over skylights so located to prevent breaking the glass by falling objects.

The method of obtaining the patterns for a skylight of this kind is similar to that already described, but shaping the various curbs and securing them is different from those previously described and will now be taken up. A sectional view is given in Fig. 318, taken through A B, Fig. 317, showing how the upper curb is formed when it is to rest direct upon the flange of the iron beam. In Fig. 318, A, shows the iron beam and B the formation of the upper curb. Note that this is bent in one piece with a standing lock at the top, the angle at the bottom being made to conform with the flange of the beam. The section of the skylight bar is shown at C and miters with the curb B. If desired a wood core, D, may be placed inside of curb B, the cores being cut to slide in easily.

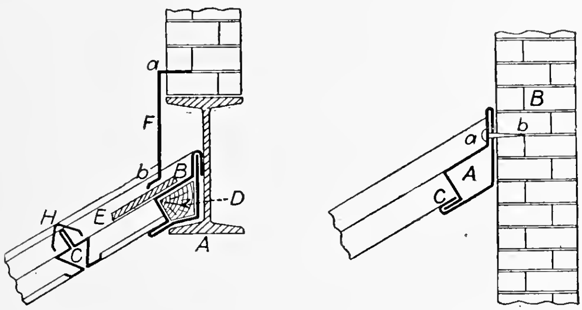


FIG. 318. FIG. 319.

FIGS. 318-19. Structural Details of Small Skylights.

When the skylight is of such size that it cannot be made complete in the shop it is usual to set it together at the building, in which case all measurements are carefully laid out so that the space between the bars will be equally divided. This being done glass E is laid in putty and a combination flashing and cap, F, placed over the glass flashed into the joint of the brick work at *a* and fastened with flashing hooks and cement.

When this work is being done the glass, of course, is all in place, and a number of planks are laid across the bars to avoid breaking the glass. The lower part of F forms a cap over the glass at *b*. When flashing F is secured, caps are placed over the skylight at H in the manner already described, and mitered to flashing F at *b* and then soldered. In this manner the upper part of the curb is made watertight.

Sometimes when a flat skylight is placed over a shaft or other enclosure, and is of small size, it may be fastened direct to the brick wall, Fig. 319, in which A is the curb, formed so as to have the lock come at the bottom as at C. Through the upper flange *a*, anchor nails are driven in the joints of the brick wall B as indicated by *b*. If these nails are placed 12 inches apart, it will be sufficient. The method of obtaining a watertight joint is similar to that in Fig. 318.

Spiking the upper curb to the wall on a large skylight would not afford the required strength to sustain the weight, and where no beam flange offers a bearing, provision must be made for a solid support. This can be done as shown in Fig. 320, in which an angle iron is secured to the wall by means of expansion bolts similar to that in Fig. 321. Securing the angle iron is done as follows: If ½-in. bolts are to be used, holes are punched into

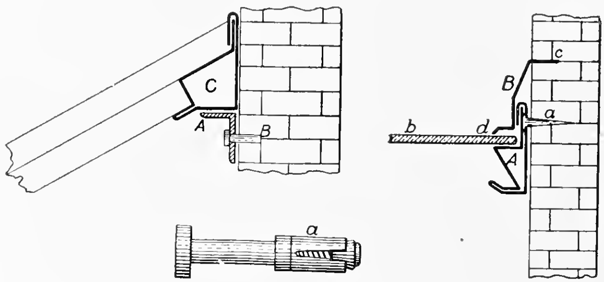


FIG. 320. FIG. 321. FIG. 322.
FIGS. 320-21-22. Details of Attaching Skylights to Side Walls.

the angle iron 9/16 in. in diameter, about 18 in. apart, the angle iron to be 3 x 3 x ¼ in., or heavier, according to the size of skylight. After the angles are punched they are held on the wall in their proper position and the holes marked on the brick wall. Holes are drilled about 3 in. deep in the wall, then sleeve *a* of the expansion bolts in Fig. 321 inserted, and passed through the hole in angle A, Fig. 320, and then screwed in the sleeve already in the wall, which causes the sleeve to expand, thus securing the angle to the wall at B. Upon this angle A curb C can be placed, and a wood core inserted in C if desired.

Where the side of the skylight in Fig. 317 butts against the wall, a half bar is used, Fig. 322, which shows a sectional view through F E in Fig. 317. Note in Fig. 322 the half bar A is bent in one piece with a lock at the top, through which, if the bar is long, it is nailed at proper intervals, as indicated at *a*. The joint between this bar and the wall is made watertight by the flashing cap B, which is flashed and cemented in the brick joint at *c* with the lower end covering glass *b* at *d*.

Three simple ways of constructing the lower part of the curb through C D, Fig. 317, may be used. The first, Fig. 323, gives the formation of the curb when it is to rest upon a cast-iron gutter furnished by the iron constructor; the second, Fig. 324, when it is to rest upon wood curbing furnished by the framer, and the third, Fig. 325, when it is to rest directly upon the brick wall, the sheet metal worker furnishing the gutter, curb, etc.: The student should carefully note the formation of these constructions, a knowledge of which will enable him to construct other shapes as occasion may demand.

In Fig. 323 A A shows the cast-iron gutter with a drip at *a* set over the wall. Drip *a* is placed so as to keep the water from flowing underneath the gutter and through the wall, should the gutter overflow. The metal curb B, or the lower part of the skylight, is formed from *b* to *c* to *d*, the groove *d* B filled with roofer's cement, and then clamped over the cast-iron gutter, the flange at *c* being riveted to the lower flange of the skylight bar C at *e f*. Holes are punched between the lights of glass as at *d*, to allow the condensation to escape, as indicated by the arrow. Care must be taken to form the curb B so that *c* will come above the upper line of the gutter as indicated by the dotted line *h*, so that if the gutter becomes clogged and the water rises it will overflow at A and not run inside the building. The gutter is usually drained to the inside by a cast-iron or copper pipe.

When the frame is constructed by the carpenter, as is usual, then the sheet metal construction is arranged as in Fig. 324, in which A is a wooden plate on which a curb 3-in. thick is fastened at B. Over this plate and curb the sheet metal gutter is placed. It is bent to the top of the wooden curb at D and with an ogee or any other shaped mold on the front to C. Care must be taken to have the top of the mold C lower than the top of the gutter at the rear D, shown by the dotted line and *a*, so that in case the gutter overflows the water will not pass inside the building.

To prevent the water from getting inside of the wall when the gutter overflows and to protect the wooden plate A, a drip angle is soldered to the bottom of the gutter at E. The front part of the gutter is held down by placing a few brass wood screws at *r* and nailing to the top of the curb D. Over this wood curb the lower metal skylight curb is set, having a shape shown by F, it being bent in one piece as from *b* to *c* to *d* to *e* to *f*, and flange *b* is riveted at *o*. The skylight bar H joins the curb, and is riveted through *m n*. At intervals a copper condensation tube

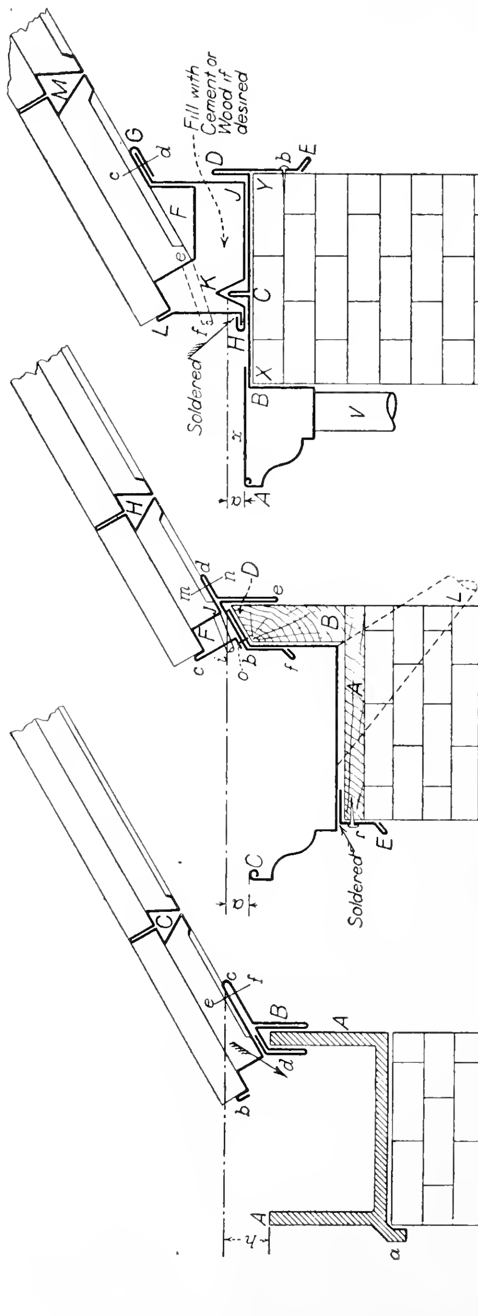


FIG. 323. FIG. 324. FIG. 325.

FIGS. 323-24-25. Methods of Fastening Lower Curb on Walls of Different Finish of Skylights and Attaching Gutter.

is placed at *j i*. By having the double flange *c* attached the curb is prevented from sliding. The outlet for the main gutter is carried to the inside by means of a tube L carried through the wall and connected to the drain pipe.

When the brick wall is left as indicated by X Y in Fig. 325 and no provision made for fastening the skylight curb, the wall is protected and the necessary curb constructed as follows: A sheet metal hanging gutter is hung over the wall shown by A B so as to cover the entire wall with a standing edge at C and D, and then turning down on the inside of the wall with a hem edge at E, nailed close to the wall at *b*. Braces are used to secure the gutter at *x* and the gutter outlet is shown by V. The standing edge at C prevents the water from flowing inside the building, the top edge of the main gutter A being placed below the top of C, indicated by the dotted line and *a*.

The lower curb of the skylight F can be made in two pieces, locked at H and G. The bottom and rear part of this curb is bent from H to K to J to G, the V-shaped form K being set over C. The front and top of the curb is formed from H to L to F to G, F being the gutter to catch the condensation, with outlets at *e f*. The lock at G is close tightly with the dolly and mallet, to which skylight bar M is riveted through *c d*. At H the lock is closed and soldered and the flange H is sweated to the gutter lining B C. While this curb is soldered to the gutter at H the standing edge C acts as a guard to prevent leakage should the seam along H burst at any point.

If the skylight is very large and heavy the hollow curb K J may be filled with cement or wood blocking at the building before it is set, say in 2-sheet lengths or 16 ft. About 2 in. from the ends should be reserved to join the seams.

With the information given about the various styles of curbs in flat extension skylights, the student should have no difficulty in devising other shapes, practicing in his spare time on his drawing board, and he should try to bend these shapes on the brake so as to acquire accuracy, which is vitally important. Bends which are not true make a lot of work in erecting on a building or in putting parts together, so that accuracy is imperative.

CHAPTER XXIV

Construction of Raising Sash for Flat Skylights

In the flat extension skylight shown in Fig. 317 provision is often made to use it for ventilation by raising one or more sashes, *a b*, hinged at the top with worm gearings on the inside and operated from the floor below. The sash is constructed so as to have watertight joints when closed. This necessitates a change in the construction of the skylight bar in which the sash is to operate, and the student will now refer to the one-quarter size detail in Fig. 326 (see Folder 7). A section view is included which clearly shows the quarter size sections of the various bars and curbs. At the right near the top the I-beam upon which the brick wall K is built is indicated by L, against which the upper curb G is fastened by either the method of Fig. 319 or 320.

Note the formation of curb G, Fig. 326. It is bent in one piece from 1 to 8. A wooden base curb M is shown at the left upon which rests the metal curb D, formed from one piece of metal from 1 to 10.

These two curbs D and C represent the lower and upper parts of the skylight frame, to which the full bars are fastened for the stationary lights as well as the half bars for the raising sash, Fig. 327. The shape of the bar in which the raising sash will operate is a half bar with full condensation gutters as in Fig. 326, section B. It is formed in one piece, as shown by the small figures from 1 to 9. Over this half bar B the sash bar is drawn with plenty of play room, as indicated by A, the formation being as shown by *m n o* 1 2 3 4 5 6 7. Note that 5 6 7 form the cap to set over the glass in the adjoining stationary light when the sash is closed and *m n o* sets in the condensation gutter 9 8 7 of the half bar B. Over this sash bar the sash cap C is fitted, as indicated by 10 4 3 11 12 13 forming a finish over the glass laid on the rabbet 1 2 of sash bar A. By referring to diagram X^3 the student will see these same sections with the parts somewhat extended which more clearly depicts the shapes of the parts. The cap C last referred to is indicated by C°.

Over the lower curb D, in the sectional view, sash curb E is drawn with plenty of play room to keep it from binding when in operation. Care should be taken to have the glass line 14 15 in E in line with line 1 2 in A.

The formation of curb E is shown from 11 to 18, holes being punched in the angle 16 to allow any condensation or leakage to flow into gutter 3 4 5 of curb D, thence to the outside through the tube at 4. The upper part of the sash curb is indicated by F F and the student's close attention is called to this formation. Note that the shape starts at 1 to 2, to 3, to 4, to 5, the distance from 5 to 6 being 1/8 in. more than the thickness of the glass used, as 6 7 8 is doubled over, forming a cap which makes a tight joint between the glass and curb at the upper part of the sash. Then 8 9 10 11 12 13 and 14 show doubled metal formed in a louvre shape, which, with the formation of the hood H, makes a watertight joint, whether the sash is open or closed, any snow or rain driven upward is caught by the louvre-shaped formation, thus preventing any leak at the hinged joint F^4. Should any snow or rain find its way in 2 3 of hood H it is carried to the outside through holes punched in the angles at 2 or 3 before bending.

To prevent rusting brass hinges are used for the raising sash. These hinges are riveted to the doubled metal at 8 9 and screwed to the hinge support, J, formed from 9 to 12, in which a wood core is placed. The height of 10 11 in J is regulated according to the size hinge used. Having this hinge support J separate from the curb G allows the entire raising sash of the desired dimensions to be finished complete in the shop and then J is set in between the half bars and soldered thoroughly to the half bars and curb G at the upper part, after which the sash can be raised or lowered, turning on the pivot in the hinge.

The hood H with flashing combined is made in one piece from 1 to 7 and flashed into the joint of the brickwork, where it is fastened with wall hooks and cemented with roofer's cement or paintskins.

The sectional view or diagram X^2 at the right shows the cap flashing over the stationary skylight in which the glass 2^A rests upon the rabbet of 1^A and is flashed by the cap 3^A, finishing in the brick joint, as previously described.

In the lower part of the detail the diagram X^3 shows a horizontal section through the sash with the half bars, sash bars and sash caps, showing how one fits into another.

The two half bars B^o, B^o, are shown with the glass of the stationary lights on their rabbets. Over these bars and glass sash bars A^o, A^o are raised or lowered. The glass of the raising sash is placed on the rabbets of the sash bars A^o, A^o, over which the sash caps C^o, C^o are slipped. This detail being reduced one-fourth size or 3 in. to the foot, the student should work out his full size detail carefully, when ready to lay out the patterns for the various parts.

The first pattern to be laid out is the lower metal curb D which is obtained by taking the girth of the lower curb D, shown by the small figures 1 to 10, and placing them on any straight line, as *a b* at the left, and adding an edge to 10 and 1. At right angles to *a b* draw lines in length about 6 ins., which will be used as the pattern for the lower curb D. As the condensation tube passes through and over angle 4 in the sectional view D, punch ¼-in. holes, tangent to line 4 in pattern for D between 3 and 4, at *r″*. When making this raising sash in the school a short piece is made, which demonstrates every point as if it were made full size, and the same course can be pursued by the home student. If the length of the skylight in question is to be 50 ft., as from L to M, Fig. 317, then the measuring points would be from 9 to 9° in the pattern for curb D, Fig. 326.

The pattern near the bottom for the upper curb G is obtained by taking the girth of 1 to 8 in that section and placing it on any line as *c d*, as shown by similar numbers, and completing the rectangle of any desired width. Knowing the length of the skylight as from M to L, Fig. 317, the measuring points in Fig. 326 would be from 7 to 7^o in the pattern for the upper part of curb G.

The girth is now taken for the hinge support J in the sectional view, as shown from 9 to 12, to 9, and place it on any straight line as *e f*, at the bottom, allowing an edge above 9 for lapping. At right angles to *e f* complete the rectangular pattern.

To obtain the length of this pattern J it is only necessary to know the distance between the half bars in diagram X^3, shown by the arrow points B° to B°. Assuming that this distance is 12 in., then make the distance from 12 to 12° in the pattern for the hinge support J that length, allowing a lap from 11 to 12 to solder to the half bar. Just as many hinge supports should be cut as there are sashes to be raised.

In the last three patterns no miter cuts were required, because the ends of the pieces butt against flat surfaces. In the patterns to be developed miter cuts will be required, and all are developed in this manner.

The pattern for the bottom of the sash is developed as follows: Take the girth of E in the sectional view, shown by the small figures 11 to 18, and place them on any vertical line as *g h* near the center, as shown by similar numbers, and allow an edge over the point 11. Complete the rectangular figure, making *i′ j′* any required length. As the lower part of sash curb E in section view from 16 to 18 is to miter with the gutter on sash bar A, take the projections from 7 to *n* and *l* to *m* with the dividers and place them on the corresponding lines in the pattern for the bottom of the sash, from *o′* to *n′* and from *l′* to *m′* on either side, and draw the miter cuts *o′*, *n′*, *m′*. Punch ¼-in. holes central over line 16, shown by *m″* and *n″*, which allows the condensation to pass through. If the width from center to center of the half bars B^o in diagram X^3 is 12 in. then the distance from *i′* to *j′* in the pattern for the bottom of sash should be ¼ in. less, or 11¾ in., indicated by the arrow pointed line *i* J″ in diagram X^3.

The pattern for the top of the sash F F in the sectional view is laid out by taking the girth from 1 to 14 and placing it on the vertical line *p r* at the right of the drawing and completing the rectangular figures *r″ s″ t″ u″*, making the distance from *i″* to *j″* equal to *i′ j′* in the pattern for the bottom of the sash or ¼ in. less than between the half bars in diagram X^3. As the lower part, 1 2 3, in the section view F F miters with the gutter in sash bar A, obtain the cuts N and O in the pattern for the top of the sash in the same manner as explained in connection with similar cuts for the bottom of sash E.

To avoid leakage at the hinged joint at F^4 in the sectional view the louvre-shaped formation in section F F from 8 to 11, to 14 is extended over the half bars on each side, not less than 2 in., as shown from a^6 to a^6 in diagram X^4, also in the pattern for the top of the sash as W″ V″ and in Fig. 328 at A. Allowing 2 in. on each side of the pattern for the top of the sash in Fig. 326 necessitates four notches to be cut. The height of these four notches will equal the height in the sectional view from the top of cap 7 8 in section F F to the top of the half bar A, also indicated by the arrows between *s*, and the width *t*, of the pattern, of all four notches is equal to width *t* in diagram X^3. When the pattern for the top of the sash is formed the two notches on each side will fit directly over one another.

When the location of the brick joint K^2 in the sectional view is known, that is, the distance the joint is above the glass line, then bend 6 of the hood pattern can be made in the brake. If this measurement is not known metal is added to the girth and bent at the building with flat pliers, roofing tongs or with a mallet over the edge of a beam.

Assuming that the location of the joint is known, the pattern for the hood is obtained by taking the girth from 1 to 7 in H and placing it on the vertical line u v in the pattern for H, allowing an edge below 1 for stiffening. This girth allows for the U-shaped formation to hook under the louvre-shaped formation in

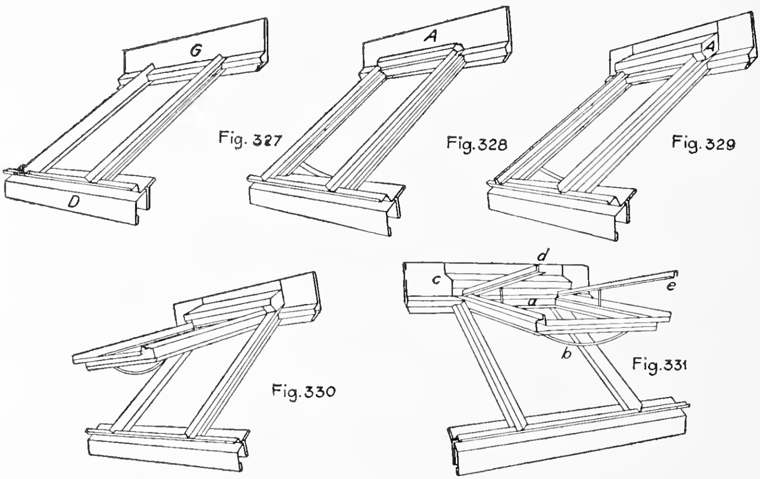


FIG. 327. Upper and Lower Curb with Two Half Bars Attached. FIG. 328. Sash Between Half Bar and Weather Guard at Top. FIG. 329. Hood Over Hinge Joint to Prevent Leakage. FIG. 330. Sash Raised. FIG. 331. Truss Under Sash and Bar Caps.

the sectional view F F, and the distance from b^t to b^t for the hood should be made 2 in. longer than from P to R in pattern for the top of the sash, which will bring it 1 in. on each side of the half bar, from b^6 to b^6 in diagram X^4

Referring to Fig. 329 it will be noticed that the end of hood A extends to the top line of the glass of the stationary light and a flat head is soldered to the end of the hood, which prevents rain and snow from driving in and allows the sash to be raised without interfering with the hood, Fig. 330. The open end of the hood minus the head is shown in Fig. 331 by c. The portion of the hood resting on the stationary light is added to the pattern for the hood in Fig. 326 by taking the girth from the corner 3 in the sectional view H to the point a^o on the glass line and placing it on the pattern for the hood from 3′ to a^o on each side, adding a double edge below a^o for stiffening and making the distance from a^t to 3′ not less than 1½ in., which will bring the hood 1½ in. to the right of b^6 in diagram X^4, at c^6, thus bringing the end of the hood 2½ in. on either side of the half bars.

A slot is cut in the pattern for the hood from b^t to a^t, because the center of the hood has a different shape from the ends, shown in sectional view H. A square bend is made on 3′ 3′ in the pattern for hood when forming, and the bend a^t, a^t drawn back to the angle 4 3 a^o in sectional view H. On line 2 or 3 in the pattern for the hood one or two ¼-in. holes are punched to allow any possible rain or snow to escape should it chance to blow in the angle 1 2 3 in sectional view H.

If the joint in the wall where the cap flashing will enter as in diagram X^2 is known, the girth of the flashing for the stationary lights is obtained from 1 to 5 in the cap 3^A and placed on the line A^2 B^2, at the top, as shown by similar numbers. At right angle to A^2 B^2 the pattern is drawn any desired width.

For the pattern for the head to be soldered in the end of the hood, as at A, Fig. 329, take a tracing of the head in Fig. 326, shown in the sectional view by 5, 4, 3, a^o, a^{oo}, 5 and place it at H^o by similar numbers. Edges should be allowed all around for soldering and stiffening.

To obtain the pattern for the half bar B, in the sectional view, take the girth of half bar B, from 1 to 9, and place on the line E^2 F^2 drawn at right angles to the pitch of the skylight, shown by similar numbers. Through these points at right angles to E^2 F^2 draw lines, intersected by lines drawn at right angles to the pitch of the skylight from similar intersection with curb D at the bottom, and from intersections with the upper part of curb G at the top. By carefully following the dotted lines the points of intersections will become clear. For example, 9 and 8 in half bar B is cut off at 9^o and 8^o in curb D a trifle above 18 and 17 in sash curb E, and from 9^o and 8^o lines are projected to the pattern on similar numbered lines.

The straight surface of 7 up to the top of the half bar B intersects the lower curb D at 4, 3, 2, 6^o and is reproduced in the pattern, shown by b^x, 5^v, 5^o, 6^o; the top point, also 5 and 4 of the half bar B intersect the line 2 6^o in the curb D and from this a line is projected to the pattern intersecting lines 6 5 and 4. All points from 4 to 1 in the half bar section B intersect 3 4 of the lower curb D, from which a line is porjected to the pattern intersecting lines 4 to 1. In a similar manner are the upper intersections obtained; 9 8 of the half bar B is cut off below the point 1 in the upper part of the sash F, while point 8 and the straight part from 7 up to the top of the half bar B intersect the upper curb G at 4, 5, 6 and 12 and is reproduced on the pattern, shown by 8^e, c^x, 5^e 5^f and 6^e. Then 4 to 5 and the straight part above 5 of half bar B intersect curb G at 12, 6 and 5, and from these points lines are projected to lines 6, 5 and 4 in the pattern. Points 4 to 1 in half bar B cuts curb G on line 5 4, from which a line is projected to the pattern.

A line traced through points thus obtained will be the pattern for the half bar B.

Knowing the length of the bar required from the line 4 5 in curb G to the line 3 4 in curb D, this distance is laid off and measurements are made from b^x to c^x in the pattern for half bar B.

To obtain the pattern for sash bar A draw any line at right angles to the pitch of the skyilght, C^2, D^2, upon which place the girth of the sash bar A, from *m, n, o,* 1, 2, 3, 4, 5, 6 and 7, shown by similar letters and figures on C^2 D^2. Through these points at right angles to C^2 D^2 draw lines which are intersected by lines drawn at right angles to the pitch of the skylight, from similar intersections on the bottom of the sash E and the top of the sash F, shown by the dotted lines drawn from sections E and F to the pattern for sash bar A. For example, *m* and *n* in the section A intersects section E at 18 and 17, which points are projected to the pattern on lines *m* and *n*.

Points *o,* 1 and 2 in section A intersects section E at 16, 15 and 14, which points are projected to the pattern on lines *o,* 1 and 2.

Points 2, 3, 4, 5, 6 and 7 in section A intersects section E at 12 and from this point the intersection is projected to the pattern to lines 2 to 7. The edge 13 14 in E represents the thickness of the glass and is set off on the pattern between lines 2 and 3 on the line projected from point 14 in E, as indicated by a^x in the pattern.

In a similar manner the student should follow the intersecting points between sash bar A and the top of sash F. A line traced through points thus obtained will be the pattern for sash bar A. The measuring points are indicated on bend *o* from d^x to e^x and should always be ½ in. less than the length of the half bar B, shown in the pattern from b^x to c^x. This ½ inch allows the sash to work easily between the top and bottom curbs G and D and also for the thickness of the metal and laps.

The pattern for the sash cap is obtained by taking the girth of 10 4 3 11 12 and 13 in section C and placing it on E^2 F^2, shown by similar numbers, and making its length from c^x to d^x as long as from c^x to d^x in the pattern for sash bar A.

This completes all patterns required for the raising sash, and in making up this exercise the student should make a sash the length of which will be as long as in the full-size detail and the width about 10 in. This will give the same practical knowledge as if the skylight sash were larger.

The forming of the sash bar A and the half bar B as well as the sash cap C, is done as explained in previous exercises. The method of forming the lower curb D will be illustrated and explained in detail. In Fig. 332 is shown the operation where the first bend is made on dot 7, turning the metal as far as it will go, from 10 to 10′. At 10 a hem edge has been bent as called for in profile D, which is a reduced reproduction of the curb D, Fig. 326. In Fig. 332 10′ 4 is reversed and placed in the brake

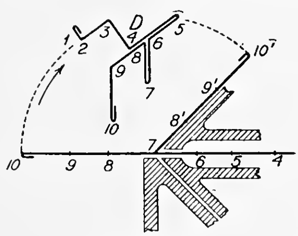


Fig. 332

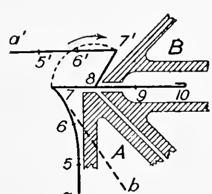


Fig. 333

Figs. 332-33. Consecutive Bending Operations in Forming the Finished Curb Shown at B in Fig. 337.

at 10 *b*, Fig. 333, in which case *b* will strike against the lower bending leaf A. In forcing 10 *b* so as to close the top clamp B, the part 7 *b* will curve as shown by 7 *a*. A bend is made on dot 8 as much as called for by angle 8 in the profile D, Fig. 332, when the curve 7 *a*, Fig. 333, will spring to its original shape as shown by 7′ *a*.

The partly formed member 10 *a*′ is now reversed in the brake in the position 10 4, Fig. 334, and a bend having the proper angle is made on dot 6, shown by 10′ 4. The bend 7′ is now closed tight in the brake and brought to the positions 10 7 5 in A, after which it is placed in the brake A 10, Fig. 335, and a bend made on dot 9 to suit angle 9 in D, Fig. 332, shown by 10 5′ in Fig. 335. It is then reversed as shown by 10 1, Fig. 336, and a square bend made as on dot 5. A hem edge is bent at 1 and the various square bends on dots 4, 3 and 2 are made as in D, Fig. 332, and by A, Fig. 337. At bend 5 the angle is turned and closed tight in the brake, as indicated by the arrow from 1 to 1′, which completes the forming of curb D, Fig. 332, shown in perspective by B, Fig. 337.

The bending of the lower part of sash E, Fig. 326, is simple

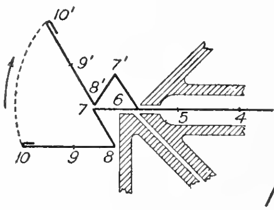


Fig.334

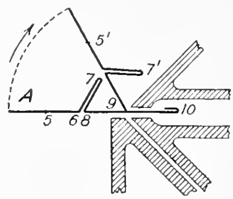


Fig.335

FIGS. 334-35. Consecutive Bending Operations in Forming the Finished Curb Shown at B in Fig. 337.

and needs no explanation. The bending of the upper part of sash F is somewhat complicated and will be demonstrated. A reduced reproduction of F is presented in Fig. 338, in which are shown the first, second and third operations in bending it. The first and second operations are to make a bend on dot 11, and close it tight in the brake, bringing dots 10 over 12, and 9 over

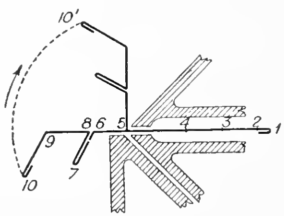


Fig.336

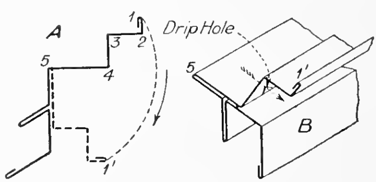
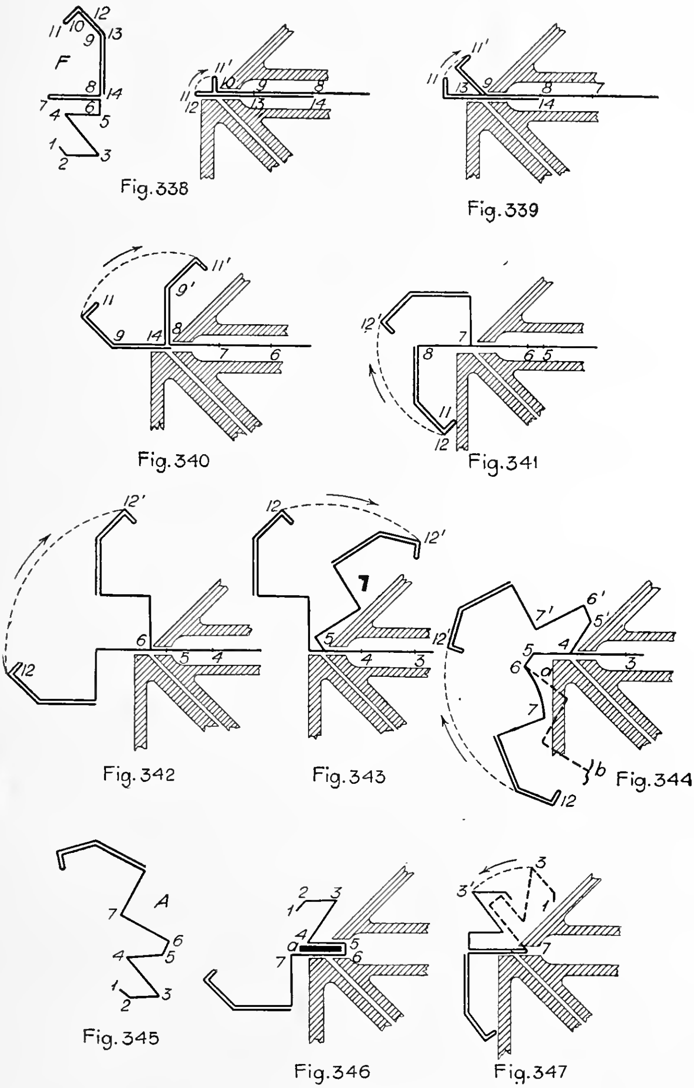


Fig.337

FIGS. 336-37. Consecutive Bending Operations in Forming the Finished Curb Shown at B in Fig. 337.

13. The third operation is to make a square bend on dots 10 and 12 from 11 to 11′. Leaving the sheet in this position in the brake, draw it out on dots 9 and 13, Fig. 339, and make a bend to the angle in F, Fig. 338, as shown by 11′ 7, Fig. 339.

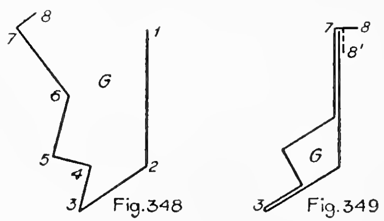
Again draw out the sheet to dots 8 and 14, Fig. 340, and make a square bend. Next reverse the sheet and make a square bend on dot 7 from 12 to 12′, Fig. 341. Reverse the sheet and make a square bend on dot 6, from 12 to 12′, Fig. 342. Leaving the sheet in the brake, close the top clamp on dot 5, Fig. 343, and turn bend 5 until bend 7 strikes the top clamp. Reverse the sheet and close the top clamp on dot 4, Fig. 344, but in doing so it will be found that the lower part 4 to *b* will have to be pressed



Figs. 338-39-40-41-42-43-44-45-46-47. Consecutive Bending Operations in Forming Upper Part of Sash F in Figure 338.

against the lower leaf which will give a slight curve between bends 6 and 7 shown by *a,* which will resume its original shape shown by 12′ and 4, when the bend on 4 has the angle called for by 4 in F, Fig. 338.

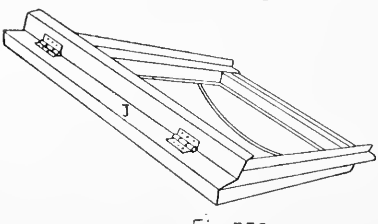
The bends 3 and 2 are made in the shape shown in A, Fig. 345. To close the groove 7 6 5 4 in A, Fig. 345, insert a piece of band iron having the proper thickness and close the top clamp over it, *a*, Fig. 346. The bend at 7 is now closed in the brake from 3 to 3′, Fig. 347, which completes the forming of the upper part of sash F, Fig. 338.

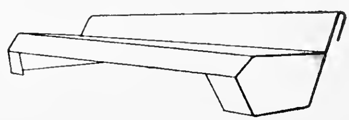


Figs. 348-49. Formation of and Finished Curb G.

The curb G in Fig. 326 is bent or formed as explained in connection with previous skylight bars and will have the appearance shown by G, Fig. 348. Bend 3 is closed tight in the brake, making the formation shown by 3 7 8, Fig. 349, after which 7 8 is turned over as indicated by 8′. The hood H and hinge support J in Fig. 326 are simple bends which require no explanation.

The various pieces having been formed, the method of joining the skylight is as follows, whether a small model is to be made as in this case or a large skylight for a building is to be built: After the curbs are in position at G and D, Fig. 327, the distances





Figs. 350-51. Hinges Attached to Sash and Curb and Weather Proof Hood for Hinge.

from center to center of the bars are marked on the curbs, and in this case the two half bars are soldered in position at right angles.

As the width between the half bars and their length are known, the sashes can be made complete in the shop and one flap of the brass hinges riveted to the upper part of curb F in Fig. 326. The other flap may be screwed to the wood core of the hinge support J, as in Fig. 350. These sashes when laid between the half bars will be shown in Fig. 328, with the rain or snow guard A uncovered. The heads are soldered to the hood, Fig. 351, and when hooked over guard A, Fig. 328, it will appear as shown by A, Fig. 329, and prevent leakage at the hinged joint in Fig. 350.

A view of the sash raised is shown in Fig. 330, while Fig. 331 shows the sash raised higher, and at *a* the groove bent in the

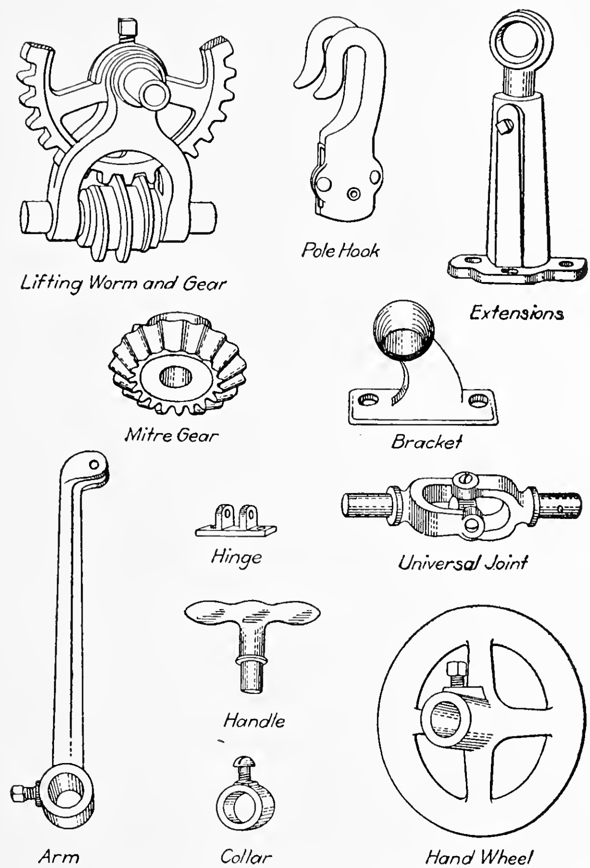


Fig. 352. Skylight Lifting Attachments.

upper part of sash to receive the glass. One side of the hood is open at *c*, while *d* and *e* are the sash caps raised, which are pressed down firmly when the glass has been slid into groove *a*. The band iron truss *b* is riveted to the bottom of the sash bars when the sash is to be raised or lowered by means of worm gearings. The detailed construction of the truss in diagram X^3, Fig. 326, shows that in this case the band iron truss is made of 3/16 in. x 1¼ in. band iron, properly bent and riveted to the walls of the sash bars. By riveting in the position shown, the drip, if any, is allowed to pass under the truss and along the condensation gutter without hindrance.

When the sash to be raised is long the sash bar is usually reinforced, as in diagram X^5, by a strip locked to the condensation gutter and soldered at *a*, after the truss is riveted in position. This makes a rigid construction. On the center of the truss a hinge is riveted, as

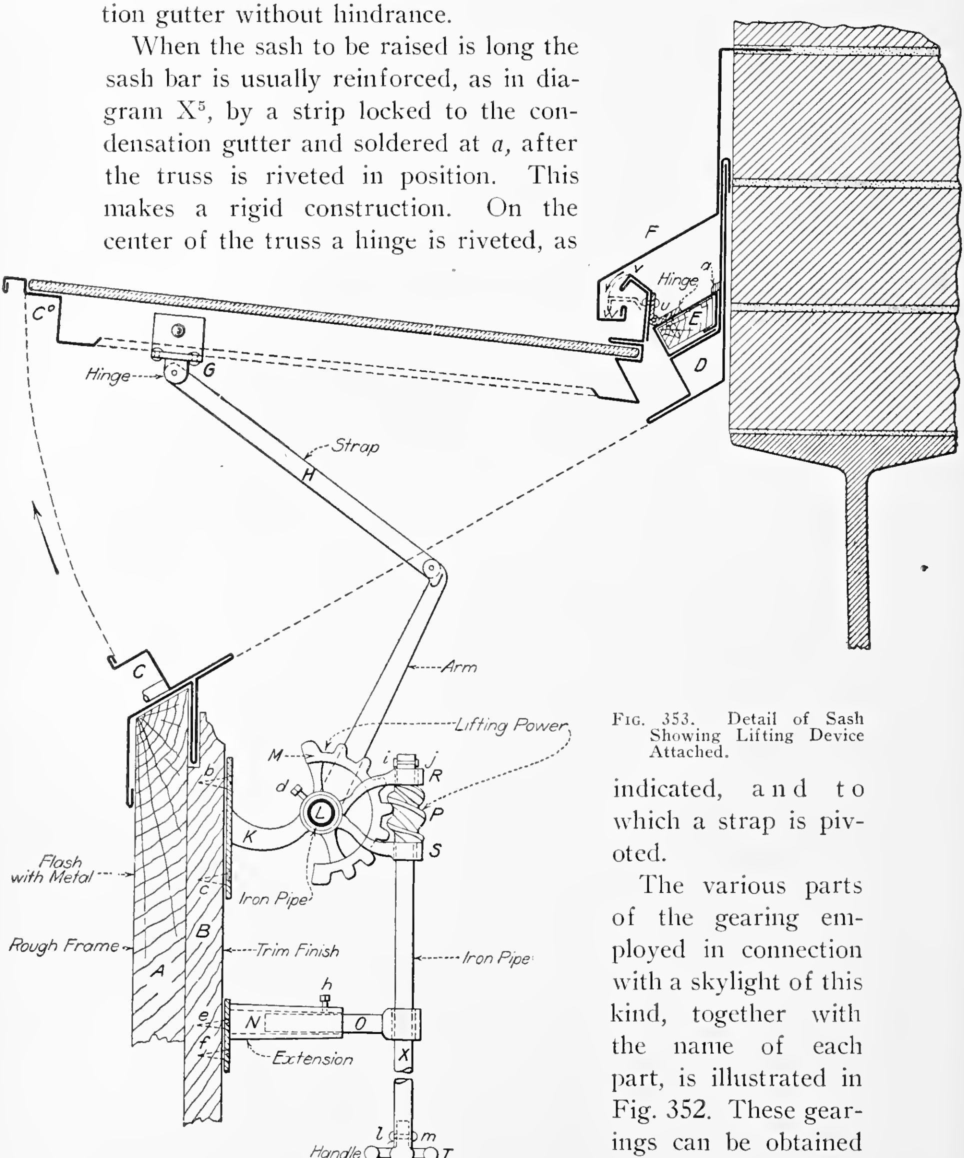


FIG. 353. Detail of Sash Showing Lifting Device Attached.

indicated, and to which a strap is pivoted.

The various parts of the gearing employed in connection with a skylight of this kind, together with the name of each part, is illustrated in Fig. 352. These gearings can be obtained in various sizes, the more usual being for ¾ in. or 1 in. pipes, outside diameters.

The method of setting the gearing when in use is shown in Fig. 353. A represents the wood frame which is flashed with metal, and over this the lower skylight curb C is set, when the finished wood trim B is put in position. The upper curb of skylight D, into which the hinge support E is thoroughly sweated with solder along a and the sides of the half bars. After E is securely fastened to the half bars the upper curb hood F is placed

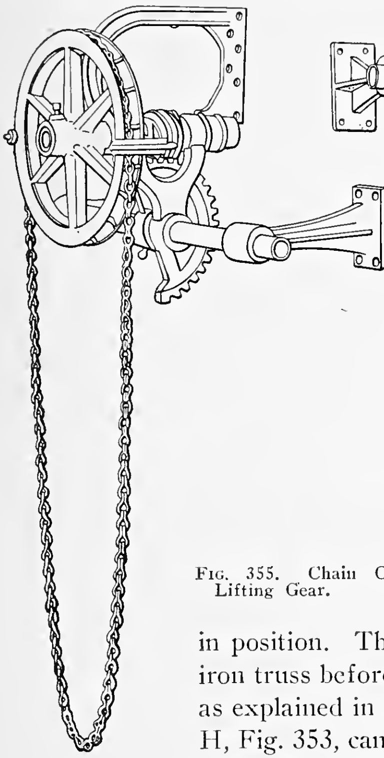


FIG. 355. Chain Operated Lifting Gear.

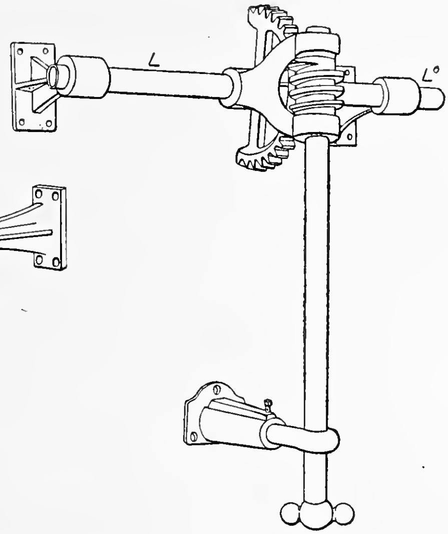


FIG. 354. Bar Operating Device for Single Sash.

in position. The hinge G is riveted to the band iron truss before the raising sash leaves the shop, as explained in diagram X^3, Fig. 326. The strap H, Fig. 353, can also be riveted to the arm before being sent to the job, the length of the strap and arm being regulated according to the height that the sash is to raise above C. Bracket K is fastened to the wood work with wood screws at b and c, and L is the section of the gas pipe passing through the bracket and to which quadrant M and the arm are fastened by the set screws d. The extension N is screwed to the wood work at e and f and is the guide through which the rod O slides, being fastened in position by the set screw h. The handle bar X and the handle T, are riveted to the iron pipe at l m. These are kept from the wall at any distance desired by means of rod O.

The quadrant M should be so fastened by the set screw d that when worm P is placed in position it can be turned to raise or lower the sash without passing outside of the teeth in quadrant

M. The worm P is held in position by the handle rod passing through the supports S and R, and projecting about ¾ in. above R. A pin, *i j*, is inserted to keep the pipe from slipping.

When the sash is being operated handle T is turned until the

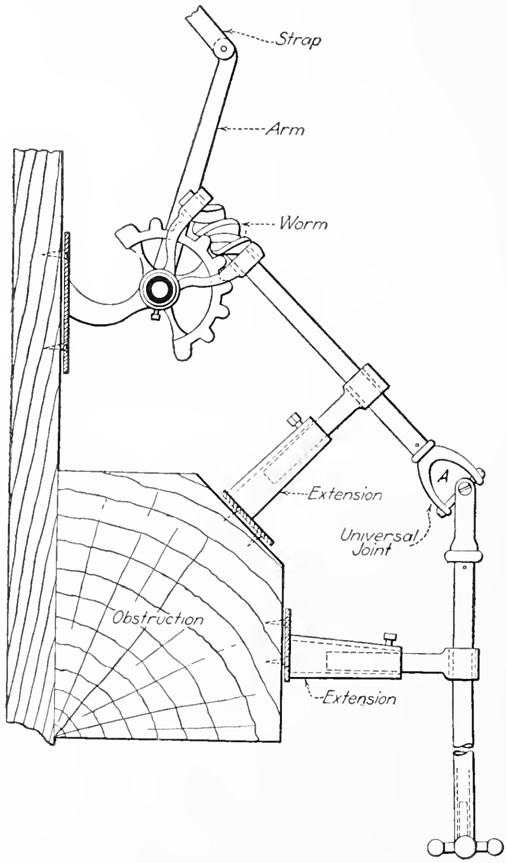


FIG. 356. Application of Universal Joint to Lifting Gear.

desired height from C to C^o is obtained, and the turn in the handle is reversed to close the sash. The turn of the sash takes place in the pivot of hinge U, which when closed brings V in the position shown by the dotted line W, insuring a tight joint. When handle T is too far above the floor a pole is employed, to which the pole hook shown in Fig. 351 is fastened.

When one sash is to be raised it is only necessary to use two brackets and a short piece of pipe, as in Fig. 354, pipe L L° being kept from moving from the brackets by placing at each end a collar with a set screw, as in Fig. 352. Where each alternate sash is to be raised in a long stretch a run of pipe is set into a number of brackets to secure rigidity, and a hand wheel shown in the illustration is secured to the end of the handle bar to enable more power to be applied in operating the sashes.

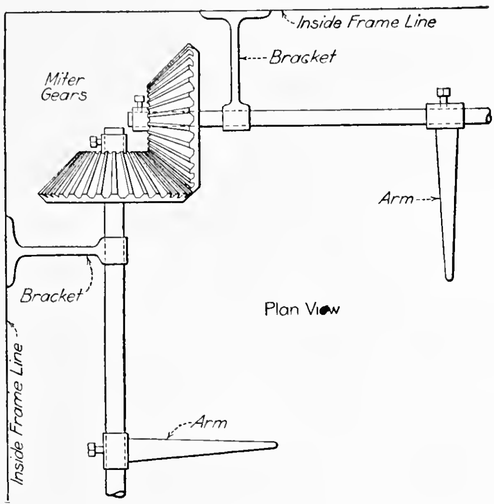


FIG. 357. Miter or Bevel Gear for Lifting Sash.

When it is not desirable to use the handle bar, or the sashes are too far above the floor to use the pole hook, or the number of sashes is such that more power must be used to raise them, the gearing in Fig. 355, can be used, which is a modification of the regular gearing with a wheel and endless chain of suitable length attached.

When a case arises in which the handle bar T, Fig. 353, cannot run down straight, owing to some obstruction, and must pass over this obstruction at an angle, the operation of the sashes is obtained through the universal joint shown in Fig. 352, the method of construction being clearly indicated in Fig. 356, in which A is the universal joint.

The miter gear in Fig. 352 is employed when the sashes in two or more sides of a skylight are to be operated with one lifting power, the method of placing this gear is indicated in Fig. 357. Any of these parts can be obtained from dealers in skylight gearings, and it would be well for the student to buy a full set, which he can obtain for a dollar or two, or he may borrow a set from a shop and then set them up for practice.

CHAPTER XXV

Making Hipped Skylights

The seventeenth exercise begins with Fig. 358 and covers all forms of hipped skylights with common, jack, hip, valley and ridge bars and a type with a ventilator at the ridge instead of the ridge bar. Also hipped skylights on turret frames containing fixed sashes or fixed louvres or movable sashes or louvres operating by gearing, chain or other devices. Any explanations in the last exercise on flat skylights, curbs, bars, gearing, etc., which are applicable to hipped skylights, are omitted in this exercise. The perspective view in Fig. 358 gives the student a good idea of what he is to make in sheet metal, namely, a hipped ventilating ridge skylight whose curb will measure 1 ft. 9 in. by 2 ft. 9 in. with a ridge ventilator 4 in. wide. The names of the parts in a hipped skylight are indicated by the letters A to E. Thus A is the ventilator, B the hip bar, C the jack bar, D the common bar and E the curb. The explanation on ridge and valley bars will be taken up separately. While the size of the skylight to be made is given in this case, the student will be instructed how to find the true lengths of the ventilator, ridge, hip, common, jack and valley bars, no matter what size the curb may be, using three different systems of measurement, namely, by the triangle, by scale measurements and by mensuration. The details of the skylight will be so arranged that the measurements of the bars will be taken upon the glass line so that in large work the glass can be ordered long before the skylight is completed. When the detail and patterns of the skylight are developed the sections of the various parts will be of a size that can be used for practical work. If the student has developed his patterns accurately he can employ them in shop use.

The half sectional view is drawn to a scale of 1½ in. to the foot, and shows the section of curb A, the common bar B and the various parts of the ventilator. The pitch of the skylight, as will be noted, is one-third; that is, the height on its center line is one-third the span. Fuller instructions on pitches will be given. Half size sections of the curb and common bar are shown to the right at A and B, the ¼-in. C H indicating ¼ in. condensation hole to be punched where indicated. When drawing the detail the full size section of curb A will be slightly changed so as to bring the curb line perpendicular to the glass line which facilitates obtaining the glass measurements. The small perspective marked H B represents the hip bar, to which an extra member has been added, shown by the arrow, allowing jack bar C in the perspective view, when mitering against

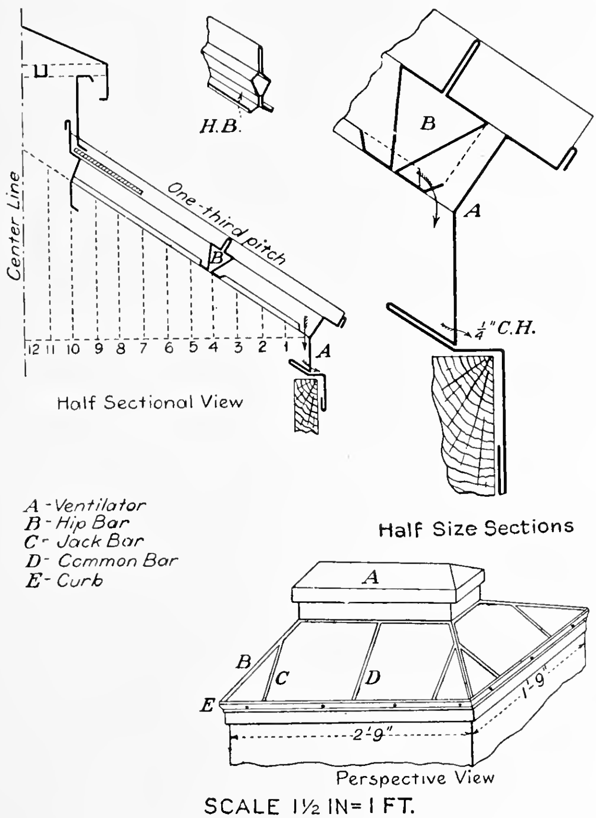
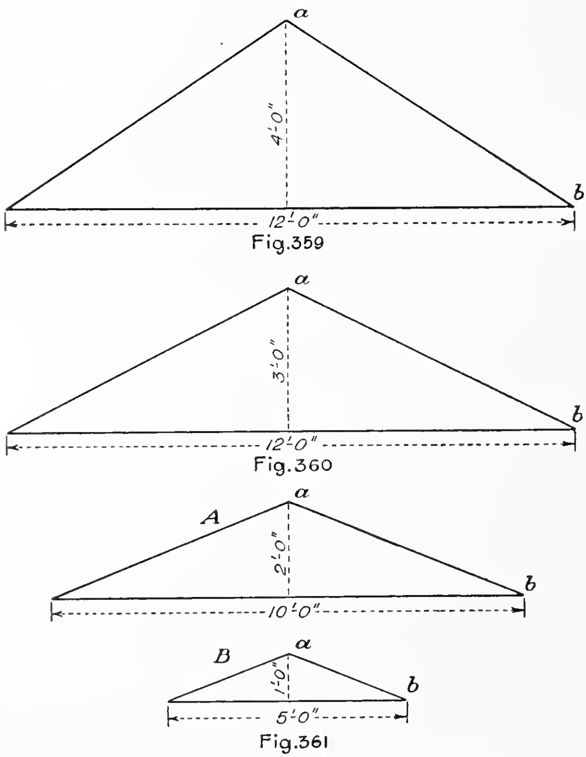


FIG. 358. Perspective and Sections of Hipped Skylight.

hip bar B, to pass above the gutter of the hip bar and in no way interfere with the flow of the drip in either. A sketch showing this construction and mention of same is made later.

From the amount of work shown in the shop detail some students get the impression that there is something very difficult about laying out hipped skylight work. This is not so, the only difficult part being to project the various points to the plan, thence into the oblique view for obtaining the hip bar which becomes a simple matter if careful attention is given to the instruction. In this case the skylight is to have the regulation one-third pitch. If however, it is desired to make it one-fourth or one-fifth or any other pitch it is only necessary to divide any given span by the number the pitch is to have to get the height. For example, if the span of the skylight is 12 ft., as in Fig. 359, a third pitch would rise on the center line one-third of 12, or 4 ft. Should



FIGS. 359-60-61. Methods of Obtaining One-Third, One-Fourth, and One-Fifth Pitch for Skylights.

a fourth pitch be desired then the rise on the center line of a 12-ft. span would be one-fourth of 12, or 3 ft., as in Fig. 360. Suppose a fifth pitch is desired, and the span is 10 ft. as in Fig. 361, then one-fifth of 10 is 2 ft., or the rise in diagram A. It makes no difference what the span may be, always divide the span by the desired pitch as in B, where the span of 5 ft. is divided by the fifth pitch, giving a rise of 1 ft. Thus *a b* in Figs. 359, 360 and 361 show 1/3, 1/4 and 1/5 pitches.

When drawing the shop detail for a one-third pitch skylight draw any line as A B shown in Fig. 362 (see Folder 8), and from any point as C draw the horizontal line C O equal to 12 in. Double 12, which makes 24, and divide by 3, or the pitch desired, which gives 8, and make the distance from C to D equal to 8 in. and draw the hypotenuse of the right angle triangle D O. Then D O represents one-third pitch. Next draw the section of curb E, placing the edge of the glass line upon the point of the triangle O, making the formation of the curb as shown. This makes the curb of different shape from that in the half size sections in Fig. 358, as previously explained. Any other shaped curb could be placed at E, Fig. 362, similar to those in Figs. 303 to 307, in the last exercise. The profile similar to the half size bar B in Fig. 358 is now drawn in the detail in Fig. 362 upon the line D O, or glass line, as indicated by F, it being immaterial on what part of the line D O, section F is set, so long as the rabbet or glass lines 3, 2, 3 are on the line D O. Next from the 1½-in. scale drawing in Fig. 358 take the heights and projections of the various parts of the ventilator and place these measurements as shown by G, H, J and K in the shop detail in Fig. 362. The section of the inside ventilator is placed a distance of 2 in. from the center line, as at G, H the outside ventilator ¼ in. over the inside ventilator and J the hood 1½ in. over the inside ventilator. Section K shows the U-shaped brace, which supports the hood while resting on the outside ventilator.

The one-half sectional view being drawn, the patterns for the parts of the ventilator will be developed upon the line A′ B′. Take the girth of 1, 2, 3, 4 of hood J and place it upon the line A′ B′, from 1 to 4, through which draw horizontal lines. Measuring from the center line A B in the sectional view, take the horizontal projections to points 2, 3 and 4 in J, using the dividers, and place these distances on each side of line A′ B′ on similar numbered lines. A line traced through points thus obtained will be the pattern for hood J. In similar manner take the girths of the outside ventilator H and inside ventilator G in the sectional view, numbered from 5 to 9 and from 10 to 13, and place them upon the line A′ B′, shown by similar numbers, through which horizontal lines are drawn indefinitely. Again, measuring from the center line A B, take the horizontal projections to points 5 to 9 in H and 10 to 13 G and place them on similar numbered lines, measuring on each side of line A′ B′, resulting, when a line is drawn through points thus obtained, in the patterns for outside ventilator H and inside ventilator G. Referring to the sectional view, it will be noticed that cap 8 9 of section H sets over the glass a' b', necessitating the notching of this cap 8 9 as high as that from 8 to 8° or as much as the outside ventilator sets over the common bar. Therefore, take this distance from 8 to 8° and set it off in the pattern for outside ventilator H, from 8 to 8° on both sides, about ⅛ in. wide, as indicated by the shaded part. This notch allows H to set over the hip bars. The method of cutting this notch in the long side of the ventilator will be explained. The girth of brace K in the sectional view is placed on the line A′ B′, shown by similar numbers, the length of the brace being made as long as the hood pattern J. This completes the full set of patterns for the ventilator, whose various measuring points are indicated by *a b, c d, e f* and *g h* for the brace K, hood pattern J, outside ventilator H and inside ventilator G, and will be used when laying out the desired lengths, which will be determined later on.

The student will next devote himself to the development of the pattern for the curb E by taking the girth of *a* 2 3 4 *b c d e f g* and placing it as shown by similar letters and figures on the vertical line L M. Through these points at right angles to L M, horizontal lines are drawn. Through *c* in curb E or any other point, erect the vertical line *l m* and from this line measure the horizontal projections to points *a* to *g* in E and place them on similar lines, measuring to the right of line L. M. Trace a line through points thus obtained, which will give the miter cut or pattern for curb E. The drip hole is punched above the bend *b* as shown by *y;* the measuring point of the curb is the arrow *n*.

The pattern for the common bar F is next in order. Note that the lower part of the bar joins curb E at 1 2 3 4 5 and 6, the condensation gutter of bar F being cut out as indicated by 4 5 6 at the bottom to allow the drip to escape to the gutter 4 *b c* of curb E, thence to the outside through tube *x*. The upper part of bar F joins the inside ventilator G as shown by 1 2 3 4 5 and 6. Knowing the points of intersection at the bottom and top, take the girth of the full bar F, from 6 to 1 to 6 and place it on line O P drawn at right angles to the pitch of the bar, as shown by similar numbers. Through these figures at right angles to O P draw lines, intersected by lines drawn parallel to O P from similar intersection in curb E and ventilator G. Trace a line through these points, and *t u w x* will be the pattern for the common bar.

Before the hip bar can be developed, a plan view showing the intersection between the hip bar and curb and the ventilator must be drawn, as in the quarter plan below the sectional view. As the angle of the skylight is to be a right angle, then from any points as D^1 on the center line A B draw the hip line at an angle of 45 degree, which is the bisection of the right angle, and intersect this line by a vertical line projected from point 1 in the sectional view in curb E, at 1 on hip line D^1 a^v. From a^v in plan draw the horizontal line a^v B, and from D^1 draw the horizontal line D^1 a^t and D^1 B and D^1 a^t will represent the center lines in the quarter plan and a^f a^v and a^v B the extreme outline in plan.

From the intersections between the common bar F and curb E in the sectional view, indicated by 1 2 3 4 5 and 6, project lines to the plan cutting the hip line D^1 a^v, shown by heavy dots, from which draw lines parallel to a^v B to the center line. In a similar manner from the intersections between the common bar F and ventilator G in the sectional view, indicated by points 1 2 3 4 5 and 6, drop vertical lines to the plan cutting the hip line D^1 a^v, shown by the heavy dots, from which points lines are drawn parallel to D^1 a^t to the center line. Note that 1, 2, 4 and 5 fall on one line, D^6.

Take a tracing of the common bar F in the sectional view and place it in plan upon the hip line, in the position F^1. The student should understand that bar F^1 will not represent the section of the hip bar, but is placed in this position to obtain the horizontal projections of the hip bar only. Number F^1 similar to F, and parallel to the hip line in plan, through 1 to 6 in F^1, draw lines intersecting similar lines previously drawn from the curb E and ventilator G, from 1 to 6 at a^v and 1 to 6 at t, and which represents the plan view showing the intersection or miter between the hip bar and curb and hip bar and ventilator.

Having obtained these miter lines draw the true elevation of the hip bar as follows: Parallel and equal in length to D^1 2 in plan, draw any line as C^1 2 at right angles to which from C^1 erect the line C^1 D^2 equal to C D or 8 in. Draw a line from D^2 to 2 in the true elevation of the hip bar, which represents the true length of the hip line D^1 2 in plan on a one-third pitch skylight. From the intersections 1 to 6 in a^v and from 1 to 6 in t in plan, erect lines indefinitely to the true elevation of the hip bar at right angles to D^1 a^v. Measuring from line C 2 in the sectional view, take the distances to points 1 to 6, showing the intersections between the common bar F and curb E, and place them on similar numbered lines erected from the plan in a^v, measuring in each instance from line C^1 2 in the true elevation.

In a similar manner, measuring from the line C 2 in the sectional view, take the distances to points 1 to 6, showing the intersections between the common bar F and ventilator G, and place them on similar numbered lines erected from the plan in *t*, measuring in each instance from line C^1 2 in the true elevation. Through these intersections trace the miter line 1 2 3 4 5° and 6° at the top and bottom, and if the intersections are true the lines connecting similar points at the top and bottom will be parallel to D^2 2, shown by lines drawn from 1 to 1, 2 to 2, 3 to 3, etc., in the true elevation of the hip bar.

To strengthen the hip bar and to make allowance for the condensation gutter of the jack bar to pass over the condensation gutter of the hip bar, as explained in diagram H B, Fig. 358, a distance of ½ in. will be added below intersections 4, 5° and 6° in the true elevation in Fig. 362, placed at right angles to C′ 2, as 4°, 5 and 6 at the top and bottom, and connect these points by lines. It should be noted that a greater distance could be added to the hip bar than ½ in., which would, however, necessitate making the distance from 4 to *b* curb E and 4 to 12 in the ventilator G a correspondingly greater distance so as to receive the hip bar.

The true profile of the hip bar is obtained by taking a tracing of the normal or common bar profile F and placing it at right angles to D^2 2 in the true elevation of hip bar F^3, numbered from 1 to 6. From the small figures at right angles to D^2 2, draw lines intersecting similar lines shown. A line traced through these intersections at R will give the true profile of the hip bar, with the ½-in. allowance from 4 to 4°. This makes a strong hip bar on which there will be no choking of condensation gutters, as clearly shown in Fig. 363, in which A is the hip bar, *b* the gutter and *a* the allowance; B the jack bar mitering to the hip bar at A and crossing above the gutter *b*, the object desired.

The pattern for the hip bar is obtained by taking the girth of hip bar R, Fig. 362, and placing it at right angles to D^2 2 on the lines S T, shown by similar figures, through which at right angles to S T, lines are drawn and intersected by lines parallel to S T from similar numbered intersections in the miter lines at top and bottom in the true elevation of the hip bar. A line traced through these points, U V & Z Y, will be the pattern for the hip bar.

For the pattern for the jack bar, draw any line in plan as a^e b^e at right angles to the line of curb a^t a^v, upon which place a duplicate of the common bar profile as F^2, numbered from 1 to 6 as in similar profiles. Through these points parallel to a^e b^e draw lines, which intersect similar numbered lines through the projections of the hip bar in plan, as shown by the short cut from 1 to 6 and the long cut from 1 to 6, which represents the miter joint between the hip and jack bars in plan. From these intersections parallel to the center line B A erect lines into the sectional view, partly shown, until they intersect similar numbered lines drawn through the profile F of the common bar. The intersections of the short cut 6 to 1 in plan or 1^a, is shown in the sectional view

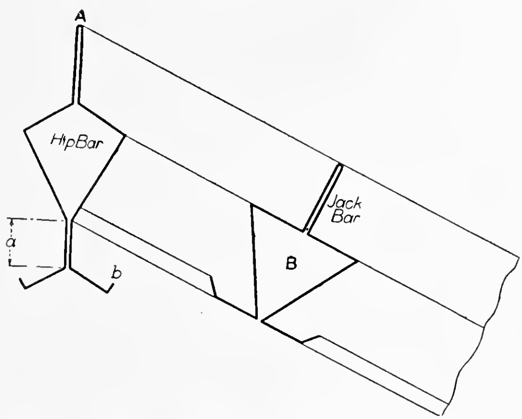


FIG 363. Diagram Showing Allowance in Hip Bar to Let Jack Bar Pass Over Gutter in Hip Bar.

by the miter line 1 to 6; and the intersection of the long cut 1 to 6 or 2^a in plan, by the miter line 1 to 2 to 3′ to 4 to 5′ to 6′ in the sectional view.

At right angles to D 2 in the sectional view from the intersections of the short miter cut 1 to 6 and the long miter cut 1 to 6′ lines are drawn intersecting the common bar pattern on either side from 1° to 6° for the short cut and 1° to 6′ for the long cut, as shown by the dotted lines. A line traced through points 6′ to 1° to 6° is the miter cut of the jack bar mitering with the hip bar. The lower cut of the jack bar mitering with curb E is similar to the lower cut on the common bar.

This completes the developments of all patterns required for constructing hipped skylights having one-third pitch with ridge ventilators, the bars placed similar to those in Figs. 364 to 367, the intersecting bars being shown in detail in diagram A^x, Fig.

362, in which the intersection $g\ f\ g$ of the common bar shows the miter with the ventilator G, shown in pattern for common bar by $t\ 2°\ u$. The intersection between the hip bar and ventilator G by the miter line $b\ a\ b$ in diagram A^x, is shown in the pattern for hip bar by U V &. The intersections between the jack bar and hip bar are shown in diagram A^x by the miter line $e\ c\ d$, and in the pattern for jack bar by 6′ 1° 6°.

When the hip bars join in a skylight without a ventilator or a skylight with a ridge bar, as Fig. 368, then another cut will be necessary in the hip bar through $c\ t$, as shown in diagram

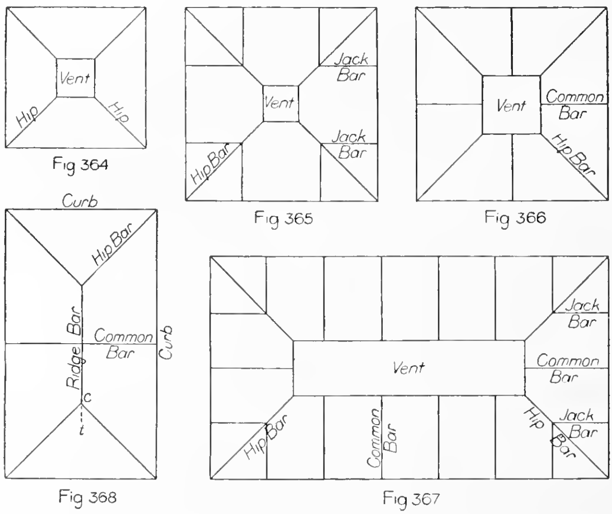


FIG. 364. Type with Ridge Ventilator and Hip Bars. FIG. 365. With Ridge Ventilator, Hip and Jack Bar. FIG. 366. With Ridge Ventilator, Common and Hip Bars. FIG. 367. With Ridge Ventilator, Common, Hip and Jack Bars. FIG. 368. With Ridge Hip and Common Bars.

A°, Fig. 362, where the two hip bars join the ridge bar and form the miter line $d\ c\ t$ on both sides. The cut $d\ c$ is seen in the pattern for hip bar from & to V or V to U, but the intersection $c\ t$ between the two hip bars in diagram A° is obtained by extending the line 1 2 4 5 in plan, outward to t, which will intersect the plan of the hip bar at 3° 6° and 5°. From these intersections at right angles to $D^1\ a^v$ lines are erected until they intersect similar numbered lines in the true elevation of the hip bar $3^x\ 5^x\ 6^x$, the balance of the intersections, 1, 2, 4 and 4° being in similar position as previously obtained. From the intersections $3^x\ 5^x$ and 6^x lines are drawn at right angles to D^2 2 intersecting similar numbered lines in the hip bar pattern, as shown on either side by $3^t\ 5^t\ 6^t$

and 3^v 5^v 6^v and would be the cut required if four hip bars were joined as in diagram A^b where the miter or joint lines between the 4-hip bar are indicated by *c t;* 6^t 5^t 3^t V and U is also the miter cut for the two hip bars of diagram A°.

In Figs. 369 to 374, are shown several other types of skylights that may be required in practical work, with the names and positions of the various bars. All these miter cuts are shown in the shop detail in Fig. 362, the detailed plan of intersections being shown in diagram A°. The ridge bar requires no miter cut, but is cut off at a right angle by *a b,* forming a lap under the hip bars *d a* and *d b*.

The true profile of this ridge bar is shown by G^a and is simply the halves of the inside ventilator G in sectional view placed together. The pattern for the ridge bar at the right of the ventilator patterns contains double the girth of the inside ventilator from 11 to 13 in the pattern for inside ventilator G, from 13 to 11 to 13 in the pattern for ridge bar G^a. When laying out the length of the ridge bar it is measured from 11 to 11′.

If a center jack bar is required, as in Figs. 371 and 372, the miter line between the jack and hip bars would show in diagram A°, Fig. 362, as indicated by *c f* on both sides and would require the long cut of the jack bar on both sides of the pattern by 6^v 5^v 4 3^v 2 1° 2 3′ 4 5′ 6′ for the jack bar. If a common jack bar were required, as in Figs. 372, 373 and 374, the miter line between the bar and the hip and ridge bar would show in diagram A°, Fig. 362, by *c f* and *c h* and would require on one-half the bar, the miter cut between the common bar and ventilator and on the other half of the bar the long miter cut of the jack bar, as shown in the pattern for common bar by *t* 2° and 2° *s r z p*.

The lower miter cuts between the hip, common and jack bars with the curb, are similar for any of the styles in Figs. 364-374.

Having all the cuts for any skylight, the student will learn how to obtain the true lengths of the bars no matter what size curb the skylight may be, by means of the triangles in the sectional view and hip bar elevations in the shop detail in Fig. 362. The triangle in the sectional view is D C O, the base C O is 12 in. long, divided into 12 parts and each part into quarters, thus representing the quarters, halves, and full inches, from O to 12. From these divisions vertical lines are erected intersecting the hypotenuse or slant line D O. It is from this slant line that the true lengths of the common and jack bars are obtained.

The triangle in the true elevation of the hip bar is C′ D^2 O, the base C′ O, is as long as the hip line D′ 2 in plan, previously obtained from C O in the sectional view. As C O in the sectional view is 12 in. long, then C′ O in the true elevation of the hip must also be divided into 12 equal parts from O to 12, and each

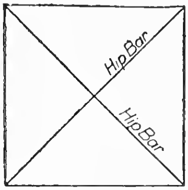


Fig. 369

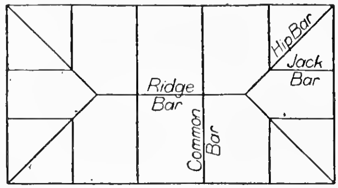


Fig 370

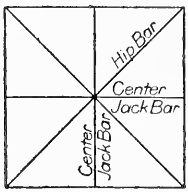


Fig. 371

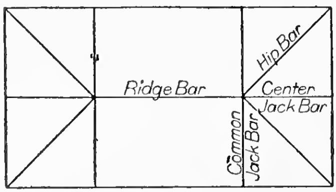


Fig. 372

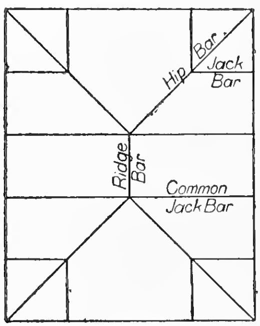


Fig. 373

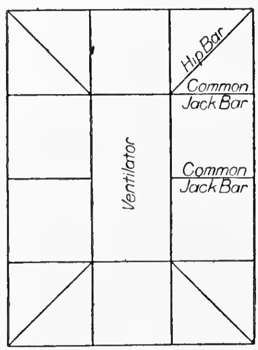


Fig 374

FIG. 369. Skylight with Four Hips. FIG. 370. Skylight with Hip, Rideg, Common, Jack Bars. FIG. 371. Skylight with Hip and Center Jack Bars. FIG. 372. Skylight with Hip, Ridge, Center, Jack and Common Jack Bars. FIG. 373. Skylight with Ridge, Hip, Jack and Common Jack Bars. FIG. 374. Skylight wtih Ridge Ventilator, Hip, Commen and Common Jack Bars.

of these parts must be divided into quarters. From these divisions lines are erected at right angles to C′ O until they intersect the hypotenuse or slant line D^2 O. From this line D^2 O the true lengths of the hip bars only are obtained.

There are certain rules to follow in finding the lengths of the ventilator, ridge, hip, common or jack bars, and before this can be done the size of the curb and the width of the inside ventilator must be known. These dimensions form the basis for obtaining the lengths of the different parts of the hipped skylight. The seven rules which the student should observe are as follows:

Rule I. To obtain the true length of the inside ventilator G in the sectional view deduct the shortest side of the curb from the longest side and add the width of the inside ventilator.

Rule II. To obtain the true length of the outside ventilator H in the sectional view, add to the length of the inside ventilator previously obtained twice the projection that H sets over G, or twice ¼ in.

Rule III. To obtain the true length of hood J in the sectional view, add to the length of the inside ventilator twice the projection that the hood sets over the inside ventilator, or 3 in.

Rule IV. To obtain the true length of the ridge bar G^a, Fig. 362, deduct the shortest side of the curb from the longest side.

Rule V. To obtain the measuring length of the common and hip bars when a ventilator is used, deduct the width of the inside ventilator from the shortest side of the curb and divide by two.

Rule VI. To obtain the measuring lengths of the common and hip bars when a ridge bar is used, divide the shortest side of the curb by two.

Rule VII. To obtain the measuring length of the jack bar use dimensions which will be given with Fig. 377.

While the ventilator in the detail is made in three parts, sometimes it is made in one or two parts. In Fig. 375 it is made in two parts, the lower part being bent from A to B with a cap bent double shown by *c d*, to protect the joint between the glass and metal against leakage, the hood being made as usual. With this style ventilator the portion *a b* of the bar must be notched at the top to slip between the doubled cap flange *c d*.

To obtain the length of this ventilator, Rule I is employed after the width from point D is known. The length of the hood is obtained by adding twice the projection *e f* to the length of the ventilator. When the ventilator is made from one piece, as is sometimes done, Fig. 376, being bent in one piece from A to B and holes punched along C D as indicated by *a a*, etc., then Rule I is used to obtain the length of the ventilator. Measurements are made from the arrow point E. To prevent insects and snow from passing into the holes *a a* convex wire mesh pieces are soldered to the outside, as in F.

The instructor figures out the first skylight for the student, after which two examples are given with and without ventilators for the students' study.

To show the practical application of the foregoing rules the student should figure out the various lengths required for the skylight in the lesson shown in the perspective view in Fig. 358, being 1 ft. 9 in. x 2 ft. 9 in., with a 4-in. wide ventilator.

After the size of the curb and width of the ventilator are known, prepare a rough sketch, as in Fig. 377, giving the title of the various parts of the skylight as well as the divisions of

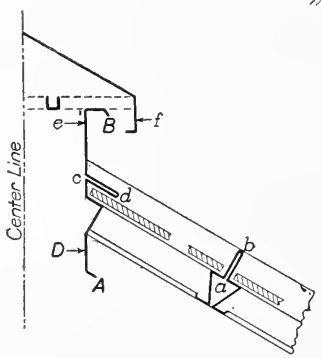


FIG. 375.

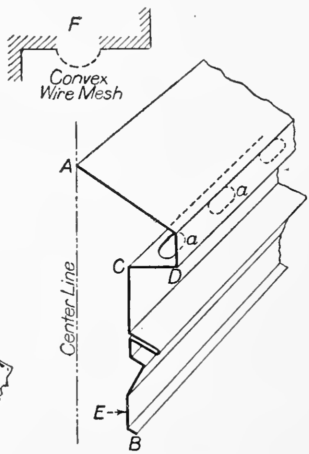


FIG. 376.

FIG. 375. Ventilators Made in Two Parts. FIG. 376. Ventilator Made in One Piece.

the glass. Thus in the diagram, A the outline of the skylight curb, is drawn with the measurements reduced to inches, or 21 x 33 in. Draw a rough outline of the ventilator, B, in this case 4 in. wide. Connect the hips as shown. The rule to follow in obtaining the glass divisions is as follows: Divide the narrow side of the curb into the desired divisions, in this case three, making each space 7 in., showing that two jacks will be required.

If the jack bars are 7 in. from the corners on the narrow side, they must be placed 7 in. from the corners of the wide side, so that they will meet at the hip and form a right angle. As the two divisors *a* and *b* in the wide side amount to 14 in., deduct 14 from 33, which leaves 19, and suggests two divisors of 9½ in. each, thus requiring one common bar on each side. Thus to build the skylight shown will require 4 hip, 2 common and 8 jack bars, the jack bars being formed right and left.

Following the rules previously given, the dimensions of the parts of the skylight are computed as follows: The size of the curb being 1 ft. 9 in. x 2 ft. 9 in. and the width of the inside ventilator 4 in., the length of the inside ventilator is obtained by following Rule I. Thus the longest side of curb 33 in., minus shortest side of curb, 21 in., leaves 12 in., plus width of inside ventilator, 4 in., gives the true length of inside ventilator, 16 in., as in Fig. 377.

The length and width of the outside ventilator is obtained by following Rule II; thus 4 in., width of inside ventilator, plus twice 1/4 in., equals 4 1/2 in., also 16 in., length of inside ventilator, plus twice 1/4 in., equals 16 1/2 in., as in Fig. 377.

The length and width of the hood is obtained by following Rule III; thus 4 in., width of inside ventilator, plus two times projection of 1 1/2 in., equals 7 in., width of hood, and 16 in., length of inside ventilator, plus two times projection of 1 1/2 in., equals 19 in., length of hood, Fig. 377.

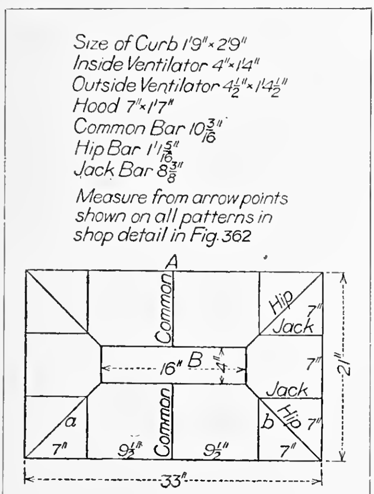


Fig. 377. Getting Various Dimensions of Skylight Parts.

To obtain the measuring length of the common and hip bars, Rule V is employed, thus, shortest side of frame minus width of inside ventilator = 21 — 4 = 17 in., and 17 in. divided by 2 leaves 8 1/2 in., the measuring length for common and hip bars.

To obtain the true length of the common and hip bars, the triangles in Fig. 362 are used. For the common bar use the triangle in the sectional view, following the base line C O to 8 1/2, the measuring length, then upward to where it intersects the hypotenuse D O, and it will measure from this intersection to O, 10 3/16 in., the true length of the common bar in Fig. 377. Using the same measuring length of 8 1/2 in. and the triangle in the elevation of the hip bar in Fig. 362, follow the base line C^1 O to 8 1/2, then upward to where it intersects the hypotenuse

D^2 O and it will measure from this intersection to O, 13 5/16 in., the true length of the hip bar in Fig. 377.

The true length of the jack bar is obtained by using the measuring length in Fig. 377, or 7 in., and the triangle in the sectional view in Fig. 362; follow the base line C O to 7, then upward to where it intersects the hypotenuse D O and from this intersection to O or 8⅜ in. will be the true length of the jack bar in Fig. 377.

This completes the dimensions of the pieces required for the skylight shown in Fig. 377, the measuring points being indicated by the arrows in the patterns in Fig. 362.

The two examples given to the student to figure out are presented in Fig. 378 and Fig. 381 and should be carefully studied, for it is important that he understand these simple rules, which will make him independent of any chart or books in which measurements are given, but cannot be proved, unless the student has the knowledge which this exercise should impart.

A skylight is shown in Fig. 378 with a curb measuring 3×5 ft. with a 5-in. ventilator. The length of the inside ventilator is found by using Rule I, thus, $60 - 36 = 24 + 5 = 29$ in. The length of the outside ventilator is found by following Rule II, thus, inside ventilator is 29 and $29 + (2 \times \frac{1}{4}) = 29\frac{1}{2}$ in.

As the pattern for hood J, Fig. 362, is laid out for a 4-in. inside ventilator, and the skylight in Fig. 378 calls for a 5-in. inside ventilator, then to obtain the pattern for the hood for a 5-in. inside ventilator, take one-half the difference between the 4-in. and the given size, 5 in., in this case ½ in., and place it in Fig. 362 in the sectional view of the hood J from 2 to 2^o or the dotted section line of the hood.

If the given size of the inside ventilator were 8 in. or any other size, take one-half the difference between the 4 and 8, which would be 2, and place it from 2 to 2^o to obtain the extra girth of material required for the top of hood 2^o 1. The reason for this is because the shop detail has been laid out for a ventilator 4 in. wide on the inside, one-half or 2 in., shown in G in the sectional view.

Take the girth from 2^o to 1 in the section of hood J and place it in the pattern for hood J from 2 to 1^o. Then measuring from the center line A B in the sectional view to 2^o, in hood J, place this distance in the pattern for hood J, on either side of the center line A^1 B^1, as 2^o and 2^o, and draw the dotted lines, which represent the pattern for the end of the hood for a 5-in. inside ventilator.

It should not be forgotten that whatever the width of this hood may be the pattern for brace K must always have a similar width, and in this case would have to be lengthened to the width 2^o 2^o of the hood pattern J.

To obtain the length of the hood for the skylight in Fig. 378, follow Rule III, thus: As the inside ventilator equals 29 in., 29 + (2 × 1½) = 32 in. when measured from c^2 to d^2 in pattern for hood J, Fig. 362.

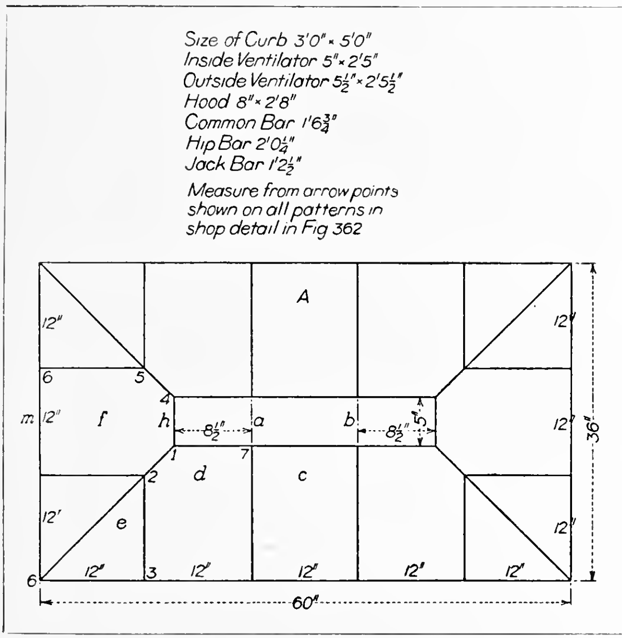


FIG. 378. First Example for Student.

To obtain the measuring lengths of the common and hip bars in Fig. 378 follow Rule V, thus:

$\frac{31}{2} = 15\frac{1}{2}$ or 1 ft. 3½ in.

To obtain the true length of the common bar use the triangle in the sectional view in Fig. 362, where the 12 in. on the base line equals 14½ in. on the hypotenuse, or to be strictly accurate, it is 14.42, but 14½ can be safely used for practical work. The 3½ in. on the base line equals 4¼ in. as shown on the hypotenuse. Then 14½ + 4¼ = 18¾ in., Fig. 378.

Using the same measuring length of 1 ft. 3½ in., obtain the true length of the hip bar by the triangle in the true elevation of hip bar in Fig. 362, where the 12 in. on the base line measures 18¾ in. on the hypotenuse, and the 3½ in. on the base line 5½ in. on the slant line; then 18¾ + 5½ = 24¼ in., Fig. 378.

In Fig. 378 the student will find that the jack bar is placed 12 in. from the corner. This becomes the measuring length mentioned in Rule VII with which to proceed to the triangle in the sectional view in Fig. 362, where 12 in. on the base line equals 14½ in. on the slant line, giving the true length of the jack bar in Fig. 378.

When the inside ventilator is long and a number of common bars intersect it, as at *a* and *b*, it is well to place cross braces between the common bars on the inside of the ventilator at *a* and *b*. These braces keep the ventilator from sagging, thereby causing a collapse of the skylight, and in skylights where the length of the ventilator is less than 6 ft. metal braces can be inserted between the common bars. These braces should be bent in rectangular form as in the sectional view in Fig. 362, indicated in G by I, II, III and IV. No pattern is shown for this brace, as it is simply a rectangular section as long as the width of the inside ventilator.

In large skylights where the surface is large and exposed to great pressure, the inside ventilators are sometimes made 2 ft. wide, and must be reinforced by angle iron frames, as in Fig. 379, where angle iron having unequal legs is used, forming the sheet metal part *a b*, then flanging around the angle iron on the inside as shown. This forms a solid bearing, against which bar A can rest without collapsing. Additional support must be placed between the common bars *c, c, c, c,* Fig. 380, where cross angles *b* and *b* are riveted to the frame *a*. This secures a firm support which will withstand snow, wind pressure, etc.

The second example for the student to figure is Fig. 381, which shows a skylight 6 ft. x 8 ft. in size, without a ventilator and with a ridge bar. This will indicate how to find the length of one or more jack bars whether spaced equally or unequally.

The true length of the ridge bar is obtained by using Rule IV, thus, 96 — 72 = 24 in., the length desired.

To obtain the measuring lengths of the common and hip bars when no ventilator is employed, use Rule VI, thus, 72 ÷ 2 = 36, or the measuring length with which to proceed to the triangles for obtaining the true lengths of the common and hip bars in Fig. 362. As 12 in. on the base line of the common bar triangle represents 14½ in. on the hypotenuse, then 36 in. on the base line will be 3 times 14½, or 43½ in., the true length of the common bar, Fig. 381.

Again, as 12 in. on the base line of the triangle for the hip bar in Fig. 362 measures 18¾ in. on the hypotenuse, then 36 in. on the base line will equal 3 times 18¾ or 56¼ in., the true length of the hip bar, as in Fig. 381.

Two size jack bars are shown in Fig. 381, each spaced 14½ in. apart, so that the true length of jack bar No. 1 will be doubled for jack bar No. 2. As the measuring length of the first jack bar is 14½, or 12 and 2½, then use the triangle for the common bar in Fig. 362, and it will be found that 12 in. on the base line measures 14½ on the slant line, and 2½ in. on the base measures 3 on the slant. Then $14\frac{1}{2} + 3 = 17\frac{1}{2}$ in. the true length of jack bar No. 1, Fig. 381.

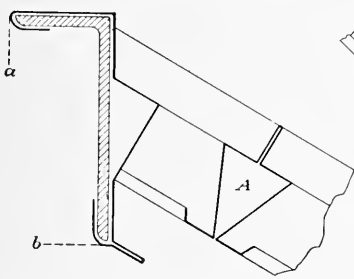


Fig. 379.

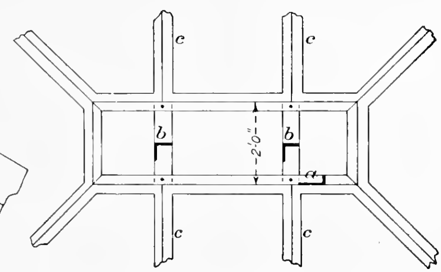


Fig. 380.

Fig. 379. Reinforcement of Ventilator. Fig. 380. Plan View of Reinforced Ventilator.

As the second jack bar is also placed 14½ in. apart, the true length of jack bar No. 2 is twice the length of No. 1, or 35 in., which is proved by adding the distance the second jack sets from the corner, or 29 in., the measuring length, being equal to $2 \times 12 + 5$. Twelve in. on the base of the triangle for common bar in Fig. 362 equals 14½ on the hypotenuse and 5 on the base line equals 6 on the slant. Then $14\frac{1}{2} + 14\frac{1}{2} + 6 = 35$, the true length of the second jack bar in Fig. 381.

Sometimes the jacks are not equally spaced, as *a* and *b*, Fig. 381, where *a* is 12 in. from the corner and *b* 17 in. from *a*. The same rule is applied as before, following the base of the triangle for the common bar in Fig. 362, the length of the slant line at the intersection 12 is 14½ in., the true length of jack bar *a*, Fig. 381. To find the true length of the second jack *b*, simply add the two divisions 12 and 17 and 29 in. is the measuring length, with which proceed to the proper triangle and obtain the true length of jack bar *b* in the same manner as for No. 2.

These rules apply to any size skylight having any width ventilators. It makes no difference whether they contain ridge, common, hip, jack, center jack or common jack bars.

When the curb of the skylight is equal on all sides, that is, perfectly square, if it contains a ventilator it will also be square, equal to the given width of the ventilator desired.

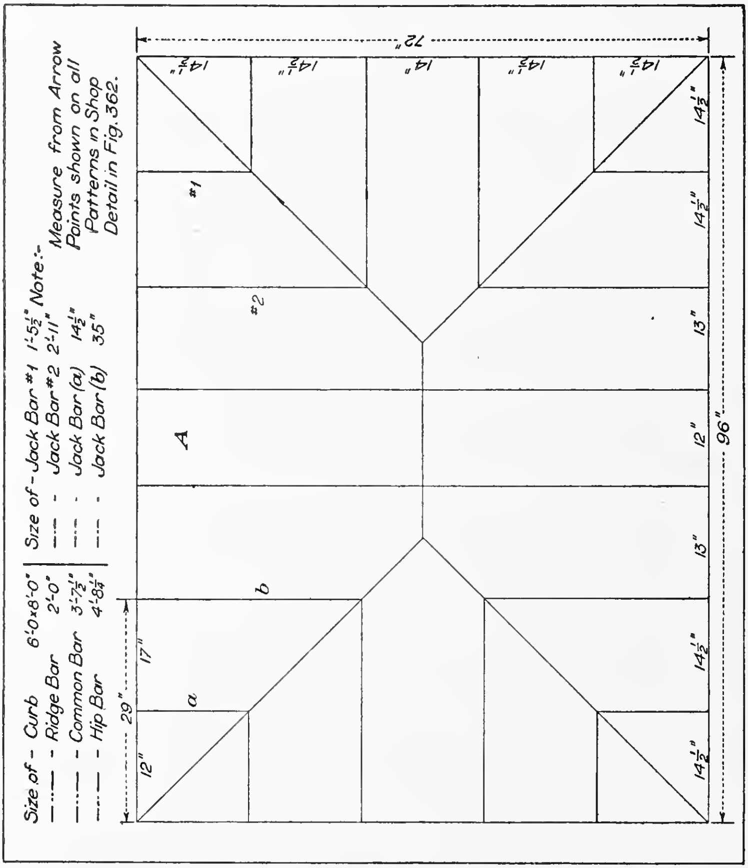
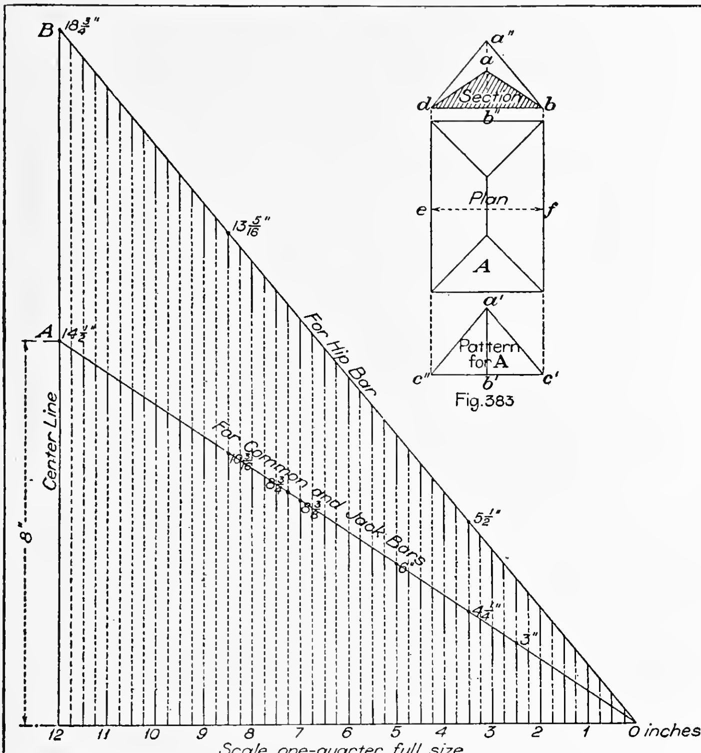


FIG. 381. Student's Second Example in Getting Various Dimensions of Skylight,

The second method of obtaining the true length of bars is by placing the two triangles on one base line as in Fig. 382. These triangles are drawn for one-third pitch and are similar to those in Fig. 362, but obtained in a different manner. If patterns were at hand for pitch skylights it would be an easy matter to construct the two triangles shown, by simply changing the rise to 6 in. instead of 8 in. as now done.

Draw the line *o* 12 equal to 12 in., Fig. 382, and erect line 12 A at right angles, making 8 in. for 1/3 pitch and draw line A *o*, from which obtain the true length of the common and jack bars. Take the distance A *o* and set it off on the center line from 12 to B and draw line B *o*, from which to obtain the true length of the hip bars. If the student will compute the lengths of the bars



FIGS. 382-3. Method of Obtaining Lengths of Skylight Bars.

for the three skylights of the sizes given in Figs. 377, 378 and 381 he will find that similar lengths will be obtained from Figs. 362 and 382.

The principle involved in finding the two triangles in Fig. 382 is explained in Fig. 383, in which A is the plan, say, of a raised cover, the section indicated by *d a b*, the rise *b″ a* being of *e f*. Then *a b* represents the amount of material required for one side, and in a skylight represents the length of the common bar A *o*, Fig. 382. If the distance *a b* is placed on the line *a′ b′*

at right angles to *c f*, measuring lines drawn through and intersected by points *e* and *f* in plan, thus obtaining *c'* and *c''*, then lines drawn from *a'* to *c'* and *c''* will form the pattern for the end A and *a' c'* will be the miter line, and the true length of the hip line.

The same pattern could be obtained by taking the distance from *a* to *b* and placing it in the section from *b''* to *a''*, drawing lines from *a''* to *b* and *d*. This is exactly what was done in Fig. 382. The distance *o* A has been placed from 12 to B, thus obtaining the true length of the hip line B *o*.

Another method of finding the true lengths of the bars is by scale drawings, and is the method used in many shops, illustrated in Fig. 384 which shows a ½-in. scale drawing of a skylight with a ventilator 5 in. wide, the curb of which measures 3 x 5 ft.

While this diagram is drawn to ½-in. scale for want of space, it is usual to lay out the diagrams in the shop to 3 or 4 in. to the foot, using the most convenient scale.

Assuming that patterns are on hand for a third pitch skylight, the curb outline is divided as required, into divisions showing the number of bars required. Extend common bar *a b* to the center of the ventilator and erect the perpendicular line *b c* equal to 1/3 of the narrow side, 3 ft. or 1 ft., and draw the line *c a*. This line *c a* represents when scaled the true length of the common bar if no ventilator is required.

In this case a 5-in. ventilator is required, therefore the line of the ventilator is extended until it meets *c a* at *d*. Scale the line *d a* and it will measure 1 ft. 6¾ in., the true length of the common bar. In a similar manner extend the hip bar until it meets the center line of the ventilator at *i*, and from *i* at right angles to *i h* erect the perpendicular line *i j*, also equal to 1/3 of 3 ft., or 1 ft., from *j* to *i*.

This length *j h* would be the true length of the hip if no ventilator were used. In this case a 5-in. ventilator is used, and for that reason a line is erected from the corner of the ventilator at *l*, parallel to *i j*, until it intersects the hip line *j h* at *m*. If *m h* is scaled it will give the true length of the hip desired and will measure 24¼ in.

The true length of the jack bar is obtained by extending the line of jack *e* until it intersects *c a* of the common bar at *f*. Then *f a* will scale 1 ft. 2½ in., proved by using the ½-in. scale rule.

Another example for obtaining scale measurements in a skylight with ridge bar is given in Fig. 385. The size of the curb is 6 x 8 ft. with glass divisions. The pitch being one-third, then one-third the span of the narrow side or 6 ft. is 2.

At right angles to the common bar *c e* and hip bar *b i* erect the perpendiculars *c d* and *b h* equal to 2 ft. each, or 1 in. in the scale drawing. Draw the slant lines *d e* and *h i* which will equal the lengths of the common and hip bars, the common bar measuring 3 ft. 7½ in. and the hip bar 4 ft. 8¼ in.

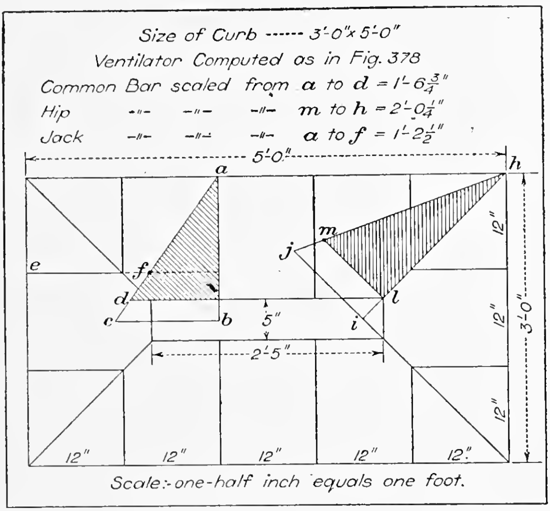


FIG. 384. Method of Obtaining Length of Bars by Scale Drawings.

Two jack bars are shown. The lengths of Nos. 1 and 2 are obtained by extending these two lines until they intersect the common bar at *f* and *g*. The length of *f e* or jack No. 1 will scale 1 ft. 5½ in. and No. 2 *g e*, 2 ft. 11 in., or twice as long as No. 1, because both divisions between the jack bars are equal.

Some students at the school bring up the question, "Suppose the drawings were destroyed and the metal patterns were at hand, would there be no way of finding the true length of the bars by mensuration without drafting another set of triangles or making scale drawings; or, in other words, could not the number and decimal be found which could be used as a multiplier in obtaining the lengths of the common jack and hip bars after the curb measure and width of the ventilator were known?" The question raised is a practical one and requires the extraction of the square root in solving, and will be explained in connection with Fig. 386.

In finding the multiplier figure on a skylight having one-third pitch so that comparisons in the results can be proved by measurements obtained in Figs. 362 and 382. Should the skylight have a different rise than 8 in. to the foot the same rule will hold good.

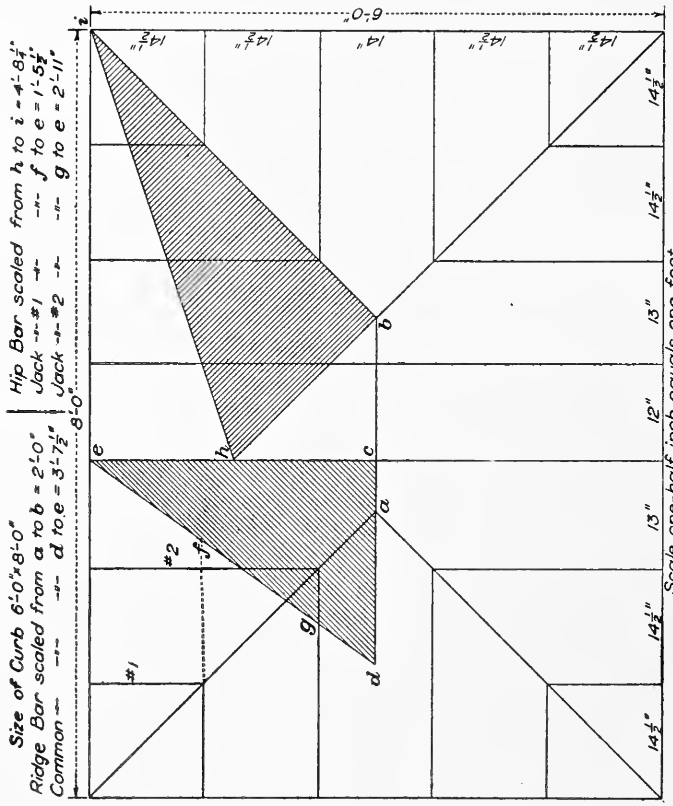


Fig. 385. Another Example in Scale Measuring of Skylights.

Referring to Fig. 386, if the base of the common bar $a°$ $b°$ is 12 in. and the rise $a°$ c 8 in., the length of the hypotenuse c $b°$ will equal the square root of the sum of base and rise squared thus:

$$\sqrt{12^2 + 8^2} = \sqrt{144 + 64} = \sqrt{208} = 14.4222.$$

The square of the base, that is, multiplying 12×12, gives 144; squaring the rise, or multiplying 8×8, gives 64; adding 64 to 144 gives 208, from which the square root is extracted as follows: The number 208 is pointed off into periods of two figures each from the right, as 2, 08. Then proceed as below:

Trial Divisor	Correct Divisor	Number Root
20	24	2,08 (14.4222 + ans.
		1
280	284	108
		96
2880	2882	1200
		1136
28840	28842	6400
		5764
288440	288442	63600
		57684
		591600
		576884

It will be noted that the greatest number the square of which is contained in 2 is 1. Therefore 1 is the first root of the figure; $1 \times 1 = 1$. Subtracting 1 from 2 and bringing down the next period 08, produces the first partial dividend 108. The double of 1, the partial root already found, is 2, and when a cipher is added, 20 is the first trial divisor. This trial divisor is contained in the partial dividends 108, five times, which suggests five as the second figure of the root, but on trial proves too high. Therefore take the next lowest number 4, add it to 20, making the correct divisor 24, giving the second figure of the root of 4. Multiply $24 \times 4 = 96$ and subtract this product from the partial dividend 108, which leaves 12, to which add a period of two ciphers. The double of 14, the partial root already found, is 28, to which add a cipher, and 280 is the second trial divisor. This trial divisor, 280, is contained in the partial dividend 1200, four times, which suggests 4 as the third figure of the root. Add 4 to 280 and 284 is the correct divisor.

When the product $4 \times 284 = 1136$, this is subtracted from the partial dividend 1200. There is a remainder of 64, to which add a period of two ciphers. Again double the partial root 14.4 already found, which will be 288, to which add a cipher and 2880 is the third trial divisor. This trial divisor is contained in the partial dividend 6400 two times, which suggests 2 as the fourth figure in the root. Adding 2 to 2880 gives 2882, the correct divisor.

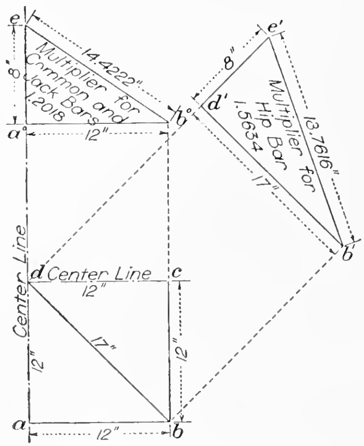


FIG. 386. Finding Length of Bars by Multipliers.

When the product $2 \times 2882 = 5764$ is subtracted from the partial dividend 6400, there is a remainder of 636, to which a period of two ciphers is added. Proceed in the manner shown in the example, until 4 figures are obtained after the decimal point. Thus 14.4222+ is the length of the hypotenuse $e\ b°$.

After this length 14.4222, has been found, divide it by 12, the length of the base, and the quotient will be the multiplier to use for finding the length of the common and jack bars. Now divide 14.4222 by 12, which gives 1.2018. In practice 1 2/10 is used as the multiplier.

In a similar manner the multiplier for the hip bar is found. As the square of the hip bar $d\ b$ in plan equals the sum of the squares of the two 12-in. sides of $a\ b$ and $b\ c$, or $12 \times 12 \times 2 = 288$, then the true length of the hip bar $e'\ b'$ will equal the square root of the sum of the squares of the two 12-in. sides and the square of the 8-in. rise $d'\ e'$, thus, $\sqrt{288 + 64} = \sqrt{352} = 18.7616$.

To find the multiplier for the hip bar divide 18.7616 by 12 and the quotient will be 1.5634. In practice 1 56/100 is used.

To prove these multipliers compute the lengths of the bars required for the skylight in Fig. 381 and see how they compare with measurements obtained from the triangles in either Figs. 362 or 382.

Referring to Fig. 381 divide the short side of the frame by two, as in the rules previously given. Thus $72 \div 2 = 36$, the measuring length. Multiply this measuring length by 1.2018 for the common bar and by 1.5634 for the hip bar, as in Fig. 386. Thus

$36 \times 1.2018 = 43.2648$, the length of the common bar, and $36 \times 1.5634 = 56.2824$, the length of the hip bar.

Referring to the diagram in Fig. 381 it will be noticed that the length of the common and hip bars when obtained from the triangles in Figs. 362 or 382 measure 43½ and 56¼ in., showing that by using the multipliers the common bar is 0.23 in. less and the hip bar 0.03 greater than the measurements obtained from the triangles. This difference is because the true lengths of the hypotenuses of the common and hip bar triangles in Figs. 362 and 382 are really 14.4222 and 18.7616 in. long, Fig. 386, but are measured 14.5 and 18.75 in Figs. 362 and 382, that being as close as can be obtained with a 2-ft. rule.

Using the multiplier 1.2018, Fig. 386 for finding the length of the jack bars Nos. 1, 2 and *b* in Fig. 381, the result is $14.5 \times 1.2018 = 17.42+$ for jack bar No. 1. Again, $29 \times 1.2018 = 34.85+$ for jack bar No. 2 and *b*. Comparing these measurements with the figures in Fig. 381, there will be a fractional difference of 0.08 and 0.15 in. less by using the multiplier, for the reason above stated.

Whether the length of the bars should be found by mensuration as in Fig. 386 or by using the triangles in Figs. 362 and 382, or by means of scale diagrams in Figs. 384 and 385, depends upon the student. However, all methods considered the best results are obtained by using the multiplier, and for this reason the student should master the method on mensuration, when he can prove and compare lengths by using either method.

The student should now proceed to lay out the various pieces required to construct his model skylight of the size given in Fig. 377, in which are shown the sizes of the ventilator, bars and curb, using the patterns developed in Fig. 362. It is usual in shop practice to prick off the various patterns from this sheet, punch a hole in each, and hang together on a hook, marking the name of the pattern on each one, also the measuring point, using marking acid, mixed as previously explained, which will not rub out.

The patterns in Fig. 362 are reproduced in Fig. 387 (see Folder 9) to show their appearance when cut from metal for use in laying out various size skylights. In addition to this the stays or templets for forming up the bars, ventilator and curb are also shown. The patterns and stays should be kept together for future use. All measurements should be taken from the arrow points on all patterns, which include cuts for any style of hipped skylight. So that no pattern may be lost, it is well to hang a card on the hook containing the full set as indicated in A, stating "this hook contains 14 patterns and 7 stays." This reminds the workman to count the patterns and stays and avoids any being mislaid when in use.

In Fig. 362 the laps are shown on all patterns in their proper position. In Fig. 387 the laps are also indicated on each pattern, but reversed on the inside, showing where the laps should be placed on the opposite side when full size work is being laid out. Marking acid, which becomes indelible when dry, is used to show the location of the laps on the different patterns.

It will be noticed that the measuring point for any of the bars is taken on line 2. This is because the curb line in the sectional view, Fig. 362, *f e,* is in line with the glass line 2 of the bar, and the triangle from which measurements are taken is constructed from or to this point.

In the patterns for the various bars in Fig. 387 U indicates the upper cut against the ridge or ventilator and L the lower cut against the curb. If the patterns have been cut from sheet metal, as in Fig. 387, the various parts called for in Fig. 377 are laid out as follows:

The size of the curb is to be 1 ft. 9 in. × 2 ft. 9 in. Use the pattern for the curb in Fig. 387 and let A B C D in quarter size drawing, Fig. 388, represent a sheet of metal cut to the required width by the squaring or hand shears. Place the lower edge of the curb pattern *a b* flush with the lower edge of the sheet A B and mark with the scribe awl the miter cut *c d,* also indent the prick marks indicating the bends. Measure 1 ft. 9 in. from *e* to *f,* slide the pattern to the opposite end at *f,* making *a′ b* flush with A B and mark the miter cut *g h.* Then *g h c d* will be the pattern for the short side of the cut, two of which are required without lap. The condensation holes are indicated by *m* and *n,* placed at pleasure. In a similar manner two pieces are cut 2 ft. 9 in. long, allowing laps, as on the curb pattern.

In precisely the same manner the inside ventilator, common, hip and jack bars are laid out, equal in length to the measurements in Fig. 377, these being made from the arrow points on the proper patterns in Fig. 387 and laps allowed.

Fig. 389 shows the pattern for the outside ventilator, laid out as previously described, but shown to make clear the notch A. In Fig. 377 a common bar intersects the ventilator in the center and a notch cut for it, as at A, Fig. 389, as high as *a* in the outside ventilator pattern B. This notch allows the outside ventilator to set over the bars as far as from 8 to 8° in the sectional view, Fig. 362. Should the bars be spaced as in Fig. 378, then the notches in the pattern in Fig. 389 would be made by finding the center of the pattern and measuring 6 in. on either side of this line, which would give the true position for the notches over the common bars in Fig. 378.

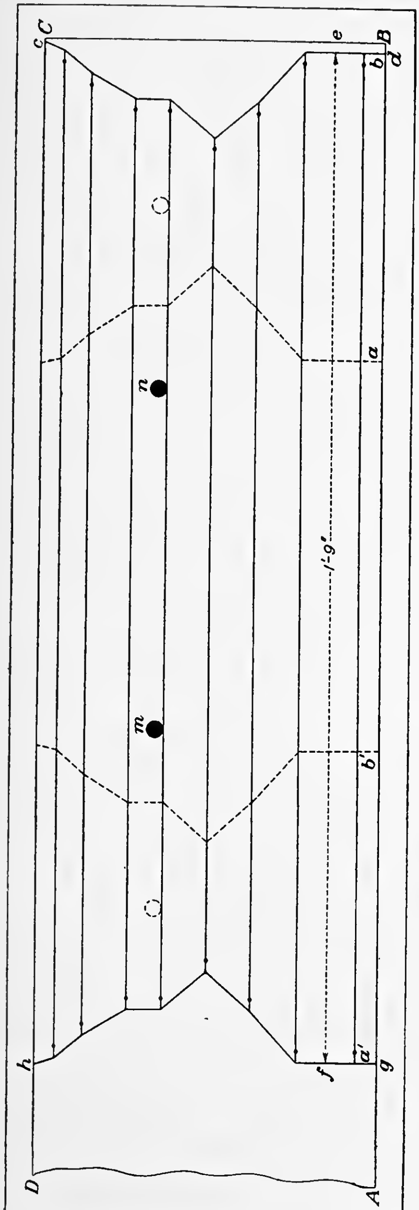


Fig. 388. Pattern One-Quarter Full Size for Short Side of Curb.

The length of the hood in Fig. 377 is 1 ft. 7 in. and is laid out in one piece minus the ends, as follows: As the width of the inside ventilator is 4 in., use the pattern for hood in Fig. 387 and cut a strip of metal equal in width to twice the distance from *a* to *b*, shown by A B C D, Fig. 390. At right angles to A B, using the steel square, draw lines B C and *d f* 1 ft. 7 in., or the length of the ventilator, shown by *e d*. Set *a b* of the hood pattern flush with A B of the metal strip, making the edge of the pattern *c* even with the line B C, and draw the miter cut *b c c*. Now slide the pattern to the opposite end at *d*, making *a″ b″* of the pattern flush with A B of the metal strip and scribe the miter cut *a″ d c′*. In a similar manner place the edge of the hood pattern *a′ b′* and *a°* *b°* flush with the edge of the metal strip C D, making the miters even at the lines B C and *d f*, and scribe the cuts *c b′* and *c′ a°*. Then *b c b′ a° c′ a″* is the pattern for the hood with laps allowed.

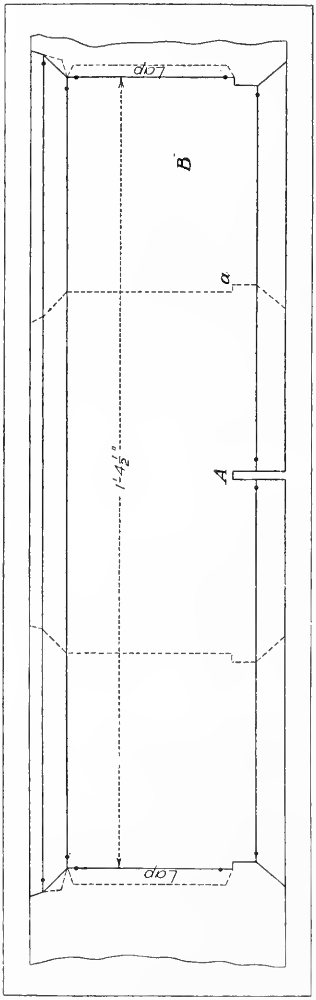


FIG. 389. Pattern Drawn One-Quarter Full Size for Outside Ventilator.

In the waste angles X and X, the heads of the hood can be marked off, which avoids waste of material.

Two braces will be required to support the hood, cut after the pattern in Fig. 387. The four piece required for the curb in Fig. 377 having been cut, as well as the four for the inside ventilator, four for the outside ventilator, three for the hood, two braces for the hood, two common bars, four hip bars and eight jack bars, then flatten the burs with the mallet when the student is ready for bending on the brake.

The only pieces to be bent right and left are the jack bars. The stays for forming are clearly shown and marked in Fig. 387. The method of forming the various parts will be omitted, as this will be done as explained in bending the bars and curbs in the flat skylight given in the last exercise.

After all pieces are formed, the laps on the ventilator, curb and bars are bent off at right angles and the various parts assembled as follows: In Fig. 391 is shown how the ventilator, hood and curb set together. The plan view of the inside ventilator A, illustrates how the narrow sides *a* and *a'* are joined at right angles to the long sides *b* and *b'*. The two halves should be soldered and then joined together at *c* and *d*.

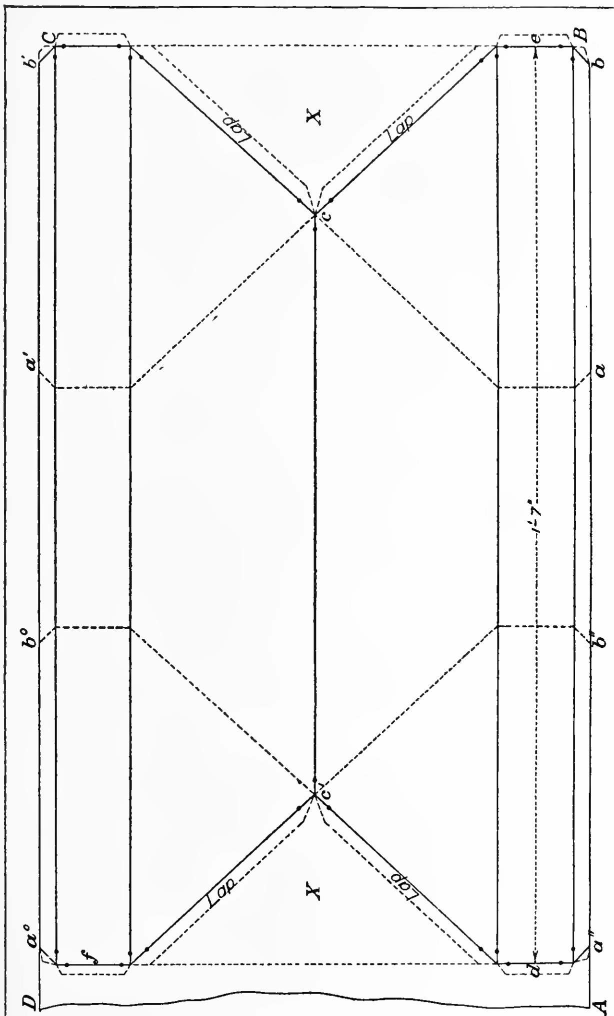


FIG. 390. Pattern Drawn One-Fourth Full Size for Hood.

The same applies to the outside ventilator. Curb B is set together in the same manner. The short sides *e* and *e'* are first tacked with solder to the long sides *f* and *f'* and then joined to the opposite corners, *g* and *h*, and the four corners thoroughly soldered.

In the hood C, the heads *i* and *j* are soldered. Inside of this hood braces D and E are well soldered, with the distance *m* and *l*, such that when the outside ventilator F F is placed in position the upper ledge will meet the cross braces D° and E°, so that an edge will be exposed at *n* and *o* for soldering.

Thus the outside ventilator and the hood are joined, forming the ventilator H, with the notches *r*, *s* and *t* in position, *v* and *u* showing the cross braces on the inside.

When the ventilator is large and it is possible that a storm may blow off the hood, it will be advisable to secure the hood as at X, where hood J is fastened to the outside ventilator K by the

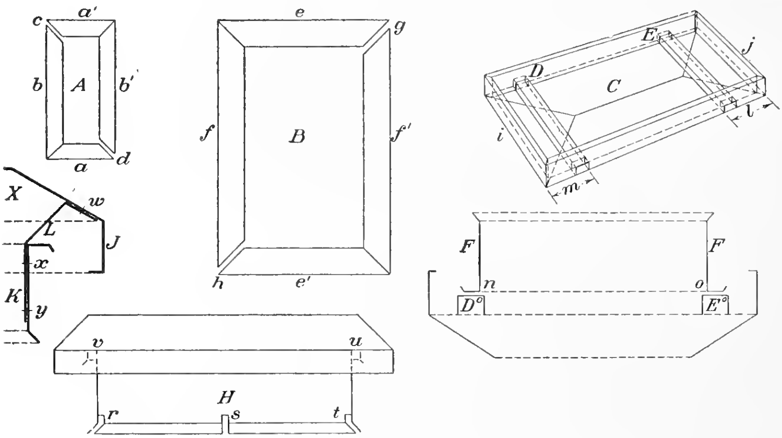


FIG. 391. Method of Assembling Ventilator and Curb.

brace L made from 1/8 × 3/4-in. bands and bolted to the hood and ventilator at *w*, *x* and *y*.

The skylight bars are assembled as in Figs. 392 to 396. Fig. 392 shows the two common bars attached to the inside ventilator. As the common bar is to meet the ventilator in the center as in Fig. 377, the student will mark off the center on the ventilator in Fig. 392 and tack common bars *a* and *b* with solder, using the small square *c d*.

The curb *a*, is next placed on the bench, Fig. 393, the location of the various bars marked on the glass line according to dimensions in Fig. 377, and the ventilator with the common bars attached in Fig. 392 set on the curb, *c d*, Fig. 393. Care should be taken to have bars *c* and *d* at right angles to the curb and the line of the ventilator 1 2 run parallel to the line of curb 3 4.

When this is done the four hip bars are placed, one on each corner, as in Fig. 394, in which two hips, *a* and *b,* are shown in position with the third hip *c* ready to be placed. If the miter

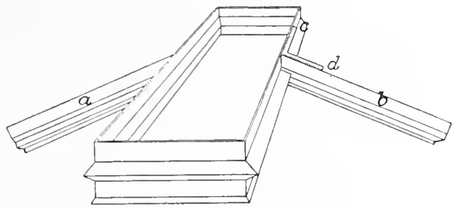


FIG. 392. Common Bar Joined to Ventilator.

cuts are true, a snug fit is the result, as at the upper intersection at *c*. The small square *f*, in Fig. 394, is used in squaring the

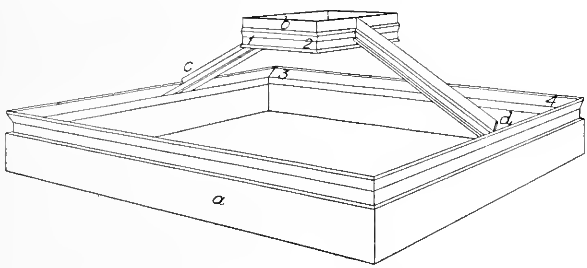


FIG. 393. Common Bar Joined to Curb.

jack bars, as in Fig. 395 where *a, b* and *c,* have been put in place according to dimensions previously placed on the curb.

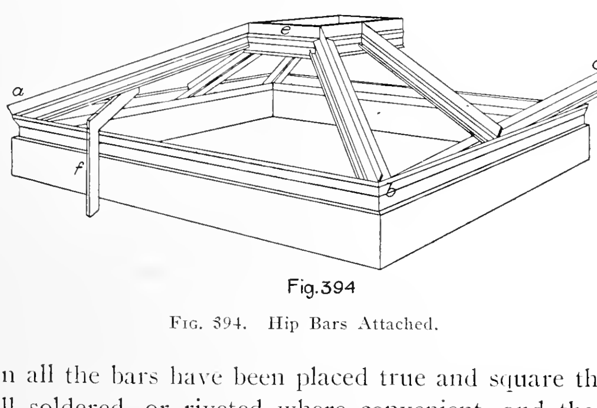


FIG. 394. Hip Bars Attached.

When all the bars have been placed true and square the joints are well soldered, or riveted where convenient, and the fastening cleats riveted or soldered in position. When completed the work will look as in Fig. 396, which is a hipped skylight with

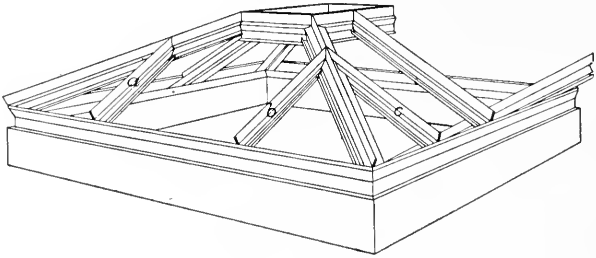


Fig. 395

FIG. 395. Jack Bars in Place.

square curb, and ventilator, without glazing or capping. Some shops rivet or solder the cleats on the bars before building the

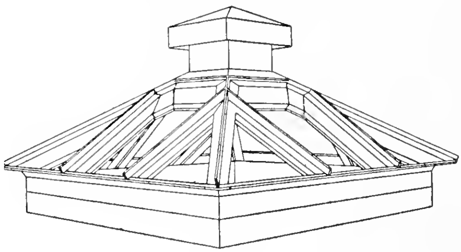


Fig. 396

FIG. 396. Finished Skylight with Square Curb and Ventilator.

skylight, while others only put the cleats on after the skylight has been constructed.

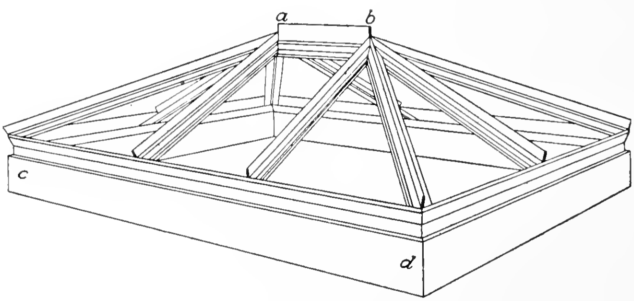


Fig. 397

FIG. 397. Finished Skylight with Ridge Bar, Center Jacks, Common Jacks and Semi-Intersecting Hips.

A finished skylight, is shown in Fig. 397, with ridge bar, center, jack, common jack and semi-intersecting hip bars. In this case the four hip bars would have to be placed first and tacked with solder slightly to the corners of the curb, then set in ridge *a, b.* Care should be taken to have the line *a b* of the ridge parallel to *c d* of the curb when sighted from top to bottom. The common and cented jack bars are tacked square in position as before, and the work soldered or riveted where possible, as desired.

At the beginning of this exercise, it was stated that in large work when the skylight is so constructed that the curb line runs perpendicular with the glass line, the dimensions of the lights can be secured before the skylight is completed. In large work this is important, especially when a large quantity of wire glass is to be used and must be ordered from the factory. The method of computing the sizes of the lights is explained in Fig. 398, which

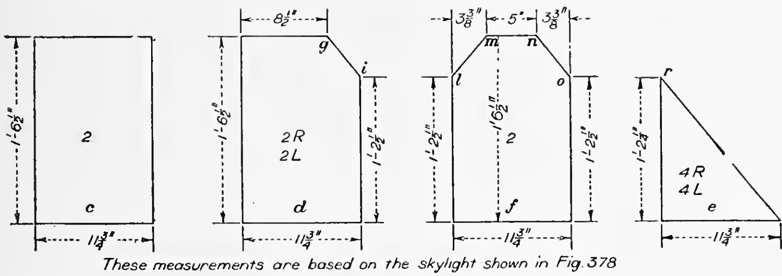


FIG. 398. Diagram Showing How to Compute Size of Glass Required for Skylight.

is based on the measurements given for the skylight in Fig. 378. In Fig. 398 are presented rough diagrams of the lights of the shapes desired, on the basis of those in plan A, Fig. 378, in which two lights would be required as *c;* two right and two left of *d;* four right and four left of *e* and two of *f.* The width of the lights in plan A minus ¼ in., will give the width and the length of the common and jack bar, minus ¼ in., will give the length of the glass, because the bars have been measured upon the glass line or line 2 in the patterns. This ¼ in. allowance is made to provide for expansion and contraction of the metal and give the glass slight play room all around.

The width of *c* is 12 in. and the length of the common bar 1 ft. 6¾ in. Therefore allow ¼ in. both ways, making diagram *c,* Fig. 398, 11¾ in. × 1 ft. 6½ in., two of which are required. In Fig. 378 the width of *d* is 12 in., the length of the common bar 1 ft. 6¾ in.; length of jack 1 ft. 2½ in. and of the inside ventilator 2 ft. 5 in. Take the width of *c* from 2 ft. 5 in. and there remains 1 ft. 5 in., which, divided by 2, shows 8½ in. to be the distance from a to h. Therefore make the diagram d, Fig. 398, 11¾ in. wide; 1 ft. 6½ in. long on the one side, deducting ¼ in. in the width and length; no allowance has been made on the top width of 8½ in. or the opposite side of 1 ft. 2½ in., for the

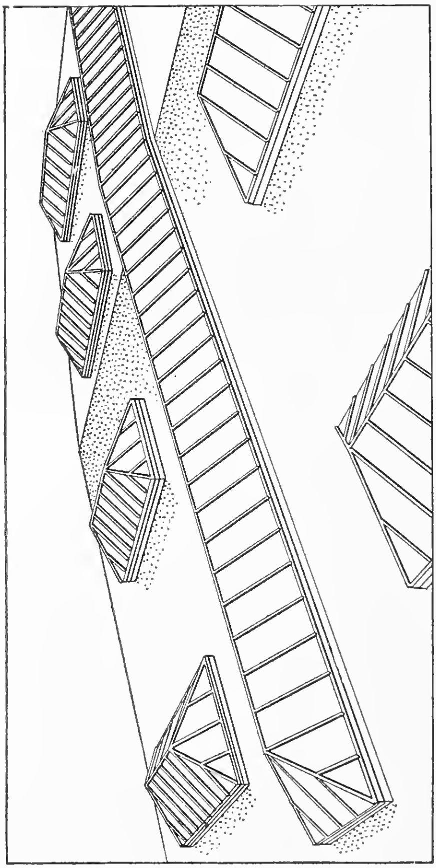


FIG. 399. Group of Hipped Skylights with Ridge Bar, Glazed and Capped Complete.

reason that where the jack bar forms an obtuse angle with the hip bar at 1, 2 and 3 in d, Fig. 378 or the hip bar forms an obtuse angle with the ridge or ventilator at 2, 1 and 7, the full measurements must be taken, as shown in d, Fig. 398. No measurement need be given for $g\ i$, for this is obtained by connecting g of the top to i of the side. Two right and two left of these lights are required.

In Fig. 378 the width of f is 12 in.; the length of the jack bar 1 ft. 2½ in.; the distance through the center $m\ h$ the same as the length of the common bar, or 1 ft. 6½ in.; the width of the ventilator is 5 in., which is directly in the center of the light, and the angle 6 5 4 and 4 1 2 are obtuse on both sides. Therefore make the diagram *f*, Fig. 398, 11¾ in. wide; 1 ft. 6½ in. long through the center; 1 ft. 2½ in. at the sides, and 5 in. wide at the top, placed in the center, and connect the lines *m l* and *n o* when cutting the glass, two being required.

In Fig. 378 *e* is 12 in. wide and the length of the jack bar on the glass line 1 ft. 2½ in. and 6 2 3 is an acute angle. Where the angle between the jack and hip bars is acute ¼ in. deduction should be made. Therefore make the diagram *e* Fig. 398, 11¾ in. wide and 1 ft. 2¼ in. long, and draw the connecting line *r s* and this gives the size of lights. Four right and four left are required.

In this way, no matter how large the skylight, the glass can be ordered before the skylight is built, providing, however, that the curb line runs perpendicular with the glass line; measurements are taken on the glass line, 2, of all bars, no deduction being made for any obtuse angle, but ¼ in. deductions are made for all acute and right angles.

The method of glazing and capping the skylights is similar to that explained in connection with the flat skylights in the last exercise. Fig. 399 shows the illustration of a group of hipped skylights, glazed and capped at the building, having ridge, common, hip, jack, center and common jack bars. Thus it will be seen from the illustration that it makes no difference how long the skylight may be, only four hips and eight jacks are required whether the length of the curb is 3 ft. or 300 ft., the balance of the bars being common bars.

CHAPTER XXVI

Developing the Valley Bar in Pitched Skylights

In building hipped skylights the curb sometimes contains an interior angle as A, Fig. 400, or a single pitch skylight, B, Fig. 401, is placed along the interior angle of the wall. These interior

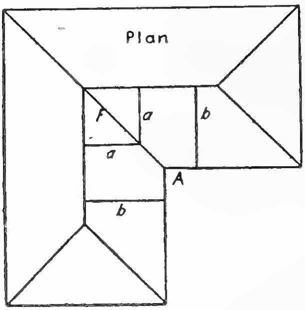


FIG 400.

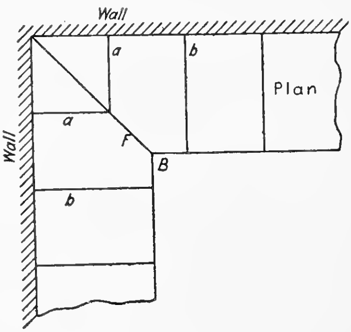


FIG. 401.

angles require a valley bar, F, and the miter cut of the jack and common bars as in Figs. 400 and 401, *a* and *b*. The student will understand how these bars are developed with the aid of the quarter full size shop detail in Fig. 402 (see Folder 9). From this the student is to develop his detail and the patterns full size for the model skylight in Fig. 403.

In the shop detail in Fig. 402 the profiles of the ridge and common bars and the curb are the same as those used in the shop detail of the hipped skylight. As the principles in developing the valley and jack bars are similar to those in the hip bar, this detail will be briefly described. As in the last exercise, the student should draw the pitch 1/3 or 8 to 12. Draw the center line A B, at right angles to which from O draw the base line of the triangle, 12 in. long. Make the distance O C, 8 in. high, and draw the hypotenuse C 12, which represents one-third pitch. Place the section of curb D in its proper position so that the curb line *r c* will be vertical with the glass line, or the point of the triangle, at 12. In a similar manner place the full section of the ridge bar C in position so that glass line 2 3 of the ridge bar C will lie on the hypotenuse C 12. Place the section of the common bar E, and the section of the jack bar J, so that the glass line 2 3 in both sections will lie on the hypotenuse.

The section of the common and jack bars are similar, with the exception that in jack bar J the standing ridge 1 2 is made only as high as the thickness of the glass in use. This is done so that when the two jacks meet at the valley, as at *a* and *b*, diagram A^x, the water will pass over the top surface of the glass, whereas if the standing ridge 1 2 in jack bar, section J, were made as high as 1 2 in the common bar, section E, a pocket would be formed, which would catch the water. Through the bends 1 to 6 in both the common and jack bar sections draw lines parallel to the hypotenuse until they intersect ridge bar C from 1° to 6 and at curb D, also from 1° to 6, allowing the opening at 4 5 6 at the lower part of the bar for the condensation drip to pass into the curb gutter, then to the outside at *m*, indicated by the arrow. This completes the sectional view of the skylight from which the patterns for the curb, ridge and common bars will be obtained.

Inside miters will be required for the curb and ridge and to obtain the interior right angle miter for the curb, draw any vertical line as C° D°, on which place the girth of the curb D, shown by similar letters and figures. From the small figures 1, 2, 3, *l*, *m*, *n*, etc., at right angles to C° D° draw the usual measuring lines, intersected by vertical lines drawn parallel to C° D° from similar letters and figures in section D. Trace a line through points thus obtained, shown by *f*° *h*° *i*°, which will be the inside miter cut for the curb. When using this pattern measure from the arrow point S, the size curb required, allowing laps as shown by dotted lines.

The cut *f*° *h*° *i*° could be used for an outside miter or for an exterior angle by simply using the opposite side of the pattern shown dotted by *f*° *h*° *i*° *k*° *j*°.

The pattern for the half ridge bar is developed by drawing the vertical line A° B° above the ridge C and placing the stretchout of C on A° B° at 1′ to *i*, through which points lines are drawn at right angles to A° B°, and intersected by lines drawn parallel to A° B° from similar numbered intersections in C. Trace a line through points thus obtained. Then *l*° *m*° *n*° will be the miter cut for the interior angle, representing the one-half pattern for the ridge bar when the skylight has a single pitch.

If the double pitched or hipped skylight is used, as in Fig. 400, the pattern would be doubled, by reversing it on the line l° 1' Fig. 402. This same cut l° m° n° could be used as the pattern for an exterior or outside miter, by simply using the opposite side of the pattern shown dotted by s° l° m° n° r°. When laying out the patterns always measure from arrow point *j*, allowing laps on one side as indicated by the dotted lines. No matter what formation the curb D or ridge C may have, the same rule is used when developing the inside miters.

The next pattern to be developed is common bar E. The girth of E is placed on K L, drawn at right angles to 1° 1°, the usual measuring lines drawn and intersected from intersections on curb D and ridge C. The developed pattern is shown by P O N S. When full size lengths are laid out, measurements are taken from the arrow points *d b* or glass line 2.

The most important part of this problem is to draw the plan view showing the intersections between the valley bar and the curb and ridge, from which the valley bar section and pattern for the valley bar is obtained. From any point as G on the center line A B draw the line G F. From G at an angle of 45 degrees draw the valley horizontal line, G H. This valley line G H is the bisection of the right angle B G F. Should the angle B G F be other than a right angle it would simply be bisected and the line thus obtained would be the center line of the valley bar, the same as G H is the center line of the valley bar and the bisection of the right angle.

From the various intersections between jack bar J and ridge bar C in the sectional view and jack bar J and curb D, from 1 to 6 in C and 1 to 6 in D, drop vertical lines in the plan indefinitely as shown by similar numbers in the plan of the ridge and curb. Where these lines intersect the valley line G H, as shown by the heavy dots in ridge and curb, horizontal lines are drawn indefintely, also shown by similar numbers. Take a tracing of the jack bar J with the numbers on it in the sectional view, and place it on the valley line G H in plan in the position J^1. It is immaterial at what part of the valley line it is placed, as long as 1 4 of the bar is directly on the line G H. This profile J^1 represents the horizontal projections of the valley bar in plan but does not show the true section of the valley bar. Parallel to G H from the bends in J^1 lines are drawn intersecting similar numbered lines in both the ridge and curb as shown by the miter line numbered on one side from 1 to 6 in the curb and from 1 to 6 in the ridge.

The miter lines in plan having been obtained, the valley section is developed as follows: Equal in length and parallel to G 1, draw the line 12 O at right angles to which from 12 erect the line 12 2 equal to 8 in. or to O 2 in the sectional view. Draw a line from 2 to O in the valley section. From the intersections between the valley bar and ridge in plan from 1 to 6, and the intersections between the valley bar and curb also from 1 to 6, erect lines indefinitely at right angles to G H.

Measuring from the line O 12 in the sectional view take the vertical distances above and below this line to points 1 to 6 in the curb as well as above the line O 12 to points 1 to 6 in the ridge in sectional view, and place these distances on corresponding lines previously erected from the plan, measuring above and below the line 12 O in the valley section, from 1 to 6 in the curb and 1 to 6 in the ridge. Trace the miter lines through points thus obtained and connect them by lines shown, which then completes the true elevation.

To obtain the true profile of the valley bar, take a tracing of profile J′ in plan and place it in any location shown by J^2, being careful that the center 1 2 of section J^2 is at right angles to 2 O. From the same figures in J^2 draw lines at right angles to 2 O intersecting similar numbered lines in the valley section. A line traced through points thus obtained, shown by A^2, will be the true section of the valley bar. Note the acute angles between 1, 2 and 3. As in the jack bar, the standing edge 1 2 in the valley bar A^2 is as high as the thickness of the glass so as to form an open valley to allow the rain and snow to run off.

The pattern for the valley bar is obtained by taking the girth of A^2 and placing it on line E° F° drawn at right angles to 2 O in the valley section. At right angles to E° F° lines are drawn through the small figures and intersected by lines drawn from similar numbers in the ridge and curb in the valley section at right angles to 2 O. Lines traced through these points, shown by *t u v* and *y x w*, will be the pattern for the valley bar.

In laying out full size patterns for the valley bar, measure from the arrow points *d*° and *c*°, which represent line 2 or the glass line, allowing laps as shown.

The last pattern required is that of the jack bar. If the student will refer to his detail on hipped skylight he will notice that the jack bar in the hipped skylight runs upward from the curb to the hip bar. In the valley skylight the jack bar runs downward from the ridge to the valley bar. Therefore take a tracing of the jack bar and place it at right angles to G B, as shown by J^3. Through the figures in J^3 and at right angles to B G draw lines intersecting similar numbered lines on one side of the valley bar as shown by the miter lines 1 to 6 in both the long and short cuts. From these intersections as in the hipped skylight erect vertical lines until they intersect similar numbered lines in the sectional view. The miter line 1 2 3 4 5 6 represents the short cut and the miter line 1 2 3^v 4 5^v 6^v the long cut.

As the standing edge 1 2 in jack bar J in the sectional view is less than 1 2 in the common bar E, a new stretchout must be taken of J and placed on the line T U drawn at right angles to 2 12. The usual measuring lines are drawn through the small figures on and at right angles to T U, intersected by lines drawn

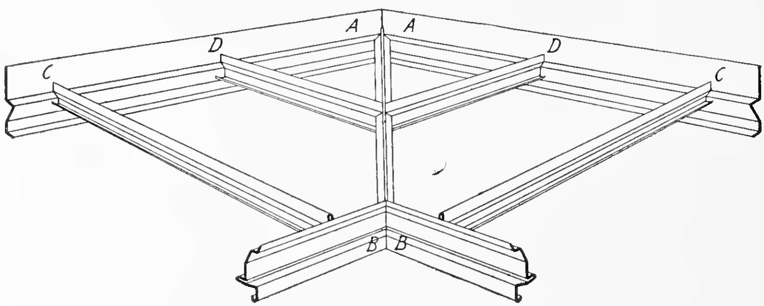
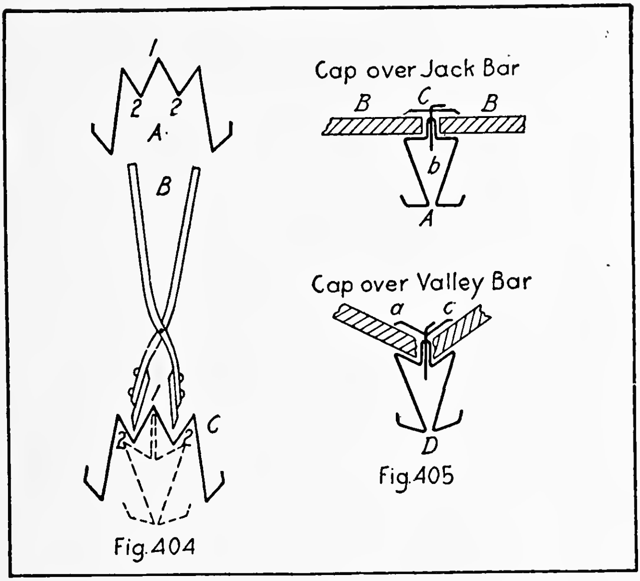


FIG. 403.

parallel to T U from the intersections 1 to 6 on the ridge C and from the long and short jack intersections in R, the short cut in R projected being to one side of the jack bar pattern and the long cut in R to the other side. When a line is traced through points thus obtained, then V W X Y Z will be the pattern for the jack bar, W *f* a° being the short cut of the jack and a° b° c° V the long cut. All measurements are taken from the glass line 2, indicated by the arrow points *e, f*. Laps are allowed at the ridge cut as shown. This completes the full set of patterns.

Having completed the patterns for constructing the model skylight, the student will find that the ridge C A in Fig. 403 should measure 1 ft. 6 in., and the curb B, 6 in.; the horizontal distance between the ridge and curb 12 in. The skylight to contain one valley A, two common C, and two jack bars D, the working plan being shown in diagram B^x in the shop detail in Fig. 402, in which are shown the various divisions and lengths. Using the one-half pattern for the ridge bar the student should cut from galvanized iron two pieces 1 ft. 6 in. long, measuring from point *j*. In a similar manner, using the pattern for the curb and measuring from point S lay out two pieces 6 in. long.

Referring to diagram B^x the horizontal distance between the ridge and curb or the measuring length is 12 in., and the jack bar is to be placed from the ridge a horizontal distance of 6½ in. As the detail contains these measurements, namely, 12 in. from the center line to the outside curb line in sectional view, and the jack bar 6½ in. from the ridge line in plan, then the patterns ob-



Figs. 404-5. Details of Valley Bars for Pitched Skylight.

tained from the common, jack and valley bars in the detail are the true lengths and can be pricked directly on to the metal in making the model skylight. One valley, two jack and two common bars are required.

When all the pieces have been cut from sheet metal, they are ready to be formed on the brake after their respective profiles in the same manner as in previous exercises.

Care must be taken to have the angles true in the valley bar, and when it is formed as far as A, Fig. 404, it will be found that the parts 1 2 cannot be clamped in the brake owing to its narrow width. This is overcome by using the tongs shown by B in diagram C which presses the edges 1 2 together as shown by the dotted lines. Tongs can also be used to advantage when forming the jack bars.

When setting this model together, mark off the dimensions on the ridge and curb as in diagram B^x, Fig. 402 and set together, at right angles, the ridge D D and the curb B B, Fig. 403. Tack the center of the common bars C C at right angles to the ridge, then set them on the curb B B in their proper location or 4 in. from the corner. Tack valley bar A, place the jack bars D D in position, then the joints can be fully soldered. This model will prove the miter cuts, and show the appearance of a valley bar in an interior angle whether in a single or double pitch skylight. While this model gives the student practical experience on joining the bars, a larger skylight would have to be put together at the job, as mentioned in the exercise on flat skylights.

When glazing the valley the glass should be laid in white lead putty so as to make a tight joint in the valley. Sometimes, to make a neat finish over the jack and valley bars, a plain metal capping is placed so as to be in keeping with the balance of the common bars and is done as in Fig. 405 in which A is the jack bar, B B the glass and C the capping fastened either by copper cleats or wire *b,* as mentioned in a previous exercise, being careful to solder the cleat or wire where it turns down over the capping. In capping the valley bar the same method is employed, bending the cap as in the angle *a c* in D. As before mentioned, the glass must be laid in white lead putty to insure a tight joint, before the caps are put in place. The common bars are capped in the usual manner.

To show how the length of the bars would be obtained, refer to diagram A^x, Fig..402, which shows a single pitch skylight setting against the interior angle of the brick wall, the ridge 7 ft. 6 in., the horizontal projection from wall to curb 3 ft. 8 in., making the curb 3 ft. 10 in. because 3 ft. 10 in. + 3 ft. 8 in. = 7 ft. 6 in. The bars are spaced 18 in. apart, requiring six common and two right and two left jack bars of different size and one valley bar. The horizontal projection of 3 ft. 8 in. between the wall and curb, forms the basis from which to obtain the true length of the various bars. Reducing the 3 ft. 8 in. to inches gives 44.

As this skylight has 1/3 pitch, the multipliers previously obtained can be used for 1/3 pitch, namely, 1.2018 for the common and jack bars and 1.5634 for the hip or valley bar, as in Fig. 386. Thus, to find the length of the common bar $1.2018 \times 44 = 52.8792$. For the valley bar $1.5634 \times 44 = 68.7896$. As the horizontal distance between the ridge and jack bar I is 18 in. then jack bar I will be equal to 18 × 1.2018 or 21.6324. As the distance between the ridge and jack bar II is 36, then jack bar II will be equal to 36 × 1.2018 or 43.2648 or twice the length of jack bar I, because the two divisions 18 are equal. The student now has the true lengths of all the bars required in diagram A^x, the fractional part of the inch being given in decimal. The decimal equivalents to fractional parts of lineal measurement are given below in a table taken from "The Tinsmith's Helper."

Decimal Equivalents to Fractional Parts of Lineal Measurement
(One Inch the Integer or Whole Number)—

0.96875	equal	7/8 and 3/32
0.9375	equal	7/8 and 1/16
0.90625	equal	7/8 and 1/32
0.875	equal	7/8
0.84375	equal	3/4 and 3/32
0.8125	equal	3/4 and 1/16
0.78125	equal	3/4 and 1/32
0.75	equal	3/4
0.71875	equal	5/8 and 3/32
0.6875	equal	5/8 and 1/16
0.65625	equal	5/8 and 1/32
0.625	equal	5/8
0.59375	equal	1/2 and 3/32
0.5625	equal	1/2 and 1/16
0.53125	equal	1/2 and 1/32
0.5	equal	1/2
0.46875	equal	3/8 and 3/32
0.4375	equal	3/8 and 1/16
0.40625	equal	3/8 and 1/32
0.375	equal	3/8
0.34375	equal	1/4 and 3/32
0.3125	equal	1/4 and 1/16
0.28125	equal	1/4 and 1/32
0.25	equal	1/4
0.21875	equal	1/8 and 3/32
0.1875	equal	1/8 and 1/16
0.15625	equal	1/8 and 1/32
0.125	equal	1/8
0.09375	equal	3/32
0.0625	equal	1/16
0.03125	equal	1/32

The common bar is 52.8792 long. Following the table, the nearest decimal to 0.8792 is 0.875 which equals 7/8 in. The common bar will be 52 7/8 in., as in diagram A^x. The length of the valley bar is 68.7896. The nearest decimal to 0.7896 is 0.78125, which equals 3/4 and 1/32 or 25/32 in. The valley bar is then 68 25/32 in. long, as shown in diagram A^x. The jack bars I and II are 21.6324 and 43.2648 in. respectively. The nearest decimals to 0.6324 and 0.2648 are 0.625 and and 0.25, which equals 5/8 and 1/4 in. The lengths of the jack bars I and II are then 21 5/8 and 43 1/4 as in diagram A^x.

By using the multiplier the true lengths of the bars are thus obtained. These lengths could also be obtained by dividing the triangles in the sectional view and valley section in 12 equal spaces, as explained in connection with the hipped skylights, obtaining the lengths from the hypotenuse in both triangles, that in the sectional view being for the jack and common bars and that in the valley section for the valley bars. The figures 0 to 12 in the sectional view have been numbered from left to right, which is an advantage when obtaining the length of the jack bar, because the jack bars run from ridge downward to the valley bar. However, it makes no difference which way the figures run, the lengths will be the same.

CHAPTER XXVII

Construction of Stationary and Movable Louvres

In many cases the ventilator placed at the ridge of the skylight will answer for ventilation, but sometimes more ventilation is required and can be obtained by placing under the fixed skylight, stationary louvres or movable louvres operated by quadrants attached on one side to the louvres and on the other to an upright bar which is pulled up or down by cords or chains from below. Different shapes of louvres can be employed, three stationary shapes being shown in Fig. 406, A, B and C, and two movable shapes in Fig. 407, D and E.

In Fig. 406 the louvres or slats in A are bent in the brake and are spaced as to allow the foul air to pass out at *a*. In B the

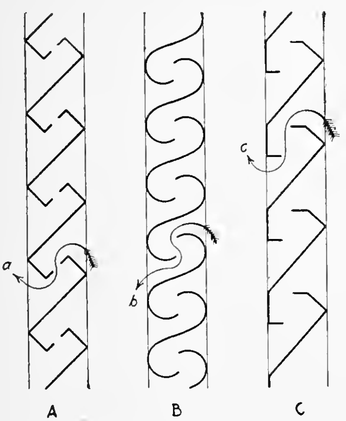


Fig. 406. Three Types of Stationary Louvers.

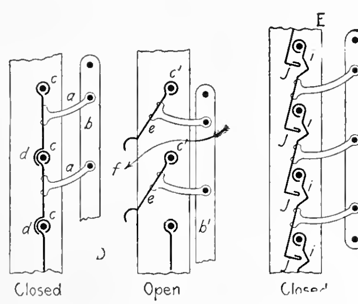


Fig. 407. Two Types of Movable Louvers.

louvres are S shaped, being rolled right and left in the pipe rollers, the air escaping at *b*. The louvre or slat generally used is shown in C. This allows a greater amount of space for ventilation at *c* and is the style the student should employ for his model.

In Fig. 407, D shows one style of movable louvre in which 3/16-in. wires are passed through *c*, *c* and *c*, over which the lower part of the louvres closes at *d* and *d*. The quadrants *a* are riveted to the louvres and pivoted to bar *b*. When bar *b* is drawn downward, as at b' the slats open, turning on the wire pivots c' c' to the position e e, allowing the air to escape at f.

Another style is shown closed at E. Here the slats have wire pivots, with a V formed in each slat, into which the lower part of the slat fits at j. The position of the open louvre is omitted, because it will be taken up in the detail drawing, from which the student is to construct a working model.

This model should contain four movable louvres and the curb should measure 1 ft. 8¾ in. × 2 ft. 8¾ in., to allow the hipped skylight, made from measurements in Fig. 377, to fit over the louvres constructed from patterns shown in Fig. 409 (see Folder

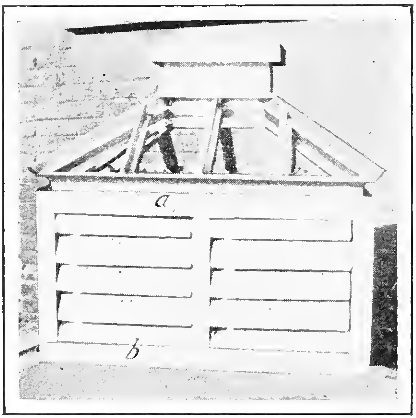


FIG. 408. Model of Louvred Skylight.

9). The hipped skylight referred to measures 1 ft. 9 in. × 2 ft. 9 in., showing that the curb of the skylight must be ¼ in. larger all around so as to fit over the louvres.

The completed model, Fig. 408, is of a movable louvred skylight made by a student at the New York Trade School. The height of the louvres from a to b can be made as required, the more height given the more louvres being required. To show the constructive features of the stationary and movable louvres as well as the method of developing the patterns, the student should draw a full size working detail from Fig. 409, in which the quarter size sections of the stationary louvres are shown, each containing four slats. It will be noticed that the first slat in the stationary section is formed on to the curb A.

The first step after finding the size of the wood curb over which the metal curb A is to set, is to make a rough diagram, B, showing the number of corner (C^o) and middle (D^o) posts required, as well as the length to cut the louvres. In this case the size of the curb will be 1 ft. 8¾ in. × 2 ft. 8¾ in. The corner posts will be 1¾ in. wide and the center posts 1½ in. A post will be placed on each corner and a middle post in the center of the long side. In this case one long side is to have stationary louvres, while the opposite side is to have movable louvres, the two ends to remain open to show construction.

In practice, of course, the two ends would be finished with louvres. From the long side measuring 2 ft. 8¾ in. deduct the corner and middle post dimensions, 1¾ + 1½ + 1¾ = 5, 2 ft. 8¾ in. — 5 = 2 ft. 3¾ in.; divide this by 2, and 1 ft. 1⅞ in. is the distance between posts. From this distance deduct ⅛ in., making the length for either movable or stationary louvres 1 ft. 1¾ in. If louvres are to be placed in the ends they would be cut 1 ft. 5⅛ in. length.

By making diagram B, Fig. 409, a great amount of time is saved; for by referring to it at any time a glance gives the size of the curb, number of posts, length of louvres and distances between posts. Whatever the length of the sides they should be so spaced as not to have the louvres over 36 in. wide.

At any convenient part of the detail draw the section of the corner post C 1¾ in. square, the joint being locked as at *a*. Directly below this draw the middle post D, 1½ in. face width, locking the back as at *b*. In line with corner post C, draw the sectional view of the stationary louvres, making the shape of the curb as at A and of the louvre as at E, having the point 12 of the louvre E in a horizontal line with 1 2 of the top. Make the post extend ¾ in. above the top of the upper louvre. Over this post the curb of the skylight will set as shown by F. This section is all that is required in developing the patterns.

To obtain the pattern for middle post D, take the girth of the front part of post D and place it from G to J on the line G H. Draw the usual measuring lines, intersected by horizontal lines drawn from similar points in the sectional view. A line traced through points thus obtained, as J G f^v e f, will give the desired pattern. The girth of the back *b* of middle post D, including the locks, is placed on line G H from K to L and made as long as from J to *f*, thus forming the pattern for the back of the middle post D.

Take the girth of corner post C and place it on the line G H from M to N. Draw the perpendicular measuring lines, intersected by lines drawn from the sectional view, and M N *h* is the pattern for the corner post. Take the girth of *a* in corner post C, and place it on G H from O to H, and make it as long as N to *j* in the corner post, which completes the pattern for the back of the corner post.

The top of these four patterns are cut square, on which the skylight curb rests, the lower part having the bevel as in A in the sectional view. Laps are allowed in the patterns, shown by the dotted lines. From the lower bends in the louvres at *k, l* and 11, in the sectional view, horizontal dotted lines are drawn across the patterns, cutting the bends in the corner and middle posts, shown by the heavy dots. These dots should be pricked on to the metal, as they show the location for the louvres when soldered in position, without further measurements. Whatever the length of these posts may be, the height is measured from *c* to *c* in the middle post and from *h* to *i* in the corner post.

Take the girth of louvre E in the sectional view, from 10 to 15, and place it on the vertical line 10′ to 15′. Through these points draw horizontal lines, making the rectangular shape shown by 10′, 15′, 15″, 10″, allowing laps. The lengths of the louvres are measured from *m* to *n* according to measurements in diagram B.

The pattern for curb A in the sectional view is obtained as follows: Take the girth from 1 to 9 in A and place it on the vertical line R S, from 1 to 9. Through these small figures at right angles to R S draw lines indefinitely, and draw the perpendicular lines T W and U V at any desired distance apart. Measuring from line 7 3 in the sectional view A take the horizontal distances to points 4, 5 and 6, and in the pattern place them on similar lines on either side of lines U V and T W., measuring in each instance from U V and T W. From points 3′ on both sides erect the vertical lines 3′ U and 3′ T. These lines do not miter, but are cut off at right angles so that when they are formed to their required shape they will lie against the post as indicated by *a*, Fig. 410.

Connect the points of intersection previously obtained in the pattern for curb A, Fig. 409, then U V W T will be the desired pattern, with laps shown by the dotted lines. When laying out the full lengths of the curb, measure from *o* to *p* in the pattern. When center posts are to be placed on the curb, as in the diagram

B at D^0, then the divisions between the posts must be measured off on the full size metal pattern from 3′ to c^x and f^x to 3′ in the pattern for curb A, and the shaded part, c^x d^x e^x f^x, must be notched out 1½ in. to allow the center post to set at its proper place in the upper part of the curb louvre. This completes the full set of patterns for stationary louvres.

To facilitate the use of the patterns for the corner and middle posts for both stationary and movable louvres, curb A in the sectional view from 3 to 9, Fig. 409, has been traced in the lower section of Fig. 409A (see Folder 9), as shown in line with post sections from 14 to 20 in curb section P and the snow and rain guard A^1, from 14 to 9, added to it. The height of the post is made similar to that in the stationary louvre and the movable louvres are formed to the shape B^1. This louvre, B^1, as will be noticed, turns on the wire pivot *s*, but has a V-shaped angle, *t*, bent in it, to receive the lower part of the hem-edged angle *u*.

These louvres can be made any width from 3 to 4, but care must be taken that the lower angle *u* fits into the V-shaped formation *t*. Below this the quadrant C^1 is riveted at *v* on one side and pivoted to the upright bar D^1 on the other at *w*. Under no circumstances should bolts be used at *v*, for they loosen in time and make a poor job. The pivot at *w* is riveted so that it turns easily while the bar is held firmly.

The holes in the posts to receive the wires or pivots of the louvres, shown by the letters *s*, should be punched into both sides of the posts before forming and the proper location is transferred to the patterns from a tracing of d^v, c^v, f^v, e^v, in the sectional view, on which the centers are marked *s*. Therefore, in the patterns for the posts Fig. 409, the heavy dots *s* indicate the holes for the pivots and would be placed in patterns for the posts bounding the movable louvres. In the patterns for the posts bounding the stationary louvres these heavy dots *s* are omitted and the lighter ones shown like on line d^v e^v substituted as mentioned before.

The pattern for movable louvre B^1 in sectional view, Fig. 409A, is obtained by taking the girth of B^1 from 1 to 8 and placing it on the vertical line in the pattern for movable louvre B^1 from 1 to 8, making the distance from 7 to 8 as much as is required for the wire which acts as the pivot. Complete the rectangle of any desired length and lay out the true length of the louvre, obtaining measurements from diagram B, Fig. 409, and measuring from j^v to l^v in the pattern B^1 in 409A. Using one of the quadrants C^1 in the sectional view, set it below line 4 in the pattern for movable louvre, and mark off the rivet holes h^v and i^v, which should be punched before bending.

As the profile for the movable louvre curb P, from 14 to 20 is the same as the profile A, Fig. 409, in the stationary louvre curb from 3 to 9, then the pattern for P from 14 to 19 in Fig. 409A, will be the same as the pattern for A from 3 to 9 in Fig. 409. The pattern for curb P in Fig. 409A from 14′ to O^v and 14′ to n^v, and is obtained in the same way as curb A, Fig. 409. Above 14′ in the pattern for curb P, Fig. 409A, add the girth from 14 to 9 in curb P in the sectional view as shown by similar numbers on the vertical line G^1 E^1. From 14′ on both sides draw the perpendicular lines 14′ r^v and 14′ m^v, which, when formed to shape, will lie against the side of the post *a*, Fig. 410.

When A^1 in the sectional view in Fig. 409A has been formed as shown in curb P, Fig. 409A, and the louvres are opened in the sectional view H^1 P^1, snow or rain is likely to gather in the angle A^3. To allow this to escape small holes are punched at the arrow *a″* in both profiles P and P^1. Therefore, before bending the pattern for curb P punch small holes about 12 in. apart on line 11, s^v and w^v. The shaded part m^x, h^x, i^x, l^x is notched out 1½ in. wide down to line 13 to receive the middle post as explained in the pattern for curb A in Fig. 409. In laying out the pattern for curb P, Fig. 409A measure from arrow points u^v and t^v.

The quadrants to open and close the louvres can be bought from dealers in skylight gearings, while the upright bars are made from band iron about ⅛ x ¾ in. When a large number of louvres are to be raised and lowered heavier band iron is required.

Care must be taken when punching the holes in the band iron to have them equally spaced, as in the drawing. The section on the right shows the bar up, which closes the louvres; while the section on the left shows the bar down, which opens them. The holes a^v in the top of the band in both sections, as well as the holes b^v at the bottom, are used to fasten operating cords or chains.

Having developed the necessary patterns for the movable louvre ventilator, the student should now lay out on sheet metal the necessary pieces. Using the pattern for curb A, Fig. 409, for the stationary louvre, measuring from points *o* and *p*, cut two pieces 1 ft. 8¾ in. long for the ends without lap, and one piece 2 ft. 8¾ in. long with lap for one long side to receive stationary louvres, notching out the 1½ in., shown by R in the pattern, to receive the center post in diagram B.

Using the pattern for curb P, Fig. 409A, for movable louvres, measuring from points U^v to t^v, cut one piece 2 ft. 8¾ in. with laps to be used for the long side having movable louvres, making the notch of 1½ in., shown by E^1. As the curb pattern A, Fig. 409, is the same as curb pattern P, Fig. 409A, where they miter, both can be used in making this curb frame. The pieces cut from curb pattern A in Fig. 409 will be formed after curb section A, while the piece cut from curb pattern P in Fig. 409A will be formed after curb section P.

The student should cut four backs full size as in Fig. 409, for the corner posts and two backs for the middle posts; two corner posts with the light dots for the stationary louvres and two with holes *s* punched for inserting the pivots for the movable louvres; also one middle post for stationary and one for movable louvres. Using the pattern for the stationary louvres E, in Fig. 409 cut six pieces 1 ft. 1¾ in. long, as in diagram B, and, using the pattern for movable louvres, Fig. 409A, cut eight pieces of the same length, being careful to punch the holes exactly in the center to receive the quadrants.

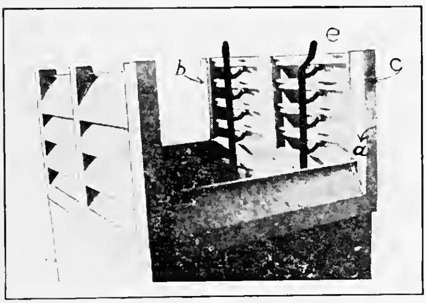


Fig. 410. Partially Completed Ventilators with Louvres.

No louvres will be cut for the ends, as these are to remain open so that the constructive features can be inspected. Having cut all the work, punched all necessary holes, cut the required profiles or stays and flattened the burrs, the student is ready to bend or form the work. The louvre E in Fig. 409 is easily formed and needs no further description; this also applies to curb A. The corner and middle posts C and D are bent, as in Fig. 411, where A shows how the corner is bent; B the back of the corner, C, how the back is attached to the corner, and D, the position when clamped tight. When this corner post is high it can be bent more easily by putting a standing seam at *a* in diagram F. G, H and J show the operations of forming the middle post. G shows the front of the middle post; L, the back; H, the back and front joined, and J the back clamped to the front.

The forming of curb P in the movable louvres, Fig. 409A, needs no further explanation than is given by the two diagrams in Fig. 412. The numbers in A, Fig. 409, correspond to the

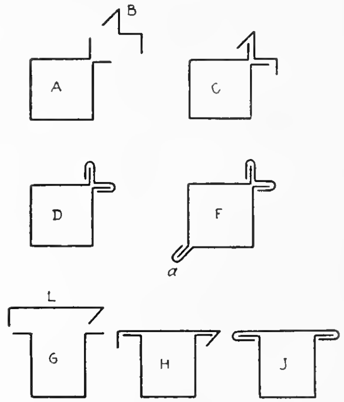


FIG. 411. Bending Corner and Middle Posts.

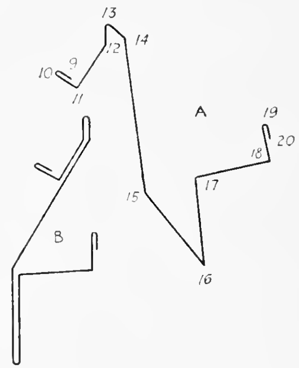


FIG. 412. Forming Curb P in Fig. 409A.

numbers in P, Fig. 409A and are similar in Fig. 412. Bend that part from 9 to 13 according to the stay, also that part from 13 to16 and from 16 to 20. Clamp together in the brake the bends 13 and 16 and the result will be shape B. When bending the movable louvre B^1 in sectioanl view, Fig. 409A, the upper

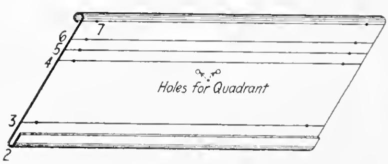


FIG. 413. Bending the Movable Louvre.

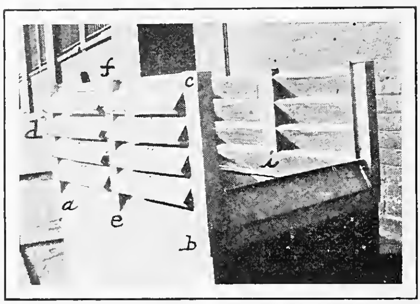


FIG. 414. View Showing Stationary and Movable Louvres.

wired edge *s* and lower hem edge 1 2 should be made, before any forming is started, as in perspective Fig. 413, after which the bends are made on 3 4 5 and 6. When all is formed the curb *a b i*, Fig. 414, is set together square, after which the corner posts *b c* and *a d*, and the middle post *e f* are soldered to the curb at right angles to *a b*. Care must be taken that these posts are set perfectly square to the base, otherwise the louvres will not fit.

The laps on the stationary louvres are then turned at right angles and soldered to the sides of the post.

Sometimes, instead of soldering the louvres against the post, ing, the posts have wood cores, to which the louvres are screwed as in Fig. 415. When the movable louvres have the wire inserted, *h i*, in F, Fig. 416, they are inserted between the posts as follows: When corner posts A and C have been set square, and before the center post is soldered tight, the wire pivot *h i* in each louvre is inserted in the hole punched in the sides of the post, *a b* and *b c*, and when all louvres are inserted, the middle posts are soldered square, in position.

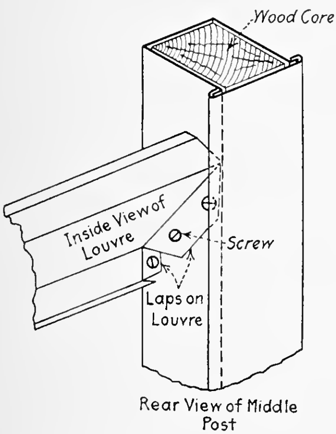


Fig. 415. Louvre Screwed to Post.

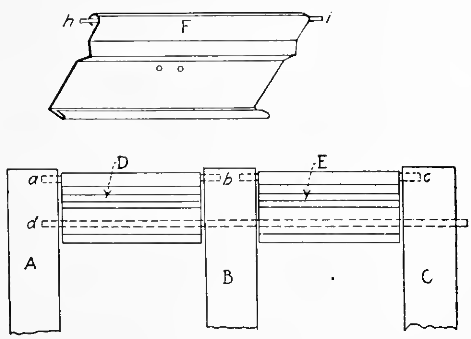


Fig. 416. Wire Pins Inserted in Movable Louvres.

Sometimes it is desirable that the movable louvres be placed in the skylight frame last, when all posts are soldered tight and plumb when a wire rod of the length of the side is inserted from the outside of the post C at *e*, the louvres held in their proper position so that when rod *e d* is pushed through the holes in the posts, it will pass through the wire edge on the louvres. This leaves a hole on the outside of a corner post, as at C, Fig. 410, on each side and this is closed by soldering over it a concave metal button.

The quadrants must be riveted to the movable louvres before they are placed in position, and after the louvres are in place the operating bar is riveted to them, as in the sectional view, Fig. 409A. When this has been done the finished louvres will look as in Fig. 410, which shows the stationary louvres on the outside and the inside of the movable louvres with the quadrants and the operating bar *e*. Fig. 414 shows a reversed view.

It will be noticed that a rail or angle, Fig. *a b* 417, has been placed along the top of the posts. While in large size louvre work this angle frame is employed, in small skylights, where the entire skylight can be finished in the shop, it can be omitted and the skylight placed directly over the posts, as in the sectional views in Figs. 409 and 409A, and as completed Fig. 408. Should the louvre frames under the skylight be of such lengths that they can-

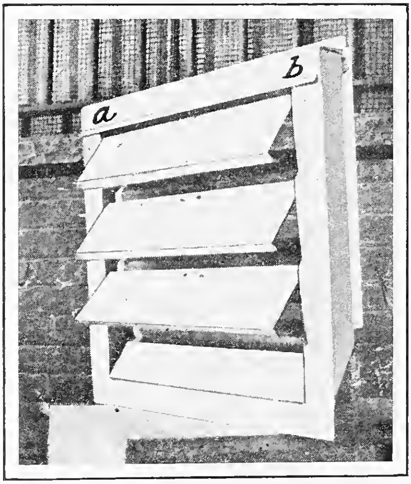


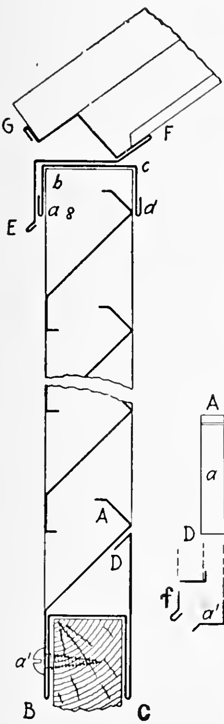
FIG. 417. View of Outside of Leuvres.

not be joined to the skylight in the shop, each side is usually finished complete, Fig. 418, A B C D. In this case the posts, *a b c d* and *e*, are set square with the curb D C and upper angle A B, and the louvres put in position.

The sectional view of the posts is shown below. The student should note that the corner posts *a′* and *e* are half posts, the connecting half being similar to *f*. Then when all of the sides have been hoisted to the roof the miters at the corners are soldered, locking *f* to *a′* and closing the inside angle with *h*. This method allows of easy transportation to the building.

A sectional view of the louvre frame is given in Fig. 419, which shows a frame, A B, used for heavier construction. Note that the lower curb is formed by A B C D, fastened to the wood curb at *a′* the distance between the flanges, B and C, being equal to the thickness of the wood curb. The flange, C, keeps the curb from slipping outward. The upper rail, A B, Fig. 418, is shown by *a b c d* in Fig. 419, and simply has square bends at *b* and *c* and affords a support to which the louvre posts are fastened and over which the skylight curb, E F G, is set.

When the length of the louvres sides are great it becomes necessary to brace them in the center to hold them rigid. Assuming



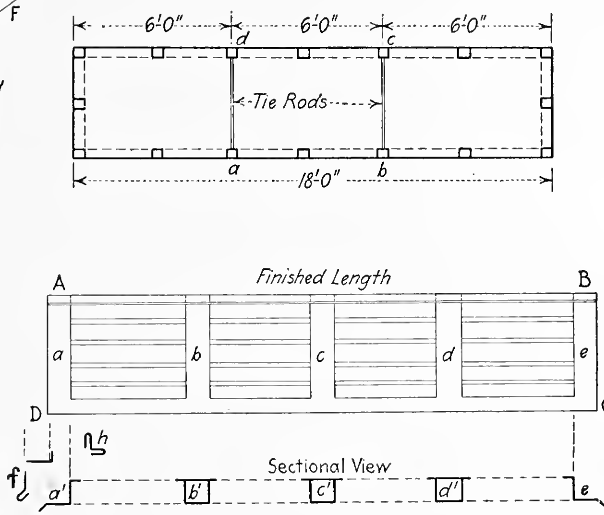


FIG. 418. FIGS. 419-420.

FIG. 418. Parts Constructed in Shop Ready to Send to Building. FIG. 419. Heavy Construction for Large Louvres. FIG. 420. Location of Tie Rods.

that the side is 18 ft., Fig. 420, two tie rods would be required, making the distance 6 ft. apart, as indicated in the diagram. The simplest way of fastening these tie rods without any angle iron construction is shown in Fig. 421, in which the tie rod is fastened to the posts marked *a b c* and *d* in Fig. 420. These posts have wood cores, Fig. 415. Iron gas pipe ½ in. in diameter and ½ in. shorter than from *b* to *c*, Fig. 420, is used for the tie rod, and have threads cut on each end as far as C, Fig. 421, with hexagon nuts to fit. A hole, A, is cut in the top metal angle, X, and the front of the metal post ¼ in. larger than the hexagon nut, and another hole a trifle larger than the pipe, B, is cut from the inside of the middle post and flange of the top angle.

The wooden core is now bored on the outside, of the size and to the depth of the hexagon nut, *a b c d*. When this is done another hole is bored through the entire core to admit the tie rod, B. This being done, the nut, C, is screwed to each end of the tie rod, D, the rod inserted in the two posts and the nut, F, screwed in position. Adjust the two nuts, F and D, until the sides stand plumb and the tie rods are firm. Over this opening, A, the curb, H I J, is set, which closes and hides the hole.

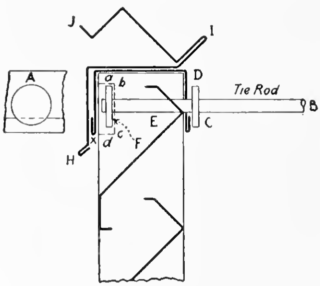


FIG. 421. Tie Rod Brace for Large Louvres.

The skylight over the louvres being large, some arrangement must be made to fasten to the louvre frames and to prevent it from spreading. Three methods are given. Fig. 422 shows how curb B is fastened to the top angle A, by brass bolts *a* fast-

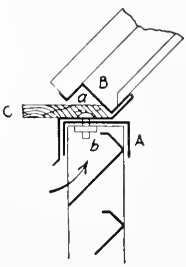


FIG. 422.

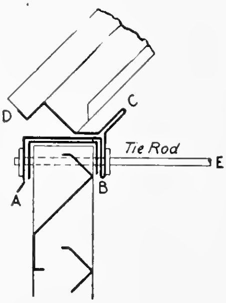


FIG. 423.

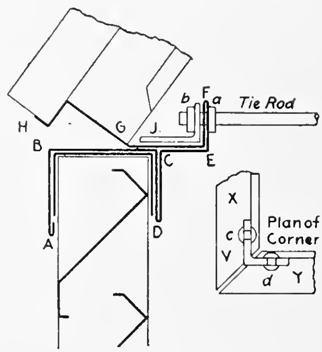


FIG. 424.

FIG. 422. Bolting Louvres to Curb. FIG. 423. Using Tie Rod to Fasten Louvre to Curb. FIG. 424. Another Method of Using Tie Rod.

ened at the bottom at *b* and then soldered over the head *a* in this manner: After the curb B has been set over the frame A, holes are punched upward about 18 inches apart, through the two thicknesses of the metal from the bottom *b*, using a large size rivet punch, and a strip of wood C, after which, brass bolts 3/16 inch thick, are inserted from the top and nuts screwed on the inside at *b*.

The method in Fig. 423 is similar to that in Fig. 421, excepting that the tie rod E passes through the skylight curb in addition to the louvre posts, and the skylight curb is formed as shown by A B C D, thus having a flange over the outside of the post at A and one over the inside at B. The tie rod can be employed as in Fig. 424 with an angle iron frame placed in the condensation gutter of the skylight curb. The skylight curb in this case is formed by A, B, C, D, E, F, G, H. Note how this is formed, the bend E being made after F was clamped. The angle iron J fits inside of gutter C, E, F and the tie rod is fastened with nuts at *a* and *b*. The skylight is then bolted to the frame as in Fig.

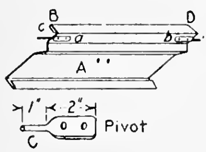
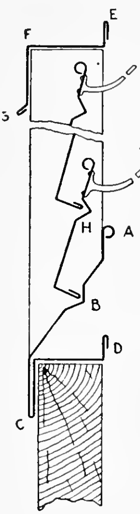
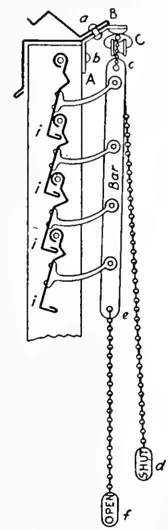


FIG. 425

FIG. 425. Pivot for Movable Louvre





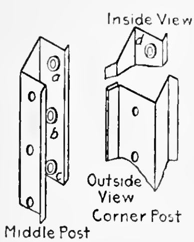


FIG. 426. FIG. 427. FIG. 428.

FIG. 426. Soldering in Washers to Strengthen Pivot Bearings. FIG. 427. Another Form of Movable Lourve Curb. FIG. 428. Louvre with Quadrants and Bar in Position.

422. Where the angles join at the corners, they are mitered at X, Y and reinforced by the angle V riveted at *c* and *d*.

In Fig. 409A the movable louvres had beaded edges into which wires were placed for the pivots. If desired these beaded edges can be omitted and the upper edges bent square, B, D, Fig. 425, with a hem edge *c* to stiffen and a pivot C, riveted at each end with two tinned (4 lb.) rivets at *a* and *b*. These pivots can be made from 3/16 inch rod, heated at one end and flattened out and two holes punched in them, after which they should be tinned or galvanized. When the louvres are long, the pivots have a tendency to wear out the thin metal or pivot bearings. To overcome this tinned washers are soldered on the inside of the middle and corner posts, after they are formed and before the backs are put on, as shown in the two views in Fig. 426, *a, b, c,* in the middle post and *d* of the corner post.

Some time the student may be called upon to construct an operating louvre to fit an opening in a wall or window, and the section he should then employ is shown in Fig. 427. Note that the curb is bent as indicated by A, B, C, D and the top frame by E, F, G, with a drip at G, the posts and louvres being bent in the

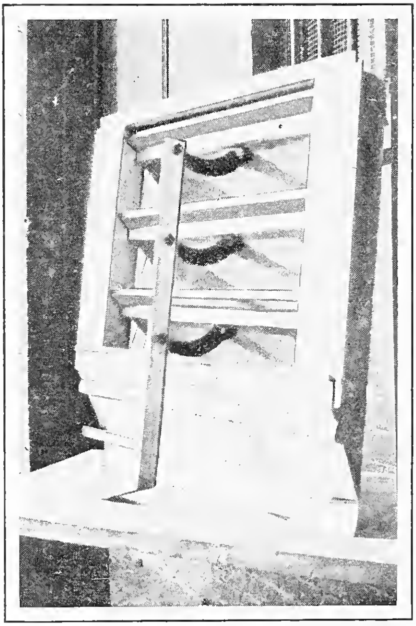


FIG. 429. Arrangement for Operating Louvres.

usual manner. How these louvres are operated by cords or chains is explained in connection with Fig. 428. A band iron angle, A, B, is bolted to the top frame at *b* and riveted to the skylight curb at *a*. To this angle B a brass pulley C is riveted. A brass chain or cord is fastened in the hole *c* at the top of the bar, passed through the pulley and made long enough to be reached from below and a bronze tag *d,* with the word "shut," attached to the end. At the lower end of the bar at *e,* another cord or chain is fastened of the required length, and a tag *f,* with the word "open" attached to the opposite end. When tag *f* is pulled down, the louvres open, and when tag *d* is pulled down they close. A frame having this construction and made by a New York Trade School student is shown in Fig. 417 with the louvres open, viewing it from the outside. The same frame, viewing it from the rear, with the quadrants and bar in position is shown in Fig. 429. The foregoing exercise on louvre work forms an interesting study for the student as well as the mechanic, and should be thoroughly mastered before going on with the final work of skylight construction.

CHAPTER XXVIII

Patterns and Construction of Stationary and Movable Sashes

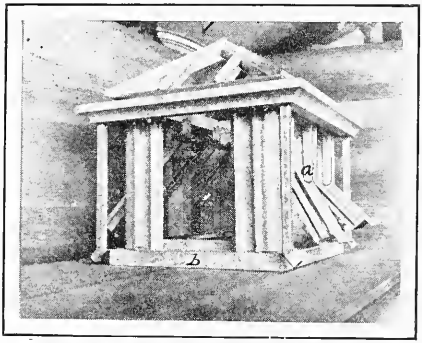


FIG. 430. Hipped Skylight.

In Fig. 430 is shown a hipped skylight with movable and stationary sashes below, the model being 18 x 24 in., the ends having stationary sashes and the sides movable sashes, 16½ in. high. Using this dimension as a guide the home student will construct a full size sectional view, showing the various constructions and interlocking features between the posts and sash in precisely the same way as is done at the New York Trade School. From these details the patterns are developed and a model sash minus the skylight on top is constructed the size of which will be hereinafter given.

In Fig. 431A (see Folder 9) is the shop detail of a movable sash reduced one-half full size, from which the home student should take his measurements. As the scale is one-half full size, Fig. 431A can be enlarged two times. When laying out the detail, reference should be made to the reproduced photograph in Fig. 430 which will help to give the shape of the various pieces, their location and appearance when completed.

Referring to Fig. 431A, the wood curb is shown over which the lower metal curb marked No. I is placed. Measuring from 4 in No. I, on the vertical line extended through 3 4, measure 16½ in. or as high as desired and place in the proper position, the upper curb No. II, making the angle drawn through 4 2 of the same pitch as the upper skylight, in this case one-third. Over this upper curb the hanging gutter and skylight curb is placed as in No. III, the gutter and curb being in one piece, by simply turning over on bend 10.

In line with 3 4 of curb No. I, a section No. IV through the lower half of movable sash and post is drawn below the pivot line. Note how this post is formed with the sides and back in one piece, and locked to a separate front piece. This makes easy bending and avoids a twist in the post. Around the standing seam of this post the section No. V of the lower part of the movable sash is drawn. Note that 1, 2, 3, 4, 5 is bent to receive the glass which lies against the rabbet 4 5, the glass being 3/16 in. thick. Should thicker or thinner glass be used, it would only be necessary to make the angle 1 2 3 more obtuse or more acute. Then 4 5 6 doubles together and forms the rabbet and 6, 7, 8, 9 forms the lock which closes over the standing seam of the post. No. IVa shows a section through the upper half of the movable sash and post. This post is similar in section to No. IV, but the upper half of the sash No. Va above the pivot, is only formed as far as 10, over which the interlocking cap No. VI is placed, as at *a*, Fig. 430. Underneath the hanging gutter 111, Fig. 431A, a square leader No. VII, is placed, the leader having an elbow at the bottom at *v y* with a hem along *y* to stiffen it.

In line with sections No. V and Va of the side of the movable sash draw the section of the bottom as indicated by No. VIII. Note that ⅛ in. play room has been given at the bottom at *h* and that the flap 7 8 laps over the lower curb. At 2, 3, 4, 5 arrangement is made to receive the hinge and the bolts, which will not interfere with the glass. In a similar manner, in line with No. V and Va, the section of the upper part of the movable sash is drawn as shown by No. IX. That is so arranged that the flap 2 3 closes against No. II and that 4 5 6 of No. IX can be bent obtuse or acute to suit the thickness of the glass, short sections of which are shown in the different sections.

In post No. IV the wire pivot is shown, indicating in what part of the post and sash pivot holes must be punched through which the pivot is to pass and on which the sash opens and closes. In line with the pivot in post No. IV the section of the pivot is drawn in the center between curbs No. I and II, indicated by the heavy circular dot marked pivot. The student should note that the side elevation of the post *f*, 3, *h* 4 is cut along the standing seam *i, j, k, l,* and the side elevation of the sash is cut as indicated by *f, u, t, h°*. When the sash is opened, the angle at *t*, strikes against *j, k* of the side of the post and prevents the sash from opening farther. How these cuts are determined, to suit any desired angle of sash opening is explained in connection with the enlarged sketch in Fig. 432, in which a partial side of the post and sash is shown, being a reproduction of the center part containing the pivot in Fig. 431A.

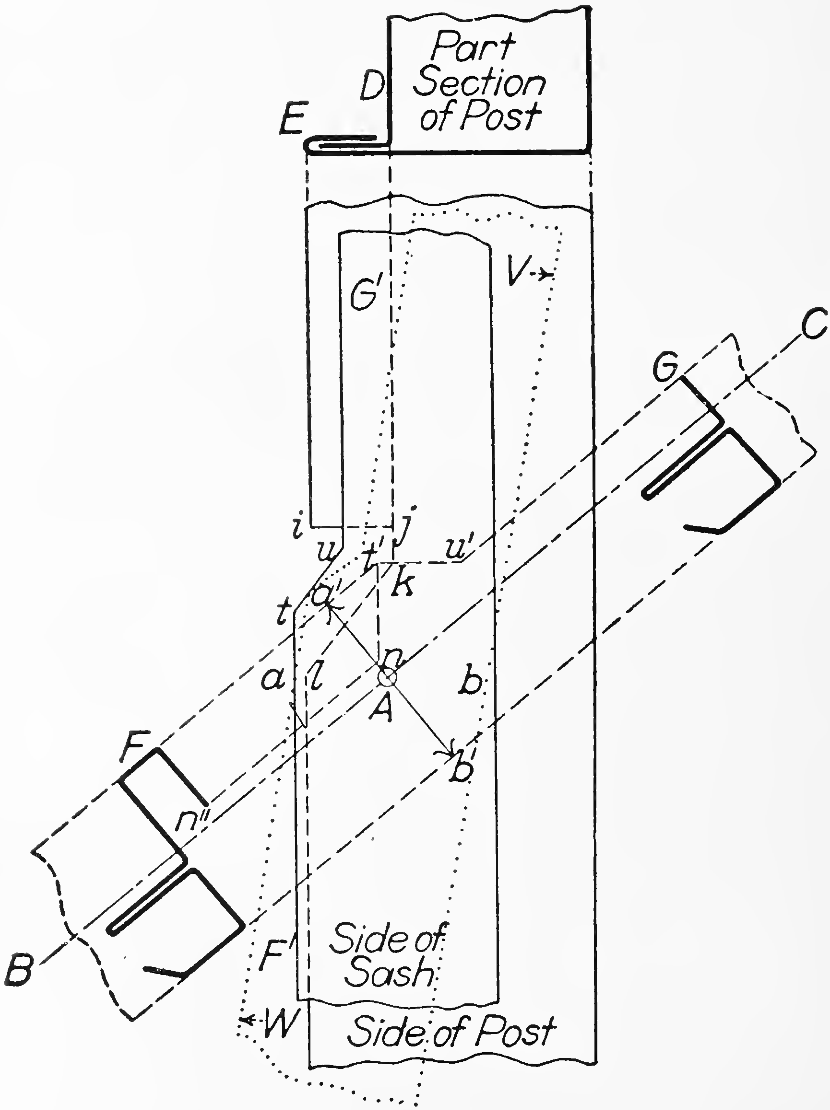


FIG. 432. Partial View of Opened Sash.

In Fig. 432 is the pivot hole in the side of the sash, obtained as previously described. Through the pivot A draw the line B C at any angle which the sash shall have when opened. Take the horizontal distance from A to l and A to b and place it from A to a' and A to b' on a line drawn at right angles to B C. Through a' draw a line parallel to B C until it comes within a horizontal distance of 1/16 in. to the left of the vertical line dropped from the front of the post D, as at t'. From t' draw the horizontal line t' u' until it meets the line from the outer edge of section G at u'. From t' drop the vertical line t' n, until it intersects the line drawn from n'' in the section F parallel to B C at n. Then t' n n'' is the proper angle to be cut on the flange F n''. This point n is shown in the closed sash in Fig. 431A, at s. Now through b', Fig. 432, draw a line parallel to B C which completes a partial view of the opened sash. The amount to cut from the standing seam E in the post is determined as follows: Where the line from D meets the line t' u' at k, erect the vertical line k j not less than ¼ in. and draw the horizontal line j i until it meets the vertical line from E at i. The angle j k l is obtained by placing the point l far enough below k so that when sash F G closes it will easily pass over l as indicated by the sash V W, shown dotted. These cuts having been obtained in Fig. 431A, draw the quarter circle t $d°$ in the sectional view, which represents the finish added to the sides 7 8 and 1 2 of the interlocking cap No. VI, Fig. 431A, as clearly shown at a, Fig. 430, which covers the wire pivot. In drawing this sectional view in Fig. 431A each section should be distinctly shown in the detail. The sash opened, as A^3 B^3, shows that the side below the pivot up to t is formed as indicated by A^3, which, when closed, locks around the standing seams 7, 8, 9, of post No. IV. The upper part of the sash above the pivot is formed as B^3 and, when closed, slips inside of the interlocking cap No. VI at 7.

The patterns are now in order and the home student will start with No. I, Fig. 431A, which is the lower curb. Number the bends in this lower section No. I from 1 to 7, from which points draw horizontal lines, until they intersect any vertical line at D^2 E^2. Draw any vertical D E, Fig. 431B, upon which place the girth of curb No. 1 from 1 to 7 on D. E (see Folder 11). Through these points at right angles to D E, draw the usual measuring lines indefinitely. Measuring from the line D^2 E^2, Fig. 431A, take the projections to points 1 to 7 in curb No. 1 and place them on similar numbered lines, measuring in each distance from the line D E, Fig. 431B. Trace a line through the points thus obtained, which will be the pattern for the miter cut for curb No. 1. When laying out the full length patterns on the metal, measure from point C the size of the frame in the roof, allowing laps as shown by the dotted lines. As the width of the post No. IV or IVa, Fig. 431A, is 2 inches, set off on pattern for No. 1, Fig. 431B, 1 in. as shown by the three dots. In all the patterns to be developed, the profile or stay after which the pattern will be formed, will be shown on the pattern; this will show at a glance what part of the movable sash the pattern represents.

Take the girth of the upper curb No. II, Fig. 431A, and place it on the vertical line C D, Fig. 431B, shown by the small figures 1 to 6, through which draw the usual measuring lines indefinitely. Measuring from any vertical line as C^1 D^1 in No. II curb, in Fig. 431A, take the horizontal distances to points 1 to 6, and place them on similar lines in the pattern, measuring from the line C D, Fig. 431B. Trace a line through points thus obtained, which will be the pattern for the upper curb No. II. When laying out full length patterns, always measure from arrow *b*, making them the same size as the lower curb No. I.

The pattern for the skylight curb and gutter combined, No. III, Fig. 431B, is developed as follows: Divide the curve from 4 to 7 into equal parts and number the bends from 1 to 14. At pleasure draw any vertical line as A B, upon which place the girth of No. III as shown by similar numbers. At right angles to A B, draw lines intersected by lines parallel to A B, from similar numbered intersections in the profile No. III (partly shown). A line traced through points thus obtained will be the desired pattern. The measuring point in this pattern is taken from *a* and the full size lengths should be ¼ inch longer than curb No. I or II. The shaded portion a^2 b^2 c^2 is cut out to receive the leader No. VII in Fig. 431A.

Since sections No. IV or IVa, Fig. 431A, are similar, the pattern for the back and sides of post No. IVa will be developed. On any horizontal line as H J, Fig. 431B, place the girth 1 to 6 of the post No. IVa, Fig. 431A, shown by similar numbers on H J. Through these small figures at right angles to H J, draw lines indefinitely. At pleasure draw any horizontal line, K^1 L^1, in the sectional view, Fig. 431A, and measure from this line K^1 L^1 to the bottom of curb No. II. At the same distance from the girth line H J, Fig. 431B, draw the horizontal line L^2 K^2. Measuring from the line K^1 L^1, Fig. 431A, take the various distances to points *h* and 4, which represent the intersection between the side of the post and wash of lower curb No. 1. Place them in the pattern on corresponding lines, measuring in each instance, from the line K^2 L^2, thus obtaining the points of intersections h' $4'$ on both sides. Now take a tracing of the cut i j k l, Fig. 431A, including the pivot center in the sectional view, and place it in similar position in the pattern on both sides, i' j' k' l', Fig. 431B. The upper cut on the post is square. Allow laps and indicate the center of the post by two dots on each end. The bevel h' h'' is similar to h' $4'$. Lines connected then represent the pattern for the back and sides of post No. IV or IVa. For the pattern for the front of this post take the girth of 7 8 9 10 in No. IVa, Fig. 431A, and place it on the line H J from 7 to 10, Fig. 431B. Draw the usual measuring lines at right angles to H J making them as long as 6 h'' in pattern for back and sides of post. Cut out m n in the pattern for front of post on both sides, in width equal to i' l in the adjoining pattern as indicated by the dotted lines. Allow laps and notch off the corners n', which allows the pivot to pass when the front is double seamed to the back. This represents the pattern for the front of post No. IV or IVa. These posts can be made as high or low as desired, but care must be taken to have the pivot hole in the center of the height and the two holes in the same position horizontally, as in the pattern.

The pattern for the side of movable sash No. V or Va is obtained by taking the girth of section No. V, Fig. 431A, and placing it on any line as K L, Fig. 431C, from 1 to 9, through which perpendicular lines are drawn indefinitely. From the small figures 1 to 9 in section No. V, Fig. 431A, vertical lines are dropped until they cut the wash of 7 6 of the lower part of sash No. VIII; then from the line K^1 L^1 measure the distances to these intersections and place them on similar lines in the pattern No. V, Fig. 431C. The height 6° 5° is obtained from 6 5 in section No. VIII, Fig. 431A. Trace a line through points thus obtained in the pattern, which will be the lower cut for the side of the movable sash. Measuring from the line K^1 L^1 in the sectional view in Fig. 431A take the various heights to points s, t and u, and place them on corresponding lines in pattern No. V, Fig. 431C, measuring always from line K L, thus obtaing s t t and u, the point u being placed on the line 10^A previously obtained from 9 to 10 in section Va., Fig. 431A. Establish the pivot hole r in the pattern for side of sash obtaining its proper position from the sectional view. From the center of the pivot s, Fig. 431A, take height to f and place it from r to o in the pattern. Connect lines and make the notch 4° 5° as deep as the distance from 4 to 5 in section

No. IX, Fig 431A, with which it is to miter. This completes the pattern for the side of the movable sash No. V or Va. When these sashes are made higher or lower, the distance from the pivot *r* to *p* and *r* to *o* should be 3/16 in. less on each end than from *r* to *p* and *r* to *o*, in the pattern for post, Fig. 431B. While all of these patterns are shown in groups, the student can, if he so desires, place these patterns on separate sheets, if his drawing board is too small to receive them all; it is good practice too, because many shop drawings are laid out thus.

The next pattern is the interlocking cap in section No. VI, Fig. 431A. Take the girth of No. VI from 1 to 8, Fig. 431A, and place it on any line as R S as shown by similar numbers, Fig. 431C (see Folder 11). At right angles to R S through these small figures draw lines and make the distance from c^2 to d^2, as long as from *r* to *o* in the pattern for side of movable sash No. V. The distance from T to U in pattern No. VI is the girth added for the half bead which forms a cap over the pivot *s* in the sectional view in Fig. 431C. With c^2 in pattern No. VI Fig. 431C as centers describe the quarter circles V and W which form the sides to cover the pivot end, *t* $d°$, in the sectional view, Fig. 431A. This completes the pattern for the interlocking cap No. VI for the upper part of the movable sash.

The pattern for leader No. VII, including the elbow at the bottom, is made in one piece, by taking the girth of 1 to 6 in section No. VII, Fig. 431A, and placing it on the horizontal line M N as shown by similar numbers in Fig. 431C. Perpendicular lines are drawn from these points and line V 7 thereon, is placed the distance from M N that V is from the bottom of the hanging gutter, Fig. 431A. From V also draw the horizontal line V 7; measuring from this line take the various projections to points 1 to 6 on the miter line V 5, and place them on similar lines in pattern No. VII, Fig. 431C, measuring in each instance from the line V 7, thus obtaining the miter cut W X. Take the distance from X to the line 7 and set it off below from X to 7′ and draw the horizontal line 7′ V′ and in similar manner as before, obtain the miter cut W W′ X, and make the distance from X *y* and W to *y*′ equal to *v* to *y*″ in Fig. 431A. Allow a lap below the upper miter cut in pattern No. VII, and when cutting this pattern, cut from W to W″ to W° at the top and from W to W′ to W° at the bottom, thus loosing the shaded portion, so that when bending the leader a slight bend is made along W° X to complete the angle. Allow laps top and side and hem at bottom.

The next pattern to be developed is the bottom of sash No. VIII of the sectional view in Fig. 431A. Take the girth of this section from 1 to 9 and place it on any vertical line as F G as shown by similar numbers in Fig. 431C. At right angles to F G though these small figures draw the usual measuring line as long as, from *e* to *d*, and complete the rectangle. On the line 5 notch out a distance equal to 2 3 in section No. V, Fig. 431A, as shown by 2° 3° on each side in pattern No. VIII. This completes the pattern for the bottom of the movable sash, and in laying out full size lengths make the distance from *d* to *e* ¼ in. less than between the posts in Figs. 433 and 434. The pattern for the top of the movable sash No. IX, Fig. 431A, is obtained in a similar manner. Take the girth from 1 to 6 in No. IX and place it from 1 to 6 on the vertical line O P, Fig. 431C. Through these points draw lines to form a rectangle, as long as from a^2 to b^2. On both ends of the lines 5 and 6 cut out 1°, 2° 3°, making from 3^v to 1° and 3° to 2° equal to the distance measured from the line 3, 4, section No. V, Fig. 431A, to points 1 and 2, with which the top of the sash No. IX is to miter. When laying out the full size length patterns for top of sash No. IX make the distance from a^2 to b^2, Fig. 421C, ¼ in. less than between the posts in Figs. 433 and 434. This completes all the patterns required for the movable sash.

To obtain the patterns for the various pieces required to make up the stationary sash in end *b*, Fig. 430, the full size detail in Fig. 433 must be prepared (see Folder 10). This represents the detail of the stationary sash, showing the horizontal section below the pivot line of the stationary and movable sashes, and also the full size developed patterns.

The method of computing the width of the sashes is also shown in this detail. In this case a curb 18 × 24 in. has been taken as an example and it is well for the student to lay it out the full size, as it will give him a better knowledge of the constructive features of the stationary and movable sash, as well as the construction at the corners. When once understood and the patterns are developed, the curb need not be laid out full size, but only a rough diagram made, as in Fig. 434.

Draw the outline of the curb, C D E F, in Fig. 433 18 × 24 in., and outside of it, in the upper left hand corner, place in its proper position a duplicate of the lower curb No. I, Fig 431A, as shown by No. I, Fig. 433. As shown by the dotted lines, complete the plan view of the lower curb, G H I J, being the innermost outline of it. Referring to Fig. 431A, in the sectional view, it will be found that the back of post No. IV sets against 3 4 of curb No. 1; therefore, take a tracing of post No. IV and place it on similar line in plan in Fig. 433 as shown by K on each corner. In similar manner place a post, K^0, in the center of the long sides. Take a tracing of the section of the movable sash No. V, Fig. 431A, and place it on either side of posts K and K^0, Fig. 433 as L. Connect the two corner posts by the watertight cap No. X and place this cap on each corner marked X. Take a part tracing of L, as much as is shown by No. XI, and place it as shown on the ends of curb, each section being marked XI. Draw a section of the glass to lie against 5 6 of section No. XI and draw the section No. XII, which must be soldered against the side of the post at 9. This section XII is placed on both ends, indicated by XII. It will be observed that section No. XII is first soldered against the posts right and left, before they are soldered to the curb, and when the posts are in position, the glass is laid against No. XII, and held in position by cap No. XI. This constitutes all that is required for the stationary sash.

On the movable sashes, M indicates the hinges bolted to the bottom of the sash as in No. VIII, Fig. 431A. The pivot between the strap and hinge is shown in Fig. 433. By means of these straps, hinges and gearings the movable sashes can be operated, as will be explained later.

Having completed this horizontal section or plan, the patterns for No. X, XI and XII are now in order, and are shown inside of the plan view. To obtain the pattern for corner cap No. X take the girth from 1 to a^0 to 1 and place it on the line A B from 1 to a^0 to 1. Draw perpendicular lines indefinitely and make the line 2 2^v as long as h' 2 in pattern for post No. IV, Fig. 431B. From the various spaces from $a°$ to 1 in the lower half of section No. X, Fig. 433, erect lines indefinitely until they cut the wash of curb No. I. At pleasure draw any horizontal line as a b, then take the distance from point 2 on the wash No. I to the line a b and place it from 2^v to $2'$ in pattern No. X and draw the horizontal line a' b'. Measuring from the line a b in section No. I, take the various distances to points a to 3 on the wash, and place them on similar lines in pattern No. X on each side, measuring in each instance from the line a' b', thus points, which will represent the lower cut. This completes the pattern for the corner cap No. X.

For the pattern for the cap on stationary sash No. XI, take the girth of the section from 1 to 6 and place it on line A B, from 1 to 6. From these points draw perpendicular lines, making the length from 2 to 2^x as long as the line 2 2^v in pattern for corner cap No. X. The bevel 2^x 1^x and 3^x 4^x in pattern No. XI should be similar to 3^t 4^b in pattern No. X, and 4^x 6^x in pattern No. XI should be a horizontal line. This completes the pattern for the cap on stationary sash No. XI. For the pattern for the separate rabbet in section No. XII, take the stretchout from 7 to 10 and place it on the line A B, from 7 10, from which perpendicular lines are drawn, equal in length to a^0 a^v in pattern for corner cap No. X, which completes the pattern. This completes all the patterns required for the stationary sash.

Sometimes there are objections to soldering rabbet No. XII against the post, which can be overcome by bending the corner post as in diagram N, in which the rabbet O is bent direct to the post, and making the outer cap as at XI^a. Using this method of construction, the center posts for the stationary sashes would have to be formed as in diagram P on which two rabbets are bent as indicated by R and S. The outside cap in this case would be bent in one piece, from T to U.

The method of computing the widths of the sashes is as follows: As the projection of the lower curb No. 1, to the rear post line, is 2⅜ in., Figs. 431A and 433, and as the width of the post is 2 in., then the width of the stationary sash on the 18-in. side will be $2\frac{3}{8} + 2 + 2 + 2\frac{3}{8} = 8\frac{3}{4}$. $18 - 8\frac{3}{4}$ gives 9¼ in. as the width between posts, which is also the width of the stationary sashes. In the long side of the curb the computation is $2\frac{3}{8} + 2 + 2 + 2 + 2\frac{3}{8} = 10\frac{3}{4}$. $24 - 10\frac{3}{4} = \frac{13\frac{1}{4}}{2}$ $= 6\frac{5}{8}$, the distance between posts, $6\frac{5}{8} - \frac{1}{4} = 6\frac{3}{8}$, the width in inches to make the movable sashes. While the size in Fig. 430 was made 18 × 24 in., with one stationary sash on each end and two movable sashes in each side the home student can get sufficient practice by placing one stationary sash at the end and one movable sash in the side.

The size of the curb to be made by the student should measure 15 × 18 in., and, if he desires, he can make a hipped skylight over it with a ridge bar. Having decided upon the size, a rough diagram is made, giving the desired dimensions, as in Fig. 434. Using dimensions for the curb and post in Fig. 433 a distance, as in Fig. 434, is found of 6¼ in. for the stationary sash and 9 in. for the movable sash, after making the allowance of ¼ in. for play room. The student should cut from sheet metal the various full and part patterns, including stays, as in Figs. 431A, 431B, 431C and 433, in a similar manner as was explained in the hipped skylight patterns in Fig. 387, after which the length of patterns in Fig. 434 should be laid out as follows:

Using pattern No. I, Fig. 431B, and measuring from the arrow point *c*, lay off two pieces from metal, with miters on both ends, without laps 1 ft. 3 in. long; also two pieces with laps 1 ft. 6 in. long, These pieces are formed after the stay shown, and require no description.

Using pattern No. II and measuring from arrow point *b*, lay off two ends and two sides of similar size. The bending of these pieces requires no description except to say that the first bend should be made on dot 2 in the pattern, 2^f in the stay.

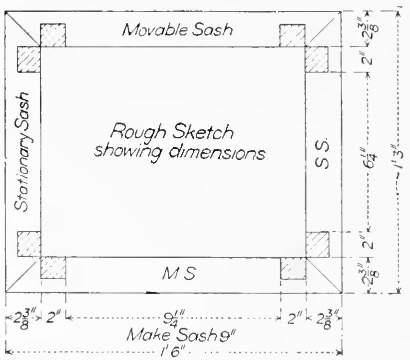


FIG. 434. Rough Sketch Showing Dimensions of Sash.

Using pattern No. III for skylight curb and gutter, measuring from arrow point *a*, cut two end pieces without laps 1 ft. 3¼ in. and two side pieces with laps 1 ft. 6¼ in.; the ¼ in. added being the allowance made to slip over the posts easily. When forming this gutter, bend and flatten the hem edge, 1, 2, 3, Fig. 435, then form the gutter starting at 3, in the usual manner as explained in the second exercise on "Moulded Gutter," and complete the bends to 10, Fig. 435. From 10 make the right angle bends as in the stay up to 14, shown by dotted lines, after which put 10 11 in the brake, close the top clamp to bring 11-14 in the position 11° 14°, which completes the gutter and skylight curb.

As the height of the sash is to be the same as in the sectional view in Fig. 431A, cut eight posts of patterns No. IV, Fig. 431B, cutting off the portion shown by *m n* and *i′ j′ k′ l′*, and punching out the pivot holes with the proper size rivet punch on a block of lead, before starting to form. The rivet punch should be of a size to easily admit the pivot, so that there will be no loss of time in reaming out the holes afterwards. The method of forming the post is shown in Figs. 436 to 439.

The two locks on the post are bent in the brake, making each side appear as shown by 1 2 in B, Fig. 436. Take a strip of metal, 2 in. wide and a little longer than the length of the post and about 1/16 in. thick, and bend off ½ in. lengthwise, as at *b*. Press down 1 2 in the brake over the strip *a*, as shown by 2′ *a*″, diagram A, after which the strip *a*″ is removed as in C using it over and over again for the purpose of keeping the locks from being pressed together. By having the edge *b*′ bent up, it keeps the strip rigid and easy to handle. When the two locks have been closed, the metal sheet of the post will look like A, Fig. 437.

This is now placed in the brake and bend 3 made; then drawn out to dot 4, the top clamp closed and the bend 4 3′ made, which completes the bending of the back and sides. The front of the sides of the post, Fig. 438, after which the locks *a* and *b* are closed tight in the brake, Fig. 439.

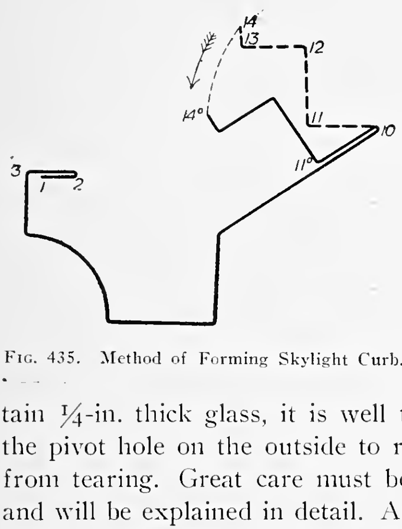


FIG. 435. Method of Forming Skylight Curb.

The pattern for the side of movable sash No. V or V^a, Fig. 431C, shows its true length, eight of which must be cut, formed four right and four left, being careful to punch out the pivot hole *r* before bending.

If the sashes will contain ¼-in. thick glass, it is well to solder a tinned washer over the pivot hole on the outside to reinforce the metal, and keep it from tearing. Great care must be taken in bending these sides, and will be explained in detail. Assume that 1 9, Fig. 440, is the side of the sash to be formed. tarting to bend on dot 2 which represents bend 2 in section No. V, Fig. 431A, make the angle 1°, Fig. 440, as called for by the stay, by closing the top clamp A on dot 2, and raising the bending leaf B to the proper angle.

This angle is determined by the thickness of glass which will be placed in section No. V, Fig. 431A. If the glass is thinner than that shown the angle must be turned up more, while if it is thicker it will be bent less, so that point 1 of No. V will lie well against the glass to keep it from rattling in a storm. This explanation applies to bend 5 in section No. IX in Fig 431A, and to bend 8 in section No. XII of the stationary sash, Fig. 433.

Draw out the sheet and close the top clamp on dot 3 as shown by 1° 9, Fig. 441, and make the square bend C. Leaving the sheet in the brake, draw it out to dot 4 at C, Fig. 442, and make a square bend as far as it will go, D.

Take out the side, reverse it in the position D, Fig. 443, and close brake on dot 5, and make a bend as far as it will go as indicated by E. While in this position press down 2 E, in the position *b*, tapping along the angle at *a* with the hammer, until the angle is square. Again reverse the side of the sash in posi-

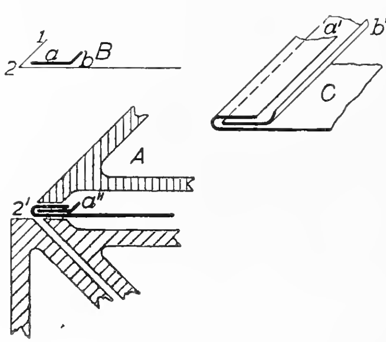


FIG. 436.

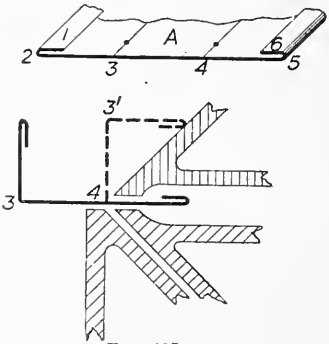


FIG. 437.

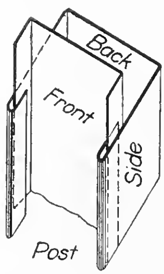


FIG. 438.

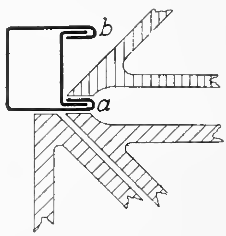


FIG. 439.

Method of Forming the Part.

tion E, Fig. 444, and close the brake on dot 6, on which make the square bend F. Reverse the side in position, Fig. 445, and make a square bend on dot 7 at G. Draw out the metal to dot 8 as G, Fig. 446, close the top clamp, and make a bend on 8 as far as possible, as H.

Place the acute angle *a* in the jaws of the brake, Fig. 447, close the top clamp so that H will be pressed down as J. Obtain for this purpose for any sash a piece of band iron as thick as J, as long as required, and place it in position *a* inside of J, Fig. 448. Place J in the jaws of the brake, close the top clamp firmly, bringing J down to L, which completes the forming of the side of the sash.

The pattern for the interlocking cap No. VI, Fig. 431C, shows its true length, four of which will be required from 1 to 6 only, cutting off on the line 6 6^e. The full pattern is only used for the middle posts K° K°, Fig. 433, but on the corner posts, K^v K^v, the portion from line 6 6^e to line 1 in pattern No. VI, Fig. 431C, is all that is required, as flange 5 6 of the pattern will be capped by the corner cap No. X, Fig. 433. When bending pat-

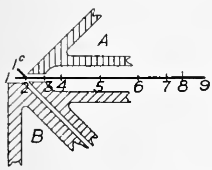


FIG. 440.

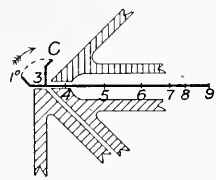


FIG. 441.

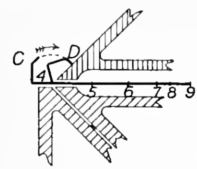


FIG. 442.

FIGS. 440-41-42. Successive Operations in Forming Side of Sash.

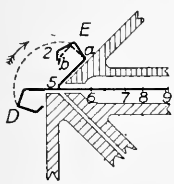


FIG. 443.

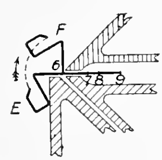


FIG. 444.

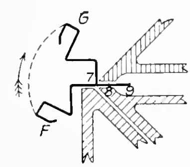


FIG. 445.

FIG. 443. Sash Forming Operations, continued. FIGS. 444-5. Sash Forming Operations, continued.

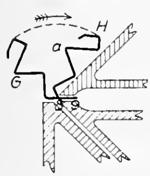


FIG. 446.

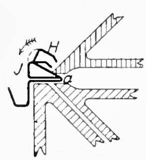


FIG. 447.

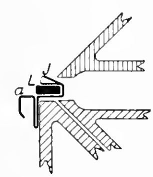


FIG. 448.

FIG. 446-47-48. Sash Forming Operations, continued.

tern No. VI, Fig. 431C, start on either bend 4 or 5, bending U U° on hatchet stake and turning the half bead on the proper size rod with a mallet.

When bending the four leaders, shown by pattern No. VII, Fig. 431C, turn off the hem edge and close in the brake, after which bend the pipe in the usual manner, forcing it to the proper shape by using a square iron bar X a trifle smaller than the pipe, as in Fig. 449. When the pipe has its proper square profile and is soldered along the joint at *a*, it will look as shown by A B. Turn B toward A on C, and the leader and elbow in one piece will look as shown by A^1 B^1. Solder the miter along C^1, which completes it.

Referring to Fig. 431C lay out the pattern for bottom of sash No. VIII and top of sash No. IX, measuring from points *d* to *c* in No. VIII and from a^2 to b^2 in No. IX, making both ¼ in. less than the distance between the posts in Fig. 434, or 9 inches long, two of each being required. These pieces are formed in the usual manner and require no description. Four pieces like pattern No. X, No. XI and No. XII, Fig. 433, will be required, bending the square locks as explained in connection with Fig. 448. Section No. XII in the horizontal section in Fig. 433 must be soldered to the posts, before the posts are soldered to the curbs, unless posts N and P are used, on which no soldering will be required.

After the work is formed, the posts are soldered in position as follows: First tack the posts to curb II, as in Fig. 450, being careful to follow the dimensions in Fig. 434 and that the posts

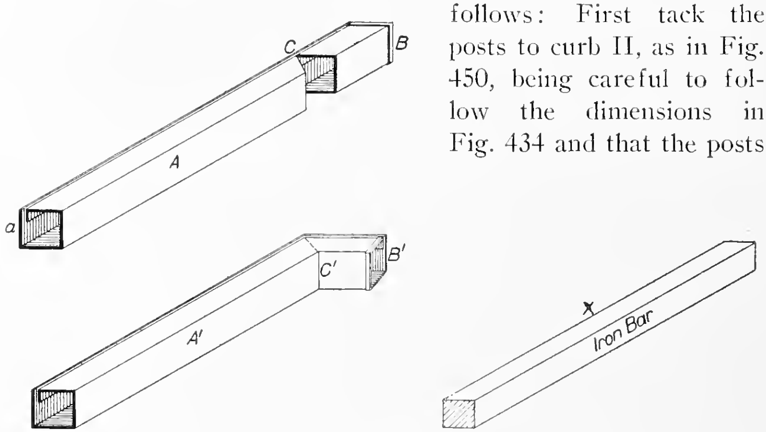


FIG. 449. Assembling and Soldering the Leaders.

are perfectly square with the curb, using the steel square *a b*, Fig. 450. When posts are tacked square to upper curb, tack them to lower curb I, being careful that each angle is a right angle, otherwise the sashes will not operate. In this case only corner posts are used, but where the ends and sides are long and contain middle posts, then all are soldered in position, as in the louvre work in Fig. 418, and the sides are joined at the corners on the building, as in the horizontal section in Fig. 433, and made watertight by the corner cap No. X. Care must be taken in making the model to place the posts for the stationary sash on the short side and for the posts for the movable sash on the long side.

The four sides being completed, movable sashes are set together, joining one right and one left side of pattern No. V,

Fig. 431C, to the bottom of sash No. VIII and top of sash No. IX. The sashes are now fitted between the posts where they belong, and pivots of galvanized steel or brass passed through the two sides of the sash and posts, as in section No. IV, Fig. 431A, allowing the pivot to project slightly on each end, at d° and 6, and to prevent it from slipping out at either end it is tacked with solder against the post at 22. The sashes should have the hinge bolted in position as in section No. VIII, before they are placed between the posts. For large skylights in actual practice use stove pipe wire to fasten the sashes temporarily against the posts, to prevent them from swinging outward until placed on the roof curb. The sides are now ready to be set together, soldering the miters at the corners of the curbs at c and d, Fig. 451, which is a model of similar size made by a student in the New York Trade

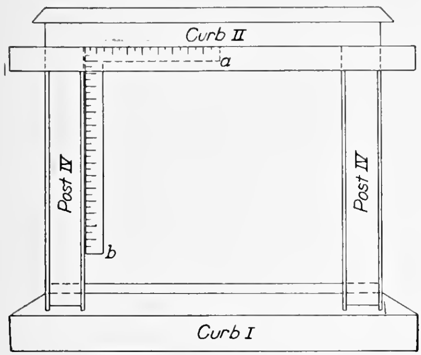


FIG. 450. Soldering Posts in Position.

FIG. 451. Finished Model—Closed Sash.

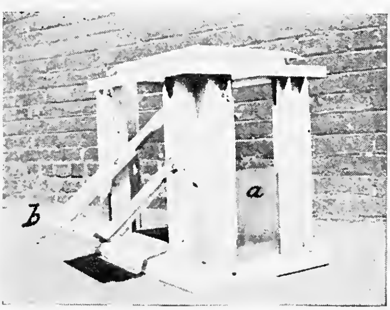


FIG. 452. Finished Model—Open Sash.

School. Notice that a piece of glass, a, has been placed in the stationary side and the operating sash b is in position but closed. Fig. 452 shows similar conditions, but the sash is opened. In Fig. 453 is shown the same turret with the caps loose. a represents the outside stationary cap No. XI, b the corner cap No. X, and c the interlocking cap No. VI for the corner post cut off on the line 6 6^e in Pattern No. VI, Fig. 431C, as before mentioned.

Note the flap *d* in Fig. 453, which closes against the lower curb. Fig. 454 shows all the caps in position with the interlocking cap *f* fastened by a few soldered tacks at the side; the gutter *e*, known also as No. III, is placed over the top curb, and leaders

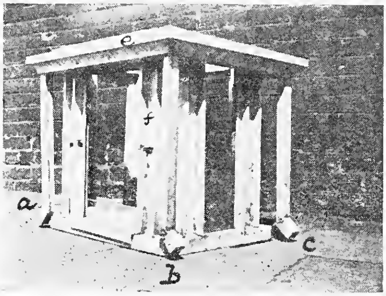


FIG. 453.
Showing Caps Loose.

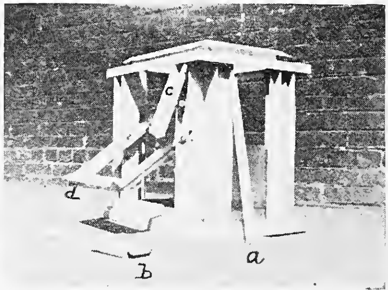


FIG. 454.
Showing Caps in Position.

a, *b* and *c* soldered in position. After the gutter *e* is in position, the leaders are soldered to it, as in Fig. 455, in which A is the gutter and B the leader, slipped in the gutter from the bottom and laps *a* turned down and soldered from the top at *b*. An angle is placed at the bottom of the leader in Fig. 454, secured to the lower curb, which secures the leader at the bottom. This completes the model turret over which a skylight can be placed as desired and as previously mentioned.

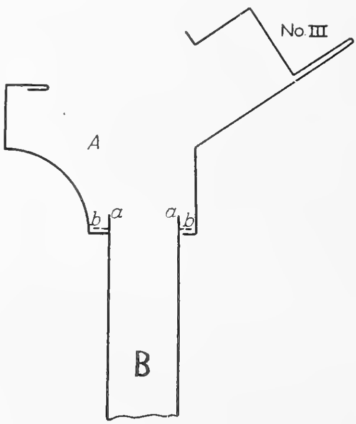


FIG. 455.
Assembling Gutter and Leader.

In practice, after the sides of the movable sashes are in position and the skylight is set over them, the sashes are usually glazed before the glass is laid in the skylight. The glazing of the sash is done by passing the glass from the top between the skylight bars at A, Fig. 456, and then sliding the light between the grooves in the open sash. Fig. 456 is an illustration of a hip skylight with a ventilating ridge and a turret having movable and stationary sashes. No putty is employed in glazing the sash, but to avoid loose lights, a little putty is placed in the corners to prevent rattling. After the glass is placed in the sash, it is closed and the upper skylight glazed. Sometimes in very large lights the upper skylight is glazed first, to prevent breakage of glass in the sashes, when the building mechanics have not completed their work on the roof. While the sashes can be glazed from the inside, it involves an extra amount of labor, which is to be avoided. Fastening the gearing to the sashes is explained farther on in the text.

When the turret sides are in long lengths, it is sometimes necessary to insert a tie rod at the top and bottom to keep them rigid, when the skylight is set over it, as in Fig. 420, but when the skylight is small all that is necessary is to solder the skylight curb, No. III, Fig. 431A, to the upper curb, No. II at 10. When

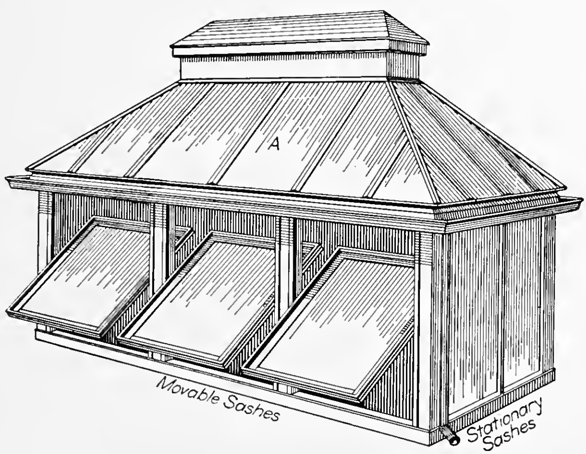


FIG. 456. Hip Ridge Ventilating Skylight with Movable Sash Turret.

the sides are long, the skylight can be made rigid by means of tie rods secured as in Fig. 457, which shows the curb or top rail of the turret, No. II, into which an angle iron $1\frac{1}{2} \times 1\frac{1}{2} \times 3/16$ in. is fitted, the corners being reinforced as in Fig. 424. In Fig. 457 angle F is bolted to the lower part of curb No. II, being careful to have the holes counter sunk at *a* so as to have a smooth surface on the outside, which will not interfere with the operation of the top part of the sash. At intervals of not less than 6 ft. holes are drilled in angle F to admit the tie rod H, which is threaded at the ends to receive the outer nut J. More rigidity can be obtained by placing another nut on the inside, shown dotted by K.

To keep the bottom curb, No. I, Fig. 431A, from spreading, its formation can be modified as shown by curb No. I, Fig. 458. In this case the curb is formed in one piece, from A to B to C, with screws passed into the wood curb at *a* and *b*. If, however, the roof curb was of angle iron, as shown by D E, then the inside flange C would be turned around the angle iron at *d e,* before the fire blocks were in position.

The method of operating the movable sashes in Figs. 454 and 456 is by means of gearings, the various pieces of which are shown in Fig. 352. When these gearings are to be fastened to the roof curb, use the same construction as in Fig. 353, or if an obstruction hinders the operation of the movable sash, the uni-

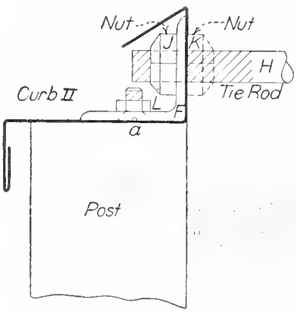


FIG. 457. Tie Rod in Upper Curb.

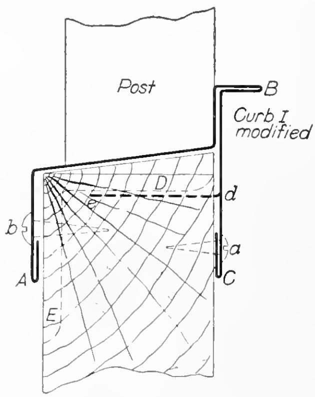


FIG. 458. Modified Curb.

versal joint should be used as explained in connection with Fig. 356, or when the sashes in the sides and ends are to be operated with one lifting power, use the miter wheels shown in Fig. 357.

When rods or pole hooks cannot be used to operate the sash owing to the height, or if more power is required, then the chain can be used to open and close the sashes, Fig. 355. Sometimes the gearings are fastened direct to the posts of the movable sashes, as in Fig. 459, in which case the posts must have a wood core into which bracket 1 is screwed at 2 and 3. The extension 4 is fastened to the roof curb at 5 and 6. Otherwise the gearings are assembled as explained in connection with Fig. 353. A perspective and sectional view showing the gearing in position, with the brackets fastened to the posts, and the extension fastened to the roof curb, is given in Fig. 460, in which the strap A, arm B and bracket C in the sectional view are shown by A^1, B^1

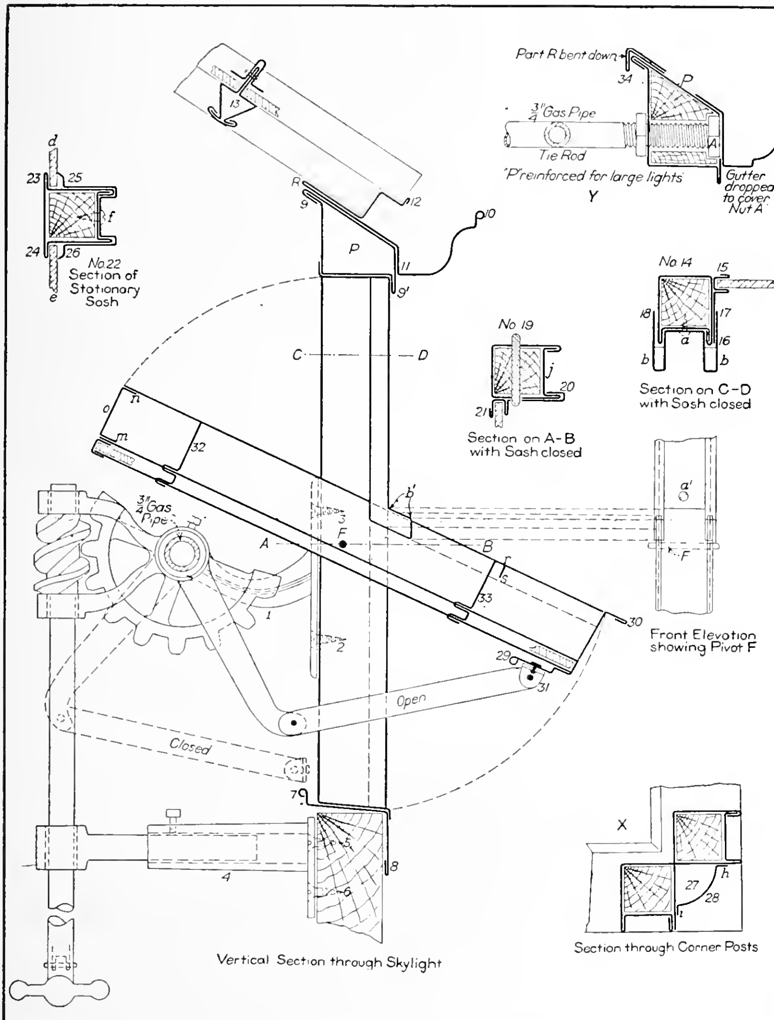


FIG. 459. Another Form of Movable Sash Construction.

and C^1 in the perspective view. If it was desired to swing sash D E out farther it would only be necessary to lengthen the strap A and use a longer arm at B.

Fig. 459 is a one-quarter full size section of movable and stationary sash, showing different construction from that in Fig. 431A, and Fig. 461 shows a still different construction. While various shops have different methods, the two different constructions are given, from which the home student can obtain practical hints which only years of experience can bring.

The construction of the two types in Figs. 459 and 461 will be explained briefly, and the student is advised to work out these sections full size, as done at the school by students. Referring to Fig. 459, in the vertical section through the skylight: 7 8 represents the lower metal curb, with a beaded edge at 7 and a hem edge at 8, resting upon the roof curb 5 6. P represents the upper part of the curb, bent in one piece, with a lock at 9 and a drip at 9′ against which the sash closes. The skylight curb and gutter, 10, 11, R, 12, rests upon P and the bend R is doubled over to form the curb, R, 12, to receive the skylight bar in section 13. The vertical section shows the sash open, also the elevation of the side of the post and side of the interlocking cap, with the snow-proof hood *b′* attached, as 17, 16, *b, a, b,* 18, in diagram No. 14.

This diagram is a section of the post, sash and interlocking cap through C D in the vertical section when the sash is closed. Notice that the post is bent in one piece, with a standing lock at 16, the metal post having a wood core, to which bracket 1 in the sectional view is screwed. The side of the operating sash at the top is formed as indicated by 15 16, the glass sliding in the groove shown.

The interlocking cap is bent as 17 *a* 18, the projections *b* and *b* indicating the view looking down on *b′* in the vertical section. The screw *a* in No. 14 is used to hold or fasten cap 17 18, shown in the front elevation by *a′*, in which is shown the pivot F of the vertical section, also marked F, and requiring a hole bored through the wood core for its insertion. The section taken through the line of pivot A B when the sash is closed is shown in diagram No. 19, in which the posts is bent in one piece with joint at *j*, the section of the sash below the pivot line being shown by 20 21; lock 20 indicating where the sash locks around the standing edge of the post when closed. Diagram No. 22 shows a section through the stationary post, on which rabbets 23 and 24 have been bent in one piece, against which the glass *d e* rests and is held in place by the cap, formed in one piece from 25 to *f* to 26, secured by the small brass wood screw.

The section through the corner post in diagram X, shows where the posts are soldered together in corner 27, and if desired a round corner 28, is tacked with solder against the posts at *i* and *i* for a finish.

In the open sash, 29, 30 and 31, indicates the section of lower part of the sash, with a beaded edge, if desired, at 29 (a hem edge will answer just as well) and a flap at 30 to close against the bottom curb 8. Hinge 31 is bolted to the bottom of sash,

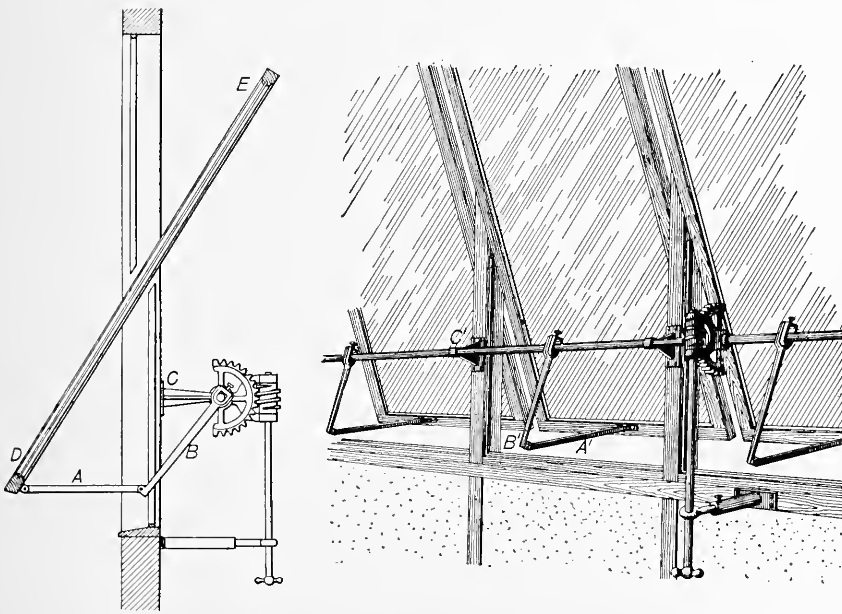


FIG. 460. Method of Attaching Gearing for Movable Skylights.

making the offset at 31 sufficient to prevent breaking the glass by the bolt when operating the sash. The section of the top of the sash is shown by *m o n*. The section of the side of the sash above the pivot line is shown in 32, and that part which locks into the interlocking cap 17 16 in diagram No. 14. Section 33 is the same as section 32, excepting that below the pivot line the lock *r s* in section 33 is added, locking over post 20 in section No. 19.

When curb P in the vertical section must be reinforced by tie rods, it is done as in diagram Y, which explains itself. In this case the top edge of the skylight curb R in the vertical section is turned down so as to hook over P in diagram Y, as at 34.

Fig. 462 has been prepared to make clear the interlocking feature of this type of sash, in which B shows the post with wood core C to which the gearing brackets can be fastened, and into which, in its proper position, a hole is bored to admit pivot D. The lower curb is shown at E with a beaded edge F. On

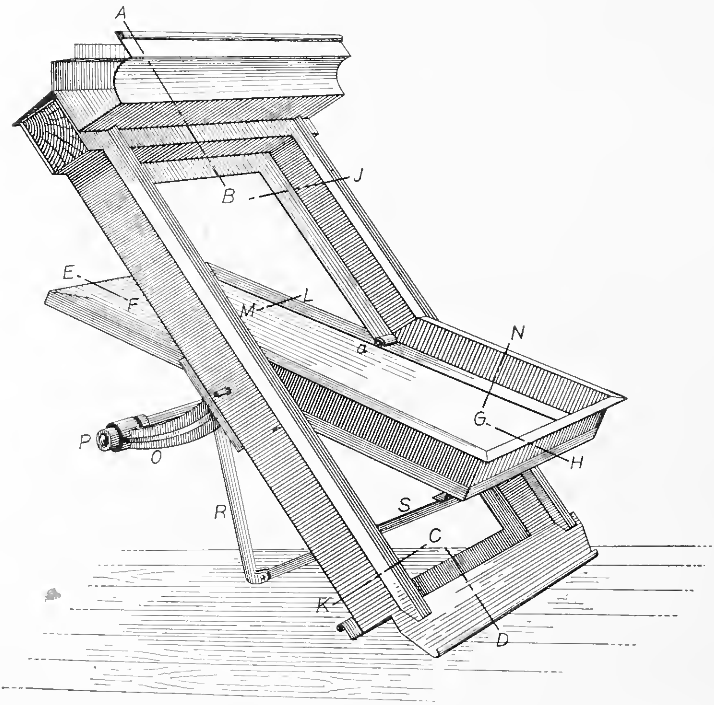


FIG. 461. Movable Sash Skylight Showing Gutter, Curb and Gearing in Position.

curb E the post is soldered along *a b*. The upper part of the side of the sash above the pivot line is shown at G, formed to receive the glass H. The sash is closed, showing where the side flange *d* locks into the cap at J. The interlocking cap J K is shown with the storm hood attached at L M with a seam along *e f*. This cap is fastened by the brass screw A. The section O of the side of the sash below the pivot line is similar to the top, except that lock P is added, which, when closed, locks over the standing seam P° of the post. The glass R is shown in position, placed in the groove at *i*.

Referring to Fig. 461 it will be noticed that it is of different construction, in which, as in the former construction, the gearing bracket O is screwed to the wood core in the post. The gas pipe P to which arm R is fastened, is shown with the strap S hinged to the arm R as well as to the hinge not shown. The home student can with care successfully work out his full size section of this sash. A section drawn to a scale of 4 in. to the

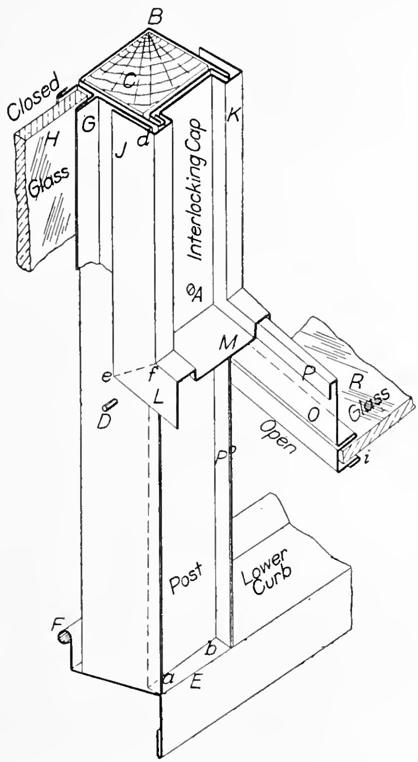


Fig. 462. View of Interlocking Sash Construction Shown in Fig. 459.

foot or one-third full size is given in Fig. 463. Using a 4-in. scale, every inch will represent 6 in.; ½ in. will equal 3 in.; ¼ in. will equal 1½ in. and so on, always three times larger than the diagram.

A section of the top curb is shown at A locked at *a*; in large lights a wood core is placed in it, to secure the tie rod. The skylight curb B is bent in one piece from *b* to *c* to *d*, fastened to the top curb A by screws in *f* if a wood core is used, and soldering a button over it to prevent leakage by condensation, or soldering in the angle between *a* and *d* if no wood core is employed. A section of the bar is at *h* and *e* is the condensation tube. Notice that the top of the gutter at *b* is lower than tube *e*, so that in case of an overflow the water will flow over *b* before it enters the tube *e* to the inside of the building. A flange C is soldered to the bottom of the top curb A against which the sash closes. What has just been described represents the section through A B, Fig. 461.

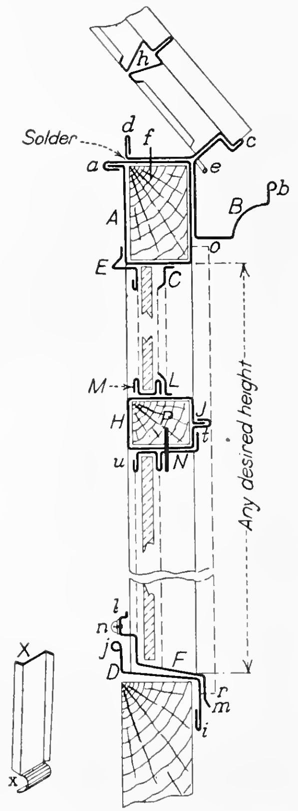


Fig. 463. (At Right) Reduced Side Sections Through Planes in Fig. 461.

The bottom curb D, Fig. 463, is formed from *j* to *i* and represents the section through C D, Fig. 461. The section through E F, Fig. 461, is shown by E, Fig. 463. The bottom of the sash F is bent from *l* to *m*, with the hinge secured at *n* and represents the section through G H, Fig. 461.

A section through B J, Fig. 461, is shown in Fig. 463 by the post H and the angle L which is soldered thereto only above the pivot, as in Fig. 461 at *a*. Notice that post H, Fig. 463, is bent in one piece with a standing lock at J; when bending the strip L it is formed as in diagram X, which has a semi-bead at the bottom *x* which covers the pivot as indicated by *a*, Fig. 461.

The section through C K is similar to the post already decribed. The section through L M above the pivot is shown in Fig. 463 at M. The section N of the side of the sash below the pivot is formed as indicated by *u t*. Through N the pivot P is placed. The pivot P should pass through the wooden core P to the other side of the sash, in this case partly shown. This constitutes the section through G N, Fig. 461.

The method of fastening the hinge by rivets to the side of the sash is shown in Fig. 464, A, represents the hinge made from brass or galvanized band iron 1/16 in. thick by ½ in. wide, the curve at *c* corresponding to the size of pivot and is riveted to the side of the sash B at *a* and *b*. In practice the holes *a* and *b* in the

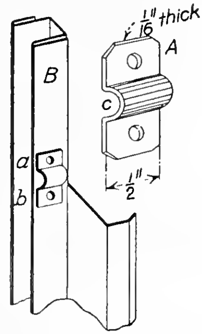


FIG. 464. Method of Fastening Hinge to Sash.

sash and hinge are punched before forming.

The height of the post in Fig. 463 can be made as desired, allowing the standing lock J to extend at the top to *o*, and to the bottom to *r*, which makes a rigid construction. The student should study the various constructions shown, which will enable him to devise different constructions and shapes, as occasion may demand.

CHAPTER XXIX

Drawing Details in the Construction of Bay Windows

The final exercise in Part II will now be taken up by the student and for this a 1-in. scale drawing is given in Fig. 465. It gives a one-half front elevation, a vertical section through the center line A B and a horizontal section through C D. Notice that the front elevation in the mullions X are broken, but the length that they should be made is given as 2 ft. 9 in. from *a′* to *b′*. The small letters from *a* to *n* represent the various centers from which to strike the arcs of the different molds.

While a front elevation is shown in the scale drawing, this is not necessary when laying out the full size detail, but is only given to show what is to be made, the same as any architect's drawing would show. When laying out the full size detail, the only elevation necessary is that of the bracket E in front elevation. In the sectional view A° B° represents the sheathing line of the bay window when the framing is wood; or represents the face line when the framing is angle iron filled with fireproof blocks. This sheathing or face line A° B° is also known as the measuring line for the various sections of the bay window.

When the bay window is one story high or about 10 ft. and not more than 5 or 6 ft. wide, and can be transported to the building, it is usually made complete in the shop, then set on the projecting beams at the building as in Fig. 466 in which A is the beam, B the base of the bay and C the $\frac{1}{4} \times 1\frac{1}{4}$-in. band iron braces placed 2 ft. apart, bent to the shape shown, bolted to the window base at *a, b* and *c,* with an angle turned at the bottom at D, which rests upon the beam, and fastened with the anchor nail *d.*

After the other parts of the bay window have been securely fastened to the wall as at *f,* the carpenter proceeds to construct the framing from the inside. The finish made at the bottom H, with a metal panel, will be shown in other diagrams. This is the style of bay window that the student is to be taught to construct, put together complete in the shop, as in Fig. 467, with the student's initial on each side and the year in the center.

The right way to construct bay windows when they must be fastened to the buildings, either wood or iron framing, and the proper way to take the measurements from the rough framing at the building will be explained.

Let it be supposed that in this case the bay window is made complete in the shop and the framing built in against it at the

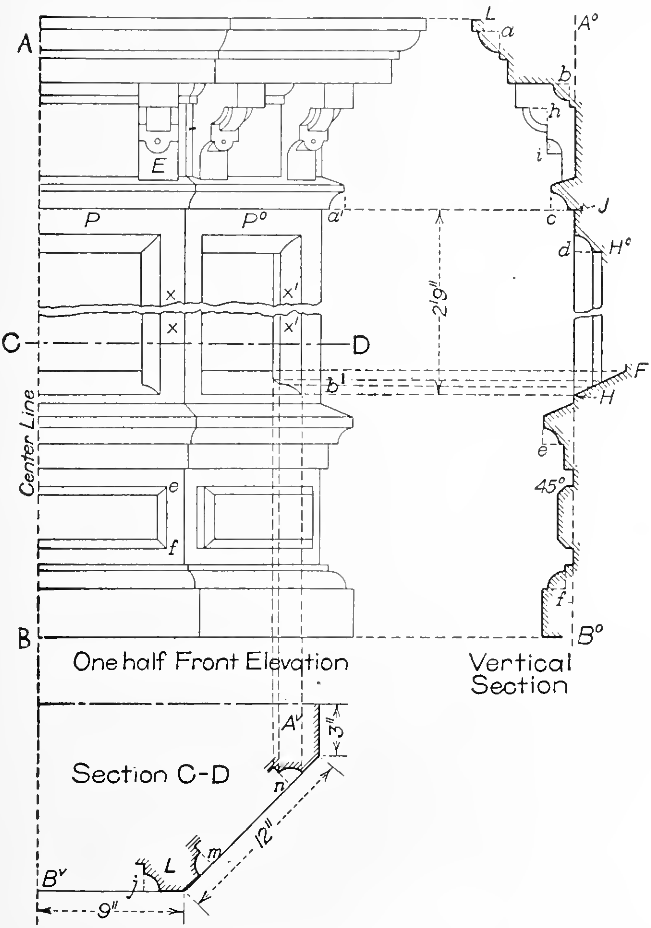


FIG. 465. Elevation and Section of Bay Window.

building after it is set; then the size of the metal bay must first be known and is given in the section through C D Fig 465 along the line A^v B^v, and also shown in the vertical section A^o B^o. Where line A^o B^o passes through any member of the bay, it become the measuring point for laying out the sizes shown in the horizontal section.

At pleasure designate the points from which the measurements shall be taken, as at H for the bottom and at J for the top. Also L and A^v in the horizontal section, show the profiles of the middle and end mullions.

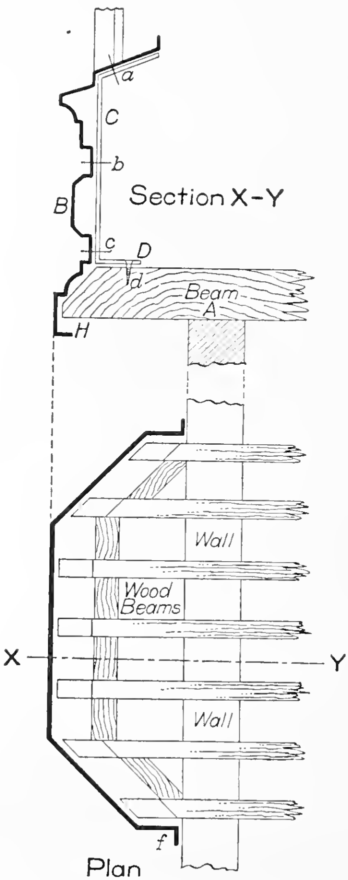


FIG. 466. Attaching Bay Window to Building.

The student is now ready to proceed with the shop detail and will draw the bottom of the bay window from F to B°, Fig. 465.

Using the 1-in. scale rule, obtain the heights of the members in the bottom of the bay, taking the measurements from the center line A B in the front elevation, and placing them as shown by full size measurements on the line A B, Fig. 468 (See Folder 10). Notice that the entire height from the top of sill to bottom of base is 1 ft. 4⅜ in.

At right angles to A B from these measurements, draw horizontal lines indefinitely and at a distance of 3 in. from and parallel to A B draw the line C D. Measuring from the vertical line H B° in the scale drawing, Fig. 465, take the various projections, using the 1-in. scale rule, and place these measurements on their proper lines in the shop detail, Fig. 468, as shown by the full size measurements.

The student should carefully take from the scale drawing in Fig. 465 each measurement and put it full size on his drawing of Fig. 468, and not copy them, as that would not give him the much needed practice. The measurements given to enable him to verify the measurements which he takes from the scale drawing.

The centers *a* and *b* in the detail in Fig. 468 represent the centers for describing the cove and quarter round. Connect the points obtained, by lines shown shaded. That part from 1 to 13 is the sill mold, from 13 to 20 the panel course, and from 20 to 29 the base mold.

This sectional view is all that is required in developing the necessary patterns for the base of the bay window, and the next step is to place a part plan in its proper position below the sectional view in which the proper miter line is drawn from which to get the projections in developing the pattern, and is obtained as follows: In this case the angle of the bay is to be 45° and is known. When the angle is not known and it must be obtained from the building, the method of taking the bevel will be explained in a future diagram. Diagram A° represents a rough plan of the bay, measurements and angles being obtained from the horizontal section in Fig. 465. Take the bevel A^v L, Fig. 465, and place it in the position E F G in the detail in Fig. 468 being careful to place it in line with the extreme projection of the base, or, in other words, in line with 27 28. Obtain the miter line of this angle by using F as center and with any desired radius draw arcs intersecting lines E F and F G at *c* and *d*. With *c* and *d* as centers, with the same or any radius, describe arcs cutting each other in *e*. Draw a line from F through *e*. Then F H is the desired miter line.

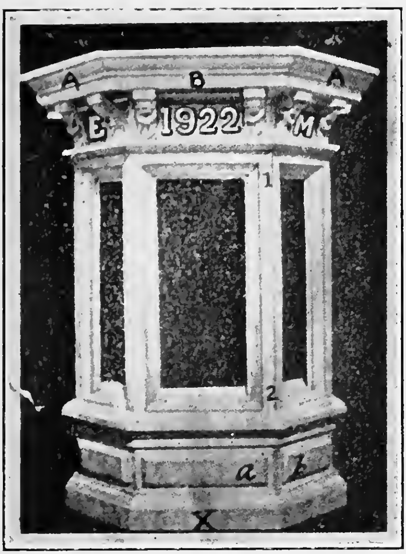


Fig. 467. Students' Finished Work.

Divide the profile C D of the base into equal spaces, from 1 to 29 and from points 1 to 13 and 20 to 29, drop vertical lines until they intersect the miter line F H as shown by similar numbers. From the intersection at 1 2 at right angles to E F, draw the line 2 28. On any line as J K place the girth of the base mold from 1 to 29 in the sectional view as shown by similar numbers on J K. In this case the entire girth is taken because it does not take up more than the full width of the sheet.

When the girth cannot be in one piece, seams should be made at 14 and 20 in the sectional view, as 14^a and 20^a, which allows the water to pass over it. These seams are riveted or they can be locked, as shown by 14^b and 20^b. Through the various points on the girth line J K and at right angles to it lines are drawn indefinitely.

Measuring from line 2 28, in part plan, take the projections to the various points on the miter line F H and transfer them on similar numbered lines, measuring in each instance from the girth line J K. A line traced through points thus obtained, from 1 to L^1 to f', and from f^x to U, will be the octagon miter for that portion of the molds above and below the panels, in the part elevation in Fig. 465.

As the part from e to f, Fig. 465, is a panel or face miter, the short method for adding this to the miter cut in Fig. 468 is as follows: Extend 16 17 and 20 21 in the sectional view until they intersect at f. Measuring from the line f 20 take the projections to points 17, 18 and 19, which represents the corners 16, 15 and 14 on the opposite side, and place them on similar numbered lines drawn through the girth line J K, measuring in each instance from the line drawn from f' and f'', to the left of the pattern. A line traced through points thus obtained, as shown by f', 14, 15, 16, 17, 18, 19 and f^x, will be the miter cut for the square panel miter.

To obtain the patterns for the panel heads simply take h as center and h h' as radius and describe the quadrant h' h''. From h and h'' erect perpendicular lines to the line 13 as h i and h'' i'. Measuring from the line h i, take the various projections to points f', 14 and 15 and place them to the left of the line h'' i' from f'' to h''. Allow a lap along h h'', which is soldered along h h' in the main pattern. Also a lap along f f'', as shown and at right angles to f' f'' draw the lines f' o and f'' r a distance of 3 in. as required by diagram A°. Along r o allow a lap. This finishes the three patterns for panel heads. One, shown from i'' to j, of which two are required, to be soldered to the 18-in. side of the base at a, Fig. 467. The second shows from l to k, Fig. 468, which includes the lap, two of which are required, to be soldered to the 12-in. sides at b, Fig. 467, and the third from m to n, Fig. 468, to which the 3-in. return has been added and a lap, as required by diagram A°, and as shown at a, Fig. 469.

Having decided that H, Fig. 465, should be the measuring point, it is shown by L in the sectional view in Fig. 468, between points 3 and 4. Measure from similar points in the pattern shown by L^1, and lay off a distance of 3 in. to M; 6 in. to N, and 9 in. to O, which represent the depth of the return in diagram A° of 3 in., one-half of each of the 12 and 18-in. sides. Through points N and O draw vertical lines the entire height of the pattern shown by V W and Y X.

As the 3-in. return between points 13 and 20 in the sectional view has been added to the pattern for panel head *m n*, then the base and sill mold 1 and 2, Fig. 469, will have a seam at points 20 and 13 in the sectional view, Fig. 468. Therefore through M in the pattern draw vertical lines from line 1 to 13 and 20 to 29 allowing a lap below line 13 and above line 20. These two laps then join $f'\ o$ and $f''\ r$ in the panel pattern.

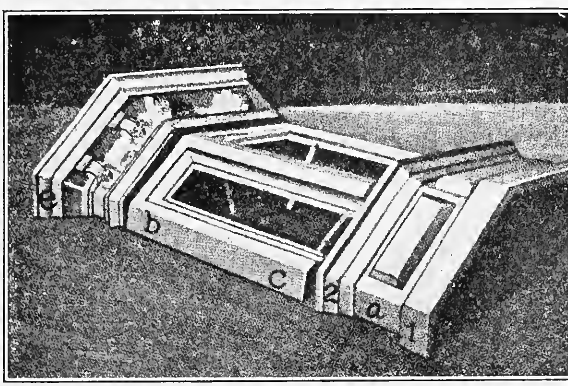


Fig. 469. View of Bay Window.

As stated before, Y 1 U X is the half pattern for the front piece which is reversed on the dots Y and X to complete the full pattern, one of which is needed. No laps, except the four in the panel cut marked 1 2 3 4, are allowed. The half pattern for the 12-in. sides is V 1 U W and is reversed on the dots V W to obtain the full patterns, on both sides of which laps are allowed from 1 to U, and two of which are to be cut from metal. The pattern for the sill return, two of which are required, and to which no laps are required on the miter, is indicated by P 1 f' R in the pattern, Fig. 468, and its position is shown by 2, Fig. 469. The pattern for the base return, two of which are needed without laps on the miter cut, is shown in Fig. 468, S, f^x, U, T, and its position by 1, Fig. 469.

It should be understood by the student that if the bay window was of such a size that the half pattern could not be developed on paper, it would only be necessary to use a short piece of the miter as V 1 U W, and then lay out the sheets any desired length, as explained in the Ornamental Cornice in a previous chapter.

This completes all the patterns for the bottom of the bay window in Fig. 468. Before they are cut from metal the upper part of the window as well as the mullions should be drawn and developed.

The preparation of the detail of the upper part of the bay window from L to H° in the vertical section in the 1-in. scale drawing, Fig. 465, is now in order. It will be noticed that brackets are placed in the cornice, two on each side, requiring six in all. Using the 1-in. scale rule obtain the heights of the cornice on the center line A B including the mullion head P, and place them on the line A B as shown in Fig. 470 (see Folder 11). Notice that the height of the cornice is 11¾ in. and of the mullion head 2¾ in. Measuring from the line A° B° in the vertical section, Fig. 465, scale the projections from L to H°, and place them on corresponding lines in the shop detail in Fig. 470, as shown by full-size measurements. Note that the extreme projection of the cornice from the line A B is 6½ in. and of the mullion head 1¾ in. Also that *a, b, c* and *d* represent the centers for describing the various arcs in the molds. If the detail of the main cornice was of such size that it could not be laid out in one piece, seams would have to be located in different parts of the cornice as indicated in the sketches, given in the plain and ornamental cornice in previous chapters. Notice that a seam is made between the mullion and bottom of cornice at C, which is a lapped joint, riveted and then soldered on the inside.

Having completed the detail of the cornice, the side view of the bracket is now drawn. Scale the various heights and projections from the vertical section, Fig. 465, and place them as shown by full-size measurements in the sectional view, Fig. 470. The center point of the 1 in. radius from which to draw the arc *h i* of the bracket is also the center, using the proper radius, from which to draw the arc *f j* of the raised dentil.

The arc from 9 to 13 in the side of the bracket is drawn free hand. From this side view of the bracket draw the front elevation C°, the face to be 2½ in. wide. The dotted lines projected from the side view show the drawing of the face of the bracket. Note that the dentil is 1½ in. wide and that the drop is struck from the center *e* with a ¾-in. radius.

While the full size measurements are given to the student as a guide, to verify his when scaling, and which can easily be copied when drawing the detail, he should, however, scale all of his measurements from the drawing so that he may become proficient in taking scale measurements.

Having completed the sectional view of the cornice and side elevation of the bracket in Fig. 470, the patterns are developed, starting with the bracket. The pattern for the side of the bracket is shown in the sectional view by *l* 12 15 16 17 18 *m* 9 *i h* 3 *l*, but to show it more clearly, it has been reproduced in diagram B° with the necessary laps allowed. Of this pattern B°, twelve pieces should be cut from metal, forming the sides right and left. A reproduction of the side of the face dentil in the sectional view *h i j f* is given in diagram D°, twleve of which must be cut.

For the pattern for the upper face of the bracket and drop, take the girth from 1 to 9 in the side elevation of the bracket and place it on the vertical line in E°, shown by similar numbers, and complete the rectangle 2½ in. wide, this being the width of the face. Bisect the line 9 and obtain *e′*, which is the center from which to strike the semi circle or face of drop with a radius equal to that in the front elevation of the bracket. In similar manner describe the small circle *e′*, shaded in the pattern E°, which is to be sunk ⅜ in.

For the pattern for the bottom face of the bracket, take the girth from 9 to 14 in the side elevation of the bracket and place it on the vertical line in F°, from 9 to 15; make the width 2½ in., which completes the pattern, the dots indicating where the bends will be made. The shaded part *c″* should be cut out of the pattern; this allows the sink of *c′* marked sunk, in pattern E°, to set back into F° at *c″*, as in the side elevation of the bracket.

For the pattern for the face of the raised dentil, take the girth from 16 to 22 in the side elevation of the bracket and place it on a line as shown by similar numbers in G° and complete the rectangle 1½ in. wide as required by the front elevation. Six faces will be required of E°, F° and G°.

For the pattern for the drop return, 9 *f′* 13 in the side elevation, divide one-half of the face of the drop in front elevation into equal spaces from 1 to 5, from which draw horizontal lines to the left cutting the curve of the side of the bracket from 9 to 13 as shown by the heavy dots and meeting the line 9 *f′*. In line with *f′* 9 erect a vertical line in H° upon which place the girth of the drop in the front elevation from 1 to 5 to 1. Through these points draw horizontal lines, intersected by lines parallel to f' 1, from similar intersections on the curve 9 13 in side elevation. A line traced through these points, 1 E 1, will be the pattern for the return of drop, six of which will be required. This completes all the patterns required for the brackets.

Preparations to get the patterns for the various pieces of the cornice for the bay window are made as follows: A lock is allowed at 0 for the roofing or gutter lining, the method of which will be explained in connection with another illustration. Assuming that joint C, will be riveted and soldered, divide the molds in the cornice in equal parts, and number the divisions 0 to 25, which includes the lap at C. As the angle of the bay is an octagon diagram A°, place this angle in the position as F G H being careful that one side of the angle is in line with the extreme projection of the cornice as 2, 3, no matter what the bevel may be. Bisect the angle F G H by the arcs *n o* and *r* as previously described and obtain the miter-line G K, and complete the part-plan F B J H.

From the small figures in the sectional view 0 to 25 drop vertical lines, until they intersect the miter-line G K. From point 25 at right angles to G F draw the line 25 3, which represents the line from which measurements will be taken to the intersections on the miter-line G K. Place the girth, 1 to 25, of the cornice on line L M and through the small figures at right angles to L M draw lines indefinitely. Measuring from the line 3 25 in plan, take the various projections to the intersections on the miter-line G K and place them on similar numbered lines in the pattern, measuring in each instance from the line L M. Trace a line through these points, U to 25, which will represent the miter cut for the angle F G H in plan.

As J in the scale drawing in Fig. 465 represents the measuring point for the upper part of the bay window, shown in the detail at C, Fig. 470 and at 25 in the miter pattern, and as the lengths of the sides are to be similar to those in the bottom of the bay window, diagram A°, then measuring from the arrow point at 25 in the pattern, lay off 3 in. for the depth of the return; 6 in. for one-half of the 12-in. side and 9 in. for one-half of the 18-in. side and erect the perpendicular lines N T, O S and P R, representing the full pattern for the 3-in. return; one-half pattern for the 12-in. side and one-half for the 18-in. front.

When cutting these pieces from sheet metal two 3-in. returns, T U 25 N will be required without laps. The pattern S U 25 O will be reversed on the line O S, two of which will be required with laps on both miters, as indicated by the dotted line along the miter cut. The pattern R U 25 P will be reversed opposite the line P R, thus making the complete pattern of the front piece, one of which is to be without laps. This completes the patterns for the cornice. Referring to Fig. 467 it will be noted that it bears the student's initials E M on the 12-in. sides of the bay and place for the date, on the 18-in. front. A majority of the students thus make dated souvenirs of their work. The letters and figures are to be of the block style, as expained in a previous exercise, "Ornamental Cornice," and are to be 3½ in. high.

The last patterns required for the bay window are the mullions *a′ b′*, Fig. 465, and the mullion heads P P°. The sections of the mullions at X and X^1 in elevation are shown by L and A^v in the horizontal section and are simply reproductions of the profile of the mullion head in the vertical section from J to H°, shown in the shop detail in Fig. 470 from C to S.

The patterns for the mullions and heads are on separate details in Fig. 471A and Fig. 471B, in which the profile, A, Fig. 471B, is a reproduction of C S, Fig. 470, and the bevel of the wash or sill line B C, Fig. 471B, of the wash 1 2 3 4 in the sectional view in Fig. 468. The distance between 8 in the section A, Fig. 471B, and the intersection 8 on the sill line B C can be made at pleasure, because all that is required are the miter cuts at top and bottom of the mullion, which can be cut any length desired by extending the distance between the miters. The section through the center mullion L, Fig. 471A, is a reproduction of two profiles, like A, Fig. 471B, joined at an octagonal angle at the corner 1 in L, Fig. 471A. The section of the end mullion A^v has one profile like A in Fig. 471B joined at the corner 1 in A^v in Fig. 471A with a flat portion 3 in. deep at an octagonal angle, and an angle or lap bent toward the inside at X to nail against the wall through Y.

To obtain the face miter between the mullion and head at 1, Fig. 467, and the butt miter between the mullion and sill at 2, proceed by the short rule given in Fig. 471B, as follows:

Divide the profile A, Fig. 471B, into equal spaces shown by the small figures 1 to 9. Through these points drop vertical lines until they intersect the sill line B C by similar numbers. At right angles to O C as shown draw any line as E D, upon which place the girth of double the section A from 9 to 1 to 9. Through these points at right angles to E D draw lines, intersected by lines parallel to E D from similar numbered intersections in profile A and on wash B C. A line traced through points F to G to H at the top, will be the square face miter; while a line traced at the bottom I to J to K will be the butting miter against the sill. F G H I J K represents the miter cuts for the center mullion L in Fig. 471A, also X X in Fig. 465, the length of which from a' to b' should measure 2 ft. 9 in. Therefore when laying out the full size cut from sheet metal, a duplicate of F G H I J K, Fig. 471B, is used to scribe the miter cuts for the full size pieces, making the distance from G to J, 2 ft. 9 in. and allow laps along the top from F to G to H and along the bottom from I to J to K; two of these mullions will be cut.

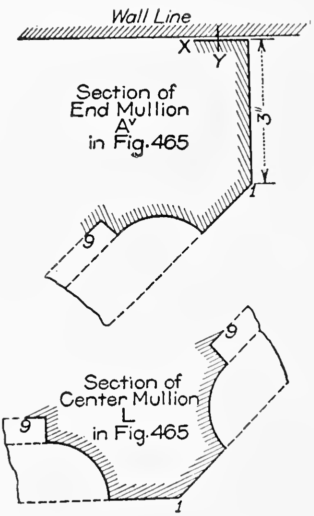


FIG. 471A. (2 Figures) Details and Patterns for Mullions.

As the end mullion A^v, Fig. 471A, has a return of 3 in. added including the lap X, simply add to the mullion pattern, Fig. 471B, at right angles to G J, 3 in., and draw the line L M and add the lap *a b*. Ten M G H I J L is the pattern for the end mullion which should be made 2 ft. 9 in. long, as before described, allowing lap at the top from G to H and at the bottom from I to J; two of these mullions will be cut from metal.

Two mullion heads 12 in. long and one 18 in. long at the extreme points will be required for the top P° and P, Fig. 465. Using the same miter cut G H, Fig. 471B, measure from the point G a distance of 6 in. and 9 in., shown by N and R, and at right angles to G J draw the lines N O and R P. Allow a small edge at *c*, shown by O 1 in the profile A, representing the edge, placed to avoid buckles when the mullions are joined to the cornice at C in the sectional view, Fig. 470. Then G H O N in Fig. 471B is the half pattern for the 12-in. mullion head to be reversed on the line N O for the full pattern, two of which will be cut from metal without laps. The half pattern for the 18-in. side is G R P H, reversed on the line R P for the full pattern, one of which is to be cut, without lap. This completes all the patterns required for the bay window.

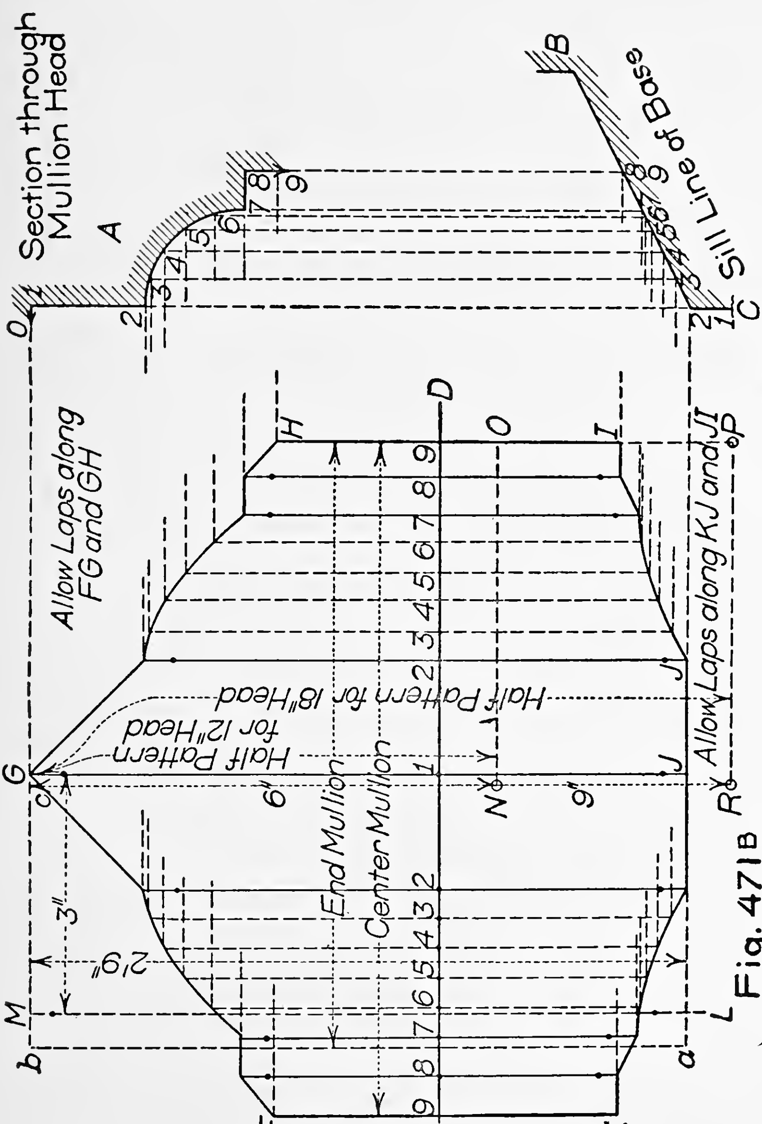


Fig. 471B. (2 Figures) Details and Patterns for Mullions.

When cutting the pieces from galvanized sheet iron care should be taken to have as little waste as possible, cutting the largest pieces first, and from the pieces left, cut the small pieces, such as the panel heads, bracket sides and faces, letters and figures. The student should use a little judgment and consider what pieces are to be cut, and waste can be reduced considerably. Nothing in a shop looks so bad and shows carelessness as a lot of scrap and waste under the benches, which could be avoided by a little foresight.

Having cut all the various pieces, the forming of the parts is now in order. Bending the bracket sides B°, Fig. 470, requires no further description than to say they are formed right and left with the laps turned toward the outside to allow them to be soldered to the cornice. The faces of the brackets are formed after the bracket side, from which the girth was taken. Forming the cornice in the sectional view is done as explained in a previous exercise on "Ornamental Cornice" to which the student should refer.

The next work for the student is the cornice brake, and consists of forming the various parts. As the lower part of the bay window, Fig. 468, is to be bent in one piece, which includes the base, panel and sill, the method of making the bends will be described in Figs. 473 to 494. Let A, Fig. 472, represent the reduced stay of the bottom of the bay similar to that in the sectional view in Fig. 468. The girth of A, Fig. 472, is shown to the right of A.

When starting, make the first bend on either dot 22 or 26 as shown by the square bend on dot 22, Fig. 473. Place the proper size former A in position and press B down until it fits over the former A at C, having C 26′ in a horizontal line. Now remove the former A, take out the sheet, and place it in the brake as C, Fig. 474, close the top clamp on dot 26, and make a square bend, bringing C in the position D. Reverse D in the position D, Fig. 475, and fit the stay to see whether the angles at 22 and 26 are accurate, and if so, make a square bend on dot 27 as E. Leave the sheet E in the position shown, but draw it out and close the top clamp on dot 28 as E, Fig. 476, and make a square bend bringing E in the position F.

Place F in the position F, Fig. 477, and make a square bend on dot 21 as G. Reverse the sheet, close the top clamp on dot 20 as G, Fig. 478, and make the square bend indicated by the arrow to H. Leave H in the brake, but draw it out, and close top clamp on dot 19 as H, Fig. 479, and make a square bend at J. In making these square bends no stay is required to test the angles, as the stop is set at the desired angle.

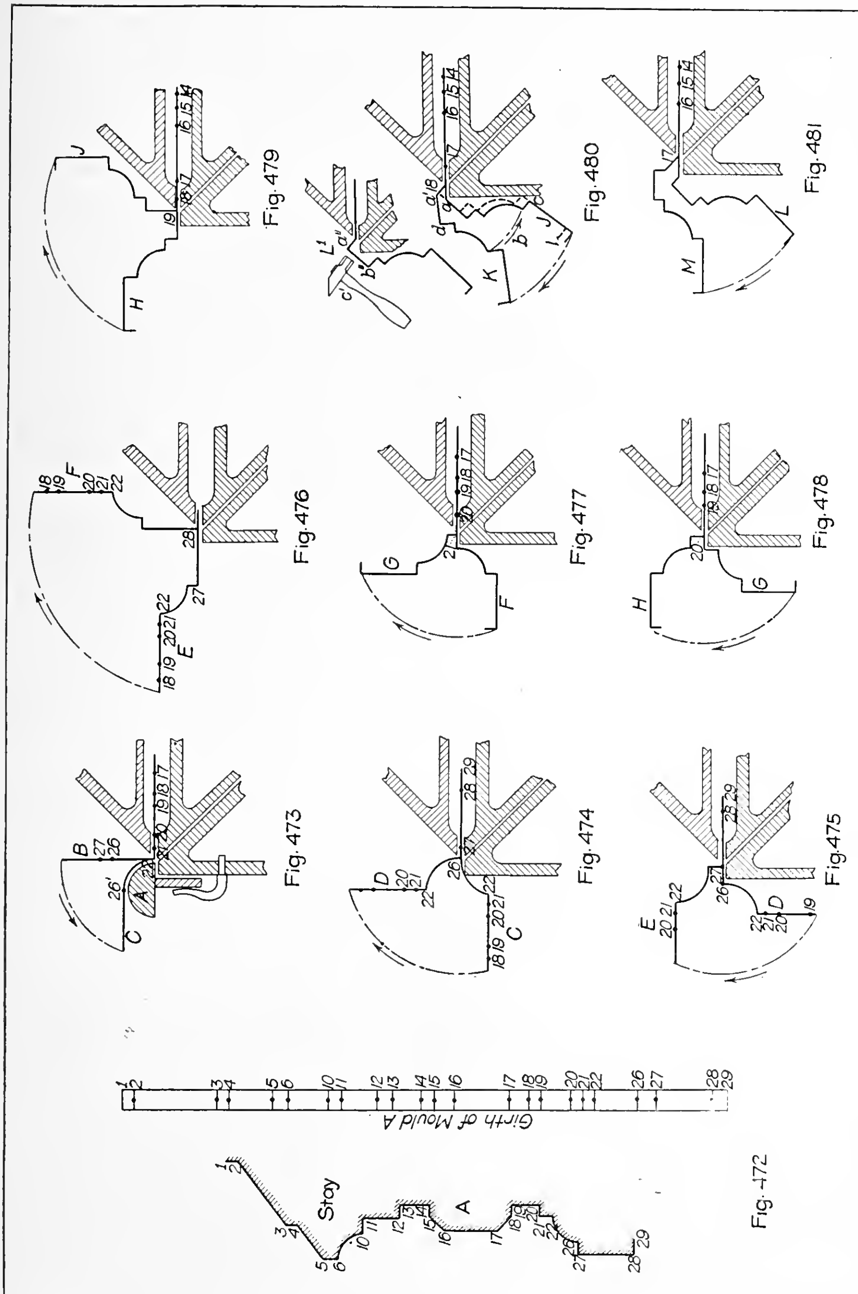


FIG. 472. Girth Strip for Molding to be Formed. FIGS. 473 to 481 Inclusive. Final Operations in Forming Molding.

The work J is now taken out of the brake, reversed and placed as shown by the solid section J, Fig. 480, but, when closing the top clamp on dot 18, bend C in J strikes against the bending leaf, and in forcing the sheet J to close on dot 18, the previous square bend made on dot 19 is pressed out of square as shown by *a*. The bend on dot 18 is now made to conform to the angle at 18 in the stay A, Fig. 472, as K, Fig. 480.

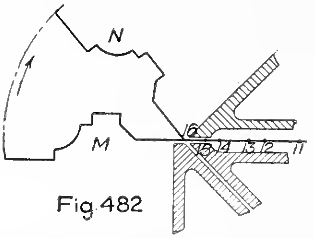
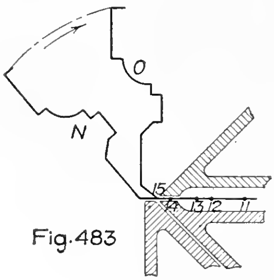
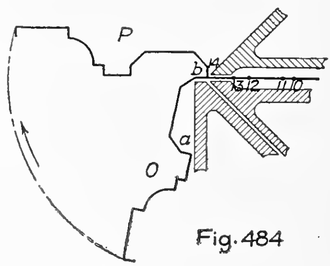


FIG. 482. Operations in Forming Molding.

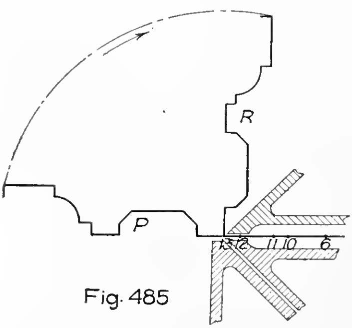
As the angles 15, 16, 17 and 18 in stay A, Fig. 472, are equal, set the stop in Fig. 480 to the required angle, after which the corresponding bends can be made. With the sheet in position K,

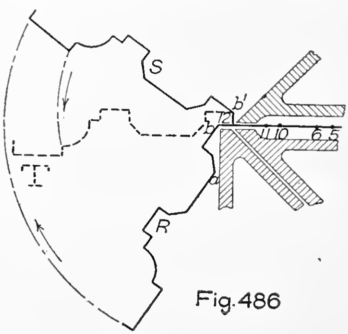




FIGS. 483-84. Operations in Forming Molding.

press down slowly at *d*; using the hammer *c′* in diagram L^1, tap along the corner *a″* until *a″ b″* has a level surface and the sheet





FIGS. 485-86. Operations in Forming Molding.

is brought in the proper position shown by the dotted section L *a′*.

Draw out the sheet and close on dot 17 as L, Fig. 481, and make the proper angle, M, using the required stop. Again draw out the sheet and close the top clamp on dot 16 as M, Fig. 482, and make the proper angle N. Still leaving the sheet in the brake,

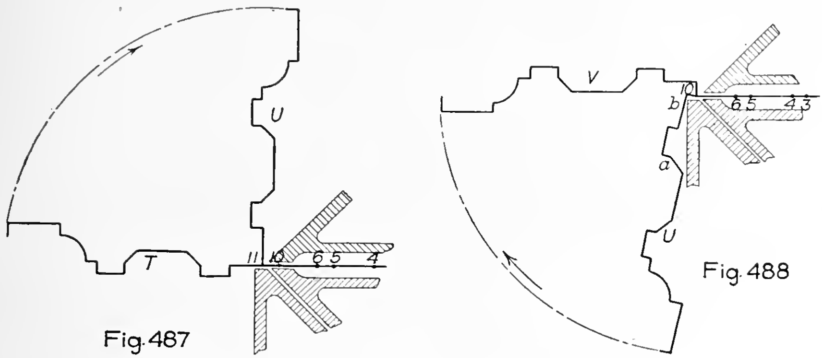
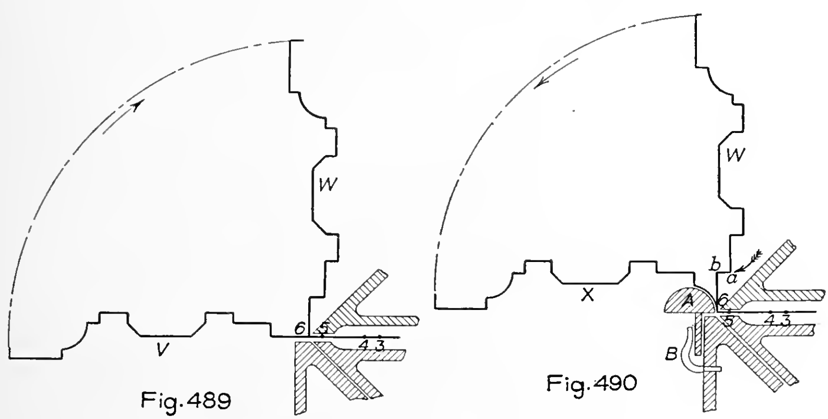


FIG.: 487-88. Operations in Forming Molding.

draw it out to dot 15 as N, Fig. 483, and make the proper bend indicated by O.

Take out and reverse sheet O as O, Fig. 484, and close the

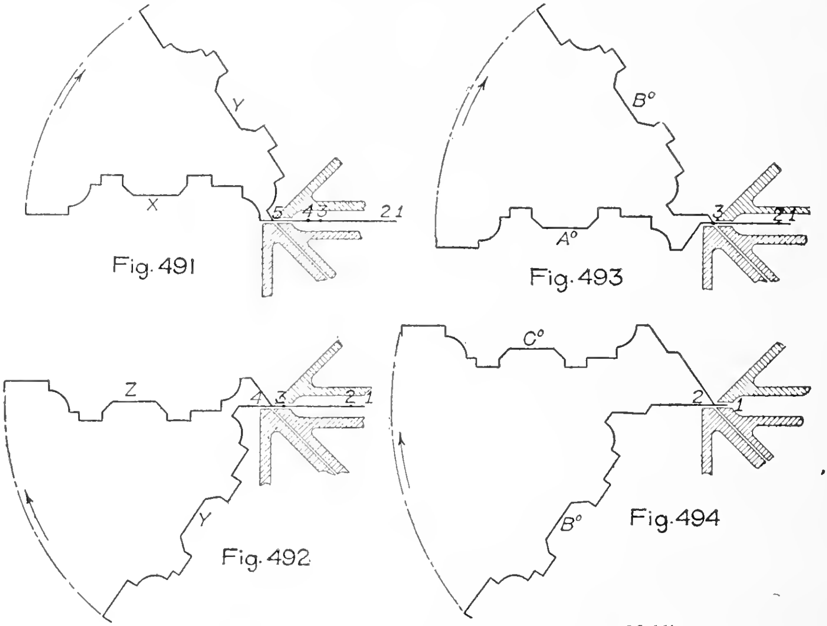


FIGS. 489-90. Operations in Forming Molding.

top clamp on dot 14; in doing this the lower part of panel *a* strikes against the bending leaf and causes the bend at *b* to spring, which will resume its original shape when the square bend is made on dot 14, as P.

Leave the sheet P in the brake, draw out to dot 13 as P, Fig. 485, and make a square bend on 13 as indicated by R: Reverse R, Fig. 486, and close top clamp on dot 12; in doing so the previous angle will be pressed out of shape at *b*, because panel *a* strikes against the bending leaf.

Make a square bend on dot 12 as S. Now press S down to obtain a square angle at b^1, using the hammer as in Fig. 480, which will bring the sheet as T, Fig. 486. Reverse T, Fig. 487, and make a square bend on dot 11, as U. Reverse U, Fig. 488, and close top clamp on dot 10, which will cause the previous angle to spring slightly at *b* because the panel forces against the bending leaf at *a*, and make a square bend on dot 10 as V. Draw out the sheet and close top clamp on dot 6 as V, Fig. 489, and make



FIGS. 491 to 494 Inclusive. Final Operations in Forming Molding.

a square bend, previous to forming the cove from 6 to 10, stay A, Fig. 472.

Leaving W, Fig. 489, in the position shown, place the proper size former A in position, Fig. 490, fasten with the clamp B and press W down in the position X, being careful in pressing W down to press on the angle *a* in the direction of the arrow, being careful not to press angle *b* out of shape.

Draw out the sheet to dot 5 as X, in Fig. 491, and make a bend to the required angle called for by the stay, as shown by Y. Reverse Y, Fig. 492, close the top clamp on dot 4 and make the proper bend indicated by Z. Again reverse Z as A°, Fig. 493, and make the proper bend on dot 3, as B°, setting the stop as required. Reverse B°, Fig. 494, and make the final bend on dot 2, as C°, the completed molding.

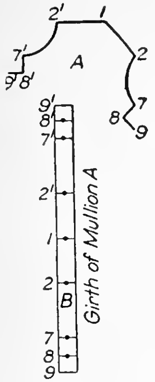


Fig. 495

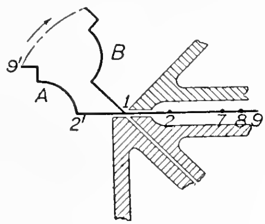


Fig. 496

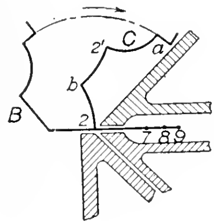


Fig. 497

FIG. 495. Section and Girth Strip of Mullions. FIGS. 496-97. Different Operations in Forming Mullion.

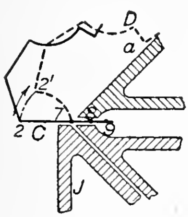


Fig. 498

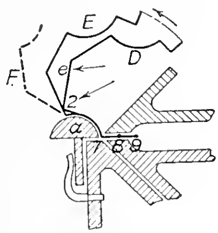


Fig. 499

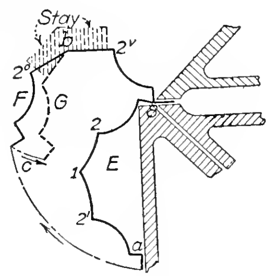


Fig. 500

FIGS. 498-99-500. Different Operations in Forming Mullion.

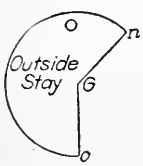


Fig. 501

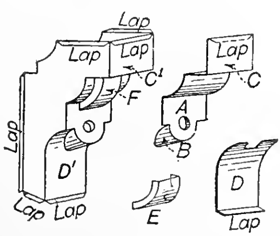


Fig. 502

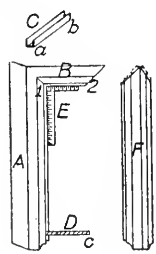


Fig. 503

FIG. 501. Stay for Forming Octagon. FIG. 502. Assembling Bracket. FIG. 503. Joining Mullion to Head.

In this way all of the base sides are formed, taking less time to form than to describe it. In bending the sides the student is cautioned to bend each and every angle and mold accurately to its proper shape, without which no proper miter can be joined. Be sure to have all forming accurate and true to their respective stays, and time will be saved in joining the corners.

The last part of the bay window to be formed by the student is the mullion 1 2, Fig. 467, or sections L and A^v, Fig. 471A. In Fig. 495, A is a reduced section of the center mullion and B its girth. The bending of section A from 1 to 9′ is done in the usual manner, but the opposite portion, 1 to 9, needs some explanation. After the shape A has been formed from 1 to 9′, place it in the brake as A, Fig. 496, close top clamp on dot 1 and make the required angle according to the stay, which will bring A in the position B.

Leave B in the brake, but draw it out and close the top clamp on dot 2, as B, Fig. 497, and make a square bend; in doing this *a* of C strikes against the top clamp and in making bend 2 the flat surfaces in angle 2 *b* 2′ become curved, which however will spring back to its original position when the sheet is released from the brake.

Leaving C on the brake, draw it out to dot 7, as C, Fig. 498, and when making the square bend on dot 7, the opposite end of the mullion will strike against the upper clamp at *a,* so that when lifting the bending leaf J, it will press the surface 2 7 in C in a shape similar to 2′ 7 in D.

Leaving D clamped in the brake, place the proper size former *a* in position, Fig. 499, and place the fingers in the corner 2 in D and press in the direction of the arrow, bringing D in the position E.

Some students make the mistake of pressing against *e,* which presses the angle 2 out of shape, as indicaed by the dotted section F. The stay must be used to see whether the mullion *e,* 2, 7 has the proper formation, and if true the last bend can be made.

Reverse E and place it in the brake, as E, Fig. 500, where it will be noticed that in pressing E in the brake to close the top clamp on dot 8, the lower part of the mullion strikes against the bending leaf, making the surfaces 2 1 and 1 2′ curved and flattening angle 2 1 2′

After a square bend has been made on dot 8, the angle 2 1 2′ will spring back as F, but not in its original position, and therefore must be pressed together by hand, along the bend *b*, pressing the two sides 2° *b* and *b* 2^v in the direction of the arrow *c* and testing with the stay until the proper shape is obtained, as G.

While the soldering coppers are being heated the laps on the miters are turned up with the pliers, using the octagon angle stay, Fig. 501, obtained from the plan *o* G *n*, Fig. 470, as a guide to show how far outward the laps should be bent. Solder the small work together first, such as the date and initial in the frieze, Fig. 467, making the strip as wide as the face of the letters.

Next complete the brackets, setting them together, as indicated by the various parts in Fig. 502. Solder the 3/8-in. sink strip around circle A and back it up with metal, then solder on the return of the drop B. Now solder the upper face C and lower face D to the sides of the bracket, C^1 and D^1, then set the raised dentil E in position F. Care must be taken not to have any twist in the bracket, and all bends in the face of the bracket must run parallel to each other.

In large work the brackets are set in their proper position in the sides of the cornice, before the corner miters are joined; in this case as the bay is small in size the corner miters can be joined first and the brackets set in last. Set on to the 12-in. sides of the cornice the 3-in. returns, *e*, Fig. 469, one right and one left, after which join the two 12-in. sides to the 1-ft. 6-in. front piece, Fig. 467, where A and A are the 12-in. sides and B the 1-ft. 6-in. front.

When joining the corners, two students usually work together, one helping the other to tack the miters to the proper stay in Fig. 501, after which the joint can be soldered by one student, being careful not to open the tacks when soldering.

After the miters have been joined, the cornice is reversed, setting the top on the bench and soldering in the six brackets, each one placed 1/2 in. from the corner, as in the scale drawing, Fig. 465. The brackets being in position the initials and date are placed in the frieze, as in Fig. 467.

Before soldering the base miters together, the small panel heads as at *a* and *b*, Fig. 467, are soldered in position as well as the return panel head *a*, Fig. 469.

After this, as in Fig. 467, the 3-in. return base mold 1 and sill mold 2 are joined to the return panel head *a*, when the 12 and 18-in. sides are joined, being careful to have the angles true to the stay in Fig. 501.

Setting together the mullions or window openings is next in order, and the following is the best way of doing it. Take the end mullion, or the one to which the 3-in. return has been added, A, Fig. 503, and join it to the 12-in. mullion head, B, being careful to join it perfectly true and square, using the steel square E in the position shown. Now turn up from any scrap metal a U-shaped brace, C, making the distance *a b* as long as from 1 to 2 in the head B. Tack this brace C, with solder, to the lower part of the mullion A, at D. Now if A and B are joined perfectly square, the center mullion F can be soldered to B, without using a square, as brace D gives the proper width at the bottom to *c*.

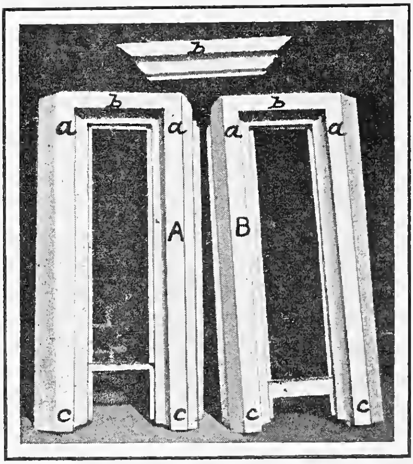


FIG. 504. Assembled Mullions and Mullion Heads.

The right and left sides completed in this manner are shown by *a, b c,* Fig. 504, with the 18-in. mullion head *b* placed over same, ready to be joined to mullions A and B, using a brace at the bottom to hold the proper width as before described.

After the mullions or window openings have been joined, set them on the floor as indicated in Fig. 469, in which *a* is the bottom of the bay, *b, c* the mullions and *e* the cornice. Note the space between each part, ready to be slipped together and soldered, so that when completed it will look as in Fig. 467.

When putting up a bay window in one piece when there are no obstructions on the inside to prevent nailing, the framing being done after the bay window is set, as explained in Fig. 466, then the nailing flange X of the end mullion A^v, Fig. 471A is nailed through Y on the inside against the wall and paintskinned, as in the perspective view, Fig. 505, in which case a good size flange must be left at *a* on the top wash of sill C, as indicated by A^e in the pattern for the 3-in. top return, Fig. 468, and over this flange *a*, Fig. 505, the flange *r* of the end mullion H sets and is nailed in the brick joints at A and B and paintskinned all the way down the inside. Behind flashing *a* a step flashing D is placed, flashing into the joints at *b* and *c* using wire nails and paintskins to make a clean job. Flanges are placed at *d* and *e* to solder to the sill course.

Should any leak occur at the side of the mullion, the water would follow down, pass over flange *a,* which is flashed water-tight to the wall on the inside, then follow the inclination of the wash, running out at *i* over the flashing D and drip down at E. To the flat return F a flange is turned outward and nailed at *f.*

When the flange on the mullion is turned toward the outside,

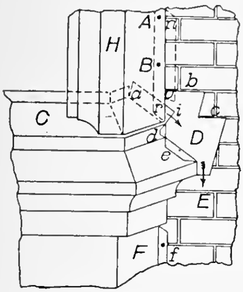


FIG. 505. Making Connections Water Tight.

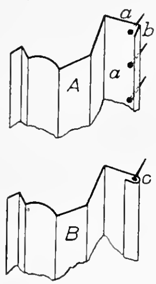


FIG. 506. Blind Nailing the Mullions.

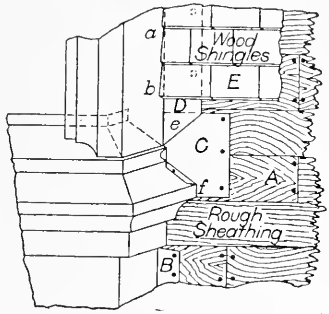


FIG. 507. Method of Arranging Flashing.

as *n o,* flashing D must be put in, over which *n o* is placed, shown dotted, bending and nailing the flange *n o.* In Fig. 506A shows how the end mullion is bent in the brake, the nail passing through at *a,* after which edge *b* is closed, diagram B, which hides the nail heads, and prevents the nail *c* from pulling out.

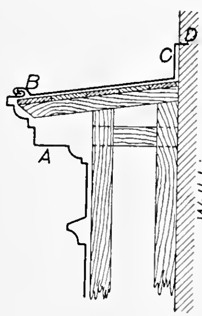


FIG. 508. Covering Top of Bay Window.

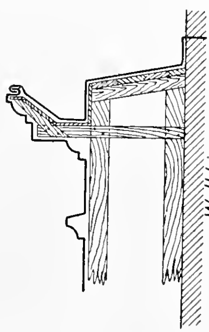


FIG. 509. Constructing Gutter.

The flashing D, Fig. 505, represents the method of obtaining tight joints between the metal and wall and is the one to be applied on all projecting moldings, no matter at what part of the bay they may be.

When the wall of the building against which the bay is to be fastened is of wood, covered with shingles or clapboards, the flashing is flashed against the rough sheathing, Fig. 507, in which

A represents the sheathing, against which the flashings B, C and D are nailed, flashing D of the mullion overlapping flashing C of the sill.

Then when all flashing has been nailed against the sheathing and the corners, *e* to *f*, soldered watertight, the shingles or clap boarding E are placed in position, butting against the metal work at *a b*, or cutting them to the shape of the mold where they butt against the metal work.

The method of covering the top or roof of the bay is shown in Fig. 508, in which A represents the top or main cornice of the bay, with a lock attached, into which to lock the metal roofing and carried to the wall C, then up not less than 6 in. and flashed into joint D.

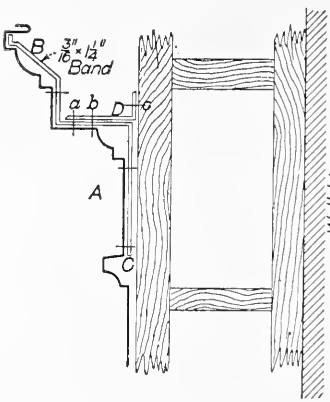


FIG. 510. Fastening Cornice.

If the wall is of sheathing the angle D is not required, the flashing remaining in a vertical position, C, over which the shingles or clapboards are fastened.

When a gutter is required inside of the cornice, it must be constructed as indicated in Fig. 509, after which it is lined with tin, galvanized iron or copper. When the bay is very large, the cornice at the top requies iron bracing, Fig. 510, in which A is the main cornice, supported by band iron braces B C, which in turn are fastened to the metal cornice by the bolts indicated by the dash lines, and to which an anchor D is bolted at *a b*, turned up at the back and nailed to the framing at *c*. This method holds the cornice and secures it firmly, and inside of this bracing the gutter is framed, Fig. 509. To make a smooth job, the iron braces should be countersunk on the outside, so that when the ¼ × ¾-in. stove bolts are inserted the face of the molding will present a smooth surface. Should the bay be constructed from cold rolled copper, the iron braces should be painted before they are inserted and brass bolts used. This completes the method of fastening the bay to the wall, and covering the roof.

The method of making a watertight joint between the mullion and wooden window sill and sash is similar to that explained in the dormer window article previously given.

Some students at the New York Trade School finish their bay at the bottom with a paneled soffit, others with a reversed ogee molding. Both constructions will be explained in reduced diagrams, from which the home student can obtain the principle required in laying out the patterns.

Fig. 511 (see Folder 11) shows the method of fastening the base of the bay window at the bottom as well as the panel. Below this is a half plan showing the soffit of the panel; also the patterns for the various pieces of molding forming the panel. The large surface inside of the panel is crimped. This crimped iron can be purchased from dealers if the shop has no crimping machine. The use of crimped iron takes away the waves and buckles in the metal, which would otherwise show when painted. In this case the base A has a drip formed at B, the panel C D being fastened to the furring strips *a a* by brass screws *c* and *d*.

A small edge should be bent downward at 1 to remove buckles, and another bent upward at *b* as shown.

When laying out this half plan, full size, the student should make E F G H equal in lengths and angles to the size taken around the finished bay window on the base line X, Fig. 467. Care should be taken if a paneled soffit is desired to add the drip B, Fig. 511, to the patterns for the base previously obtained. Having drawn E F G H to the proper size and angles, draw the wall line H *b*, and between the wall line *b* and drip B draw the section of the panel desired. The home student is to use his own judgment in drawing this profile. He can use the one shown, or either of those in diagrams A^1, B^1 and C^1. After the profile is selected, the section at C must be exactly like the one at D. In drawing the half plan the drip continues along E F, F G, and G H, butting against the wall. In this space *e* K 1 1′ *f* the paneled soffit is drawn, bisecting the angles to obtain the miter line as already explained.

To obtain the four patterns in one, proceed as follows: Divide one of the profiles, C, into equal parts, shown by the small figures 1 to 6, from which vertical lines are dropped until they intersect the miter line F *h*.

From these intersections, parallel to F G, lines are drawn, cutting the miter line G *i*, and from intersections parallel to G H, lines are drawn intersecting the miter line 1′ *j*.

At right angles to G H draw the line R S upon which place the girth of the profile C, from 1 to 6. Through these small figures, at right angles to R S, draw lines indefinitely, intersected by lines drawn parallel to R S from similar numbered intersections on the miter lines *i* 1 and *j* 1′. A line traced through points thus obtained, as shown by M N O P will be the pattern for the panel mold for the side A°.

In the pattern, N O represents the miter cut to make a square angle, while M P in the pattern is the miter cut to make an octagon angle. To bend 6 add a lap to which the crimped surface is riveted.

To obtain the pattern for the half length B°, take the distance from 1′ to *f* and place it from O to U in the pattern, and draw the vertical line U T. Then T U O N is the half pattern for B°. To obtain the full pattern, reverse on the dots T and U, and add a lap along O U, which turns upward at *b* in the sectional view. Bisect the length of 1 K and obtain L; take the distance from 1 to L and place it from P to W, and from W erect the vertical line W V. Then V W P M is the half pattern for the side C°, and must be reversed on the line V W to obtain the full pattern.

Take the distance from K to *e*, and place it from P to Y, and draw the vertical line Y X, then P M X Y is the half pattern for the full side D°, and must be reversed on the line X Y to make the full pattern. Laps should be allowed on the miter cuts of sides C° and B°, but no laps on the miters of sides A° and D°.

After the various pieces are cut they are formed after the stay, bending the pieces for the sides A° right and left, and soldered together after their proper angle. The crimped iron is riveted to the inside of the panel frame, as in the sectional view, and the panel riveted to the bottom of the bay window, which completes the paneled soffit.

In building construction after the bay window has been secured to the wall the paneled soffit is fastened with brass screws, to the furring *c* and *d*, shown in the sectional view.

When the bottom of the bay window is to have a molded finish, the miters terminating in a common center, as in Fig. 512, (see Folder 12), proceed as follows: Let A B C D E F represent the outline of the bottom of the bay window through X, Fig. 467, being careful when drawing this outline or plan view to make it the size of the student's bay window at its base. At right angles to A F in Fig. 572 from A and F draw the vertical line A H and F G and draw at pleasure the horizontal line P *f*. Bisect P *f* and draw the center line L K. Establish 1 on the line P *f* and 8° on the center line L K and draw at pleasure the profile 1, 7, 8°, to full size, which is reversed on the opposite side at 8° 1′. Where the center line L K crosses the wall line A F in plan at J, draw miter lines to the corners B C D and E, which represent the miter or joint lines in plan. While in the reduced drawing the full plan and elevation have been drawn, in the full size drawing but one-half is required, as both halves are symmetrical. At right angles to B C in plan from the center J, draw the line J *b*.

If the student will measure on his full size drawing the length of lines *a* J, *b* J and *c* J in plan, he will find that each is different, showing that the profile 1, 7, 8° in elevation can only be used for obtaining the pattern for the sides A°, and before the patterns can be obtained for the sides B° and C° true profiles must be obtained on lines *b* J and *c* J in plan and he must proceed as follows: Divide the profile 1 8° in elevation into equal spaces, from which points drop vertical lines into the plan until they intersect the miter line B J. From the intersections on B J parallel to B C draw lines until they cut the miter line C J, from which intersections parallel to C D lines are drawn cutting the center line J K, as shown by similar numbers.

Where these lines intersect the lines *b* J and *c* J, take the various divisions from *b* to J and place them on the line 1 1′ in elevation extended, from P to O. In similar manner take the divisions on *c* J in plan and place it as shown by similar numbers on 1′ 1 extended by O N. At right angles to N P from the various divisions in N O and O P draw lines, which intersect with lines drawn parallel to P N from similar numbered intersections in the profile 1 8° in elevation.

Trace a line through points thus obtained, then B^x will be the true profile through *b* J in plan and C^x the true profile through *c* J, from which the girths must be taken in developing the patterns.

To obtain patterns for the sides A°, extend the line F A, upon which place the girth of the profile 1 8° in elevation as shown by similar numbers on the girth line 8 1°. At right angles to this line from the small figures, draw lines which intersect, by lines drawn parallel to A F from similar numbered intersections on the miter line B J. Trace a line through points thus obtained, then M 8 1° will be the pattern for the sides A°.

For the pattern for the sides B°, take the girth of the profile B^x, being careful to measure each space separately, as all are unequal, and place it on the line V W at right angles to B C in plan, as shown by similar figures. Through these small figures at right angles to V W draw lines which intersect lines drawn at right angles to B C from similar numbered intersections on the miter line B J and J C. A line traced through points between W X Y, will be the desired pattern.

For the pattern for the front C°, take the girth of the profile C^x, measuring each space separately, and place it on the line R T at right angles to C D, as shown by the small figures 1 to 8. Through these small figures parallel to C D draw lines, which intersect lines drawn at right angles to C D from similar numbered intersections on the miter line C J. As the whole of the plan is drawn in this reduced sketch, the points of intersections for the right side of the pattern could be obtained from the miter line D J. But where only one-half the plan is drawn, as in the student's detail, the projections of the various points are measured from the line R T to the intersections in the miter cut 8 S, and transferred opposite R T, at 8 U. Then R S U is the pattern for the front C°. Laps are allowed over line 1 on all patterns, to allow the molding to be soldered to the base of the bay window P *f* in elevation.

When cutting the pieces from sheet metal allow laps on the miter cuts of sides B°, but none on sides A° and C°. Each side must be bent to its respective profile and soldered and riveted together as shown in plan, after which it is soldered to the bottom of the bay window. So that the molded finish can be well secured to the wall, a flange, *d e f* in elevation, is cut parallel to the profile of the mold, about 1½ in. wide, and thoroughly soldered to sides A°, and nailed at intervals, which makes a neat finish and holds the profile of the mold in its true shape. If this molded finish would have to be secured to the bottom of the bay, after the bay window was in place, then the bottom of the bay H G in front elevation could be bent as in diagram A^1 and the lower part slipped into the lock shown; or the lower part could be formed with a drip as in B^1 and the molded finish screwed to the wood furring C^1. No matter what size or angle the bay may have, nor what profile the mold may have, the foregoing principles are applicable to any case.

In the bay window which the student has completed, the size was known; that is, no measurement had to be taken from the building. When, however, the bay is of such size that it cannot be made complete in the shop, and measurements must be taken from the rough framing at the building, then the method of obtaining them is the same as will be explained in connection with Fig. 513 (see Folder 12). Whether the bay is one, two or more stories in height, or the structure is other than a bay window, the same methods are used. The elevation of the rough framing of a one-story bay window is shown, with three window openings, one on each side, as in plan, the sides butting against the wall at angles of 45 deg.

In taking measurements, first measure the entire height, which is assumed to be 18 ft. Prove this by measuring the height of the window opening, the space above and below it, as 10 ft. + 3 ft. 4 in. + 4 ft. 8 in. = 18 ft.

In similar manner obtain the widths; the sides, which it is assumed, measure 4 ft. on the slant and 6 ft. on the front. These measurements are proved by measuring the window widths and the stiles. On the sides there are 8 in. + 2 ft. 8 in. + 8 in., which equals 4 ft. On the front there are 8 in. + 4 ft. 8 in. + 8in., which equals 6 ft., these measurements being shown in plan.

While the surface just measured is sheathed with wood and is free from projections, care must be taken if the framing is of angle iron, as in the lower plan. In this case measurements should not be taken on the surface of the angle iron, but along the projecting bolts or rivet heads (if any), as indicated by the dotted lines drawn flush with the head of the bolts *a a*, etc. This hint also applies to obtaining the width of the window openings and of the angle iron uprights, which would have to be measured from outside to outside of bolt heads *b b* for the windows, and from the outside of the head *b* to the corner *i* for the uprights.

When taking these measurements a rough diagram is made in the note-book similar to the elevation. The bevel at the corners is obtained by using any ordinary bevel and holding it on the corners of the rough framing, as indicated by C and D, and then measuring from corner to corner the distance *d*. This latter operation should be done in exactly the same manner as was explained in obtaining the bevels of pitched roofs in the exercise on dormer windows, to which the student is referred.

The bevels can now be closed, and with the measurements obtained proceed to lay out the full size details of the mullions E and F, around which the line of the metal is drawn as indicated by the heavy line, allowing ¼ in. on sides and front, as in F and E. Allow a lock for blind nailing if the wall is brick, as at F.

In similar manner draw the base of the bay G and the cornice H, in the sectional view, drawing the sections to fit over the 4-ft. 8-in. and 3-ft. 4-in. measurements, making a ¼-in. allowance where indicated. The distance below the cornice at *c* in the sectional view must be the same width as *c* in the plan view, as they form the joint between the mullions E and F in the lower part of the cornice H. The flange *c* of the lower part of the cornice H is nailed against the window frame, while the metal sill of the base G extends under the wooden sill of the window frame. For different ways of obtaining tight joints between the metal work and window frame, the student is referred to the exercises on "Plain and Ornamental Window Caps," also on "Dormer Windows" previously given.

As the length of the window opening was 10 ft., then the metal mullion F and E in plan will be 9 ft. 11½ in., or ½ in. less, which is deducted for two ¼-in. allowances made in the sectional view. The gutter in the cornice H and roof over same are lined as previously explained. The paneled soffit under the base G is also constructed as before described.

The measurements on the sheathed bay were 4 ft., 6 ft. and 4 ft., but must be slightly longer on the metal bay, because ¼-in. allowance has been made at *e* and *f* in the sectional view. The lines *e* and *f* in the metal bay represent the measuring lines when laying out the bay window. How much longer the distance on *e* and *f* must be than the 4 ft. and 6 ft. obtained from the sheathed bay is found by referring to Fig. 514, which is a full size sketch, having the true angles at A and B and represents the line of the sheathed bay.

If the allowance is set off, whatever it may be, in this case ¼ in., and lines are drawn parallel, then by actual measurements the distance from *a* to *b* will be ⅛ in. at the miter joint and from *c* to *d* ¼ in. where it butts against the wall. Then, when laying out the full size patterns on the lines *e* and *f* in the sectional view, Fig. 513, the true length of the 6-ft. side will be 6 ft. ¼ in., notching out from the return flange *c* a distance of 8⅜ in. from the ends, which leaves a distance of 4 ft. 7½ in. to turn in against the window frame between the mullions. This 4 ft. 7½ in. is ½ in. less than the window opening, and allows for the ¼ in. play room on either side of the mullion in plan. Then 8⅜ in. + 4 ft. 7½ in. + 8⅜ in. = 6 ft. ¼ in. The true length of the 4 ft. side will be 4 ft. ⅜ in.

Notching out from the end nearest the joint miter a distance of 8⅜ in., and from the end nearest the butt miter against the wall 8½ in., leaving the portion which enters the window opening 2 ft. 7½ in., allows for ½ in. play between the mullions.

Then 8⅜ in. + 2 ft. 7½ in. + 8½ in. = 4 ft. ⅜ in. Sometimes only ⅛ in. allowance is given between the metal work and sheathing so as to have the metal lie close, but experience has shown that ¼ in. is the best practice, as it makes allowance for the thickness of the metal, laps and rivet heads. No matter what allowance is made, the amount to add to the frame measurement is obtained as explained in Fig. 514.

Where the sides of the bay in Fig. 513 butt against the wall, a different miter cut from that obtained in the previous bay window is required, Fig. 515 (see Folder 12), has been prepared so the student may understand how to cut any butt miter oblique in plan, the same principle can be employed, whether the bay has a plan as in L, where the sides butt against a wall running parallel to the front of the bay, or whether the sides of the bay butt against brick or other piers at right angles to the front of the bay window as in diagram M. In either case the girth lines *d e* or *m n* are drawn at right angles to the face of the molding, and intersections obtained as shown by the dotted line.

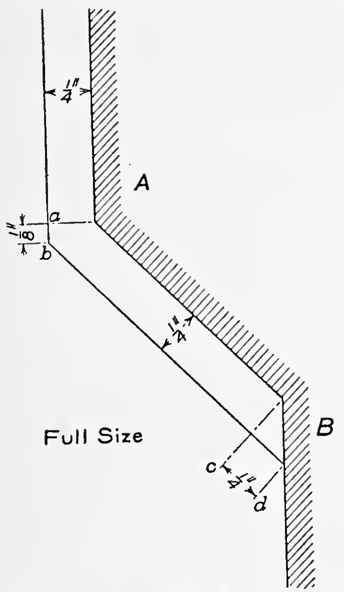


FIG. 514. Method of Making Allowance for Projection.

To show the principle involved, let A represent a portion of the profile of the cornice. Open the bevel to the required width as noted at the building when measurements were taken, and place it in the position *a* B C. Bisect the angle in the usual manner by the arcs *a b c* and draw the miter line B D. At any point on the line B C as C, draw the wall line C N. Divide the profile A into equal spaces from 1 to 16, from which drop lines to the miter line B D. From these intersections parallel to B C lines are drawn intersecting the wall line C N.

For the pattern draw the line E F at right angles to B C, upon which place the girth of the mold A. Through the small figures on E F at right angles to it draw measuring lines, intersected by lines drawn at right angles to B C from similar numbered intersections on the miter line B D and butt line C N. A line traced through points thus obtained, as G H J K, will be the miter cuts required for the bay in Fig. 513. The measuring line f in the cornice H is shown by f in the cornice A, Fig. 515, the measuring point in the pattern will be from f' to f'' in length, as previously figured.

After the sides have been laid out, cut, formed and soldered together in the shop, they are sent to the building, and if not too awkward to handle the three sides in Fig. 513 are set together at the building, and then fastened to the rough framing, starting with base G, then mullions E and F, and then cornice H, after which the gutter and roof are covered, and the leader connections made from the gutter, as explained in the exercise on "Leader Heads." If, however, the sides are of such size as to prevent the miters from being joined before being set, then each piece must be carefully set, using the spirit level, *a b*, Fig. 516, so as to have all horizontal moldings level, and using the same level to have the mullions *c d* plumb.

FIG. 516. Leveling Bay Window in Attaching to Building.

When possible the corners should be fastened to the woodwork with small brass wood screws, the joints well soldered and scraped to give a sharp miter. If the bay is made of copper, then all solder must be filed from the corners and sand-papered to make a clean surface. Fig. 516 shows the bay window finished complete at the building, also portion of a plain window cap A and a lintel course B, mitering to the base of the bay window.

PART III

PRINCIPLES OF CURVED MOLDINGS

CHAPTER XXX

Construction and Patterns of a Ten-Inch Ball

The student now comes to Part III, covering six exercises in the principles of curved moldings, when made either by hand or machine. The first three exercises will show how to use the various hand hammers and stakes and the position to hold the tools when the molds are to be curved by hand, followed by three exercises which will explain how the curved moldings are produced by machine.

The first exercise in hand work is that of hammering out the sections for a 10-in. ball from flat sheets. Balls are sometimes spun in the lathe or pressed on the drop press, a branch of work done in factories and not covered in this study. The 1½-in. scale drawing in Fig. 517, in which is the elevation of a 10-in. ball, each half ball to be composed of four horizontal sections, A, B, C, and D. Through the center of the sphere is a center line, with which the various radii intersect at *h, f* and *e,* representing the centers from which the patterns shown partly by A^v, B^v, C^v and D^v are struck.

In obtaining the patterns or blanks for any curved work, whether hammered by hand or machine, the radial line method is employed, or the same rule as laying out the pattern for a cone, and the greatest care must be taken to average the line correctly through the mold, which will form the radius to strike the pattern.

The rule employed in averaging this line in either hand or machine work will be explained to the student in proper order. The home student who has never used the raising hammer will probably think that the raising of a ball or other mold is a very difficult job. It may encourage the student to say that there is nothing difficult to it if the flare of the patterns are correctly drawn, as will be explained, and if he follows the explanations which will be given with illustrations taken from practical work. The shop detail in Fig. 518 (see Folder 14) is now laid out full size. As the ball is to be 10 in. in diameter, set the compasses 5 in., and with G on the center line E F as center, draw the full circle. Through the center G draw the diameter H J, and divide the quarter-circle J L into as many parts as the semi-circle is to have pieces, in this case four, L M, M N, N O and O J.

While a ball of the same size could be made in fewer sections, practice has shown that it is better to use a few more flares, or sections, and save time in raising. In other words, the semi-circle H L J will be made in four sections, or flares, making the depth to be raised in each flare as much as is indicated by *a*. If this same semi-circle had only two flares or three sections, J *c d*, then the depth to be raised would be almost twice as much, or as shown by *b*. If the ball is smaller than 10 in. less flares are employed, while if larger, more are used, so as to require the least amount of labor with the raising hammer, for it is quicker to cut an extra flare and get the ball to a truer circle than to raise to a greater depth.

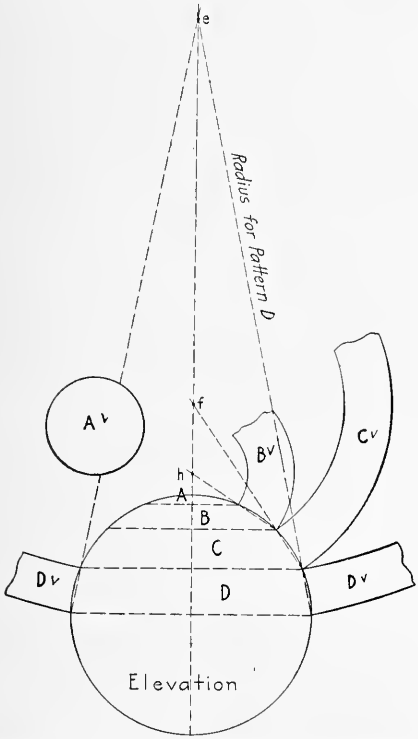


FIG. 517. Laying out Patterns for 10 inch Ball
Scale 1½ inch to 1 Ft.

Having divided the quarter circle into four parts, the radii to develop the patterns are obtained as follows: Draw a line through the intersections J and O until it meets the center line F E at S. In similar manner through O N, N M and M L draw lines which will intersect the center line at R P and L. Then S is the center from which to strike the pattern for the flare D; R the center for C; P for B, and L for the pattern for A. To obtain the pattern for the piece marked A, set the compass equal to L M and with L^1 as center draw the circle, to which allow an edge as indicated by the dotted line. Two of these circles will be required.

Where the flares B and C join together on the line N^0 N, Fig. 518, use T as center and with T N^0 as radius describe the quarter circle N^0 G T, which represents the half section through N^0 T.

In similar manner G H K will be the half section through H G. Divide both sections into equal spaces from 1 to 7. When developing the pattern for the flaring pieces, four times the spaces in the quarter circle N^0 G are placed on the outside curve of flare B and the same amount on the inside curve of flare C, because flares B and C will join on the line N° N. Four times the girth of the quarter circle H K will be placed on the outside curve of flare D.

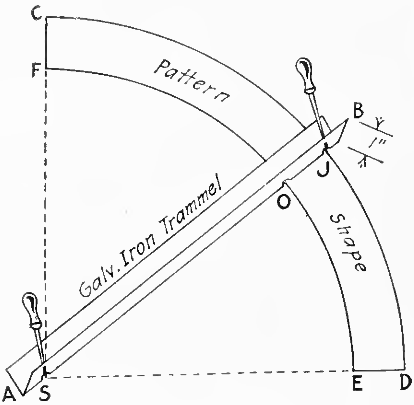


Fig. 519. Sheet Metal Trammels for Long Radii.

To obtain the pattern for flare B, use P^1 as center, and with radii equal to P M and P N draw the arcs M^1 M^2 and N^1 1^0. On the outer arc draw any radial line as N^1 P^1, and starting from N^1 set off on the outer arc four times the number of spaces contained in section N° G from 1 to 7 to 1 to 7 to 1° in the pattern. From 1° draw a line to the center P^1, intersecting the inner arc at M^2. Then M^1, M^2, 1^0, N^1 will be the pattern desired, two of which are required. Allow laps as shown by the dotted lines.

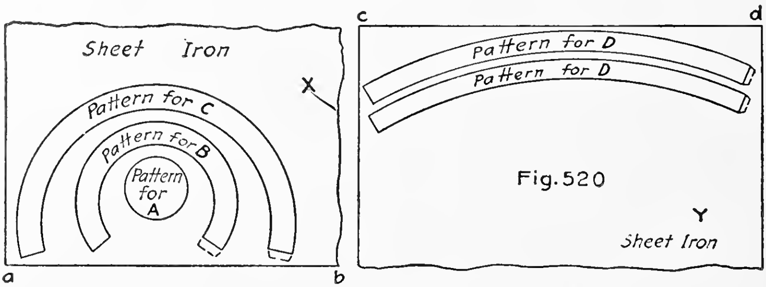


Fig. 520. Placing Patterns to Avoid Waste of Material.

For the pattern for flare C, use R as center and with R N and R O as radii, describe the arcs N 1^0 and O O^2. At any point on the outer arc as O^2, draw a line to the center R, crossing the inner arc at 1^0. Starting from 1^0 in the pattern for C, lay off on the inner arc four times the girth of the quarter section N^0 G, from 1^0 to 7 to 1 to 7 to N^2. From R draw a radial line through

N^2, intersecting the outer arc at O^1. Then O^1 O^2 1^0 N^2 will be the pattern for flare C, two of which are required, allowing edges for soldering, as indicated by the dotted line.

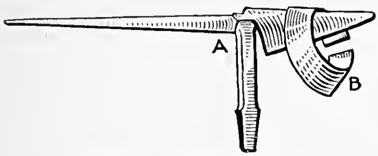


FIG. 521. Blow Horn Stake.

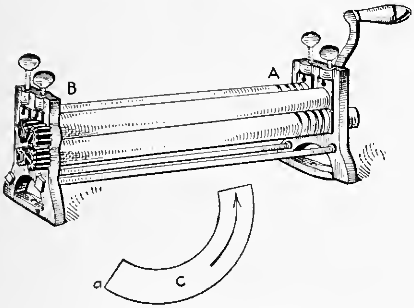


FIG. 522. Forming Rolls.

When striking the pattern for flare D the beam compasses in Fig. 28 should be employed. If, however, none is handy, a V-shaped metal trammel can be quickly made in the shop as in Fig. 519, bent as shown by A B, each side about 1 in. high. In the bend of the trammel prick marks are made at S, O and J to correspond to the radii S, O and J, Fig. 518. Using a scratch awl at S, Fig. 519, as center, and another at O and J, the arcs C D and E F are drawn. Assuming that such a trammel has been made as explained, then to obtain the pattern for flare D, Fig. 518, use S O and S J as radii, and with S^1 at the extreme right as center, draw arcs O^1 O^3 and J^1 1^v. As H K G in elevation represents the quarter section on the line H J, and arc J^1 1^v represents the pattern cut on this line (H J), then starting at any point on arc J^1 1^v as 1^v, lay off four times the girth of the quadrant H K from 1^v to 7 to 1 to 7 to J^1, and from points 1^v and J^1, draw radial lines to the center S^1, intersecting the inner arc O^3, O^1 at O^3 and O^1. Then will O^3 1^v J^1 O^1 be the pattern for flare D, two of which will be required, allowing edges for soldering. This completes all the patterns required for the sphere, and it makes no difference what size the sphere may be, the same principle applies.

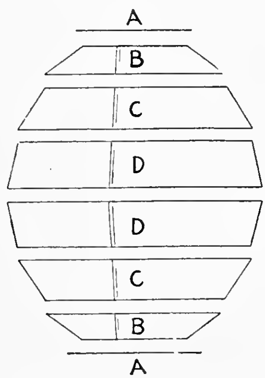


FIG. 523.. Flares Rolled and Soldered Previous to Raising.

When cutting these patterns or flares care should be taken to avoid waste in material by placing the patterns on the sheet as in Fig. 520; diagram X, shows how patterns A, B and C are laid in each other on a line with the bottom of the sheet at *a b,* while in diagram Y the pattern for flare D is marked one under the other, tangent to the edge of sheet *c d.* In this way there is very little waste.

When all the pieces have been cut, they are rolled up either on the blow-horn stake, Fig. 521, or the forming rolls, Fig. 522.

When the blow-horn stake A in Fig. 521 is used, the ends of the patterns are slightly rounded with the mallet, after which the flare B is rounded over the stake, using the hands to make the curvature.

When the flares are to be shaped in the forming rolls, Fig. 522, one end, A, of the rear roll must be raised higher than the one at B, so that when flare C is passed between the two front rolls

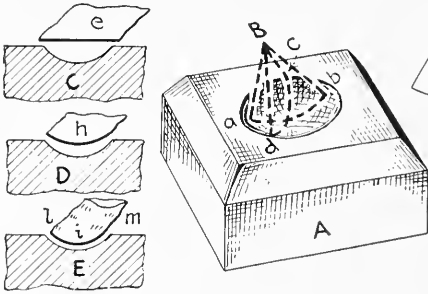


FIG. 524. Preparing Lead Block for Raising.

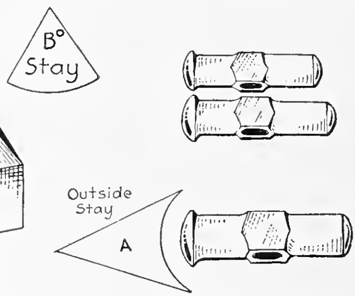


FIG. 525. Different Sizes of Raising Hammers.

the rear roll will give the proper curve and flare. How much the rear roll at A must be raised will be determined when passing C through the rolls. If the ends of flare C do not meet after being passed through, A must be raised higher; or if the ends in C pass over each other, A must be lowered.

Experience will show how the rear roll must be set. If A is raised on the right side, then flare C must be pasesd through the rolls with the largest curve to the right; while if A were lowered and B raised, then the end at *a* would have to be passed through with the greatest curve toward B.

After the flares have been rolled or formed to a true circle they are riveted and then soldered together on the inside. The seams are thoroughly sweated to avoid bursting when raising with the hammer. When the home student has all the flares soldered, their appearance will look like those in Fig. 523, the letters representing the patterns, A A representing the flat disks.

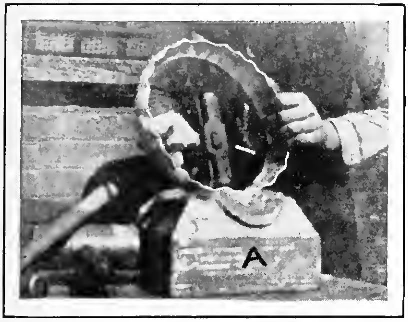


FIG. 526. First Operations in Raising Sections of Ball.

The raising of the flares is the next step in order. A stay must be cut of a part of the circle, shown in elevation, Fig. 518, indicated by G N J and a reduced reproduction B° in Fig. 524. When doing any raising by hand a lead block or part of the trunk of a tree can be used. At the school lead blocks are employed, cast similar to A. These are about 10 × 14 in. in size and about 6 in. high; this gives the block great weight and prevents it from moving. How-

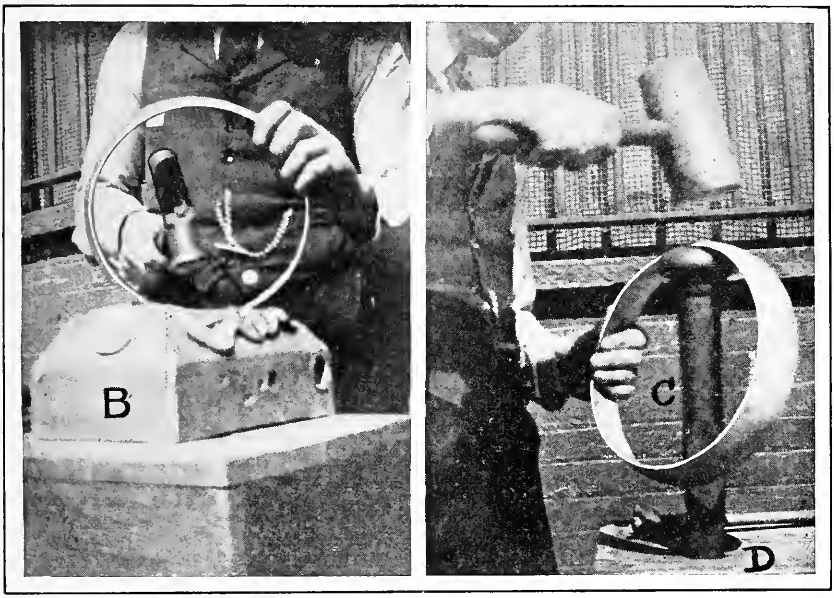


FIG. 527. Smoothing Out Buckles in Section. FIG. 528. Dressing Sections on Round Head Stakes.

ever, a smaller size would answer the purpose just as well, or perhaps the home student can more easily obtain part of the trunk of a tree about 24 in. high and about 10 in. in diameter. When the lead blocks have been pretty well used they can be recast or the trunk of the tree sawed off as far as used, presenting a new surface to work on.

Assuming that a lead block A is employed, the proper size raising hammer must be used to form the shallow surface in the top of the lead block. These raising hammers can be obtained in different weights and sizes. See Fig. 525. In selecting a hammer, one should be taken the head of which will conform to the outside stay A of the article to be raised. Having selected the proper hammer and with some help from shop mates or foreman the home student should proceed to form the concave surface in the lead block A, Fig. 524, as follows: Using the raising hammer in the right hand, strike steady, forceful blows until a smooth, hollow surface is obtained, in size equal to stay B°, the stay being held in the hollow part to prove the accuracy of the curve, *a b* and *c d* in B. As the article to be raised is a ball, and has the same curve when viewed in either direction, the hollow surface in the lead block must have the same profile no matter how the stay B is placed. If, however, a curved mold was to be hammered whose profile was other than that of a part of a sphere, the hollowed surface would be prepared in a manner described further on.

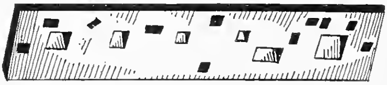


FIG. 529. Bench Plate for Holding Stakes.

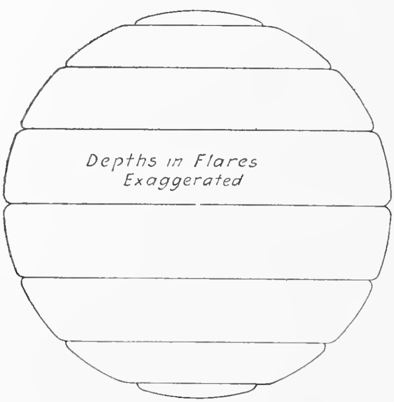


FIG. 530. Appearance of Ball if Flares were Raised Too Deep.

The method of raising flare D, Fig. 523, will be explained and is applicable to the rest of the flares as well as to the disk A. The flare D is held in the left hand and placed over the hollowed surface in the lead block C Fig. 524, as shown by *e*. Light blows are struck directly in the center of *e* with the raising hammer, which is held in the right hand, which will bring the metal in the shape shown by *h* in D. Strike a little harder, in the center of *h*, gradually turning the flaring piece as each blow is struck, so that the hammer touches all the surface of the metal along the center of the flare. This will bring it to the required depth shown by *i* in E.

When the metal has been brought to its proper shape along the center of the flare, it will be found that the edges have buckled, as indicated by *l* and *m*, which must be dressed out on the block, striking lightly along the edges of the flare.

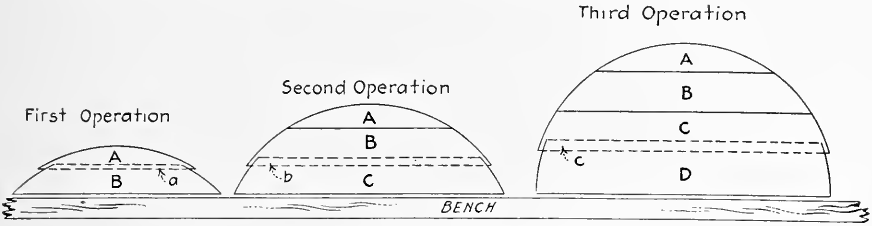


FIG. 531. Assembling the Various Flares Composing the Ball.

Figs. 526 to 528, are three pictures of a student at work raising flare D. In this case the flare has been raised to its deepest depth along the center and the buckles show as before described. Notice position of student's hands, and how the flare and hammer is held in Fig. 526. The buckles in Fig. 527 are being smoothed on block B, while Fig. 528 shows how the raised flare is dressed free from all marks or dents by using the wood mallet on the round head stake C. The latter is fastened to bench D by having the proper size square hole cut in it or by having a cast-iron bench plate fastened to the bench, Fig. 529. These bench plates can be obtained with polished surface, and have holes for screwing to a bench, and with different size holes for holding stakes, bench shears, etc. They come in different sizes, contain more or less holes and can be obtained from dealers in sheet metal workers' tools. Notice how the operator holds the work and tool.

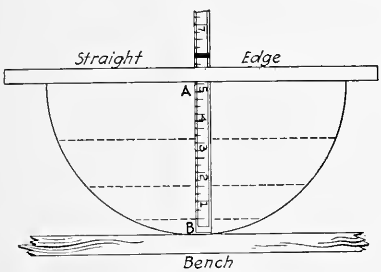


FIG. 532. Testing Hemisphere.

In this manner all the flares should be raised and it might be well to add that in raising always start at the seam, for then the student knows where to start and finish his courses of blows.

The mistake which the student is liable to make is to strike too hard, resulting in the flare being too round or of greater depth than called for by stay B°, Fig. 524. Each and every flare must be raised true to the stay, otherwise when the ball is soldered together it will not represent a true sphere. If the flares are not raised deep enough, which, however, does not happen very often, the ball will have a pointed shape when soldered together, while if the flares are raised too deep, which very often occurs, the ball would look as in Fig. 530, in which the depths of the flares are exaggerated.

Assuming that all flares have been raised true to the stay, they are joined together as in Fig. 531, in which the three operations

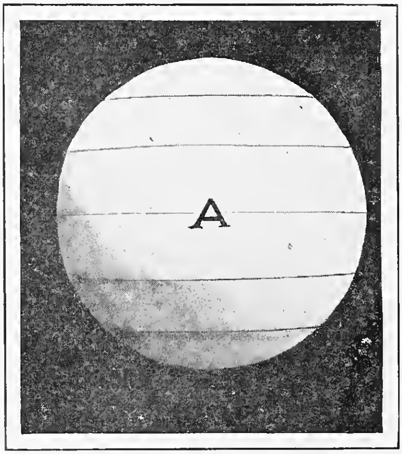


FIG. 533. View of Finished 10 Inch Sheet Metal Ball.

are shown for joining them. In the first operation flare B is laid upon the bench and A pressed tightly over it, being careful to have an even edge all around, and when the joint fits smooth and tight, slight tacks are made with solder on the outside. If desired, the edge or lap can be scribed along the top of B, C and D, at *a, b* and *c,* which will guide the student in tacking the flares together. Next set flare C upon the bench, over which A B is tacked as before. Then set D on the bench, over which tack A B C and solder all the seams on the inside of the sections.

When the two half spheres have been solderd, test them to see if the hemisphere is true, as indicated in Fig. 532. A straight edge is laid across the top and the distance measured from A to B should be, for a 10-in. ball, 5 in. plus the lap. The two hemispheres are then soldered together by tacking a quarter inch wide metal strip on the inside of one-half hemisphere, and then slip-

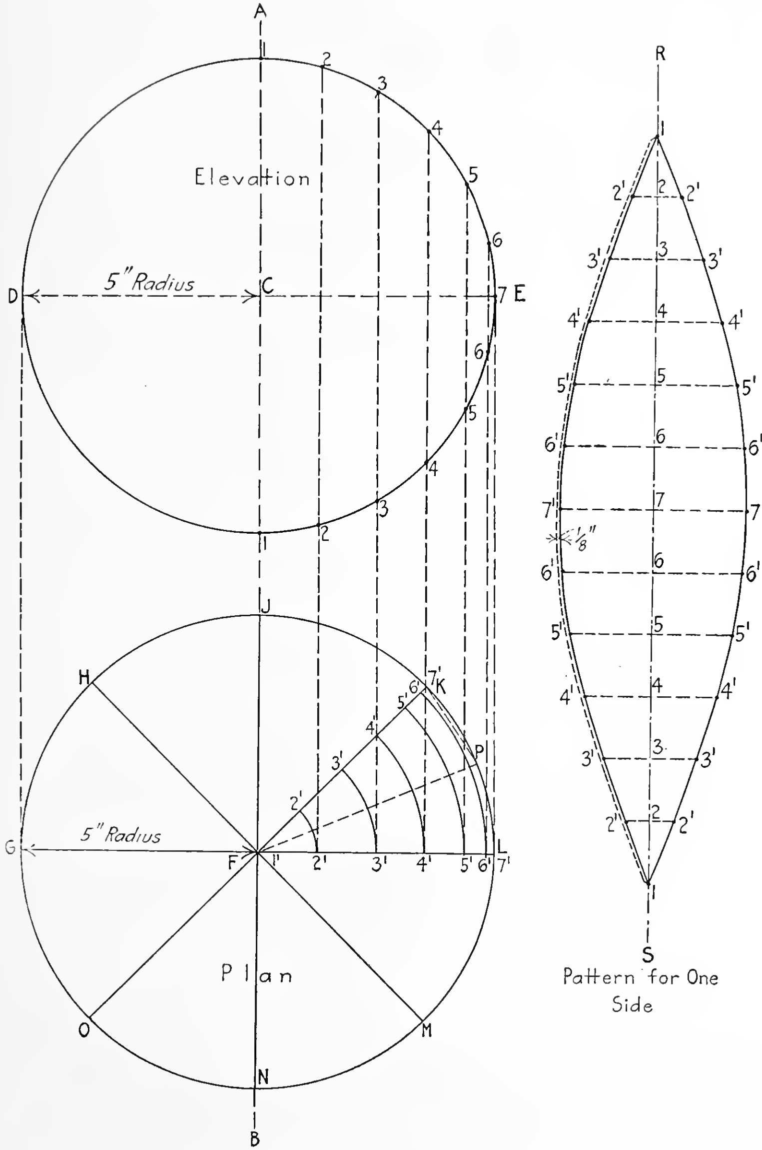


FIG. 534. Details and Gore Patterns for 10 Inch Ball.

ping the other half over same with a butt edge, then scraping smooth, as in Fig. 533, which shows the finished ball with seam

A which joins the two halves. Another method of making a ball adapted to larger sizes will next be given.

Sometimes a ball is made in vertical sections or gores, and while this method takes more time in raising, it saves material, especially if large balls are to be constructed from sheet copper. As an example of this method of construction, which the home student should practice. The detail of developing a ball of this kind is shown quarter size in Fig. 534. First draw any center line as A B upon which establish at pleasure the center point C. Set the compasses to a 5-in. radius, and, using C as center, describe the circle, which represents the elevation of the ball. Through C draw the diameter D E. Below the elevation, with any point F, on the line A B, as center, with the same 5-in. radius, describe the circle, which represents the plan view of the ball. In this case the ball is to have eight gore pieces, although any number of pieces can be used and the principle will apply. Therefore, divide the plan into eight spaces, G H J K L M N O, and draw miter or joint lines to the center F. In practice it is not necessary to draw each gore in plan; all that is required is one gore, F K L, from which to obtain the pattern.

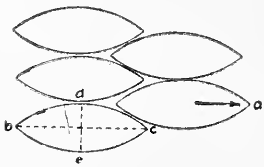


FIG. 535. Gores Laid to Avoid Waste

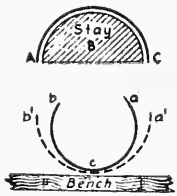


FIG. 536. Raising to Conform to Stay.

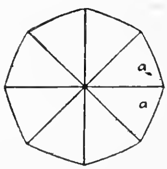


FIG. 537. Effect of Shallow Raising.

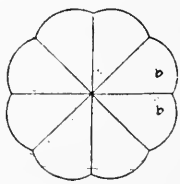


FIG. 538. Effect of Deep Raising.

Having drawn the plan and elevation, the pattern is laid out as follows: Divide the one quarter circle in elevation into equal spaces, shown by the small figures 1 to 7. From these points parallel to the center line A B drop lines until they intersect the joint line F L, which must be at a right angle to A B, shown by the small figures 1′ to 7′. Using F as a center with radii equal to the distance from 2′ to 7′, draw arcs intersecting the joint line F K, also from 1′ to 7′. Bisect the curve L K at P and draw the line P F. Draw any vertical line, R S, upon which place the girth of the semicircle in elevation from 1 to 7 to 1 on R S. At right angles to R S through these small figures draw lines indefinitely. Measuring from the line F P in plan take the distances along the curves to points 2′ to 7′, measuring either to the joint line F K or F L, as both are alike, and place these distances on each side of the line R S in the pattern shown by

FIG. 539. Assembling the Gore Pieces.

similar numbers. Students often make the mistake of measuring from the line F P to the joint line F K, on a straight line, as from P to 7′; this is wrong; the measurements must be taken along the various curves drawn, using the dividers to ascertain the number of spaces in each. Through the points thus obtained in the pattern, trace a line, adding a small edge ⅛ in. wide to one side only.

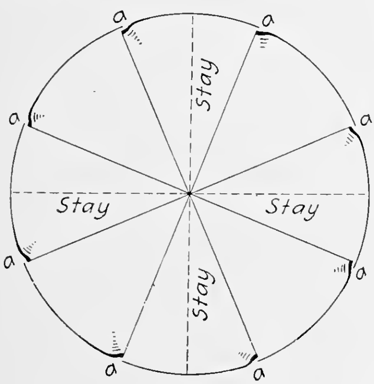


FIG. 540. Edges of Gores for Soldering.

This represents the pattern for one side of the gore, eight of which will be required to complete the ball, as it will contain eight gores.

When cutting the gores from sheet metal, place them so as to avoid waste, as in Fig. 535, and after they are cut, pass them through the forming rolls in the direction of the arrow *a* until they conform to the stay B, Fig. 536, which represents a reduced stay of half of the 10-in. ball, A C.

When raising the gores the block, hammer and stake are used as in the preceding exercise, being careful to strike along the center indicated by the dotted line *b c*, Fig. 535, dressing out the buckles along the edges on the block and a round head stake. When raising gore pieces, they have a tendency to curl in the form of a circle, *a c b,* Fig. 536, which makes it necessary to grasp both ends at *a* and *b,* with *c* resting on the bench, pressing *a* and *b* down until the proper curve is obtained, shown by the dotted curve *a' b'*. By pressing *a* and *b* down it will be found that the curve through *d e,* Fig. 535, has a tendency to curve more than called for by the stay; therefore, care must be taken not to raise the part *d e* too deep in the block. The gore piece must conform to the stay both ways, for, if they are not raised

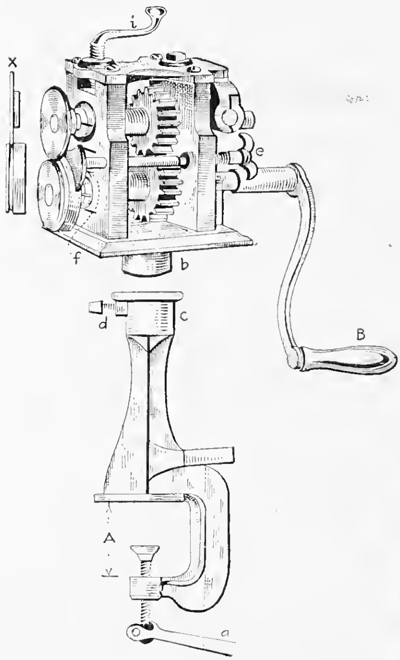


FIG. 541. Small Turning Machine and Standard. FIG. 542. Ball Made With Gores.

deep enough the sides will look like *a a* and the ball will have the appearance shown in Fig. 537. If they are raised too deep the gores will look as in *b b* and the ball will have the appearance indicated in Fig. 538. The eight gores are shown in Fig. 539, the first three being joined and the other five ready for joining.

When joining the gores, a small edge should be turned on one side of each piece, so that they can be joined as in *a a,* etc., Fig. 540. This edge is turned on what is known as a small turner, Fig. 541, in which X indicates the section of the two faces of wheels, which makes the small groove *a a,* etc., Fig. 540. At *i,* Fig. 541, is the hand screw for setting the faces to whatever depth the groove is desired; *e* the wing screw for setting the sliding gage *f* to whatever width edge is desired, in this case ⅛ in., and B the handle for operating the machine. The standard A can be fastened to any bench up to 3 in. in thickness by the wrench *a*. In connecting the standard *b* sets into *c,* fastened by the set screw *d*. When the home student uses this machine for the first time, he should practice on small strips of metal, asking the advice and permission of the foreman in the shop.

After the edges have been turned on all the gores, stays are tacked in four of the gores indicated by the dotted lines in Fig. 540, placing the stays alternately. This is more clearly shown in Fig. 539, where two stays are shown tacked in at 1 and 2. These stays can remain in the ball as they keep the proper height from *c* to *d,* without which the ball would either be too flat or too pointed at top and bottom. The half-spheres are first completed, then joined, being careful that the joints have the proper curve along *a b* in gore 4. A finished view of an eight-piece ball made with gore sections is shown in Fig. 542, as made by the school student.

CHAPTER XXXI

Construction and Patterns for a Round Finial

The second exercise on hand hammer work is a little more complicated, containing raised as well as stretched work. While in raised work the metal is bulged outward in the center of the flares and drawn inward at the edges, in stretched work the edges are stretched outward, that is, stretching the metal to give more material, while the center of the flare remains stationary.

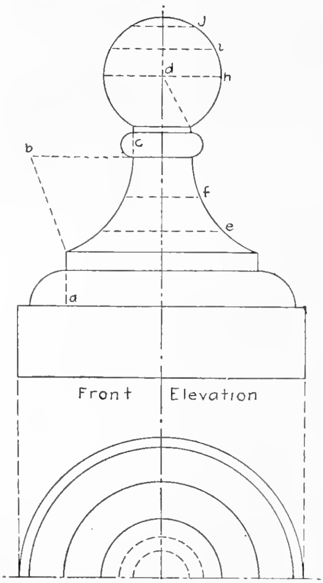


Fig. 543. Half Plan and Elevation of Round Finial—Scale 1½ Inches to Ft.

The scale drawing given to the student, Fig. 543, is drawn to a scale of 1½ in. to the foot. The full front elevation and half plan are shown, although in laying out the detail no plan will be employed. The plan, however, is necessary in the scale drawing, to know whether the finial is to be round, square or octagonal. *a, b, c* and *d* in the elevation are the centers with which the arcs for the molds are struck, while the horizontal lines through *e, f, h, i* and *j* show the seam lines or the number of pieces which the mold will contain. Using the 1½-in. scale rule, measure off the heights on the center line and place them as shown by full size measurements on the center line A B in Fig. 544 (See Folder 13).

In similar manner obtain the various projections from the scale drawing in Fig. 543, measuring from the center line, and place these distances on each side of the center line A B, Fig. 544, the full size of the projections being shown on the left side. The various radii for drawing the molds are also scaled from the lesson drawing in Fig. 543 and are shown by full-size measurements in the detail in Fig. 544, *a* and *b* representing the center points for the quarter round and cove. The center for the bead being on the horizontal dotted line marked ½″ R, R meaning radius. After *e* and *f* of the upper neck of the finial have been obtained, knowing that the ball is to be 5 in. in diameter, then with the compasses set 2½ in., using either *e* or *f* as centers, draw an arc intersecting the cented line at *d*, which is the center for describing the ball. This completes the elevation of the round finial.

The quarter round struck from *a* as center, will be raised in one piece; the cove struck from *b* will be made in three parts, and the curve is therefore divided into three equal spaces, N O, O P and P R on the right hand side of the drawing; the horizontal lines through O and P represent the seam lines. The bead is made in two halves. The full ball will be made in six sections; therefore the hemisphere is divided in three parts, as indicated by F H, H J and J G. The horizontal lines through F, H and J show the seam lines.

Flaring patterns or blanks will be required for the different sections of the molds, marked 1, 2, 3, 4, 5, 6, 7 and 8, while the vertical strips required are marked C, D and E.

In this connection it is proper to explain to the home student that while the cove will be made in three flaring sections, it could just as well be made in two, but would require more time and labor in stretching the flares. The point to bear in mind is this: If the mold in diagram X^2 were made in two flares, then the flare b^6 c^6 would have to be curved a distance from d^6 to c^6 and from d^6 to b^6 equal to a depth shown at each end by a^6.

By using more flares, the length of the curve is only from O^1 to N^1 and the depth equal to distance O^1 O or N^1 N in the front elevation. Those who have not done work of this kind do not realize the amount of labor and time saved in stretching, by simply adding one or more flares. Before starting to lay out the patterns, diagram X has been prepared, showing in reduced size, a half sectional view of the finial, and where and how the joints are made. The parts of the different molds, and the vertical strips in the diagram, are numbered and lettered to correspond to the elevation.

Starting at the bottom, E^1, this strip has a flange turned outward at *x;* F^1 is the ring with a burr turned over E^1, and 8^1 is the quarter round with a burr turning out on F^1. The vertical strip D^1 has edges at top and bottom; 5^1, 6^1 and 7^1 are joined together, forming the cove, an edge being allowed at the top of

5^1 to join to bead 4^1. Bead 4^1 is made in two pieces and the vertical strip C^1 is soldered raw edge to the bead and ball. The joints in the ball are joined in a manner similar to that given in the first exercise on the 10-in. ball.

In developing the various flares or patterns, start with the ball. To obtain the radii from which to strike the flares, draw a line from F through H until it intersects the center line A B at L. In similar manner draw a line from H through J until it intersects the line A B at K.

For pattern 1, use G J as radius and with G^1, shown in the lower right-hand corner of Fig. 544, as center draw the circle J^1, which is the desired pattern two of which are to be cut. Using K as center and radii equal to K J and K H, draw the arcs J^1 J^2 and 1 1^0. From any point as 1 draw a radial line to K. With h as center and h H^0 as radius draw the quarter circle, which represents a half section through 1 h. Divide this into equal spaces from 1 to 5, and starting from 1 on the outer arc 1 1^0 in pattern for 2, lay off four times the spaces contained in the quarter circle through 1 h, from 1 to 5 to 1 to 5 to 1^0 in the pattern and draw a radial line from 1^0 to the center K, crossing the inner arc at J^2. Then 1^0 1 J^1 J^2 will be the pattern for part 2, two of which are needed, allowing edges for joining, shown by the dotted lines.

Using L as center and radii equal to L H and L F, draw arcs F F^0 and H 1^0. From any point on the outer arc as F^1 draw a radial line to the center L, crossing the inner arc at 1. Starting from point 1, lay off four times the spaces contained in the section through 1 h, from 1 to 5 to 1 to 5 to 1^0 and draw a line from L through 1^0 until it intersects the outer arc at F^0. Then 1 F^1 F^0 1^0 will be the pattern for 3, with edges allowed for joining, shown by the dotted lines, two of which must be cut. The student should understand that the reason four times the girth of the quarter circle 1 h is placed on the outside curve of pattern 2 and on the inner arc of pattern 3, is because the two flares join on line H H^0 in elevation and h 1 5 represents the quarter section on that line.

In drawing the flare through the sections in the ball, no further calculations were made in averaging this line, F H or H J, than to draw it from corner to corner and then extend it until it met the center line. This line is drawn from corner to corner because the amount to be raised shown by 10 in 3 is so small.

When, however, a quarter round is to be raised, as in 8, the averaged line would not be drawn from corner to corner in getting the length of the radius, but the short practical rule would be employed as follows, no matter what diameter the mold may have.

Thus to obtain the radius from which to draw the pattern for mold 8, draw a line from corner to corner, *i* to *j* at the left of part 8; bisect this and obtain K; from K draw the perpendicular K 4, and divide into as many parts as the distance from K to the center line contains inches, in this case 4¾, which counts 5. Any measure less than ½ does not count, while up to and over ½ counts one.

If the distance from K to the center line were 4⅜, use four; if 4⅝, use 5, and so on. In this case, as above stated, the distance from K to the center line measures 4¾ in. Therefore, divide the line K 4 into five equal spaces, through the first space or dot nearest to the mold, at *l* draw a line parallel to *i j*, extending it until it meets the center line A B at M.

Divide mold *i* 4 *j* into equal spaces, and take the girth from 4 to *j* and 4 to *i* and place it from *l* to *j'* and *l* to *i'* on the averaged line just drawn. Then *i' j'* represents the amount of material required to form or hammer up the mold *i* 4 *j*. From the first dot *l* draw the horizontal line until it intersects the center line at A B at *m*. Using *m* as center, and *m l* as radius, describe the quarter circle *l* 8, divide into equal spaces, from 1 to 8. This quarter circle *m* 1 8 represents the half section through *l m*, and is used for obtaining the girth in laying out the pattern. For the pattern use M^1 below the elevation as center, and with radii equal to M *i'*, M *l*, and M *j'*, draw the arcs *i'' i'''*, *l'' l'''*, and *j'' j'''*. From any point as *i''* draw the radial line to M^1, crossing the middle and inner arcs at *l''* and *j''*.

Starting from *l''*, set off on the middle arc four times the number of spaces contained in the section through *l m*, from 1 to 8 to 1 to 8 to 1 in the pattern. From M^1 draw a line through 1 cutting the inner arc at *j'''* and the outer arc at *i'''*. Allow an edge on the outer arc, as in diagram X, 8^1; allow a lap for riveting to one end of pattern for 8, shown by the dotted lines. Then *i''*, *i'''*, *j'''*, *j''*, will be the pattern for 8, one of which is needed.

The practical rule just given applies to obtaining the pattern for the half bead 4. Draw the seam line through the center of the bead, and a line from corner to corner in the half bead, from *s* to *t*. Bisect *s t* and obtain *u*, from which erect the perpendicular *u v*, and divide into as many parts as the horizontal distance *u w* has inches. *u w* measures 1½ in. and counts 2. Therefore, divide *u v* into two parts, and through the first part, 1, draw a line parallel to *s t* until it meets the center line A B at V. Take the girth from *v* to *t* and *v* to *s* and place it from 1 to *t'* and 1 to *s'*, which represents the amount of material to form *s v t*. With radii equal V *t'*, V 1 and V *s'*, with any point V^1 as center, shown to the right of the elevation, draw the arcs t° t^v, 1° 1, and s° s^v.

From any point as s^o draw a radial line to the center, V^1, cutting the middle and inner arcs at 1^o and t^o. Starting from 1^o on the middle arc, lay off the girth of four times the spaces contained in the half section through *u w* (obtained by using *w* as center and *w u* as radius, describing the arc *u* 6), from 1^o to 6 to 1 to 6 to 1 in pattern for 4. From the center, V^1, draw a line through 1, intersecting the inner and outer arc at t^v and s^v. Allow laps and edges shown by the dotted lines. Then s^o t^o t^v s^v will be the pattern for 4, two of which will be required to complete the full bead.

The method to use, in averaging the line, when the mold is to be stretched, is explained in connection with molds 5 6 7 in elevation. The method of developing the flare for part 7 will be explained in detail and is the precise way that the flares for 6 and 5 will be obtained. The student, therefore, should pay careful attention to that which follows, because the detailed explanations will be omitted in connection with parts 6 and 5.

To obtain the pattern for 7, draw a line from N to O and bisect the curve O 1 N at 1. Through 1 draw a line parallel to N O until it intersects the center line A B at S. Take the girth from 1 to N and from 1 to O and place it, from 1 to N^1 and 1 to O^1. Then O^1 N^1 represents the amount of material required to form curve O N.

When stretching the surface O^1 N^1, the center of the surface at 1 remains stationary, while the portions 1 to O^1 and 1 to N^1 are stretched to conform to the curve 1 to O, and 1 to N. As 1 is the stationary point, then from 1 in the pattern the girth can be placed.

From 1 draw a horizontal line until it intersects the center line A B at *o*. Using *o* as center and *o* 1 as radius, describe the quarter circle 1 6. Then *o* 1, 6 is the half section through *o* 1.

Divide the quarter circle 1, 6 into equal parts, from 1 to 6. With radii equal to S O^1, S 1 and S N^1 and with S^1 in the pattern for 7 as center, describe the arcs O^2 O^3, 1° 1 and N^2 N^3.

From any point on the outer arc, as N^3, draw a radial line to the center S^1, crossing the middle and inner arcs at 1 and O^3.

As the middle arc 1 1° represents the stationary point 1, in O^1 N^1 in elevation, take four times the number of spaces contained in the half section through *o* 1, and, starting at point 1 in pattern for 7, set off the spaces, from 1 to 6 to 1 to 6 to 1°. From the center point S^1 draw a line through 1° cutting the inner arc at O^2 and the outer arc at N^2. Allow lap on the end for riveting and an edge on the inside curve for joining as in diagram X for 7^1. Then N^2 N^3 O^3 O^2 will be the pattern for part 7 in front elevation. In part 6, O^1 P^1 represents the amount of material required to form up O P, while *n* 1, 5 represents the half section through 1 *n*. The radii used to strike the pattern for 6 are shown by T P^1, T 1 and T O^1 at the left of the elevation and by similar letters and figures in the pattern for 6, the girth being laid off along the arc 1 1° equal to four times the spaces contained in the half section through 1 *n*. Edges are allowed to this pattern, shown by the dotted lines, as in the diagram X. R^1 P^1 in 5 of the elevation is drawn parallel to R P and represents the girth required to form the mold R 1 P. 1 being the stationary point, *r* 1 5 represents the half section through *r* 1, while P^1 R^1 extended to the center line at U gives the radii to strike the pattern. These radii are equal to U R^1, U 1 and U P^1, shown by similar letters and figures in pattern for 5 shown at the upper left hand corner.

On the arc 1 1° in the pattern for 5, lay off four times the number of spaces contained in the half section through *r* 1 in elevation and allow lap and edge to the pattern for 5 as in diagram X. This completes all the patterns required for the molds, cutting one of 5, 6 and 7 from sheet metal to complete the cove struck from the center *b* in elevation.

The length of the vertical strips C, D and E in the elevation are obtained as follows: As the distance from *e* to *f* for C is 2½ in., multiply this by 3.1416, thus $2.5 \times 3.1416 = 7.854$ or 7 8/10; cut one strip 8 in. long which allows 2/10 in. lap, by the width from *t* to *e* which is ¼ in. As the diameter of strip D is 8 in. then $8 \times 3.1416 = 25.1328$ in.; add 0.17 in. for lap, making the length 26 in. and the width ¾ in., plus ⅛ in. on each side for edges, as called for by D^1 in diagram X. The length of strip E in the elevation is found by multiplying the diameter 12 by 3.1416, which equals 37.6992 in.; allowing 0.3 for lap, cut one strip 38 in. by 3 in. plus ⅜ in. flange as in E^1, diagram X, or 38 in. x 3⅜ in. The pattern for the ring F^1 in diagram X is obtained by using as radii W X and W Y in elevation and with

L on the center line A B as center, describe the arcs X^1 X^2 and Y^1 Y^2, being careful that the radial lines Y^2 L and L Y^1 form a right angle. Add the outer edge shown by the dotted line, as in diagram X, and add a lap to one end of the pattern at X^1 Y^1. Then X^1 Y^1 Y^2 X^2 will be the one quarter pattern for the ring, four of which will be required to complete the full circle.

The student should now transfer the paper patterns to the metal, and if, for example, pattern for 8 were being transferred, then all that is necessary to prick through are the points i'' j'' j''' i''' and the center point M^1. The paper is removed, and, using dividers or sheet metal trammel as explanned in Fig. 519, arcs are struck.

When cutting the flaring patterns, the largest flare should be

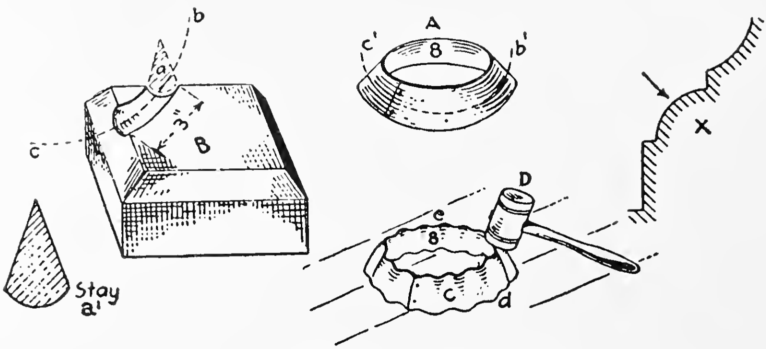


FIG. 545. Raising Quarter Round Molding.

cut first, and the smaller ones laid inside of it, to avoid waste, as explained in Fig. 520.

The vertical strips C, D and E in the elevation, Fig. 544, are shaped to the required circle on the forming rolls in Fig. 522, while the flaring patterns can be formed or rolled on the blowhorn stake in Fig. 521 or the rolls in Fig. 522.

The flares for the ball and vertical strips in Fig. 544 need only be soldered, but the flares required for the bead, cove and quarter round, numbered 4, 5, 6, 7 and 8, must be tacked with solder, then rivet holes punched in the laps, placing two 1-lb. rivets in each lap, being careful that the laps are placed toward the inside.

After the joints are riveted, the rivets as well as the flanges are soldered to avoid bursting the seam when the strain of raising and stretching is put on the various flares. The method of raising the 5-in. ball is similar to that explained in raising the 10-in. ball except, of course, that a smaller raising hammer will be used and that the concave surface hammered into the block must correspond in size to part of the profile of a 5-in. ball.

When preparing the lead block to raise mold 8, Fig. 544, this should be done as in Fig. 545, in which B represents a lead block, A the finished flare for mold 8 and the stay is shown in the lower left-hand corner, after which flare A is molded.

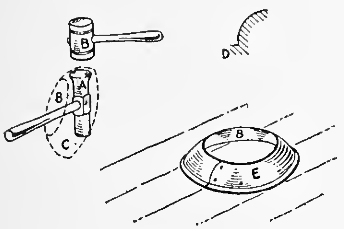


FIG. 546. Dressing Quarter Round Molding.

In raising a ball, the concave surface can be hammered at any part in the block and is a part of the required size sphere; in raising mold 8 the concave surface is usually hammered along a corner of the block, making curve a correspond to the stay, and curve b c to curve b^1 c^1 in flare A. This curve or profile hammered in the block B represents the shape of the mold into which the outside of the flare A is laid and raised with the hammer, striking from the inside. If the distance of the curve in block B is about 3 in., this will be sufficient. The flare A is raised in a manner similar to diagrams C, D and E, Fig. 524, striking along the center of the flare, gradually going deeper, until the proper depth is obtained. Care must be taken in raising a mold similar to 8, Fig. 544, or as shown reduced by X, Fig. 545, to keep the mold to a true circle, as its tendency is to become elliptical.

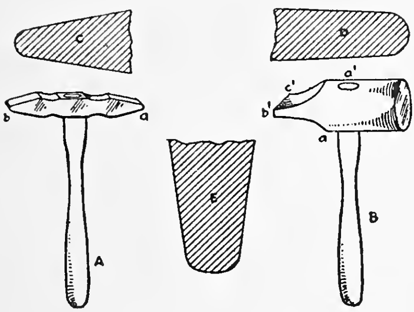


FIG. 547. Stretching Hammer and Mallet.

If the operator when raising, would strike each blow of equal force, the result would be a true circle. But the chances are that some blows are struck with more force than others, and that part of the metal which is struck the hardest turns up the quickest and the result is an elliptical instead of a true circular shape.

After the first operation has been gone through in raising, and the flare has a tendency to turn elliptical, it should be set upon the level bench, as in diagram C, and using the mallet D strike slight blows along the upper edge at e, until the flare becomes circular in shape. The mold is raised a little deeper, always tapping with the mallet along the upper edge *e* to keep it round, if necessary.

When raising along the center of the flare the edges at *e* and *d* will buckle, and must be dressed out on the block, as explained in the exercise on 10-in. ball. The stay should always be tried to see if the proper depth has been obtained. It is better to have the flare raised a little deeper than called for by the stay, for in dressing out the mold on the round head stake it will open a trifle, which will bring it to its proper profile.

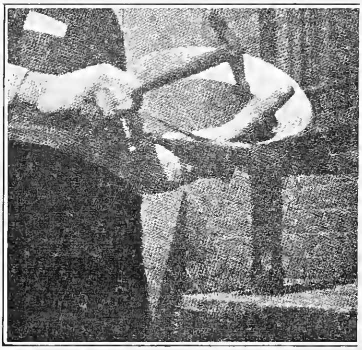


Fig. 548. Stretching Section.

Sometimes a round head stake of the proper size is not at hand, in which case the raising hammer can be fastenend in a vise, in the position A, Fig. 546, the mold 8 placed as shown by C, and using the mallet B the mold is dressed even and smooth. When this mold is completed it must have the dimensions called for in the detail Fig. 544. The same operations are required in raising bead 4. Mold 8 should have a small flange turned outward at the bottom, as in diagram X, at the bottom of mold 8^1. This edge is turned out on the small turner in Fig. 541, gradually raising the mold while turning the handle until the angle in diagrams D E, Fig. 546, is obtained. If the home student cannot work the small turner, any of his shopmates will help him if he uses a little tact in asking for the information.

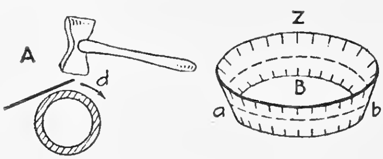


Fig. 549. Appearance of Section After First Operation.

Stretching molds 5, 6 and 7 in the detail in Fig. 544 is next in order. In stretching, lead or wood blocks are not employed, but a stretching hammer, mallet and blow-horn stake are used. In Fig. 547, A shows the stretching hammer and B the stretching mallet. Notice how the edges of the stretching hammer are made. Each end has a different profile or curve. Thus the edge of the hammer at *a*, would be forged as shown full size by C, while the edge at *b* would be made full size, D. Three hammers usually constitute a set having six different hammer edges. Thus a blow struck with edge C would turn the metal quicker than a blow struck with D, or E, which is still flatter, because C is sharper.

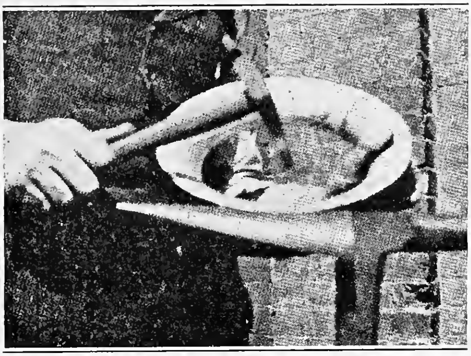


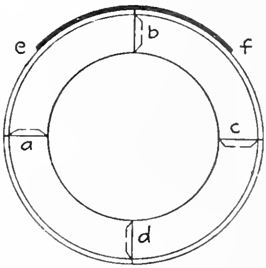
FIG. 550. Curving Section.

For the molds in working, E is the best shape to use, as it is flatter and will not leave dents when striking, but stretches the metal evenly and smoothly. An ordinary wood mallet B is cut

FIG. 551. Finishing Section.

with a scroll saw, as from *a* to *b′* to *a′*, the curve from *b′* to *c′* to correspond to the curve of the mold from *o* j^1 of Fig. 544.

Having cut a stay of either mold 5, 6 or 7, Fig. 544, as they are all alike, proceed to stretch flare 7, the first operation being shown in Fig. 548 with a student at work. Notice that the flare is placed upon the blow-horn stake, and, holding it with the thumb and fingers in the left hand, light steady blows are struck along the outer edges of the flare, shown by the small dashes *a* to *b*, Fig. 549. This is continued along the entire outer curve, striking one blow next to the other, after which the flare is reversed and the same operations performed along the inner edge of the flare, being



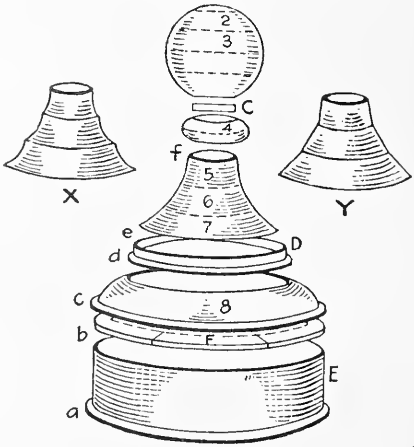


FIG. 552. Joining the Sections of the Molding. FIG. 553. Assembling Parts of Finial.

careful to have a slight space between the flare and blow-horn stake at *d*, diagram A, Fig. 549, which allows the metal to turn so that when the outer and inner edges of the flare have been stretched in the first operation it will look similar to Z, Fig. 549. That is, having a slight curve at *a* and *b*. The slight blows on

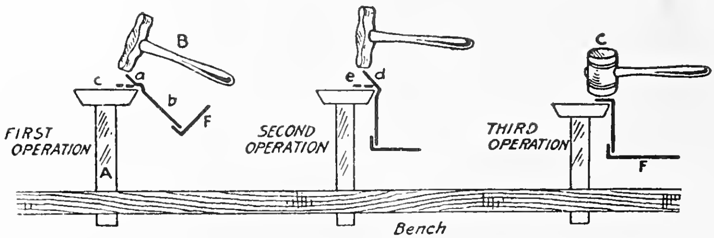


FIG. 554. Stretching the Circular Flange.

the blow-horn stake are continued, striking toward the center or stationary line of the flare, tipping the flare slightly, so that when struck the metal will gradually stretch and turn to the required curve, see Fig. 550. The stay is now tried, and if the flare has the proper curve, the stretching mallet B, Fig. 547, is used to dress or finish the mold smooth, Fig. 551, which shows the student using the mallet B to finish the mold.

It requires a little practice to become proficient, and many students make two or three finials before proficiency is obtained. The home student should not be discouraged if the first attempt does not turn out well.

In the same manner flares 5 and 6, Fig. 553, are stretched. When flares 5, 6 and 7 are soldered together they must show a true curve or part of a circle, as from *f* to *e*. If the flares are stretched too deep they will look as at X; while if they are not

Fig. 555. View of Finished Finial.

stretched deep enough they will appear as in Y. Therefore, care must be taken to follow the stay. A small edge is turned out on the top of 5, using the small turner, the edge being shown by *f*.

When joining the four quarter rings in Fig. 552, which form ring F, Fig. 553, a scribe mark is made on the bench or piece of metal, indicated by *e f*, Fig. 552, which has the same curve as the outer arc of the ring, and after this mark the quarter rings are soldered in the position shown, two at a time, and the two halves tacked together, after which the full ring is soldered at *a, b, c* and *d*, and on the outer curve of F, Fig. 553, a small edge is turned, shown by *b*.

The vertical strips C, D and E are formed in the rolls and soldered. Strip C has no edges, but strip D should have an edge turned inward at *c* and another turned outward at *d;* as edges *c* and *d* are only to be 1/8 in. wide, they are turned as required on the small turner. Strip E must have a flange turned outward at *a* 3/8 in. wide, and this flange as well as any other which may occur in circular work, is done as follows: Set the gage on the small turner 3/8 in. from the edge of the face, and turn a slight groove in strip E, which acts as a guide in turning the flange on the square head stake. Solder ring F in position, which holds the strip to a true circle.

The three operations in stretching the circular flange, whether

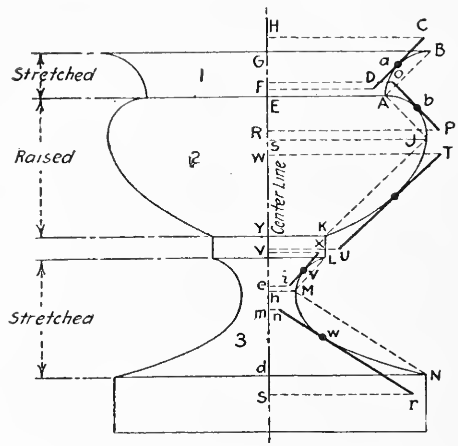


FIG. 556. Examples to Show Difference Between Raised and Stretched Moldings.

3/8 in. or 1 inch wide, are shown in Fig. 554. In the illustrations F represents the ring soldered to the strip. *a* in the first operation shows the slight groove previously obtained in the turner on strip *a b*. Placing strip *a b* in the position shown, with the guide groove *a* placed over the corner of the square head stake A, slight blows are struck with the stretching hammer B, until flange *a* is in the position shown dotted by *c*. Each blow must be struck with equal force alongside of the other, so that sufficient material is obtained to make the turn. After the flange has been turned to the position *c b*, it is placed on the stake *d* in the second operation and flanged down with the hammer to the position *e,* after which the flange is dressed smooth and flat with the mallet, shown in the third operation.

In turning any flange of this kind, no more of the metal should be stretched than is absolutely necessary, so that when the flange is dressed with the mallet C, a smooth, even flange is the result and not wavy and uneven, caused by too much stretching of the metal.

All the various parts are now ready to be assembled and are shown ready to be joined in their relative positions in Fig. 553, each part being numbered and lettered as in the detail drawing.

Assuming that ball 1, 2, 3; bead 4, mold 5, 6, 7 have been joined and ring F soldered to strip E, then the balance of the finial is joined as follows: Solder strip D to the bottom of cove 7; then the top of 5 to the bottom of bead 4. Solder strip C to the bottom of the ball; then strip C to bead 4. Solder strip D to the quarter-round 8, and 8 to ring F, which completes it.

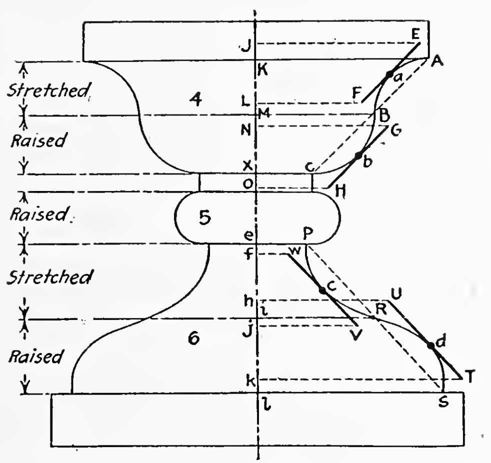


FIG. 557. Examples to Show Difference Between Raised and Stretched Moldings.

Where the head of a rivet projects toward the outside on any of the riveted seams, it should be filed smooth, seams scraped and sand-papered, and when completed should show like the finished round finial in Fig. 555.

The student not having any experience outside of the finial completed in the previous exercise, he naturally does not know when a mold must be raised or stretched, if the profile of the mold was different from that in the finial just completed and to make him proficient in this, two rules are given in connection with Figs. 556 to 558

Rule I. When the diameters of the edges of the averaged flare, C and D, Fig. 556, are less than the diameters of the edges of the finished mold, B and A, then flare C D must be *stretched,* so as to increase the diameters at C and D equal to those at B and A.

Rule II. When the diameters of the edges of the averaged flare O and P are greater than the diameters of the edges of the finished mold A and J, then flare O P must be *raised,* so as to decrease the diameters at O and P, and draw them inward, equal to the diameters at A and J.

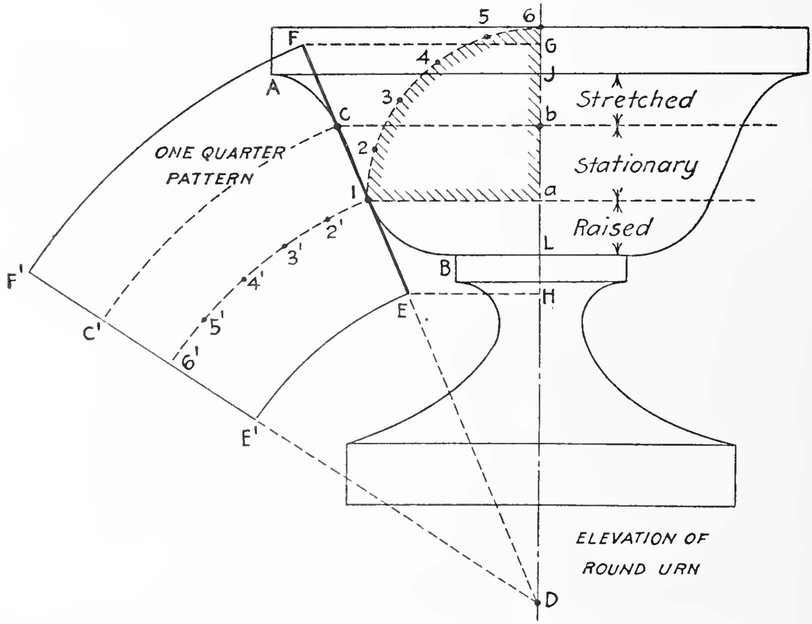


FIG. 558. Developing Pattern for Ogee in One Piece with Raised and Stretched Portion.

To prove these two rules the elevation of a round urn has been drawn in Fig. 556, having a profile different from those already given.

Starting with the top mold 1, draw a line from A to B; bisect mold A B and obtain *a;* through *a* parallel to A B draw D C and make *a* C and *a* D equal to the curve *a* B and *a* A. By measurements, it will be found that the semi-diameters H C and F D are less than G B and E A, showing, in Rule I, that flare C D must be stretched. In mold 2, one seam has been placed along S J, but in practice more seams would be placed and developed as in Fig. 544. Draw a line from A to J in mold 2, Fig. 556; bisect curve A J and obtain *b*; through *b* parallel to A J draw O P, making *b* P and *b* O equal to the girth of the mold *b* J and *b* A. Notice that the distances from F to O and R to P are greater than E to A and S to J showing, as explained in Rule II, that flare O P must be raised or the edges O and P drawn inward.

Following the same principle to the lower part of mold 2, notice that W T and V U of the flare are greater than S J and Y K of the mold, showing that flare T U must be raised. But one seam has been placed along *h* M in mold 3. Obtain the bisecting points *v* and *w* through which the averaged lines X *i* and *n r* are drawn. Notice that the distances V X and *e i* in the upper flare are less than V L and *h* M in the mold, and that the distances *m n* and S *r* in the lower flare are less than *h* M and *d* N in the lower mold, showing that both the flares for mold 2 must be stretched.

To obtain the center points to strike the patterns for these flares, it would only be necessary to extend the lines of the flares until they meet the center line of the urn and follow the rule for obtaining the girth of the flaring patterns, as explained in Fig. 544 in connection with raised molds 4 and 8 and stretched molds 5, 6 and 7.

Fig. 557 is another example giving the elevation of a round urn having an ogee, bead and an ogee reversed. Bead 5 is similar to the one made of metal in Fig. 544 and an explanation is omitted. Assuming that mold 4 will have a seam along M B and mold 6, a seam along *i* R. draw A B and B C in mold 4 and P R and R S in mold 6 and bisect each semi-mold as *a b c* and *d*. Through *a b c* and *d*, draw flares E F, G H, W V and U T, following the rules in the detail in Fig. 544, of their proper girth as previously explained, when Fig. 557 will show whether they are to be raised or stretched. Thus J E and L F are less than K A and M B, proving that F E must be stretched. N G and O H are greater than M B and X C, showing that flare G H must be raised. In the reversed ogee, *f* W and *j* V are less than *e* P and *i* R, showing that V W must be stretched. Again, *h* U and *k* T are greater in semi-diameter than *i* R and *l* S, showing that U T must be raised.

Using this method the home student should have no difficulty in finding whether molds are to be raised or stretched in circular work when made by hand, obtaining the pattern and doing the mechanical work, as explained in connection with the finished finial in Fig. 555.

Another profile not yet explained is a circular ogee made in one piece, as in Fig. 558, the rule also applying to a reversed ogee having this shape. It is seldom an ogee is hammered in one piece, unless its center between the top and bottom curves runs on a flare as from C to 1.

Assuming that the shape of the flare is from A to B, then the pattern is obtained as follows: Draw a line through flare C 1 until it meets the center line at D. Take the girth of the upper mold from C to A, and place it on the averaged line from C to F, also the girth of the lower mold from 1 to B and place it from 1 to E. Using D as center and radii equal to D E, D 1, D C and D F, draw arcs E E^1, 1 6′, C C^1 and F F^1. As C and 1 will remain stationary, the stretchout of the pattern can be taken from either of these points, in this case from point 1.

From 1 draw the horizontal line until it intersects the center line at *a*, using it as a center, and with *a* 1 as radius, describe the quarter circle 1 6, which divide into equal spaces. On arc 1 6′, place the girth of the quarter circle 1 6, and through 6′ draw a radial line to the center D, extending it upward until the outer arc is intersected at F^1 and the inner arc at E^1. Then F F^1, E^1 E will be the one-quarter pattern.

If the quarter circle had been drawn on the line C *b*, using *b* as center and *b* C as radius, the girth of quarter circle so drawn would be placed on the arc C C^1 in the pattern. As C 1 is straight, it remains stationary, requiring no stretching, and to find which part of the ogee is to be raised or stretched bear in mind the two rules previously given.

As the semi-diameter F G is less than A J, it shows that the flare from F to C must be stretched. As E H of the flare is greater than B L of the mold, it shows that the flare from 1 to E must be drawn inward or raised. The profiles given, cover all molds which may arise.

CHAPTER XXXII

Patterns for a Center Piece

The third and last exercise in hand hammer work is shown in Fig. 559, which is the 2-in. scale drawing given to the student at

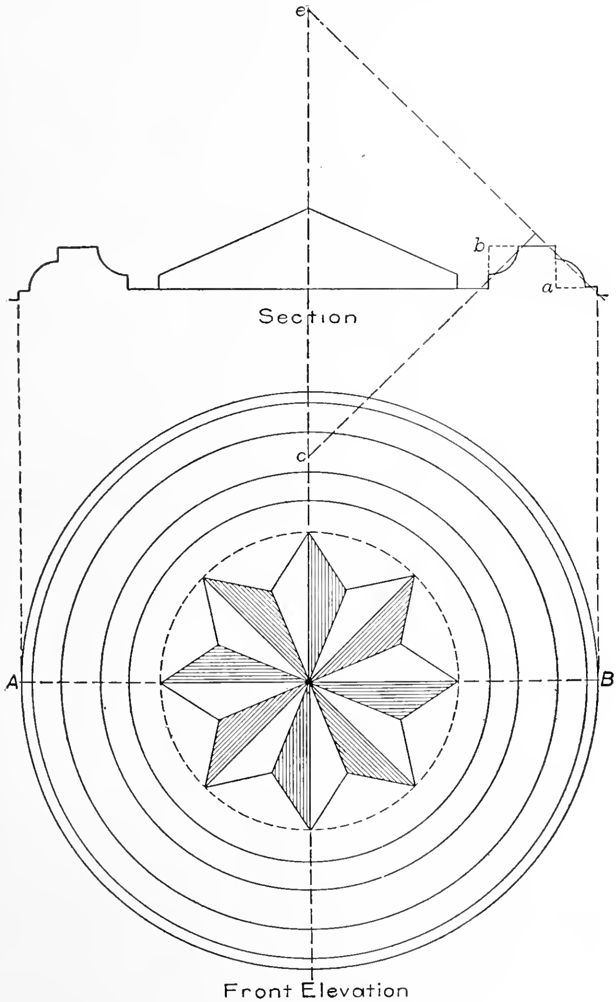


FIG. 559. Scale Drawing of Center Piece.

the New York Trade School. It is called the center piece, such as might be used in a metal ceiling or circular panel in cornice work, and gives the principles to be employed when making circular molding by hand for pediments or window caps.

In the center of the panel is an eight-pointed raised star. The method of obtaining the pattern for it can be applied to any star, having any number of points or any height, and will be solved by triangulation.

Above the front elevation a section through center A B is shown, *a* and *b* representing the centers for striking the curves of the molds. The centers for striking the flares are *c* and *e*, and the method of using them will be explained in Fig. 560, in which the center line A B is first drawn (see Folder 14).

Scaling the elevation in Fig. 559, the extreme diameter of the panel will be found to measure 1 ft. 6 in. Set the compasses to a 9-in. radius, and with C on the center line, A B, Fig. 560, as center, draw the semi-circle A° A^T and through the center C, at right angles to A B, draw the line D E, as only one-half elevation will be required in the detail. At right angles to D E from A° and A^T erect lines at pleasure at A° and A^T in the sectional view. With the 2-in. scale rule take the various heights and projections of the mold in the scale drawing in Fig. 559, as shown by full size measurements in Fig. 560. To the left of the center line, the centers with which the quarter round and cove are struck are shown by heavy dots, the one at *a* being for the quarter round.

A tracing of this mold is placed in its proper position to the right of the center line. The solid line A° to D° to D^T to A^T then represents the sectional view of the center piece through line D E in elevation. From members B° C° and D° to the left project lines to the center line D E, as shown by similar letters. Using C as center, with radii equal to C B°, C C° and C D°, draw the semi-circles, which completes the half elevation of the center piece, minus the star, which will now be drawn.

Scale the diameters of the star in the drawing in Fig. 559 at both inner and outer points, also its height in the section, and draw the half star and its section in Fig. 560, as follows: Using C as center, with a radius equal to 4½ in., draw semi-circle A E° in elevation. With the same center with a 3-in. radius, draw another semi-circle F° K°. The former gives the length of the hip lines, and the latter the valley lines.

As the star is to have eight points, divide the semi-circle A E° into four spaces, B° C° D°, from which draw lines to the center point C, crossing the inner semi-circle at G° H° and J°. Bisect F° G°, G° H°, H° J° and J° K°, obtaining points P°, N°,

M° and L°, and from these points, draw lines to the center point C. Connect by lines drawn from A to P° to B° to N°, etc., which completes the half elevation of the star. Draw the section of the star directly above the elevation, A^v C^x A^x, its total hight being 2½ in.

The entire star will be made of eight separate points, the pattern for one point being developed as follows: The true length of the line CA in elevation is shown by C^x A^x in the sectional view. A P° in the elevation shows its true length. The true length of C P° in the elevation is found by taking this distance and placing it from C^2 to P^x in the section; then a line drawn from P^x to C^x will show the true length. These three true lengths are all that are needed in drawing the pattern.

Draw any vertical line C A in diagram X equal to C^x A^x in the section. With radius equal to A P° in elevation and A in X as center, draw arcs P and P^1. With radius equal to C^x P^x in the sectional view, and C, in X, as center, intersect the arcs previously drawn at P and P^1. Draw lines from C to P to A to P^1 to C and at right angles to the lines P A and A P^1 from points P, A and A, P^1, draw the lines P *r*, A *s*, A *s'* and P^1 *r'* equal to the distance of the rise A^x B^x in the sectional view or ½ in. Connect the points in X from *r'* to *s'* and *s* to *r*.

Bends are made along the lines shown by heavy dots, as will be explained When bending the star along the line C A a stay is required to find at what angle the bend should be made, and is obtained as follows: At right angles to the hip line E° C in the half elevation, from the point in the valley line L°, erect a vertical line until it intersects the base of the star at L^v in the sectional view and from this intersection at right angles to A^v C^x draw the line L^v L^2. Take the distance from L^v to L^2 and place it in the half elevation, L^3 to L^4 and make L^3 to L^5 equal to L^3 L°. Draw a line from L° to L^4 to L^5, shown shaded, and represents the true section through any one of the points from L° to M° at right angles to the hip line, as A^v C^x in the sectional view.

The student should bear in mind when finding this true section, that it must always be taken on a line drawn at right angles to hip line E° C on the line of the longest point of the star.

If the pattern X is true, and the section L° L^4 L^5 has been accurately drawn, then the distance in the pattern from P to *t* to P^1 will equal the girth in the section from L° to L^4 to L^5, and will prove the accuracy of both. Developing the patterns for the curved moldings is now in order.

The home student must remember what was said about determining whether the molds require raising or stretching, and find this by making a tracing of the molds in diagram Y, where, by following the rule previously given, it will be found that the edges of the flares at 1°, 2° and 3°, 4° are greater in diameter than the edges of the finished molds at 1, 2 and 3, 4, showing that the flares must be drawn inward or raised.

Knowing that the work must be raised, the rule given for raising is now applied. Starting with the inner mold or cove at the right of the sectional view, draw a line from *a* to *b*; bisect this line and obtain *c*. From *c* at right angles to *a b* draw the line *c d* until it intersects the mold at *d*. Divide this space *c d* into as many parts as there are inches in the half diameter *c l*, which contains 6⅝ in., showing that *c d* must be divided into seven parts, omitted for want of space. Through the first part nearest to mold *d*, draw a line parallel to *a b* until it intersects the center line A B at H. Take the girth of the mold from *d* to *a* and *d* to *b* and place it from *d* to *a'* and *d* to *b'*. From the first point *d* through which the averaged line was drawn, drop a line into the elevation, until it intersects the line D E at *d'*. Then using *C* as center with *C d'* as radius, describe the quarter circle *d' d''* and divide it into equal spaces from 1 to 9. With any point H^1 as center and radii equal to H *b'* H *d* and H *a'*, draw the arcs $b^\circ\ b^v$, $d^\circ\ d^v$ *and* $a^\circ\ a^v$. Starting at 1 on the middle arc $d^\circ\ d^v$, because the quarter circle *d' d''* in elevation was taken on the middle point *d* in the flare in the sectional view, lay off four times the number of spaces contained in the quarter circle *d' d''* as in the pattern for inside mold from 1 to 9 to 1 to 9 to 1 on the middle arc $d^\circ\ d^v$. From the center H^1 through the extreme points 1 and 1 draw radial lines, cutting the inner and outer arcs.

Then $a^\circ\ a^v\ b^v\ b^\circ$ will be the pattern for the inner mold, to which a lap is allowed for riveting, shown by the dotted line. If it is desired to make this mold in two or four parts it would only be necessary to lay off on the middle arc $d^\circ\ d^v$, the number of spaces contained in the quarter circle *d' d''* for a one-fourth pattern, or twice the amount for the half pattern.

In precisely the same manner is the pattern obtained for the outer mold. A line is drawn from *e* to *f* at the left of the sectional view, bisected at *i* and the perpendicular *i j* drawn, which in turn is divided into eight parts, because the semi-diameter from *i* to the center line *m* measures but 8⅜ in. Through the part nearest to the mold *j* the averaged line *f' e'* is drawn until it meets the center line A B at J. From the point j a line is projected to the elevation at o' and the quarter circle o' o'' drawn, using C as center, and the quadrant divided in equal parts. The girth of the semi-molds j e and j f are placed as shown by j e' and j f'. With radii equal to J e', J j and J f', using any point as J^1 as center, the arcs e° e^v, j° j^v and f° f^v are drawn. On the center arc j° j^v four times the girth of the quadrant o' o'' in elevation is placed, and radial lines drawn from the center point J^1. Then f° f^v e^v e° with lap added, is the pattern for the outer curve.

This completes the patterns for the molds and star, eight points like X being cut from sheet metal with prick-marks in same, and one of each of the flares. A flat disk of sheet metal must now be cut whose diameter will be 18 in. as in the half elevation, and on this metal disk the various circles must be drawn shown by B° C° and D° in the half elevation which were obtained from similar letters in the sectional view. When these circles are cut, there will then be three rings and one center disk, numbered 1, 2, 3 and 4 in the half elevation. The circle marked S° in the elevation will not be cut out of the metal disk; it only shows the line on which the lower edge of the outer mold will be soldered by the ¼-in. margin A° in the sectional view. Each of the rings 1, 2 and 3 will be stripped as indicated in diagram Z, in which the horizontal lines represent the rings, also numbered 1, 2 and 3, and the vertical lines the heights of the strips to which 1/16-in. edges are allowed, except that on the outer strip the lower edge is ⅜ in. Full size widths are given, showing the edges allowed.

When cutting these strips, they should be cut on the squaring shears, or must be cut carefully by hand to be perfectly straight, if no squaring shears are available. The length of each strip is found by multiplying its diameter by 3.1416 as explained in the exercise on the round finial.

For example, the 15/16 in. strip required in diagram Z is 18 in. in diameter as in the sectional view. Therefore $18 \times 3.1416 = 56.5488$. Cut this strip 57 in. long, which will allow for a lap of 0.46 in. for soldering. Strips of this kind need not be in one continuous length, but are usually cut the width of the sheet or 30 in., cutting as many as are required.

How rings 1, 2, 3 and disk 4 in Fig. 560 are cut out with the hand shears is explained in connection with Fig. 561, in which a reduced reproduction of the full size elevation and section of the strips are shown. After cutting the metal disk, cut a slot from the outer edge to ring 3, from A to B, then turning the shears, cut along the various circles and obtain rings 1, 2, 3 and disk 4, on which the star is soldered. The full reduced section of the vertical strips in their various positions is shown by similar numbers in the section. After the proper strips have been cut and the 1/16-in. edges turned up on the folder or cornice brake, they are passed through the forming rolls in Fig. 562, in which A is the strip and a' and b' each a 1/16-in. edge. Before passing the strip through the rolls, the top and bottom rolls are opened to the width of a, or as much as the combined width of a' and b', then raising the rear roll until the proper diameter is obtained. The best way to proceed in soldering these strips is to lay the ring on a smooth, flat surface on the bench, then set the edge on the inside and tack on the proper strip, being careful that the outer surface of the ring is smooth and flat, without buckles, after which the joint is soldered on the inside. Join these strips as in Fig. 563. Join the strips to ring 2, the inner strip to ring 3, then the star, when completed, to disk 4.

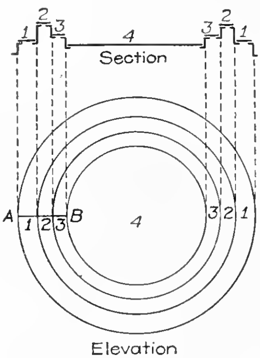


FIG. 561. Cutting the Rings and Disk.

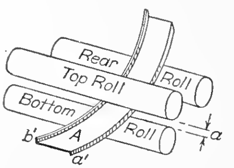


FIG. 562. Forming Edged Strips.

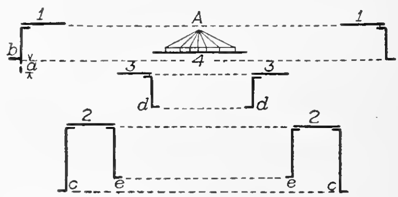


FIG. 563. Soldering Strips to Rings.

Join the outer strip to ring 1, turning the lower 3/8-in. flange a in the position b after the strip has been soldered to ring 1. When flanging a to the position b, use the same methods as explained with Fig. 554. Having soldered the strips as in Fig. 563, drop disk 4 on edges d d and solder inside; drop ring 3 3 into edges e e and solder inside, then drop ring 1 1 into edges c c, also soldering on the inside. When this is completed the square angles will look as in the photograph in Fig. 566, which is minus the star.

The flaring patterns for the inside and outside molds are now formed-up in the rolls, two rivets placed in each lap, thoroughly sweated with solder and raised on the block, after the proper stay, following the directions in connection with raising mold 8, Fig. 545. When the molds are raised the outer and inner molds are dropped in the stripped panel in Fig. 565, shown by *a b* and *c d*. Some metals stretch more than others, and if the molds are not of the right diameter, sometimes being ¼ in. more or less,

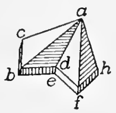


FIG. 564. Joining the Star Points.

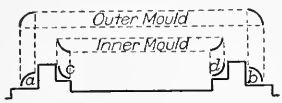


FIG. 565. Soldering Molds in Place.

then the seam should be opened and drawn together or apart and neatly soldered in the position shown in the sectional view Fig. 560.

The soldered joints are now smoothly scraped and sandpapered. The assembling and soldering together of the parts of the star are done as partly shown in Fig. 564. The bend is first made along *a b* after the stay L^0 L^5 in the elevation in Fig. 560, after

FIG. 566. Center Piece Before Attaching Molds.

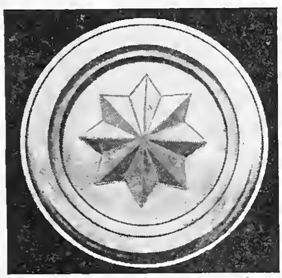


FIG. 567. Finished Center Piece with Star.

which the ½-in. bends along *c b* and *b c*, Fig. 564, are made, using either end of the brake.

When the eight pieces have been formed, they are joined in two's, soldering along *a d* on the inside, being careful that the lower edge *c b e f h* corresponds to M^0 C^0 N^0 B^0 P^0 in the elevation Fig. 560. Join the star in halves, then complete, and solder in the center piece, which is shown completed as in Fig. 567.

If this center piece is employed in cornice work the lower ⅜-in. flange is used to solder to the cornice, while if employed for a ceiling piece a hole must be cut through the star to receive the gas pipe or electric wires, then nailed to the furring strips and the metal ceiling fitted around it.

Should the molds be different from those in Fig. 560, they are averaged in a manner similar to those in Figs. 556, 557 and 558 and developed as explained in connection with Fig. 560. When, however, a mold or bead E is required as in diagram D, Fig. 568, which would necessitate too much time and labor in hammering; this is usually overcome by substituting a zinc or lead pipe, bending it to the required curve in the manner explained in connection with bending the zinc stems in the exercise on the upper part of the ornamental finial.

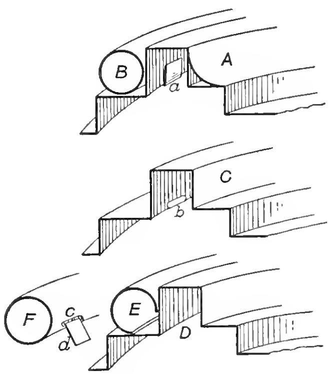


FIG. 568. Attaching a Curved Bead.

Having bent the bead to the proper curve, small copper cleats about ½ in. long and ¼ in. wide are soldered to the bead at intervals of 3 in. by cutting a slot with a sharp narrow chisel in the position *c* in the bead F and soldering therein the copper cleat *d*. In corresponding position in the stripped panel, slots are cut as shown by *b* in diagram C, after which bead B is fastened by drawing taut the copper cleat and turning over at *a* in diagram A. The cove A is fastened as explained by *c d*, Fig. 565.

While a full circle in the work just completed forms a circular panel or center piece, the arc of the panel or center piece also forms what is known as a circular pediment in cornice and window cap work.

CHAPTER XXXIII

Making Curved Moldings and Window Caps

The application of circular molding to window caps and arch work is explained in Fig. 569 (see Folder 14). This includes the method of finding the radii for developing the patterns and determining which flare must be raised or stretched.

The rule to be employed in developing the molds when made by hand in circular pediments or window caps, whether the mold has the shape of a cove, quarter round or ogee will be explained.

Assume that l' i i' h h' is the background of a pediment or the shape of the window opening over which the mold is to be placed, the arc i i' h being struck from the center point C. Through C draw the vertical center line A B and at right angles to A B from i' draw the horizontal line to the right indefinitely. Above this line at a' draw the section of the mold a' 1′ containing the cove mold D E.

As the mold will be made by hand and soldered in separately as shown, construct the square angles as at 2′. From the various members in the cove mold project lines to the center line A B, shown by the heavy dots, using C as center with the various dots as radii, draw arcs. Take the vertical heights of the mold indicated by the dots on the line l k, and place point l upon line i l', as shown by the various dots on l' k'. Through these dots parallel to l' h' draw lines intersecting similar arcs a d e i on the left and b c f h on the right, which gives the miter line or line of joint between the curved and horizontal molds.

In making this curved mold by hand, a b h i would be cut from sheet metal, allowing laps along the miter a i and h b, after which arcs d c and e f are cut. Arc a b c d is shown in section by 1′; the arc d e f c by the vertical face 2′, and arc e f h i by 3′. Strips would be soldered to these arcs as high as indicated by the horizontal lines in the cove mold section E, allowing edges for soldering as previously described. While the curved molding is stripped in squares as in section E, the horizontal molding is formed in one piece shown by section T, in its proper position and being a proper tracing of section E.

The pattern for this horizontal mold is obtained as follows:

Divide the profile T into equal parts from 1 to 8, from which draw horizontal lines until they intersect the miter line *b c f h*. At right angles to the line of the mold, draw the girth line U V upon which place the girth of profile T, shown by similar numbers. Through these small figures at right angles to U V draw lines which intersect lines drawn parallel to U V from similar intersections on the miter line *b h*. A line traced through points *b'* 1 8 *h'*, will give the desired miter cut.

The desired number of pieces are now cut and formed after the stay or profile T. When the curved mold has been stripped the horizontal molds are joined to it, being careful that the bends in both molds lie in horizontal planes, when a chalk line is held across same as from *l' to h'*. The joints or miters are now soldered, after which the cove can be put in place.

The pattern for the cove D E is obtained as follows: Draw a line from D to E, which bisect and obtain F, through which, parallel to E D, draw a line, until it meets the horizontal line drawn through C, the center from which the arcs in elevation were struck, at P. Take the girth of the cove from F to D and F to E, and place it from F to H and F to G. From G or H (in this case G) draw a horizontal line until it meets the center line A B in elevation at 7. Then using C as center with C 7 as radius, draw the arc from miter line to miter line, shown dotted. Divide one-half of this into equal spaces from 1 to 7, which is used in finding the girth for the pattern. Using P as center, with radii equal to P G and P H, draw the arcs, and on the inner arc, set off twice the girth of 1 to 7 in elevation from 1 to 7 to 1 in the pattern, and add an extra space for lap 1 to 0. Draw a radial line from P through O, until it intersects the outer arc. Particular care need not be taken in laying off the length in the pattern, as it is better to have it a little longer, as the ends have a tendency to curl upward when being formed with the hammer and require trimming at the ends to fit the miter on the horizontal mold. By referring to the section, it will be found that the edges of the flare at H and G are greater in diameter than the edges of the finished mold, showing that the blank or pattern must be raised as previously described.

When the section has a quarter round, as section J, the girth O N is obtained as before, and R becomes the center from which to strike the arcs M S. Either point O or N could be carried to the center line in elevation, and the arcs drawn, from which the length of the pattern could be obtained as explained in connection with curve 1 7 in elevation. As the upper edge of the flare N° N and the lower edge O° O are less in diameter than corresponding edges from the center line to the finished mold at K and L, this shows that the pattern when fully developed must be stretched to increase its diameter.

Section X shows an ogee mold hammered in one piece. A line is drawn through the flare *a b* until the center line is intersected at W. The girth is taken of the mold from *b* to *c* and *a* to *d* and placed from *b* to *c'* and from *a* to *d'*. As the diameter from the center line *d''* to *d'* is greater than the diameter to the finished mold at *d,* the outer part of pattern Y must be raised or drawn in to a smaller diameter, while the center flare from *a* to *b* remains stationary. As the diameter from the center line *c''* to *c'* is less than the diameter to the finished mold at *c,* the inner part of the pattern must be stretched or increased to a larger diameter. That part of the pattern from *a* to *d'* is raised on the block, while the lower part from *b* to *c'* is stretched on the blow-horn stake, being careful that from *a* to *b* remains stationary.

While in the full circular panel special rules were employed for obtaining the patterns for raised and stretched work, it is not necessary where there are arcs of circles, as the rules given in Figs. 569, 570 and 571, are perfectly true and practical. If the home student, having made a detail drawing from Fig. 569 to whatever size desired, will again refer to the shop detail in Fig. 560 and assume that D E is the center line of the window cap, D^a A^a H^a E^a the horizontal mold and D^T to A^T of the sectional view the section of the cap mold, it will prove that the principles heretofore stated are similar whether the mold has a full circle, forming a panel or has the arc of a circle, forming a window cap or pediment. The heights H^a G^a F^a E^a are obtained from A^T B° C° D°, on the line D E at the left of the half elevation, and lines from these points, H^a, etc., are drawn at right angles to D E until they intersect similar curved lines at A^a B^a C^a and D^a, which forms the miter line.

CURVED MOLDINGS FOR CORNERS OF BUILDINGS

In Fig. 570 (see Folder 14) are shown the various methods of construction and developments of different shaped molds made by hand when curved moldings pass around the corner of a building as shown in the inverted plan.

Draw the plan view of the wall line 8 H *l e m n* to its proper dimension, *d'* representing the center point from which the arc *l e* is struck, the radius being obtained from the plans or measured at the building, as described in a following exercise. In line with the wall H 8 place the profile of the curved mold A, showing the face, and sink strips, also the cove B C, which is put in separately. Below the section of the curved mold A, made up in pieces, draw the section of the horizontal or straight molding, shown in one piece by L, both profiles being similar in height and projection. As the angle 8 H *l* in plan is a right angle, then from H draw the miter line H J at an angle of 45 deg. Divide the profile L into equal spaces, from 1 to 8, from which points drop vertical lines in the plan until they intersect the miter line H J from 1 to 8. Parallel to H *l* from the intersections on H J, draw lines indefinitely. Take the projections of all the spaces on *a b* and place them on any radial line, from the center *d′*, from *a′* to *b′*. Using *d′* as center with the dots on *a′ b′* as radii, describe arcs until they meet similar numbered lines drawn from the miter line H J. Trace a line from *l* to *i*, which will be the miter line between the curved and straight molds.

A mistake often made by the student is to take the projection of the mold, as from *a′ to b′*, draw the arc through *b′* and where it intersects at *i*, to draw a miter line from *i* to *l*. By inspection of the drawing it will be found that the miter line *i l* is not a straight line but is irregular, caused by having different length radii when striking the arcs. In this case the full plan is drawn, which is not necessary in developing the full-size patterns; all that is required is one-half the plan, which can be transferred to the opposite side when laying out the curved mold on sheet metal. Cut from sheet metal that part indicated by *l i h c* in plan, allowing a lap at the miters, and along the arcs *f k* and *g j;* then *c l k f* represents that plane, in the section shown by I; *f k j g,* that in section by II and *g j i h* that in section by III. The heights of the vertical strips are shown by A, F, and X, allowing edges for soldering.

How the pattern for cove mold B C is developed and the working of the cove determined is as follows: Draw a line from B to C and parallel to this line through the center of the mold at D, draw the averaged line E F. Find the girth from D to B and D to C and place it from D to E and D to F. Take the distance from the center point *d′* in plan to the wall line *a′* and place it from and at right angles to the wall line in the section from *a″* to *d″*. Through *d″* draw the vertical line parallel to the wall line, marked "center line." This method saves time; the profile can be placed on any part of the paper, and by simply taking the distance from a' to d' in plan and setting it off from a corresponding point in the section the line drawn through d'' is obtained. Extend the averaged line E F until it meets the line drawn through d'' at G. Using G as center draw the two arcs from F and E. To find the amount of material to complete the curve in the pattern, drop a vertical line from F in the flare until it meets the miter line H J in plan, from which point parallel to H l draw a line until it cuts the miter line l i at 1. Then using d' as center and d' 1 as radius, draw the arc to the opposite miter line at 8. Divide 1, 8 into equal parts and place this girth in the pattern on the arc drawn from F, from 1 to 8, and add an extra space for lap 8 to 0. From G through O draw the radial line, meeting the outer arc, which completes the pattern.

As the diameters of the edges of the flare E E^1 and F F^1, are less than the diameter of the finished mold at B and C, the pattern must be stretched so as to increase in diameter to meet B and C. This cove mold when completed is not soldered to the stripped work until the horizontal returns have been joined to the stripped curves, after which the cove is trimmed to fit the miter on the straight molds. While the pattern for the cove is in one piece, where the curve l e in plan is large, the curved mold pattern is cut from iron, in 30-in. lengths, which allows the pattern to be handled with ease. The joints in the curved mold must be neatly done so that the seam will not be noticed.

The method of obtaining the pattern for the return O in plan is as follows: At right angles to the line of the mold l H draw the line M N upon which place the girth of the mold L, at right angles to M N, as shown by similar numbers on M N, through which intersect with lines drawn parallel to M N from similar numbered intersections on the miter lines H J and i l. A line traced through points will give P R S T will be the pattern for the return O. The cut from R to S also answers for the miter cut on the molding O^1 in plan on the miter line J H.

If this curved mold contained a quarter round as in section W the pattern would be obtained by drawing a line from a to b and parallel to a b through the bisection of the mold draw the line a' b' equal to the girth of a c b, extending a' b' until it intersects the center line at F^1, the center point from which to strike the pattern. The edges of the flare a' b' are greater in diameter than the edges of the finished mold at a and b, consequently the flare will be drawn inward at the edges to a smaller diameter.

When the section contains an ogee mold as in U, the flare of the ogee in the center being such that it can be made in one piece, then a line is drawn through the flaring part and extended until it meets the center line at V which becomes the center from which to strike the pattern. The girth of the lower part of the ogee from b to d is placed from b to d' and the girth of the upper part from a to c placed from a to c'. As the semi-diameter of the upper part of the flare from the center line c'' to c' is less than the semi-diameter to the upper edge of the finished ogee at c, then the upper part of the pattern from a to c' will be stretched and the middle part from a to b remains stationary. The semi-diameter d' d'' of the lower part of the flare is greater than the semi-diameter to the finished mold d, showing that the pattern from b to d' will be raised.

The home student will do well to study what has been described in Figs. 569 and 570, for it will bring to mind other problems of similar work and make him think.