THE UNIVERSAL · SHEET METAL · PATTERN CUTTER

VOLUME TWO

NEUBECKER

THE UNIVERSAL SHEET METAL PATTERN CUTTER

A COMPREHENSIVE TREATISE ON ALL BRANCHES OF SHEET METAL PATTERN DEVELOPMENT

VOLUME II

ARCHITECTURAL SHEET METAL WORK

Including Drawing, (Full Size) Detailing and Lettering, Development and Construction of Sheet Metal Cornices and Skylights, Leaders, Roof Gutters and Conductor Offsets, Moldings, Miters, Pediments, Copings, Finials, Circular Work, Dormer and Bay Windows, Sheet Metal Ornamentation, Electrically Illuminated Signs, Hollow Metal Windows, Frames and Fire Doors, Metal Roofing, etc.; Reading Plans and Taking Off Sheet Metal Items and Quantities.

BY

WILLIAM NEUBECKER

ILLUSTRATED BY MEANS OF 711 ORIGINAL ENGRAVINGS SHOWING ALL METHODS UNDER TREATMENT, AS WELL AS PERSPECTIVE VIEWS OF THE SUBJECTS OF THE PATTERN AND OTHER DEMONSTRATIONS, IN THEIR FINISHED STATE

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PREFACE

Of great assistance and encouragement in the publication of Volume Two has been the generous welcome and favorable criticism on the part of draftsmen and sheet metal workers, attending the appearance of Volume One of which reprint editions were soon required to meet the general demand.

The classification of the subject matter of the two volumes of this treatise brings to Volume Two, chapters that have to do principally with sheet metal work on the exteriors of buildings.

The discussions are not confined exclusively to solutions of problems of pattern development and connected subjects, without regard for other phases of trade practice not coming specifically within the range of treatment suggested by the title chosen for this work. This would necessitate omitting important chapters which it is believed are highly desirable to include with the object of affording the sheet metal worker full access to various methods usually applied in his daily routine.

Therefore, while adhering to the purpose of having the two volumes of the work present a very comprehensive series of pattern demonstrations embracing all prominently typical examples and formations of sheet metal work, the present volume aims to incorporate full information as to methods relating to each given branch of sheet metal work, including the procedure of manipulating the metal and executing the work at hand.

Parts I to III of this volume were prepared with special regard for the requirements of the draftsman and student sheet metal worker. Mainly, this material was prepared by the late George W. Kittredge. It treats: 1—The terms and definitions of architecture and sheet metal work, with engravings of members, parts, constructional features and uses of sheet metal, comprising an illustrated dictionary. 2—The principles of projection or, in other words, the mechanical representation of objects on the drawing board. 3—Architectural design, methods of drafting, detailing and the groundwork instruction for qualifying the operative to design and proportion sheet metal work for the various ornamental and architectural purposes for which it is extensively applied in the equipment of buildings.

Proceeding from the chapters designed for the preparation and training of the mechanic, this volume takes up in Parts IV to XV the numerous and varied solutions and discussions of methods designated in the general table of contents. These methods comprise the major portion of the contents of Volume Two. They form the basis of its appeal as a work of reference for the use of sheet metal workers in many branches of the calling who, it is hoped, will find it ever responsive and reliable as a source of help.

Part XVI is designed as a concise treatise and key to assist the many who, through lack of opportunity or experience are unfamiliar with the reading, or interpretation, of architects' plans and the language of scale drawings. Part XVII, which concludes the work, is devoted to methods of taking off items and quantities from plans, a subject requiring the closest attention of those who aim to become proficient as estimators.

We believe the reader will readily share in the opinion that the two volumes of this work are an impressive testimonial to the high standard of the diversified calling of the sheet metal worker, which vocation while presenting numerous and varied exactions upon the skill of the operative, also affords exceptional opportunity to such as become competent in its pursuit. In few industries will individual success be more largely achieved by the capacity to study and utilize information on mechanical and technical procedure. Thus, it would seem that there is almost no limit to the advantages to be gained by frequent reference to and study of so great a range of methods as are presented in Volumes One and Two.

William Neubecker.

CONTENTS

PART I

TERMS AND DEFINITIONS

1. What is termed an *Order* in architecture is one of the five principal methods of constructing and ornamenting a building (exemplified mainly in the portico). There are five orders of architecture, viz: *Tuscan, Doric, Ionic, Corinthian* and *Composite*. An order consists of a pedestal, a column and an entablature. Fig. 1 shows an outline drawing of the Ionic order.

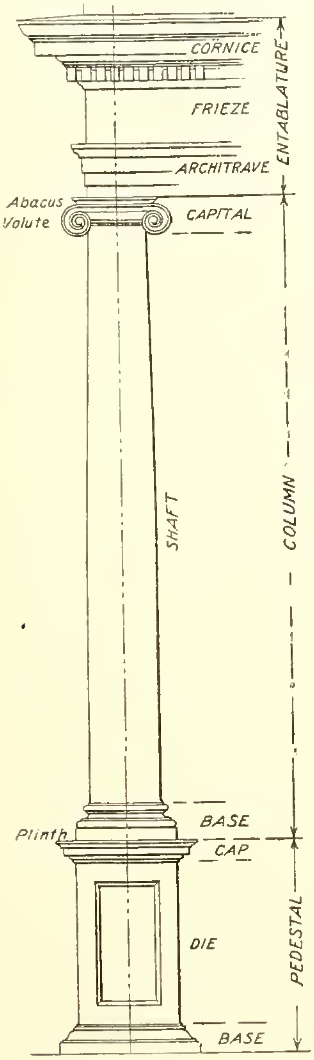


Fig. 1.—The Ionic Order

2. A *Pedestal* is a structure consisting mainly of a block of stone (or the representation of such) duly ornamented, whose use is to support a column, statue, vase or any ornament which requires being placed in a conspicuous position. It consists of a *base*, a *die* and a *cap* or cornice. Designs for pedestals include one for each of the five orders. In modern architecture they may be of fanciful shapes to suit the character of surrounding work. The lower part of Fig. 1 shows the pedestal for the Ionic order, which does not differ much from that of the Corinthian order.

3. A *Column* is primarily a pillar or support for the roof or upper part of any superstructure. In architecture it is cylindrical in shape and occupies a vertical position. A column is usually used in its entirety but may be united with a wall, when it is said to be an *engaged column*. In such case it projects from the wall one-half its diameter or more. There is one for each of the ancient orders, each being designed according to a prescribed set of proportions. It consists of a base, including a *plinth*, a shaft and a capital, all as shown in Fig. 1. While the designs of the bases do not differ greatly for the several orders, each order has a capital which is distinctively its own.

4. A *Pilaster* is a pillar or support but differs from a column in that it is square in plan instead of round. Although sometimes used in its entirety it is usually engaged, that is, projects from the face of the wall of which it forms a part. It may thus project very little or it may project as much as half or even three quarters of its diameter. A pilaster usually has parallel sides while a column tapers, being smaller at the neck than its base as shown in Fig. 1.

5. A *Capital* is the head or upper member of a column or pilaster. Its design varies according to the order or style of architecture employed. It consists usually of a *neck*, *mold*, a *bell* and an *abacus*. The bell is usually decorated with foliage, though sometimes is entirely plain. The form and details vary perhaps more for capitals than for any other unit of design all of which can be learned only from an exhaustive work on architecture.

6. An *Entablature*, which signifies literally the putting on of boards, may be described as the finish of an order, as in a portico or at the top of a wall. It consists of three parts, the lintel or architrave, the frieze and the cornice. In Fig. 1 the different parts of an ancient entablature are shown and their names given.

7. The *Architrave* is the first or lower division of the entablature. It is an ornamented lintel, which is in reality a stone or timber placed across the space from one column to another and is designed to support that which is placed above it.

8. The *Frieze* is the second or middle division of the entablature and may be considered as a continuation of the wall to add hight to the building (it being understood that the columns stand in the place of the wall). Its purpose in ancient buildings was the display of symbols, inscriptions or ornamen-

tation, suitable to the purpose of the building. In modern work it is often ornamented by panels, but its principal use is that of displaying signs.

9. The *Cornice* is the uppermost projecting and must ornate part of the entablature. In the Tuscan order it is very plain, consisting of simple moldings, but in the other orders dentils or modillions, sometimes both are introduced and most if not all of the moldings have their surfaces carved with enrichments. In modern times and especially by sheet metal contractors, the term cornice constitutes as it were, a unit of design and has come by common usage to be applied to the entire entablature or as much of it as is used as a finish upon a wall often

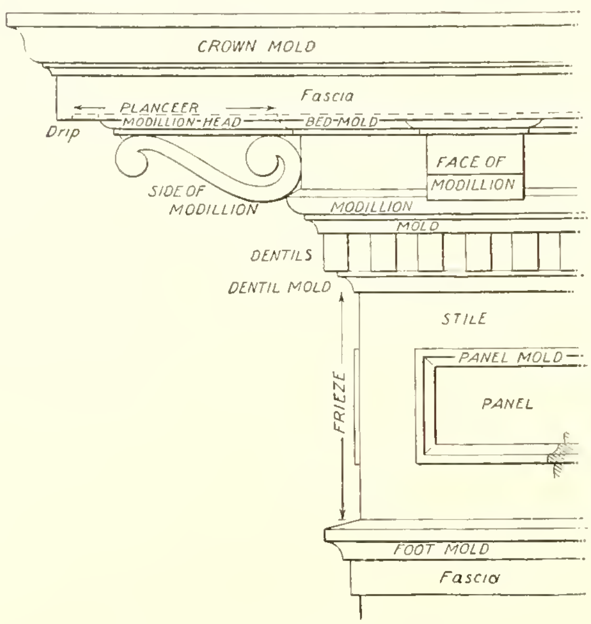


Fig. 2.—A Cornice and Its Parts

of other material as brick, terra cotta or stone. A cornice of modern design as well as the names of the several parts and members are shown in Fig. 2.

10. *Lintel Cornice* is designed to form a finish above the first story, that is in connection with the lintel.

11. The term *Deck Cornice* is applied to the moldings forming the finish around or along the top of a mansard roof, or to finish the edge of any flat roof where it joins a steeper roof below.

12. A *Pediment* is a triangular or segmentally arched ornamental finish to the wall surface over the end of a building portico, formed by dividing and varying the pitch or inclination of the cornice. Pediments are termed Triangular, Segmental or Broken according to their form or design, several forms of which are shown in Fig. 3.

13. A *Triangular Pediment* is one in which the cornices above the wall surface are straight but inclined, thus meeting at an apex above the middle of the design and forming a triangular space between the upper and lower or level cornices, known as the *tympanum,* as shown in diagram 3, Fig. 3.

14. A *Segmental Pediment* is one in which the upper cornice forms an arc of a circle thus leaving the tympanum segmental in shape, at the top, as in Fig. 3, diagram 2.

15. A *Broken* or *Open Pediment* may be either triangular or segmental in shape having the central portion of its cornice above the tympanum omitted to make room for an ornamental design, the upper cornice being terminated according to any one of several methods as in diagrams 4 and 5 in Fig. 3.

16. A *Gable* is that part of the end of a building contained between and below two sloping roofs, shown in diagram 3, Fig. 3.

17. An *Arch* is that which forms the top, usually curved, of an opening in a wall. Its curve is usually a semicircle, an ellipse, or consists of two or more arcs of circles and is constructed to be self-supporting and to support also that part of a wall or structure which is above it. In a semi-circular arch a horizontal line drawn through the center is termed the *springing line,* Fig. 4, and if of masonry, the joints between the blocks radiate from the center of the circle at *a* in Fig. 4.

The system of joints by which it is rendered self-supporting is sometimes applied to a number of stones placed so as to form a horizontal line in which it is known as a *Flat Arch.* Fig. 5.

18. A *Modillion* would be best understood if defined as a kind of bracket. In its original form it is used as a support under the *Ionic* and the *Corinthian Cornices.* It differs from the usual form of bracket in that it has more projection than depth. It is sometimes called a cantilever. One form is shown in Fig. 2 and another in Fig. 6.

19. A *Bracket* in sheet metal is simply an ornament to the cornice and like the modillion simulates a support to the projecting part. Fig. 7.

20. A *Dentil* is also a cornice ornament of rectangular shape and much smaller than a modillion. Dentils are placed less than their face width apart and thus form a course which is placed in the bed of a cornice below the modillions, when modillions are used. Fig. 2.

21. A *Corbel* is a form of bracket intended to appear as the support of window sills or caps, or of arches in the place of columns. Fig. 8.

22. A *Head Block* is a large bracket placed at the end of a main or lintel cornice and is of suffi-

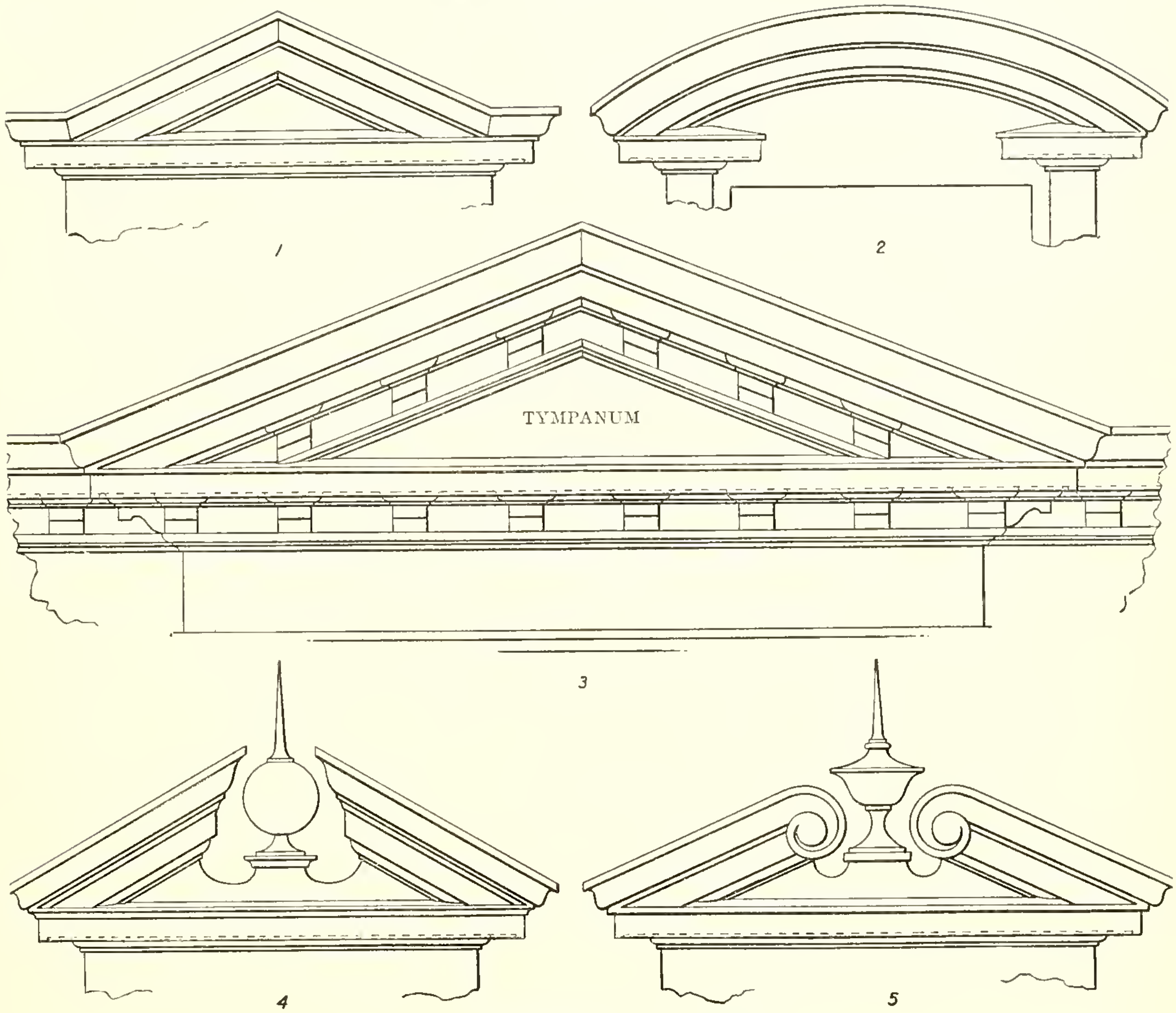


Fig. 3.—Various Forms of Pediments

cient projection to receive all the moldings of the cornice, and thus form a finish to the same as shown in Fig. 9.

23. A *Finial* is an ornament designed to form the finish at the top of a spire, pinnacle, pediment, gable or roof. Fig. 10.

24. A *Volute* is an ornament consisting of a fillet or small flat member accompanied by a hollow mold, curved into a spiral and placed under the angles of the abacus in the Corinthian, Ionic and Composite capitals, as shown in Fig. 11.

25. A *Pinnacle* is a slender turret rising higher than the main building, used usually about the base of a larger tower or steeple. It may be called a small spire. Fig. 12.

26. A *Panel* is a compartment usually sunken below but sometimes raised above any plane surface, as a frieze in a ceiling, a door, etc. The part or margin surrounding the panel usually of uniform width is called the *Stile*. Fig. 2.

27. A *Baluster* is a small column, usually of fanciful design, used to support the rail of a staircase. In external sheet metal work the baluster in Fig. 13 usually stands upon a base rail and support an upper rail, when the whole combination constitutes a *Balustrade,* which is usually placed in sections separated by pedestals. Sometimes the spaces between pedestals is filled by plain panels instead of balusters, in which case the combination is known as a *Pedestal Course.*

28. A *Molding* is a combination of parallel forms both angular and curved, projecting from a wall or other plane surface.

29. A *Crown Mold* is the upper and most projecting member of a cornice. One is shown in Fig. 2.

30. A *Planceer* is the lower or under side of the projecting part of a cornice. It represents the under side of the stone, called in stone architecture, the *Corona.* Fig. 2.

31. The *Bed Moldings* of a cornice comprise the

molding or group of moldings lying between the planceer and the frieze and include sometimes a course for modillions, or a course for dentils or both. See Fig. 2.

32. A *Cap Mold* is the upper mold or member of the group, if there are more than one. It is carried around the top of the brackets or modillions to form a head or cap. Fig. 2.

33. The *Modillion Mold* is that line of molding running below the modillions. The plain surface or band above the molding and back of the modillions is called the *Modillion Band*. Fig. 2.

34. The *Dentil Mold* is that line of molding running below and back of the dentils. Fig. 2.

35. The *Foot Mold* is a term used to designate the lowest mold of the cornice. It is usually a simple mold of suitable design but is sometimes designed to represent an *architrave* which it replaces in ordinary cornice work and it is often so called. See Fig. 2.

36. *Gable Mold* is the name applied to the inclined moldings forming the cornice or finish of a gable or pediment.

37. A *Ridge Mold* is the cap or mold, usually in the form of a roll, used as a finish and protection to the ridge of a roof. Fig. 14.

38. A *Hip Mold* is a mold of similar design to a ridge mold, and is similarly used upon the hips or angles of a roof. Fig. 14.

39. A *Fascia* is a surface or band, usually plain but sometimes enriched, just below a mold. Fig. 2.

40. A *Fillet* is a narrow member of a mold usually plain, placed above, between or below those which are curved in profile. Fig. 15.

41. A *Drip* is a downward extension of any projecting member or fascia used to prevent the water from running back and thereby down over the parts below. Fig. 15.

42. The term *Raking Mold* signifies any mold placed in an inclined position as in a gable or pediment, and therefore since it is necessary in order to effect a perfect miter at a horizontal angle that the profile of the mold forming one arm of the miter should be changed, the mold so treated is termed a *Raked Mold* and the miter made between the two arms is termed a *rake miter*.

43. A *Raked Profile* is the profile ot a mold which has been changed from the normal to make a miter. Raked profiles are shown in most of the problems relating to pediments.

44. A *Normal Profile* is the original or adopted profile for the main part of the cornice from which the raked profile is derived.

45. The *Return* of a mold is the part running at right angles in the plan to the part forming, or running parallel with the front.

46. The term *Soffit* refers to the underside of any projecting member of a cornice as a mold or fillet. It is sometimes synonymous with "*planceer*." Fig. 2.

47. A *Stay* is a piece of sheet metal cut to the profile of a mold. Fig. 16.

48. A *Hip* is the angle formed when the two sloping sides of a roof meet to form an external angle.

49. A *Valley* is formed when the sloping roofs meet so as to form an internal angle.

50. A *Sink* is a depression of whatever shape in a plain surface, as in a panel, the side or in the face of a bracket. See *a* Fig. 7.

51. *Incised Work* is a form of ornamentation sunken into a plain surface, forming narrow sunken lines usually in the shape of scrolls.

Terms used by draftsmen will be defined in connection with Architectural Drawing in Part II, to which the reader is referred.

52. The *Enrichment* of a mold is really the carving of its surface into leaves, eggs, arrows or other designs which shall embellish it without materially changing its profile. Designs for the enriched molds are stamped in short length, placed in the profile instead of the regular formed mold. Fig. 17 shows three types of enrichments.

53. *Miter.*—This term signifies primarily a joint at any angle between two pieces of molding having the same profile. The ends of the two pieces are cut off at such an angle as will bisect the angle of junction. It is a term originally used in carpentry, hence in reading the definitions one must have in mind pieces of wooden molding sawed off at the same angle, one right and the other left, so that the angle of the finished miter made by matching the pieces together is twice that of either piece. The term has, however, been extended by sheet metal workers to signify a joint between dissimilar parts, as when a molding, cylinder, cone or any geometrical solid is joined to any geometrical surface or solid. Every miter therefore has two parts or arms. When the arms are similar and both arms are in the same vertical plane it is spoken of as a *face miter*. When both arms are in the same horizontal plane it is termed a *return miter* in which, if the miter is made to fit or go around an exterior angle, it is called an *outside miter* and if to fit a reentrant or interior angle, it is called an *inside miter*. Miters made for the top or bottom of a gable or pediment, are spoken of as *gable miters*. Sometimes one end of a mold-

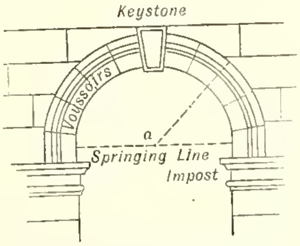


Fig. 4.—Semi-circular Arch and Its Parts

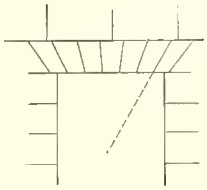


Fig. 5.—Flat Arch

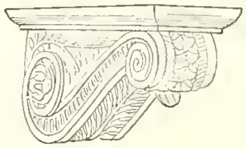


Fig. 6.—Modillion

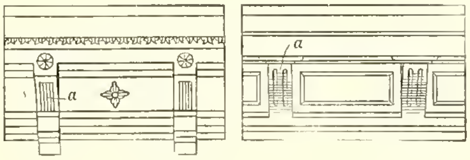


Fig. 7.—Brackets in Cornice Work

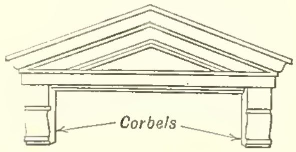


Fig. 8.—Corbels on Window Cap

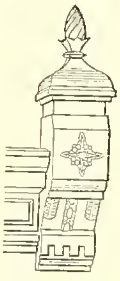


Fig. 9
Head Block or End Truss

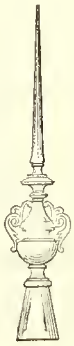


Fig. 10.—Finial

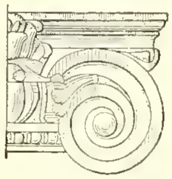


Fig. 11.—Volute

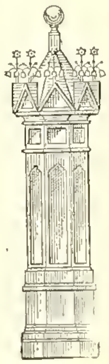


Fig. 12.—Pinnacle

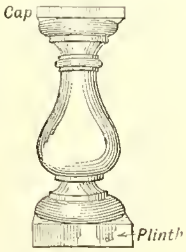


Fig. 13.—Baluster

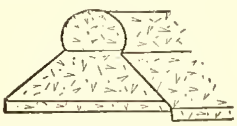


Fig. 14.—Ridge of Hip Mold

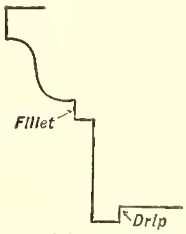


Fig. 15
Fillet and Drip

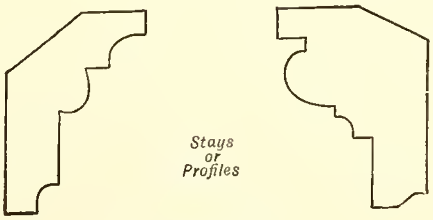


Fig. 16.—Stays

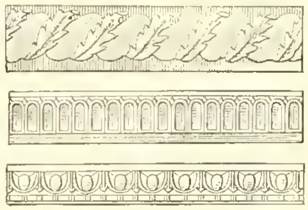


Fig. 17.—Enrichments

ing is made to fit against a surface, either plane or curved. In such case the miter has but one arm and is called a *butt miter.*

54. A *Profile* is a right section through a mold or combination of moldings.

55. *Impost.*—Any projecting block, bracket, cap or capital which serves as the support for the first stone of an arch, and thereby for the whole arch, as in Fig. 4.

56. *Keystone.*—The Top or middle stone of an arch. Fig. 4. It is usually made wider (higher) than the other stones of the arch and frequently has some device or emblem upon its face or is otherwise ornamented. The other stones of the arch are termed *voussoirs.* Fig. 4.

Skylight Terms and Definitions

57. *Skylight.*—A type of window built into a roof, ceiling or ship's deck for the admission of light and ventilation. Various formations of skylight are designed to meet different structural requirements of buildings.

58. *Flat Skylight.*—A type of skylight usually built upon roofs, where a curb flashing has been provided as in Fig. 18. Occasionally these skylights are set over flat roofs, when the pitch in the metal skylight frame occurs as at *a, b, c,* in Fig. 19. The construction may provide for ventilation, without impairing the light surface, by placing a ventilator along the elevated part of the skylight. See Fig. 20.

59. *Double Pitched Skylight.*—A skylight having a slope in two directions. Fig. 21. When this type of skylight does not exceed 4 ft. width, from *a* to *b,* Fig. 21, the ends *a, b, c* are constructed of metal. If of greater width the ends may be constructed of material alike to that of the roof, after which the metal roof covering is applied. This type of skylight is occasionally provided with a *ridge*

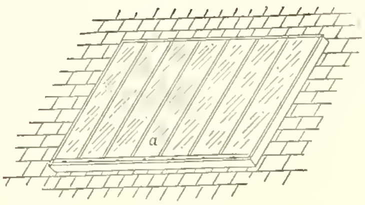


Fig. 18
Flat Skylight on Pitched Roof

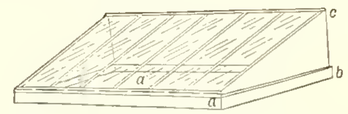


Fig. 19.—Flat Skylight with Pitch in Metal Frame, for Flat Roofs

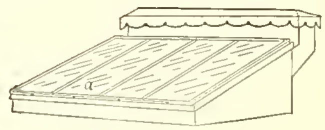


Fig. 20
Flat Skylight with Ventilator

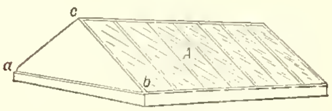


Fig. 21.—Double Pitch Skylight

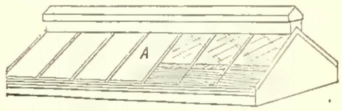


Fig. 22.—Double Pitch Skylight with Ridge Ventilator

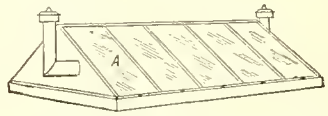


Fig. 23.—Double Pitch Skylight with Tubular Ventilator

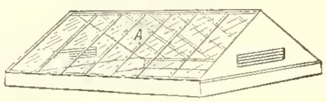


Fig. 24.—Double Pitch Skylight with Stationary or Movable Louvres

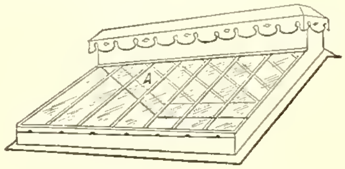


Fig. 25
Skylight over Ridge of Roof

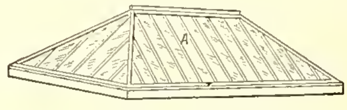


Fig. 26.—Plain Hipped Skylight

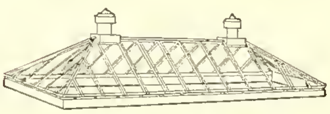


Fig. 27.—Hipped Skylight with Tubular Ventilators

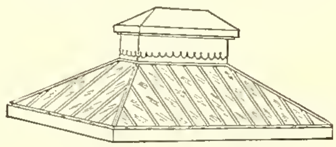


Fig. 28.—Hipped Skylight with Ridge Ventilator

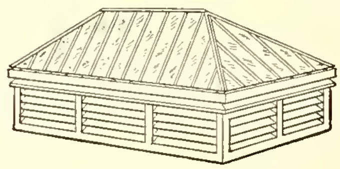


Fig. 29.—Movable or Stationary Louvres Under Skylight

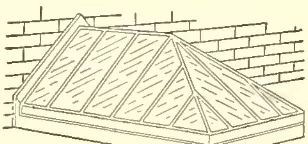


Fig. 30.—Semi-Hipped Skylight

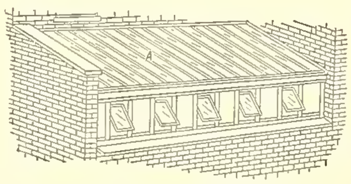


Fig. 31.—Movable Sashes under Extension Skylight

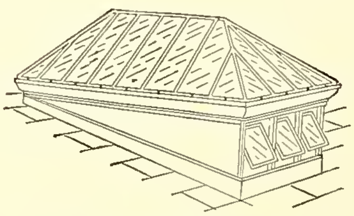


Fig. 32.—Movable Sashes under Hipped Skylight

ventilator, as shown in Fig. 22. Another method is to set in tubular ventilators at the ends, as in Fig. 23 or stationary or movable slats or louvres may be placed at each end, as in Fig. 24. The term "double pitch" is also applicable to skylights set over the ridge of a roof as indicated in Fig. 25. A "ridge bar" or "ridge ventilator" is frequently constructed thereon.

60. *Hipped Skylight.*—A type of skylight on which the four sides are sloped. Fig. 26 illustrates a "plain hipped skylight without a ventilator." This skylight is sometimes equipped with a "tubular ventilator" as shown in Fig. 27 or with a "ridge ventilator" as in Fig. 28.

61. *Louvres.*—Sloping slats set under skylights to shed rain water outwardly and provide ventilation. Fig. 29. Louvres are constructed to be stationary or movable. They are operated with *worm gearings* which are hereinafter referred to.

62. *Semi-Hipped Skylight.*—A type of skylight designed for junction at one of its ends to a wall. Fig. 30 shows a semi-hipped skylight set lengthwise.

63. *Movable* or *Operated Sash.*—A framework of glass placed under various types of skylight to provide for light and ventilation. The operation is by means of "worm gearings," and the use of a "pole hook" or an "endless chain." Fig. 31 shows the movable sashes used in connection with an extension skylight. Fig. 32 shows the sashes placed under one end of a hipped skylight over an attic roof.

64. *Extension Skylight.*—A term usually applied to a flat skylight placed at the rear of a building and forming an extension thereto. Fig. 31.

65. *Gearings.*—In skylight construction, mechanism employed to operate movable louvres and sashes.

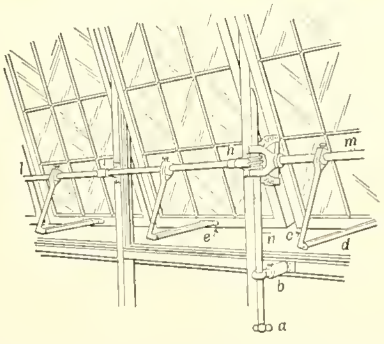


Fig. 33.—General View of Skylight Gearing

A general view of skylight gearings is shown in Fig. 33. The names of the various parts of such gearings are considered under their several designations.

66. *Lifting Power.*—In skylight gearing, a mechanical appliance utilized for raising a skylight. In Fig. 34 the pipe *a-b* is constructed to a required length to be reached with the *pole hook,* thus operating the handle *a* in Fig. 33.

67. *Pole Hook.*—In skylight gearing, an iron hook for mounting upon a wooden pole, used to turn skylight gearing or sashes. Fig. 35.

68. *Hand Wheel.*—In skylight gearing, a wheel for operating pipe connection to lifting power for operating skylight gearings. Fig. 36.

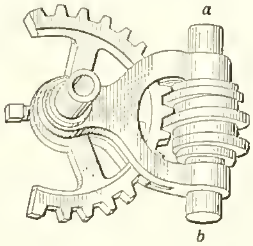


Fig. 34.—Lifting Power

Fig. 35 Pole Hook

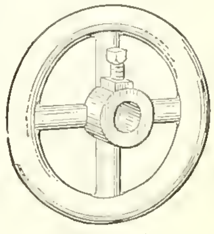


Fig. 36 Hand Wheel

69. *Extension.*—In skylight gearing, a device of adjustable length to accommodate the projection of a lower skylight curb. Seee Fig. 37 and Fig. 33 at *b.*

70. *Handle.*—In skylight gearing, a connection to pole hook for reaching and operating by hand a small number of sashes. See Fig. 38 and Fig. 33 at *a.*

71. *Arm.*—In skylight gearing, an accessory employed in conjunction with a *Strap* to assist in opening and closing sashes. See Fig. 39 and Fig. 33 at *c.*

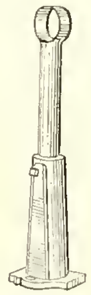


Fig. 37 The Extension

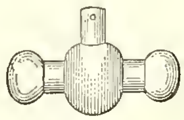


Fig. 38 The Handle

Fig. 40 The Hinge

Fig. 39.—The Arm

72. *Strap.*—In skylight gearing, a band iron skylight sash operating connection. This accessory is cut and adjusted to accord with the hight of sash. See *d* in Fig. 33.

73. *Hinge.*—In skylight gearing, a pivotal fitting bolted to the foot of metal sash for holding the strap. See Fig. 40 and *e* in Fig. 33.

74. *Bracket.*—In skylight gearing, a horizontal pipe support to which "lifting power" and "arms" are fastened. Two brackets are shown in position at *h* and *i* in Fig. 33.

75. *Collar.*—In skylight gearing, a flange attached to the ends of the horizontal gearing pipe to prevent its sliding. Collars are usually placed at each pipe end. See *l* and *m* in Fig. 33.

76. *Universal Joint.*—In skylight gearing, a hinge attachment for operating skylight "lifting

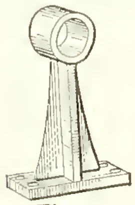


Fig. 41
The Bracket

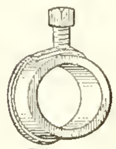


Fig. 42
The Collar

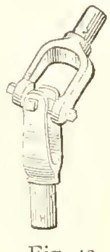


Fig. 43
Universal
Joint

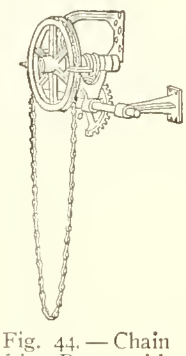


Fig. 44.—Chain
Lifting Power with
the Various Parts

power" in construction requiring non-vertical drop of the handle bar, as in passing beams or intervening members. Fig. 43.

77. *Chain Lifting Power.*—In skylight gearing, a chain-operated wheel gearing for controlling long lengths of movable louvres or sashes by the medium of "endless chain." Fig. 44.

Skylight Curbs and Bars

78. *Curb.*—The base or lower frame of a skylight, resting upon the roof frame. See A B C D in Fig. 45.

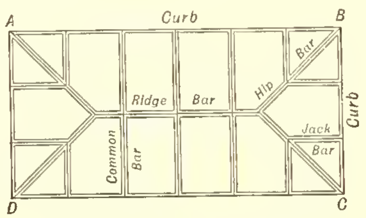


Fig. 45.—Plan of Hipped Skylight
with Names of Bars

79. *Ridge Bar.*—The framework at the ridge of a skylight. The ridge bar is incident to the construction of skylights having no ventilators at their ridge. Fig. 45.

80. *Hip Bar.*—The corner bar of a hipped skylight, set on an external or outside angle. Fig. 45.

81. *Valley Bar.*—The corner bar occurring in the corner of a pitched skylight on an internal or inside angle.

82. *Common Bar.*—Any skylight bar which runs from curb to ridge. See *a* in Figs. 18, 19, 20; or A in Figs. 21 to 31; also Fig. 45.

83. *Jack Bar.*—A term applied to the bar which makes an intersection with the hip bar, as in Fig. 45. Two variations of jack bar are referred to below.

84. *Common Jack Bar.*—A bar the half of which intersects a ridge bar (or a ventilator) as at *a* in Fig. 46 and the other half the hip bar at *b*.

85. *Center Jack Bar.*—A bar which intersects directly between the center of two intersecting hip bars, as indicated in Fig. 46.

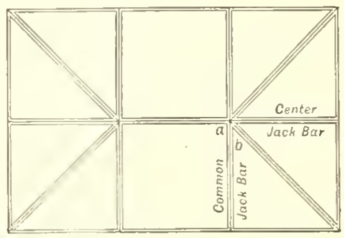


Fig. 46.—Plan of Hipped Skylight
with Names of Jack Bars

86. *Cap Flange.*—The lower part of a curb, covering the flashing around a roof curb. See A B in Fig. 47.

87. *Curb Rest.*—A section of a skylight curb resting upon a roof curb, as at B D, Fig. 47.

88. *Condensation Gutter.*—In a skylight curb, the part of the curb which receives condensation from skylight bars. See C D in Fig. 47.

89. *Rabbet.*—On a skylight curb, a curb section to receive skylight glass, sometimes designated "glass rest." See E F Fig. 47.

90. *Weep Holes.*—Small punched holes in skylight curb between each light of glass, as indicated in Fig. 47. They are also known as *condensation holes.*

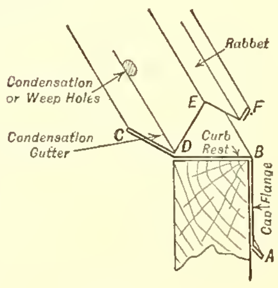


Fig. 47
The Parts of a Curb

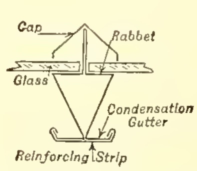


Fig. 48.—The Parts
of a Skylight Bar

91. *Condensation Gutter.*—In a skylight bar, the lower part of a bar formed to a gutter for receiving drippings (condensation) resulting from contact of warm air with the cold glass surface or for receiving rain leakage between the glass and metal bars. See Fig. 48.

92. *Rabbet.*—On a skylight bar, an intake in a bar for receiving skylight glass which latter is usually imbedded there in putty. Fig. 48.

93. *Re-enforcing Strip.*—A band for fastening together and re-enforcing the two walls of a skylight bar. Fig. 48.

94. *Cap.*—A finish between skylight glass and bar employed to conceal the unfinished edges of glass or of glass and putty. The caps are usually secured with copper wire or cleats. Fig. 48.

95. *Cleat.*—In skylight construction, a metal strip for securing *cap* to *bar.* Fig. 49. Cleats are usually made of 14. oz. sheet copper, soldered or riveted at intervals, to the skylight bars, as indicated.

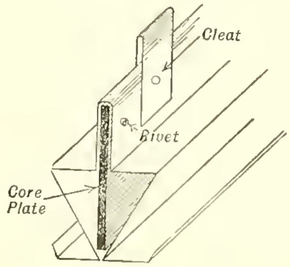


Fig. 49
Cleat and Core Plate

96. *Core Plate.*—A central re-enforcement of a skylight bar for imparting rigidity and resistance to wind pressure and to the weight of snow or frozen matter. Fig. 49. On large skylights of great span the construction is usually of angle iron, erected by the iron workers. Specifications usually stipulate size of core plate.

97. *Saw Tooth Skylight.*—A combination of flat skylight placed at an angle to the roof, forming a series of "teeth" as in a saw. Fig. 50.

98. *Theatre Stage Skylight.*—Types of skylight designed for amusement houses and auditoriums.

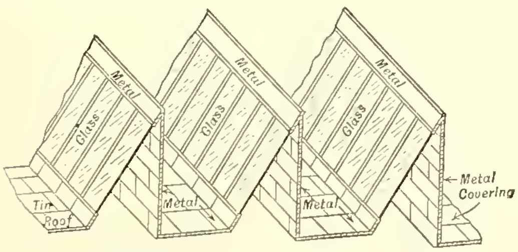


Fig. 50—Sectional View of Saw Tooth Skylight

Two types of the stage skylight are the *counter balanced sash,* having two sashes or skylights hinged to the outer edge of the curbing or frame, which latter, if properly constructed is of hip shape permitting the upper edges to come together when the sashes are closed and arranged in such manner that one side of the skylight is provided with an overhanging lip or batten to exclude snow, sleet or rain; and the *rolling type* consisting of two rolling skylights fitted with brass wheels which revolve on hard brass tracks and are held together by means of two cords secured with a fusible link, which melts at a low temperature, as on the occasion of a fire. Stage skylights thus made conform to the regulations of the National Board of Fire Underwriters.

99. *Fusible Link.*—A fusible metal connection in

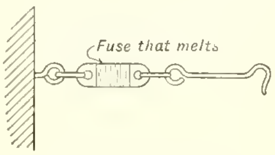


Fig. 50a
Fusible Link and Hook

a skylight support, intended to melt in case of fire. Fig. 50 a. The fusible link, disintegrating in the heat generated by fire releases the cords which hold the skylight when, by means of rolling or counter-balancing, the skylight is automatically opened and an outlet for smoke is provided.

100. *Puttyless Skylight.*—A skylight on which the glass parts are set directly upon the metal rab-

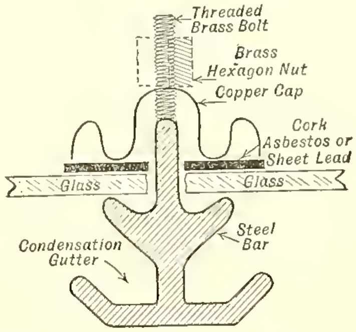


Fig. 51.—Puttyless Skylight Bar

bet of the metallic bar. In the construction of this skylight the necessary provision for arresting leakage is effected by condensation gutters set in the rabbet and below the bar. Fig. 51.

Roofing Terms

101. *Eave Gutter.*—A channel for drainage of a pitched roof, set at its lowest extremity. Fig. 52.

102. *Roof Gutter.*—A drainage channel set upon a roof above its eaves or outside the line of a wall. See *a b* in Fig. 53.

103. *Box Lined Gutter.*—A sheathed roof drain-

age channel, lined with metal. This gutter is usually sheathed to the required pitch by the carpenter, when it is lined by the roofer with tin, galvanized iron or sheet copper. Fig. 54.

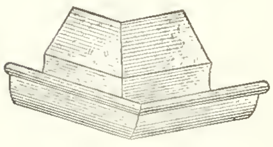


Fig. 52.—Eave Gutter

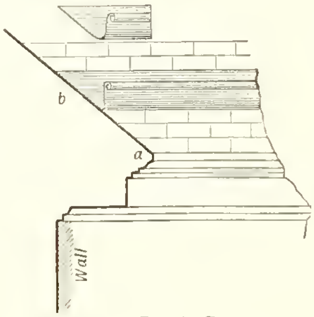


Fig. 53.—Roof Gutters

104. *Gutter Brace.*—A support for sustaining a gutter. The brace is fastened at one of its ends to the gutter and the other end is connected to the roof.

105. *Plain Leader or Conductor.* — A round, square or rectangular pipe connected to a roof gutter to conduct drainage to the building line.

106. *Corrugated Leader.*—A roof gutter drainage discharge pipe of corrugated sheet metal. This material is given preference as providing a leader

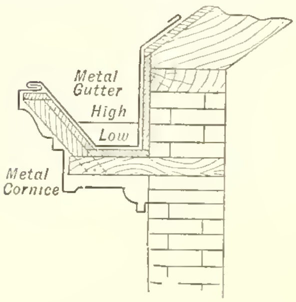


Fig. 54
Section of Box Lined Gutter

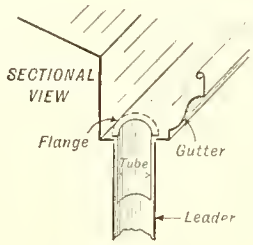


Fig. 54a
A Conductor Tube

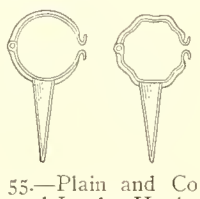


Fig. 55.—Plain and Corrugated Leader Hooks

that will expand when congested with ice in periods of low temperature, thus avoiding bursting of seams.

107. *Tube.*—A short pipe forming a connection between a gutter and a leader. The tube is of six inches approximate length and is soldered to the gutter. Fig. 54a.

108. *Conductor Hook.*—A metal fastener for attaching a leader or conductor to a wall. Two styles of conductor hook, the *plain* and the *hinged,* respectively, for the plain and the corrugated leader, are shown in Fig. 55.

109. *Ornamental Leader Fastener.*—An ornate metal clamp placed over the hooks. Several designs of O. L. Fastener are shown in Fig. 56. Such fasteners are soldered to the leaders.

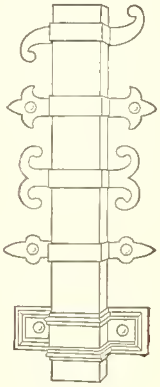


Fig. 56
Ornamental Leader Fasteners

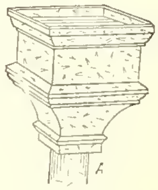


Fig. 57
Leader Head

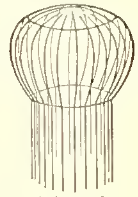


Fig. 58
Wire Strainer

110.—*Leader Head.*—A receiver of molded or of ornamental sheet metal construction for conveying roof drainage to leader pipe. Fig. 57. The connecting leader indicated at A continues to the grade line or sewer pipe.

111. *Strainer.*—A round or square shield of copper or galvanized iron wire, used to prevent clogging of tubes or leader openings. A wire

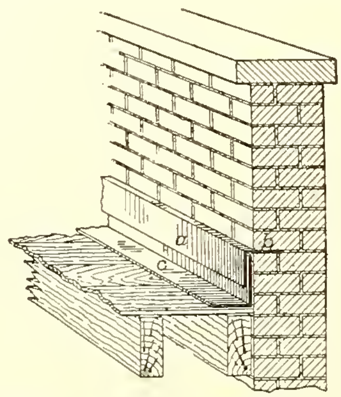


Fig. 59.—Base and Cap Flashing Against a Brick Wall

strainer for protecting round leader pipe is shown in Fig. 58. To accommodate the angle of tube passing through walls, a hinged strainer is frequently employed.

112. *Rain Water Cut-Off.*—A Y-shaped fitting formed by the junction of two elbows and equipped

with a central pivoted damper for the control and direction of drainage to cistern or to sewer.

113. *Expansion Joint.*—A movable junction in the elevated part of a gutter to provide for the expansion and contraction of the metal.

114. *Base Flashing.*—A lower metal strip making a watertight connection for roofs and walls, inserted under the cap flashing. See *c* in Fig. 59.

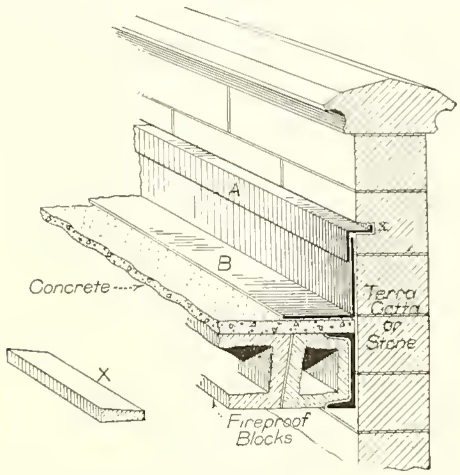


Fig. 60.—Flashing in Stone or Terra Cotta Reglet

115. *Cap Flashing.*—A metal strip which usually overlaps the base flashing. See *a b* Fig. 59. Cap flashing is usually built into the wall as the building construction progresses. An overlap from 3½ to 4 in. is customary.

116. *Reglet.*—A groove molded in terra cotta or cut in stone work to receive the cap flashing. X in Fig. 60 is the *reglet*, A the *cap flashing* and B the *base flashing*.

117. *Flat Seam Roofing.*—Roofing laid with flat locks, which first are cleated, locked, closed and soldered.

118. *Standing Seam Roofing.*—A roofing laid

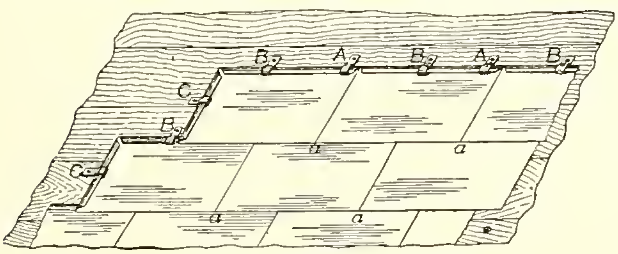


Fig. 61.—Cleats and Butts

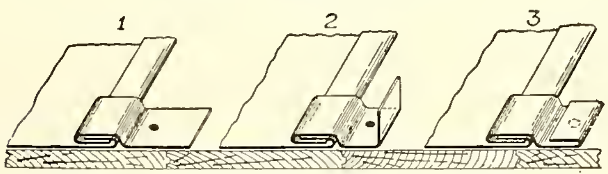


Fig. 62.—Three Operations in Securing Cleats

with seams extended vertically from the roof. Standing seams usually extend upward about one inch and are *cleated* and *double locked*. Unlike cross seams they are not soldered.

119. *Cleat.*—In flat seam roofing. A metal strip for fastening roofing sheets without driving nails through the sheets, thus allowing for expansion and contraction of the metal. A B and C in Fig. 61 show

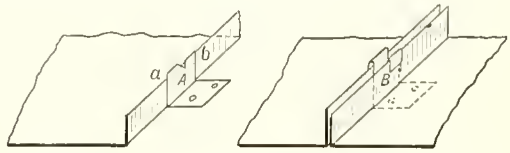


Fig. 63.—Cleat for Standing Seam Roofing

cleats in position on 10x14 in. sheets and 1, 2 and 3 in Fig. 62, shows the three operations of securing the cleat. *Cleats,* in standing seam roofing are shown in Fig. 63 where two views indicate the method of fastening; the laps *a* and *b* in A are used to lock over the standing edges shown in B.

120. *Butt.*—An intersection of short seams in metal roofing. See *a* in Fig. 61.

121. *Roof Flange.*—A plate or ring usually, of

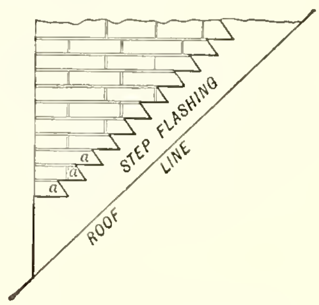


Fig. 64.—A Step Flashing

sheet lead or copper, to fit around a soil pipe, vent pipe, or stack passing through a roof.

122. *Step Flashing.*—A watertight metal protection to a wall, run along a steep incline. Fig. 64. The metal is stepped as indicated at *aa*.

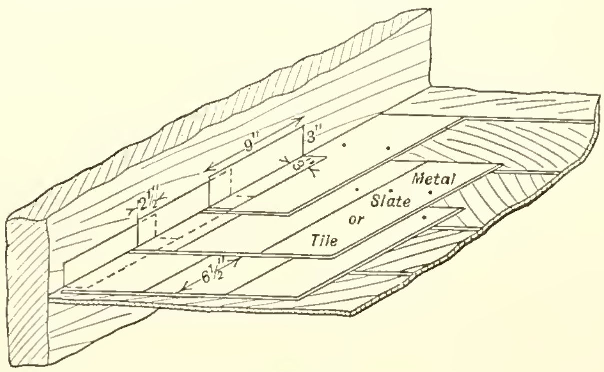


Fig. 65.—Shingle Flashings

123. *Shingle Flashing.*—A watertight protection for steep roofs, adjoining parapet walls or chimneys. Fig. 65. This flashing is usually cut to 2½ in. excess of length over that to which the tile or slate is laid to the weather and the step flashing overlaps.

124. *Deck Roof.*—An upper roof level surmounting the slope of a mansard roof. Fig. 66.

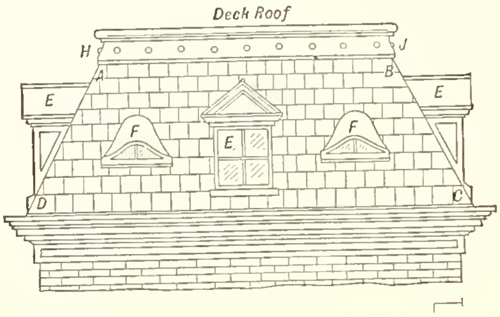


Fig. 66.—Deck and Mansard Roofs, Dormers, Eyebrows and Deck Molding

125. *Mansard Roof.*—A roof having two slopes on all sides; or an inclined roof capped with a deck, as in Fig. 66 at A B C D.

126. *Deck Molding.*—A molded finish or cornice placed above a mansard roof or around a deck roof at its edge. See Fig. 66 at H J.

127. *Dormer Window.*—A vertical window set in a sloping roof, as a mansard or pitched roof. See Fig. 66 at E E E.

128. *Eyebrow Dormer Window.*—A small window having a curved upper outline, set on a mansard or pitched roof. See Fig. 66 at F F.

129. *Saddle in Roofing.*—A metal lined incline usually placed behind chimneys to shed the water to either side and prevent forming of snow pockets. Fig. 67.

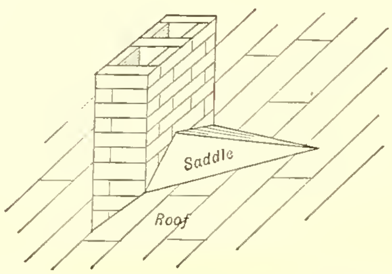


Fig. 67.—Saddle Behind Chimney on Pitch Roof

130. *Cant Strip.*—A metal lined incline placed behind roof bulkheads to shed water to leader outlets. Fig. 68. Referring to the engraving, the cant prevents water from settling at O. Cants at A and B shed the water to outlet.

131. *Bulkhead in Roofing.*—A superstructure built on a roof, to cover stairs, elevators, ventilation pipes, etc.

132. *Shingled Roof.*—In metallic and tiled roofing, a term customarily applied to roofs covered with either metal shingles or tile.

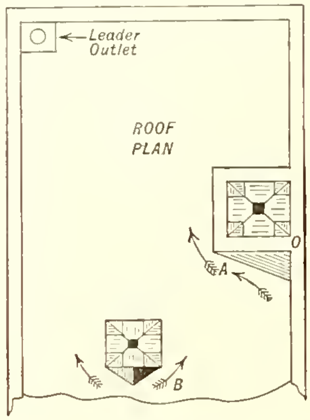


Fig. 68.—Cant Strips on Flat Roof

133. *Hip Tile.*—A tile designed for placing along the hips of a roof.

134. *Ridge Tile.*—A tile designed for covering the ridge of a roof.

Corrugated Metal Roofing and Siding

135. *Corrugated Iron Roofing.*—Corrugated metal sheets for roof covering. This material is fastened to wood purlins by means of galvanized iron nails or is fastened to angle iron purlins by means of band iron clips which are riveted to the metal roofing and bent around the purlins.

136. *Corrugated Iron Siding.*—Corrugated metal sheets for protecting the sides of buildings. This material is fastened to the vertical sides of structures in the manner referred to in connection with corrugated iron roofing.

137. *End Wall Flashing.*—A metal watertight protection applied to roofs which butt against walls at the top. Fig. 69. The vertical flashing A joins the wall and the corrugated flange B overlaps the corrugated sheets.

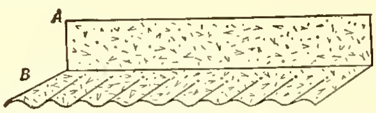


Fig. 69.—Corrugated End Wall Flashing

138. *Side Wall Flashing.*—A corrugated metal watertight protection applied to pitched roofs intersecting walls at the side. Fig. 70.

139. *Corrugated Ridge Roll.*—A coping of corrugated metal set at the top or ridge of roof. Fig. 71.

140. *Curb Flashing.* — The metal protection around a skylight or curb projecting above the roof line.

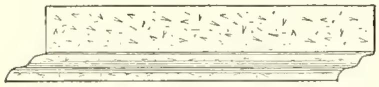


Fig. 70.—Corrugated Side Wall Flashing


Fig. 71.—Corrugated Ridge Roll

141. *Snow Guard.*—A device to prevent the sliding of snow from pitched roofs. Snow guards are made in the form of small hooks of copper wire to be slated in with the courses of slate or shingle roofing. Others are constructed of upright steel or copper standards which are placed about 6 feet apart and have adjustments for receiving two or three lines of iron pipe forming rails which serve as guards, thus confining the sliding snow within the roof's eaves. Fig. 72.

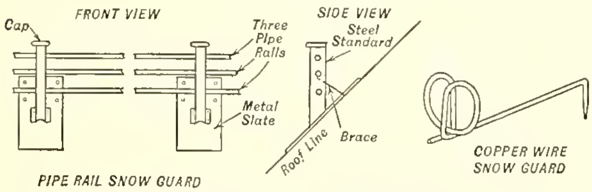


Fig. 72.—Snow Guards of Copper Wire and Guard Rails

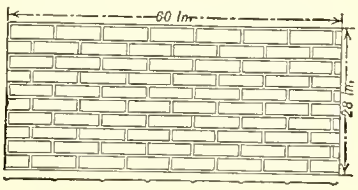


Fig. 73.—Brick Siding

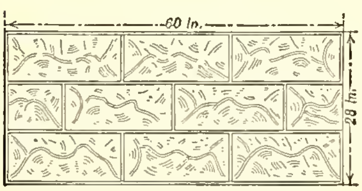


Fig. 74.—Rock Face Siding

142. *Brick Siding.*—A metal covering for vertical walls, stamped in imitation of brick work. Fig. 73.

143. *Rock Face Siding.*—A metal side wall covering stamped in imitation of stonework. Fig. 74.

144. *Weather Board Siding.* A metal side wall covering stamped to imitate wooden weather boards. Fig. 75.

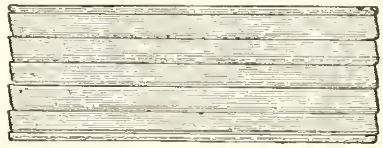


Fig. 75.—Weatherboard Siding

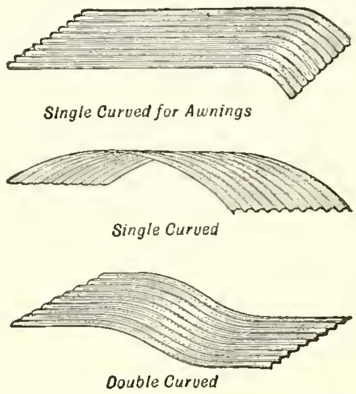


Fig. 76
Curved Corrugated Roofing

145. *Curved Corrugated Roofing.*—A metal roofing stamped in curved formations to meet requirements of profile. Fig. 76.

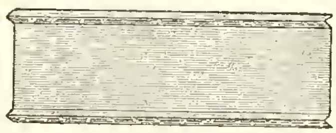


Fig. 77.—V Crimped Roofing

146. *V-Crimped Roofing.*—Stamped metal sheets of V shape. Fig. 77. These sheets reach 10 feet length and have as many as four V grooves to the sheet.

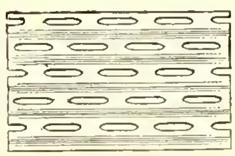


Fig. 78.—Metal Lath

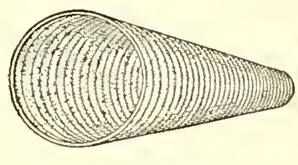


Fig. 79
Corrugated Culvert

147. *Metal Lath.*—Stamped metal sheets for supporting plastering, in place of wood laths. Fig. 78.

148. *Corrugated Culvert.*—A corrugated iron waterway or drain. Fig. 79.

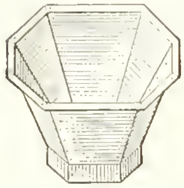


Fig. 80.—Concrete Mold of Octagonal Column Cap

149. *Concrete Mold.*—A metal form for receiving poured concrete in the construction of columns, walls, etc. The molds are most frequently assembled from number 10 gauge steel. Fig. 80 shows a mold for forming a concrete octagonal column cap.

Doors, Window Frames and Sashes

150. *Tin Clad Fire Doors and Shutters.*—Fireproof doors and shutters of wooden cores covered with tin sheets. For the purpose 14x20 in. tin is used, locked as shown in Fig. 81 at A and B.

151. *Hollow Metal Fire Doors.*—Hollow fireproof doors provided with insulated stiles and rails. The construction is of at least 1¾ in. thickness with insulated panels of 1 in. thickness and upward.

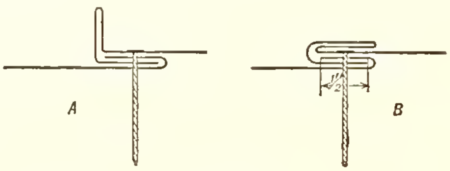


Fig. 81
Locks Used in Covering Fire Doors

152. *Hollow Metallic Windows.*—Windows having fireproof exteriors of sheet metal. There are several types, namely: *Sliding, Pivoted, Casement, Top Hinged, Stationary, and Tilting.*

153. *Sliding Window.*—A window having two sashes usually designed to slide upward and downward. The motion of these sashes may be independent and subject to control by weights, in which case the window is designated as *double hung* or the two sashes may counter balance, in which case the window is known as *counterbalanced.*

154. *Pivoted Window.*—A window having one or more of its sashes mounted on pivots, permitting each movable sash to turn upon an axis.

155. *Casement Window.*—A window having its sashes attached to the frame by means of hinges at the vertical side and operated in the manner of a door.

156. *Top Hinged Window.*—A window whose sash is attached to the frame by means of hinges at the upper horizontal part.

157. *Stationary Window.*—A window whose sash has a permanent position.

158. *Tilting Window.*—A window whose sashes are attached to the frame as well as together, so as to permit an inclined or tilted position.

159. *Twin Window.*—A window whose sashes are mounted alongside in contrast to the more common vertical construction. Fig. 82.

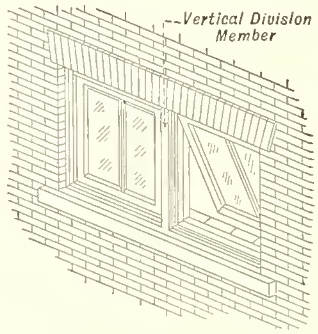


Fig. 82—Twin Hinged Windows

160. *Combination Window.*—A window which combines the features of construction of a number of types. Thus one having a pivoted upper sash and a stationary lower sash, is called a *pivoted upper, fixed lower sash window.* One having two sashes, both of which are pivoted, is called a *double pivoted window.* One having a single pivoted sash, is called a *single pivoted window,* and one having a top hinged upper sash and double hung lower sash is usually designated a *double hung window with top hinged transom.*

161. *Rabbeted Frames.*—Frames formed with offsets or shoulders to receive masonry, in connection with hollow metallic window construction.

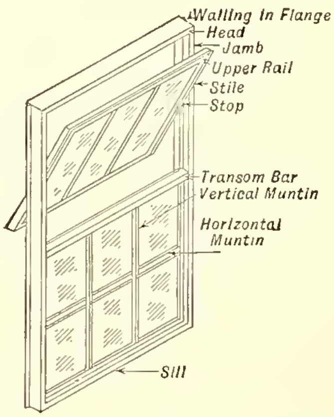


Fig. 83—Pivoted Window Before Installation

Frames not provided with rabbets are usually formed with metal wings *or flanges.*

162. *Walling-in Flanges.*—Flanges designed to be built into the masonry. Fig. 83.

Note:—The frames of all windows having a single sash and the frames of sliding sash windows having two sashes are composed of two horizontal members called the *head* and *sill* and two vertical members called the *jambs,* all as shown in Fig. 83.

163. *Head.*—The top part of a window frame. The lower surface of the head is the *soffit* and the upper surface of the top, the *member.*

164. *Sill.*—The horizontal piece forming the under part of a window frame. The uppermost part of the frame is the *tread* and the lowest the *base.*

165. *Jamb.*—The vertical side of a window. Hence the part which is in contact with the masonry is the back of the jamb and the part in contact with the sash, the front of the jamb. Projections on the front of the jambs, designed to confine the movement of a movable sash, are called *stops.* Fig. 83. Sliding sash windows are frequently equipped with stops which may be separated from the jamb and these separable parts are customarily referred to as *sash guide strips,* while a common designation of the strip dividing the two sashes is *sash parting bead.*

The frame of a pivoted window having two sashes is composed of the same members as that of a sliding sash window. An additional horizontal member is the *transom bar.* Fig. 83.

The frame of a *twin window* is composed of a head, sill, two jambs and a *vertical division member* which separate the sashes. Fig. 83.

166. *Sash.*—The framing in which the pieces of glass of a window are set. In case the sash is designed to be permanently attached to the frame it is called a fixed or *stationary sash.* If the construction is such that its position is changeable, it is called a *movable sash.* Each sash is composed of horizontal and vertical members. The horizontal members at the top and bottom of the sash are called the *rails.* Fig. 83. The rails of sliding sash windows which join at the center of the window when the sashes are closed, are the *meeting rails.* The vertical members at the sides of the sash are the *stiles.* In casement windows the stiles to which the hinges are attached are called *hinge stiles* and the stiles to which the locking mechanism is connected are *lock stiles.* When casement windows are made in two parts which meet at the center, the stiles coming into contact are the *meeting stiles.* The intermediate members separating the glass panes are the *muntins.* Fig. 83. If a muntin be installed in a vertical position, it becomes a *vertical* muntin and correspondingly if in a horizontal position, a *horizontal muntin.* Muntins which are so designed that a part may be removed for purposes of glazing are *separable type muntins,* and such as are not constructed on this principle are designated *non-separable type muntins.* In the practice of the architect the term "muntin" is employed to designate vertical sash members which separate the lights, while the horizontal members are referred to as "bars." However, metal window manufacture in conjunction with trade parlance has given to these members the terms vertical and horizontal muntins, as recognized and set forth herein.

Alphabetical List of Terms

PART II

PRINCIPLES OF PROJECTION IN ARCHITECTURAL DRAWING

THE first practical work on the drawing board which demands attention is that of the mechanical representation of objects upon paper, and commonly designated as *mechanical drawing*. The methods and principles employed in these operations are essentially the same for all classes of constructive work, whether the subjects treated be machinery or buildings of whatever material, as stone, wood or sheet metal, or of any part of a subject necessary to be represented. Involving as it does the principles of abstract geometry, the science which treats of this class of representation is properly termed *descriptive geometry*.

Descriptive Geometry, therefore, as a science treats of the exact representation of forms upon planes, the planes employed being represented by the surface of the paper spread upon the drawing board; and the method by which the representations are accomplished is termed *orthographic* or right line of *projection*. To assist in gaining a correct idea of the theory of representation, we may pause to note, first, that objects become visible through the action of light which moves in straight lines, called rays, from the object toward the eye. In the natural operations of vision, the rays proceed in straight lines from all parts of an object viewed, toward the eye, from which it will be seen that they must converge. If now a plane (represented, for instance, by a plate of glass) be interposed between the object and the eye, the point of intersection with the plane of a ray from any point of the object would properly be termed the projection of that point and the ray itself would be termed the line of projection or the projector. In like manner the projections of all the points in the outline of the object, if they be marked upon the glass, which may be termed the plane of projection, would constitute an outline of the object upon that plane.

It will be seen farther that since the rays or projections converge toward the eye, the resulting outline upon the glass plate will be larger or smaller according as the intervening plate is farther from or nearer to the eye, the point of convergence. Following this course of reasoning still farther, the greater the distance between the object and the eye, the more nearly parallel will the rays become, hence if the object be placed at as great a distance from the eye as possible and the plane of projection be placed as close to the object as possible, the resulting image, or projection of the object upon the plane, will be very little smaller than the object.

In the operations of descriptive geometry the visual rays or projections are considered as being exactly parallel, with the result that the projection of any object upon a plane thus becomes the full size of the object and constitutes a view of the same upon which accurate measurements may be taken.

We have spoken of a plane (Def. 19, volume one) as having two dimensions and of solids (polyhedrons Def. 69, volume one) as having three dimensions; the projection of a solid upon a plane, therefore, is a view of the same in which two of its dimensions only can be shown. Thus if the plane is supposed to have been placed in a vertical position in front of any subject the resulting projection may show the hight and the length of the subject, and may thus be termed a front view. If, now, another projection of the subject be made upon a plane placed at right angles to the first, as, for instance, in a horizontal position, either above or below it, the rays or projections being carried vertically to intersect the plane, the resulting view, termed a plan or top view, will show the length and the width. Thus two projections of any subject made upon planes at right angles to each other are sufficient to give its three, that is, all of its dimensions, and the relative position of every part of it will be shown. While this is true, yet in modern methods of mechanical drawing, a representation of the subject upon a third plane placed at right angles to the other two is considered advantageous and desirable, if not always necessary.

The idea of three planes placed at right angles to each other can most easily be grasped by standing a book or the covers of a portfolio upon any horizontal surface, as the top of a table, in such a position that its back shall be vertical. If now the covers be opened until they are at right angles to each other, it will be seen that both are also at right angles to the table top because they are in a vertical position. Thus the three planes represented by the two covers of the book and the top of the table are all at right angles to each other.

A projection made upon another vertical plane placed at right angles to the first mentioned, say parallel to a side or end of the subject, would thus show the hight and the width, and altogether, in the three views, each dimension would be given twice. Thus the *hight* would be shown on the front and the side views, the *length* would be shown on the front and the top views, while the width would be shown on the side and the top views. The methods of projection can of course be extended to the construction of any number of views, as for instance, a view of both sides or ends and the back of the subject, or to a view projected obliquely at any desired angle, as when the subject contains an oblique surface which it is desirable to show in detail, by placing the plane of projection at the desired angle.

The general idea carried out in the operations of orthographic projections can best be fixed in the mind by reference to Fig. 84, in which the subject to be represented is, in imagination, placed within a rectangular prism or box having glass sides which represent the planes of the several views. The rays or projectors are partially shown by dotted lines carried from the principal points of the subject to intersect the planes of projection at right angles. In the illustration, projections may be supposed to have been made upon the front, both sides and the top of the box, although those upon the top and the left or farther side have been omitted to avoid confusion of lines. When these have been completed, we may suppose the planes of the two sides and the top to be hinged to the plane of the front along the dihedral angles A B, C D and A D, and that the three planes mentioned are swung into one plane. All this having been done the several views would then appear as shown in Fig. 85, the lower part of which represents a plan of the glass box. The quarter circles, E E^1 and F F^1, show the movement of the side planes.

In mechanical drawing, any view is termed a "projection," the term being qualified when necessary by the position of the plane upon which the projection is made, as a "vertical" or a "horizontal projection." Projections made upon vertical planes are termed *elevations*, and projections made upon a horizontal plane are termed *plans*.

It sometimes becomes necessary to show upon a drawing that which could only be seen if the subject were cut by a plane passed through it in any desired position or direction. Such a view is termed a *section* and may be "longitudinal" if made by a vertical plane passed through the long way, or "transverse" if made upon a vertical plane passing through it the shorter way. In the case of buildings or machinery a plan is often a section on a horizontal plane passed through the subject some distance above its base.

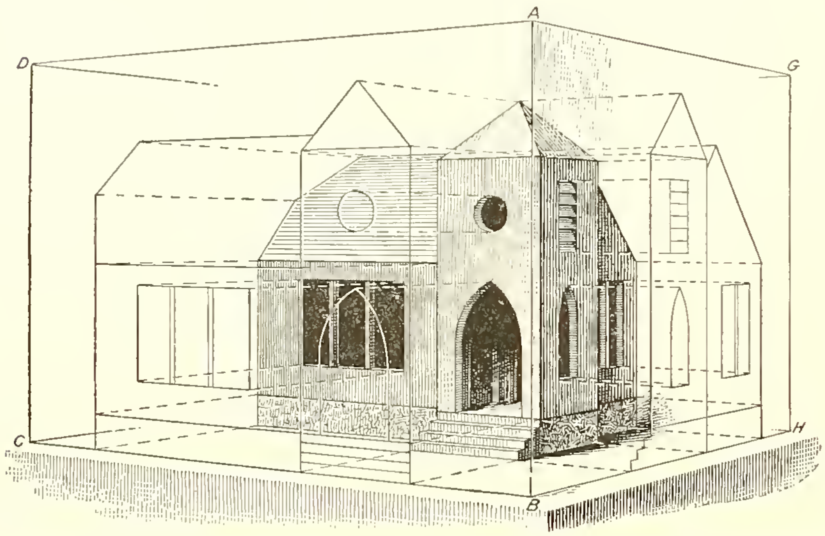


Fig. 84.—Theory of Orthographic Projection Illustrated by the Use of a Plane for Each Side of the Subject

The purpose of the idea illustrated and explained in Figs. 84 and 85 is to fix in mind the nature and relation which the several views that can be made of any given subject bear to each other, from which it appears that the elevation of the right end or side of an object appears at the right of the front elevation, while that of the left end appears at the left of the front and the top view, above. This seems to be the most logical system, inasmuch as, if the paper upon which the several views have been projected be folded along lines corresponding to A B and D C of Fig. 85 and then stood up on a level surface, in a manner to correspond with the sides of the glass box shown in Fig. 84, one in passing around the folded paper would thus see the several views of the subject in the same order or succession that

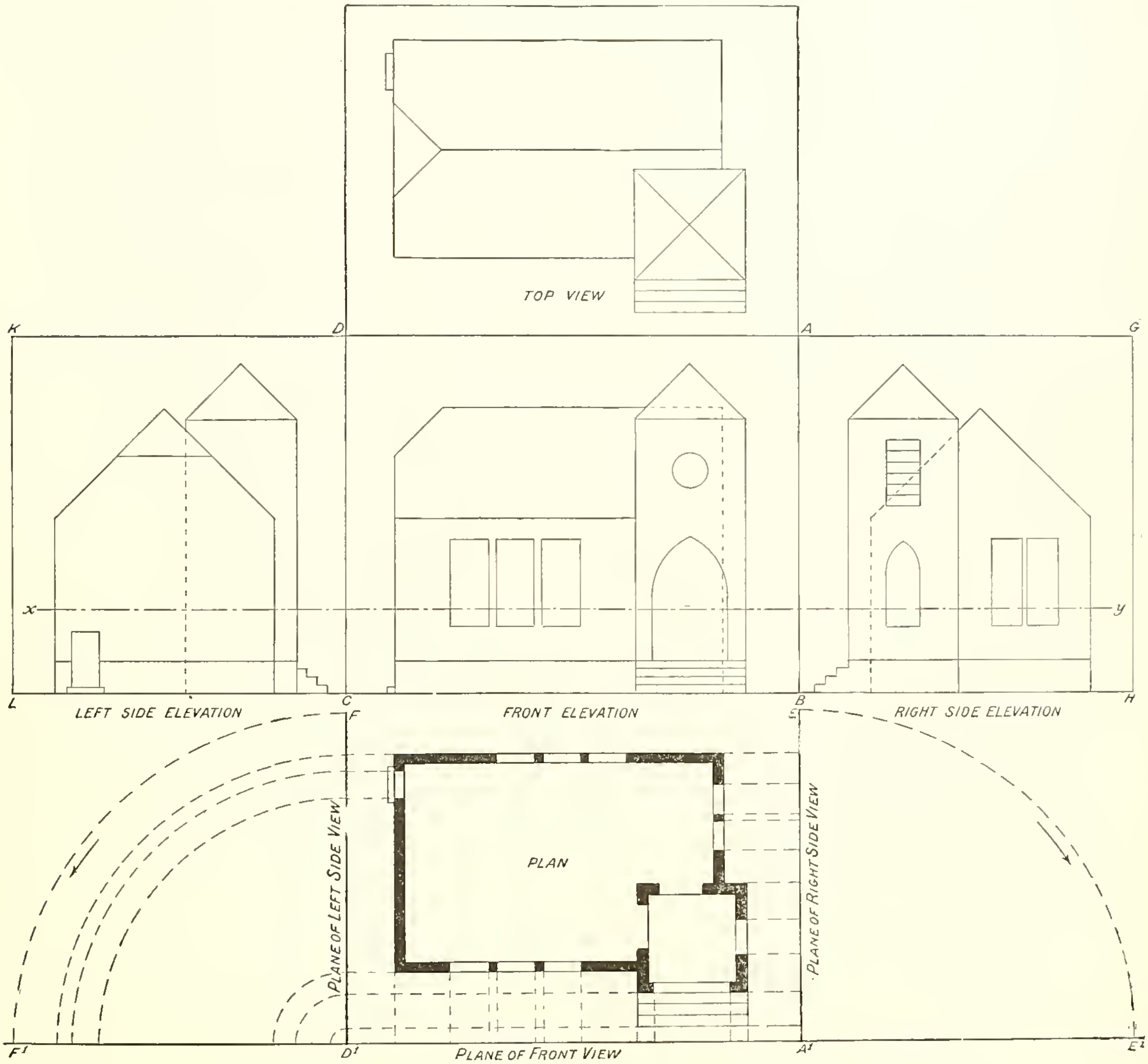


Fig. 85.—Planes of the Several Views Brought into One Plane

he would in passing around the subject itself. This system is now generally recognized in this country, and is so obvious in character that it should be accepted without question, and yet there are other methods based upon a different supposition with regard to the positions of the planes of projection by which the view of the right end appears at the left, and that of the left at the right of the main elevation.

It must be admitted that, in the varied operations of pattern drafting, it is not always convenient to strictly follow out this system, since for the purposes of convenience and efficiency it is often necessary to place the views otherwise, but a clear idea of these relations will be of great assistance to the pattern draftsman in obtaining many of the oblique views required in the course of some work.

It is especially desirable that the hinging of the planes along their lines of intersection just described be understood, as by this means a view upon any oblique plane is brought into the plane of the general view. This idea or method applies particularly in case of the intersection of pipes at various angles where a right section, or, in other words, a profile, of an oblique branch is necessarily upon an oblique plane, which, for use, must be brought into the plane of the view in proper relationship to the elevation.

The one great elementary idea of descriptive geometry is that of determining the position of a point in space by the measurement of its perpendicular distances from three planes all at right angles to each other, all as explained above. Put into the form of a practical problem, this principle may be stated as follows: Given the position of a point in one view, required to find its position in the other two views. The position, for instance, of one point in a desired section or view having been thus determined, the remainder of the required points follow in logical order.

Having, we hope, conveyed a clear idea of the character and relationship of the several views to each other and of the general theory of projection, we shall take up the work on the drawing board.

In the operations of mechanical drawing, it is of course understood that the several views of any subject are made before the subject is built, and therefore operations analogous to those illustrated in Fig. 84 are impossible, but since all of the views are to be constructed in one plane, as shown in Fig. 85, projections can be made from one view to another as the various points of the subject are located. Thus one view plays the part of a model, as it were, to all the other views. Especially is this true of the plan which is so drawn or placed upon the drawing board that its front or that side of which the principal elevation is desired is turned toward the draftsman, that is, toward the bottom of the board, as shown in Fig. 85. In proceeding with the work, then, projections are made from the front side of the plan to the elevation, that is, vertical lines are erected from all the angles in the outline of the plan, upon which the hights of parts represented by each are set up from a base line, called the ground line, as C B. This line is continued to the right and left to form the ground line of the other elevations, as shown by B H and C L.

In making projections from the plan to the side views one of two courses may be taken. In one case the plan must be turned one quarter around, so as to bring the side or end of which the elevation is desired toward the bottom of the board, as in the case of the front elevation, when the lines can be erected as before. In the other case, projectors can be carried to the right and left to cut the lines A^1 E and D^1 F, which represent respectively the planes of the right and the left side elevations, as shown. The points so obtained can then be swung around the points A^1 and D^1 as centers, to cut the horizontal lines A^1 E^1 and D^1 F^1, as shown at the left only, whence projections can then be made up into the side elevations.

The swinging around of the points described accomplishes upon the board just what has been done in theory by the hinging of the side planes upon the front, as described in connection with Fig. 84. This feature is fully shown in Fig. 85, only at the left of the plan, the projections from F^1 D^1 to the left side elevation having been omitted from the drawing, but the application of a T square or other straight edge will show the correspondence between the lines of the elevation and the points on F^1 D^1. In regard to the hights and all other matters of detail necessary to complete the elevation, these must be made to conform to the requirements of the case, or specifications, for the construction of elevations is usually a matter of design or conformity to requirements rather than merely making a drawing of something which already exists.

In mechanical drawing the students should note that several kinds of lines are used for different purposes.

The *outlines* of the subject represented should be a strong firm line, but not too heavy.

Lines representing parts which are *invisible*, but which it is necessary to show, should be dotted, as the outline at the left of the tower in the left side elevation, or that of the walls which are beyond the tower in the front and right side elevations, Fig. 85.

Projectors, when it is necessary to show them, should be represented by a series of short dashes, as in the plan of the same engraving.

Center lines are usually shown by a line consisting of a dash and two dots, although sometimes by a dash and one dot. So far as the pattern draftsman is concerned, either will do, but in drawings of machinery the latter is used to show the motion

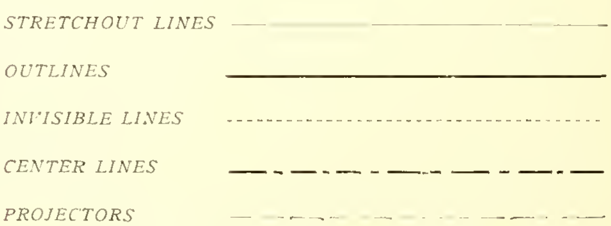


Fig. 86.—Lines Used in Mechanical Drawing

or travel of a moving point, or the line upon which a section is taken, as the line x y in Fig. 85.

Stretchout lines, as well as *measuring lines*, are shown by a very fine continuous line, but not as heavy as those used for outlines.

Dimension lines are made the same as projectors, but have an arrow head at the ends to indicate the points between which the dimensions are taken. Fig. 86 shows how these lines should be drawn.

In the application of the principles of projection to the representation of geometrical forms, some general statements kept in mind will be of value, viz.:

The end view of a line is a point. A point, therefore, in one view may be the projection of a line in another view in which many points of importance are located.

The edge or side view of a plane is a line. Of two planes at right angles to each other, one may appear as a line while the other appears in full in the form of a plane figure.

A plane figure may be an elevation of a solid.

The principles which have been explained will now be put into practical use in the representation of some simple and familiar object. For this pur-

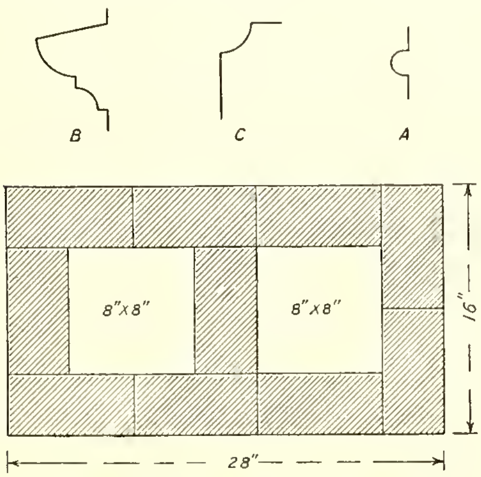


Fig. 87.—Plans and Profiles to be Used in Fig. 88

pose a chimney top provides an excellent subject. The first thing to know evidently is the breadth and thickness of the chimney. Knowing the dimensions of a brick to be 8 $\times$ 4 $\times$ 2 inches, let us suppose it to be 28 $\times$ 16 inches. The plan will therefore work out as shown in Fig. 87. Having placed the plan thus drawn near the bottom of the paper as in Fig. 88, we first erect perpendiculars from all its angles indefinitely as a beginning of the elevation, as shown, drawing the lines at first lightly until it shall be determined just how much of them shall remain upon the paper. The next thing to be determined is the profiles of moldings to be used. These may be assumed to be those shown at A, B and C in Fig. 87, using that at A as a foot or neck mold, that at B as a cornice, and perhaps chamfering off the upper corner to form a finish, using a plain bevel or a small cove, as shown at C. Proceed therefore to place these in position at one side of the elevation, as shown at A and B of Fig. 88, when lines from their several angles or outer limits may be carried lightly across the elevation as shown, repeating the profiles (in a reversed position, of course) at the opposite side as shown by A^1 and B^1.

Suppose now, that it should be decided to introduce a gable in the cornice mold on the two wider sides of the chimney, leaving the narrow or short sides plain. First find the center line of the elevation by bisecting any one of the horizontal lines as at *e*, and through it drawing the vertical line *a b*. Allowing 18 inches as a suitable width for the gable set off 9 inches each way from *e* on the top line of the molding locating the points *c* and *d*, from which points draw lines at an angle of 45°, meeting upon the center line at *b*. Now, upon lines drawn at right angles across *c b* and *b d* at any convenient position, as at *x* and *y*, set off the several spaces in the width of the molding equal to the corresponding spaces on the line *m n*, as indicated by the small figures. Through these draw lines parallel to *c b* and *b d*, meeting in the center on the line *a b*, and draw the miter lines through the intersection at the bottom as shown by *c g* and *d h*. The whole design may now be completed by the addition of the small cove above referred to, just above the top point of the gable, as shown by profile C at the sides, the quarter circle being drawn from *i* as center. This completes the front elevation.

The plan may now be completed by projections carried from the elevation back to the plan, as shown, drawing first those from the several angles in the profiles at B and B^1, which will give the plan of that part of the molding which crosses the ends of the plan. Since the moldings are supposed to go entirely around the chimney, they must of course miter at the corners. We may therefore draw the miter lines from each corner of the plan by means of the 45° triangle and take the lines which represent the molding across the front and back of the chimney from the intersections of the lines first drawn, with the miter lines.

One other point demands careful attention. The roof on top of the profile B has been drawn slanting, as shown by *m p*, not as a matter of design, but as a wash, that is, to shed the water. As there is obviously no need of this on that part of the molding which forms the gable, one slant being enough, a peculiar shaped valley will thus be formed from *q* to *c*. This is shown on the plan by carrying projectors down from these points, remembering that point *q* is on the wall line while point *c* is at the nose of the mold, thus producing the oblique line c^1 q^1 there shown, which is the miter

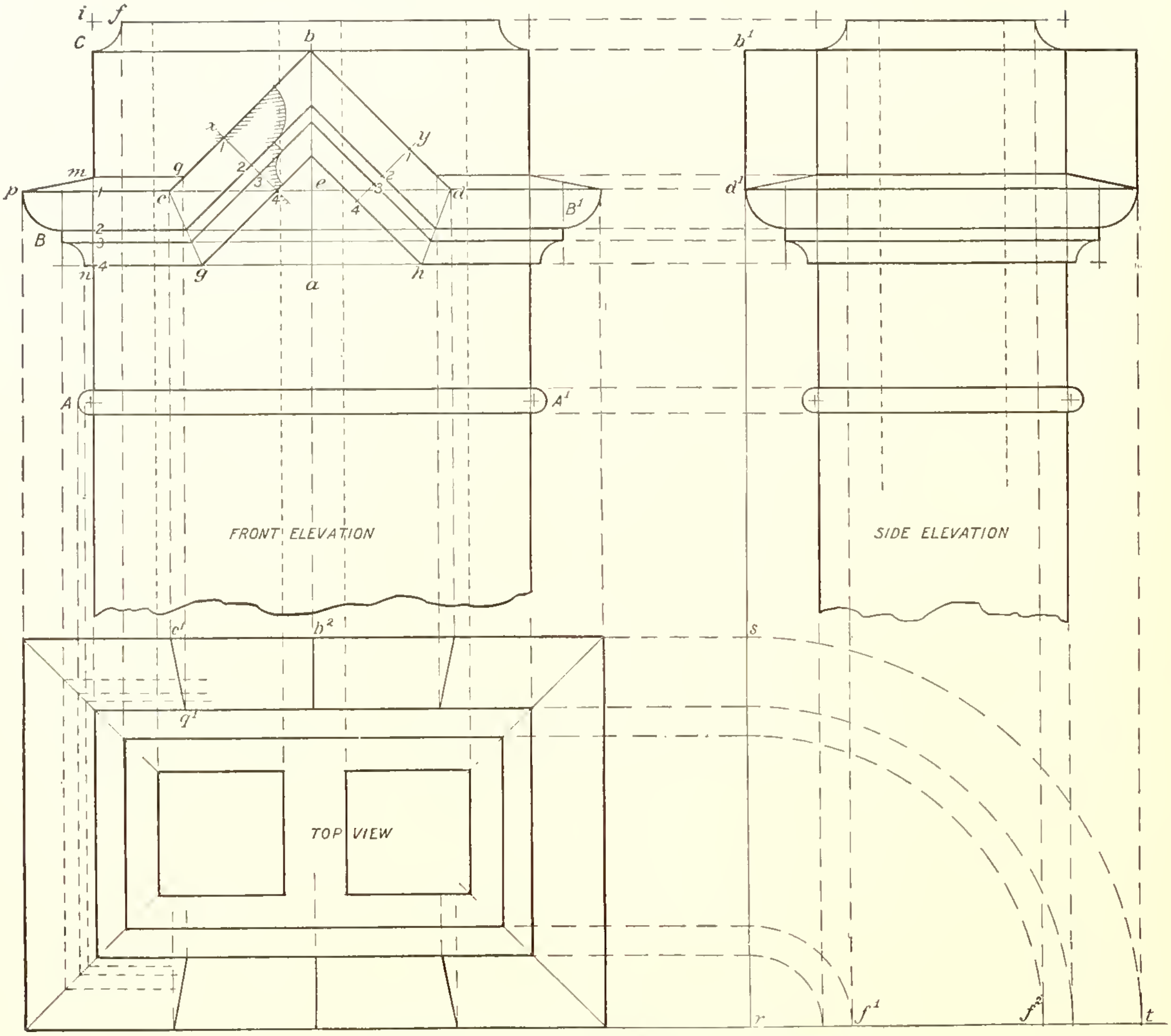


Fig. 88.—Practical Work in Mechanical Drawing

or joint between the two slanting surfaces, while the ridge *b* is shown in the plan by a right line, at b^2.

In constructing a side elevation, lines may be carried from the several points of the plan to any convenient vertical line as *r s*, as shown at the right, whence they may be carried through a quarter circle to the horizontal line *r t*. Projectors from the several points on *r t* are carried up into the side elevation to be crossed by projectors from the front elevation, all as clearly shown, thus locating all the required points. Note that the line b^1 d^1 is the projection of the oblique line *b d*, the space between it and the body of the chimney showing the roof of the gable.

These may be followed by a projector drawn from *f* to meet those brought up from the corresponding points f^1 and f^2 of the plan, as shown in the elevation. The showing of this member upon the plan will make it a top view, which being the case will render the small members in the lower part of profile B invisible, as well as the smaller mold at A. The lines which represent these members will therefore be drawn as invisible lines according to Fig. 86, as shown.

After all views in Fig. 88 have been completed, all lines called for by the elevation may be strengthened by using a somewhat softer pencil, as shown by the darker lines in the drawing and the remaining lines erased, as those shown between *c d* and *g h*, those drawn across the mold, as at *m n* and at similar places, and any others which in the preliminary work have been drawn farther than were required. To make the drawing really complete, invisible (dotted) lines should be projected up through the elevations from the angles of the flues in plan as shown.

An inspection of the drawing will now show that each and every point in any view is represented by a corresponding point in each of the other views, a matter which it is essential that the pupil should well understand since these operations are continually required in subsequent work.

In this figure the planes of the several views, though not indicated in the drawings, as in Fig. 85, are hinged upon the line of their intersection; thus the front and the side elevations are projections upon vertical planes which intersect upon a line, necessarily vertical, somewhere in front of and between the two views as indicated by the point *r* in the plan in Fig. 88, and the drawing of the quarter circles from the line *r s* to *r t* signifies the hinging or revolving of the plane of the side elevation to bring it in to the same plane with the front.

A custom frequently employed in working drawings is to draw the profile of a part, as a mold within the lines of the elevation in places where the exact relation of parts might not be apparent or where its presence may be required. For instance, in the inclined mold forming the small gables on the chimney above described (while it is of course understood that the profile here is the same as that shown at B) it becomes necessary to have the profile in position for use in the operations of laying out the pattern of that mold. The plane upon which a section of the mold would be taken can only be represented by a line as *x* 4, since its edge is presented to view. The plane of the section can therefore be brought into view only by hinging it upon the line of intersection with the plane of the front elevation, which is the line *x* 4, it being turned in either direction, according to convenience, until it becomes parallel to the plane of the view and thus shows the sectional view or profile, as shown at the right of the line. Profiles so drawn are always indicated by the shade lines placed upon the *inner side*, as shown. Thus the hinging of the oblique planes follows the same law which governs the vertical planes, and if once understood, there need be no chance of error.

PART III

ARCHITECTURAL DESIGN, DETAILING AND LETTERING

THE department of constructive drawing which most demands the attention of the sheet metal worker lies in the field of architecture because his work involves to a great extent, the rendering of architectural subjects. Sheet metal as applied to buildings has to do entirely with their superficial or external form and appearance and thereby simulates the form of designs which were originally made, for the greater part, in stone. For this reason it is the matter of design and detail and not the construction of a building that demands first attention.

What is usually known as practical architectural drafting applies to general constructive work, such as to cottages, city dwellings, etc., in which wood, brick and concrete construction form the important parts of the work. This, of course, does not concern the pattern draftsman ; but the details of architectural work in the sense of the several features, parts or units, which go to make up a design, should be made a study, so far as time and opportunity afford. In this field the classic and the gothic models will form the principal subjects to be studied.

In the case of buildings where an architect is employed, the pattern draftsman will have little to do in the matter of design beyond the possible alteration of minor details to facilitate construction or more particularly forming, as for instance, the slight alteration in the profiles of moldings to reduce them to the nearest arcs of circles where they have been drawn as irregular curves, and such other changes necessary to adapt them to the machines used in the process of forming.

It often happens, however, in the experience of the sheet metal contractor that a building is to be altered or enlarged, when an additional cornice, belt course or window caps are required. No architect is employed other than the "boss" carpenter and mechanics necessary to do the work. In fact, the owner looks upon the sheet metal man in the light of an architect. Since his work embodies the embellishment of the building, he is therefore expected to furnish designs as may be required. For such occasions as this it is very desirable that the proprietors of a sheet metal establishment shall have in their employ a draftsman who can do something more than merely lay out patterns.

In the interest, therefore, of those who aspire to the higher planes of the science, a short chapter on this subject is here introduced in which some of the elemental features of design which the prospective draftsman should become familiar with will be considered, as well as the methods of detailing the various designs. From this point the study of architecture may be pursued to any desired extent from such works as are at hand or can be obtained, remembering that public libraries usually contain reference books on this subject. An excellent work for this purpose is Ware's "American Vignola." Chambers' "Treatise on Architecture," is a reliable authority and other standard works will be found.

History of Classical Architecture

Following this course the features of what is termed "classical" design will be first taken up, the models for which are now to be found in Greece, Rome and other ancient countries. These are the ruins of temples and other buildings constructed in very ancient times, when a civilization, long since passed, made those countries the greatest centers of art and learning in the world. It is deduced from a study of these ancient examples that the architecture of these fine examples reached its high degree of perfection through a long process of development or evolution from the more primitive methods of building.

It will be of little use to repeat here what is termed "the story of architecture" beyond the statement of a few points, viz.: The modern portico finds it prototype in the rude hut, built by first setting up posts, as the trunks of trees, across the tops of which was placed a timber or "lintel" to form one side or wall of a prospective structure. From this lintel to another similar one other timbers or rafters were laid across to support a roof, somewhat as shown in the sketch in Fig. 89. Looking forward, in point of time, from this primitive structure, the posts are the elementary columns, the lintel becomes the architrave, while ends of the rafters, which were allowed for safety to project somewhat outside of the lintels, become the primitive modillions (or brackets) so frequently seen in modern designs. In the perfecting of such crude designs with the advance of civilization, the posts would be well rounded and dressed and receive capitals and bases

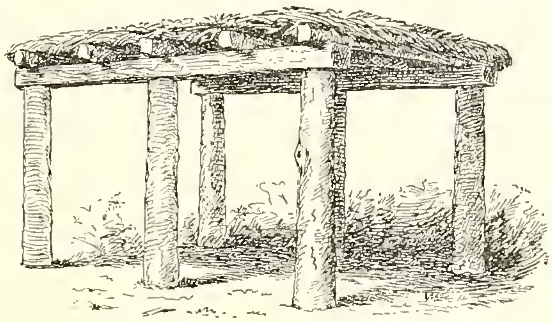


Fig. 89.—Framework of Primitive Hut

and thus become "columns," and in the further elaboration of the design would be placed upon pedestals. The projecting timbers would be cut to measure and the roof would be extended out to form extra shade and shelter, and thus, when moldings have been added for decoration, become the "cornice." Add to this the supposition that when a building is erected for a purpose, it is necessary to have a plain surface upon which to place an inscription, and we have the "frieze," which is the plain surface placed between the lintel or "architrave" and the cornice. The frieze in modern building is designed to receive both inscriptions (signs) and ornamentation, usually indicative of the purpose of the building. The whole combination of architrave, frieze and cornice is termed the entablature.

Thus a building (or more properly a portico), from the ground to the roof, consists of three parts, the pedestal, the column and the entablature. The pedestal has three parts, a base, a central plain cubical block, called the die, and a projecting molding at the top, called the cap. The column consists of three parts, a base, a shaft and a capital. Finally, the entablature consists also of three parts, the architrave, the frieze and the cornice.

It should be remembered that these designs originated in a warm climate, and that the protection from rain and the sun's rays came first and the wall afterward, which having been built between the columns gave rise to what is termed the engaged column, or to the pilaster, whose plan is square, in contrast with that of the column, which is round.

In order that the roof should form an efficient protection from water, it was necessary that it be somewhat higher along the middle than at the eaves; thus the two ends of such a roof would form gables from which were evolved what are termed "pediments," a feature of ancient as well as modern design which provides an opportunity for the most elaborate ornamentation.

Such, in brief, are the characteristics of Greek architecture, which, as elaborated in different parts of that country, became known as the Doric, Ionic and Corinthian orders, all differing in their details and styles or ornamentation. The material used being stone, the spaces between columns was limited to the length of stone obtainable to form the lintel or architrave which must span the distance from center to center of columns, and support also the frieze and cornice, the parts of which could then be cut from smaller blocks.

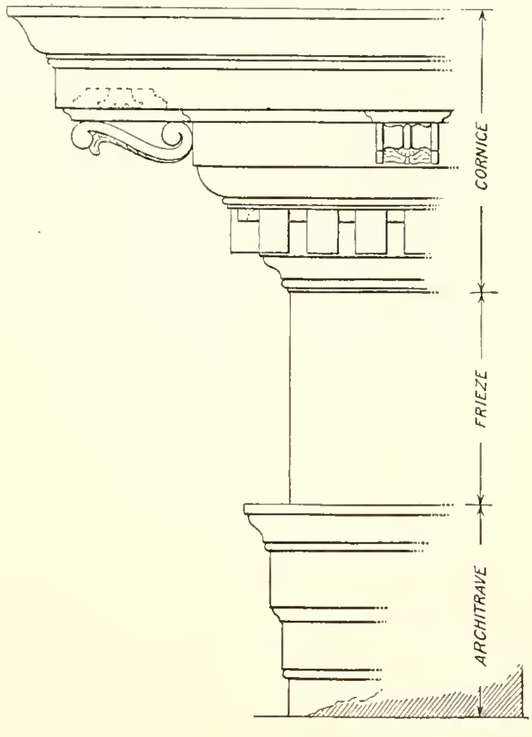


Fig. 90.—Corinthian Entablature

Later the Romans, imitating their Greek antecedents, formed the Tuscan, the Roman Doric and the Composite orders, of which the Tuscan is the plainest, while the Composite is a sort of combination of the Ionic with the Corinthian. The several orders are most easily distinguished by the capitals of their columns, although they also differ in nearly every detail of ornamentation and profile of moldings. Fig. 90 shows the profile of a Corinthian entablature, in which the general proportions have been very carefully maintained, but from which all carving or enrichment has been omitted. In studying its proportions it should be noted that the architrave and the frieze are of the same depth, while the cornice has a depth which compares with either as four to three; or, in other words, if the hight of the entablature be divided into ten equal parts, three parts are taken for the architrave, three for the frieze and four for the cornice. It may be further noted that the projection of the cornice is equal to its hight. This set of proportions does not vary greatly throughout all of the work of the Corinthian and Composite orders. These proportions also bear a specified relation to the hight of the column and the pedestal, which questions are identified with the study of architecture, a subject treated in numerous volumes and need not be considered here at any greater length.

The profiles of the Greek moldings were usually irregular in character and were carefully designed to produce pleasing light and shade effects, while the Romans reduced their profiles usually to arcs and circles. But the one great distinctive characteristic of the Roman architecture is the invention of the arch, which may be described as a curved or semi-circular architrave whose two ends rise from the caps of smaller columns or pilasters placed against the sides of and between the larger ones, and whose summit helps to support the center of the main or level architrave above, thus allowing of a wider spacing of the principal columns; as the distance from center to center of columns could thus be the length of two stones, the intermediate points being supported by the arches. The moldings, modillions, friezes and capitals of the ancient buildings were ornamented by elaborate carvings, which the stamped designs, called enrichments, leaves, rosettes, etc., now so much used in sheet metal work, are intended to imitate. The designs of enrichments, as may be seen by inspection of the catalogues of many prominent firms in the sheet metal trade, are in many cases only slight modifications of the carving still to be seen in the ancient ruins.

Leaving these ancient monuments of art to crumble as they must, it is of importance to note that approximately four hundred years ago there sprang up in Italy a revival of the ancient styles, which ultimately spread throughout Europe and became known as the Italian, German or French Renaissance, each of which partook of the characteristics respectively of the people and ideas of the countries in which they were practised. In the treatment of these styles, more or less liberty has been taken with the original models, the result of which has been the erection of many fine edifices which have had a governing influence upon the architecture of this country. The greatest freedom in the handling of this style has been employed by the French, with whom originated the so-called French or mansard roof, named after a French architect, François Mansard.

Many of the public buildings of this country have been built in this style, notable among which may be mentioned the Capitol at Washington and the City Hall in New York City. A very fine and more ornate example is the new Hall of Records in this city, which bears the stamp of the French influence.

We have thus far, as we intimated at the beginning, treated of the matter of design without reference to material. It has been shown in many fine buildings that sheet metal is admirably adapted to the rendering of such designs. Referring again to Fig. 2 on a foregoing page we find illustrated a cornice of Renaissance design suitable for sheet metal construction, upon which, for the benefit of the beginner, the names of the several parts and members were placed. A comparison of this with the design shown in Fig. 90 will show that the proportions of the former are greatly at variance with its classical prototype. Designed as a finish to the top of a building, as a store front or perhaps a school building, the heavy architrave shown in Fig. 90 is no longer a necessity, and is replaced by what is termed the foot mold. While the term "cornice" properly applies only to the uppermost division of an entablature, common usage now applies it to the entire design, since it constitutes, as it were, a unit of design and is frequently used as a finish upon a wall of other material, as brick or stone.

The Gothic Styles

Besides the Renaissance styles of architecture, which have for their antecedents the classic models just referred to, those styles which follow the Gothic forms are next in importance to the sheet metal draftsman. In a comparison of these two great schools of architecture, the feature of first importance is that of proportions. The designs of ancient Greece and Rome were regulated by a very exacting system of proportions in which the unit of measure was a recognized fraction of the diameter of the column, called a *module*. Thus the hight of the column, or of the entablature, or the dimensions of any of the details, was expressed by a certain number of modules, in consequence of which it will be seen that whether a design were great or small, so far as its dimensions in feet were concerned, the proportion of one part to another, or to the whole, remained the same.

With regard to the Gothic styles it must be understood that they are, freely speaking, quite as much a matter of history as of form and fashion. Following the downfall of the Roman Empire came a period concerning which not much that is authentic is to be found, a period in which the principal occupation of mankind seems to have been war, in consequence of which the civilization and art of former ages were lost. During the slow process of recovery from this calamity the buildings erected were but a crude imitation of the ancient forms.

Thus originated what was termed the Romanesque or Norman style, the principal feature of which was the round (semi-circular) arch, which had, however, little resemblance to its Roman prototype. The columns were short, the arch stones heavy and often decorated with zigzag ornaments along the inner edge. Moldings were heavy and with little projection. These styles were followed throughout western Europe and were carried into England, to be followed there by what was termed the early English. In this style the pointed form of arch was adopted, a form which has since become the distinguishing characteristic of Gothic architecture. As this was the style of mediæval times, walls were finished at the top with parapets and battlements rather than projecting cornices. In some of the castles of England, France and Germany are to be found excellent examples of this style.

After this came what is known as the "perpendicular," a style in which, as its name indicates, the perpendicular lines were dominant. Its leading external characteristics are its buttressed walls with high peaked roof, its pinnacles and tall spires often studded with ornaments. Its window openings are pointed arches, finished with many mullions or divisions, which combined to make often very elaborate traceries. It is a style particularly adapted to churches, although also applied to colleges, public buildings and other edifices, and sometimes to dwellings.

Internally its chief characteristic is the groined ceiling, forming, in church work, a series of crossing or interlacing pointed arches rising to different hights and springing from the tops of the two rows of columns, to be found in all cathedrals, or from corbels placed against the walls at a greater altitude. The highest of the arches meet under the apex of the roof, along which runs a heavy rib molding. Over this rib carved bosses are placed at the intersections of the lesser arches or cross ribs. It will thus be seen that the construction of a ceiling in this style presents many interesting problems in mitering and the laying out of curved moldings of long radii, for groined ceilings are now often finished with sheet metal moldings and stamped work. Almost any catalogue of stamped ornaments will be found to contain a variety of finials, crockets, crestings, rosettes, leaves and capitals peculiar to this style.

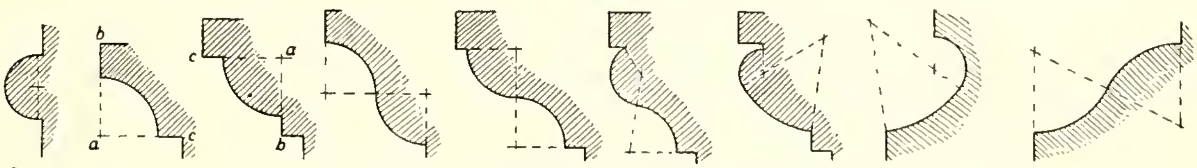


Fig. 91.—Classical Profiles

It may be said in general of Gothic architecture that it follows no system of set rules or symmetry of proportions, and much variety prevails in the capitals of the columns and other carvings. A thorough knowledge of its features can only be obtained from reading and from good illustrations and photographs.

Many fine examples in this style are to be found in England, Belgium and France, as well as in this country. Trinity Church, St. Patrick's Cathedral and the new Episcopal Cathedral of St. John the Divine, in New York City, are representative structures of the perpendicular style. Later styles in England have been known as Elizabethan, Tudor, Queen Anne, etc., all of which may be called modifications of the Gothic style.

In presenting to the sheet metal draftsman that which is useful in the matter of detail of the several styles to which we have referred, we note first that what is termed the *pediment* of the Renaissance styles is perhaps the most important feature or unit

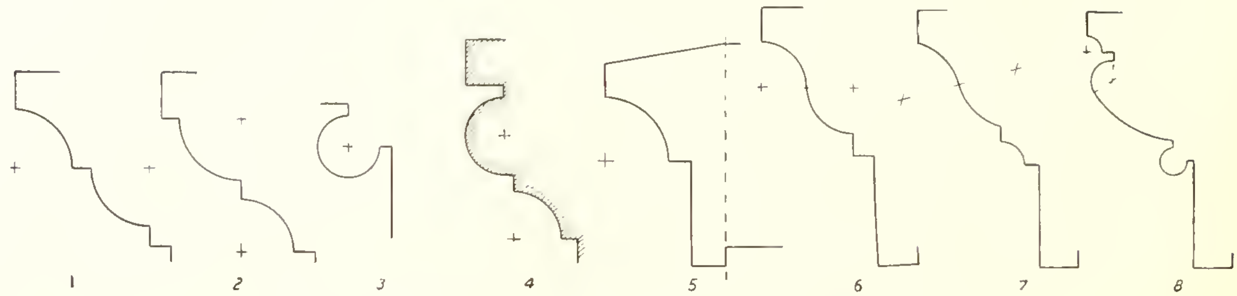


Fig. 92.—Additional Classical Forms Suitable for Sheet Metal Designs

of design. On account of its general use and variety of form, this feature, with others of less importance, will be treated later as a separate subject.

We shall for the present call attention to the profiles of the moldings as a most distinguishing characteristic of the two styles or schools of architecture mentioned. In Fig. 91 are shown the principal Roman moldings with their modern and in some cases their ancient names, while Fig. 92 shows some additional combinations especially adaptable to sheet metal, based on the elemental forms of Fig. 91. In all cases the centers from which the curves are described are indicated by crosses so that their construction may be understood, and thereby they may be properly drawn. It will be noted that the curves are, for the greater part, quarter circles, which are terminated above and below by lines drawn either vertically or horizontally through the centers mentioned, as shown by the lines *a b* and *a c* in the cove and the ovolo in Fig. 91. In some of the molds formed by compound curves, as the quirked molds and the scotia, the curve is composed of two arcs, one being greater and the other less than a quarter circle.

As a matter of accuracy in naming the parts of a mold, the term "mold" properly belongs to the curved portions of the profiles, the vertical (or sometimes oblique) surfaces being termed the fillets, and the horizontal straight parts are properly called the soffits. The term "soffit" is synonymous with "planceer," as applied to the under side of a projecting cornice, but in a more general sense it signifies the under side of any projecting part. As a rule, every mold is accompanied by one or more fillets. Thus the ovolos of Fig. 91 have an upper and lower fillet, the upper fillet being usually the larger. The lower fillet is spoken of as being "square," because its depth is equal to its projection. Square lower fillets are also shown in Nos. 1 and 6 of Fig. 92. In Nos. 5, 6, 7 and 8 the broad plain surface is called a fascia.

In Fig. 91, the bead, the cove, the ovolos, the quirked ogee, also Nos. 1, 2 and 4 of Fig. 92, may be used as panel molds; the bead in Fig. 91, with a square fillet placed below, is commonly used as the neck mold of a capital, while the others of the list mentioned may also be used as bed molds. Nos. 1, 2, 4 of Fig. 92, and the reversed ogee and the two quirked molds of Fig. 91, are suitable for the mold to go below a modillion or a dentil course. Nos. 6, 7 and 8 of Fig. 92 show different forms of crown molds. No. 5 shows a form of foot mold in which the cove can be replaced by such forms as a reversed or a quirked ogee shown in Fig 91, or by the forms shown in Nos. 1, 2 and 4 in Fig. 92.

In strong contrast with these profiles are those shown in Fig. 93, which represent a few of the forms of the Gothic styles. In the matter of the carving or enrichment of moldings, the Renaissance designs are often very elaborate and much more delicately carved than those of the Gothic school, the moldings being first cut to profile, such as are

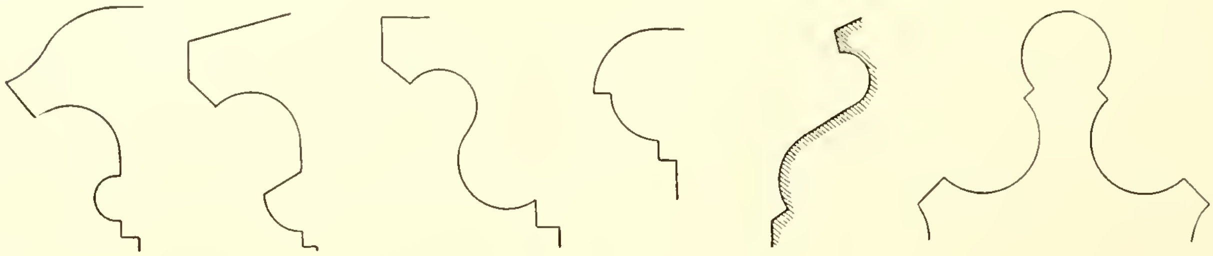


Fig. 93.—Some Gothic Profiles

shown in Figs. 91 and 92, after which the design was sunken into the mold. In the carvings of the Gothic school the matter of design is said to have been left in many cases to the carver, as a result of which rows of columns exist in which the design of every capital is different, each having presumably been carved by a different sculptor.

In mechanical and architectural drawing it is customary to cross with diagonal lines all parts through which the cutting plane passes, covering thus the entire surface. In the case of sheet metal moldings, when the extent of the surface cut amounts only to the thickness of the metal, and is therefore too small to be shown on a drawing except by a single line, as in Figs. 92 and 93, it is usual to place a little shading just inside the line as shown in No. 4 of Fig. 92 and by the one next to the last in Fig. 93, since in some cases doubt might arise as to which is the outside of the mold.

Pediments

It will be to the advantage of the draftsman who aspires to become a designer in architectural sheet metal work, to familiarize himself with what may be termed the principal features of design. We may, for instance, speak of a mansard roof, a tower, a cornice, or a portico as a feature of design. The term may be extended to less important parts of a structure as a finial, a dormer, twin or triplet window, an arch, a pediment, a belt course, a column, a pedestal, a capital, or even a bracket, continuing the list down until it becomes difficult to draw the line btween what may be termed "features" and what is only detail.

Designing, when strict adherence to the classical styles is maintained, consists for the greater part, simply of recombinations of features whose origin lies in remote antiquity, the character of whose detail is, however, well understood, and is, in fact, almost a fixed arrangement of details. When following the Renaissance styles, however, much freedom of proportion as well as of detail is permitted and an opportunity for inventive genius is afforded. When this point is reached, a more perfect knowledge of designing as an art, independent of architecture is required. Such knowledge can, of course, be acquired from books on the principles of design and by the inspection and study of recognized good examples of architecture.

One of the most important "features" of architectural design to the sheet metal draftsman in respect to the variety of its form and particularly in regard to the character of the miters required is known as the "pediment." This feature, had its origin in the meeting of the end walls of a building with the eaves of a roof built with a ridge in the middle, a feature which would ordinarily be termed a "gable." While a gable calls usually only for an inclined cornice on the ends of a building so designed as to be a continuation of that on the sides, the pediment includes also a level cornice or perhaps only to a part of cornice on the end of the building and below the inclined cornice, the whole being so arranged that the several parts meet at the corner to form a perfect and harmonious junction or miter.

A carefully detailed arrangement of these parts is shown in Fig. 94, in which it will be seen that the fascia and fillet below the ogee are first carried horizontally across the front of the pediment, while the ogee and upper fillet follow the inclination of the roof, a duplicate fascia and fillet being added below the ogee at the same angle. By this arrangement the profile of the inclined cornice, as shown by a section on any line at right angles to the same as *a b*, is the same, so far as the number of its members are concerned, as that on the line *c d* of the level cornice.

This peculiarity in the design will perhaps be better understood and more easily remembered if we turn back again for the moment to consider its origin. As already explained, the antique designs were executed in stone. That particular stone which lay at the very top of an entablature and projected out beyond the frieze (a sort of cap sheaf, as it were) was known as the "corona" or crown. It was simply a flat stone level on its lower side and extending back upon the wall sufficiently to anchor itself with safety. Its front surface was usually plain and vertical, though sometimes slant-

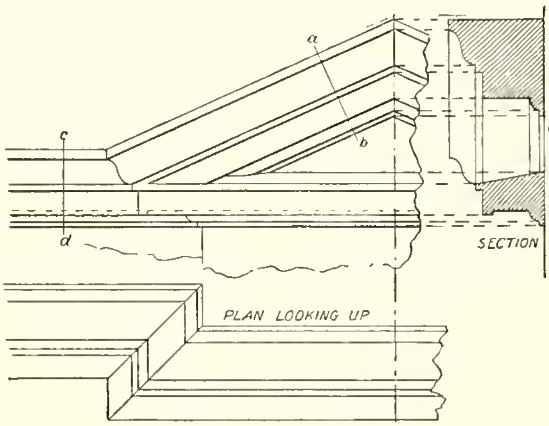


Fig. 94.—Construction of a Pediment

ing back slightly, while along its upper edge a small fillet was allowed to project just as a finish. This constituted in many cases the entire top finish of the entablature. Consequently when a pediment was wanted it was formed by other stones, same as the corona set on above the level part at an angle, the whole taking the form shown in Fig. 95. In some of the antique examples the ogee was an added ornament, a separate stone set along the outer edge of the corona, sometimes not continuously, being placed only at intervals and alternated with other ornaments, as may be seen in illustrations of certain ancient temples. Therefore, when applied as the finish of a pediment it was placed upon the inclined or upper cornice only, as seen in the several designs shown in Fig. 3. A very small mold, sometimes elaborately carved, was often placed just below the fillet and against the fascia in both the level and inclined cornice, as at No. 4 of the same figure.

The details just described are of important interest to pattern draftsmen in regard to the character of the miters involved. In all cases where a level mold is required to miter at any angle in plan, with an inclined mold, it becomes necessary that the profile of the mold forming one arm of the miter

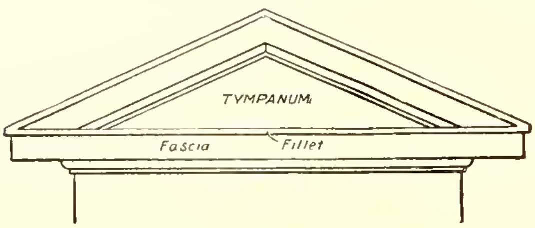


Fig. 95.—Pediment Without Crown Mold

shall be altered to suit the angle of inclination and other conditions. Miters so made are termed "raking miters." In these cases either the profile of the level return or that of the inclined mold of the front may be selected to undergo the change, while that of the other must remain normal in order to effect a miter. This matter is decided usually by the comparative number of lineal feet required of both profiles, it being customary to change or "rake" the profile of that of which the least is required. For instance, if the pediment mold is part of a cornice or other mold carried around or along the front of a building, as in Fig. 94, or at No. 3 of Fig. 3, the inclined part is raked; but if the pediment occurs upon a window cap in which the returns or side cornices end squarely against a wall, as in the other elevations in Fig. 3, then the inclined mold should remain normal and the returns be raked.

Another interesting miter occurs at the base of the pediment, where the inclined fascia with its fillet and also the bed molds, are required to miter upon the roof of the level part of the cornice, which is made slanting as a wash to shed the water. Still another problem is suggested in No. 3, in the pediment or raking modillions (placed above those in

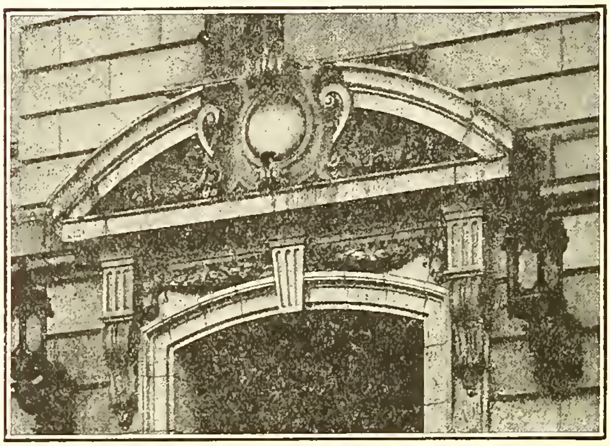


Fig. 96.—Broken Pediment Used Over an Entrance

the level cornice), the construction of which is a subject for especial treatment. These problems will all be treated in the later parts on *Developments*.

Pediments are designated as angular or segmental, according as the moldings of which they are formed are straight or curved. Thus No. 2 of Fig. 3, and the pediment shown in Fig. 96, are called segmental, while all others here illustrated are termed angular. The triangular space between the inclined and the level cornice is called the tympanum and is properly flush with the wall or frieze of the level cornice, and is in fact sometimes a continuation of the wall when only a portion of the level cornice is used, as shown in the elevation of the segmental pediment at No. 2, in Fig. 3.

Several methods for determining the proper inclination or pitch of the upper moldings of a pediment are explained in works on architectural drawing, but this may usually be left to fancy, remembering that the angle seldom exceeds 30 degrees.

As before intimated, the pediment is properly used as the finish at the end of a roof, where it is treated with modillions or dentils to correspond with the level cornice on the other parts of the building. It is, however, more often used decoratively as a finish over doors and windows, and, with this in view, is often made with an opening at the top in which to place a vase, bust, figure or other ornament. In such cases it is properly termed a "broken pediment." Two methods of finishing the mold at the top are shown at Nos. 4 and 5 of Fig. 3, which are applicable to either angular or segmental pediments. That shown at No. 4 requires a second raking or change of profile for the return at the top, while the design shown in No. 5 calls more particularly for skill in *hammered work* in carrying the tapering portion of the ogee around the curves of the scroll.

As an example of a segmental broken pediment, which may be looked upon as a model of design, we have reproduced in Fig. 96 a photograph of the finish over the Centre street entrance of the new Hall of Records at the corner of Chambers street, New York City. This work is executed in stone and shows a shield in the opening of the pediment, at each side of which elaborate carvings fill the entire space of the tympanum.

The pediment has always been regarded as the place for the heaviest and most elaborate carvings of the building. Probably the most notable of the antique example of this is the Parthenon at Athens, Greece. Though now in a state of ruin some of the figures from the pediment are still preserved in European museums, and plaster casts of them are to be found in the art museums of this country. As a remarkable modern example of this, we have reproduced in Fig. 97 a view of the Stock Exchange on Broad street, New York City. This building is executed in marble and is a fine example of Renaissance architecture. Our illustration shows also a portion of the supporting columns. The design follows very closely the Corinthian order and affords a fine study to architectural draftsmen whether for sheet metal or other material in its columns, capitals, entablature, and particularly the pediment in which the details previously described are visible, to which have been added the carving on the crown mold and the frieze, also the pediment figures.

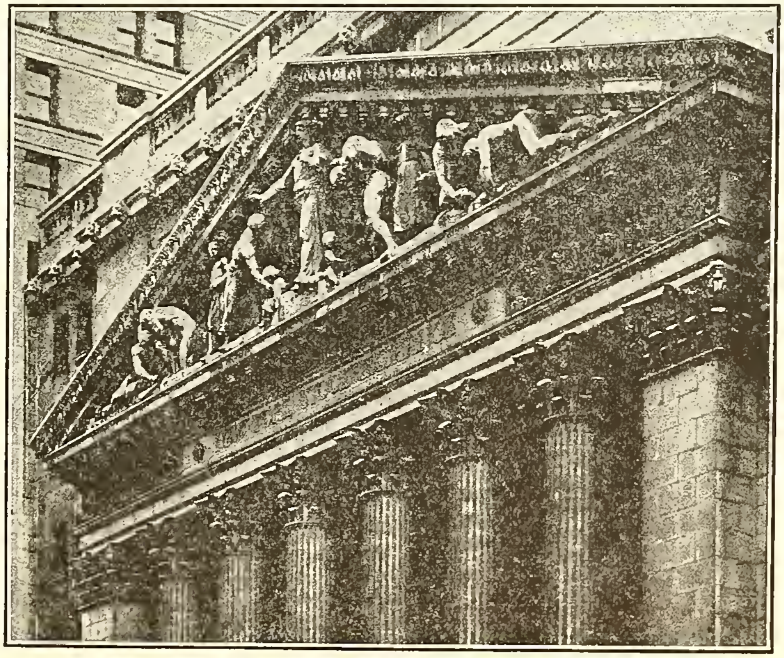


Fig. 97.—Pediment with Figures

Having considered the general outlines of classical designs, so far as origin is concerned, we can only offer as advice to the draftsman for his advancement that he seek out and study the best Renaissance designs; in other words, the works of recognized good architects, both as seen in the buildings themselves when opportunity occurs, as well as in the illustrations to be found in books and magazines published in this line.

It is of course understood that the matter of detail concerns the draftsmen for sheet metal work rather more than that of the design as a whole.

In continuance of this subject we shall take up the analysis of the "portico" for the principal reason that, generally speaking, it includes in its design much as regards details that is applicable to the various parts of an entire structure.

Architecture has two phases or purposes to be considered, viz.: construction and design. In respect to the first, it is a science which deals with the strength of the material used, its power to support what is above it, or to hold together the several parts of the structure, in which case it is synonymous with building. In the second, it is art, more particularly that of sculpture, than of any other classified branch, but withal it is art in respect to all that has to do with the appearance of a building, as its size, shape, proportion of parts, color and, above all, its decoration, which includes sculpture first, of the conventional variety, as in the enrichment of the moldings, the carving of the friezes, the capitals, and of other ornaments used to embellish its pediment, roofs and other parts; and second, of the natural and perhaps higher type, as when statues, groups or other figures are used.

The motive of the art expressed in the decorations of a building lies in the fact that every part has an idea to express; thus a foliated capital seems to say that the column has more strength than that just sufficient to carry what is placed above it, and that its surplus strength or energy has grown out at the top into a foliated embellishment, and further, that the leaves and scrolls seem to indicate the upward movement of growth, thereby assisting, figuratively, in the support of what is above. This is particularly marked in the case of the scrolls, called volutes, which roll out under the projecting angle of the abacus.

In studying the uses and forms of moldings, one must not lose sight of the fact that the existing and oft used designs were created in stone and for stone construction. In view of this, therefore, it will appear that when a stone is to support a projecting stone above it, as an overhanging cornice,

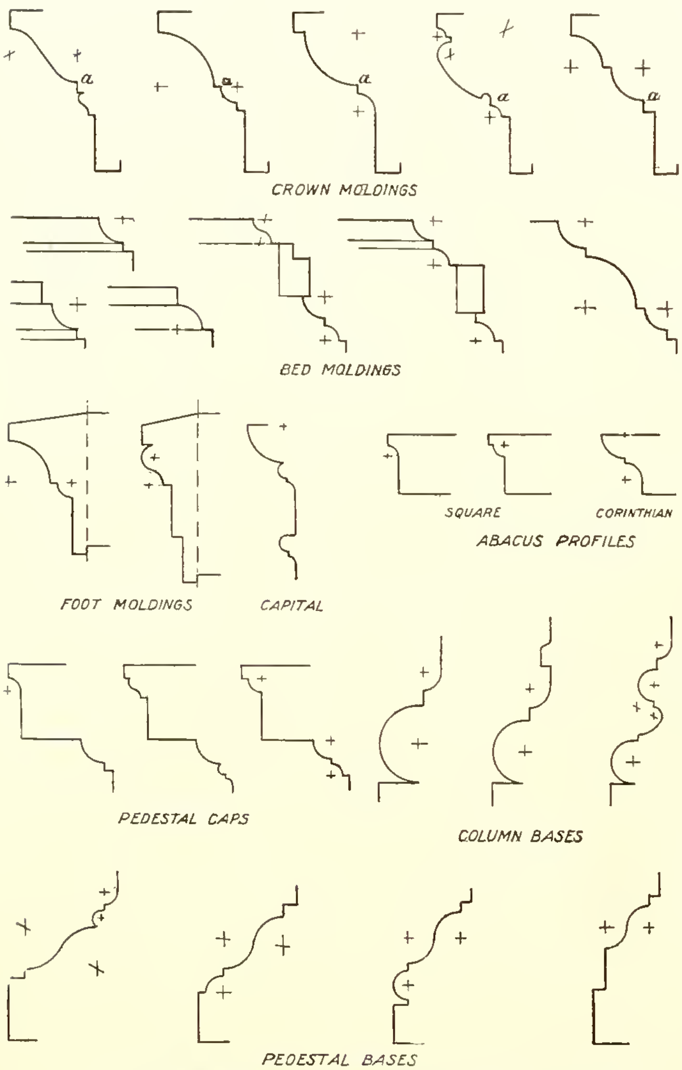


Fig. 98.—Moldings Arranged According to Purpose

its upper or supporting surface should be widened out or projected forward, so as to thereby assist in its work. A projecting molding upon the outer and upper edge of a frieze (as a bed molding) will throw the point of equilibrium of the stone above nearer to its outermost point and thus require less weight or balancing power at its inner end. For this reason a molding used as a support to a projecting part should have a full or convex form, instead of being concave in profile, in which case it necessarily would have much less bulk of material, and thereby strength for supporting purposes, than a mold of convex profile. Ovolas, cyma reversas, and other forms of moldings which are full in the upper curves, are properly used in bed molds and below dentil and modillion courses, while coves and hollow forms may be used where no idea of support is conveyed, as in the crown mold or the architrave or in the foot mold of a cornice. Thus each form has a meaning in its treatment. It is a principle of art, however, that variety of form is also necessary in order to avoid sameness or monotony, thereby making the design uninteresting.

In order the prospective designer may become acquainted with some of the primary facts of the case, let us refer to Fig. 1 which shows a pedestal, column and entablature, all bearing the general proportions of the Ionic order. The reader will readily note the style and purposes of the several profiles. These we have supplemented, in Fig. 98, by a number of profiles in detail, adaptable to sheet metal work, which are arranged and classified with respect to the purposes and placed in which they may be used. In the necessarily limited space which can be devoted to this subject it will, of course, be impossible to give an exhaustive treatise, but a few of the more important facts will serve as a leader, which the interested draftsman can follow up as opportunity affords.

As previously stated, an "order" (the portico from the ground or foundations to the roof) consists of three primary parts, viz.: the pedestal, the column and the entablature, each of which also consists of three subdivisions, thus making in all nine parts which require analysis as to profiles, proportions, etc. We have not given proportions in figures, for the reason that modern Renaissance design follows the classical forms only in spirit or in the idea, varying proportions to suit the character or sentiment of the design under consideration. The designs shown, which are by no means exhaustive, are therefore capable of considerable variation in respect to minute detail and proportions. A glance through the collection will show that all curves are composed of arcs of circles, usually quarters, the greater part being made up of the combination of the ovolo and the cove in different positions and proportion. Thus the second and the last of the crown molds are identical so far as the elements of design are concerned, the difference being in the relative proportion of the parts. The small crosses show the center from which the curves are struck.

In this connection we should mention that, properly speaking, the term crown mold applies only to the cyma, or to the moldings above *a* in the illustrations, but common usage in the sheet metal trade applies it to the entire design from the topmost member down to the drip.

The bed mold of a cornice is usually carried around the modillions or brackets to form a "head." Sometimes, however, a heavy bed mold is required, when the bed mold is so designed that its upper members only are used to form the bracket head, the remainder being carried behind, or through, the bracket. In the illustration the parts used to form the heads are indicated by the horizontal lines drawn from the profile to the left.

Coming now to capitals, that part termed the "abacus" is generally a square block laid upon the capital, which, like the column of which it is a part, is round. This is true in the case of all capitals except those termed Corinthian, the abacus of which is concave on the four sides, thus leaving the angles projecting and supported by the volutes, as will be illustrated later.

Molded capitals and the bases of columns, being round, are usually of spun zinc or copper, thereby permitting the use of somewhat finer or smaller members than could conveniently be formed in the manner usual with straight moldings. The "plinth," like the abacus, is square, and of the same diameter as the die of the pedestal upon which it stands.

The pedestal cap is simply a small cornice and, like that of the entablature, has a projection about equal to its depth, which is about one-fifth or one-sixth of the width of the die. As pointed out in connection with pediments, it is usually designed to represent the "corona" of a stone cornice with the crown mold left off; however, a small "cyma" is sometimes used. Pedestal bases usually have less projection than the caps.

The pilaster, which, though it may be considered as another form of column, yet has certain characteristics which distinguish it from the column. The principal difference between the two is that the column is round in plan, while the pilaster is square. In embodying them into a design either may be used whole or in part. The column, though most frequently used in its entirety, is yet often used as part of the wall, in which case it is known as an engaged column, and consists in that case of not less than one-half, and may consist of about three-quarters of the whole column as measured upon the diameter of the moldings of the base, while the projection of the pilaster may be reduced to a very slight amount and it is less often used in its entirety.

This will be understood by reference to Fig. 99, which shows a plan of each, of which A B is the center line. Reference to the plan shows that the wall surface in the case of the column could not

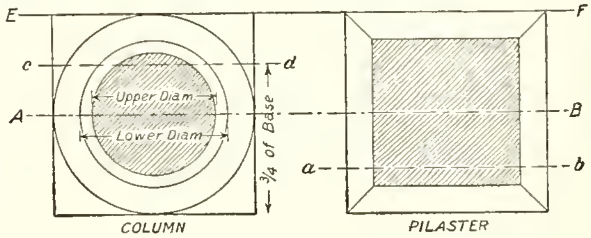


Fig. 99.—Comparison of Column and Pilaster

be brought forward of the center line without decreasing the diameter of the column. In the case of the pilaster, however, the wall surface could be placed as far forward as the line *a b* without altering its character or contour. Another important difference is in the fact that the column is always made tapering in its shaft, the diameter at the neck being usually about five-sixths of that at the base, while the pilaster does not usually taper. The plan also shows that in an engaged column the wall surface can be moved back to the center a distance somewhat less than half the upper diameter, as shown by the line *c d* since, if the wall were placed anywhere between the lines *c d* and E F, it might cut into the shaft in such a manner as to either leave it detached from the wall in only the upper portion of its length, or if placed far enough back to entirely free the shaft, would then cut the base in an awkward manner.

In regard to the tapering of a column, the sides are seldom drawn straight from bottom to top. The usual rule is to make the sides of the column plumb or vertical up to a point about one-third of the way to the top, from which point they are curved in for probably more than one-half the remaining distance and made straight but tapering to the neck mold. In some of the ancient examples the shaft is bellied, being larger at a point about one-third of the way up than at the base, the sides being curved throughout their entire length, this curve being known as the *entasis*.

It is needless for our present purpose to go into exact details of the five orders, save in one or two points. Details can best be obtained when needed from some work on the subject. The orders are termed the Tuscan, Doric, Ionic, Composite and Corinthian, each of which has its distinctive characteristics. The names indicate their origins except in the case of the Composite, which by some authors is not considered as entitled to a place along with the other four, being by them regarded rather as a combination of the Ionic with the Corinthian, which in fact it seems to be.

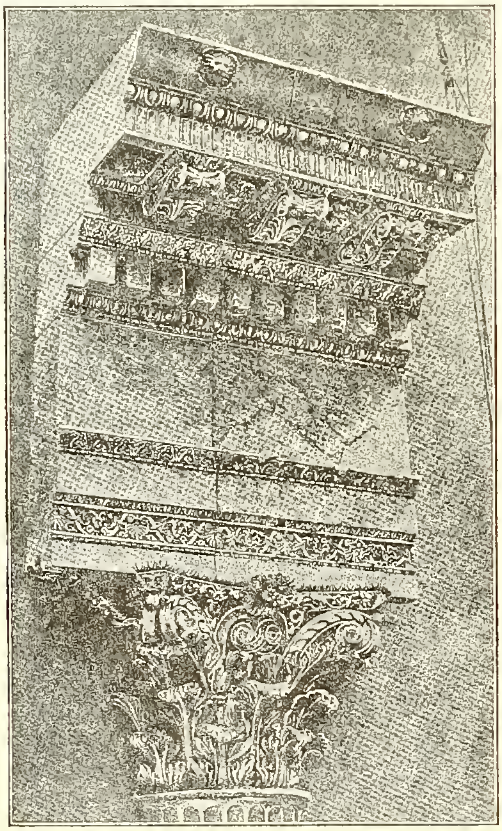


Fig. 100.—Entablature and Capital of Temple of Jupiter

Those who are interested in the study of ancient architecture, and who are within reaching distance of Central Park, New York City, will find much to interest them in a visit to the Metropolitan Museum of Art. The architectural exhibits contained therein consist in part of scale models of the most illustrious examples of ancient temples, etc., and, in many cases, of plaster casts taken directly from the objects which they represent, in which, therefore, the present condition of subjects created many centuries ago may be seen.

Fig. 100 is reproduced from a photograph of what is termed a "restored" model of a Corinthian entablature and capital. Reference to the illustration will show a line passing down through the entablature near its center. That portion to the right of this line is a plaster cast made directly from a fragment of the entablature of what was known as the Temple of Jupiter at Rome, and shows the effect of over 2,000 years of time upon its surface, which is particularly noticeable on the facia of the cornice, the dentils and on the architrave. The part to the left of the line is a newly constructed model, representing the design in its original and perfect state. The capital is also "restored," that is, completed from such fragments of the originals as exist.

This is considered by some authorities as one of the best examples of the Corinthian order. It differs from other examples principally in respect to the interlacing scrolls seen at the middle of the capital, these scrolls in other examples usually coming together somewhat like the volutes at the angles, but without passing through one another.

This subject besides giving a correct idea of relative proportions of the several parts of an entablature, is in itself an excellent study in the design, character and disposition of the enrichments, and shows how closely modern renaissance architecture follows the antique examples. As may be seen, some of the designs here shown have been almost exactly reproduced in stamped sheet metal.

In the matter of details of the orders, above referred to, the capital of the Ionic column possesses a distinguishing feature which will interest the sheet metal worker, and that is its volute or scroll. It is made proportionately larger in this order than in the Corinthian, and the method of drawing it is one of the problems which the draftsman should be familiar with, inasmuch as it can be applied to the Corinthian volute as well as to scrolls in all forms. Several methods for drawing it are given in different architectural works, but the method given herewith will render the problem in the most simple manner for general application.

Theoretically, the curve is what is mechanically termed an involute, that is, a curve made with a constantly and regularly decreasing radius. Practically, however, it is made up of quarter circles, each being drawn with a radius somewhat shorter than the preceding. The amount of decrease in the radius is determined by the amount of space between the starting point of the scroll and the end of its first revolution, that is, the space *a b* of Fig. 101, which must be determined by the number of revolutions required and purpose for which it is intended.

First enclose the space in which the scroll is required to turn by the lines A C, A B and B D and bisect A B, obtaining the point E. Then place

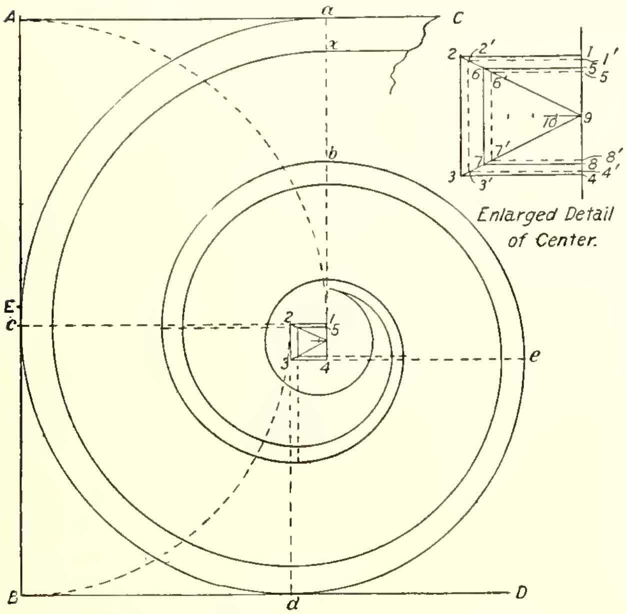


Fig. 101.—Method of Drawing Ionic Volute

the point *c* below E a distance equal to one-eighth of *a b,* and from *c* as center describe arcs from A and B, as shown by A 1 and B 2. This brings the distance from 1 to 2 in the eye of the scroll, equal to one-fourth of *a b,* hence the perimeter of a square constructed upon 1 2 as a base will be equal to the distance *a b,* and the points 1, 2, 3 and 4 may be used in numerical order as the centers respectively of the arcs *a c, c d, d e* and *e b.* If now the spiral just drawn were continued through another revolution from the same centers, it would necessarily be parallel to the curves of the first revolution. A feature of this design is that it is desirable to have the space between the lines of succeeding revolutions diminish regularly, and when the method is applied to the drawing of the Ionic volute, it is also necessary to have the width *a x* of the scroll or fillet diminish toward the eye of the volute. To provide for this, the centers of the four following quarter circles continuing the outer curve must be drawn from the angles of a smaller square constructed inside the first. The method of constructing this square is more fully shown in the detail above and to the right in which the numbers correspond with those in the eye of the volute as far as given. The other figures in the detail show the succeeding centers, which are used in numerical order. In constructing the inner squares, first bisect the side 1 4, obtaining the point 9, and from 9 draw lines to 2 and 3 as shown. The point 5 is located at a distance from point 1, equal to one-fifth of the distance 1 9, and point 6 is found by carrying a line from 5 parallel to 1 2, to cut the line 9 2, as shown at 6. The location of the remaining points will be understood by reference to the detail. The centers for the inner line of the scroll, starting at *x,* can be found by constructing squares just inside those used for the outer curve, as shown by the dotted lines. Should the fillet required be very narrow, the point 1′ can be so located that the distance 1 1′ is about one-third of 1 5. If *a x* be supposed to be equal to *x b,* then the point 1′ may be located at the middle point between 1 and 5. The spiral lines are drawn from the centers thus fixed in numerical order, and continued till they meet to form the "eye" of the volute. In applying this method to the scroll on the side of a modillion or bracket, the inner curve is drawn parallel to the outer, when therefore only one set of centers will be required, which will seldom include more than 6 points. It is usually necessary to fix the position of the last center at will to suit the size of the scroll end or eye required, as for instance, the size of a stock rosette to be used thereon. In the drawing, point 10 is the center of the eye.

In the erection of an order the face of the plinth is set flush with the die of the pedestal (when pedestals are used), and the lower fascia of the architrave, as well as the frieze, are set flush with the column at the top.

In the case of a cornice or entablature placed above a wall without columns, the frieze is always flush with the wall surface below it. It sometimes happens that a portico is formed in an opening or space in the wall, or that a colonade is finished with pilasters at the ends, the whole being surmounted by an entablature without breaks. In such cases the frieze is placed flush with the wall surface or with the face of the pilasters, with the result that the frieze and architrave must project somewhat beyond the face columns at the top.

In the treatment of window and door openings, either an arch or a lintel is the normal means of spanning the space. When the opening is rectangular at the top the lintel takes the form of an architrave, which, for the sake of a finish, is carried also down the sides of the opening; and when the opening is semicircular the same profile is used, since the arch of the Romans is what might be termed a curved lintel. When a more elaborate finish is required the arch is made to rest upon the caps of small pilasters or columns. Again, in the case of rectangular openings, that portion of the architrave which spans the opening may be surmounted by a frieze and cornice, ending with what are termed "self-returns" at the sides, thus forming a complete entablature. Modern renaissance methods use the cornice often without the frieze or architrave, which use is undoubtedly the origin of the window and door cap, many forms of which are constructed of sheet metal.

Detail Drawing

Having possessed himself of a knowledge of architectural drawing the sheet metal pattern draftsman will find it advantageous to proceed with his exercises by laying out full size details, preparatory to the development of the patterns. There are a number of rules applicable to laying out details or working drawings from architect's scale drawings which when well understood make comparatively simple that which may at first appear complicated. In order that these rules or methods may be established in the mind of the reader, three examples in detailing are presented.

Detail of Square Molded Leader Head

The first exercise is that of a square molded leader head. Fig. 102 shows a one-inch scale drawing such as is furnished to the sheet metal contractor by the architect. From this is prepared a full size detail. Since the drawing is scaled one ince to the foot, the one-inch scale rule is required first for measuring the entire hight of the head and tube combined, which will be found to scale 12 in. Such measurements should be proved by the aid of memorandum slips. Thus we make a note of the 12 in. and by measuring or scaling each member separately they will be found to tally with the full size measurements shown at the right in Fig. 103. After placing sufficient paper on the drawing board, proceed to draw the detail by means of any vertical line, as A B, upon which place the various divisional measurements. Through these points draw horizontal lines indefinitely. Now we resort again to the inch scale rule to measure from the center line in Fig. 102 the various projections of the several members there shown, which are then placed on corresponding lines in the working detail in Fig. 103, as indicated. It will be noted that the extreme projection at the top measured from the center line, is 6 in. and, that the various projections are shown by full size measurements at the left, the tube being 3 in. in diameter, as shown. The *quarter round* or *ovolo* is struck from the center *a* while the *cavetto* or *cove* is struck from the center *b*. Trace the half elevation, just drawn, opposite the line A B as shown. Then will E F G H be the front elevation of the leader head. Referring to the scale drawing in Fig. 102, it will be seen that the head is ornamented with raised discs and triangular dentils. The front of the head is designed to have three discs and four dentils, and the side of the head (representing the distance to the left of the wall line), two discs and three dentils. These ornaments are spaced in the detail as shown in Fig. 103. Bisect the distance *c d* on the center line and obtain the point *e*. Since the disc scales 1½ in. as seen in the scale drawing in Fig. 102, set the compasses to ¾ in. radius, and using *e* in Fig. 103 as center, draw a circle of 1½ in. diameter as shown. Tangent to the circle on the left, draw the vertical line *f g*, forming a rectangle, shown by *f g h i*. From these corners draw two diagonal lines, partly shown, so that they will intersect at *j* which use as a center and describe a circle of similar diameter. In like manner draw the circle to the right. The projections of these discs are indicated in the scale drawing in Fig. 102. They measure ¼ in. and are so indicated in the detail in Fig. 103. Since the hight of the triangular dentils are equal to one half the width of the fascia on which they are placed as shown in the scale drawing in Fig. 102, draw a line in the

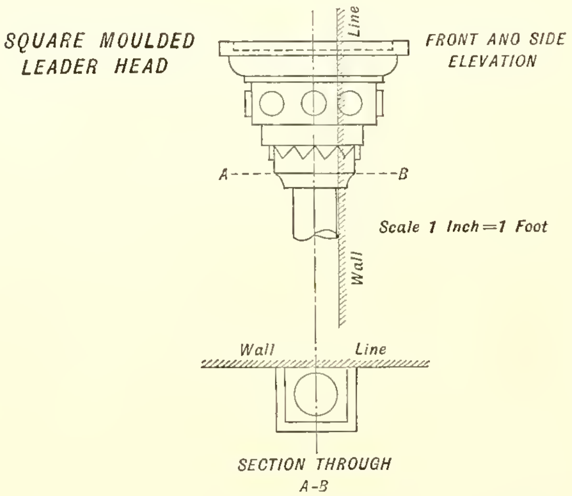


Fig. 102.—One Inch Scale Drawing of Square Molded Leader Head

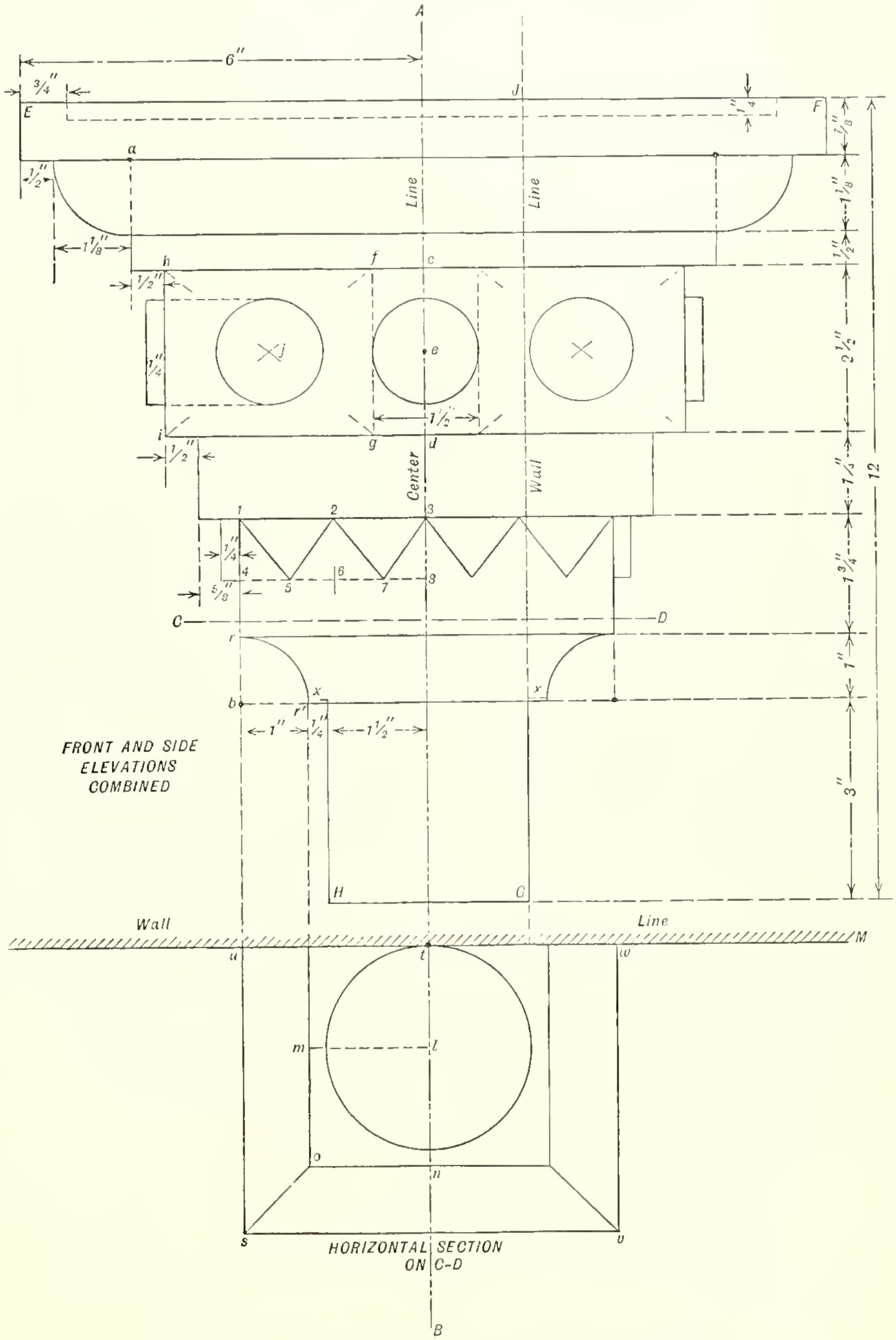


Fig. 103.—Working Detail of Square Molded Leader Head

detail in Fig 103, through the center of the fascia, as shown by 4—8. Now divide the upper line of the fascia in two parts as indicated by 1—2—3 and the center line, 4—8, in four parts as shown by the divisions 4—5—6—7 and 8. Proceed by drawing lines from 1 to 5 to 2 and 2 to 7 to 3 which operation forms the outlines of two dentils. Repeat this procedure on the opposite side. The height or rise of these dentils are also ¼ in., as shown. As the leader head is to lie flat against the wall, a perpendicular line erected from G to J will represent the wall line, and J E H G will be the side elevation of the head on which are placed two discs and three dentils, as shown. In this manner the front and side elevations are drawn one over the other, a common practice in shop detailing where time and space are important considerations. It becomes necessary to construct below the elevation a horizontal section through the line C D, which is accomplished as follows: Extend the center line indefinitely, and at right angles thereto, draw the wall line L M crossing the center line at *t*. It is required to set the compasses to one-half the diameter of the tube, that is, 1½ in., when with *t* as center describe the arc, cutting the center line at *l*. Using the same radius, with *l* as center describe the circle shown, thus representing the plan view of the tube. Now from the edges of the *cove* *r* and *r′* in elevation, drop vertical lines below, indefinitely, as shown, and from *l* draw the horizontal line *l m*. Set off this distance *l m* as indicated by *l n* and complete the outline shown. From the corner *o* draw a line at an angle of 45 degrees, intersecting the outer line dropped from *r* at *s* which becomes the miter line *s o* and complete the opposite side, as shown. *u s v w* then represents the horizontal section on C D, and X X in elevation shows the flange of the tube. This completes the full size details from which the patterns are developed by the methods set forth in the following problems.

Working Detail of Ornamental Window Cap

The second exercise on making working details is that of an ornamental window cap with a pediment, a one-inch scale drawing of which is shown in Fig. 104 where are seen a front elevation and a side view. As will be seen the cornice or cap is to be placed over a door or window opening and contains corbels, triangular dentils in the chamfer, brackets and raised panels in the bed mold with an ornamental scroll in the tympanum of the pediment. In this case the normal profile of the ogee is placed in the horizontal return, so the ogee in the pediment mold will require to be raked or modified, all of which procedure we will show in the working detail. The first step, as in the detailing of the leader head, is to scale the entire hight of the cap, proving this measurement by scaling each member separately, the sum of all of which will equal the full measurement just obtained. The rule scaled an inch to the foot is next employed to take off the distance from the top of the pediment to the bottom of the corbel. The measurement is found to be 2 ft. 6 in. as indicated to the right of the wall line in the working detail in Fig. 105. Each member in the scale drawing in Fig. 104 may then be scaled separately and the result proved. After which place these hights on the wall line in Fig. 105 as shown by full size measurements. From these divisions draw horizontal lines throughout the sheet indefinitely. Next scale the projection of the horizontal return in the side view in Fig. 104 which is found to measure 8 in. and place it as indicated in the detail in Fig. 105, where the various projections are marked as of full size. It will be seen that the lower fascia in the front elevation in Fig. 104 is enriched by a molded chamfer, indicated in the side elevation in the working detail in Fig. 105 from *d′* to C′, the soffit of which returns and is nailed to the window frame at a^2. The side view of the corbel indicated by S, is now drawn in position as well as the side view of the small bracket and cap shown by R. The dotted line R° indicates the sink in the face of the bracket. The heavy dots in the side elevation indicate the centers from which are struck the various molds. Having thus completed the side view, there remains only to draw the one-half front elevation proceeding as follows: Draw the center line, as shown, at right angles to which lay off a distance of the one-half width of the window opening. This distance is shown to be 1 ft. 6½ in. Scale the width of the corbel in the front elevation in Fig. 104 and place the distance of 5½ in. as shown in the half front elevation in Fig. 105. Extend the outside of the corbel to point A, and make the profile A X B alike to A° X° B° in the side elevation. From B, draw the rake of the pediment B D and parallel to this line from points 2 and 7 in the profile B C draw lines as shown. Now take the hights of the various members between *a* and *b* in the half front elevation, and place them at right angles to the raking line drawn from point 7 in the profile B C as shown from *a′* to *b′*. Through these points parallel to

ORNAMENTAL WINDOW CAP

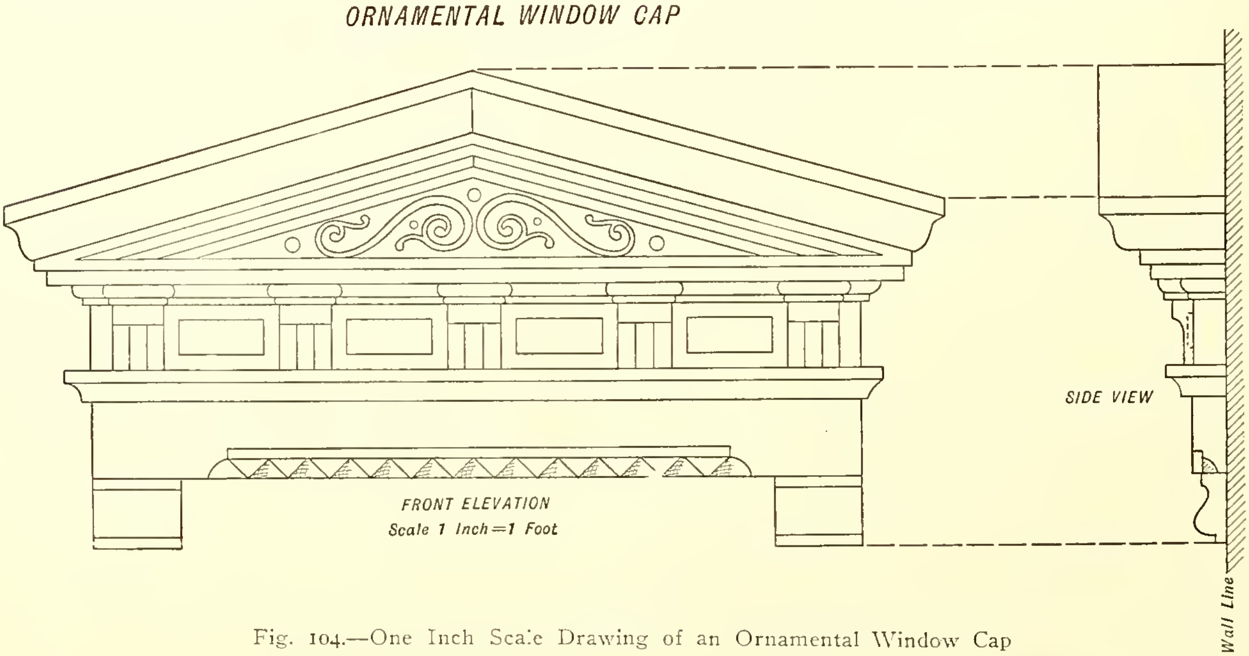


Fig. 104.—One Inch Scale Drawing of an Ornamental Window Cap

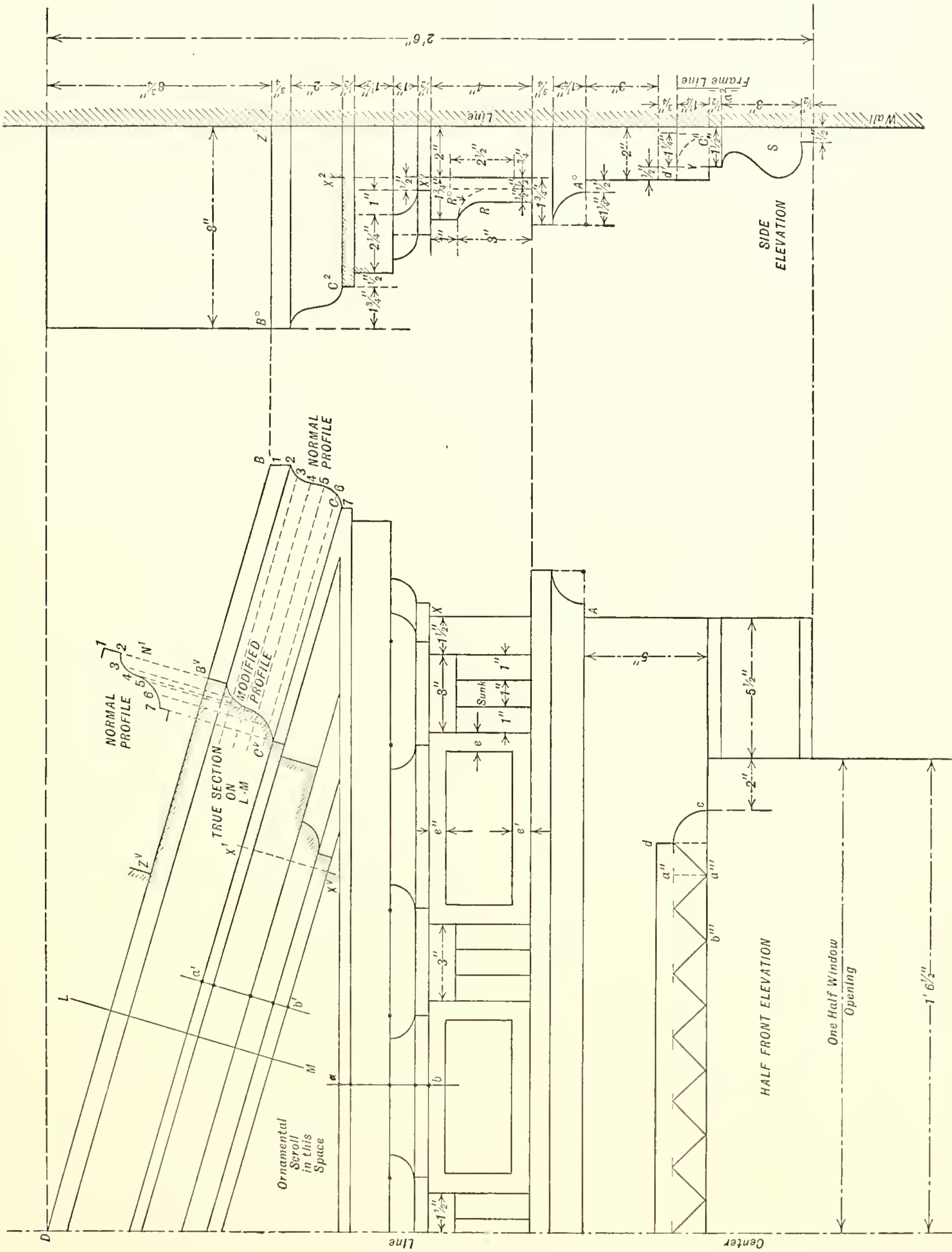


Fig. 105.—Working Detail of an Ornamental Window Cap

B D draw lines intersecting the horizontal line C *a*, as shown. Again by means of the one inch scale rule, measure the distances in the front elevation in Fig. 104 from the corner, to the side of the bracket. Measure also the width of the bracket. These distances will be found to measure 1½ and 3 in. respectively. The sunk face in the center of the bracket is one inch wide. Transfer these measurements to the working detail in Fig. 105 as shown by corresponding measurements. Since the scale drawing in Fig. 104 calls for five brackets one directly in the center, lay off the half face of the bracket in Fig. 105 as shown by the 1½ in. division. Place another bracket between the end and center brackets thus locating the position of the raised panels. Observe that the margin *e* between the panel or brackets is equal to either e′ or e″ which is ¾ in. as shown in the side elevation. Again referring to the scale drawing in Fig. 104 it will be seen that twelve triangular dentils occur in the molded chamfer and that the distance between the lowest line of the chamfer return and the inside of the corbel in the front elevation, scales 2 in. Set off this distance of 2 in. in the half elevation in Fig. 105 as shown at *c* and make the profile *c d* to correspond to C′ *d*′ in the side elevation. Space the half length of the chamfer in the front elevation in six parts as shown, and bisect one part, thus obtaining the point a″, from which drop a perpendicular, intersecting the lower line at *a*‴. By means of the division corresponding to that used for spacing the six dentils, step off from *a*‴ to *b*‴, etc; and draw lines connecting the dentil faces as shown. The face line of these dentils is shown in the side elevation by the dotted line Y.

Raking the Profile

In some cases the architect will show a true section on the line L M at right angles to the pediment or gable mold, but usually the sheet metal draftsman is required to modify the profile from the normal or given profile shown from B to C at the foot of the pediment. The method of modification, commonly called "raking" is as follows: Space the normal profile of the ogee B C into an equal number of divisions as shown by the small figures 1 to 7, from which points parallel to the rake B D draw lines a short distance above the profile as shown. Now take a tracing of the normal profile B C with the various intersections in same, and place it at pleasure, above the raking line B D, with care that the member 1—2 is at right angles to the line B D as shown at N^1. From the divisions 1 to 7 in N^1, at right angles to B D, draw lines which intersect correspondingly numbered lines drawn from the normal profile B C. Trace a line through points thus obtained. Then will B^v C^v be the modified profile of the ogee. Next take a tracing of the mold shown from C to X and place it as shown in the rake from C^v to X^v. Take the depth of the return from B° to Z° (8 in.) in the side elevation and place it in the rake as indicated from B^v to Z^v. Then will the shaded line from Z^v to B^v to C^v to X^v be the true section on L M. From this true section is obtained the girth in developing the pattern for the raking molding. It now becomes necessary to ascertain how far the top bend at *a* in the half front elevation will turn back to receive the miter cut at the foot of the gable or pediment mold. This is determined by drawing a line from the corner X^v in the true section on L M at right angles to the rake until it intersects the raking line drawn through C^v at X^1. C^v — X^1 is then the required distance, which is set off in the side elevation from C^2 to X^2, shown shaded. A flange is turned up at X^2 to facilitate soldering. This completes the architectural drafting of the window cap, preparatory to the development of the several patterns by the sheet metal draftsman.

Detailing a Main Cornice

We come to the third and final exercise in detailing, that of a cornice with panels, brackets, modillions and returns. In this connection is presented the simple procedure of figuring the various spacings of the modillions, brackets and the lengths of panels based upon the measurements obtained from mason's work as occurs in practice.

Computing Divisions

Fig. 106 shows a typical quarter-inch scale drawing such as is usually furnished by the architect. The measurements of the piers and windows are those presumed to have been taken at the building, while the front wall was in course of erection. We have the following sum:

2′ — 0″
3′ — 0″
2′ — 8″
3′ — 0″
2′ — 8″
3′ — 0″
2′ — 8″
3′ — 0″
2′ — 0″
———
24′ — 0″

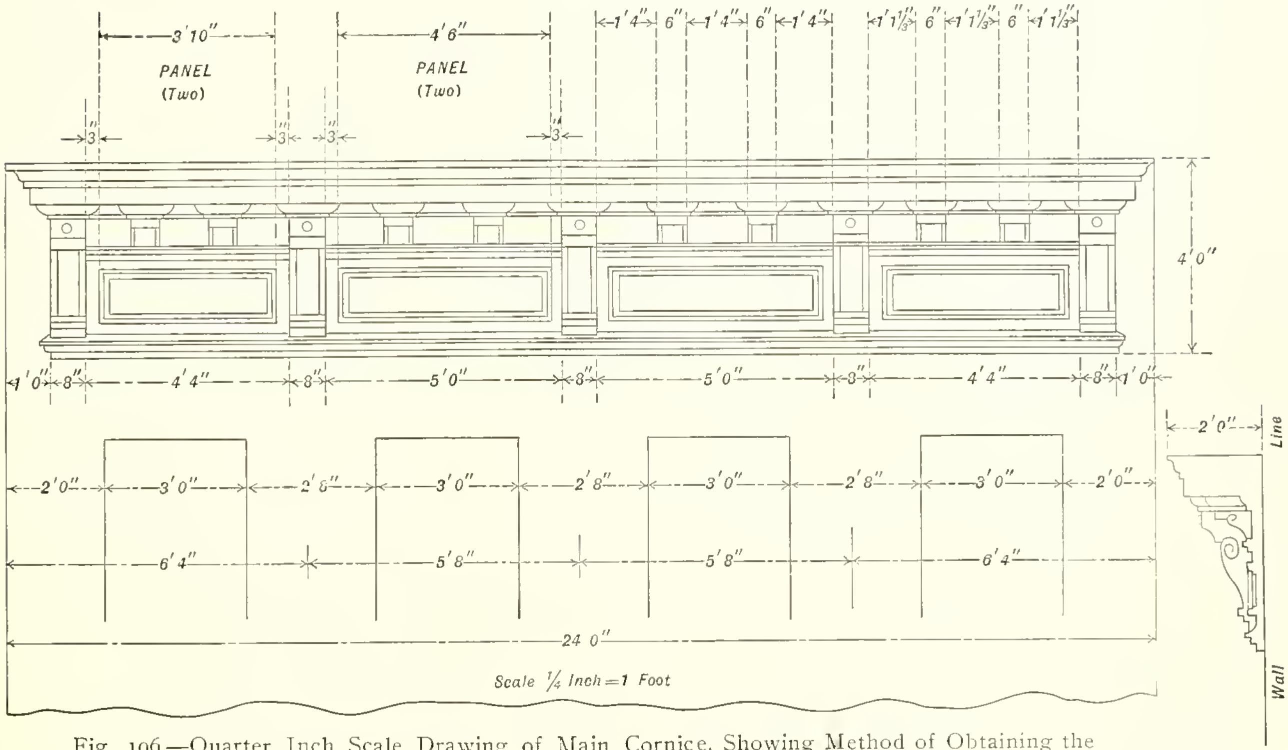


Fig. 106.—Quarter Inch Scale Drawing of Main Cornice, Showing Method of Obtaining the Various Dimensions

It will be observed that the cornice in this case is 4 ft. high with 2 ft. projection and that the end brackets are 1 ft. from the building line on either side, as shown. The three center brackets occur directly over the center of the brick piers as shown. With the measurements just obtained from the piers and windows to serve as a basis, the various divisions to the centers of the three center piers are simply obtained as follows: 2 ft. + 3 ft. + (½ of 2 ft. 8 in.) or 1 ft. 4 in. = 6 ft. 4 in. Continuing the simple calculations, we have 1 ft. 4 in. + 3 ft. + 1 ft. 4 in. = 5 ft. 8 in., as shown. Since the piers and windows possess symmetrical halves, the measurements of 6 ft. 4 in. and 5 ft. 8 in. naturally apply alike to either half. The measurements of 5 ft. 8 in. are seen to represent the distances from center to center of brackets for the center divisions. Now since the brackets are 8 in. wide simply deduct this measurement from 5 ft. 8 in., leaving 5 ft. as the distance between brackets for the two center divisions. The distance between the two brackets for the two end divisions is readily found by deducting the sum of 1 ft. + 8 in. + 4 in. = 2 ft. from the length of 6 ft. 4 in. leaving 4 ft. 4 in. as shown. Thus as a simple proving of these divisional measurements we have:

6′ — 4″
5′ — 8″
5′ — 8″
6′ — 4″
———
24′ — 0″

Summing the faces of the brackets and the spaces between them we have:

1′ — 0″
8″
4′ — 4″
8″
5′ — 0″
8″
5′ — 0″
8″
4′ — 4″
8″
1′ — 0″
———
24′ — 0″

Proceeding in the same simple manner for the margin or stile between the panel and bracket which is to be 3 in. as shown, we have 2 × 3 = 6. Thus 6 in. deducted from 4 ft. 4 in. and 5 ft. leave respectively 3 ft. 10 in. and 4 ft. 6 in. as the length of the panels, two of each of which are required.

Since two modillions occur between each two brackets, and each has 6-in. face, we simply deduct 2 × 6 from 4 ft. 4 in. and 5 ft. respectively and divide by 3. Thus, 4 ft. 4 in. = 52 in. and 52 in. — 12 in. = 40 in. Finally 40 in. divided by 3 = 3 spaces each of 13 1/3 in. Thus each of the spacings between the modillions in the 4ft. 4 in. division equal 1 ft. 1 1/3 in. Applying this simple method of figuring to the 5 ft. division we have 60 in. — 12 in. = 48 in. ÷ 3 = 16 in. or 1 ft. 4 in. for each space, as shown.

Preparing the Working Details of Main Cornice

A practiced sheet metal draftsman would readily be enabled to obtain full size measurements from a quarter-inch scale drawing such as is shown in Fig. 106, but we present in Fig. 107 a one-inch scale drawing from which the reader of less experience can obtain such measurements. With the proficiency acquired through experience he can obtain accurate measurements from the quarter inch scale drawing employing the quarter-inch scale rule. Proceeding with the fact in mind that the hight of the cornice is 48 in. and the projection, 24 in. lay off these measurements on the detail drawing in Fig. 108, as shown. Now by means of the one in. scale rule, measure separately the hight of each member in the one in. scale drawing in Fig. 107, finding their total which correctly computed is 48 in., as shown to the right of the wall line in Fig. 108. From these divisions draw lines indefinitely to the left, upon which place the various projections as shown by the full size measurements all as obtained from the scale drawing in Fig. 107. Draw the outline of the entire cornice or entablature as shown. The ogee is drawn free-hand, while the various coves and quarter rounds are struck from centers indicated by the heavy dots. In a corresponding manner obtaining the full size dimensions from the scale drawing in Fig. 107 and detail the side of the modillion and bracket as shown in Fig. 108, drawing the volutes free-hand as shown. In placing the cap mold over the sides of the modillion and bracket as shown respectively by *a b* and *a′ b′*, it is important that the mold be alike to the cap mold at A B. The preparation of these shop details does not involve the necessity of drawing

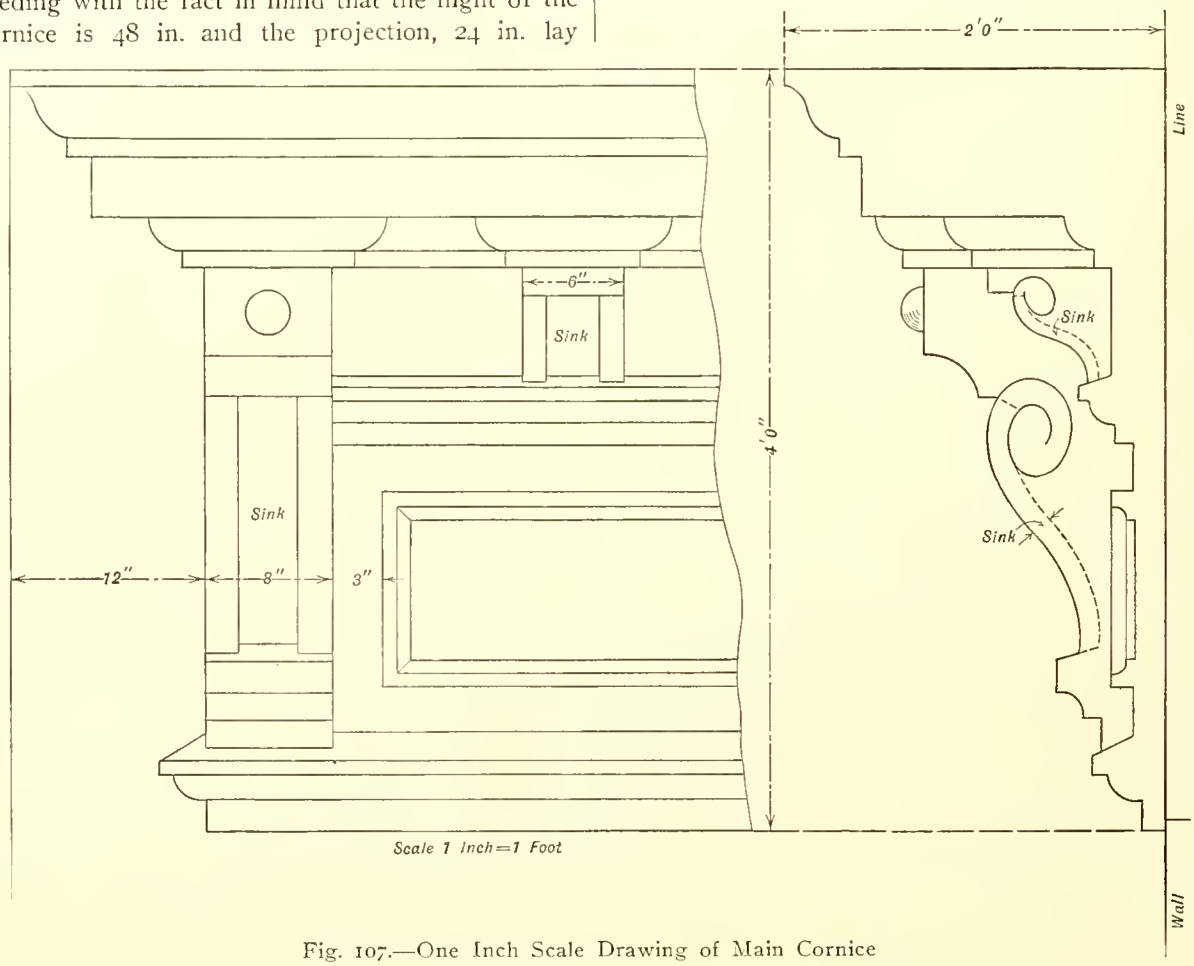


Fig. 107.—One Inch Scale Drawing of Main Cornice

front elevations of the bracket faces. It is required only that a section through the modillion and bracket faces be drawn roughly with full size widths of the face strips, the amount of sink in the face being indicated in the side views of the modillion and bracket as shown by the dotted lines. The band iron lookout or "brace" as it is usually termed is next drawn in position. This procedure is not subject to any fixed rule except that the band iron shall fit compactly against the various parts of the cornice in order to receive stove bolts, indicated by the short dashes. The formation of the brace is indicated by the shaded line. The detail as shown in Fig. 108 serves all requirement in developing the patterns for the cornice as called for in the quarter inch scale drawing in Fig. 106. In laying out the girth of the several moldings in the detail in Fig. 108, it is well to exercise foresight in placing or locating the seams with regard

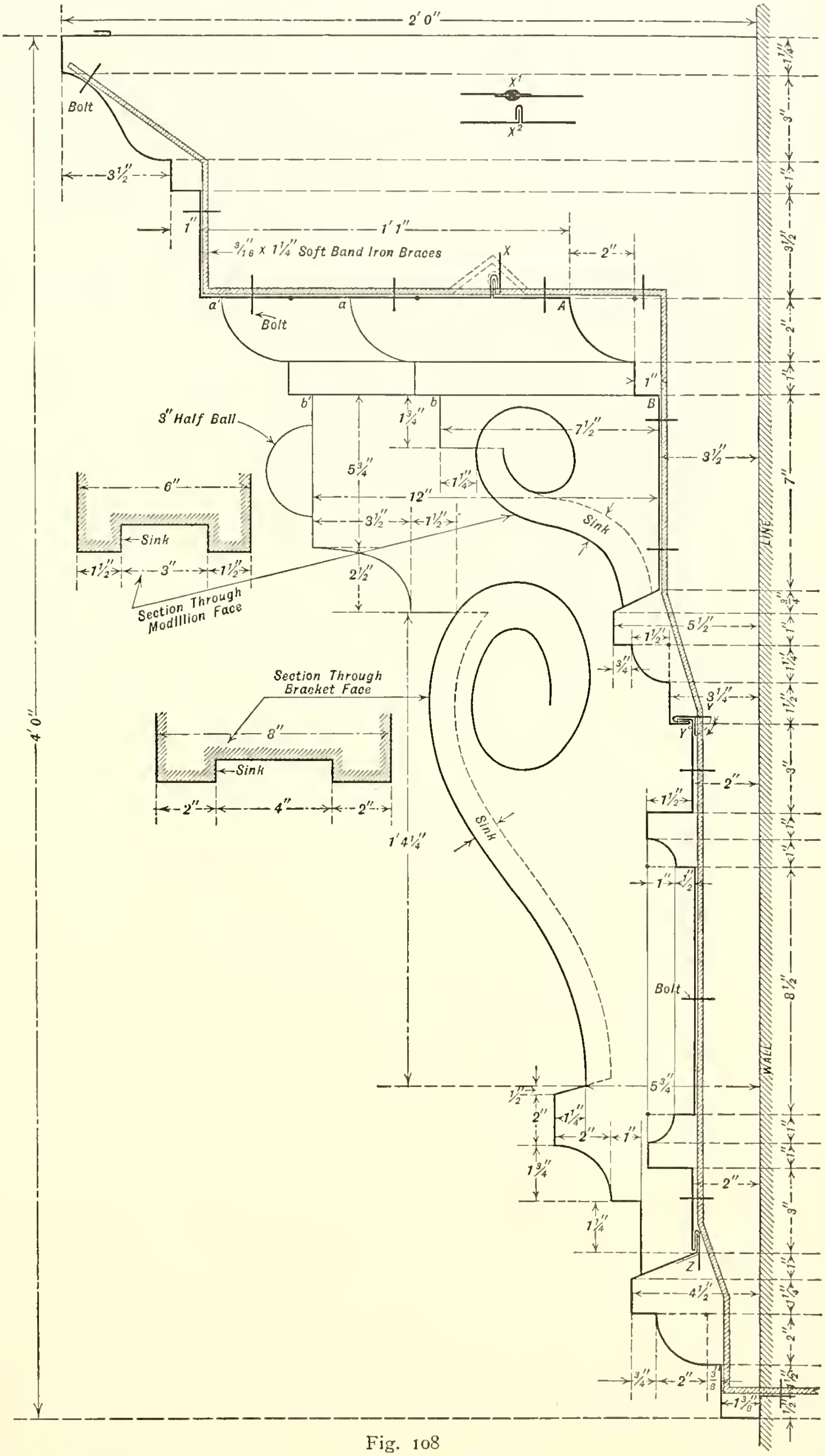


Fig. 108
Working Detail of Main Cornice, Showing Horizontal Joints and Band Iron Lookouts

for the width of metal carried in stock. In short, the seams should be so located that the least amount of waste of material will result. When occasionally it occurs that the girth is such, that less than the stock width is required a width may be selected, with a view to a trim that may be used for some other purpose, as skylight caps, dentils or other small items. Various types of seam are available for constructing the long seams of the cornice. The simplest and most common is the lapped and soldered or riveted seam, see X^1; a single lock seam may also be advantageously used, see X^2 or a locked seam may be employed as indicated at X, Y and Z in the detail. Note carefully at X the formation of the seam. This seam is secured and made tight by turning over the material at X as indicated by the dotted line. Note the formation of the lock at Y which is turned down at Y°. This lock occurs also at Z, the solid line being turned under the wash as shown by the dotted lines. In the case of standing seams as shown at X, the seams are usually turned down at required intervals to receive the band iron braces; or the braces may be turned V shape as shown by the dotted line over X. Soft steel is required for its working properties in bending these lookouts or braces, since it permits bending the work cold, requiring no heating at the forge. The patterns for the brackets and modillion sides may be pricked directly upon the metal from the detail drawing, when allowance is provided for laps for riveting to the parts of the cornice.

Lettering Applied to Sign Boards and Electric Signs

The extensive use of electric, frieze and panel signs renders a knowledge of lettering a valuable acquisition to the sheet metal draftsman. The method of proportioning the letters and figures is comparatively simple. In Figs. 109, 110 and 111 are shown respectively, the Block, the Roman and the Egyption forms of letters and figures. These formations constitute at least the basis of requirement for constructing the letters and figures for the purpose under discussion.

A rule of simple application is to divide the proposed hight of letters or figures into five equal spaces, taking the width of one space in the dividers and stepping off indefinitely as shown by the square divisions, when the proportions may be followed as shown in the engravings.

In the preparation of such letters for electrical signs they are raised, "stripped" or sunk. In either

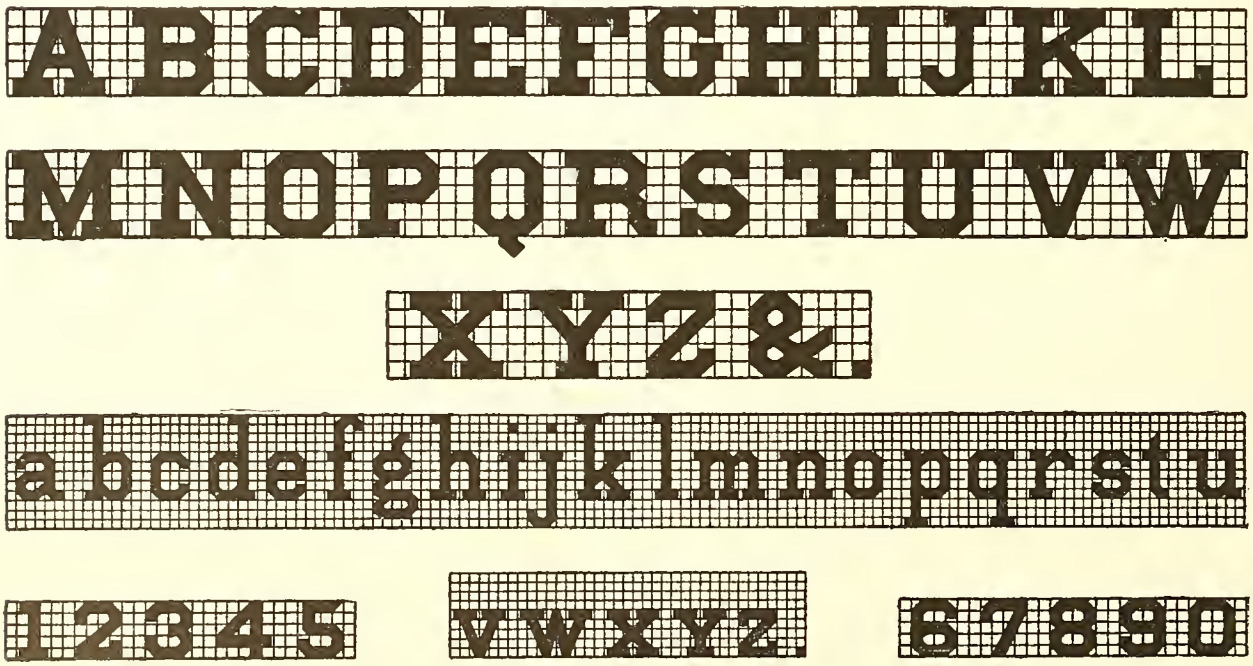


Fig. 109.—Block Letters and Figures

Fig. 110.—Roman Letters and Figures

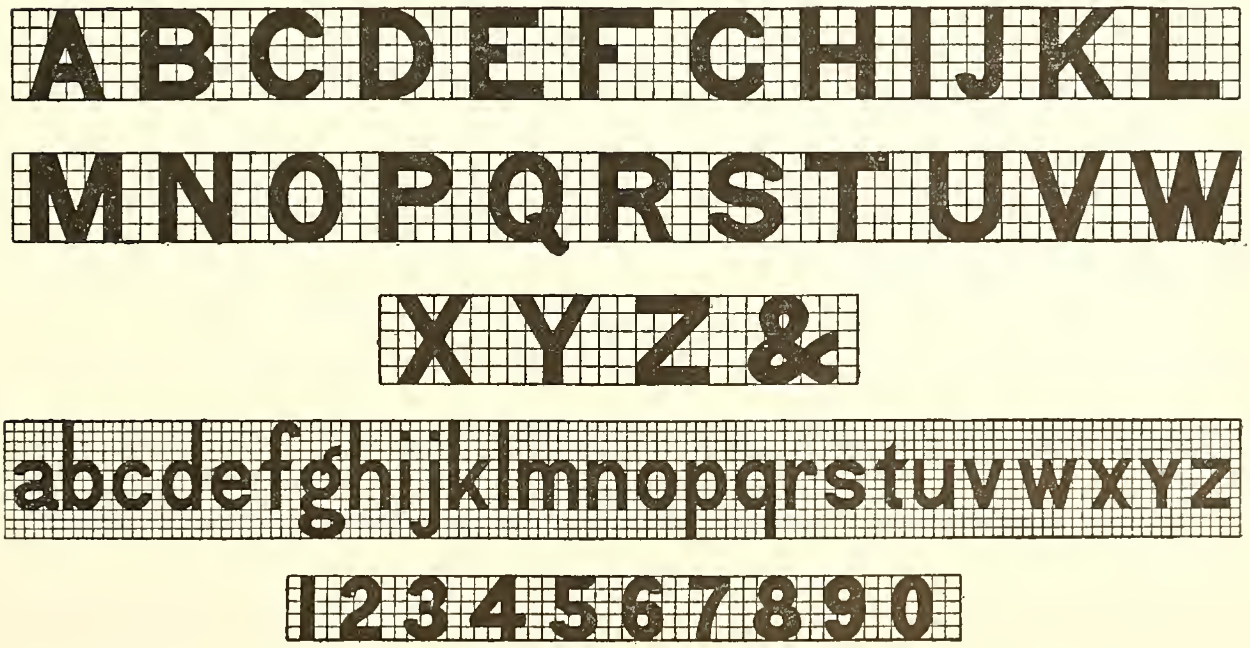


Fig. 111.—Egyptian Letters and Figures

case holes are usually punched in the letters to receive the bulbs as indicated in Fig. 112. According to common practice the punching of the holes is done under the direction of the electrical worker, but full information on the installing of electrically illuminated signs is presented elsewhere in this volume. Fig. 113 indicates the procedure of laying out any size of letter. As an example, the words SHEET METAL are shown. Let A-B represent the desired

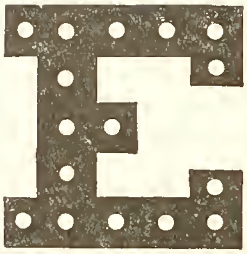


Fig. 112.—Letter Used in Electric Signs

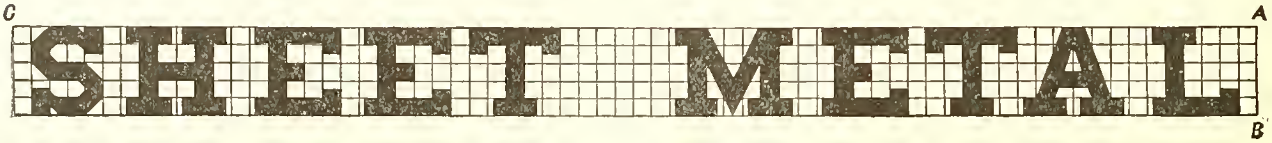


Fig. 113.—Drawing Block Letters

hight of the letter. Divide this space into five parts and step off one of the spaces on the line A-C into indefinite divisions as shown. For block letters the proportions shown in Fig. 109 may be followed and for purpose of practice the student may, if desired, lay out the words "Sheet Metal," in Fig. 113, as shown.

Of course, the punching of holes in letters or figures is performed according to requirement dictated by the use for which the electrically lighted sign is intended. In the case of large letters of copper, built into the courses of brick while the construction of the wall is in progress, copper lugs of about 6 in. long and 2 in. wide are riveted to the top and bottom of the letters which are built in with the brick courses. The letters are then of such hight as to meet the mortar joints at top and bottom.

It is hoped that this brief consideration of letter design will furnish the necessary suggestion to the sheet metal worker who may refer to Part XII of this work for a discussion of the mechanical methods applied to the construction of illuminated signs.

PART IV

PATTERNS FOR SHEET METAL CORNICES, RETURN, FACE, BEVEL AND BUTT MITERS, PANELS, MOLDINGS, PEDIMENTS, DORMER AND BAY WINDOWS

THE treatment of miters most commonly required in cornice work, are now in order.

In plain square miters results are obtained directly from the given profile in the simplest manner possible.

Plain miters may be divided into three classes, commonly termed *return* miters, *face* miters and *butt* miters. A butt miter may really belong to either of the other two classes, and differs from them only in having but one arm. A return miter is one in which the two arms lie in the same horizontal plane, whence it will be seen that if the angle be a right angle, as it usually it, one arm will appear in elevation while the other arm appears in profile. This constitutes what is usually termed a "square miter." Fig. 114 shows a perspective view of a square return miter of a crown mold.

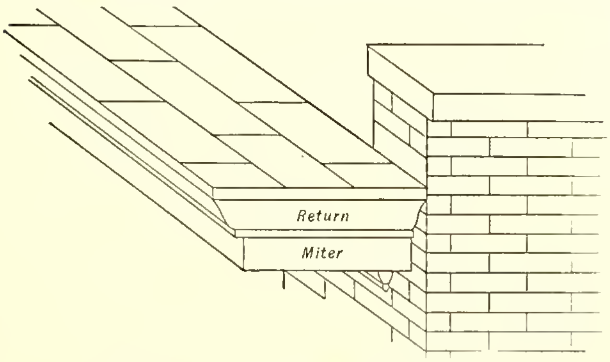


Fig. 114.—View of Square Return Miter

PATTERN FOR RETURN MITER AT A RIGHT ANGLE IN PLAN

Solution 1

Return miters may be either "inside" or "outside," according as they are made to fit an internal angle, or an external angle, as will be explained in succeeding solutions.

A face miter is one in which the two arms lie in the same vertical plane and, like the return miter, may assume any angle, that at 90 degrees being termed a "square" face miter. Fig. 115 shows a view of a portion of a cornice having two face miters, the lower one, A B, being a "square" or right angle miter, while the other, C D, is oblique.

What ever be the angle of the miter, whether its arms lie in a vertical or in a horizontal plane, the method of developing its patterns follows much the same course of procedure, the difference being principally in the view from which the development is made. If the reader will turn for a moment to the carpenter and see him cut or saw a miter upon a piece of wooden molding, he may learn something that will be an unfailing help to him in making the necessary drawing which must always precede the development. Having placed the piece of molding in what he terms the miter-box, the carpenter places his saw into the proper grooves or slot and saws down through the wood, and in so doing produces an olique plane surface, which may be termed the miter plane, that is, the plane on which the two arms of the miter meet when they have been brought together.

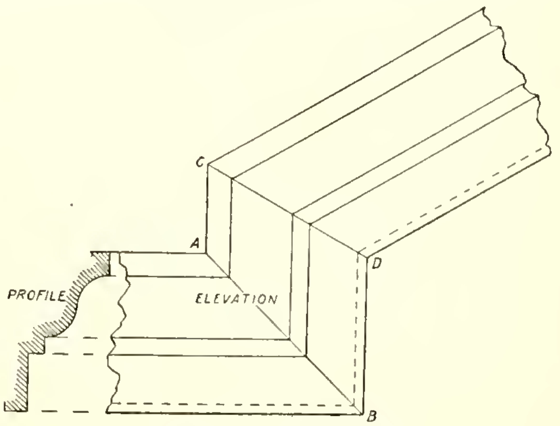


Fig. 115.—Face Miters

The all important principle to be kept in mind is, therefore, that before the pattern can be developed such a view of the required molding must be made as will show an edge view or profile of the miter plane. The edge view of a plane is a line, consequently what is really the miter plane is commonly termed the *miter line*. Thus when both arms

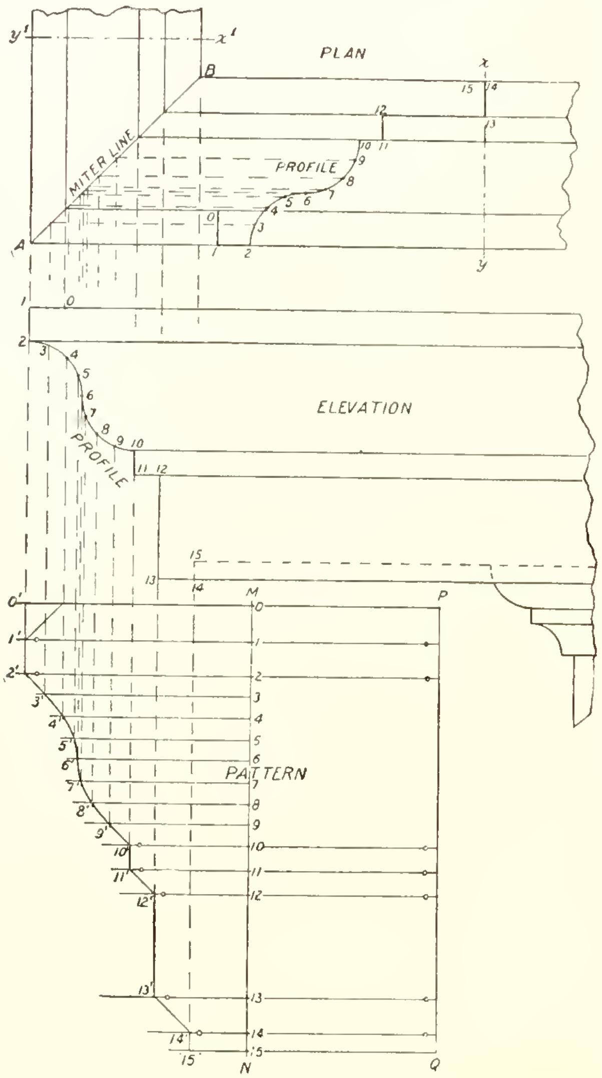


Fig. 116.—A Square Return Miter and Method Usually Employed in Obtaining Pattern

of the miter lie in a horizontal plane, the plan shows an edge view of the miter plane, as A B in the upper part of Fig. 116, and becomes the view from which the pattern is obtained; while when both arms of the miter lie in a vertical plane, the elevation is the view which gives a profile of the miter plane, and is therefore the view to be employed in developing the pattern.

Having now drawn such a view as will show the miter plane in profile, placed at its proper angle, and at the same time a profile of the mold properly turned, the universal rule to be followed in all miter work is to first divide the profile of the mold into a convenient number of equal spaces, then to carry lines from each of the points thus obtained parallel to the lines of the view to intersect the miter line, and finally to carry lines from points of intersection thus obtained on the miter line, at right angles to the lines of the view, into the stretchout.

A square return miter is the only miter in the development of which a short and at the same time correct method is employed. This we have shown in the lower part of Fig. 116, to which we have added at the top a plan from which may be deduced the reasons why the short method is correct. The elevation in this view shows at the left, a profile, or in other words, an edge view of the return or receding arm of the miter. According to the usual method, divide the curved portion of this profile into spaces, as explained above and as indicated by the figures, placing figures also at every angle or bend of the profile. On any line drawn conveniently near and at right angles to the lines of the molding (that is vertically), as M N, called the stretchout line, set off the length of the spaces upon the profile, placing them in successive order and numbering them to correspond with the points on the profile. Through each of the numbered points on the line M N draw lines parallel to the lines of the elevation, extending them in this case to the left, thus bringing them under the profile, and from all the points on the profile carry vertical lines down to intersect lines of corresponding number in the stretchout, as shown by the dotted lines, called projectors, at the left of the engraving. A line traced through the intersections thus obtained, as shown at 1′, 2′, 3′, etc., will give the outline or miter cut of the pattern. It must not be overlooked that, inasmuch as the molding extends indefinitely to the right, some point in the pattern, as P Q, must be assumed at the right of the miter as the other end of the pattern. The elevation shows an outside miter. In a drawing for an "inside" miter the profile would appear reversed, turned over from right to left, with reference to the elevation, when the pattern would of course be also reversed. However, if the line P Q were at the left of the miter cut, and the lines were continued to the left instead of to the right, the pattern would be that of an inside miter, all as will be explained.

According to the explanation given above, the plan is the view in which the edge view of the miter line is shown and should be the view employed in obtaining the miter, and, were the miter anything other than a square miter, the plan is the only view that could be employed. A plan of this miter is shown in the upper part of the drawing in which the profile represents a section on any line drawn at right angles across the mold, as *x y*, but is shown as though hinged upon that line and revolved into the plane of the view. If it be supposed to be a section on *x′ y′*, of the other arm of the miter, and to be hinged upon that line instead of upon *x y*, its position when brought into the plane of the view would then be exactly the same as that shown at the left in the elevation. Consequently, projections made from the several points in it would cross the miter line coincident with those from the profile shown and would arrive at the same point in the stretchout as those already obtained.

Allowances for laps may be made at the discretion of the cutter, but lines indicating where bends are to be made in the brake in forming are shown and the prick marks indicated.

CONSTRUCTIVE VIEW OF CORNICE AND GUTTER COMBINED

Solution 2

In the case of return miters, required for a cornice alike to that shown in the constructive view of Fig 117, the method of the preceding problem applies except that the horizontal seams must first be located to conform to the width of the sheet iron carried in stock, when the patterns may be developed. The method indicated in the figure is that of fire-proof construction. It will be noted that angle iron brackets made of 2 × 2 × ¼ in. angles are built into the wall. To this frame the cornice is secured by means of band iron cornice lookouts. To the top of these lookouts, angle iron is secured as shown, and the top gutter brace is secured thereto as indicated. Wood sheathing having the proper pitch toward the outlets, is then laid inside of the angle and band iron construction. To avoid the necessity of soldering along the top edge a special type of lock is inserted between the metal lining and cornice, as is more clearly shown in the detail in Fig. 118, in which the top of the mold is shown,

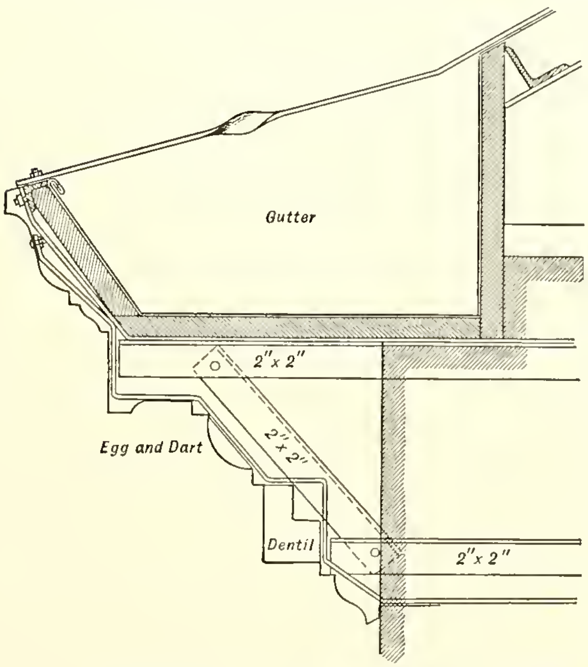


Fig. 117.—Constructive View of Cornice and Gutter Combined, on Angle Iron Construction

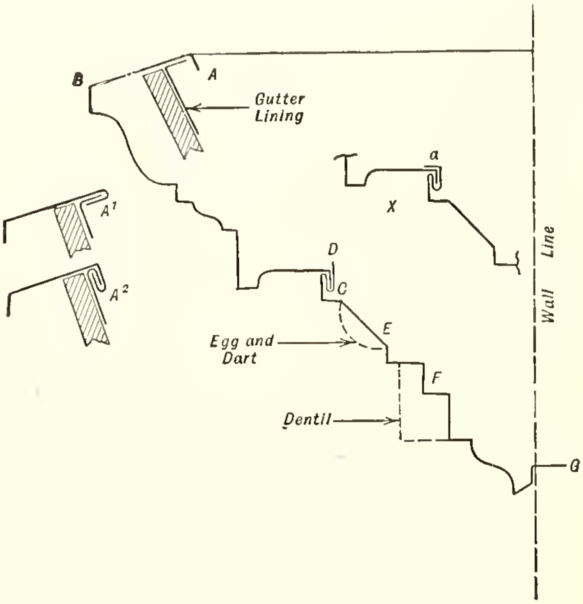


Fig. 118.—Method of Constructing Horizontal Seams without Soldering

with the flange bent at A B. The gutter lining has an outward flange, placed in the position shown, after which A is locked over the gutter flange as shown at A^1. It is then double seamed against the wood sheathing as at A^2. Assuming that the girth of the crown mold from A to B to C may be made up from stock widths of iron, a single edge should be placed along the planceer and the lock at the top of the bed mold made as shown at D. The single edge of the planceer is then set inside of this groove and at D the metal is turned over as shown in diagram X at *a*. Where the egg and dart mold is attached to the metal cornice, the background or metal body is formed to receive the pressed egg and dart, as shown from C to E. The dentils are set to the dentil course shown by F. G is the flange on the drip, built in as the construction of the wall progresses. The patterns for the returns are laid out in the usual manner, bringing into use the girth of the mold from A to C, and from D to G. The method of development is in conformity to that as explained in the next preceding problem.

PATTERN FOR A BEVEL MITER

Solution 3

Fig. 119 illustrates the development of bevel miters.

The profile chosen is modeled after a Greek form in which that part of the profile between points 4 and 15 is primarily a portion of a parabolic curve. This has been simulated by constructing it of two arcs of circles. The upper part, that from 4 to the point *c*, is drawn from the center *a*, while the remainder, *c* to 15 is an arc whose center is at *b*. It should be noted that the two curves meet at a line drawn from *b* through *a* to meet the curve at *c*. Of course, two formers must be used in forming this part of the mold.

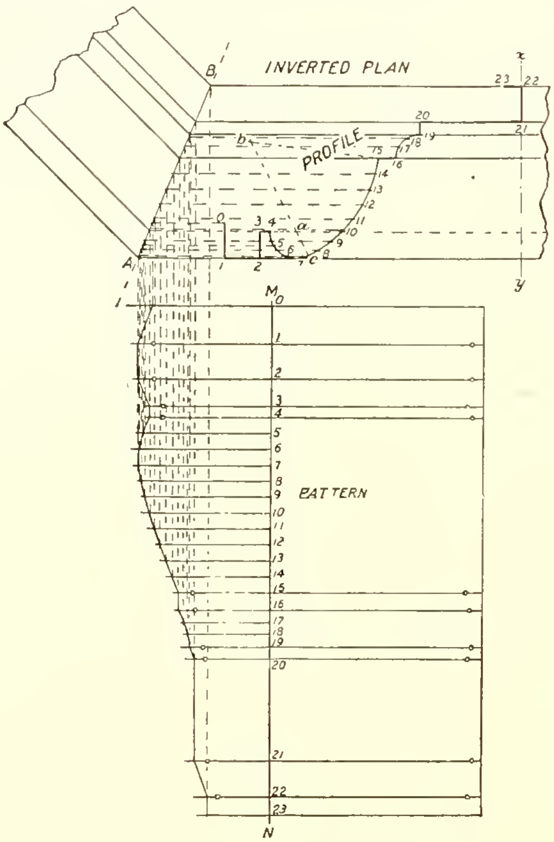


Fig. 119.—Bevel Miter in Crown Mold

As previously explained, the plan is the view in this case which shows an edge view of the miter plane A B. The view shown is called an *inverted plan,* that is, a view looking up instead of down. The profile is a section on any line as *x y* crossing the plan at right angles, upon which line the plane of the section is hinged or turned over to the left, to a position in the plane of the view as shown. Lines from the several points in the profile follow the direction of the mold till they intersect the miter line A B, whence they are carried at right angles into the measuring lines of corresponding number of the stretchout, which has been previously set off on M N, all as explained in a previous problem.

It is easily seen that this miter does not differ in any respect from a butt miter, if we remove or erase that part of the plan to the left of the miter line and extend A B so that it may represent any plane in an oblique position, as the side of a tower or some surface against which the molding is required to abut.

DEVELOPING INSIDE AND OUTSIDE MITERS AT ONE OPERATION

Solution 4

In Fig. 120 is shown a perspective view of an outside and inside miter. A indicates the exterior or outside angle, while B shows an interior or inside angle. A method of developing these inside and outside miters directly upon the sheet metal at one

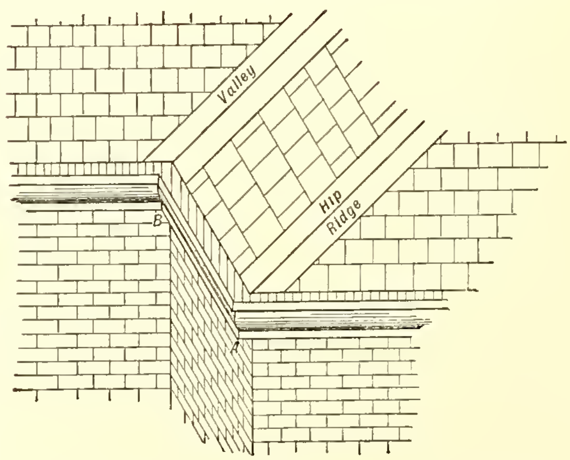


Fig. 120
Perspective View Showing Outside and Inside Miters

operation is shown in Fig. 121. In this case we will assume that the angles are right angles or of 90 degree. If it be a gutter miter that is sought, first draw the profile, as shown, from 1 to 10. Extend the eave line 2-3 as A B and divide the cove mold into equal spaces, as shown. From the various

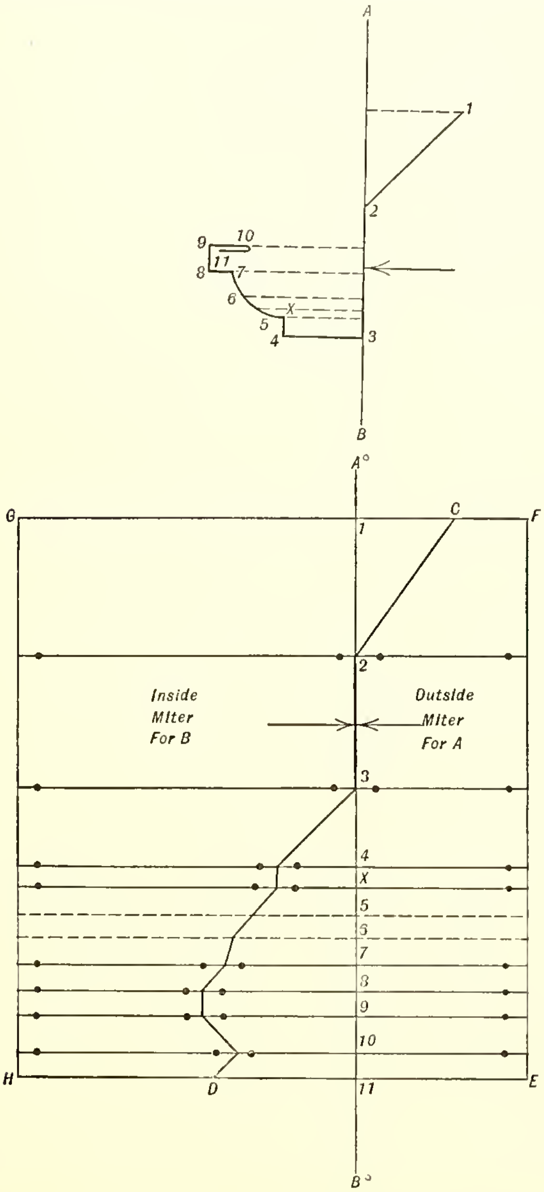


Fig. 121.—Quick Method of Obtaining Inside and Outside Miters at One Operation

points 1 to 11, draw horizontal lines to meet the vertical line A B, as shown. To obtain the pattern, draw any line as A° B°, directly upon the sheet metal, and on the metal place the girth of the gutter profile, as shown by corresponding numbers. Through these small figures, at right angle to A° B° draw lines indefinitely, right and left, as shown. Then measuring in each instance from the line A B take the various projections, right and left, to points 1 to 11 and place them right and left to the line A° B° on lines of like numbers, measuring in each instance from the line A° B°. Trace through the points so obtained, the miter cut C D. Draw parallel to A° B° the lines E F and H G. Then will C D E F be the pattern for the outside miter A in Fig. 120 and C D H G in Fig. 121 the pattern for the inside miter shown by B in Fig. 120. If the length of the gutter is to be measured along the eave line indicated by the arrow on the line A B in Fig. 121, it will be necessary in laying out the patterns to take the measurement at arrow points indicated, for the outside and the inside miters.

DEVELOPING OUTSIDE AND INSIDE BEVEL MITERS AT ONE OPERATION

Solution 5

If the angles shown at A and B in the perspective in Fig. 120 were bevel miters, or miters others than 90 degree, the development of the exterior and interior angles at one operation may be effected as

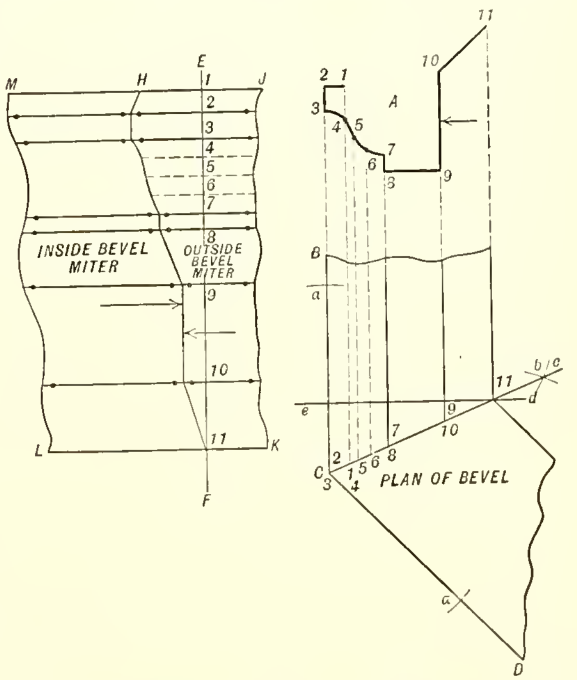


Fig 122.—Quick Method of Laying Out Directly on the Metal at One Operation

shown in Fig. 122. Here A shows the profile of an ogee gutter or molding or cornice, as the case may be. Below the profile A, draw the plan of the bevel as shown by B C D, exercising care to place this bevel so that the perpendicular arm B C is in line with the extreme projection of the profile A at 2-3, as shown. Obtain the miter line for this bevel as follows: With C as center, with any desired radius, draw a short arc cutting the arms of the bevel at *a* and *a*. Using *a* and *a* as centers, with the same or any other radius, describe arcs cutting each other at *b*. Draw the miter line C *c*. Now, divide the profile A into any number of spaces as shown by the small figures 1 to 11 from which points parallel to the bevel arm B C, draw lines cutting the miter line C *c* from 1 to 11, as shown. Through the extreme point 11, at right angles to B C, draw the line *d e*. At pleasure directly on the metal, draw any line as F E, on which place the girth of the profile A. Through the small figures 1 to 11 at right angles to F E, draw lines indefinitely, as shown. Next, measuring from the line *e d* in plan, take the various projections with the dividers to points 1 to 11 on the miter line C *c* and place them on similarly numbered lines in the pattern, measuring each instance from the line F E. Trace a line through points so obtained, 11 H will be the desired miter cut; H J K 11, the miter cut for the exterior angle and H 11 L M the miter cut for the interior angle. If measurements are taken along the eave line as at 9-10 in profile A, it will then be necessary to take measurements along the corresponding eave line, as shown by the arrow points in the patterns.

FACE MITERS AT DIFFERENT ANGLES

Solution 6

Fig. 123 shows the elevation of a cornice pediment on which face miters are required and demonstrates that the elevation is the required view from which to obtain the patterns. Fig. 124, herewith given, is a view similar to that illustrated in Fig. 123. The design shows two face miters, the

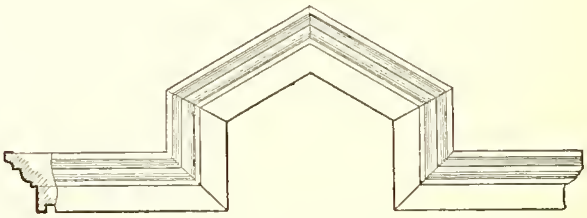


Fig. 123.—Cornice Pediment Requiring Face Miters

lower of which is a square face miter, while the angle of the upper miter is greater than a right angle.

In constructing the view in Fig. 124, first draw the profile as shown at the left and from the several

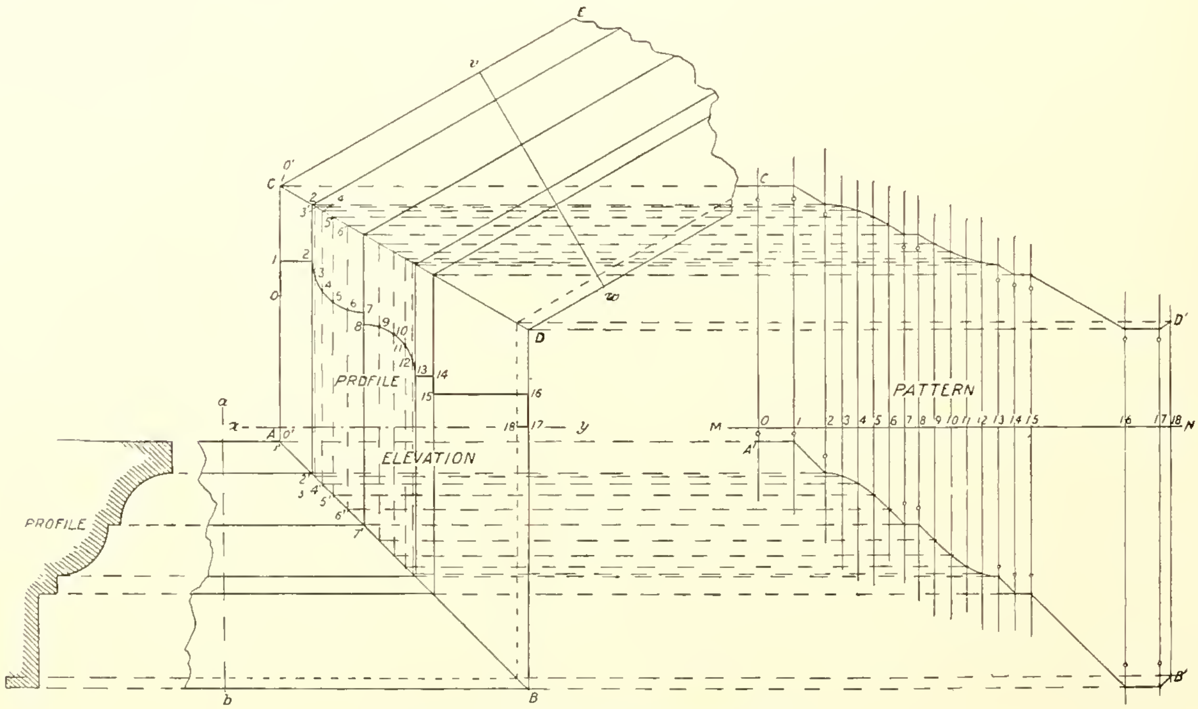


Fig. 124.—Face Miters at Different Angles

angles project lines indefinitely to the right, to begin the elevation. From A erect the perpendicular A C according to requirements. On *x y*, drawn horizontally, set off the spaces found on the perpendicular *a b*, and through the points thus obtained on *x y*, draw other perpendiculars to cut the lines first drawn, as shown from A to B. As a verification of these intersections, it should be noticed that the line A B must be at an angle of 45 degrees and that all the intersections must fall on this line. From C, draw C E at the required angle and draw *v w* at right angles to C E, upon which repeat the spacings on *a b* as before. Through the points thus fixed, draw lines parallel to C E to intersect with the vertical line just drawn, thus establishing the position and angle of the miter line C D.

Since both arms of either one of the miters shown are alike, we can economize labor by developing the pattern for the middle piece, duplicating the other arm of the oblique miter from the upper end of the pattern when obtained and that of the square miter from the lower end of the same pattern.

The profile of the mold is shown at the left, but it will be necessary to place it in the middle section as shown, so that lines can be projected to both miter lines at the same operation. This profile represents a section on the line *x y*, the edge view of the section plane, which section is brought into the plane of the view by being hinged or revolved upon the line *x y* through a quarter circle.

Therefore divide each of the curved portions of the profile into any convenient number of equal spaces, numbering the points of division as shown by the small figures, and set off a stretchout of the entire profile on a line drawn at right angles to the lines of the elevation of the piece being developed, as shown by M N. Draw the measuring lines through the points thus obtained as shown, which must be numbered to correspond respectively with the points on the profile. Project lines from the several points of division on the profile, parallel to the lines of the mold, to intersect the miter lines A B and C D, as shown, and, finally, project lines from each of the points of intersection just obtained on the two miter lines to cut measuring lines of corresponding number in the stretchout, when lines traced through the points of intersection thus obtained, as shown from A^1 to B^1, and from C^1 to D^1 will, with the line A^1 C^1 and B^1 D^1, constitute the pattern.

One of the principal sources of failure to get correct results in miter cutting is carelessness in the numbering of points. The profile should in all cases of miter work first be divided into spaces and numbered consecutively from one end to the other. Then each point on the stretchout line (M N) should bear the same number as the point which it represents on the profile. If any difficulty then arises, each point on the miter line can also be numbered to correspond with the point from which it was obtained on the profile, as indicated by 1′, 2′, 3′, etc., on either miter line. After this there should be no trouble in projecting the several points on the miter line into the proper measuring line of the stretchout.

SQUARE PANEL MITER

Solution 7

In this problem and in others following in regular sequence, various exercises are given in the development of the patterns for *face miters* in panels, as well as in angular and curved pediments.

The first problem considered is that of a square panel miter, occurring in panel shown in the finished

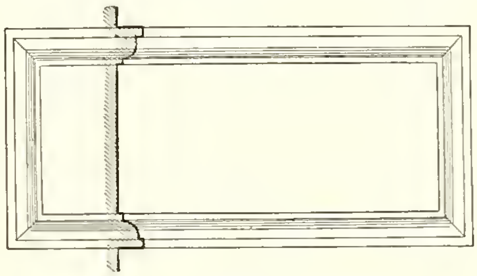


Fig. 125.—View of Panel with Square Miters

view in Fig. 125, the development of which is shown in detail in Fig. 126. Let A B C D represent part of the panel with its section drawn in its proper position as shown. Divide the lower mold X into an equal number of spaces, as shown by the small figures 1 to 10. From these points draw lines parallel to D C until they cut the miter line C E. In the elevation the lines are carried around the panel, to intersect the upper mould in section 10′. This, however, is not necessary in the development of the pattern.

The pattern may now be laid out as follows: At right angles to C D draw the line D H upon which place the girth of the mold X in the section as well as the distance from 10 to 10′, as shown by corresponding numbers from 1 to 10 to 10′ on D H. Below 10′, reproduce the girth of the mold X, as shown from 10′ to 1′. Through these small figures, at right angles to D H, draw lines as shown which

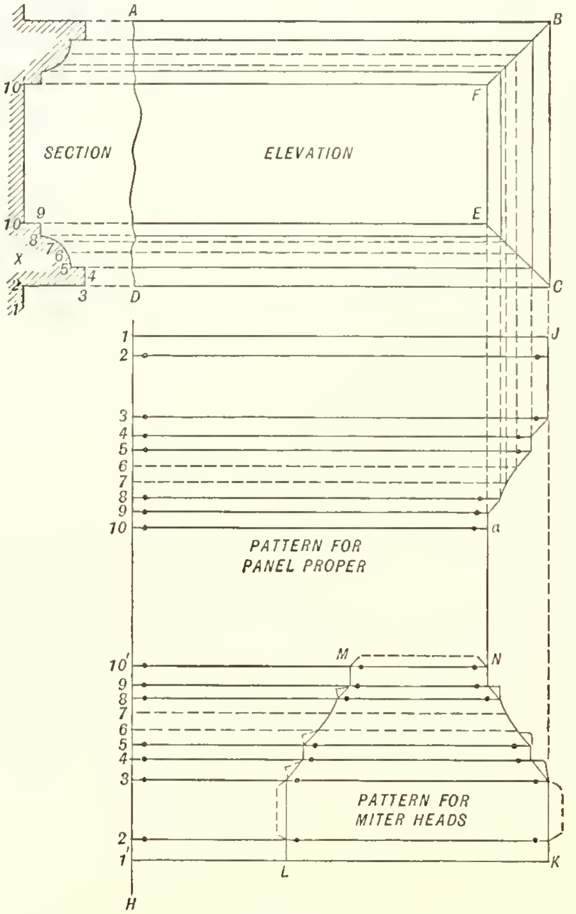


Fig. 126
Obtaining Patterns for Face Miters in Square Panel

intersect lines drawn parallel to D H from similar intersections on the miter line E C in elevation. A line traced through points so obtained, as shown from J to K, will be the full miter cut for one end, which is reproduced at the opposite end, when the proper length is known. The pattern for the molded miter head shown by B C E F, in elevation is developed as follows: Take the distance from B to C and set it off on the full pattern, as indicated from K to L. In the same manner take the distance from E to F in elevation and place it on the pattern from N M. Reproduce the cut K N, as shown from L to M. K L M N then becomes the desired pattern. The lap along M N is soldered at N *a* in the full pattern. Allow laps on the miter cuts of the head as shown.

A TRIANGULAR PANEL

Solution 8

In cornice or sign work, panels are made up in various shapes and, while the application of principles is alike in all face miters, the method of drawing the miter lines in elevation requires to be carefully followed. Fig. 127 shows a finished view of a triangular panel, also its mold section. Fig. 128 shows how this work is laid out. First draw the

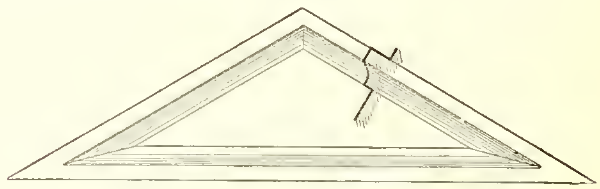


Fig. 127.—View of Triangular Panel

center line A C and then draw the outline of *one half* of the panel, as the halves are symmetrical in this case, as shown by A B C. At right angles to A B draw the profile or section of the panel mold, shown at D. The method of the next step, to obtain the miter line F B in elevation, is as follows: Using B as center, with any radius, describe arcs cutting the line A B at *a,* and B C at *b.* Again,

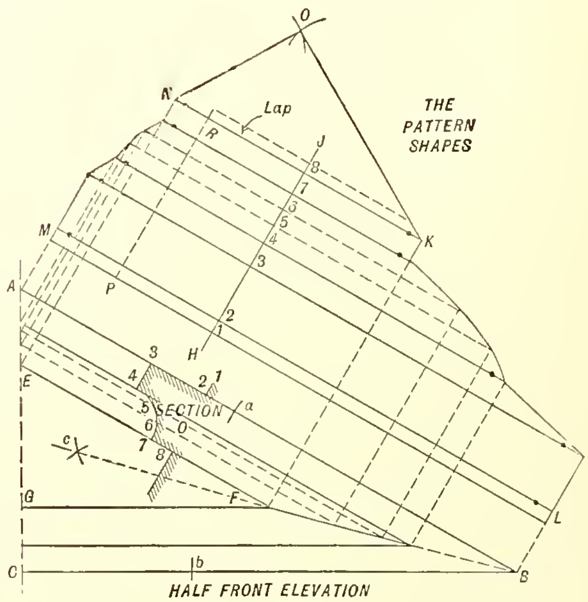


Fig. 128.—Obtaining Pattern Shapes for Triangular Panel

with any desired radius, using *a* and *b* as centers draw arcs intersecting each other at c. Draw the miter line *c* B. Space up the section D as shown from 1 to 8. Through these figures draw lines parallel to A B until they intersect the center line A C as shown, also the miter line *c* B at the bottom. If it be desired the elevation of the horizontal mold F G at the bottom may be completed, as shown. The pattern may now be laid out as follows: Take the girth from 1 to 8 of the section D, and place it on the line H J, which is drawn at right angles to A B. At right angles to H J, through the small figures 1 to 8, draw lines, as shown, intersecting lines, drawn parallel to H J, from similar intersections on the miter lines A E and F B in elevation. A line traced through points so obtained, as shown by K L M N, will be the pattern for the two oblique molds forming the panel. The pattern for the one half horizontal mold B C in elevation, is obtained by taking this distance and placing it in the pattern from L to P. From P draw the perpendicular line P R. Then P R K L becomes the half pattern, shown by C G F B in elevation. If the panel is of such size that the triangular piece E F G in elevation may be added, take F G as radius, with K in the pattern as center, and describe the arc O, intersecting another arc, struck from N as center, with radius equal to E G in elevation. Draw lines in the pattern from N to O and O to K. A lap is shown added along R K in the half pattern for bottom mold. This lap would require to be soldered along K O in the triangular addition.

PATTERNS FOR AN IRREGULAR PANEL

Solution 9

Fig. 129 presents a view of an irregular panel whose right end has broken right angular corners, while at the left end the run of the molds is oblique. The profile of the mold is an ogee and square fillet as shown. Four patterns are required, namely, two

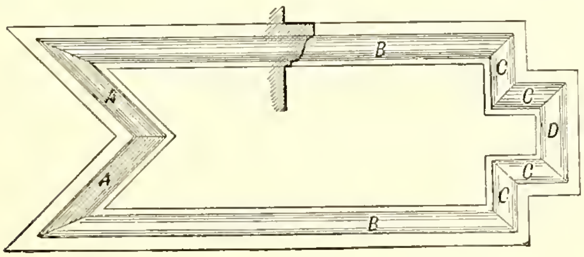


Fig. 129.—View of Irregular Panel

of A; two of B; four of C; and one of D, the pieces being formed right and left.

Fig. 130 shows how these four patterns can be laid out after the pattern for one side of the mold has been developed. First, draw the profile of the panel indicated by A, which gives the dimensions. Then construct the outline shown by B C D E F G H J K B. Obtain the miter lines at B and J, as explained in the preceding problem. The corners at C D E F G H and K being right angles, the miter lines form angles of 45 degrees, as shown. The elevation of the panel may be completed, but if desired, in practice only the miter lines at J and H are necessary so far as concerns the miter cuts. For successfully drawing a complete elevation of the panel, it is essential that the distance K *a* and K *b* are perpendicular to the outline and equal to the vertical mold through 9-1 in the profile.

Space the lower profile into equal divisions as indicated by the small figures 1 to 9. Through these points, parallel to J H, draw lines until they intersect the miter lines from the corners H and J. If the panel be of such size that the flat surface

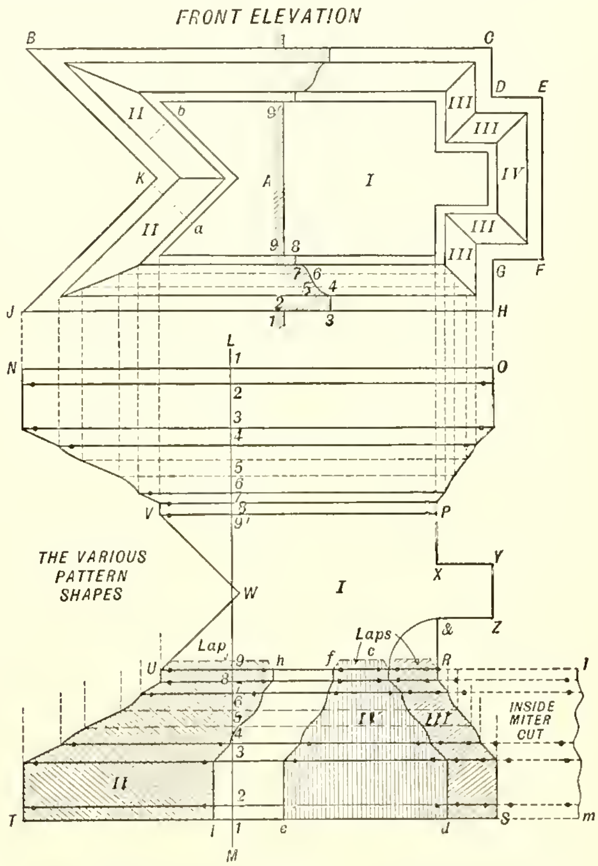


Fig. 130.—The Various Patterns in an Irregular Panel

between 9 and 9′ can be added to the pattern, the full pattern is laid out, by drawing the girth line L M at right angles to J H and on this girth line laying off the girth of the profile 1 to 9 in elevation as well as the flat surface 9 to 9′, as shown by corresponding numbers 1 to 9 to 9′ to 1 on L M. Through these small figures, draw at right angles to L M, lines intersecting lines drawn parallel to L M from corresponding intersections on the miter lines from J and H in elevation. A line traced through points so obtained, as indicated by N O P R S T U V N, will be the desired miter cuts. Between the points U and V and P and R, reproduce the flat surface of the panel in elevation, as shown in the pattern by U W V and P X Y Z & R, respectively. The entire flat pattern outline marked I represents the full pattern for the flat panel proper marked I in elevation.

To obtain the pattern for the panel molds marked II in elevation proceed as follows: The angle at K in elevation requires an inside miter cut. Therefore take the distance from J to K and place it as shown from T to *i* in the pattern. Then obtain the distance from U to W in the pattern and set it off from U to *h*. Since R S in the pattern represents the miter cut for an outside miter, take the reverse cut of R S or R *l m S*, reverse and place it from *h* to *i*. T U *h i* then becomes the pattern for mold II in elevation. To obtain the patterns for the molds marked III, use R in the pattern as center and with R & as radius describe an arc which cuts the line U R at *c*. Set the dividers to equal R *c* and step off this distance on each line in the pattern, through which trace the miter cut *c d*. S R *c d* then completes the pattern for the sides marked III.

Obtain the pattern for side IV in elevation by taking the distance from E to F and placing it in the pattern as shown from *d* to *c*. Take the distance from Y to Z in the pattern, and set it off from *c* to *f*. Then draw the miter line from *f* to *e*, which is a duplicate of R S reversed. *c f e d* is then the desired pattern. In this way are laid out all the patterns to which laps must be allowed.

PANEL WITH CIRCULAR END

Solution 10

Fig. 131 is a finished view of a panel with a circular end. The method of obtaining the true miter line between the circular end and horizontal mold as well as the pattern for the intersection is shown in detail in Fig. 132. Here A indicates the section of the panel mold and B C D E shows the outline of the panel, the curve B E being struck from the center *c*. The first step is to divide the lower part of the mold into equal spaces as shown by the small figures 1 to 8. Through these points draw lines indefinitely, parallel to E D, as shown. Complete the miter lines H D and G C, which are angles of 45 degrees. Draw the perpendicular line *a b* crossing the lines previously drawn, as shown by the heavy dots. Take a reproduction of the divisions on *a b* and place them on the radial line,

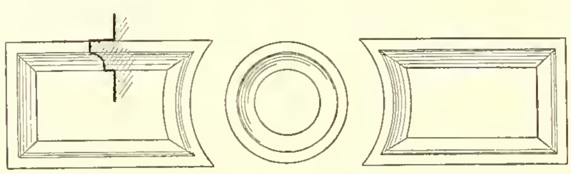


Fig. 131.—View of Panel with Circular End

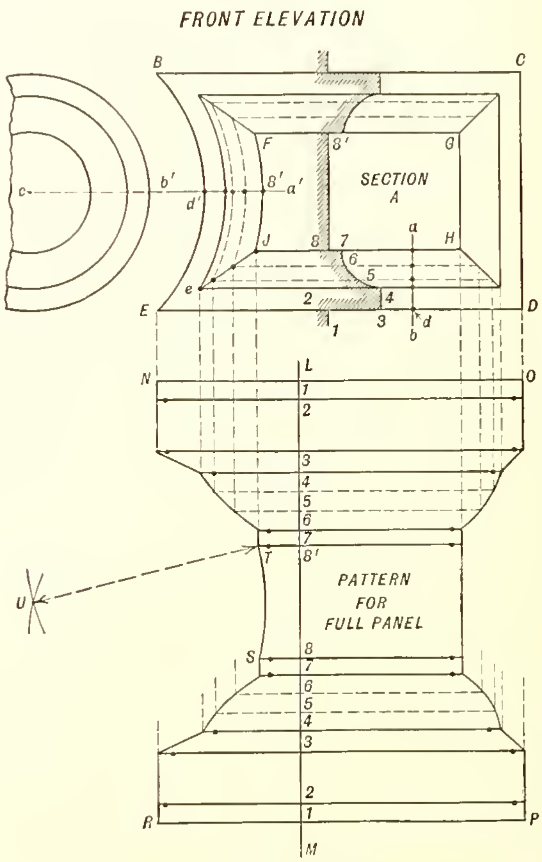


Fig. 132.—Pattern for Panel Having Circular End

drawn from the center *c*, as *a′ b′*, taking care that dot *d* on the line *b a* is placed on the intersection between the curve B E and line *a′ b′* indicated by *d′*. Then, using *c* as center, with the dots on *a′ b′* as the various radii, describe arcs, cutting the lines drawn through points 1 to 8 in the section, resulting in the points of intersections shown along the miter line J *c*. Note that this miter line J *e* is not straight, but effects a curvature because the radii of the arcs are of differing lengths. The pattern is now in order. The girth of the entire panel section is placed on the line L M, which is placed at right angles to E D. Draw lines at right angles to L M, through the small figures 1 to 1, and intersect them by lines drawn parallel to L M from similar points on the miter lines E J and H D in elevation. Trace a line through these points, when N O P R will be the desired pattern cuts. With *c*-8′ in elevation as radius and S and T in the pattern as centers describe arcs which cut each other at U. Using the same radius, with U as center, describe the arc T S. The pattern for the molded head C D H G in elevation is found as by the method illustrated in Fig. 126. The method of obtaining the various patterns for the circular head indicated by B E J F in elevation in Fig. 132 is taken up in the part treating of radial line developments. Allow laps on all patterns for soldering purposes.

METHOD OF TREATING VASES IN ANY NUMBER OF PIECES

Solution 11

Classed along with cornice work is the vase or pedestal in any number of pieces. Vases as originally designed have usually been circular in plan, though sometimes elliptical, and have at times been cut in stone of polygonal form in any number of sides. As constructed of sheet metal, they may of course be spun in copper or zinc, and are thus round in plan. When made in pieces the plan is a polygon of any number of sides, and the greater the number of sides the more nearly is the circle approached or simulated. Those best suited to architectural purposes are made with four, eight, twelve or sixteen sides, as, when thus made, a side of the vase is then parallel to each of the four sides of a pedestal upon which it may and usually does stand. This fact is further shown in the plan of the twelve-sided object shown in Fig. 133 at the right.

Pedestals, so far as their construction in sheet metal is concerned, are included in the same class as

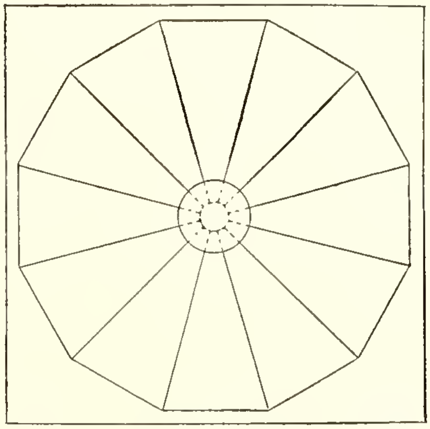


Fig. 133.—Plan of Twelve Sided Vase

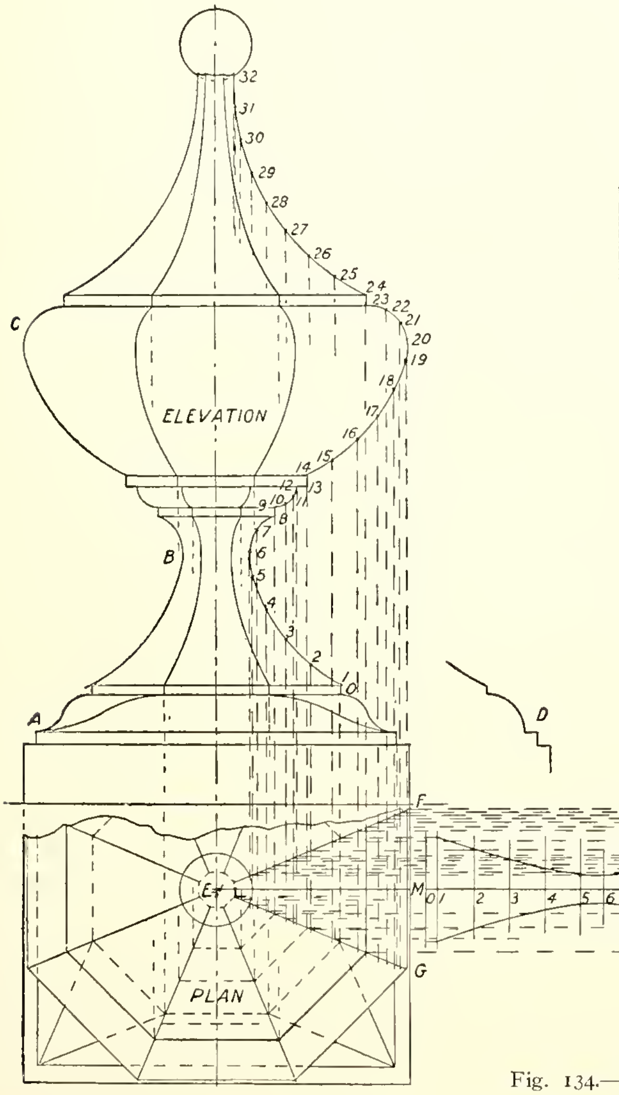


Fig. 134.—Pattern for Octagonal Vase

vases. In plan they are usually square throughout or square at the base and cap, and octagon in the shaft or die.

Since the making of a vase is, with the sheet metal worker, more or less a matter of design, we may pause here to say a few words in respect to that feature. In the majority of cases the design is provided by the architect of the building or cornice on which it is intended to be used as a decoration. But in some cases the cornice maker may be required to provide the design to the best of his ability. In making the design, therefore, he must take into consideration that a vase is, in a majority of cases, to be viewed from a point below its level, unless perchance it is to be placed upon a lawn or a porch, when it is, of course, below the eye. The designer must therefore consider how a molding or any part will appear as seen from a chosen point of view, or, in other words, what parts will be seen and what will not. For this reason it would be useless, if to be viewed from below, to introduce many members or an extra amount of ornamentation between points A and B or from C to the top in the design shown at the left in Fig. 134. For instance, the molding shown at A may be made according to the profile there given, or it may be made as shown at D to the right, and the difference will not be apparent. On the contrary, the molding shown above B will come into full view, and therefore may be elaborated to any advisable extent; and the same is true of all parts up to point C.

In designing the profile of a vase it is not necessary to adhere to the use of arcs of circles to the same extent that it is in profiling a molding, for the reason that the strips or patterns are narrow and the curves usually large and are thus easily formed.

In the study of shapes or profiles of vases generally, the student is referred to any of the many works on classical architecture.

In drawing the design the elevation must, of course, be projected from the plan and the plan so placed upon the paper that the center line of one of the sides (the side from which the pattern is to be obtained) is in a horizontal position, as at E M. The correctness of the pattern, of course, depends entirely upon the angle made by the two lines E F and E G.

The safest means of obtaining this angle is to construct the entire plan, that is, to divide a circle into the required number of parts in such a manner that one-half of the angle F E G shall be on each side of the horizontal line E M. This having been done, it now remains to divide the entire profile of the vase or pedestal into spaces as shown by the small figures, and to then set off a stretchout of the same upon E M extended as shown by M N. Lines from every point of division may now be dropped vertically upon the lines E F and E G of the plan and then projected horizontally into the measuring lines of corresponding number in the stretchout, all as shown. Line drawn through points thus obtained will then constitute the pattern for one piece, which must be duplicated to make up the required number of pieces.

We may here remark that it is not always necessary, as some are apt to think, that any portion of the profile, as, for instance, the part from 0 to 8, must be divided into equal spaces. In this case the spaces from 0 to 5 are equal, but larger than those from 5 to 8. This becomes necessary from the fact that the upper part of this line is more curved than the lower part. The same is true of the large curve above, in which, for the same reason, the spaces from 14 to 19 are larger than those from 19 to 23. It is, however, necessary that what ever spaces are assumed upon the profile must be reproduced upon the stretchout in the order taken.

The gore pieces between 0 and the base will be treated in a subsequent problem.

BEVEL AND BUTT MITER FOR AN OCTAGONAL BAY WINDOW RETURN

Solution 12

If an octagonal bay window has but three sides and the octagonal sides butt obliquely against walls, as shown in the plan and elevation in Fig. 135, the octagonal sides or returns require two forms of

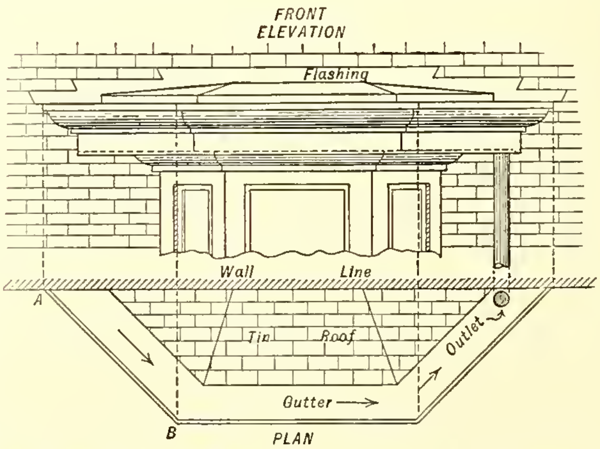


Fig. 135.—Elevation and Plan Showing Miter Patterns Required on Octagonal Bay Window

miter, the one against the wall at A in plan being a butt miter, and the one at B an octagon or bevel miter. While, in this case, the angle B is octagonal the methods of development are alike whether or not the angle B is more or less than an octagon. The method of developing these patterns shapes is shown in detail in Fig. 136. First draw the plan of the wall line as A B and from this line place the tended. Note the formation of the drip at the bottom of the cornice, where it is bent as indicated by 19-20-21-22. In this groove is set the lower part of the cornice, as shown at *a*. Then the flange 21-22 is locked around *a* as shown at *b*. This effects a rigid lock, and by means of an edge bent as at *a*, the buckles and wrinkles are removed from the lower part of the cornice, which would have a tendency

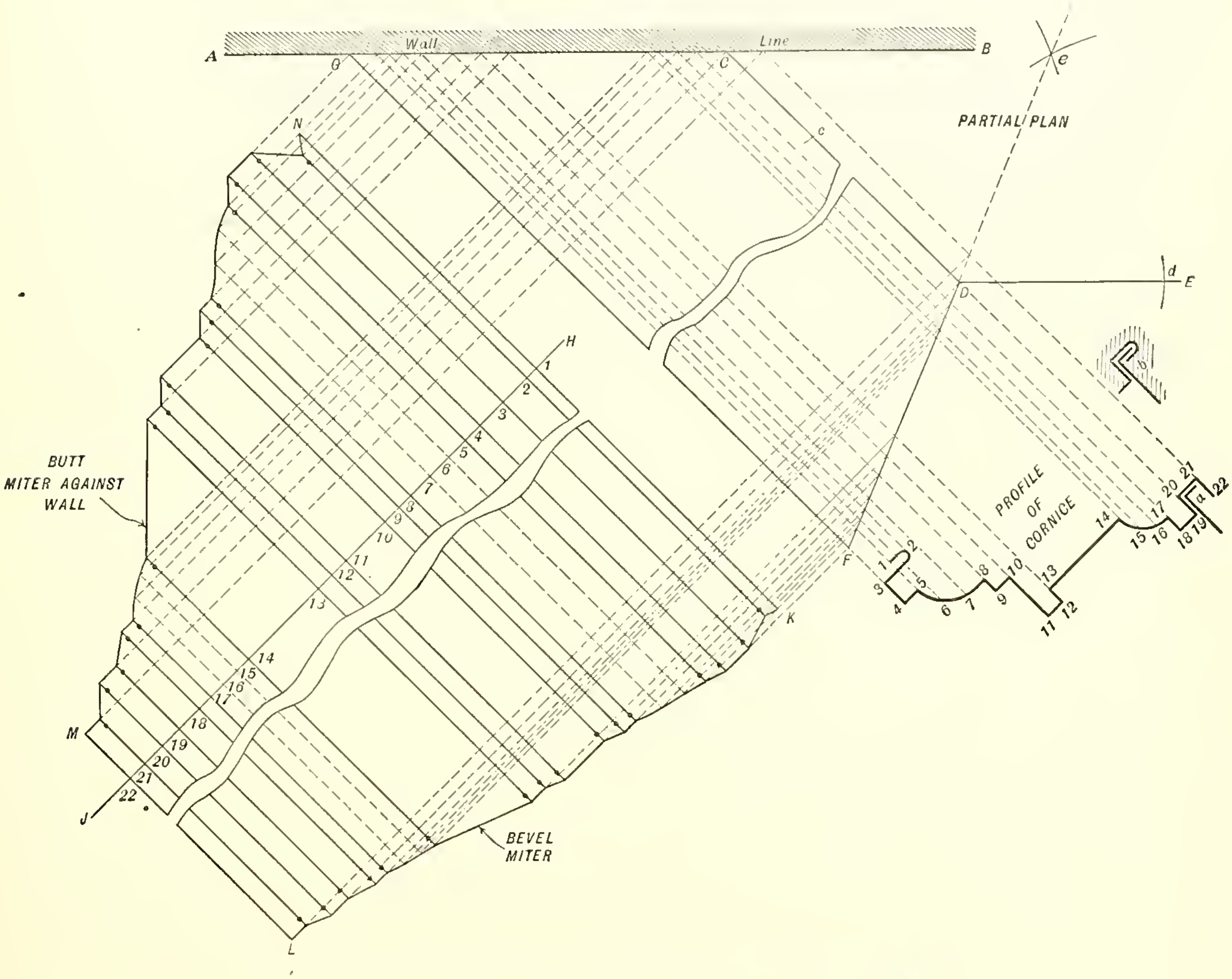


Fig. 136.—Obtaining Patterns for Octagonal Bay Window Return Miters

angle C D E in its correct position, as shown. The line D E must be accurately parallel to A B. Bisect the angle C D E by means of the arcs *c d* and *e*, as previously described, and draw the miter line indefinitely as shown by *e* D F. Extend the line C D indefinitely, as shown by C D 19 and on this place the profile of the cornice, in its correct position, as shown, having the planceer of the cornice, 13-14, accurately perpendicular to the line C D extended. to buckle without the strengthening of the edge *a*. The profile is spaced into equal divisions and points and corners are numbered, as shown from 1 to 22. From these small figures, parallel to D C, lines are erected to intersect the miter line D F, as well as the wall line B A, as shown by the dotted lines. To obtain patterns proceed by drawing, at right angles to C D in plan, the stretchout line H J on which place the girth of the profile of the cornice, as shown by like numbers 1 to 22 on the line H J. Through these small figures, at right angle to H J, draw lines, intersecting lines drawn parallel with H J from similar intersections on the wall line A B and miter line D F. Trace a line through points thus obtained. K L will be the miter cut for the bevel miter F D and M N the miter cut for the butt miter against the wall G C. Allow laps for joining.

BASE OF AN OCTAGONAL BAY WINDOW, MITERING OBLIQUELY AGAINST THE WALL, REQUIRING RAKED PROFILES

Solution 13

The present example is that of an octagonal bay window whose design constitutes three sides of an octagon thus causing the octagonal sides to miter obliquely against the wall of the house of which it is a part, as shown in the perspective view in Fig. 137. The method of developing the base of a bay

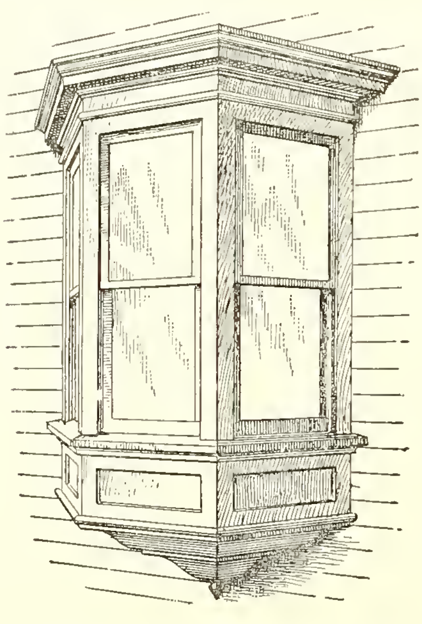


Fig. 137.—Octagonal Bay Window in which Oblique Sides Miter Against the Wall of the House

of this class is shown in Fig. 138. First draw the center line A—D. Then draw the half elevation of the base of the bay, as shown by A—2—12—18. It should be understood that the profile shown in elevation from 1 to 18, represents the miter or joint line between the oblique return C—B in plan against the wall line. From this miter line 1 to 18 in elevation must be found the true profiles of the base at right angles to B—C and C—D in plan, as follows: In line with the elevation, establish the outline of the base B—C—D in plan, and draw the miter line C—E. Divide the profile in elevation into an equal number of parts, as shown by the small figures 1 to 18, from which points drop perpendicular lines to meet the wall line in plan as shown (without numbers), and from these divisions parallel to B—C in plan, draw lines to intersect the miter line C—E. From these intersections, parallel to C—D, draw lines to cross the center line as shown by similar numbers. At right angles to B—C, from the point E, draw indefinitely the line E—F, and intersect it by the lines in B—C—E extended (without numbers). Now, take the various intersections on the line E—F in plan and place them to the right of the elevation on the horizontal line E^1—F^1 where they are correctly numbered. In a similar manner take the various intersections on the line E—D in plan and place them on the horizontal line E°—D° to the right of the elevation as shown by similar numbers. Next, at right angles to E^1—F^1, also to E°—D° draw lines, which intersect by horizontal lines drawn from like numbers in the profile in elevation. Trace a line through points so obtained. Then will the profile from $1'$ to $18'$ be the true profile through E—F in plan and the profile from 1° to 18° the true profile through E—D in plan. The pattern for the oblique side C—B in plan, may now be developed as follows: At right angles to C—B, draw any line, as H—J, on which place the girth of the profile $1'$ to $18'$ as shown by similar numbers on H—J. Through these small figures at right angles to H—J draw lines, which intersect by lines drawn parallel to H—J from similar intersections on the wall line E—B and on the miter line C—E. Trace a line through points so obtained. Then will K—L—M be the pattern for the side C—B. In a corresponding manner, take the girth of the profile from 1° to 18° and place it on the center line extended as N—O, as shown by like numbers. From these small figures, at right angles to N—O, draw lines, which intersect by lines drawn parallel to N—O from similarly numbered intersections on the miter line C—E. Trace a line through points so obtained. Then will N—O—P be the half pattern for the front D—C in plan. The patterns shown are net, requiring allowance for flanges for riveting and soldering.

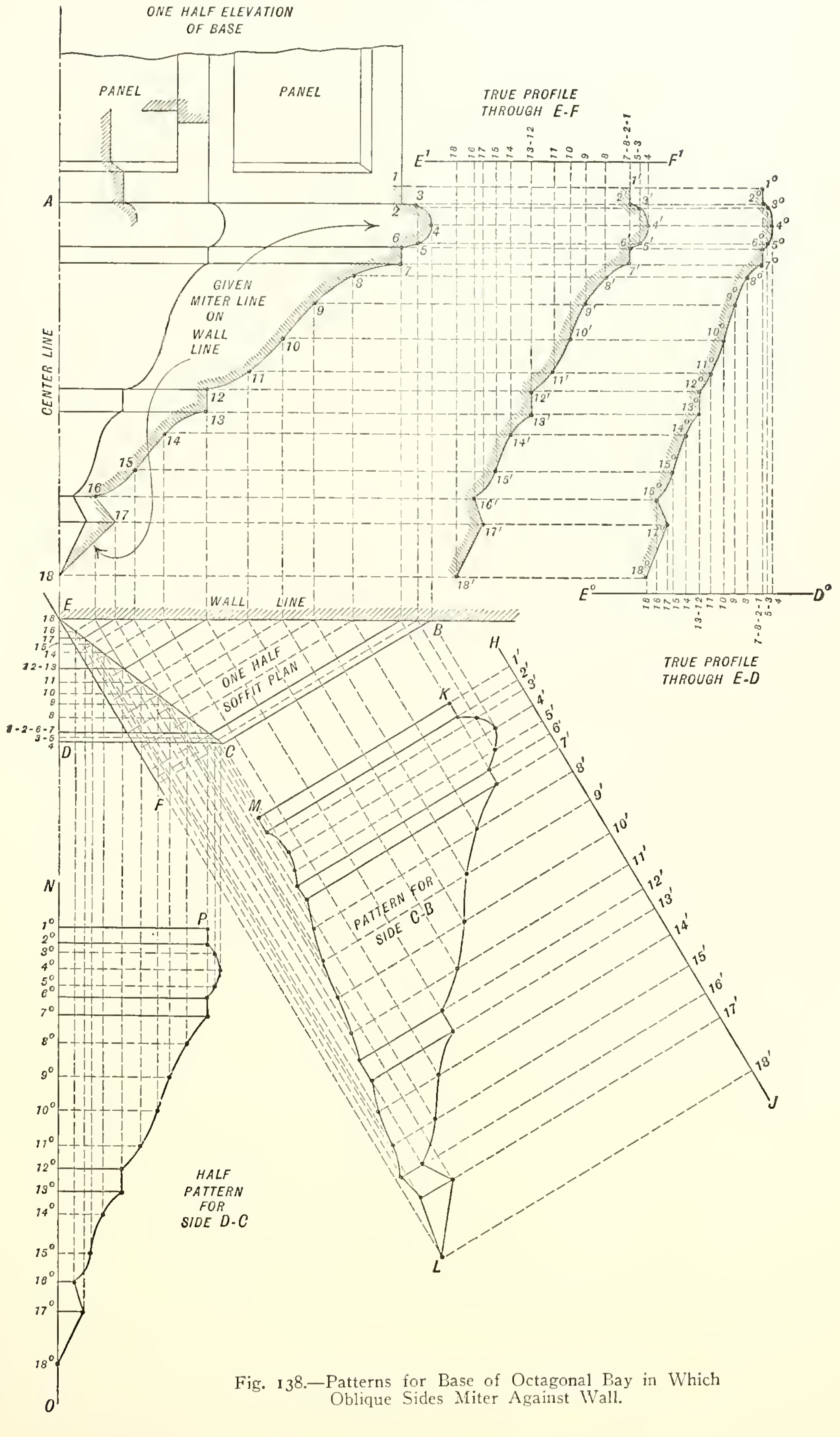


Fig. 138.—Patterns for Base of Octagonal Bay in Which Oblique Sides Miter Against Wall.

BASE OF A SQUARE BAY WINDOW, REQUIRING RAKED PROFILES

Solution 14

The illustration presented in Fig. 139, shows a perspective view of a rectangular bay window, in which case the construction concerns only the soffit or under side of the projecting bay. The laying out of the surfaces forming this part, requires the development of new or raked profiles and is therefore

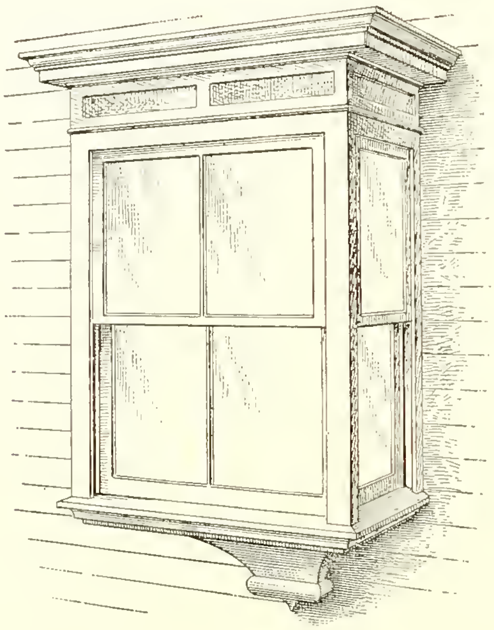


Fig. 139.—Rectangular Bay Window

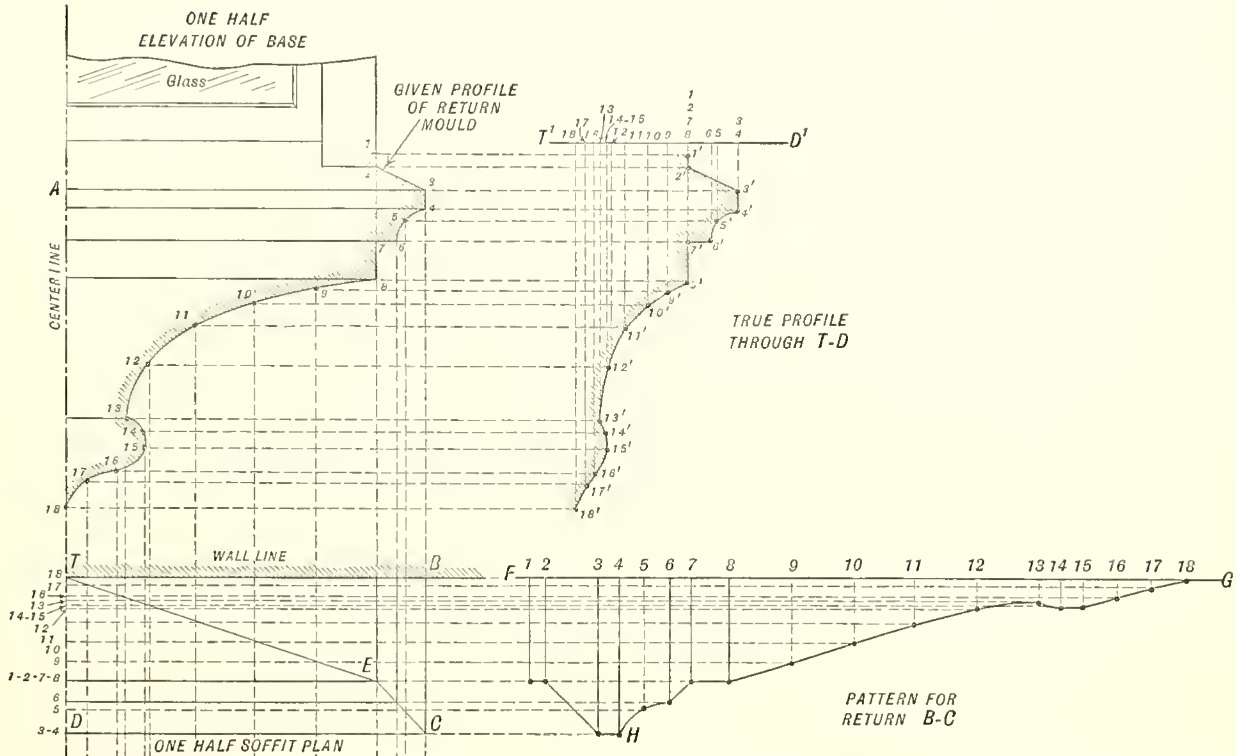
more complicated geometrically than would be the development of the patterns for the upper parts shown in the perspective, which have been treated in preceding solutions. The method of raking the profiles and developing the patterns is shown in Fig. 140. First draw the center line A—D, and construct the half elevation of the bottom of the bay as shown by A—2—18. Below the elevation in its proper position draw the outline of the plan B—C—D as shown. The profile in elevation from 1 to 18 represents the true section on T—B in plan. The only part of the profile to be raked, is that shown from 8 to 18 in elevation, as the upper portion 8 to 1 is a square miter, represented in plan by the miter line C—E, drawn at an angle of 45 degrees, while from E, which represents point 8 in elevation, a miter line is drawn from E to T. Space the given profile in elevation into equal divisions, as shown by the small figures 1 to 18, from which points draw perpendicular lines to intersect the miter line C—E—T in plan. From these intersections draw lines parallel to C—D to meet the center line T—D, as shown by numbers alike, to those in the elevation. The true profile on the line T—D in plan is obtained as follows: Take the various divisions on the line T—D and place them to the right of the elevation on the horizontal line T^1—D^1, as shown by corresponding numbers. From these points, draw perpendicular lines to intersect horizontal lines drawn from corresponding numbers in the profile in elevation. A line traced through points so obtained, as shown from 1′ to 18′, will be the profile sought. The patterns may now be developed, as follows: Extend the wall line T—B as F—G on which place the girth of the return profile 1 to 18 in elevation, as shown by corresponding numbers on F—G. From these small figures, at right angles to F—G, draw lines, which intersect by lines drawn parallel to F—G from similar intersections on the miter line T—E—C in plan. Trace a line through points so obtained. Then will F—H—G represent the pattern for the return molding C—B in plan. In like manner, take the girth of the true profile through T—D, and place it on the center line A—D extended as J—K, as shown by corresponding numbers 1′ to 18′. Through these small figures, at right angles to J—K, draw lines, which intersect by lines drawn parallel to J—K from similar intersections on the miter line T—E—C in plan. A line traced through points so obtained, as shown by L—M—N—J, will be the one-half pattern for front D—C in plan. Allow flanges for soldering and riveting, as the patterns shown are net.

BASE OF AN IRREGULAR BAY WINDOW HAVING FIVE SIDES, REQUIRING TWO CHANGES OF PROFILES

Solution 15

Fig. 141 shows the plan and elevation of the base of a bay window having five sides, the two outer sides being very narrow, constituting only short returns, the window meeting the wall line of the main building at right angles. The given profiles are shown in the short returns, X; the changes or modifications of profiles take place in the front, A, and in the oblique sides, B, of the base.

The method of finding these modified or raked profiles together with their patterns, is shown in detail in Fig. 142. In this figure the wall line in



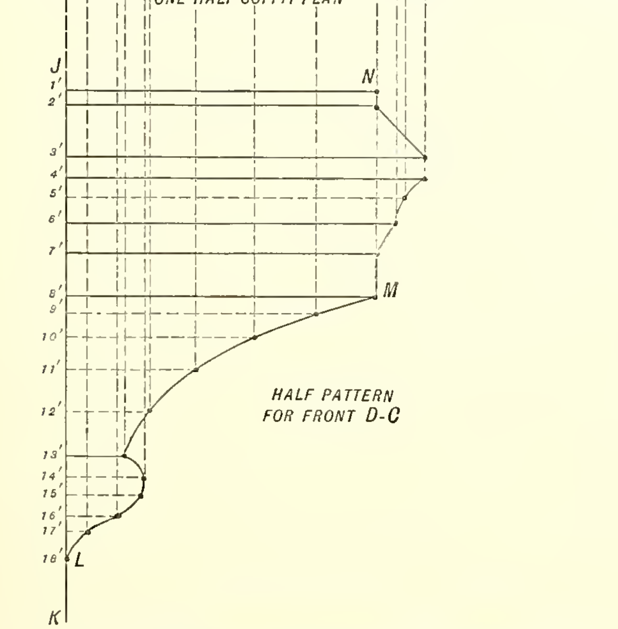


Fig. 140.—Pattern for Bay Window Base at Right Angles in Plan, Having Dissimilar Profiles

plan is first drawn, as shown by B B°. Then draw the outline of the irregular bay window, as shown by B E F G H J, and from the corners, draw the miter lines to the center A, as shown, the center A being the bisection of B J. In practice it is not necessary to draw the full plan as the half shown by B D A serves the requirement. Through the center A in plan, draw the perpendicular line K L and above the plan draw the profile of the base as indicated by 1—17—1°. The profile shown from 1 to 17 then represents the true profile for the short returns shown in the plan through A B. Divide this profile into equal spaces as shown by the small figure 1 to 17, and from these points at right angles to B J in plan, draw lines cutting the miter line E A, as shown by corresponding numbers. From these divisions on E A, parallel to E F, draw lines cutting the miter line F A, from which points, parallel to F G, draw lines cutting the center line A D, as shown by the heavy dots and partly by numbers.

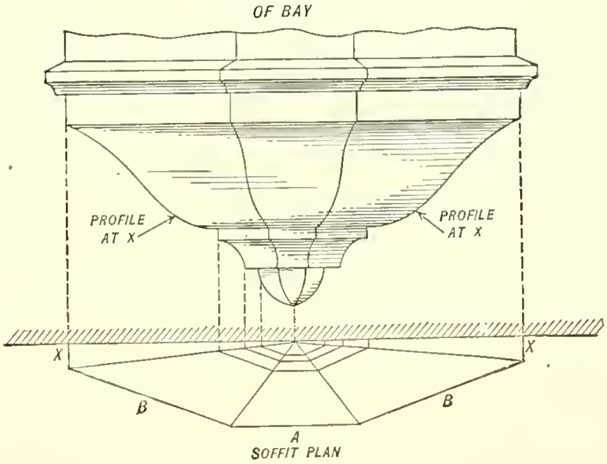


Fig. 141.—Plan and Elevation of Bay Window Having Base of Five Sides

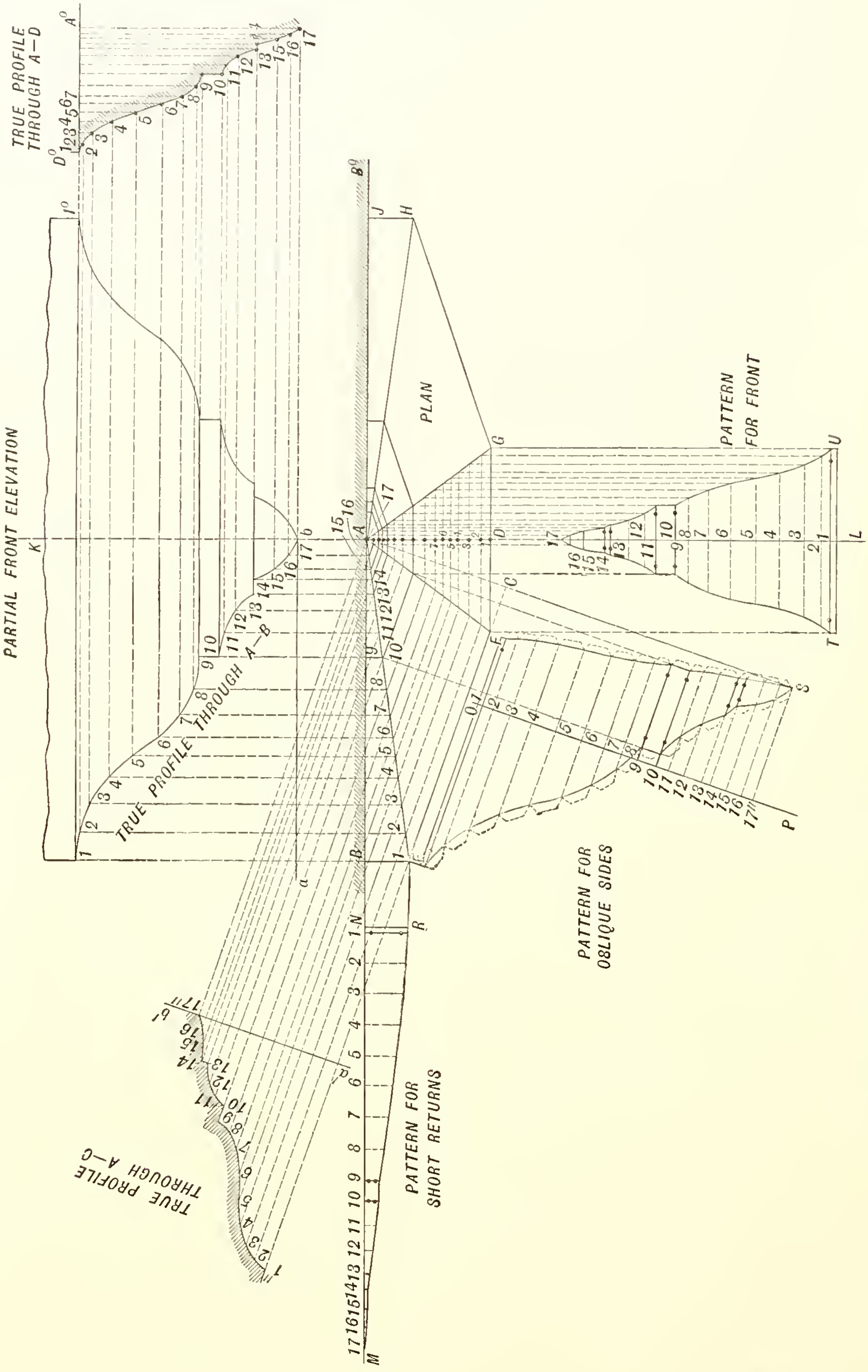


Fig. 142.—Patterns for Irregular Bay Window Base, Having Five Sides, Requiring Changes of Profiles

Continue these lines until they intersect the miter line G A as shown. Continue the line E F in plan, until it intersects a line drawn from the center A at right angles to E F at C. By measurements it will be found that the distance A B is greater than that of A C, and of A C than of A D, so that a modified or changed profile must be found on the line A C as well as on line A D. These modified profiles can be taken from the plan or from the elevation. In order that the two methods may be understood, an explanation of each, will be given.

To obtain the modified profile from the elevation, on the line A D in plan, proceed as follows: Take the various divisions on A D as indicated by the heavy dots, partly numbered from 1 to 7, and place them on the horizontal line A° D° to the right of the elevation, as shown. From these points at right angles to A° D° draw lines, which intersect lines drawn parallel to B B°, from similarly numbered intersections in the true profile in elevation. Trace a line through points so obtained, as shown from D° to 17, which is the true profile for the front side of the bay window base. The true section of the oblique sides of the base on the line C A in plan can be obtained directly from the plan, as follows: From the various intersections 1 to 17 on the miter line E A in plan, draw lines indefinitely, parallel to F E, as shown to the left. At right angles to these lines draw the line a′ b′. Then, measuring from the line *a b* in elevation, take the various hights to points 1 to 17 in the profile, and place them on similarly numbered lines, measuring in each instance from the line a′ b′. Trace a line through points so obtained, as shown from 1″ to 17″, thus obtaining the desired profile. The modified profiles having been secured the patterns are in order of procedure.

For obtaining the pattern of the short return, indicated by A B E in plan, take the girth of the profile shown in the front elevation and place it on the line A B extended as N M, as shown. Through these small figures at right angles to N M draw lines intersecting lines drawn parallel to N M from similarly numbered intersections on the miter line E A (partly shown). A line traced as indicated by N R M will be the desired pattern. For the pattern of the oblique side, draw any line, as O P, at right angles to E F in plan, and upon this line place the girth of the true profile through A C (measuring each space separately as they are all unequal), as shown by similar numbers on O P. Through these small figures, at right angles to O P, draw lines intersecting lines drawn parallel to O P, from similar intersections on the miter lines E A and A F in plan. Trace a line through points so obtained when E F S will be the oblique side pattern. The pattern for the front of the bay F G in plan is developed by taking the girth of the true profile through A D, and placing it on the center line A L as shown by corresponding numbers. Through these small figures draw, parallel to F G, lines intersecting those drawn parallel to A L, from corresponding points on the miter lines F A and A G. T U 17 gives the desired pattern. Laps are provided on both cuts of the pattern for oblique sides, as shown by the dotted lines. The miter lines are not projected in the elevation, as they would afford no service in securing the patterns.

CONSTRUCTION OF A COPPER BAY WINDOW

Solution 16

It was thought that our readers who have to do with the construction of metal windows would be interested in and assisted by this presentation of

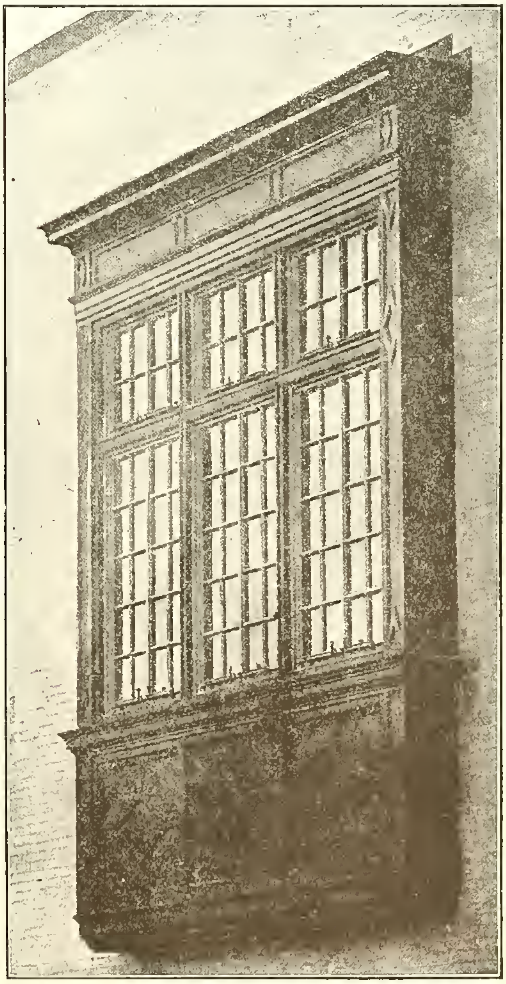
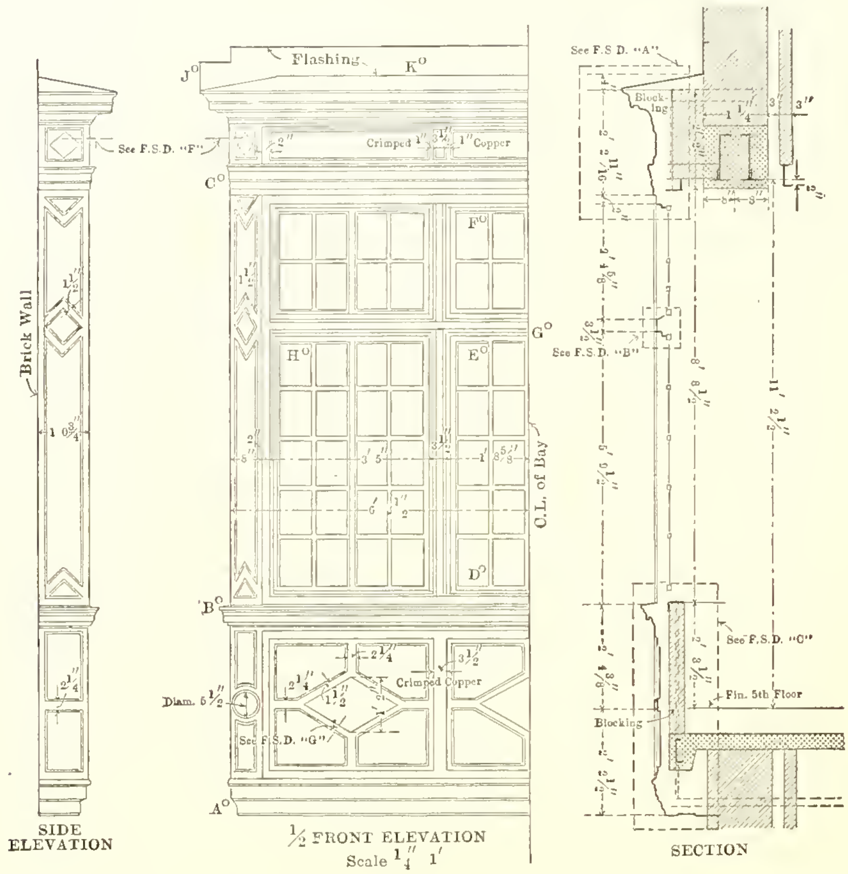


Fig. 143.—View of Copper Bay Window



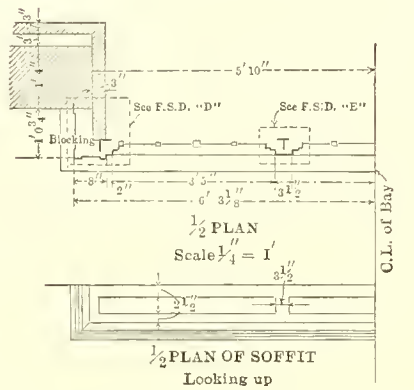


Fig. 144
Scale Drawing of Bay, with Full Size Measurements

the working drawings and description of methods of assembling and erecting a copper bay. The methods are descriptive of an actual example of successfully executed work, indicating the detail of procedure followed in this case.

In the copper bay window under consideration is shown the method of construction upon the angle iron and terra cotta of a fireproof building. Special attention is given to preparing the details, locating the proper positions of the blockings, as well as securing the copper work to the building.

In Fig. 143 is presented a photographic view of the window. In Fig. 144 is shown a typical scale drawing of this bay, with full size measurements, as received from the architect. The one-half front elevation is shown as well as the side elevation and section, also the half plan and the half plan of the soffit. The drawings are made to a scale of ¼ in. to the foot. The abbreviations throughout these scale drawings, as "F. S. D.," indicate full size details which are shown elsewhere, and correspond to the letters presented. For instance, "See F. S. D. A." means see full size detail marked A, etc.

The first step in working from the scale drawing is to study the various views, and ascertain where the joints had best be made and what parts can be completed in the shop. This is determined by the size of the various parts and the available means of transportation. As the hight of the base of the bay from $A°$ to $B°$ in the half front elevation is 4 ft. 6⅞ in. and the length 12 ft. 6¼ in., with a projection of 12¾ in., this lower base can be finished complete in the shop, including the soffit panels, as shown in the half plan of the soffit. On all of the large flat surfaces crimped copper is employed, and where miters cannot be soldered on the inside, soldering is done on the outside, all joints are scraped clean and emery papered, as no bronzing occurs. The corner pilasters from $B°$ to $C°$ have a hight of 8 ft. 5⅝ in., with a 10 in. face and a 12¾ in. return. These may also be finished in the shop, coming out complete, smooth and clean. The mullions $D°$, $E°$, $F°$ and the transom bars $H°$, $E°$, $G°$ are made in pieces and mitered at the building, at $D°$, $E°$, $F°$ and $H°$. The joints are carefully scraped so that no solder will show. The cornice from $C°$ to $J°$ being but 2 ft. 4¹¹⁄₁₆ in. high with a 20¾ in. return, with an extreme length of 13 ft. 10¼ in., is also finished in the shop. The roof and flashings $K°$ are of course laid at the job, in a manner which will be described. The details of the various parts, are drawn to a scale of 2 in. to the foot, and attention is first given to the detail of the cornice shown in the section by *A*, in Fig. 145 which shows the working detail of the cornice. It will be noted that the hight and projection are shown. The profile of the full size cornice is shown by the heavy outline, which has a lock at the top edge to which the copper roofing is locked. The method of securing the blocking which supports the roof is also shown. It will be seen that the panel is not shown in full, its measurement between the two molds being 6⅞ in. The cornice is put together complete in the shop, with the soldering and riveting of the seams on the inside to prevent solder showing.

On the inside of the cornice painted band iron braces are inserted. These are made from 3/16x1 in. band iron, three feet apart, the brace being bolted in position by means of flathead brass stove bolts sized ¼ in. x ¾ in. The five dashes placed on the brace and indicated by *C*, *C*, etc., show the position of the bolts, and where holes are punched in the brace care is taken to countersink the holes on the outside, so that the brass bolt-head will lay on smooth and flat with the copper work.

At the bottom of the cornice the copper is turned upward, as shown, to form a drip. This drip rests upon the bronze frame shown, which in turn is bolted to the 2 x 2 in. angle. To anchor the cornice securely at the bottom, a ¼ x 1 in. band iron anchor is bolted to the main brace and to the 3 x 4 in. angle, as shown. At the top, *R*, the cornice is secured to the 3 x 3 in. upright, as indicated.

The peculiar construction at the bottom of the cornice is necessary because the window frames and sashes are of bronze metal and no nailing may be done, as usually is required when wood sashes are used.

After the cornice is secured, the roof planks are laid on the blocking under the lock flange, as shown. During the erection of the building the copper cap flashing is built in the wall, as shown. This cap flashing permits the roof flashing to be slipped underneath the cap, and allows for expansion and contraction of the metal.

The locks of the main cornice as well as the cross locks in the roof are laid flat seam, all locks being secured to the sheathing by means of copper cleats, as illustrated. Before the copper roofing is edged and laid the sheets are tinned 1½ in. around on both sides, so that when the roofing is edged, laid, cleated and the lock closed with the mallet the seam

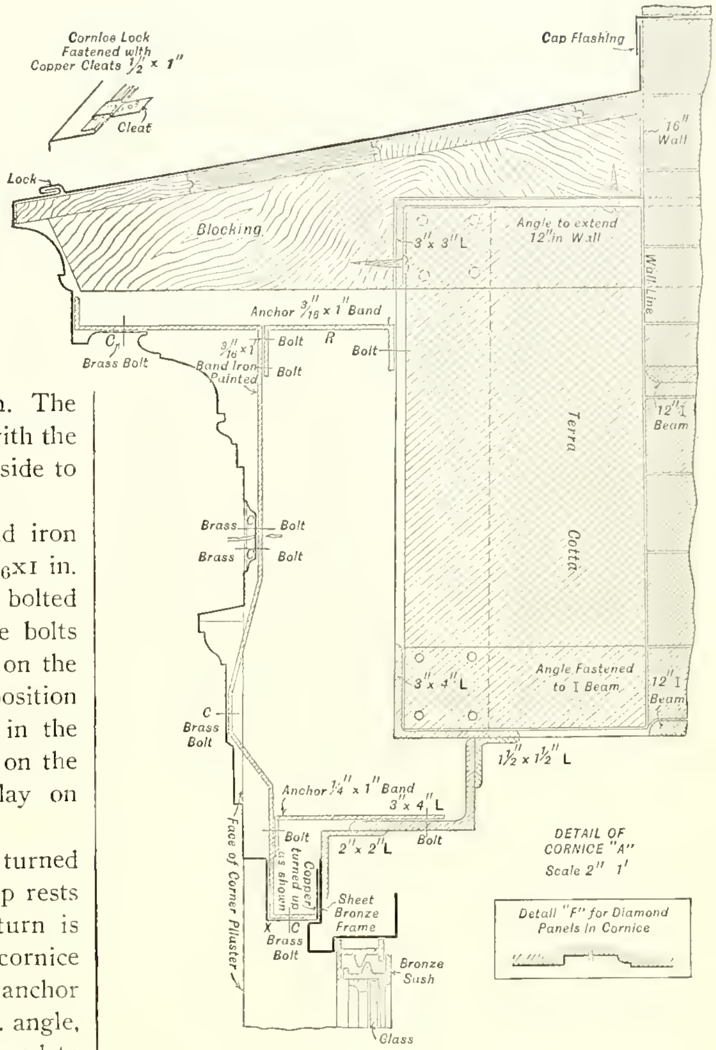


Fig. 145.—Construction Drawing of Main Cornice

can be well sweated with half and half solder, thus preventing leaks.

The portion of the bay which is next placed in position is the paneled base shown in the half front elevation in Fig. 144 and in the section. The detail of this section of base is shown in Fig. 146 with the construction drawing for base *C*. As in the main cornice, the profile of the base molds and panels are indicated by the heavy lines, with full size measurements. A similar detail, furnished to the carpenter, will enable him to secure the blocking to the angle iron and brick work, as shown.

The copper sill at the top is carried up as far as shown, while at the bottom the paneled soffit is flashed in the joint of the brickwork with a drip, bent in the position shown. If the bottom of the bay in diagram *P* should strike the center of the brick, as at *X*, the base flashing is extended down-

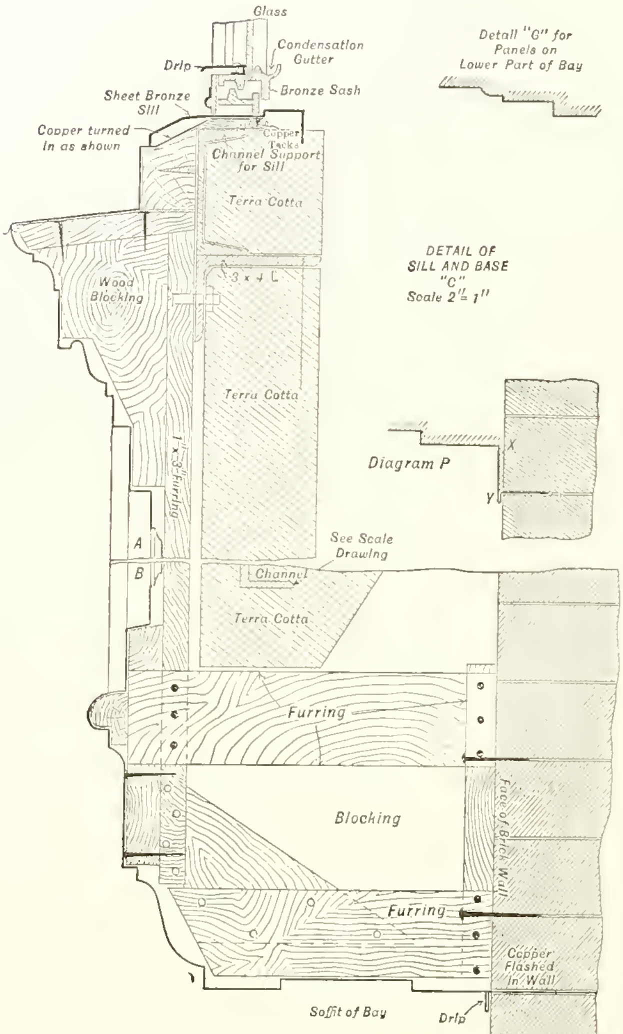


Fig. 146.—Construction Drawing for Base of Bay

ward so as to meet a joint, the drip being carefully attached as at *Y*. It will be well to note the manner in which the bronze sill is set on the top of the copper sill, also the construction of the bronze sash, this to obtain a storm-proof job.

The method of flashing the ends of the base into the wall involves similar construction to that which shows the corner pilaster. After the base of the bay is secured the two corner pilasters shown from $B°$ to $C°$ in the half front elevation in Fig. 144 are next placed in position.

The detail of the corner pilaster is shown in Fig. 147, where the heavy line shows the profile of the copper formation. The method of connection at the brick wall, involves a reglet cut as indicated at *A*, in which the copper work is placed. To hide the reglet, a projecting edge or doubled flange is bent at *B*, as shown. As the window frames are made of sheet bronze, on which no nailing can be done as on a wood frame, the copper is bent as indicated at *C*. Wood blocking is secured to the brick wall and angle iron as shown, which forms a solid back for the sheet copper work.

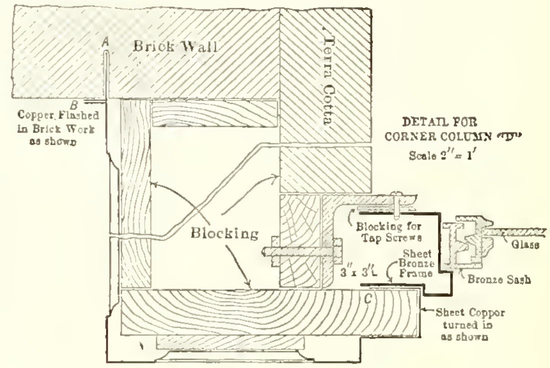


Fig. 147.—Construction Detail of Corner of Bay

Where these corner columns join the sill of the base and the bottom of the cornice all joints are sweated with solder, then scraped clean and smooth and emery papered. The diamond shaped panels in the columns shown in the front and side elevations in Fig. 144 are carefully mitered so as to show clean, sharp joints. The mullion shown from $D°$ to $E°$ in the front elevation is next placed in position, its construction being indicated in Fig. 148. The copper is turned inward against the bronze frame and the bottom of the mullion is soldered on to the sill of the base, as indicated in the half front elevation in Fig. 144. This same mullion, shown in Fig. 148, is also used for the upper part of the mullion shown in the scale drawing in Fig. 144 from $E°$ to $F°$.

The transom bar indicated from $H°$ to $G°$ in the half elevation is shown in detail in Fig. 149.

The copper sill is bent to prevent the water from backing up, and is so arranged that the lower sash bar will fit over it. The lower part of the transom bar is turned upward against the sheet bronze frame at *A*, wood blocking being provided, as shown. The construc-

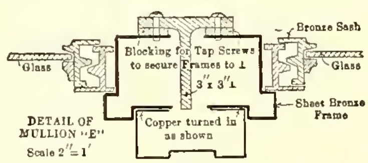


Fig. 148
Construction Detail of Mullion

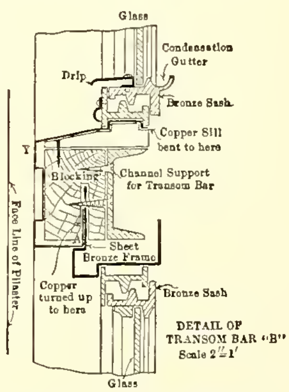


Fig. 149.—Construction Drawing of Transom Bar

tion of the bronze sash over the sill of the transom is provided with a condensation gutter as well as the outside drip, shown. Particular care is taken in joining the miters between the transom and mullion, indicated at E° in the half front elevation in Fig. 144. At the completion of the job the work is cleaned and then given a coat of boiled linseed oil, which turns the copper to a rich dark brown color. The development of the various patterns requires only square return and face miters which have been previously considered.

PATTERNS FOR LINTEL CORNICE; DETAILS OF CONSTRUCTION INTRODUCING A REDUCED MITER, SQUARE IN PLAN

Solution 17

We will proceed to take up the development of the patterns for a lintel cornice, shown in the elevation in Fig. 150. The method includes obtaining the miter cuts without using the T square, the projections being transferred with a divider to another sheet of paper or directly upon the sheet metal. This is in most shops the usual procedure of obtaining the patterns.

The aim is to cover the construction of a lintel cornice in detail and the various operations required to perform the work.

The Scale Drawing

Let Fig. 150 represent a half inch scale drawing of a lintel cornice as received from the architect. As will be noticed the full length of the cornice on the crown line is 10 ft. 2 in. The ends of the building are recessed with a 6 in. return and a 7 in. face, all as indicated, thus leaving the length of the foot molding on the drip line *a a* in elevation 9 ft. The entire hight of the cornice to the top of the roof is 2 ft.; the front cornice has a projection of 11 in., while the returns have a projection of only 7 in., as shown in plan, thus necessitating a reduced return. In other words, the projection of cornice of 11 in. on the front must be reduced proportionately to 7 in. on the side. The frieze or sign board of the cornice is to be made of crimped iron, so as to avoid buckles in the flat surface as indicated.

Laying Out the Detail

The first step is to draw the detail of the cornice. This is accomplished, as will be briefly described, in connection with Fig. 151. As the scale drawing in Fig. 150 is drawn to a half inch scale, use a half inch scale rule and take the various hights of the members on the line *b c* in the side elevation. If no scale rule is at hand one can be made by simply drawing a line, upon which one half inch divisions are placed, representing feet, and dividing one of the half inch divisions into twelve equal spaces, each

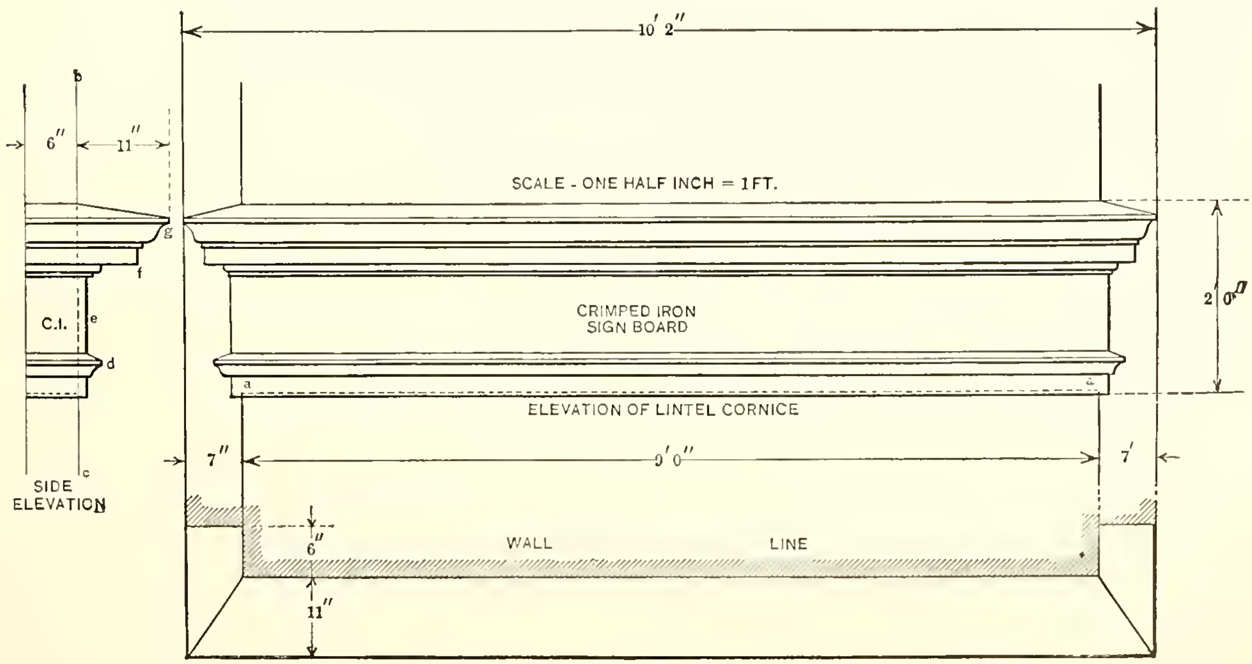


Fig. 150.—Half Inch Scale Drawing of Lintel Cornice

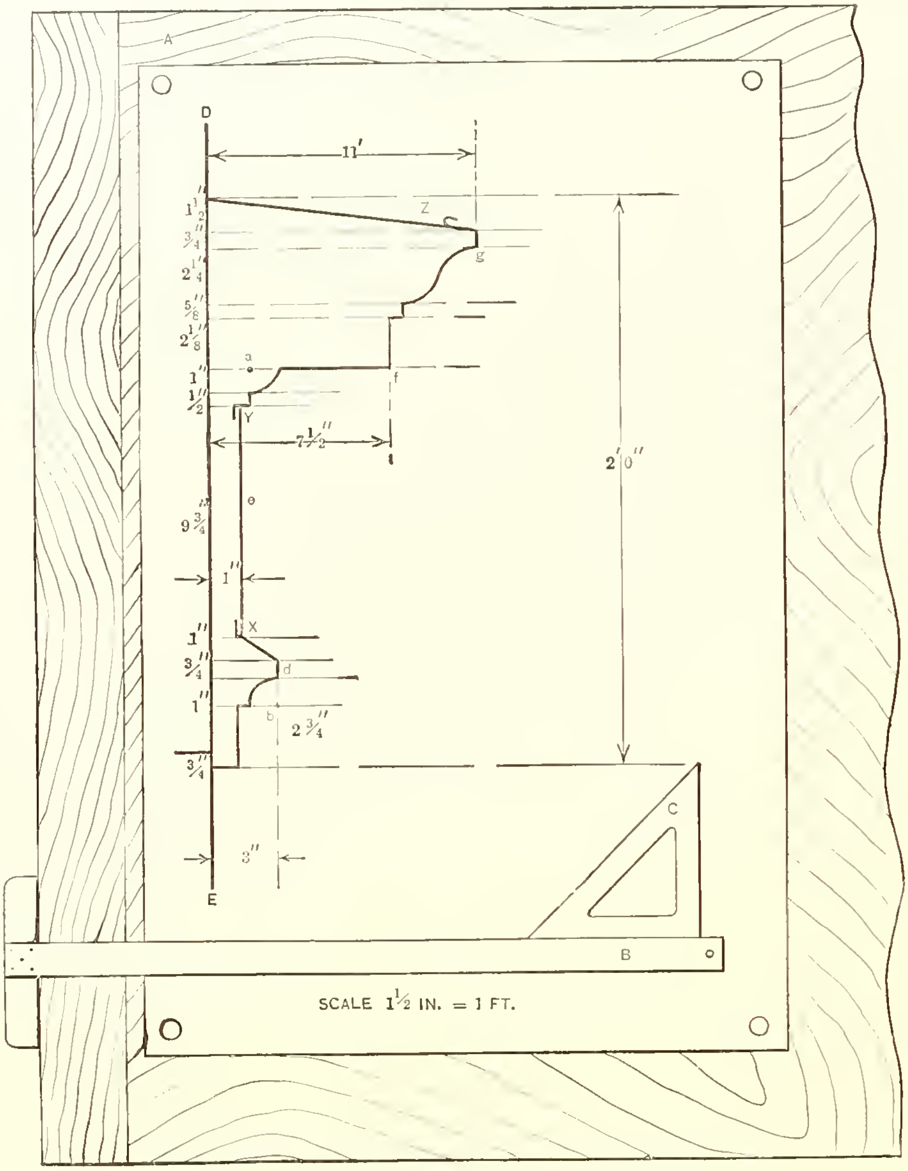


Fig. 151.—Making a Detail Drawing of Lintel Cornice

space representing a full inch on the detail. In drawing the detail use a board of sufficient size and tack upon it some drawing paper as indicated in Fig. 151 by A. By means of the T square draw a vertical line as D E, upon which place the measurements of the various members obtained from the scale drawing in Fig. 150, the full size measurements being noted on the line D E in Fig. 151 (the detail in this case having been drawn to a scale of one and one half inches to the foot). Using the T square B, from the small divisions on the line D E draw horizontal lines indefinitely as shown. Again refer to the scale drawing in Fig. 150 and scale the projections to *d c f* and *g,* measuring from the line *b c,* and place these measurements in Fig. 151, as shown by *d c f* and *g,* measuring from the line D E the distances of 3 in., 1 in., 7½ in. and 11 in., respectively. Trace the ogee and fillet *g f,* the quarter round and fillet at Y, the quarter round being struck from the center *a* and the wash X *d* and cove and drip of the foot molding, the cove being struck from the center *b,* the drip having ¾ in. fall. The cornice will be made in three parts, with a seam at X and Y and a lock at Z. When drawing the vertical lines in the detail use is made of the triangle C. Having completed the detail drawing, the reduced profile is found before the patterns can be developed.

Obtaining the Reduced Profile

This is accomplished as indicated in Fig. 152, in which is shown the plan view of the corner return and the miter line E B, which has been extended to C. In its proper position as shown, place the profile of the cornice obtained from Fig. 151 and divide the molds in same into a number of equal spaces, in Fig. 152, all as shown by the small figures from 1 to 25. From these small figures draw horizontal lines, cutting the miter line E C as shown. From the various intersections on the miter line erect vertical lines indefinitely, as shown. From the point 2 in the profile draw the perpendicular 2-A, and at pleasure draw any horizontal line in the reduced profile as 2-A¹, at a sufficient distance above the plan as shown. Measuring in each instance from the line 2-A in the normal profile, take the various distances to points 1 to 25 and place them on similarly numbered lines in the reduced or modified profile, being careful to measure in every instance from the line 2-A¹ to arrive at the points of intersections shown.

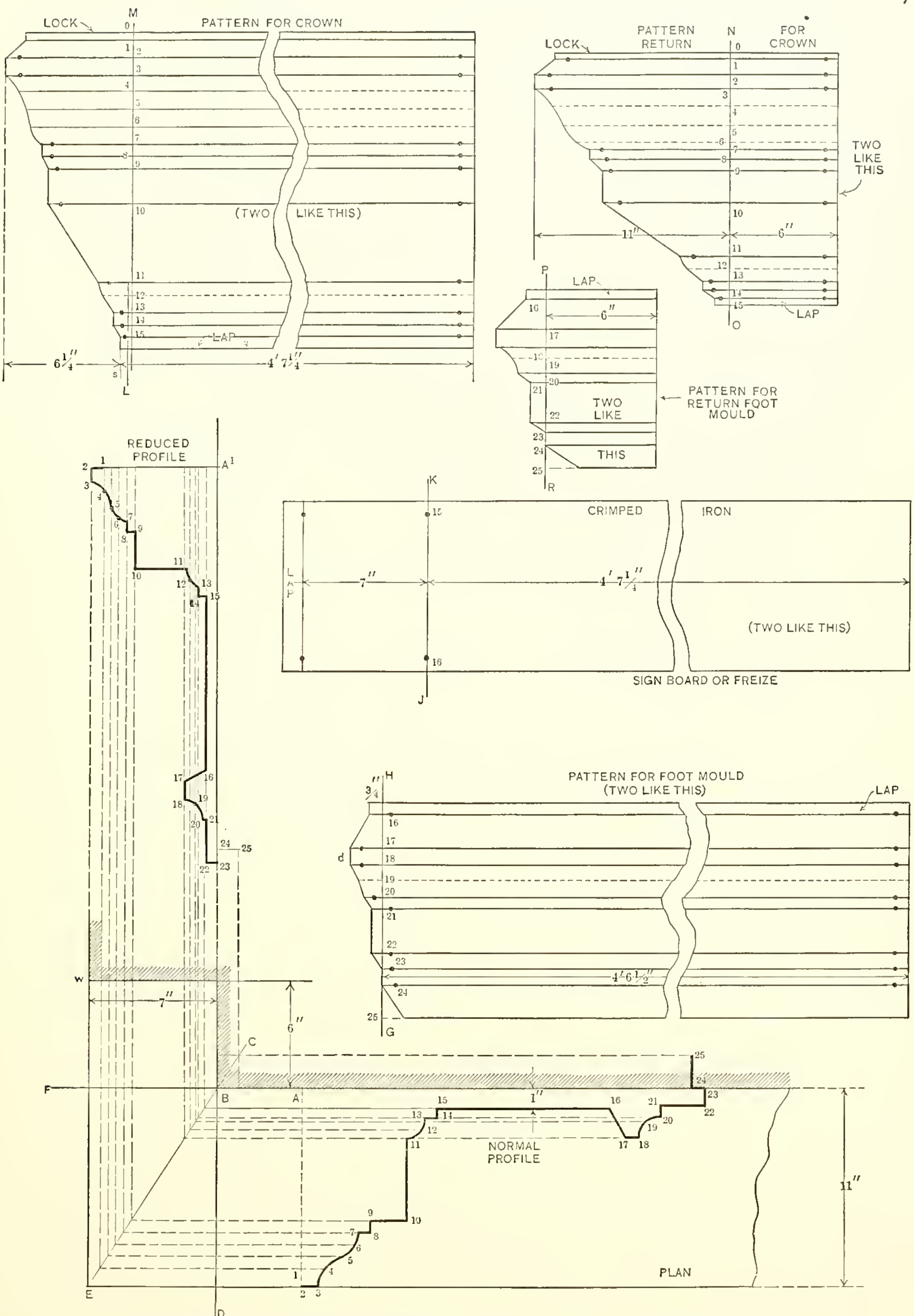


Fig. 152.—Obtaining Reduced Profile and Developing Patterns for Entire Cornice

A line traced through these points, as shown, from 1 to 25, will be the reduced profile of the return mold.

Developing the Various Patterns

As the frieze, 15-16 in the normal profile, is of crimped iron, a joint is made at 15 and 16, so that the first pattern to be developed will be for the foot mold 16 to 25 on the normal profile. Draw any vertical line, as G H, upon which place the girth from 16 to 25 as shown. At right angles to G H draw the usual measuring lines. Now, from the intersecting corner B in plan draw the vertical line B D and horizontal line B F. Measuring from the line B D in plan, take the various distances to similar intersecting points, 16 to 25 on the miter line E C, and place them on similarly numbered lines, measuring in each instance from the line H G. Trace a line through points thus obtained. Then will H *d* G be the miter cut. As the length of the wall in Fig. 150 is 9 ft., add 1 in. for lap, making 9 ft. 1 in. To obtain the seam of the cornice in the center divide 9 ft. 1 in. by 2, which leaves 4 ft. 6½ in., the distance marked from the drip edge 23-24 in the pattern for foot mold in Fig. 152. A lap is allowed for soldering, as indicated above the line 16. Thus two sheets of foot mold will be required, each 4 ft. 6½ in. long, which will allow for a 1 in. lap. The pattern for the frieze or sign board is laid out directly upon the crimped sheet, making the width equal to 15-16 in the normal profile, as indicated by 15-16 on the line J K. As the return is 6 in. on the wall line as shown in plan and the frieze projects 1 in. over the wall line, then make the distance to the left of J K, 7 in. and allow a lap as shown. As the projection to the left of the line H G in the foot mold pattern is ¾ in., then 4 ft. 6½ in. plus ¾ in. equals 4 ft. 7¼ in., the distance placed to the right of the line K J in the frieze pattern, two of which are also required. The main crown mold pattern is obtained by taking the girth from 15 to 1 in the normal profile and placing it on the vertical line L M, through which points, at right angles to L M, lines are drawn indefinitely. The various projections are now taken from the line B D in plan to the miter line B E and placed on similar lines in the crown pattern, measuring from the line L M. A line traced through these intersected points gives the miter cut shown. As the length of the frieze is 4 ft. 7¼ in., then will the length of the crown mold from the point *s* also be 4 ft. 7¼ in. A lap is allowed below point 15, and a lock above the point 1, to which the roof covering can be locked and soldered. Two sheets of crown mold will be required as shown, making the extreme length, 5 ft. 1½ in., thus making a total length of 10 ft. 2 in. when set together, as called for in elevation in Fig. 150.

The reduced return miters are now laid out as shown in Fig. 152. The girths from 1 to 15 and 16 to 25 in the reduced profile are now placed respectively on the vertical lines N O and P R, as shown by similar numbers, through which horizontal lines are drawn indefinitely as shown. Now, measuring from the line F B in plan, take the various projections to intersections 1 to 15 and 16 to 25 on the miter or joint line E B, and place these projections on similarly numbered lines in the patterns, measuring in each instance from the lines N O and P R, respectively. A line traced through points thus obtained will give the pattern shapes for the return crown and foot molds. Lock and laps are allowed as indicated. As the return is 6 in. on the wall line, make the return foot mold 6 in. as shown. In a similar manner make the crown mold return 1 ft. 5 in. at its longest part, as indicated on the pattern, to correspond to its longest part *w* E in plan, or 1 ft. 5 in.

After the various pieces of the moldings have been cut, the moldings are formed up in the cornice brake as described below.

Forming the Frieze and Foot Molding on the Cornice Brake

The forms in the frieze are simply square bends, made, as indicated in Fig. 153, with the flange *a* turned toward the inside. Fig. 154 shows a stay or profile of the foot mold which is pricked direct from

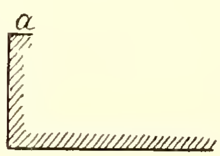


Fig. 153
Forming the Frieze

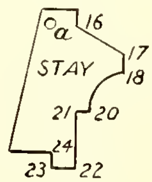


Fig. 154
Foot Mold Stay

the detail drawing shown in Fig. 151, with a hole punched at *a* in Fig. 154 by which to hang it up for future use. The numbers 16 to 24 on the stay are the same as those on the detail drawing, and will help to make clear the various operations in forming. When starting to form the foot mold, begin with bend 24, and continue until bend 18 is reached, the bends all being at right angles as shown from 24 to 18 in Fig. 155. After a square bend has been made on dot 18, place the proper size former B in position, fastening it to the bending leaf as shown, by means of the clamp A.

When selecting the formers for the various molds, one that is a trifle smaller should be selected, because the metal will spring up again after being pressed over the former. Having the former in position, the hands are placed on top of the angle 21, then pressed down and the cove formed as shown, thus bringing bend 24 in the position shown by 24′. The former is now removed and the sheet drawn out to dot 17, as shown in Fig. 156, where the angle *a b* is obtained by raising the bending leaf A to suit the stay shown in Fig. 154, so that it will give the proper angle as shown by the dotted lines at B, Fig. 156. When bending angles, the stops on the cornice brake can be used to advantage, setting them on the quadrant for any desired angle. Using the same stop, the sheet is now reversed and a bend made on dot 16, which will bring the angle in the position shown by the stay.

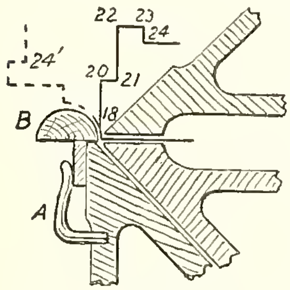


Fig. 155.—Bending the Cove in the Foot Mold

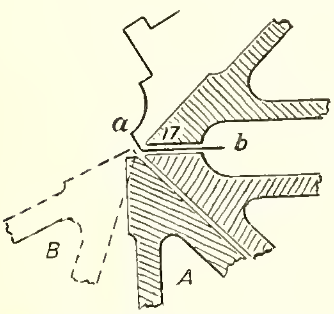


Fig. 156.—Bend for Which the Stop is Used

Forming the Crown and Cap Molding

Fig. 157 shows the profile of the crown and bed moldings from which stays are obtained, cut from scrap metal, as indicated by *a* and *b*. The corners or bends are numbered to correspond with those on the detail and also to form a guide in bending. In this case start the first bend on dot 3 or the top of the ogee and make a square bend as indicated by A in Fig. 158. Place the proper size former in position as shown, and firmly press down A until it has the position shown by B. Reverse the sheet in the brake and make a square bend on dot 7, indicated by the position 3 7 in Fig. 159. Again place the proper former in position, and press down 3, as shown by 3′, being careful in pressing down on corner 3 that the cove 3 *a*

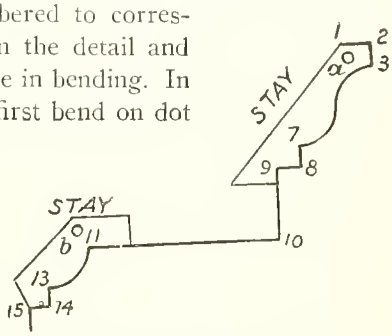


Fig. 157.—Stays for Crown Molding

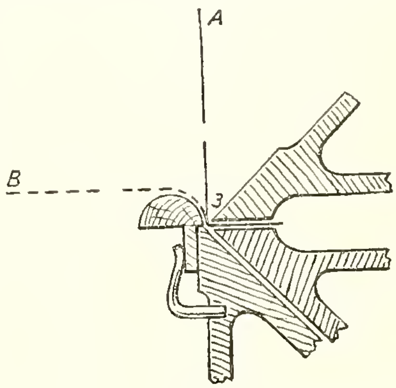


Fig. 158.—First Operation in Bending the Ogee

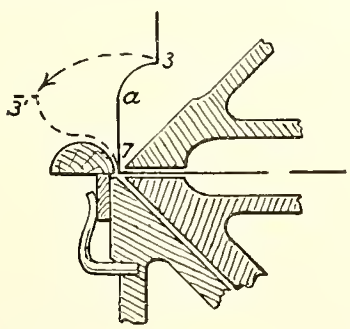


Fig. 159.—Finishing the Ogee

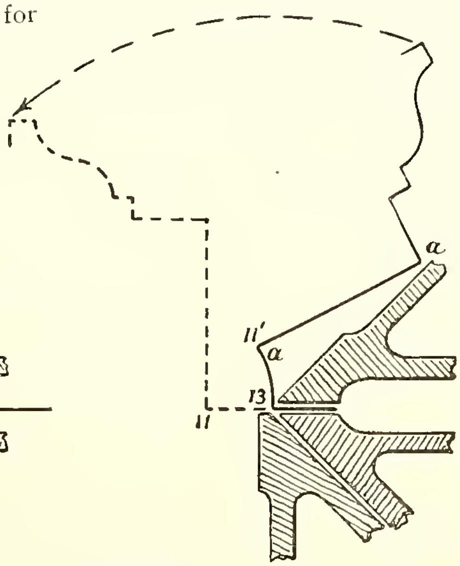


Fig. 160.—First Operation in Bending the Bed Mold

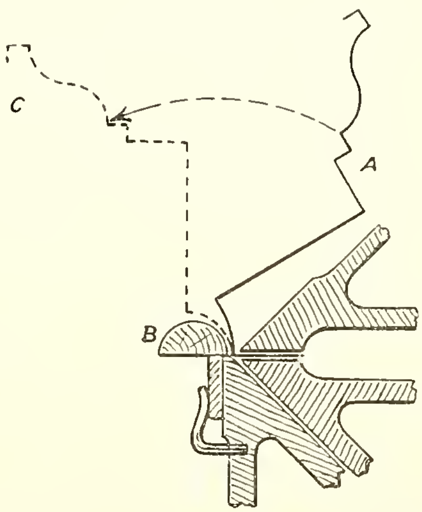


Fig. 161.—Completing the Cap Mold

will not be pressed out of shape, always exerting the most pressure upon the metal below *a* or between *a* and 7.

Now following the stay in Fig. 157, make the necessary square bends on the sheet, until the bend 11 in Fig. 160 has been made. The sheet is now drawn out to dot 13 and a square bend made on this dot as shown. In making this square bend, the sheet will strike the top part of the brake at *a,* thus causing the flat surface between 11′ and 13 to bulge at *a*, which, however, is no disadvantage. The sheet remaining in this position as indicated by A in Fig. 161, the former B is fastened in position and the mold A pressed over the former B, until the position C is obtained. The last two square bends 14 and 15 in Fig. 157 are now made, which completes the forming and bending operations. The foregoing methods apply also to the reduced return molding shown by the reduced profile in Fig. 152.

Setting the Foot Molding Together

The molding being formed, the foot molding is set together first, as in Fig. 162 to 164 inclusive. The first operation is shown in Fig. 162. Drive a roofing nail in the bench at *a,* the required distance from the edge, on which fasten the end of a stout

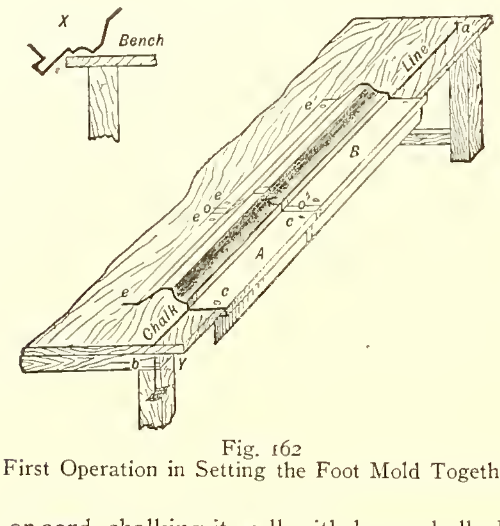


Fig. 162
First Operation in Setting the Foot Mold Together

line or cord, chalking it well with lump chalk. Draw the line taut and fasten it at the opposite end of the bench at *b*. Now, hold the thumb on the center of the line, press down on the bench, and snap each side, thus obtaining a chalk line on the bench, after which the line and nails may be removed.

The first sheet A is now laid on the bench, bringing the corner on the line as shown. It is fastened to the bench by the nails *c* and *c*. The second sheet B is now placed over A, giving the desired lap as shown by *o′ o* and after the proper length has been measured off, sheet B is fastened, by nailing as shown. The sheet can also be nailed at the upper line or wash as indicated by *c c* and *c′ c′*. The seam is now soldered along the flat surface at *o* and *o′* only.

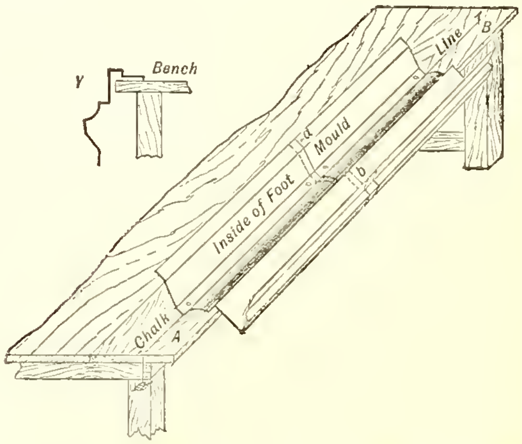


Fig. 163.—Second Operation in Tacking the Mold

The benches on which these moldings are set together usually have sliding tops, that is, the upper boards can be moved outward if desired, as will be explained hereinafter. If, however, the top is stationary, provision should be made to have a good projection as at Y. The nails are now removed from the sheets and the molding is turned over to the opposite side of the bench as indicated by X, but to

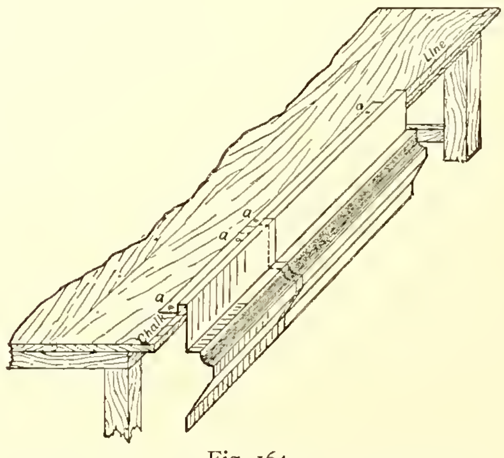


Fig. 164
Last Operation in Setting the Foot Mold Together

more clearly show the second operation, the molding has been turned around and placed on the chalk line A-B as indicated in Fig. 163, where the sheets are fastened by nails as shown, after which the joint or seam is dressed down well and tacked with solder and then soldered from *a* to *b*. If the sheets were not thus turned and the molds were soldered in the position shown by X in Fig. 162, the drip would then be hung in the position shown by Y in Fig. 163; but as the molding lies in the position shown by *a b*, it is simply turned and hung on the bench as shown in Fig. 164, snapping a new line and straightening the line of the drip by means of the nails *a a*, etc.

After this has been soldered and nails removed, the burrs caused by the nail holes are closed and soldered and all joints riveted with two pound tinned rivets. If these moldings should be of copper the joints could be made by using reverse wooden stays, cut from one inch thick spruce.

Joining the Crown and Bed Molds

The first operation in setting together the crown molding is shown in Fig. 165, where a new chalk line is made on the bench as indicated by C. L. The

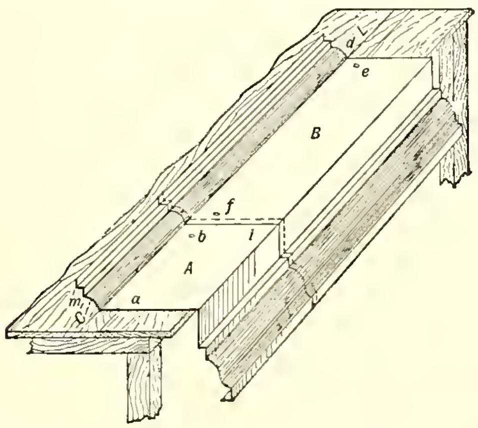


Fig. 165
First Operation in Setting Together the Crown Mold

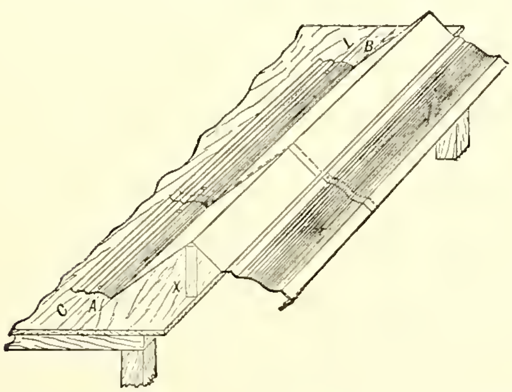


Fig. 166.—Second Operation—Straightening the Cap Mold

first sheet A is now nailed to the bench as indicated by *a* and *b*, with care to have the corner of the cap mold on the line as shown. The second sheet B is now lapped, the corner of the cap placed on the C. L. at *d* and nails put through the sheets at *e* and *f* and the seam soldered along *b i*. Leaving the molding in the position shown, it is now tipped up, so that the further corner of the cap mold at *m* will come on the chalk line as indicated by A-B in Fig. 166, tacking with nails as shown, and

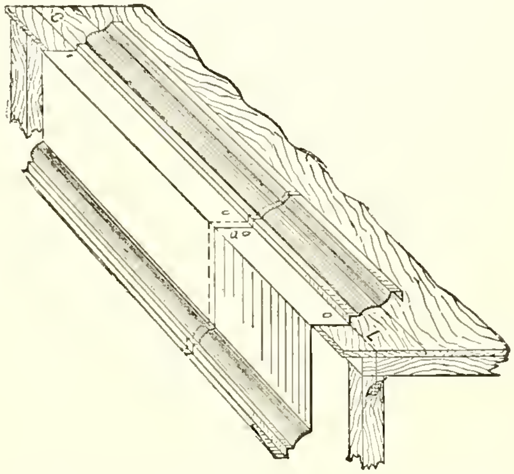


Fig. 167.—Third Operation—Straightening the Fillet

using short wooden braces to hold up the molding as shown by X.

After soldering the cap mold, a new chalk line is struck on the opposite side of the bench as indicated by C. L. in Fig. 167 and the cornice is turned over until it sets in the position shown, thus obtain-

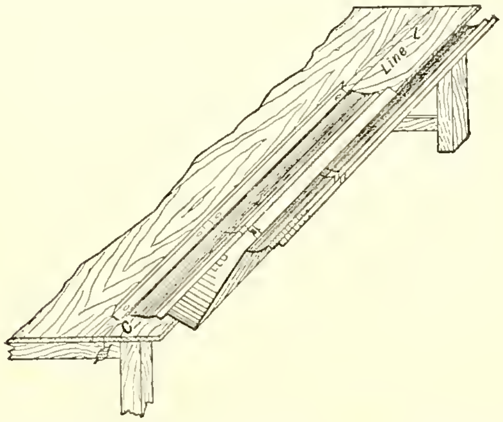


Fig. 168.—Fourth Operation—Straightening the Ogee

ing a straight line along the fillet when the flat surface *a* is soldered. The upper edge of the crown mold can now be turned down on the bench in the position shown by Fig. 168, the corner tacked with nails to the line and the ogee soldered. Finally the molding is lifted off the bench and hung on its upper edge in the position shown in Fig. 169. It is in this operation that the sliding bench becomes convenient. The detail of the standard and bench is shown by A and B in sketch C. The bench is now moved out to the required extent, as shown in the illustration, and the upper edge of the metal is tacked with roofing nails after the front edge is

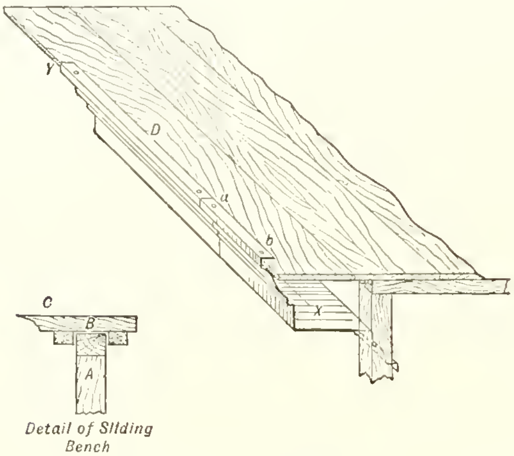


Fig. 169.—Straightening the Upper Edge and Completing the Crown Mold

sighted along XY. In sighting sheets to obtain a straight line, the sheet D should be nailed first, then the second sheet nailed at *a*. The forward end of the sheet at *b* can then be moved in or out as required and nailed at *b*. The foregoing methods are applicable to any length or number of sheets for cornices, gutters, etc.

Joining the Foot Mold, Frieze and Crown Mold

Fig. 170 shows how the foot mold, frieze and crown are lap joined. The foot mold A is first set on the bench, then the frieze B; after which the

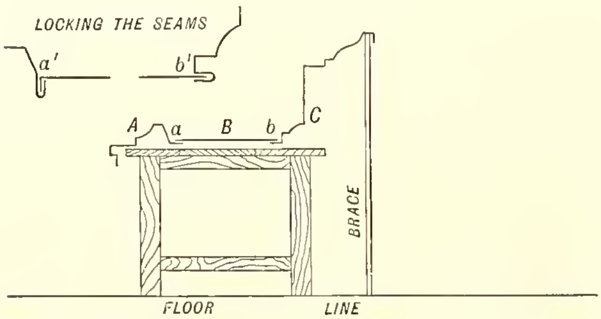


Fig. 170.—Joining the Foot Mold, Frieze and Crown Mold

crown mold C is lapped under B as shown, and supported by the wooden brace shown. The frieze is now soldered throughout at *a* and *b*. Although it has been crimped to avoid buckles, careful soldering is required to avoid buckles in the sheet, which may be best accomplished as follows:

Upon starting to tack the sheet to the foot mold always begin at the center and work out to both ends. This flattens the sheet and prevents buckling. A mistake is often made by starting to tack with solder at the ends of the frieze or sheet, thus having the buckle in the center of the sheet. Sometimes the seams at *a* and *b* are only tacked with solder and then riveted every two inches with two pound tinned rivets. A locked seam can be made at *a* and *b* as indicated by *a'* and *b'*, which is notched at intervals of 12 or 15 inches and slightly turned down with the pliers, to avoid the locks coming apart. An-

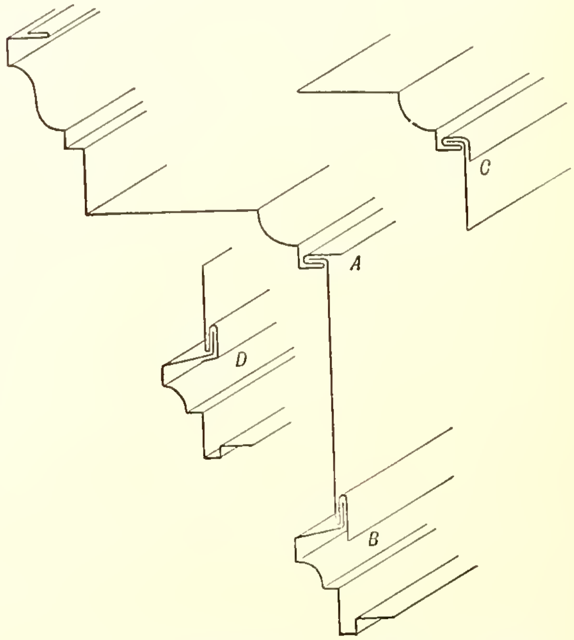


Fig. 171.—Another Method of Locking the Seams

other lock is shown in Fig. 171 where A and B indicate the position of the seams before the edges C and D are turned down. The cornice having been soldered, the wood brace is removed, and the foot mold raised, bringing the cornice in the position shown by C in Fig. 172, ready for the insertion of the lookouts or iron braces.

Bending and Inserting the Band Iron Braces

These braces are usually spaced 3 feet or more apart, and are bent in the brace bender or vise as indicated in diagram A, where the various holes for the bolts are shown. The hole at the bottom marked C. S. signifies that on the lower face the hole is to be

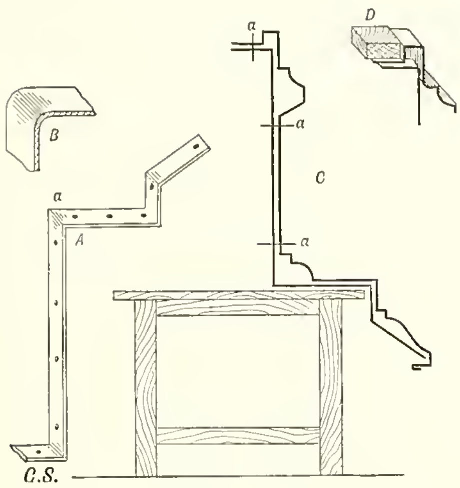


Fig. 172.—Putting in the Braces

counter-sunk, so that a smooth surface may be obtained where it rests on the wall, while the hole marked *a* is for fastening purpose, a matter to be described as we proceed.

In bending the brace, which is usually made from soft steel $\frac{3}{16}$ inch thick by $1\frac{1}{4}$ inches wide, sharp bends are not essential. They can be bent as indicated in diagram B. Having decided upon the number of braces required in the cornice and located their positions, the cornice is raised and the braces are put under as shown in the cut C, after which the bolts are placed as indicated at *a a*, etc. In order that the metal drip may not be damaged or pressed out of shape when the cornice is set on the floor, a piece of wood about 4 or 5 inches long, 3 inches

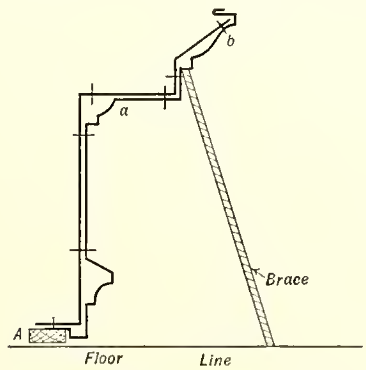


Fig. 173.—Completing the Insertion of the Brace

wide and about 1 inch higher than the hight of the drip, as indicated in diagram D, should be nailed to the drip flange. After this the cornice is placed on the floor, as indicated by A in Fig. 173, and a wood brace set up against the fillet to balance the cornice, after which the remainder of the bolts *a*, *b*, etc., are inserted. The reduced miters or returns are now soldered in position when the cornice is ready to be placed on the wall.

Securing the Cornice to Brick Wall and Covering Its Top

When the brick wall has been carried up to its proper hight as at A in Fig. 174, the cornice B is set thereon, with the anchor C bent to the brace as shown. A wire, D, is now fastened to the brace at *a* and the wire drawn taut and nailed to the beam at *d*. This keeps the drip snugly against the wall. Another wire, E, can now be fastened to the brace at *b* and secured to the beam at *c* by means of a wall hook, the wire being drawn taut until the cornice

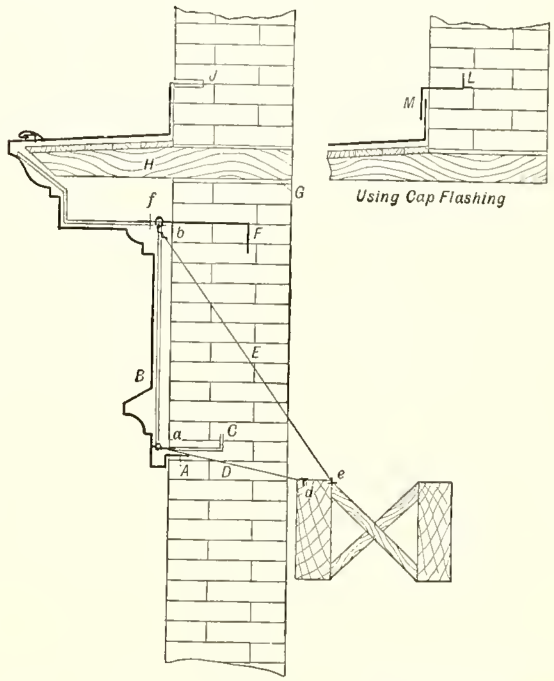


Fig. 174.—Securing Cornice to Brick Wall and Covering Top of Cornice

is plumb. An anchor F is now bolted to the brace at *f*, after which the wall is carried up to G. The wooden lookouts are now placed about 3 feet apart, after which the brick work can be continued.

At the second or third mortar joint, as indicated in this case at J, a "sand joint" should be made by the mason. This is a joint in which no mortar is placed. Sand to a depth of 2 to $2\frac{1}{2}$ inches is employed. Upon flashing the roof covering in the joint, the sand is easily scraped out of the joint with a small trowel, saving the time and labor of cutting out the mortar joint with hammer and chisel. If possible, after the roof of the cornice has been planked, measurements should be taken from the lock of the cornice to the joint in the wall, and the sheets bent in the shop on the brake, so as to obtain sharp bends, on the galvanized iron. The roof being laid, the front edge of the cornice is soldered and the joint at J secured with wall hooks and paint skins.

If the roof is to be covered with tin, the bends are made on a sharp corner of wooden joist or plank. Should a cap flashing be desired as indicated by M L, this is built in the wall as the wall is carried up, and the metal roofing flashed under same as shown. The method of using cap flashing is to be recommended, as it allows for settlement of the walls and beams and also provides for expansion and contraction.

Fastening Cornice to Iron Beams

Occasionally the lintel cornice requires to be secured to I beams, which span the opening of the building, in which case the methods of fastening are alike to that shown in Fig. 175. In this construction,

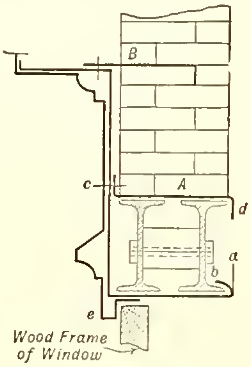


Fig. 175.—Fastening Cornice to I Beams

accurate measurements are taken, so that the cornice drip flange will come directly under the I beam, as shown, and be held in position by means of the anchor A, which is bolted in its proper position to the main brace at C, turned down at *d*. This forms a good rest for the cornice, after which the lower anchor is flattened around the flange of the beam at *a* and *b*. The anchor B is now attached and the brickwork is carried up as before described.

The drip at *c* can be made of sufficient length to form a good overhang on the wooden window frame. While different forms of construction of walls will be met with, a little study on the part of the mechanic will accomplish the desired results in respect to joining and securing the work to the building.

FACE AND BUTT MITERS IN A PLAIN PEDIMENT

Solution 18

Face miters occur in angular and curved pediments just as in panel work. Fig. 176 presents a view of an angular pediment such as is constructed

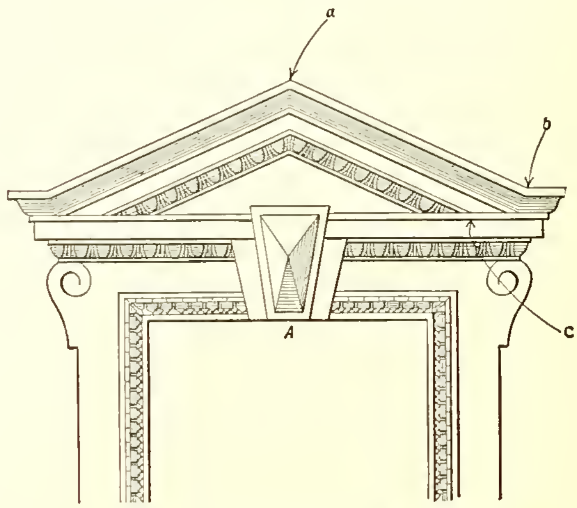


Fig. 176.—View of Face and Butt Miters in a Plain Pediment

over a dormer window. Here a *face miter* occurs at *a* and *b*, with a *butt miter* at *c*. The method of laying out the patterns for the angular and short horizontal molds is shown in Fig. 177. The center line S A is first drawn, the dimension D *a* is set off on the horizontal line, and the true profile *a* C is drawn as shown. If the distance D *a* be such that it is impracticable to place it on the drawing board, it is necessary to draw only the angles and part elevation indicated by *i′ i″ a* C B *i′* when the miter patterns are developed in a manner to be explained. But assuming that the dormer window is of such size that its one half elevation can be placed upon the drafting table, proceed to complete the elevation as follows: From the corner C in the profile, draw the horizontal line C B to given dimensions and draw the angle B A as required. It will be noted that the bed mold in Fig. 176 consists of egg and dart of stamped metal. The background for receiving these enrichments is usually formed as indicated by *a′ b′* in Fig. 177 and on this the egg and dart is soldered, as shown by *c′*. For this reason the profile was shaped as shown by *a* in elevation. Take a tracing from C to *a* and place it at right angles to A B, as indicated by the shaded profile spaced from 1 to 15. Through these small figures parallel to A B, draw lines intersecting the center line A *j*, as

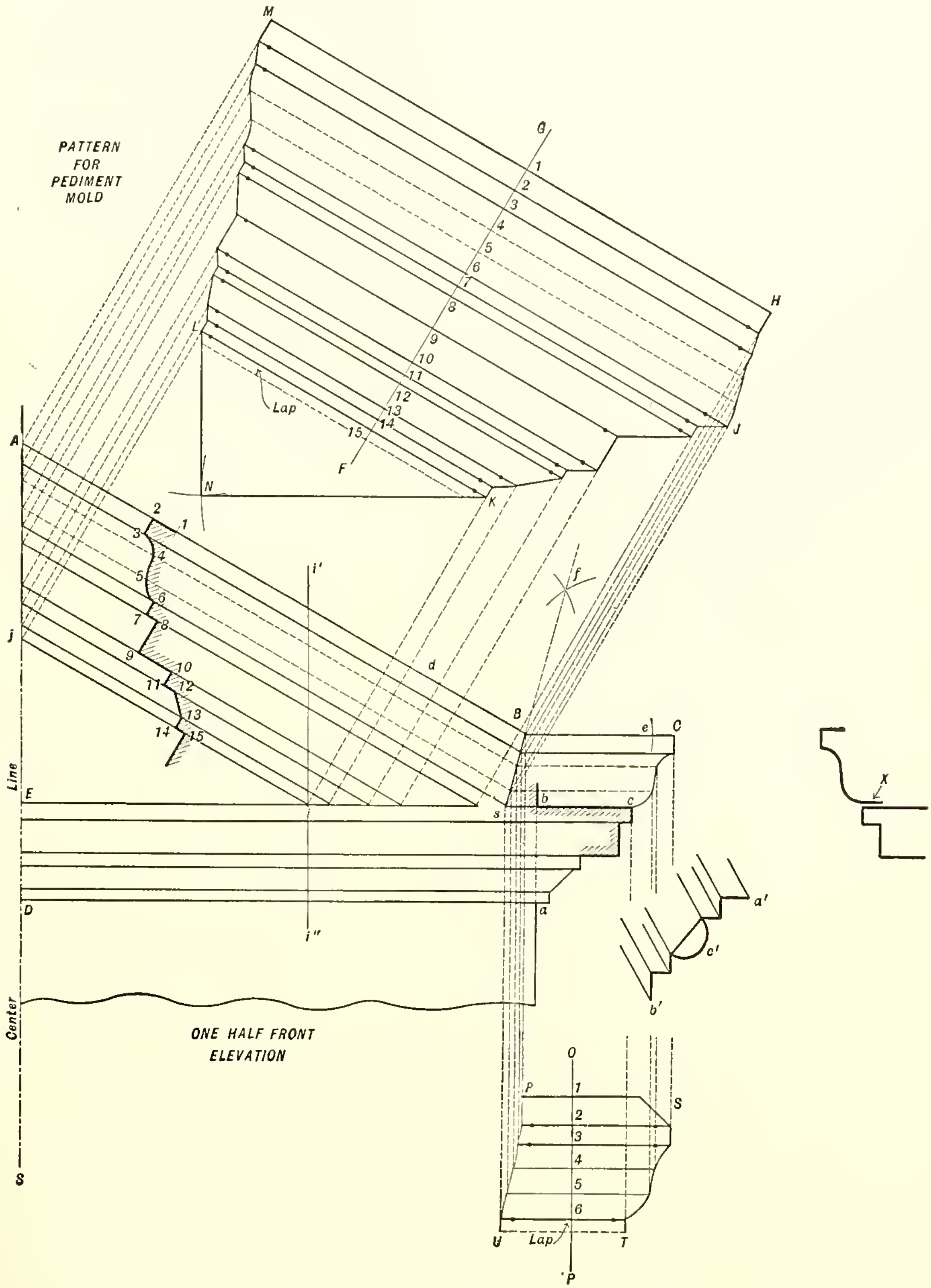


Fig. 177.—Developing the Face and Butt Miters for a Plain Pediment

shown. Bisect the angle A B C and obtain the miter line *f* B extended, by means of the small arcs *d e* and *f*. Thus, all points between 1 and 6 in the profile cut the miter line B *s* and form a *face miter*, while all points between 6 and 15 in the profile butt against the horizontal fillet and form a *butt miter*. The pattern for the pediment mold indicated in the half elevation by A B *s i j* A is developed as follows: At right angles to A B draw the line F G, upon which place the girth of the profile as shown by corresponding numbers on F G. Through these small figures and at right angles to F G, draw lines; intersect these by lines drawn parallel to F G from similar intersections on the joint lines A *j* and *i s* B. Trace lines through points so obtained; H J K L M will be the pattern shape. Add the triangular portion *j* E *i* in elevation by using *i* E and *j* E as radii, with K and L in the pattern, respectively, as centers, intersecting the arcs at N. Draw the lines L N and N K. If it occurs that the width of iron in stock does not allow the triangular piece K L N to be added, provide a lap along L K for joining the triangle as shown. To obtain the pattern for the horizontal ogee mold draw the line O P at right angles to B C, and upon this place the girth of the profile from 1 to 6 as shown on O P. Through these small figures and at right angles to O P draw lines and intersect by lines drawn parallel to O P from similar intersections on B *s* and C *c*. R S T U then gives the desired pattern. A lap is added along U T, which allows this piece to be soldered along the fillet *c s*, as detailed in diagram X. The development of the piece D E *c a* merely indicates a square miter and it may be of assistance if we show how to obtain the depth of the roof, which extends back from the line E *i* to meet bend 15 of the shaded profile. Since the profile from 2 to 15 in the shaded section is similar to C *a* in elevation, proceed to extend a perpendicular line from *a* until it meets the line *c* E at *b*. The distance *b c* then represents the depth of the roof, against which the shaded profile from 6 to 15 abuts. Edges and laps are to be allowed for joining the miters.

INCLINED MOLD MITERING ON A WASH

Solution 19

In the preceding problem the inclined or bed mold mitered against a level roof. If this roof were pitched, it would be necessary to find the miter line in elevation before its pattern could be obtained. Fig. 178 is designed to show the procedure applicable to developing butt miters of this nature. It represents one of the moldings of a pediment, as, for instance, the bed mold, which butts obliquely against a wash or slanting roof upon the level cornice below the pediment. This condition also applies to the fascia and fillet of the inclined moldings of the pediment.

In this class of miters it becomes necessary to first perform an operation whereby the position of the several points of the miter are first obtained in the elevation, or, in other words, to obtain an elevation

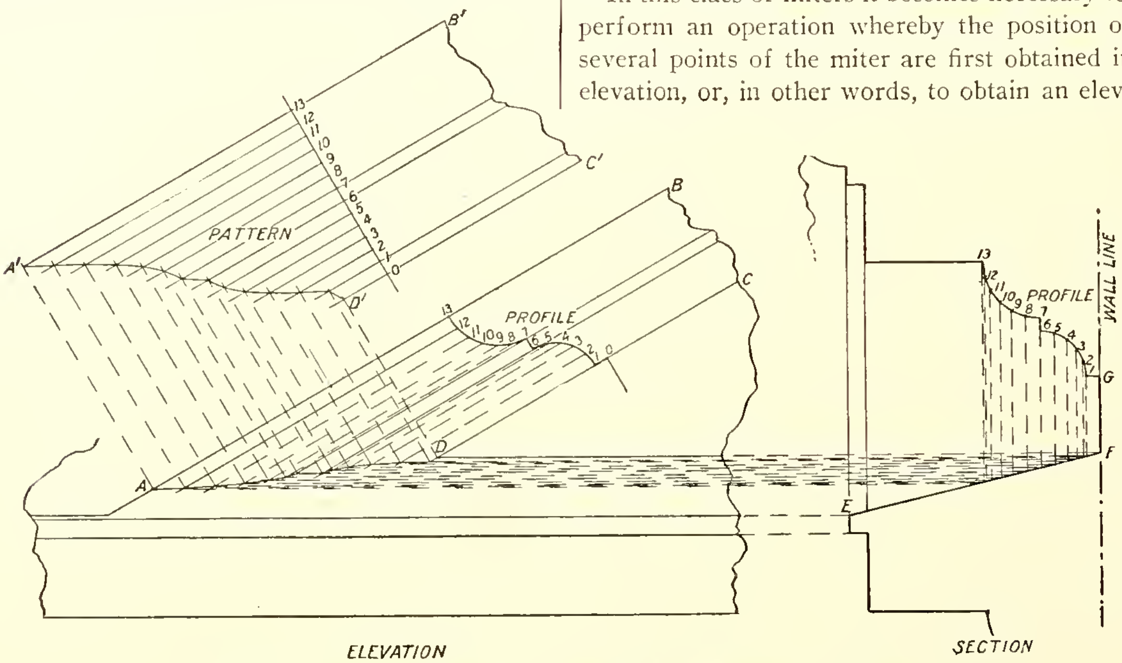


Fig. 178.—Obtaining Pattern for Inclined Mold Mitering on a Wash

of the miter showing just how it will appear when finished.

A B C D shows the elevation of an inclined bed mold, while the section at the right shows the inclination or slant of the wash or roof E F against or upon which the mold is to be mitered. An inspection of the sectional view shows that the greater the distance of any point in the profile from the wall surface, the lower down will it fall upon the wash. Therefore, having placed a duplicate of the profile in the elevation in the position shown in the upper part of the section, divide the curved portions of the both profiles into the same number of equal spaces respectively, as shown by the small figures.

From the points in the profile in the elevation carry lines parallel with the lines of the mold indefinitely toward the miter as shown, and from the points in the profile in the sectional view drop lines vertically upon the wash E F, and from the points of intersection thereon carry lines horizontally across to the elevation to intersect with lines of corresponding number previously drawn. A line traced through the points of intersection, as shown from A to D, will give the elevation of the miter.

To obtain the pattern, first set off a stretchout of the profile upon any line drawn at right angles to the lines of the elevation, as 0-13, and from the points on 0-13 draw the measuring lines, as shown at the left; then from the several intersections previously obtained between A and D project lines parallel with 0-13 to intersect measuring lines of corresponding number. A line traced through the several intersections, as shown from A^1 to D^1, will give the shape of the miter cut, and A^1 B^1 C^1 D^1 will be the pattern, to which edges for joints can be added as required.

FACE MITER BETWEEN CURVED AND HORIZONTAL MOLDINGS

Solution 20

In Fig. 179 is shown a finished view of a circular pediment on a cornice, the circular ogee of the molding mitering with the horizontal ogee mold, thus forming face miters where indicated by the two arrows. The method of finding the miter line between the curved and horizontal moldings is illustrated by Fig. 180, in which also is shown the pattern developed. First draw the center line A B, and establish the center hight of the pediment as C D. Locate the distance C 9 and draw the profile of the mold from 9 to 2. From 2 draw a horizontal line indefinitely to the left, which intersects at G by an arc, struck from A, the desired center, with A D as radius. Divide the profile into an equal number of spaces, as shown from 1 to 10, and through these small figures draw lines indefinitely to the left, parallel to C 9, crossing the line *a b* which is drawn at right angles to C 9. Take the distances of the

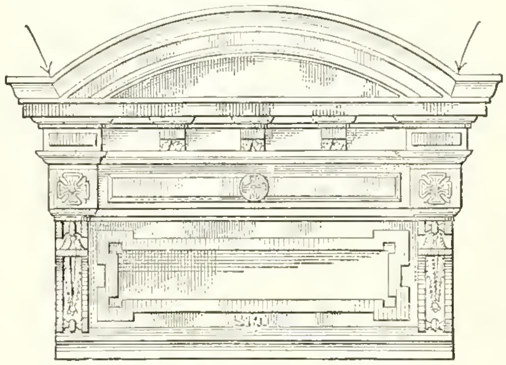


Fig. 179.—Face Miter Between Curved and Horizontal Moldings

various intersections on *a b* indicated by the heavy dots, and place them on the center line A B from D to E, as shown by the heavy dots, placing the dot 1′ on *a b* at 1″ on D E, as shown. Then, using A as center and with radii equal to the various divisions between E and D draw arcs as shown, intersecting similar horizontal lines previously drawn from the small figures in the profile 1 to 6. Trace the miter line through points so obtained, as shown from F to G. Note that this miter line F G is not a straight line, but is made up of varying curves, because each radius in the curved mold is different. In the angular pediment miter in Fig. 177, the horizontal ogee mold was developed separately. In this case and cases where the horizontal mold is very long, a vertical seam can be made along F O in Fig. 180 and the entire horizontal mold can be laid out as follows: Draw any line as H J at right angles to C 9, on this place the girth of the mold 1 to 10, as shown by similar numbers on H J. Through these small figures and at right angles to H J, draw lines. Intersect these lines by lines drawn parallel to H J from corresponding intersections in the profile 1 to 10 and on the miter and seam line, G F O. Trace a line through these points, when K L M N will be the desired pattern, K L representing the cut for the return miter and M N the cut for the face miter. It should be understood that if the curved pediment were of great length it would not be necessary in obtaining the miter line and patterns, to draw the complete half pediments, here shown. In that

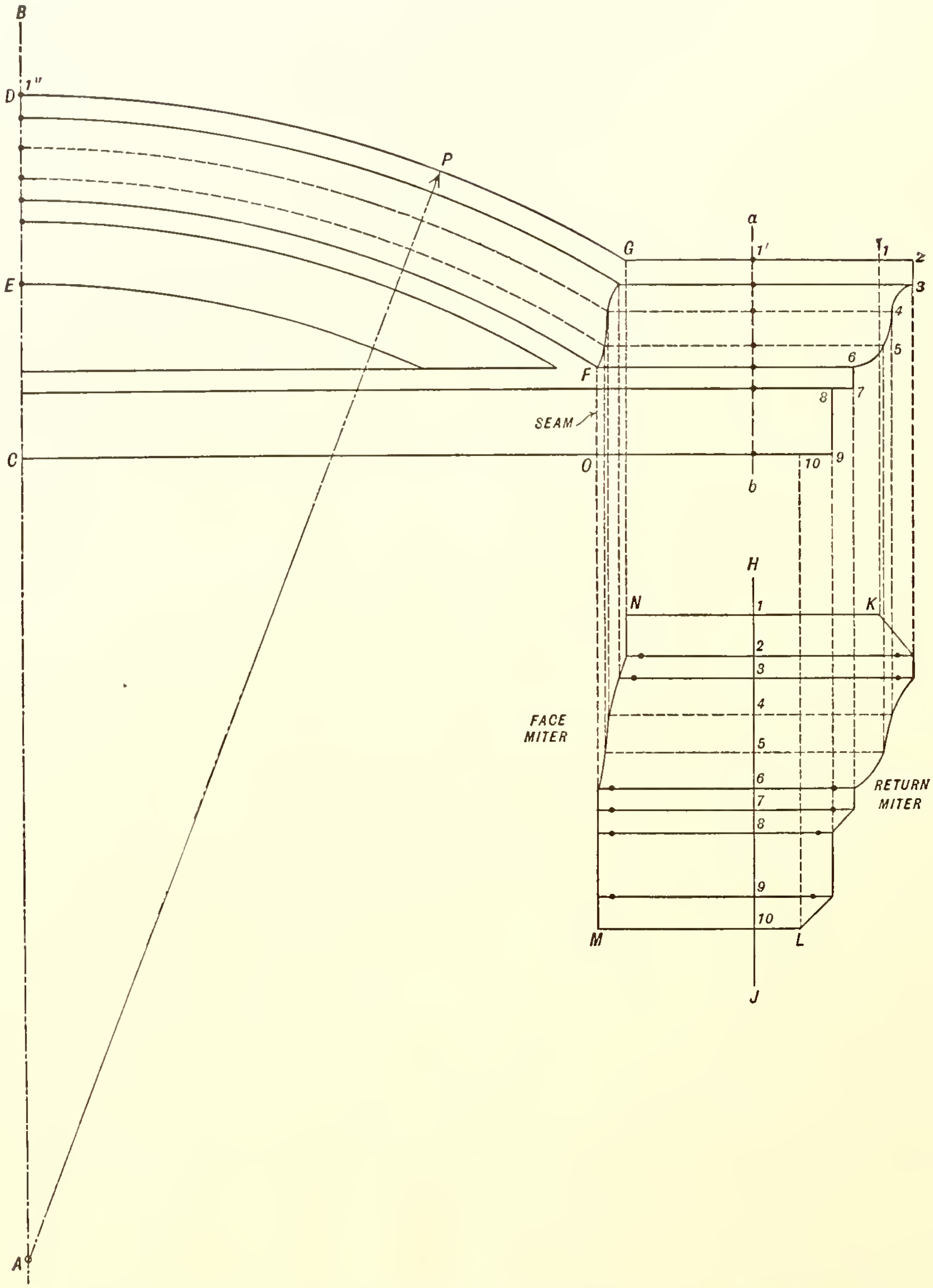


Fig. 180—Obtaining the Face and Return Miters, between Curved and Horizontal Moldings

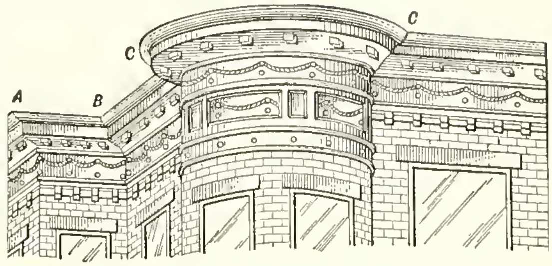
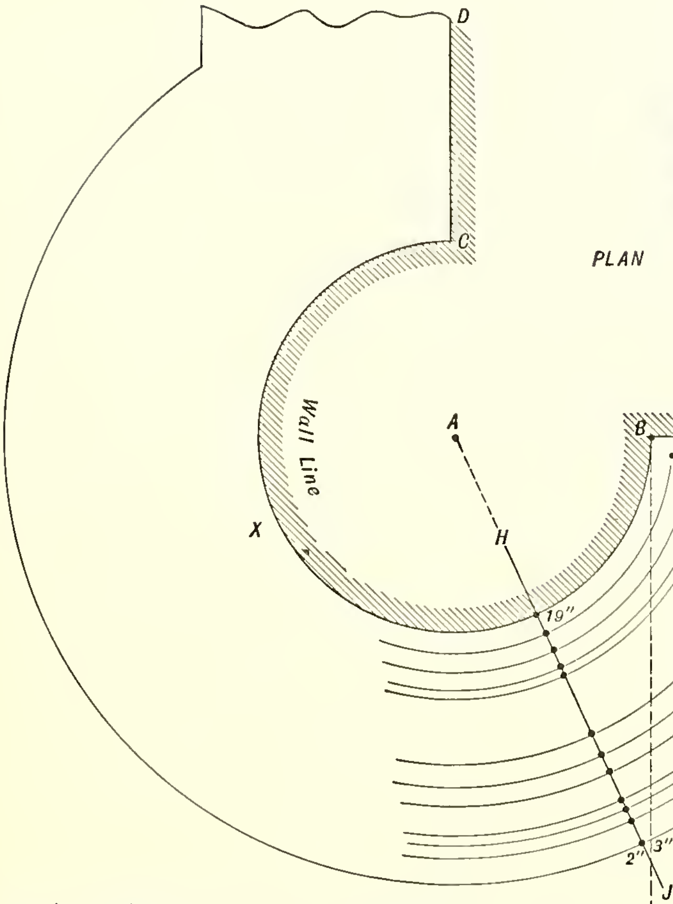


Fig. 181.—Intersecting Miters Between Curved and Horizontal Moldings



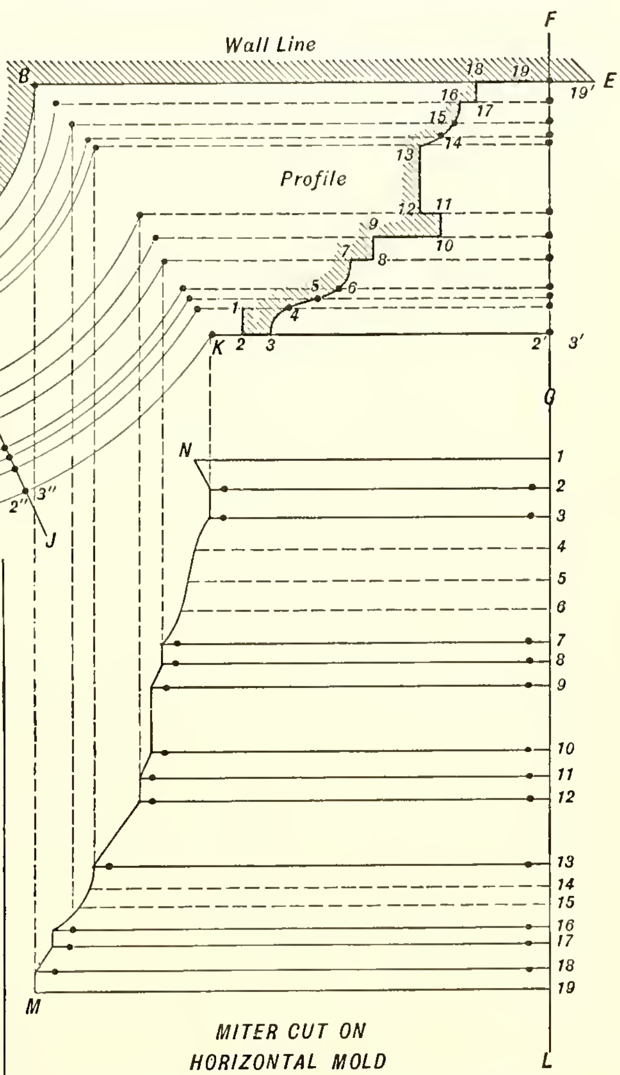


Fig. 182.—Methods of Obtaining Intersecting Miters Between Curved and Horizontal Moldings

case it would be necessary to draw only part of the pediment, after the proper radii on D E were found, or as much as is indicated from P to G. This also applies to the horizontal mold G 2, for which a separate miter could be laid out for the face and for the return, respectively.

On large curved pediments, the curved moldings are usually stamped; but if an insufficient quantity of curved molding is required, it would not pay the expense of making stamping dies; in this case the molding is made by hand. The method of laying out the patterns for curved moldings is taken up in the division of this work on patterns relating to curved moldings.

INTERSECTING MITERS BETWEEN CURVED AND HORIZONTAL MOLDINGS

Solution 21

Fig. 181 is a view of a main cornice having an outside miter at A, an inside miter at B, and an intersecting miter between a curved and horizontal cornice at C C. The distinction between this problem and the one last described is that in the former case the curves of the molds show in *elevation,* while in this problem the curves show in *plan.* The method of obtaining the miter cut at the intersection shown at C is set forth in detail in Fig. 182, where A indicates the center, from which the curve B X C is struck. D C X B E represent the wall line. To show the principle involved in obtaining the miter line in plan, we will take the crown and bed moldings as an example, since the entire cornice cannot be shown in limited space. While the entire circular wall is presented here, this is not practical nor necessary on large work in which case part of the curve serves requirements as indicated by B H J. The wall line being drawn, place the profile in the position as shown, so that the face 2-3 of the profile is parallel to B E. *Space the profile into divisions*, as shown from 1 to 19, and through them draw indefinitely lines parallel to B E, cutting the line F G drawn *to any length* at right angles to B E. Draw any *radial line* from the center A as H J, and on this place the various divisions shown by the heavy dots on the line F G taking care to place 19′ on F G upon the wall line at 19″ on the line H J. Using A as center, with the dots on H. J. as radii, draw arcs as shown, intersecting corresponding horizontal lines drawn through the small figures in the profile, as shown by the intersections between B and K. Note that the miter line between B and K is not a straight line, because each arc has a different radius. The pattern is now in order and is obtained by placing the girth of the profile from 1 to 19 upon the line G L, as shown by corresponding number, through which, at right angles to G L, lines are drawn and intersected by lines drawn parallel to G L from similar intersections on the miter line B K. A line traced through points thus obtained as shown by M N will be the desired miter cut.

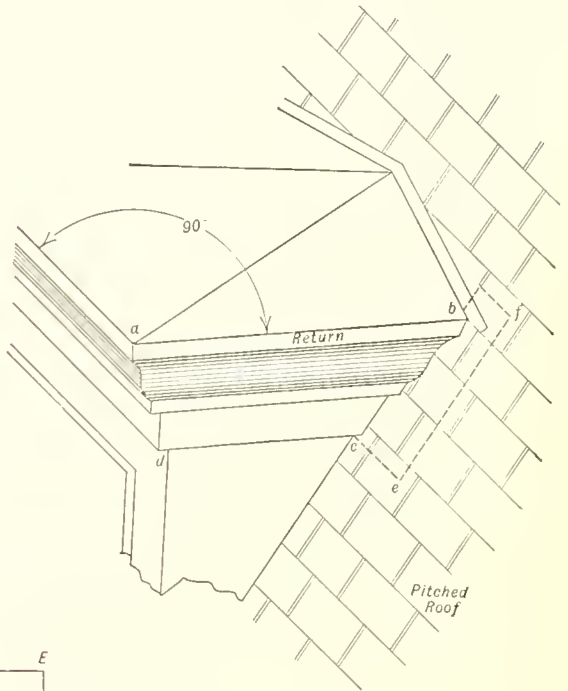


Fig. 183.—View of Butt Miter on Square Dormer Return, Intersecting an Oblique Surface in Elevation

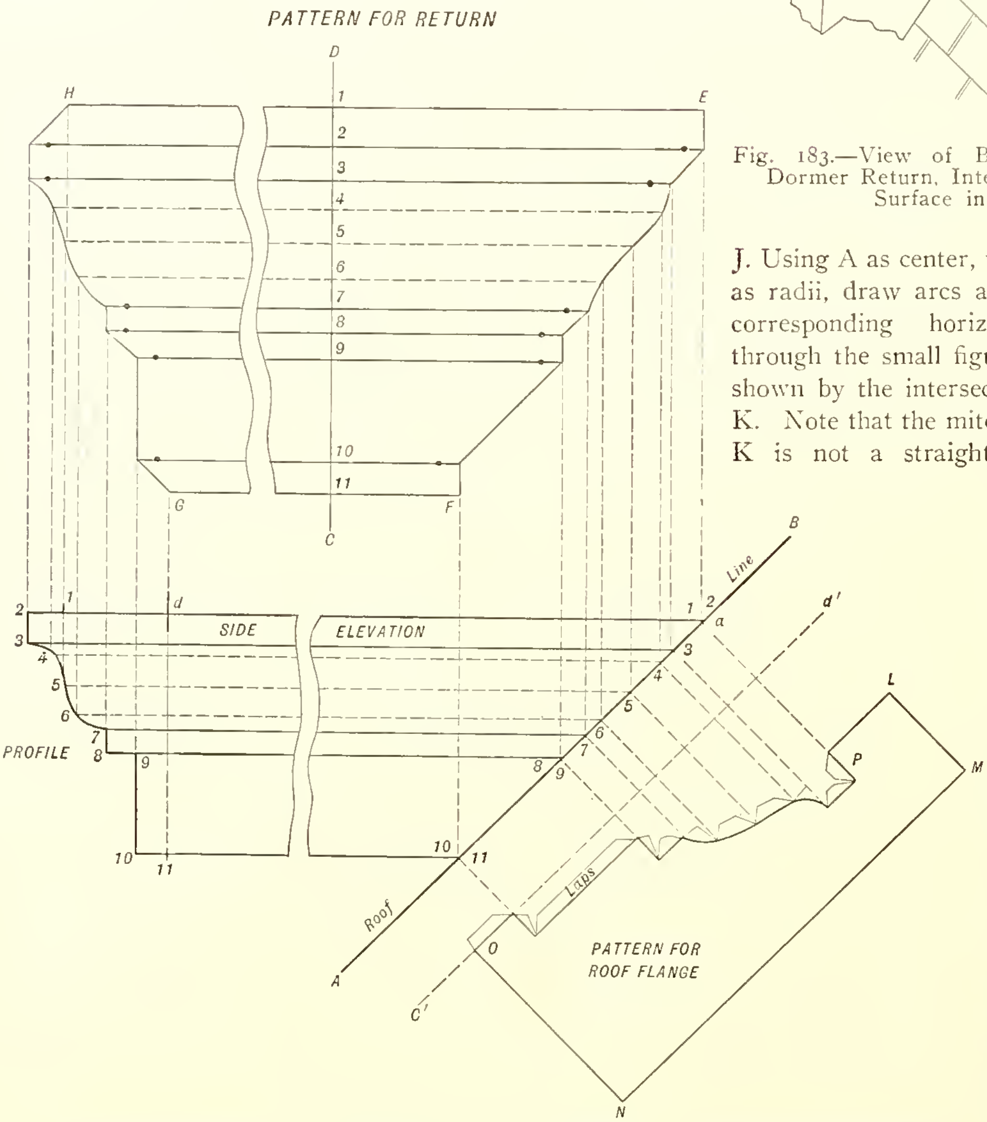


Fig. 184.—Patterns for a Butt Miter and Roof Flange on a Square Dormer Return, Intersecting a Pitched Roof

BUTT MITER AND ROOF FLANGE ON A RIGHT ANGLE RETURN, INTERSECTING AN OBLIQUE SURFACE IN ELEVATION

Solution 22

The present demonstration is that of a return miter intersecting an oblique surface in elevation, as in the return of a dormer window against a pitched roof, indicated by *a b c d* in Fig. 183, the return being at an angle of 90 degrees or right angular. The development of this pattern can be accomplished as shown in detail in Fig. 184. Here A B shows the pitch of the roof, the profile of the mold being indicated from 1 to 11. From the small divisions in the profile, lines are drawn parallel to the lines of the molding until they intersect the roof line as shown. At right angles to 2-*a* in the side elevation draw any line, as D C, upon which place the girth of the profile, as shown by similar numbers on C D. Through the small figures 1 to 11, at right angles to C D, draw lines which are intersected by lines drawn parallel to C D from similar points in the profile and from intersections on the roof line A B. A line traced through points so obtained, as shown by E F G H, will be the desired pattern for the return, E F representing the butt miter and G H the square return miter.

ROOF FLANGE ON RIGHT ANGULAR DORMER RETURN

Solution 23

In the case of a dormer return which butts against the roof surface, it is customary to join a roof flange to the butt miter of the return, as indicated by *b c e f* in Fig. 183. This flange is used when making water tight joints between shingle, slate, tile and metal roofs and it is laid out as indicated in Fig. 184. From the various intersections of the mold against the roof line A B, as indicated from 1 to 11, draw lines at right angles to A B, as shown. Now draw, parallel to A B, any line, as *c′ d′*. From the point 11 in the profile in the side elevation, draw the line 11, *d*, at right angles to the lines of the molding. Measuring from this line 11, *d*, take the various projections to points 1 to 11 in the profile and place them on similarly numbered lines drawn at right angles to A B, measuring in each instance from the line *c′ d′*. The result will be the developed section shown from O to P. Add to this shape the amount of roof flange desired, as indicated by L M N O, completing the pattern.

OCTAGONAL RETURN AGAINST AN OBLIQUE SURFACE IN ELEVATION

Solution 24

This demonstration is a return molding, having an angle other than a right angle in plan, and which butts against an oblique surface in elevation, as shown in Fig. 185, where the return of an octagonal dormer is indicated as butting against a pitched roof. The method of obtaining the pattern is as indicated in Fig. 186.

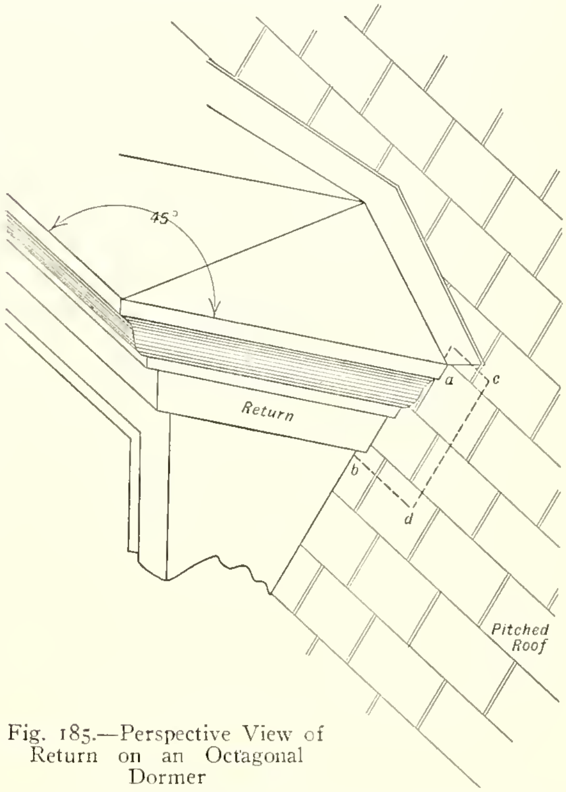


Fig. 185.—Perspective View of Return on an Octagonal Dormer

Let A B represent the pitch of the roof and C the profile of the mold. Divide the profile C into a number of equal spaces and from these points carry lines parallel to the lines of the mold, until they intersect the roof line A B, as shown by similar numbers. In line with the side elevation, as shown by the dotted lines, draw the plan view of the return indicated by 2^1 D E, making the angle at D as required. Then take a duplicate of the profile C and place it in the position shown by C^1 in plan. Divide it into the same number of spaces as appears in C. Through the small figures in C^1 draw lines parallel to D 2′. Intersect these lines by lines drawn at right angles to the lines of the mold in the side elevation from similarly numbered intersections on the roof line A B. Thus is obtained the intersections 1′ to 10′ in plan. Trace a line through points so located obtaining representation of the miter line in plan or joint line between the return mold and pitched roof. If it be desired, bisect the angle at D and obtain the miter line D F, extending which place the girth of the profile C^1, as shown by similar figures; at right angles to H J, draw lines, which intersect lines drawn parallel to H J from similarly numbered points on the miter line D F and 1′-10′. A line traced through these points, as shown

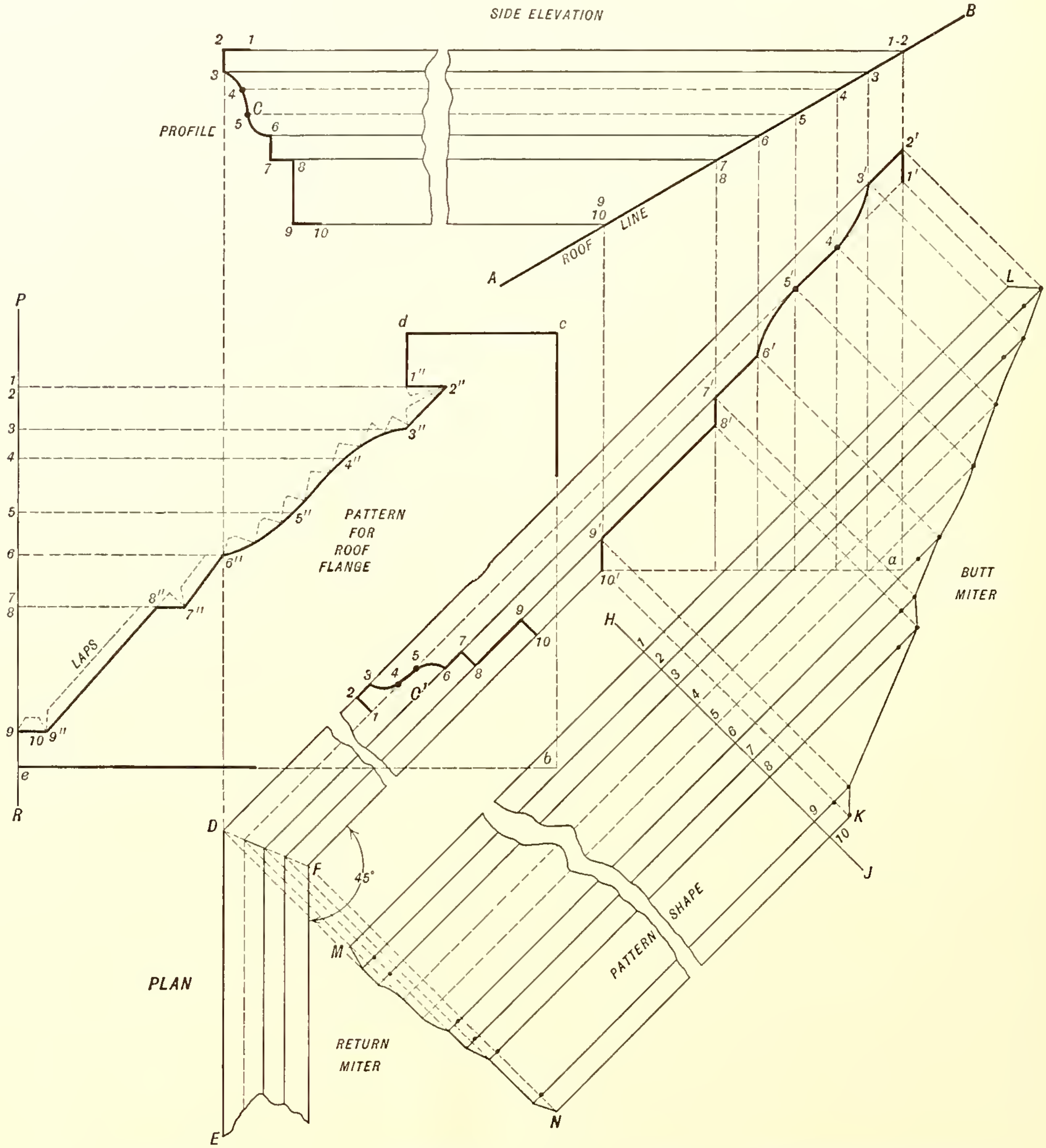


Fig. 186.—Obtaining Pattern for Octagonal Return on a Dormer, Against an Oblique Surface in Elevation

the lines drawn through the small figures in C^1 until they cut the miter line D F, as shown. We may then proceed to develop the pattern as follows: At right angles to D 2′ draw the line H J, upon by K L M N will be the desired pattern. M N represents the miter cut for the octagon return angle, while K L is the butt miter against the pitched roof, at an angle shown in plan.

ROOF FLANGE BETWEEN PITCHED ROOF AND RETURN MOLD AT OTHER THAN A RIGHT ANGLE

Solution 25

This solution is that of a roof flange for a return mold at other than a right angle, against an inclined roof, as shown by *a b d c* in Fig. 185. It is laid out as indicated in Fig. 186. The girth of the various intersections on the roof line A B is placed on any vertical line, as P R, as shown by like numbers. Through these small figures perpendicular to P R, draw lines indefinitely, as shown. Then from the intersection 10′ in the miter line in plan, draw a line at right angles to D E, as shown by 10′ *a*. Measuring from this line take the various distances to points 1′ to 10′ and place them on lines having similar numbers, measuring in each instance to the right of the line P R, and from that line, thus obtaining the points of intersections 1″ to 9″. Trace a line through points so obtained. This line, 1″, 7″, 10 will be the desired section. To the right of this section, add, as indicated, the amount of flange desired. Then will *d, c, b, e,* 10, 1″, *d* be the pattern desired.

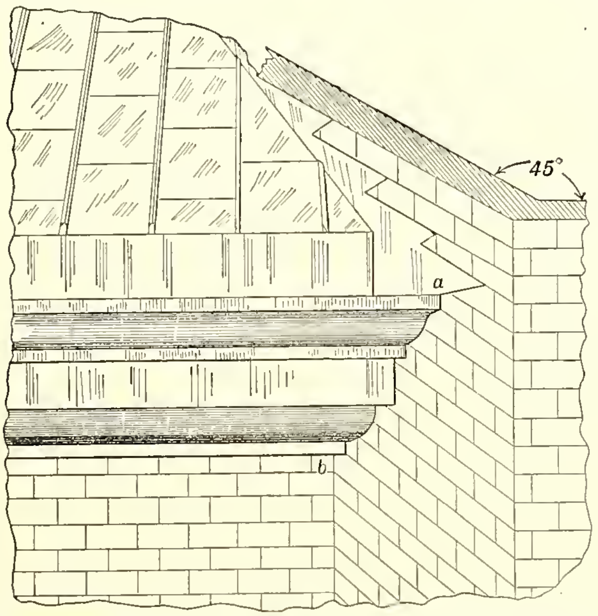


Fig. 187.—View of Butt Miter of a Horizontal Molding Intersecting an Oblique Surface in Plan

HORIZONTAL MOLDING INTERSECTING AN OBLIQUE SURFACE IN PLAN

Solution 26

Fig. 187 is a perspective view of a gutter cornice intersecting a beveled wall in plan, the wall in this case being at an angle of 45 degrees, thus forming the intersecting joint line *a b*. The method of laying out this butt miter is shown in Fig. 188, the principle being applicable, no matter what may be the angle of the wall A B C in plan. In developments of this nature the angle of the wall A B C is first drawn and the profile of the mold is placed in the position shown. This profile is divided into an equal number of spaces, as indicated from 1 to 16. Through these small figures lines are drawn parallel to the lines of the mold and intersecting the beveled wall line A B, as shown. At right angles to *a b* the girth line D E is drawn; on this line the girth of the profile is placed, as indicated by the small figures on D E. At right angles to D E, through the small figures 1 to 16, draw lines, intersect these lines by lines drawn parallel to D E from similar points of intersections on the wall line A B. A line traced through the points of intersections thus obtained, as shown by F G, will be the desired butt miter.

FLAT HEAD AT OBLIQUE END OF MOLDING

Solution 27

In case of requirement to place a flat head in the oblique end of a molding, as along *c a* in plan in Fig. 188, the head can be developed as follows: At right angles to *c a,* from the various intersections thereon, erect line indefinitely as shown and from any point, as X^1, drawn the line X^1 2^1 at a sufficient distance above and parallel to *c a*. From the point 2 in the profile in plan, draw the line 2 X at right angles to *a b*. Measuring from the line X 2 take the various distances to points 1 to 16 in the profile and place them on similarly numbered lines, measuring in each instance from the line X^1 2′, thus obtaining the points of intersection shown from 1′ to 16′. Trace a line through points so obtained, as shown. This will be the desired pattern, whose edge line will correspond with the edge line of the butt miter, shown below.

HORIZONTAL MOLDING, INTERSECTING A CURVED SURFACE IN ELEVATION

Solution 28

Fig. 189 is a perspective view of a dormer return intersecting a curved roof, the return being at right angles to the face of the dormer. The method of laying out the pattern is shown in Fig. 190. Having found the radius for the curve of the roof, use C as center and draw a short arc, indicated by A B. In its proper position, as at X, draw the horizontal line X 2, and, also in its proper position, as shown, draw the profile from 1 to 11. Space the profile as shown by the small figures, through which

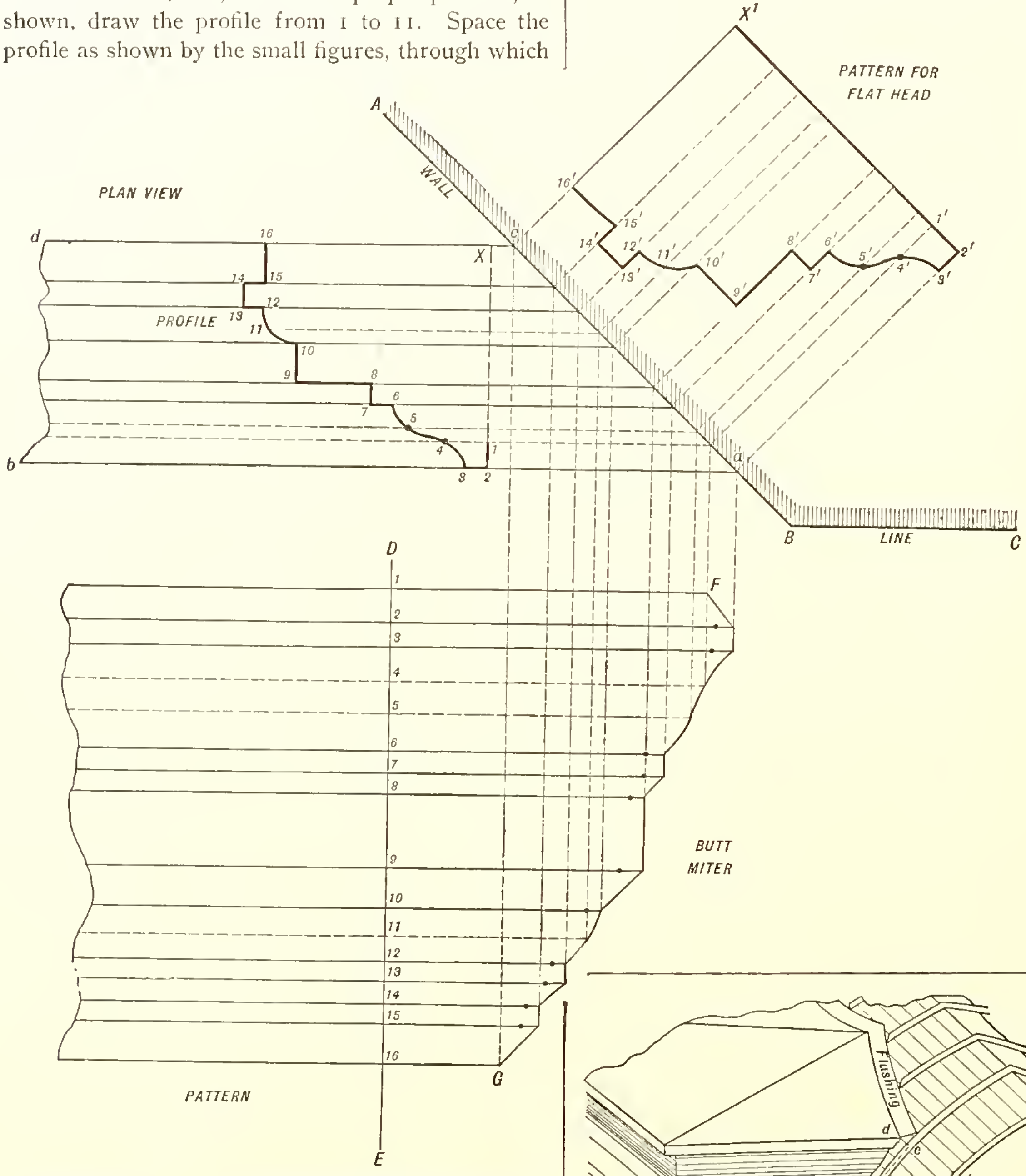


Fig. 188.—Pattern for Horizontal Molding Intersecting an Oblique Surface in Plan

draw lines parallel to 2 X until they intersect the curved roof line. Below the side elevation, draw any vertical line, as C D, upon which place the girth of the profile, as shown by similar numbers on C D, through which at right angles to C D, draw lines indefinitely. Intersect these lines by lines drawn parallel to C D from similar points of intersections on the roof line A B and in the profile. Trace a line through points of intersections thus obtained; E F will be the butt miter and G H the

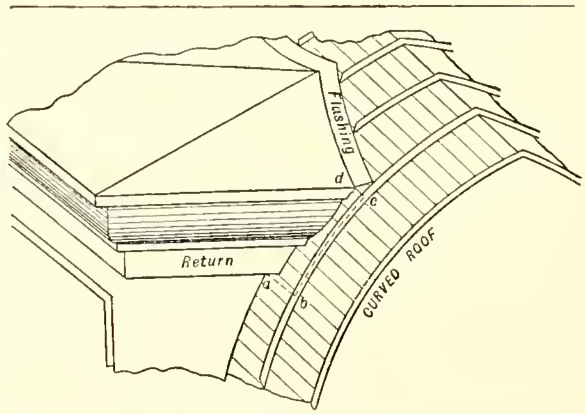


Fig. 189.—View of Horizontal Return on a Curved Surface in Elevation

return miter. Where the members of the profile 2-3 and 7-8 intersect the curved roof, as at 2′-3′ and 7′-8′, the corresponding members in the pattern can be connected by straight lines as from 2″ to 3″ and 7″ to 8″; but where the intersecting surface is large, as from 9′ to 10′ on the curved roof line, a reproduction of this curve 9′-10′ must then be transferred to the pattern 9″ and 10″. This curve can be traced or obtained as follows: Using the radius A C in elevation, with 9″ and 10″ in the pattern as centers, describe arcs intersecting each other at C¹. Then using the same radius, with C¹ as center, describe the arc 9″-10″.

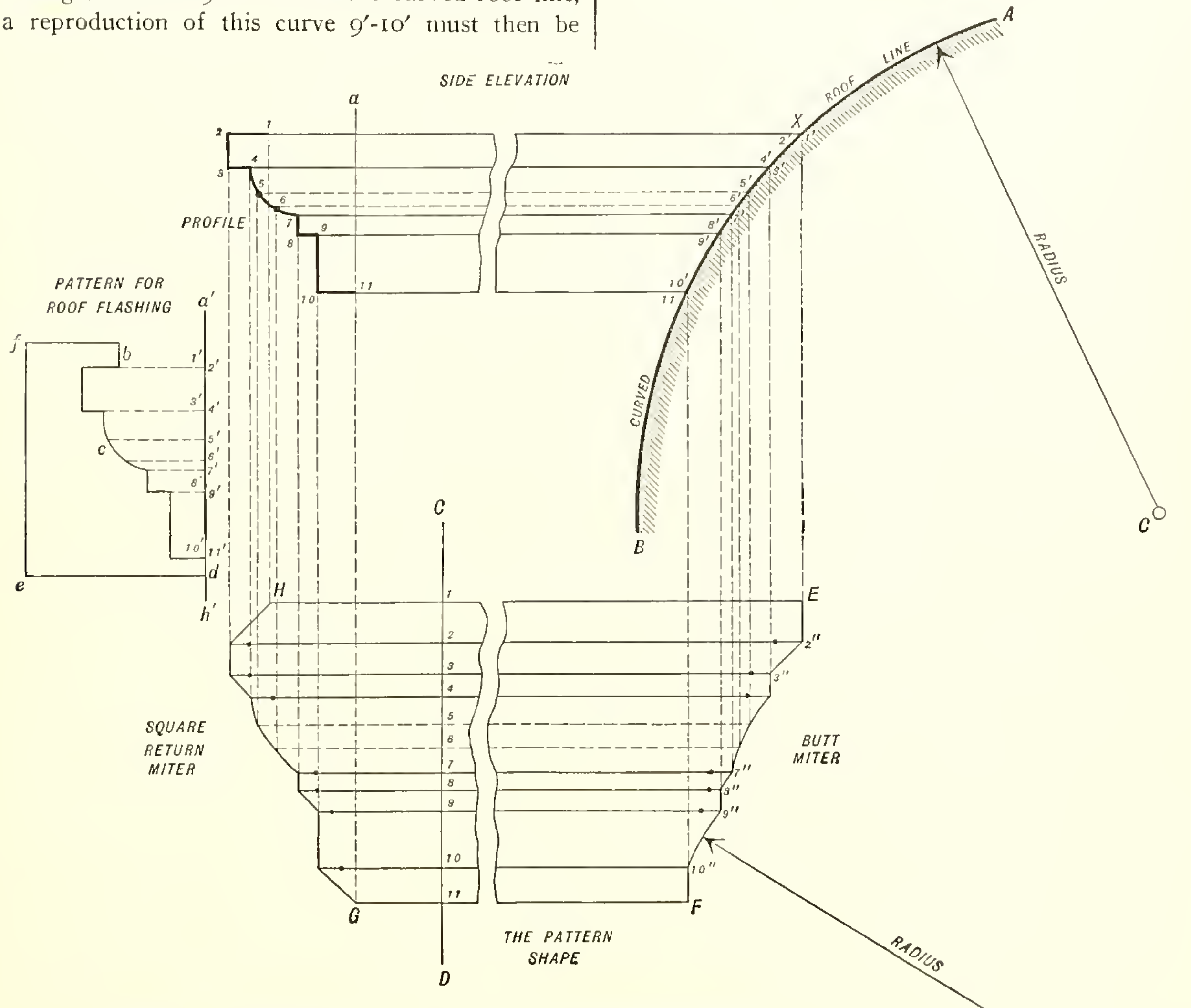


Fig. 190.—Obtaining Pattern for Horizontal Molding Intersecting a Curved Surface in Elevation

CURVED ROOF FLANGE

Solution 29

A roof flange on a curved roof, to intersect with a horizontal return, as indicated by *a b c d* in Fig. 189 may be laid out as shown in Fig. 190. Take the girth of the various divisions 1′ to 11′ on the curved roof line A B and place it on any line as *a′ h′*. Through the small figures on, and, at right angles to *a′ h′*, draw lines indefinitely to the left as shown. From the point 11 in the profile in the side elevation erect the perpendicular line 11-*a*. Measuring from the line 11-*a*, take the various projections to points 1 to 11 in the profile and place them on similarly numbered lines, measuring in each instance from the line *a′ h′*. Trace a line through points thus obtained, as indicated by *b c* 11′. To the left of this section add the desired amount of flange, as shown by *d e f*, which completes the pattern.

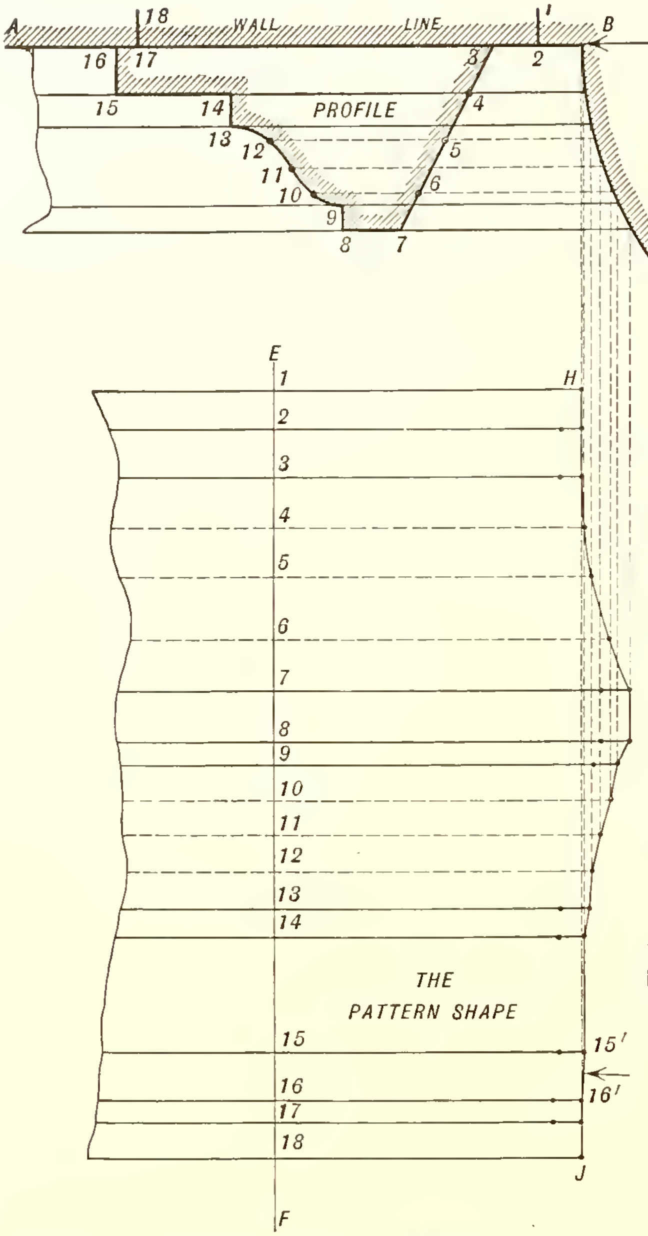


Fig. 192.—Pattern for a Horizontal Molding Intersecting a Curved Surface in Plan

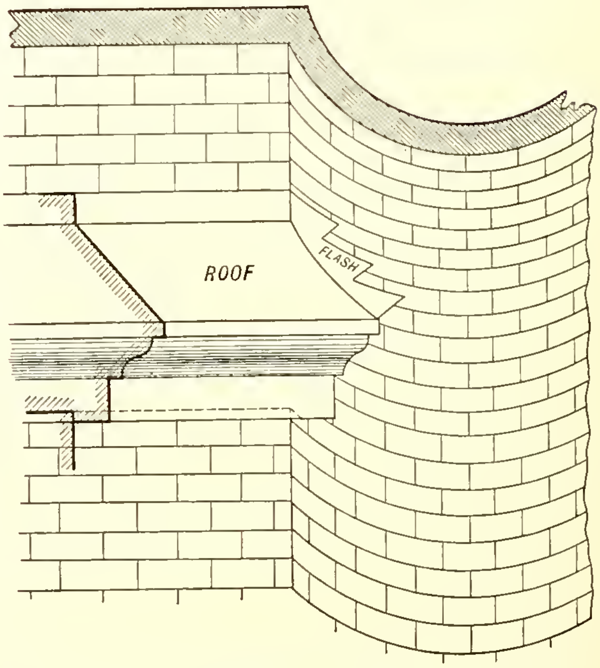


Fig. 191.—View of Horizontal Molding, Intersecting a Curved Surface in Plan

HORIZONTAL MOLDING INTERSECTING A CURVED SURFACE

Solution 30

A molding butting against a curved surface in plan, as shown in the perspective view in Fig. 191. The development of the miter cut is performed as shown in Fig. 192. Here A B C represents the straight and curved wall lines. The curve B C is struck from the center D. The profile of the mold is placed in the position shown, so that the member 7-8 of the molding lines is parallel to the wall line A B. The profile between 7 and 18 is spaced and numbered as shown and lines are drawn parallel to A B until they intersect the curved wall line. To avoid a confusion of lines, use those drawn through 14-15, 12 and 10 of the profile, which cross the wash at 4, 5 and 6, and utilized these points in obtaining the cut of the wash against the curved surface, instead of employing separate divisions along the wash 3-7. The pattern may then be laid out by drawing the girth line E F, at right angles to A B. Upon E F place the girth of the full profile, as shown by similar numbers on E F. At right angles to E F and through the small figures theron, draw lines which intersect lines drawn

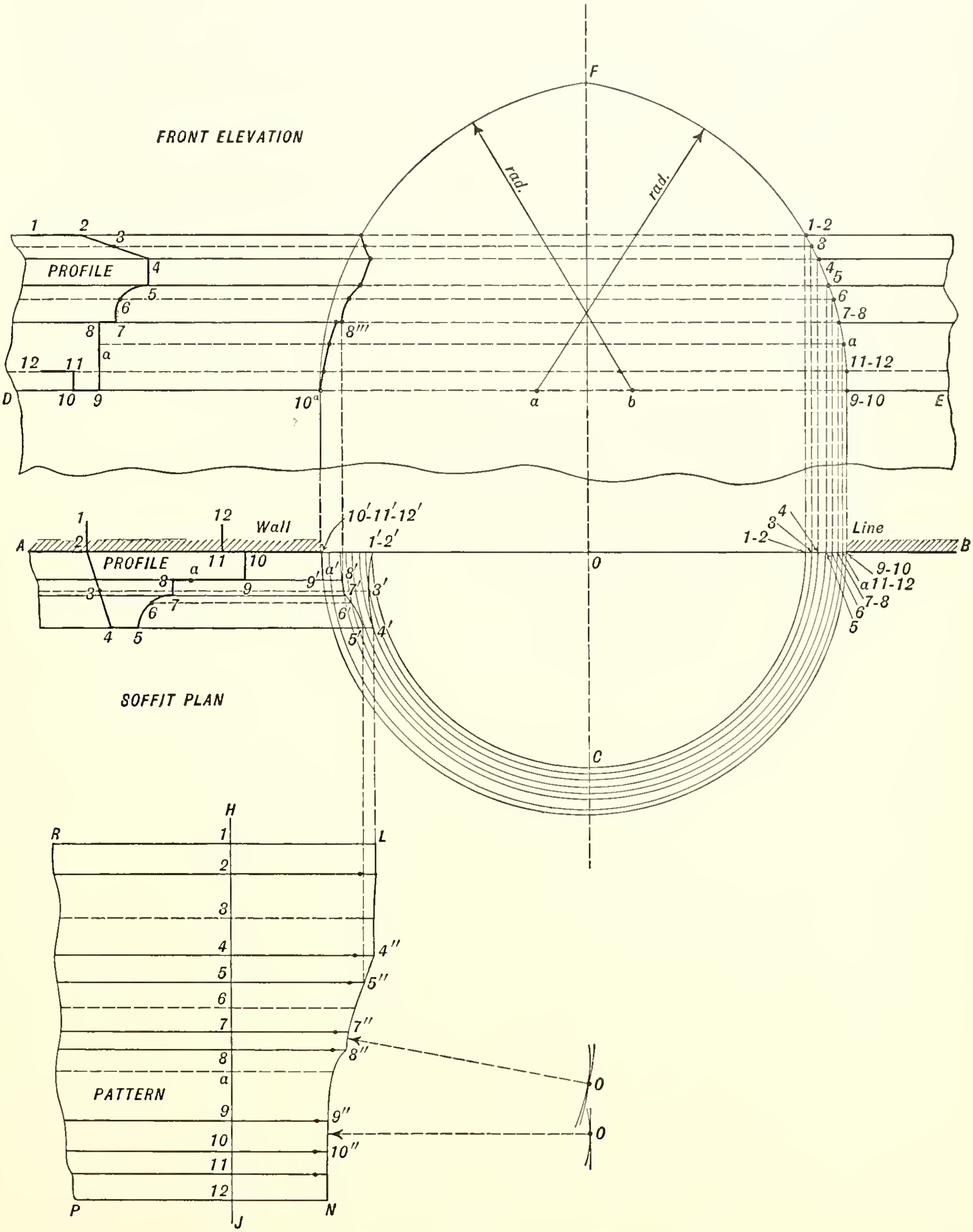


Fig. 193.—Pattern for Horizontal Molding, Intersecting a Spherical Surface, Curved in both Plan and Elevation

parallel to E F from similar intersections on the curved line B C. A line traced through points so obtained, as shown by H J, will be the desired pattern. Where the members 16-15, 14-13 and 9-8, butt against the curved surface, and are small, these points can be connected by straight lines in the pattern, as shown. If these members are wide, the intersecting curve against the curved wall may be reproduced as follows; taking as example the curve on the member 16-15 in the profile. Using D B in plan as radius, with 16′ and 15′ in the pattern as centers, describe arcs intersecting each other, (not shown). Then, using this point of intersection as center, with the same radius, draw the arc 15′-16′. By such method any of the curved surfaces can be transferred.

HORIZONTAL MOLDING INTERSECTING A SPHERICAL SURFACE

Solution 31

In the preceding solution was explained the development of the pattern, when a molding intersected a round surface in plan. In this problem is presented the laying out of the pattern for a horizontal mold when it intersects a round surface both in plan and elevation, such as a sphere or a dome, as shown in detail in Fig. 193.

Let A-B represent the line of the horizontal wall in plan, or the drip line of the horizontal mold, and O the center point with which the semi-plan of the dome is struck, as shown by 1′-C-1. Above the elevation draw the horizontal line D-E and obtain the points 10^a and 9-10 from the corresponding points in plan. With the proper centers as *a* and *b* in elevation describe the arcs 9-F and 10^a F respectively. Now place the profile in its proper position in elevation as shown, and divide it into an equal number of spaces, as shown by the small figures 1 to 12. Introduce an additional point at *a*, as shown. From these small figures in the profile in elevation, draw lines to the right, parallel to D-E until they cut the dome profile 9-F, from 1 to 12 as shown; from these intersections drop lines vertically until they intersect the center line of the dome in plan, also shown from 1 to 12. Now using O as center with radii equal to the various points 1 to 12, draw the semicircles, as shown. Take a tracing of the profile in elevation and place it in its proper position as shown in plan and divide it into parts corresponding to those of the profile in elevation. Through the small figures in the profile in plan, parallel to the wall line A-B, draw lines to intersect similarly numbered arcs, as are shown by the points of intersections marked 1′ to 12′. Trace a line through points so obtained thus representing the miter or joint line between the horizontal mold and sphere or dome. This miter line serves all requirements in developing the pattern shape, but if it is desired that the miter line be projected in the elevation it is but necessary to project vertical lines from the points of intersections on the miter line in plan, as partly shown by the line erected from 8′ in plan, to intersect the line drawn from point 8 in the profile in elevation at 8‴. The pattern may then be laid out as follows: At right angles to A-B in plan, draw any line, as H-J, on which place the girth of the profile in either plan or elevation, as shown by similar numbers on H-J. Through these small figures at right angles to H-J draw lines, which intersect by lines drawn parallel to H-J from similarly numbered intersections on the miter line in plan. Trace a line through points so obtained; then will L-N-P-R be the desired miter cut.

INCLINED MOLDING BUTTING AGAINST A PLANE SURFACE AT RIGHT ANGLES IN PLAN

Solution 32

If an inclined molding butts against a plane surface at right angles in plan, as indicated in the perspective view in Fig. 195 where the angles are

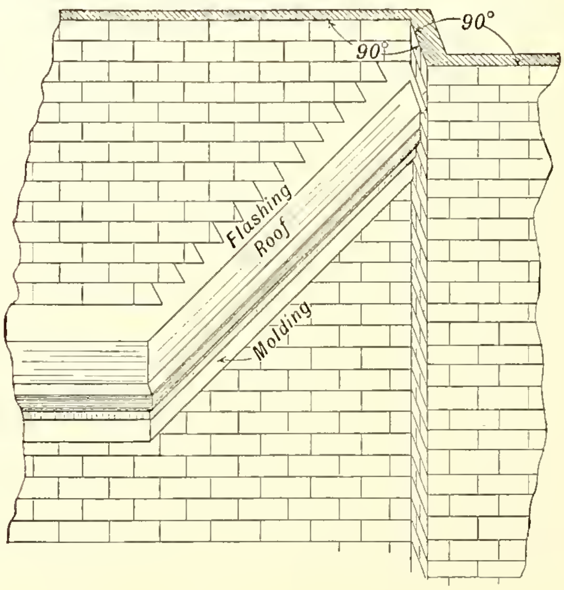


Fig. 195.—View of an Inclined Molding, Butting Against a Plane Surface at Right Angle in Plan

of 90 degrees, the pattern is developed as indicated in Fig. 196. In this case the angle of the incline is shown by A B C, the elevation of the wall line by A D and the section through the wall by E D. If it be desired to develop the butt and face miter on one stretchout, first bisect the angle A B C by using B as center, and, with any radius, draw arcs cutting the angle C B A at *a* and *b*. With the same or any other radius, using *a* and *b* as centers, intersect arcs at *c*. From *c* draw a line through B towards *d,* as shown. At right angles to the rake or incline A B, place the profile in position as shown, spacing it from 1 to 12 as indicated. Through these small figures in the profile and parallel to A B draw lines, cutting the miter line B *d* and the pier or wall line A D. The pattern is now in order. Take the girth of the profile from 1 to 12 and place it on the line H F drawn at right angles to B A. Through the small figures on, and at right angles to H F, draw lines. Intersect these lines by lines drawn parallel to H F from similar intersections on the miter line B *d* and the abutting line A D. Trace a line through points so obtained. The line J K will be the face miter for the angle at B and L M the butt miter for the intersection against A D.

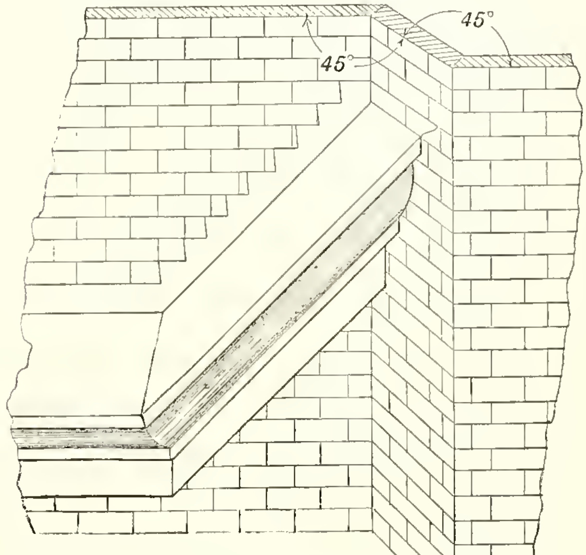


Fig. 197.—View of Inclined Molding, Butting Against a Plane Surface at Other than Right Angles in Plan

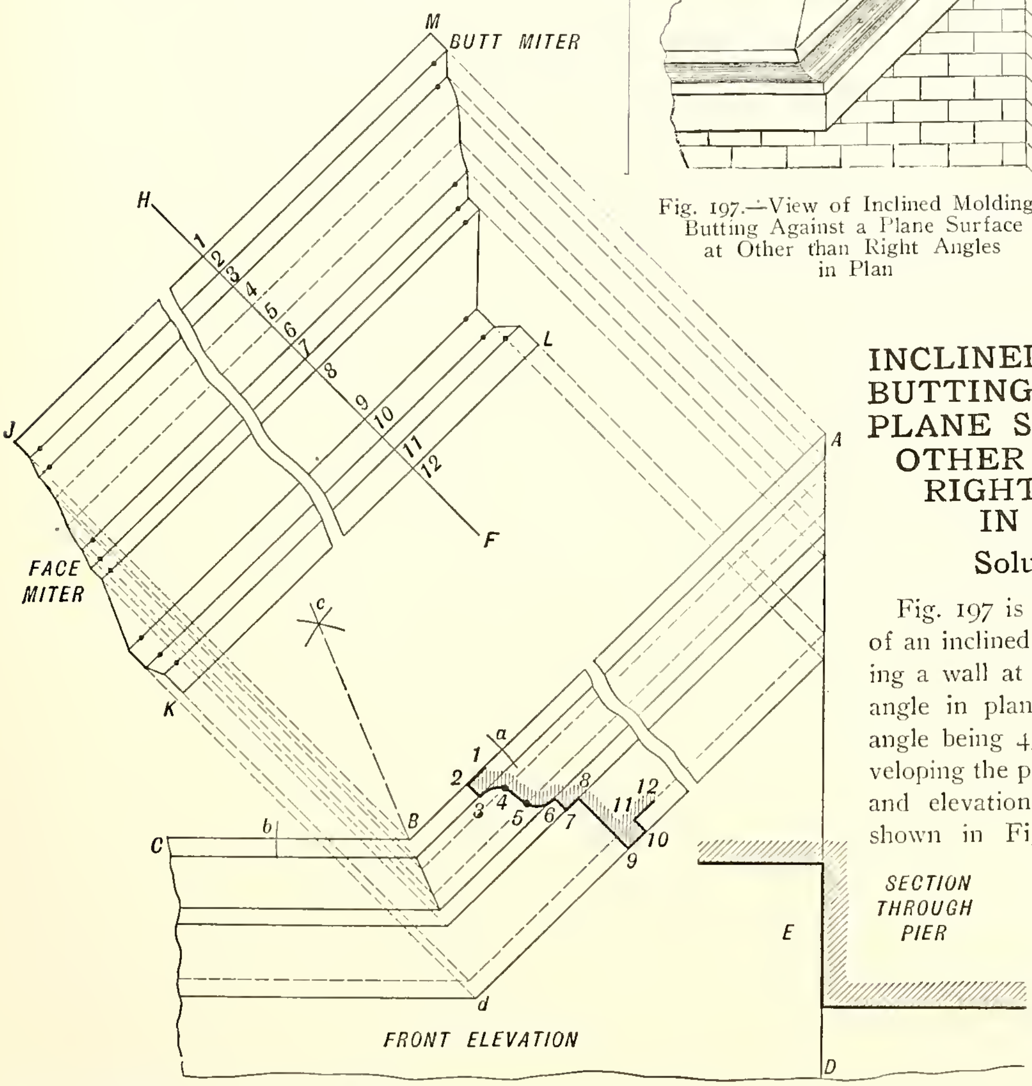


Fig. 196.—Pattern for an Inclined Molding, Butting Against a Plane Surface at Right Angles in Plan

INCLINED MOLDING, BUTTING AGAINST A PLANE SURFACE AT OTHER THAN A RIGHT ANGLE IN PLAN

Solution 33

Fig. 197 is a perspective view of an inclined molding intersecting a wall at other than a right angle in plan, in this case the angle being 45 degrees. In developing the patterns both a plan and elevation are required, as shown in Fig. 198, in which A B C E represents the angle of the wall and F the profile, placed in position as shown. D 11′ represents the angle of the

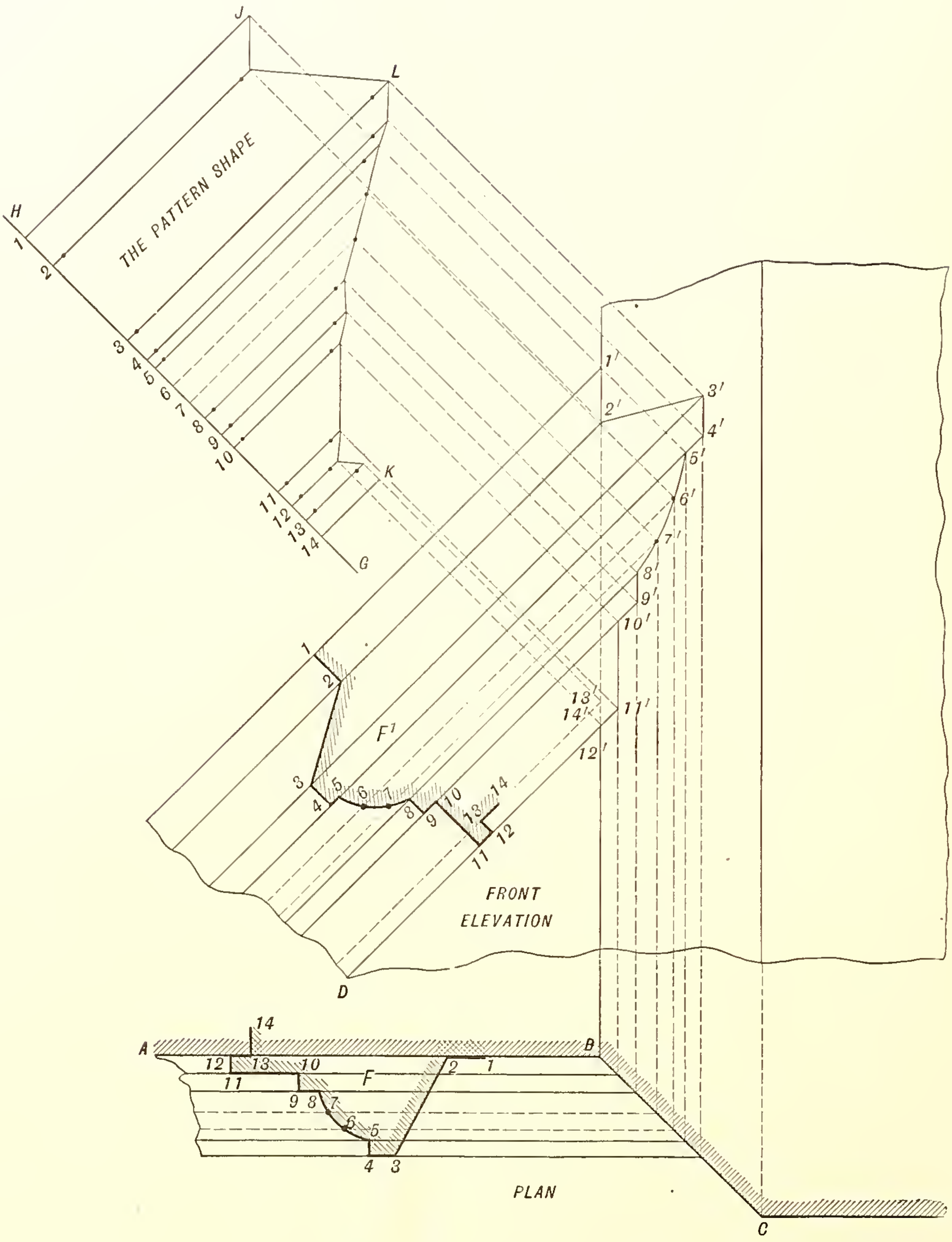


Fig. 198.—Patterns for an Inclined Molding, Butting Against a Plane Surface at Other than a Right Angle in Plan

wall in elevation, and F¹ a duplicate of the profile F in plan. Both profiles are divided into a corresponding number of parts, as indicated by the small figures 1 to 14. Through the small figures in the profile F in plan lines are drawn, parallel to A B, until they intersect the beveled side B C; from these intersecting points lines are carried up at right angles to A B, and are intersected by lines drawn through similarly numbered points in the profile F¹ in elevation and parallel to D 11′, resulting in the intersections shown from 1′ to 14′. Trace a line through these points, which will show the intersecting or miter line in elevation. The pattern may then be laid out by placing the girth of the profile F¹ on the girth line G H, which is drawn at right angles to 11′ D, as shown by the numbers 1 to 14. Through these small figures, and at right angles to G H, draw lines which intersect lines drawn parallel to G H from the miter line 1′ to 14′ in elevation. A line traced through points thus obtained will be the desired pattern, as indicated by J L K.

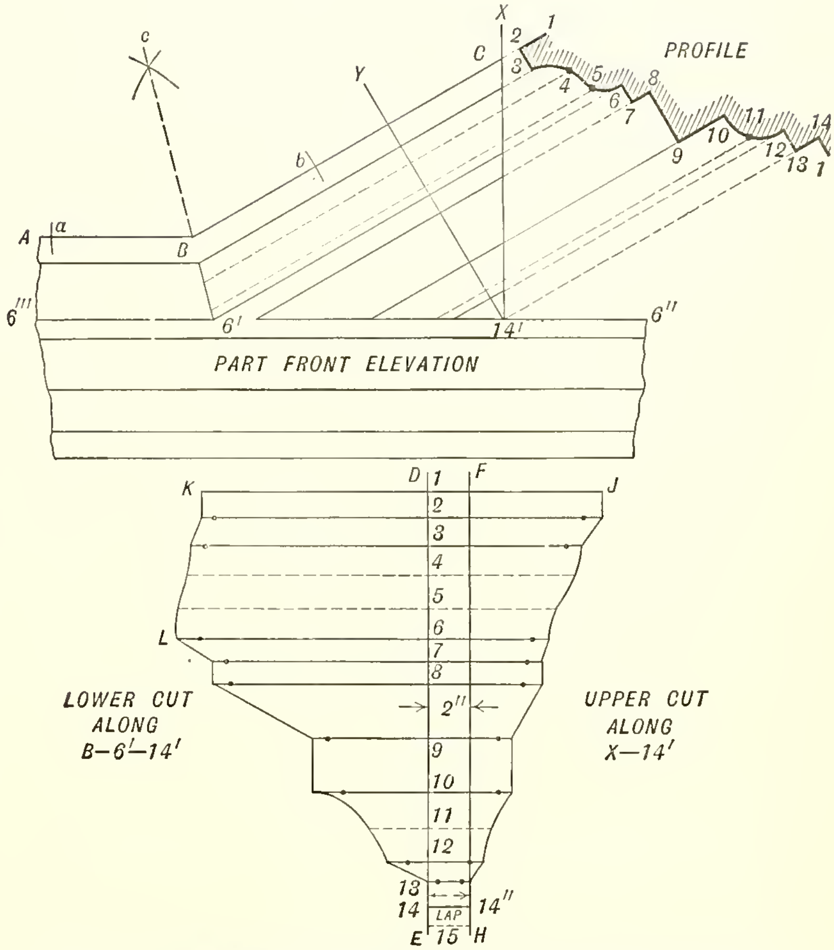


Fig. 200.—Quick Method of Finding Patterns for Bevel and Butt Miters in a Pediment Molding

QUICK METHOD OF OBTAINING PATTERNS FOR BEVEL AND BUTT MITERS IN A PEDIMENT MOLDING

Solution 34

A finished view of a bevel and butt miter in a pediment is shown in Fig. 199. In this cut *a b* and *d e* are bevel or face miters, while *b c* is a butt miter. If the pediment *a e* be of great length, it is impracticable to lay out the full size pediment since the pediment from *b* to *i* occasionally has a length of twenty or more feet. In obtaining the patterns for a large pediment, whatever may be its size, it is necessary to ascertain only the bevel or pitch and then to proceed to obtain the bevel and butt miters as is found illustrated in Fig. 200. Draw the desired bevel A B C, and in line with B C draw the profile in position, as shown. Divide this profile into an equal number of divisions, or for the purpose of practical work a free use of spaces is required. From point 6 in the profile and parallel to C B draw a line until it meets the miter line obtained by bisecting the angle A B C by means of the small arcs *a b c* at 6′. Through point 6′ draw the line 6″-6‴, parallel to A B. From the various points, 1 to 5, in the profile and parallel to B C draw lines until they intersect the miter line *c* 6′ as shown. In a similar manner parallel to C

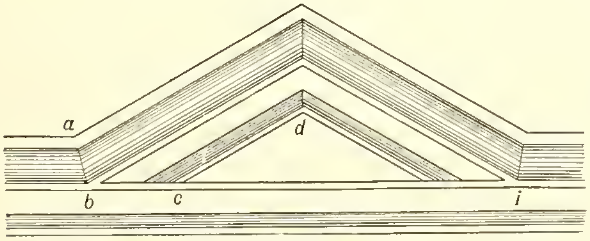


Fig 199
View of Bevel and Butt Miters in a Pediment Mold

B, draw lines from points 7 to 15 in the profile until they cut the line of the horizontal mold on the line 6″-6‴. Where the line drawn from 14 in the profile meets the horizontal line at 14′, erect the perpendicular line 14′ X at right angles to A B, as shown. From 14′ at right angles to the pitch B C draw the line 14′ Y. This completes requirements preparatory to obtaining the patterns, which are laid out as follows: Draw any two vertical lines, of say 2 in. apart, shown by D E and F H. On one of the lines, as D E, place the girth of the profile, as shown by similar numbers, through which at right angles to D E, draw lines indefinitely as shown. Measuring from the line Y-14′ in elevation take the various projections to the various points on the miter line X-14′, and place them to the right of the line F H in the pattern on lines numbered to correspond, as shown; through these points trace the miter cut J H, which constitutes the pattern for the gable miter X-14′ in elevation. Proceeding in this manner, measure to the left of the line Y-14′ in elevation and take the projections to the various points on the miter line B-6′ and the base line 6′-14′. Place these distances on similarly numbered lines in the pattern, measuring in each instance to the left of the line D E; through points so obtained trace the bevel miter K L and butt miter L E, representing the cut along B-6′-14′ in elevation. As the true length of the pediment along *c d* in Fig. 199 is known, it is only necessary when laying out the full size patterns, to measure from arrow point 14 to arrow 14″ shown in the pattern. Should the length be greater than that of the sheet, straight sheets may be set in between, allowing 1 in. laps for joining.

GABLE MOLDING MITERING AGAINST A MOLDED COLUMN

Solution 35

In the example of a gable mold intersecting a molded column, shown in Fig. 201, there is an intersection between *vertical and inclined dissimilar moldings*. This is developed as is illustrated in Fig. 202, which shows the plan and elevation of an inclined mold mitering against the side of a column.

In the plan, A B represents the surface of a wall against which the back of a half round column X and also a mold Y are placed, the molding being inclined at the angle shown in the elevation, where the intersection of the two is shown at C D E. At Y of the plan is shown a profile or right section of the mold of which *a b* is the back or part in the plane of the wall surface, the plane of the section being revolved upon a horizontal line as *a c* until it is brought into the plane of the view, that is, the plan. In the elevation *a′ b′* represents the line upon which the section is taken and upon which it is revolved to bring it into the plane of the elevation, as shown at Z.

With these relations well understood, the method of deriving the pattern is as follows: First divide the curved portions of profiles Z and Y into the same number of equal parts, number-

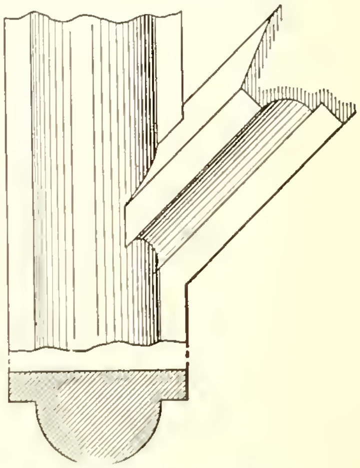


Fig. 201.—View of Intersection Between Vertical and Inclined Dissimilar Moldings

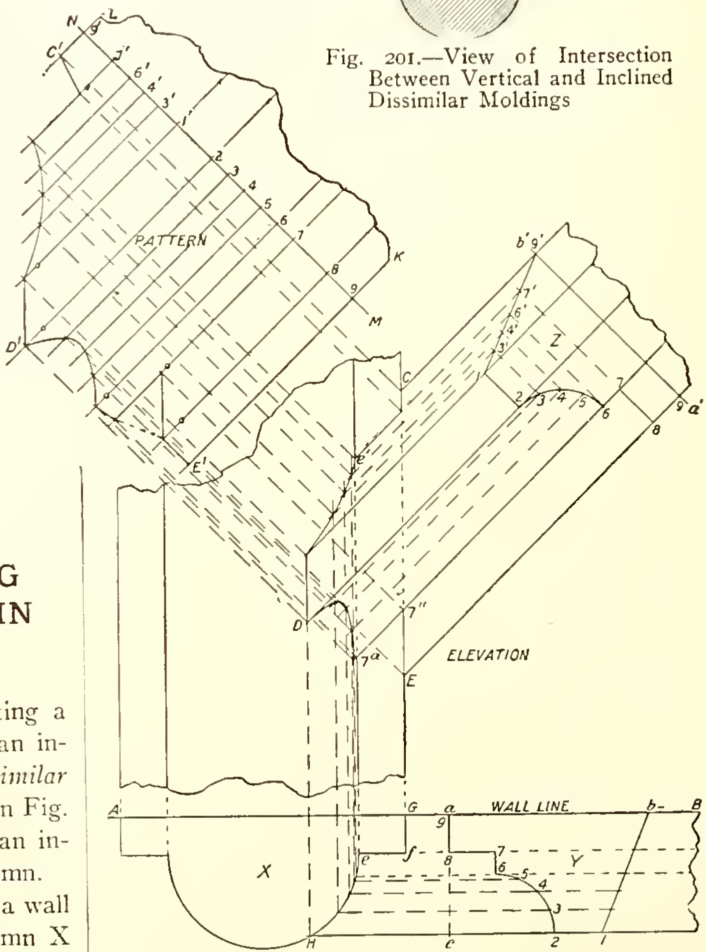


Fig. 202
Pattern for Gable Mold, Mitering Against Column

ing the points in each profile to correspond with the other, and from the points thus obtained upon profile Y carry lines parallel to the wall line to intersect the profile of the column, as shown from G to H. From the points on profile Z carry lines from all points indefinitely, parallel to the lines of the mold, across the space above the plan of the miter. Then erect lines from all of the points previously obtained in the plan to intersect corresponding lines brought from profile Z, as shown at C D E. A line traced through these intersections will give the elevation of the miter. The pattern is obtained in the usual manner, by setting off a stretchout of the profile upon any straight line drawn at right angles to the mold in elevation, as M N, and projecting the points just obtained in the miter into measuring lines of corresponding number, as shown at C^1 D^1 E^1

The intersection of the top part or roof of 1 b' of the profile, with the side of the column, presents some peculiarities which it is well to consider, although that part is governed by exactly the same rules as are the other parts of the profile. This part of the profile, although straight, must be divided into spaces, not because of any curve in it, but because it is to be mitered against a profile which is curved in plan. It must therefore have upon it, first, points which correspond with the angles or members of the profile against which it is to miter, and, second, points in that part which abuts against the curve of the column, which are close enough to yield an accurate outline in the pattern It will be noticed that the fillet 7 8 of the profile is so designed as to be flush with a similar member in the plan of the column shown by *e f*. That point in the profile of the roof 1 b', which will be cut by the surface *e f* of the column, can therefore be found by extending the line 7 8 of the profile up to intersect the roof line, as shown at point 7′. The remainder of the roof line, the part from point 7′ to 1, can then be divided into spaces, according to convenience. A simple way is, when extending the line 7 8, to also carry up lines from the points 2 to 6 on the curve below, or as many of them as may be be deemed necessary, as shown, when the spaces from 1 to 9′ must then be set off on the stretchout line, as shown, being careful that the spaces as they occur are carefully measured, since they are likely by this method to be unequal in length. The points on the roof can be numbered the same as those in the lower part of the profile from which they are obtained, adding primes (′) to them, if deemed necessary, to avoid mistakes. The intersections between e' and D of the miter will then follow the usual rule, by being made between lines of corresponding number.

The natural result of the development is to cut the fillet 7 8 from point *7a* to E in the elevation of the miter, as shown by the dotted line between points of those numbers in the pattern. The extra thickness of metal caused thereby is the space *7a* 7″ E of the elevation can be avoided by also projecting the point 7″ into the line 7 of the pattern and making the cut as there shown.

C^1 D^1 E^1 K L will then be the pattern sought, to which the necessary edges or laps can be allowed.

PART V

PATTERNS FOR LEADER HEADS, ROOF GUTTERS AND CONDUCTOR OFFSETS

LEADER HEAD OF DISSIMILAR PROFILES

Solution 36

In Fig. 203 is shown a perspective view of a leader head, whose projection of the molding at the sides is greater than the projection of the mold on the front. This problem may well be designated

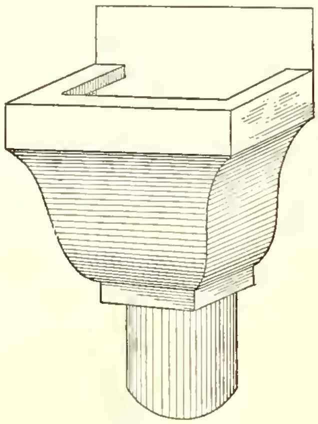


Fig. 203
View of Leader Head Having Dissimilar Profiles

the intersection of moldings having dissimilar profiles, to the consideration of which subject attention is given in a number of problems which follow. Fig. 204 illustrates the development of the various patterns comprised in the present example. First, draw the front and side elevations in their correct relative positions as shown. Observe the great projection of the ogee mold in the front elevation and the slight projection indicated in the side. Below the front elevation is shown a plan view of the head, which, however, is not required in the development of the pattern, with the exception of that part showing the round tube *o*, the quadrants of which must be added to the several patterns in the manner to be indicated as we proceed. Any one of the profiles may be selected for the purpose of spacing into equal parts. In this case the profile of the side mold, shown in the front elevation, is spaced into equal divisions, as indicated by the small figures 1 to 10. From these points horizontal lines are drawn to the right, cutting the profile of the front mold shown in the side elevation also from 1 to 10. The divisions between the points of intersection shown in the side elevation are all unequal. Therefore care is required for transferring the divisions to the stretchout line of the pattern for the front in order that that each space be separately indicated. To obtain the pattern for the front, place the girth of the profile, shown in the side elevation from 1 to 10, upon the vertical line D E, as shown by similar numbers above the front elevation. Through these small figures and at right angles to D E draw the usual measuring lines; intersect these by the lines drawn parallel to D E from similarly numbered points in the profile in the front elevation. A line traced through points so obtained, as shown from G to f' will be the miter cut. Assuring that the line D E has been drawn in the center of the front elevation trace the half pattern 1 G f' 10 opposite the line D E, as indicated by F h'. Then F G f' h' will be the full pattern for the front. Add to this front pattern on the line h' f' the quadrant *h f c d* in plan, which may be transferred as follows: From the corners *e f h* and *i* in plan draw lines to the center *o* cutting the plan of the tube at *b c d* and *a*, respectively. With radius equal to *f o* or *h o* in plan and with f' or h' in pattern for front as centers, describe arcs cutting each other at o'''. From h' and f' draw radial lines to o''', as shown. Set the compasses to equal *o c* in plan and, using o''' in the pattern as center, draw an arc cutting the radial lines just drawn at c'' and d''. This completes the pattern for the front. The pattern for the back can be pricked directly from the front elevation, adding the flange *m n* to the desired hight, also adding the lower quadrant 10″ a'' b'' 10, which is a reproduction of *i a b e* in plan. Transfer these various dimensions as previously described. *m* 10″ a'' b'' 10

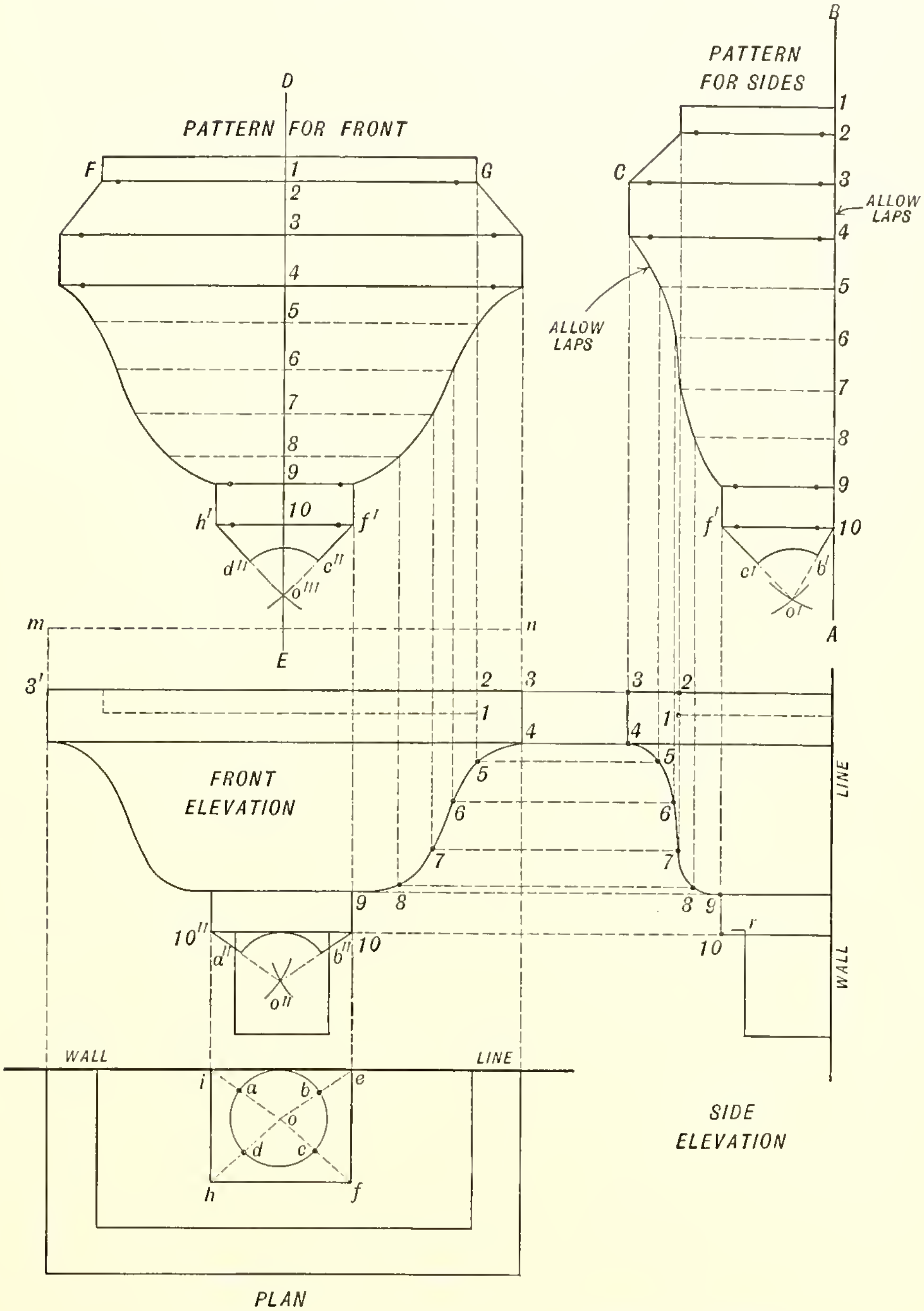


Fig. 204.—Patterns for Leader Head of Dissimilar Profiles

n is then the pattern for the back. The pattern for the sides is obtained in the following manner: Extend the wall line in the side elevation as A B; upon this place the girth of the side mold, as indicated from 1 to 10 in the front elevation, and as shown by similar numbers on A B. Through these small figures and at right angles to A B draw lines; intersect these lines by lines drawn parallel to A B from similarly numbered points of intersection in the mold in the side elevation. A line traced through points so obtained, as shown, will constitute the pattern for the two sides of the head, one formed right and the other left. Take a reproduction of *e f c b* in plan and place it as indicated by 10 *f′ c′ b′* in the pattern for sides. The various radii used in transferring this quadrant are taken from the plan, in the manner corresponding to that by which the quadrant was added to the pattern for the front. Allow laps on the two patterns for the sides as indicated by the arrows. Upon flanging the tube which is designed to be inserted on the inside of the circular opening in the bottom of the head, the flange is turned outward at *r* in the side elevation, where it is thoroughly sweated in and soldered. If the heads have similar profiles all around, a plain square outside miter serves requirements. Problems of this nature were taken up in the preceding exercises, on cornice work.

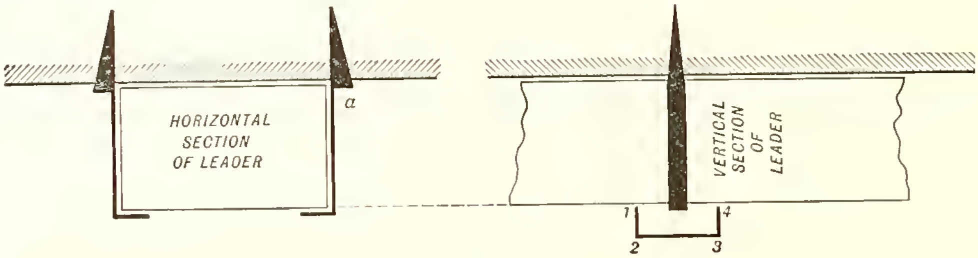


Fig. 206

ORNAMENTAL LEADER HOOK COVERING, FOR CONCEALING LEADER OR CONDUCTOR HOOKS

Solution 37

In Fig. 205 is presented a perspective view of a square leader, fastened at its two sides, with the leader hooks A and A¹, by the shank *a* driven into

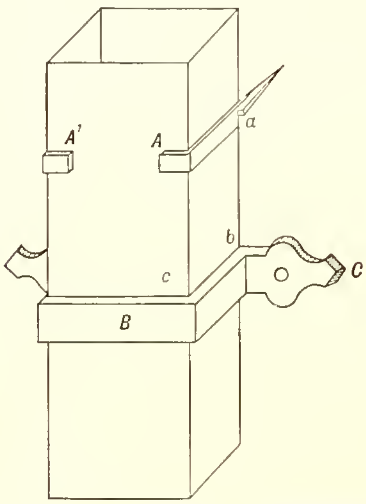


Fig. 205.—View of Ornamental Leader Hook Covering

the walls of the building. To conceal these hooks and provide an ornamental finish the leader fastener B is placed over the hooks, with any design of leaf, at C. After the fasteners have been placed over the hooks slight tacks with solder are made at *b* and *c* on the two sides, for holding the ornamental covering in place.

With work of the better class upon leaders of galvanized iron or sheet copper, ornamental leader coverings are usually employed for concealing the malleable iron leader or conductor hooks, whether the leaders be against or stand partially free off the walls. As a rule, when leaders set away from walls, a special type of hinged fasteners is employed. These devices are so made that they serve both as ornaments and as fasteners, so that no other covering is required. But if leaders be set against the walls, ordinary leader hooks are employed, so that an ornamental covering is desirable to make a neatly appearing job. In Fig. 206 is shown a horizontal section of a rectangular leader, fastened with hooks, one on either side. To the right of this section is shown a vertical section of the leader with the hook in position, capped by the metal band, indi-

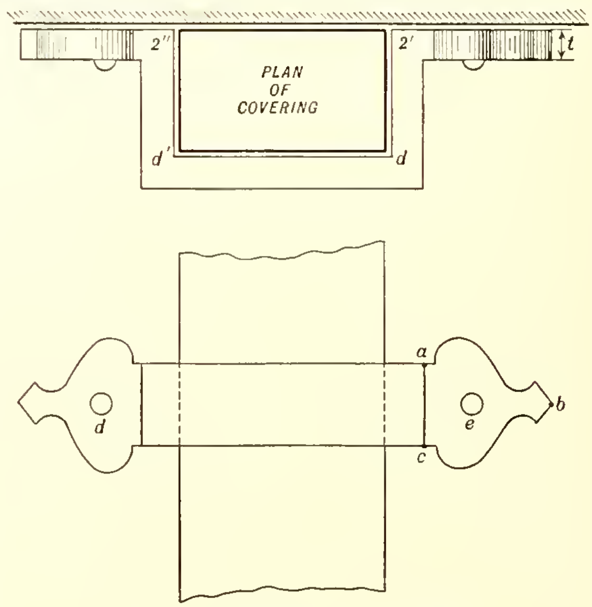


Fig. 207.—Elevation of Covering

cated by 1, 2, 3, 4. This band may be made of any desired width, as 2-3, and projecting sufficient at 1-2 to cover the projection of the driving shank at *a* in the horizontal section.

Fig. 207 shows the plan and elevation of a finished covering. *a, b, c* in the elevation represents an ornamental end or leaf which can be designed at will or according to the sketch provided by the architect. A raised ball may be soldered to the fastener at *d* and *c*. This affords a neat finish and disposes of the flat surface of the leaf. Upon deciding the shape of the end leaves, the width and projection of the band, the pattern can be laid out as shown in Fig. 208. On any line, as *a b*, lay off the girth of the band 1, 2, 3, 4 in Fig. 206, as shown by similar numbers on *a b* in Fig. 208. Through these points, draw perpendicular lines indefinitely, as shown. Take the distance from 2′ to d in plan in Fig. 207, and place it as shown from 2′ to *d* in the pattern in Fig. 208. From *d*, at an angle of 45 degrees, draw a line, intersecting the perpendicular line drawn through 2 at *r*. From *r* again draw a line at 45 degrees cutting the perpendicular line drawn through 1 at d°, and make the distance *d*° *d*′ equal to *d d*′ in plan in Fig. 207. From d′ in Fig. 208 again draw a line at 45 degrees, cutting the line drawn through 2 at *m*, and from *m*, draw the 45 degree line cutting the line 1 at *d*″. Make the distance *d*″ 2″ equal to *d* 2′ or equal to *d*′ 2″ in plan in Fig. 207, since they are alike. Reverse the miter cuts from 2′ to 2″ in Fig. 208, on the opposite right side as shown and set off the depth of the strip *t* in plan in Fig. 207, as shown by *t* at both ends in the pattern in Fig. 208. This completes the pattern in one piece.

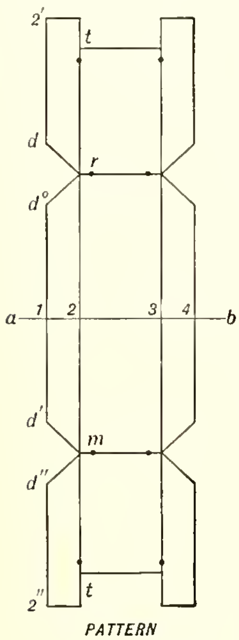


Fig. 208

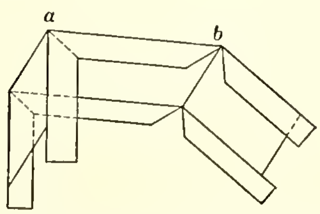


Fig. 209.—Bending Square Covering

Construction

Upon forming up the fastener, the long bends are first made, after which the fastener is turned by hand in the manner indicated in Fig. 209, where *a* is the finished square bend and *b* is partly turned.

Occasionally this style of fastener is used for round leaders, as shown in Fig. 210, when the leader hook is covered as indicated. In that case the end

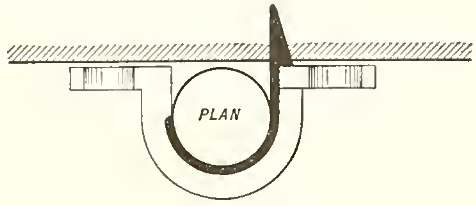


Fig. 210

leaves may be alike and the pattern laid out as shown in Fig. 211. That portion of the band covering the circular part of the leader is notched, as indicated by the heavy dashes. In bending the round

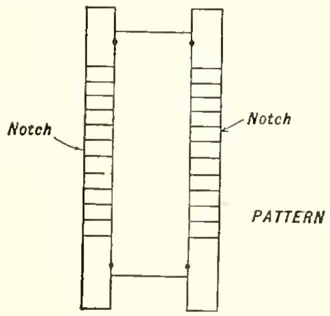


Fig. 211

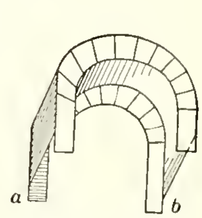


Fig. 212.—Bending Round Covering

leader covering, the long bends are first made, when the notching is done and turned to suit the profile of the leader, as shown in Fig. 212, the openings at *a* and *b* being cut out to receive the end leaves. If desired the notches may be soldered.

INSIDE AND OUTSIDE MITERS FOR EAVE GUTTER, FORMING A RIGHT ANGLE IN PLAN

Solution 38

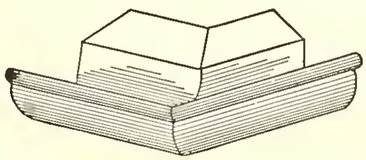


Fig. 213.—View of Outside Miter for Eave Gutter

Fig. 213 gives a perspective view of an outside miter for an eave gutter, commonly known as an exterior angle, while the perspective shown in Fig.

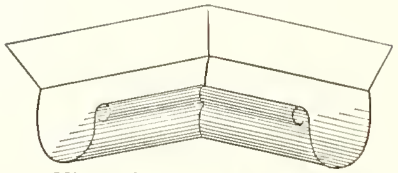


Fig. 214.—View of Inside Miter for Eave Gutter

214 shows an inside miter or an eave gutter, used for an interior angle. The development of both of these patterns at one operation is shown in Fig.

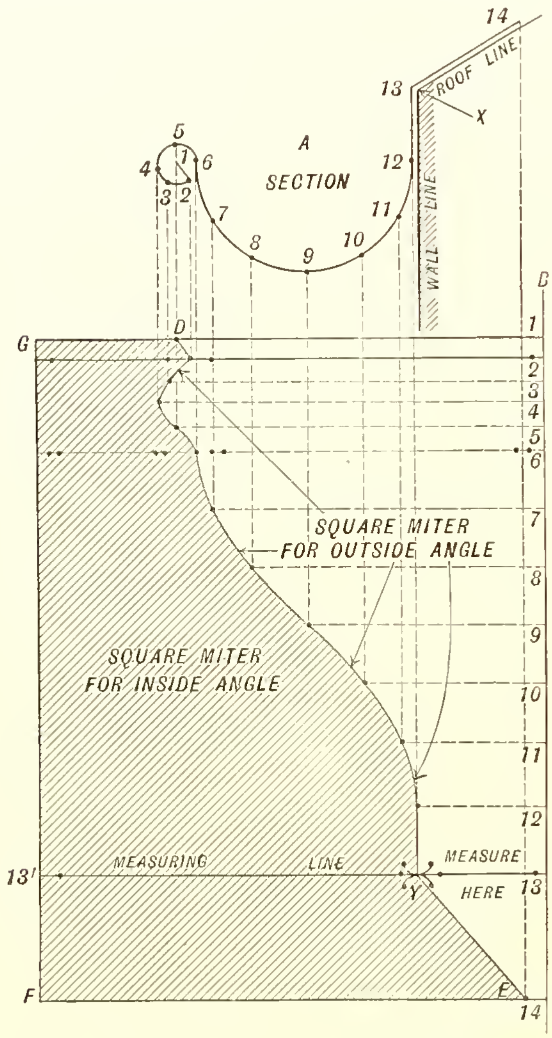


Fig. 215.—Obtaining Square Outside and Inside Miters for Eave Gutter at One Operation

215. First draw the section of the eave gutter A, as shown, spaced in equal divisions as shown by the small figures 1 to 14. Erect any vertical line, as B C, upon which place the girth of the section A as shown by similar numbers on B C. Through these small figures and at right angles to B C, draw lines; intersect these lines by those drawn parallel to B C from similar numbers in the section A. A line traced through points thus obtained, as shown from D to E, will be the miter cut. 1, D, E, 14, will be the miter for an outside angle of 90 degrees in plan. Extend 1-D and 14-E in the pattern, as shown by D G and E F, respectively, and draw the perpendicular line G F. Then G D E F will represent the miter for an inside angle of 90 degrees in plan. Thus it will be seen that if the miter cut D E is cut in the rectangular piece 1-G-F-14, the shaded part will be the pattern for the inside miter and the unshaded part, the pattern for the outside miter. The method of laying out square miters, as shown, is known as "a short rule" but it is accurate, no plan or miter line being required, and it can be employed only when the finished angle is 90 degrees. If this angle be more or less than 90 degrees, a plan and miter line is employed after a manner that will be explained as we proceed. On measuring the length of the gutter at the building, the measurements are taken at the corner or eave line indicated by the arrow X in the section. As this corner indicates bend 13 in the gutter, the measurements are laid out on line 13 in the patterns, that is, from the arrow point Y in the pattern towards 13 for the outside miter, and from the arrow point Y towards 13′ for the inside miter. Allow laps for joining at miters.

MITER FOR AN ENLARGED INSIDE GUTTER

Solution 39

Fig. 216 is a perspective view of an inside gutter miter enlarged by means of a gore piece placed between the angle.

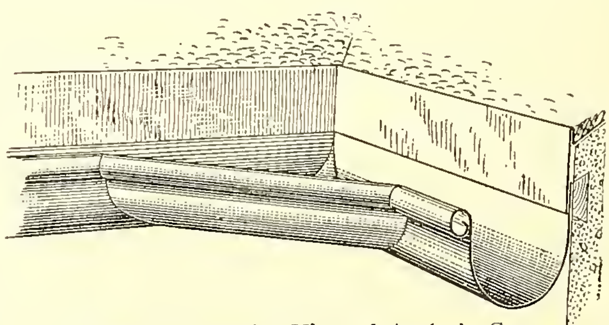


Fig. 216.—Perspective View of Angle in Gutter

To one conversant with roof drainage problems, it is evident that there are valleys on the roof at these places and that valleys deliver a concentrated stream of water to those parts of the gutter. With the customary mode of making a simple inside miter of the gutter, provision is not made for the large quantity of water delivered there. Very often the water flows with sufficient rapidity and volume to force it over the outer edge of the gutter in addition to which, water running around the miter, from the high to the low end of the gutter, must turn abruptly at the miter with the result of retarding the flow.

To avoid the possible occurrence of such troubles, the inside miter of the gutter can be designed with a gore piece, as shown in the perspective. The drawing shows that the restricted area of the usual gutter miter is amply enlarged by this procedure to provide an easy turn for the flowing water and to form a pan to catch the stream of water from the valley.

Fig. 217 indicates the manner in which the patterns are obtained. A is the profile or section of the gutter with the plan of the miter in its correct relation thereto, the gore being outlined by *a b c d e* of the plan. It may be said here that the process would vary but little if the angle of the miter, that is *f d g*, were other than the right angle shown.

In the shop where these gutters are manufactured, the bead is made on a special machine which is not adjustable so far as changing its shape is concerned, although different sizes of rods are used. In view of this fact and that the profile or section of the gore on the line *h d* is necessarily different from A, a means of maintaining the shape of the bead throughout the plan must be adopted.

The section A having been established as shown, the plan is delineated by first drawing lines *f d g*, representing the innermost edge of the gutter, and then drawing the lines of the bead parallel thereto, as shown by *i a* and *j b*. The line *a b* is drawn at an angle of 45 degrees and of a length to make the gore of a size deemed sufficient for the purpose and of pleasing proportions.

The angles *i a b* and *a b j* are bisected by the method previously explained and as shown at *a*, which gives the miter line for the bead. The profile

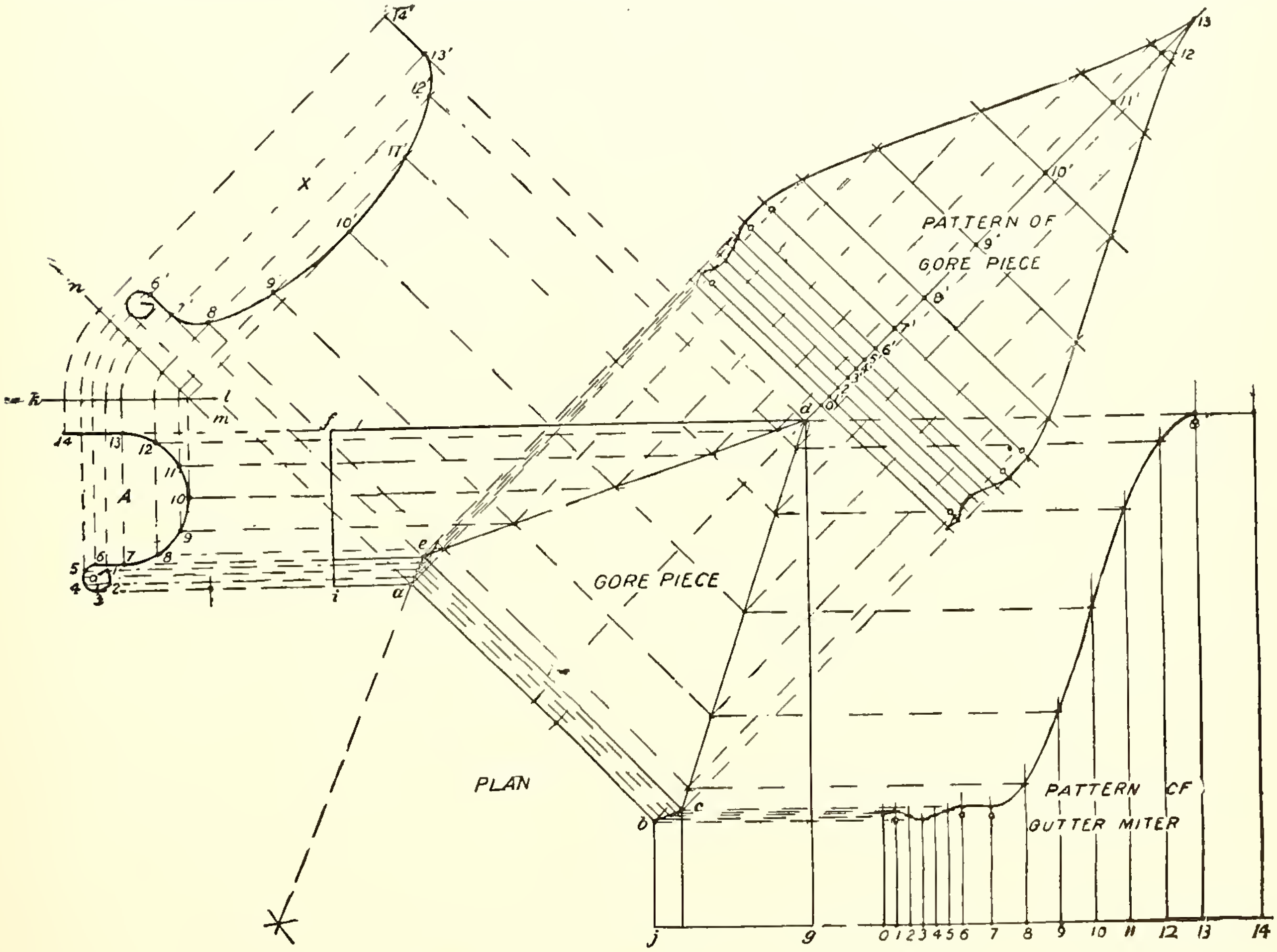


Fig. 217.—Method of Developing Pattern for Enlarged Miter

of the bead is then divided into spaces, as shown, lines are dropped to the miter line at *a* and then carried to *b*, all as shown in the drawing; point 6 shows where the gutter bead and the gutter proper join. Lines are then drawn from *c* to *d* and *c* to *d*, which will be the miter lines of the gore, extending through the circular part of the gutter only. The remainder of profile A is now divided into spaces, as shown from 6 to 14, and lines are carried from each point to the miter line *c d*, as shown.

Before developing the patterns it is essential that the true section on the line *h d* be determined, which is done by first carrying lines from each point in profile A to any horizontal line, as *k l*. Another line is then drawn parallel to *a b*, as *m n*, and the points on *k l* are transferred to *m n* by describing arcs as shown, using as a center the place where lines *m n* and *k l* cross. From *m n*, and at right angles to it, lines are projected from the points on it to the right, which are intersected by lines drawn from corresponding points on the line *c d* of the plan, thus obtaining the points through which to trace profile X, the true section on the line *h d*.

For the pattern of the gore, line *h d* is continued indefinitely, the stretchout of profile X placed thereon and the usual parallel lines are drawn at right angles, which are intersected by lines drawn parallel to *h d*, drawn from the points on the miter lines *c d* and *c d*. A line traced through the resulting points of intersection outlines the pattern.

For the pattern of the gutter, the stretchout of profile A is placed on line *j g*, extended; the usual measuring lines are drawn at right angles to it, and intersected by lines drawn parallel to *j g* from intersections on the miter line, all as shown. The laps must be so allowed that the water will flow over the joint and not against it.

INSIDE AND OUTSIDE MITERS FOR OGEE GUTTER AT OTHER THAN A RIGHT ANGLE IN PLAN

Solution 40

The perspective view of Fig. 218 illustrates the outside miter of an ogee gutter at an angle other than a right angle in plan, while the perspective of

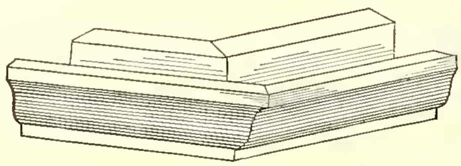


Fig. 218.—View of Outside Miter of Ogee Gutter

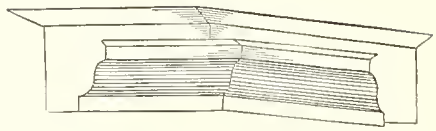
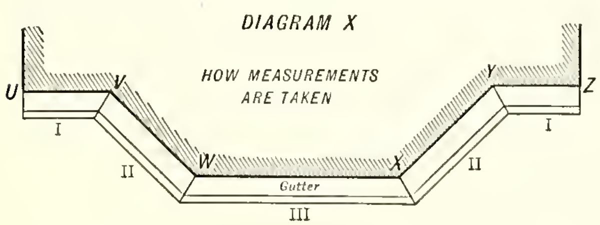


Fig. 219.—View of Inside Miter of Ogee Gutter

Fig. 219 shows the same gutter at an inside angle. As stated in a preceding problem, if the angle be square no plan or miter line is required, but if the angle be other than a right angle a plan view giving the bevel of the wall must be obtained and from this the miter line is found by the procedure shown in Fig. 220. Here the section of the ogee gutter is indicated by A, the ogee of which is divided into equal spaces in the customary manner. From the rear line of the gutter where it lies against the building line, as at 2-3, drop a perpendicular line indefinitely at B C, and from any point, as C lay off the bevel B C D regardless of what this bevel may be. To obtain the miter line, bisect the angle B C D by using C as a center, and with any radius, describing arcs cutting the lines B C and C D at *a* and *b* respectively. With the same or any other radius and with *a* and *b* as centers, describe arcs, cutting each other at *c*. Draw a line from *c* through C indefinitely as shown, and from the various points of intersection, 1 to 12, in section A, drop vertical lines until they intersect the miter line *c* F in plan as shown by similar numbers. If desired, complete the plan of the outside angle as shown by B C D H F G, but this is not essential in the development of the pattern, all that is required being the miter line *c* F. To obtain the pattern proceed as follows: Draw any line as G L, at right angles to G F, upon which place the girth of the section A as shown by similar numbers on G L. At right angles to G L and through the small figures, draw lines indefinitely, which intersect lines drawn parallel to G L from similarly numbered intersections on the miter line F *c* in plan. A line traced through points so obtained, as shown by N M, will be the miter cut for the angle B C D in plan and L G N M will be the miter pattern for the outside angle. The reverse of the cut M N constitutes the pattern for the inside angle, as indicated by the shaded part M N O P. It forms the pattern for the inside angle shown by C D E J H F in plan. It should be understood that the miter cut M N in the pattern can be used for both inside and outside angles only when the angle G F H is alike to the angle F H J in plan reversed, or when the lines B C and D E run parallel. If the conditions differ from those explained, separate patterns require to be developed.

Taking Measurement at the Building

Diagram X shows the method of taking the measurements at the building. As the lines U V and Y Z are parallel to W X, the angles at W and X will be alike, when reversed, to the angles at V and Y. In this case the gutters are to have "flat heads" in the ends of pieces I and I both of which are alike in length. Pieces II and II are also alike. Therefore the lengths need be taken only from U to V, V to W and W to X. As these measurements are taken at the wall line and as the corner 2 of section A lies against this line, it is invariably necessary in placing measurements on the sheet metal and using the patterns just developed, to measure on line 2, from the arrow point S towards T for the outside miters, as at W and X in diagram X; and from S towards R in the pattern for the inside miters, as at V and Y in diagram X. The heavy dots in the patterns indicate where the bends are to be made in the brake. The method of making these bends in the brake is taken up in a subsequent problem.



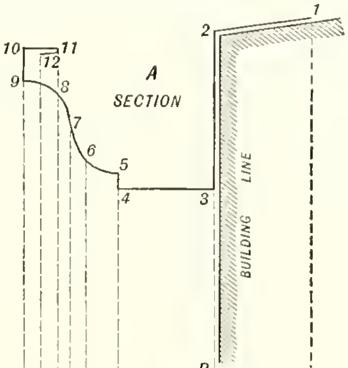
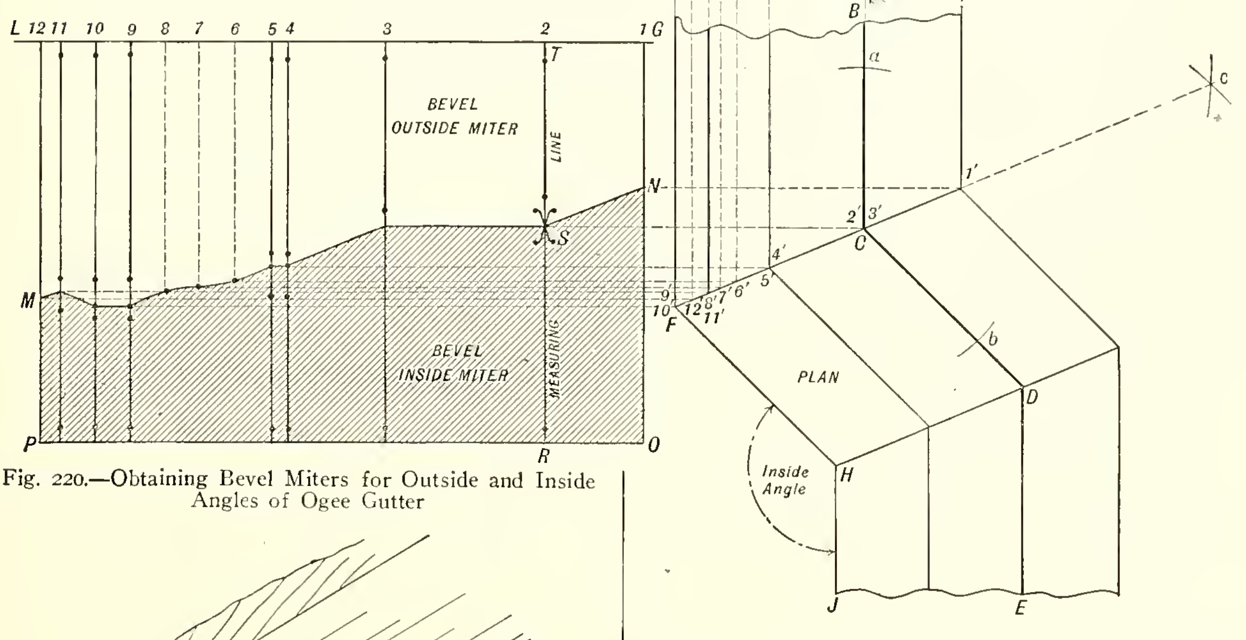



Fig. 220.—Obtaining Bevel Miters for Outside and Inside Angles of Ogee Gutter

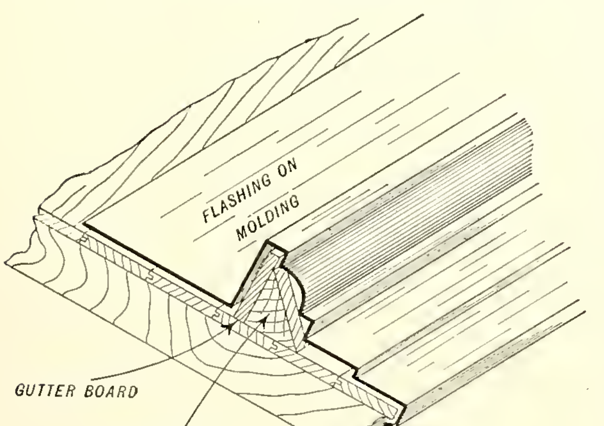


Fig. 221.—General View of Roof Gutter Molding, for which Inside and Outside Miters are Sought

INSIDE AND OUTSIDE MITERS FOR ROOF GUTTER MOLDINGS ON PITCHED ROOFS, FORMING A RIGHT ANGLE IN PLAN

Solution 41

Roof gutter moldings are usually installed at the eaves of pitched roofs and form a finish at the base, as well as a gutter and snow-guard to prevent snow from sliding with the downward pitch of the roof. Fig. 221 illustrates a typical gutter mold, with wood

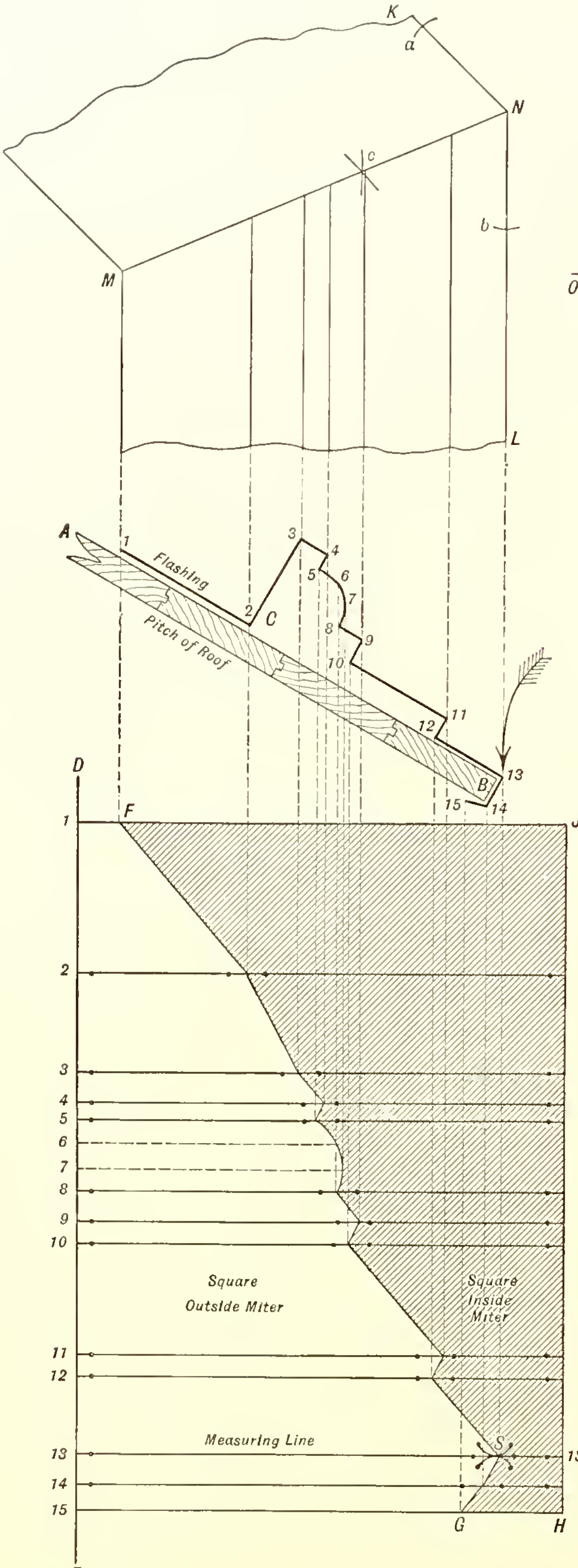


Fig. 222.—Obtaining Square Inside and Outside Miters for Roof Gutter Mold

blockings, etc., for which we will proceed to develop the inside and outside miters. The method is illustrated in Fig. 222. The first step is to draw the correct pitch of the roof as indicated by A B and then to indicate the profile of the mold C on this roof line. Space the mold C, including the flashing, in divisions, as indicated by the small figures 1 to 15, and set off this girth on the vertical girth line D E, as shown by similar numbers. Through these small figures and at right angles to D E, draw lines; intersect these lines by lines drawn parallel to D E from similarly numbered intersections in the profile C. A line traced through points so obtained, as shown by F G, will be the desired cut; 1 F G-15 will be the pattern for the square outside miter and the shaded portion, F J H G, will be the pattern for the square inside miter. In obtaining measurements for the gutter, the distances are taken along the eave line at B, which is bend 13 in the mold. Therefore, in proceeding to lay out these lengths on the sheet metal, measure along the line 13 in the pattern, measuring from the arrow S towards 13 for the outside miter, and from the arrow S towards 13′ for the inside miter. Allowance for laps is essential on all miter cuts. If the angle of the eave line in plan be other than a right angle, as shown by L N K above the profile, this angle is bisected by means of the arcs *a, b* and *c* and the miter line is drawn as shown by N M. All the points in the profile C should then be erected vertically to meet this miter line N M, the girth of profile C placed on the girth line O P and the procedure explained in detail in the preceding problem followed.

INSIDE AND OUTSIDE MITERS FOR ROOF GUTTERS ON ROOFS OF DISSIMILAR PITCH, FORMING A RIGHT ANGLE IN PLAN

Solution 42

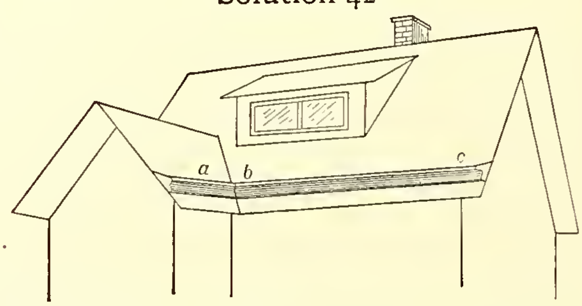


Fig. 223.—View of Intersecting Roofs at an Inside Angle, the Roofs having Different Pitches with Roof Gutters at *a, b* and *c*

With the intersection of roofs of dissimilar pitches, at an interior angle, forming a valley, as shown in the persepctive view in Fig. 223, the method of obtaining the patterns for the roof gutters *a b c* is somewhat more difficult than that set forth in the preceding problem, for the reason that one of the profiles of the gutter will require to be modified or changed from the normal to allow for a miter

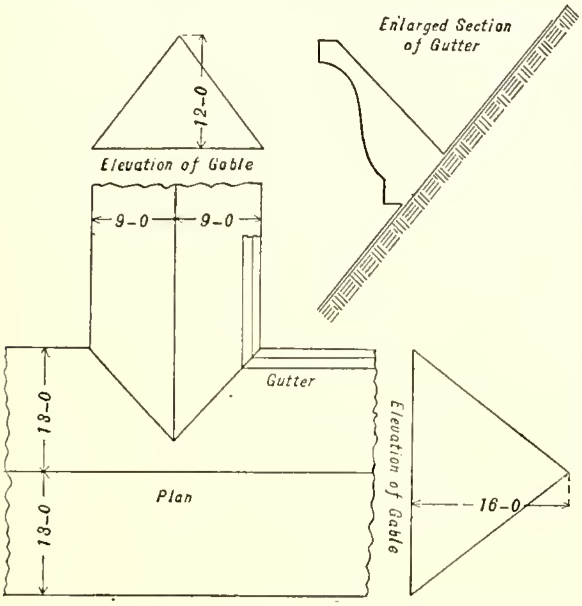


Fig. 224.—Sketch, Showing Plan and Elevation of Roof, and Enlarged Section of Gutter

joint along the miter line at *b*. Fig. 224 is in reduced size a sketch giving the dimensions of a roof as well as an enlarged section of the gutter. It will be noted that the lower wing has a slightly different pitch from that of the main roof and that the gutter shown is at an inside angle. Observe that the horizontal distance of half of the smaller wing is 9 feet, while its vertical rise to the ridge line is 12 feet.

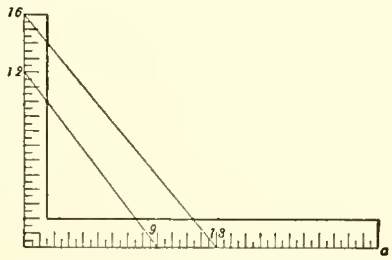


Fig. 225.—Securing Roof Pitches

The horizontal distance of the half main roof is 13 feet and its rise 16 feet. With these dimensions the true pitch can be obtained by a steel square, as shown in Fig. 225, where a line drawn from 9 to 12 and one drawn from 13 to 16 will give the correct pitch of the roofs shown in Fig. 224. While the angle 16-13-*a* in Fig. 225 is only a slight variation from 12-9-*a*, the difference in pitches in progress of developing the patterns is made more pronounced, in order that there will be no confusion of lines and so that the principle may be more readily understood.

Fig. 226 illustrates the development of the various profiles and pattern shapes. Let A X represent the pitch of one roof, having, in this case, 45 degrees. From X drop a vertical line as X C. Establish on the line X C any point as C, and draw the line C D at right angles to C B, thus forming the interior right angle. Through X draw the horizontal line E F and from any desired point on the roof line, as A, drop a line at right angles to F E, meeting this line at F. On the roof pitch A X, construct the normal profile of the roof gutter, as from 1 to 12, where is indicated the construction of the wood blocking and gutter proper. It will be noted that the metal construction has been so arranged as to form a standing lock between the gutter mold and gutter, dispensing with soldering except along the cross seams. While the normal profile is placed on the roof having 45 degree pitch and the modification found on the 60 degree pitch, the same method of procedure would be followed if the normal profile were placed on the roof of 60 degree pitch.

Draw parallel to B C in plan any line, as E^1 F^1, and extend C D until it meets E^1 F^1 at X^1. Draw a short line, *b c*, parallel to E^1 F^1 and at a distance therefrom equal to F A in the normal profile as shown. From the corner X^1 draw the desired angle of the pitched roof, (60 degrees), meeting the line *b c* at A^1. From this point, A^1, and parallel to C D in plan, draw a line, intersecting the line A F extended, at A^2. Draw the miter line in plan from C to A^2 as shown. Having thus found the miter line in plan, the modification from the normal profile is now in order. Set off on the mold in the normal profile, *an equal number of spaces,* and number the corners in the entire profile, as shown by the small figures 1 to 12; from these intersections draw parallel to A F lines cutting the miter line C A^2 in plan, as shown and from these intersections and parallel to A^2 A^1 erect lines indefinitely, all as shown. Then, measuring from the line E F in the normal profile, take the various distances to points 1 to 12 and place them on corresponding lines, measuring in each instance from the line E^1 F^1. Trace a line through points so obtained, as shown from 1′ to 12′; this will be the modified pro-

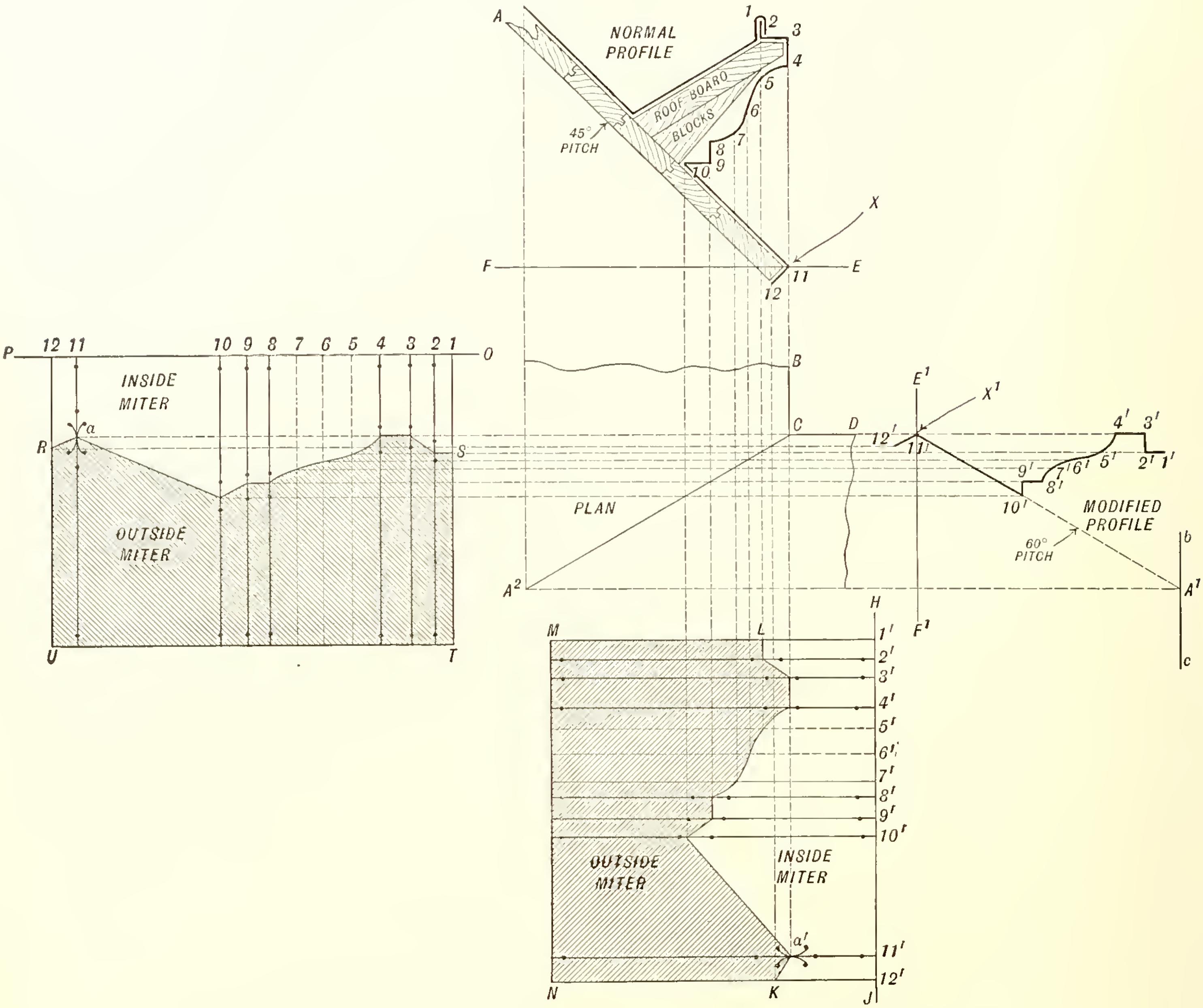


Fig. 226.—Patterns for Inside and Outside Miters for Roof Gutters on Roofs of Dissimilar Pitches

file on the 60 degree pitched roof. The miter patterns are now in order of procedure.

To find the pattern for the gutter mold on the 45 degree pitched roof, proceed as follows: Draw any line, as O P, at right angles to F A^2; upon this place the girth of the normal profile, as shown by similar numbers 1 to 12 on O P. At right angles to O P and through the small figures 1 to 12, draw lines; intersect these lines by lines drawn parallel to O P, from similar points on the miter line C A^2. A line traced through points so obtained, as indicated by R S, is the miter cut, and 12 R S 1 becomes the inside miter pattern. Extend the lines 12 R and 1 S as R U and S T respectively and draw from U a line parallel to P O, as shown by U T. Then R S T U is the miter pattern for an outside angle.

The pattern for the modified mold on the 60 degree pitched roof is developed in a manner similar to that just described. Draw any line, H J, at right angles to A^2 H; upon this place the girth of the modified profile, measuring the spaces separately, as they are all unequal as shown by the small figures 1′ to 12′ on H J. Through these small figures and at right angles to H J, draw lines which intersect lines drawn, parallel to H J, from similar intersections on the miter line C A^2. Through these intersections trace the miter cut L K. Then 1′ L K 12′ will be the inside miter pattern and the opposite, L M N K, an outside miter pattern.

In taking the measurements for the gutter mold at the building, measure along the eave line X and X^1 and place these dimensions on the metal; measuring invariably from the arrow points, *a* and *a′*, respectively, in the patterns, in the manner explained in preceding problems.

RAKING GUTTER MITERS, MITERING AT RIGHT ANGLES IN PLAN

Solution 43

Fig. 227 presents a practical example of raking gutter miter. Here is shown a plan of a pitched roof running in the direction of the arrow, the upper eave

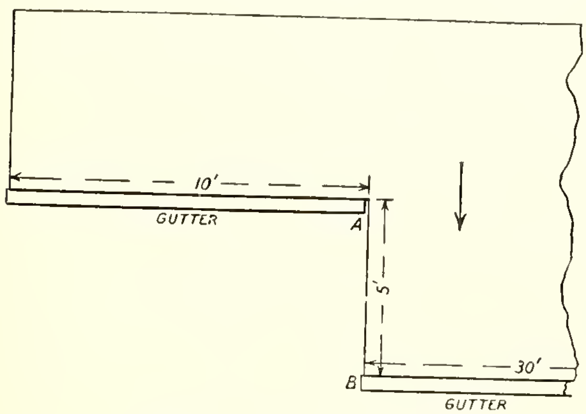


Fig. 227.—A Practical Example

gutter at A being designed to join the lower eave gutter at B, thus requiring a raking gutter between A and B, forming an inside as well as an outside miter at A and B respectively. The subject of the problem is more clearly shown in the perspective view in Fig. 228, where A and C represent the horizontal eave gutters containing the normal or given profile while B indicates the gutter to be raked which contains the changed or modified profile, all angles being 90 degrees or right angles. Fig. 229 illustrates the development of patterns of this nature. First draw the vertical line S T, and a line to show the pitch of the roof, R F. S T and S^1 T^1 show the two vertical angles or corners of the wall at A and B of Fig. 227, while the profile marked A in Fig. 229 is the profile of that part of the gutter shown from A towards the left in Fig. 227, and B in Fig. 229 is the profile of that part from B towards the right in Fig. 227. Whenever an inclined mold, be it gutter or any other form of mold, miters with a level mold, at any angle, it becomes necessary that either the level or the inclined mold should undergo a change of profile; therefore, either one may be "raked" (changed), and it is usual to rake that of which there is the least in length. It should be understood that the miters at the ends of the level pieces are just the same as they would be if all parts were level, that is, ordinary inside and outside miters; and therefore that part of the operation is not shown.

To obtain the profile for the raking or inclined gutter, first divide the profile A of Fig. 229 into any convenient number of equal spaces, as shown by the figures, and from each point of division carry lines indefinitely to the right, parallel to the angle of the roof, R F, as shown. Next, draw any line, as E G, at right angles across the lines just drawn and, considering it as a vertical line, construct upon it, somewhere below or above, another profile of the gutter, as shown at C, which also divide into the same number of equal spaces as A. Now from each of the points of division in C, erect lines parallel to E G, or at right angles to R F, to cut lines of corresponding number previously drawn from the profile at A. A line traced through the points of intersection will give the required profile of the inclined gutter, all as shown by profile D. The stretchout for the inclined mold must now be taken from its profile, D, and set off on any line drawn at right angle to R F, as M N. Remembering that the spaces on D have now become unequal by the raking operation, each space must consequently be taken separately and set off on M N, in the order

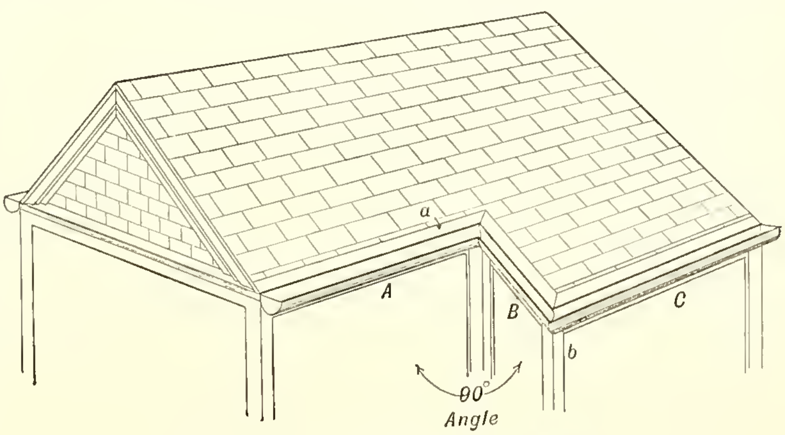


Fig. 228.—View of Raking Gutter Miters

in which they occur on the profile. Through the points thus obtained on M N, draw the usual measuring lines parallel to R F, as shown, and intersect each with a line from the point of corresponding number on profile A, drawn parallel to M N. A line traced successively through the several intersections, as shown from H to K, will be the shape of the inside miter cut.

The drawing indicates that the profile of the lower part of the gutter, shown by B, has also been divided into the same number of equal spaces as profile A, from which points lines have been projected into the measuring lines below M N (to the right), thus giving the outside miter at the lower end of the raking gutter, which of course is the same in contour as the other. Laps must be allowed for soldering and riveting. It may be well to mention again that the miter pattern for the outside angle *b* in Fig. 228 of the level gutter is an ordinary outside square miter, while the pattern for *a* is an ordinary square inside miter on the level gutter *a*.

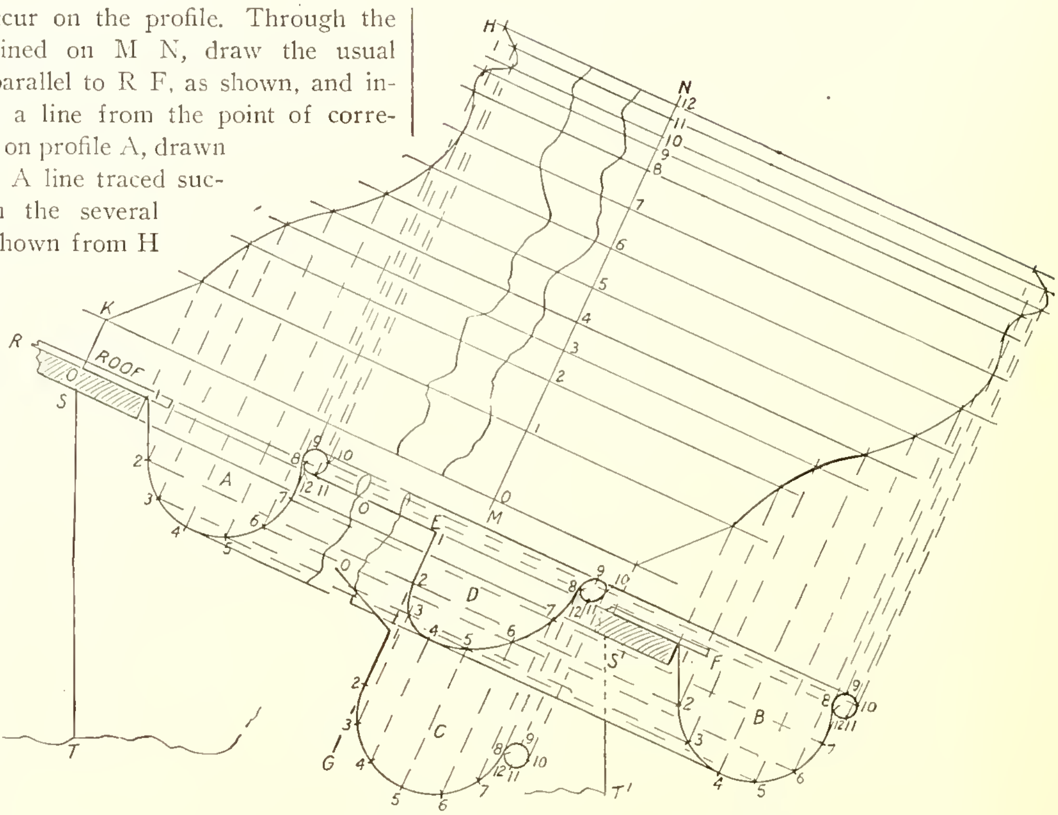


Fig. 229.—Method of Laying Out Raking Gutter Miters

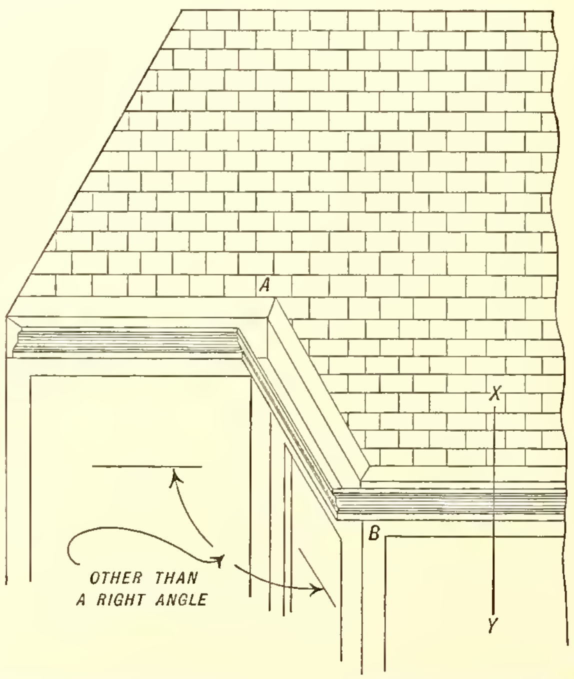


Fig. 230.—View of Raking Gutters, Joining at Other Than a Right Angle in Plan

RAKING GUTTERS ON PITCHED ROOF, AT OTHER THAN A RIGHT ANGLE IN PLAN

Solution 44

The example of a gutter on a pitched roof whose angle is other than a right angle in plan, shown in the perspective of Fig. 230, requires in the procedure of development a plan of the miter lines and patterns. In this case the patterns for the miter cuts at A and B of the level gutters, as well as the raking miters, are taken up in detail. Fig. 231 shows how the patterns are developed. First draw the normal or given profile A, which represents a section on the line X Y in Fig. 230. Below A, in Fig. 231, draw the plan view, giving the angles in plan, as partly shown by B C D E. Bisect the angles B C D and C D E by the miter lines C F and D G respectively, and complete the plan H J by projecting the extreme edge of the roof flange of the gutter A at 12. Divide the ogee of section A into an equal number of spaces, shown from 3 to 8, and number all corners in the section A, shown from 1 to 12. From these small figures drop vertical lines until they cut the miter line C F in plan, as shown by similar numbers.

The patterns for the exterior and interior angles of the level gutters may then be laid out. At right angles to B C in plan draw any line, as K L, upon which place the girth of the normal profile A, as shown by the small figures 1 to 12, on K L. Through these small figures and at right angles to K L, draw the usual measuring lines; intersect these by lines drawn parallel to K L from similarly numbered intersections on the miter line F C. A line traced through points so obtained will be the miter cut. 1-N-M-12 will then be the miter cut on the level gutter for the exterior angle and N O P M the miter cut on the level gutter for the interior angle. As the bend 11 in the normal profile A comes directly on the eave line, then in taking measurements for the metal gutter the edge 11 of the roof board is measured and laid off from b' in the pattern towards 11, for the exterior angle; and from b' towards 11′, for the interior angle.

Obtaining the raked profile and patterns for the raking gutter, shown from A to B in Fig. 230, is next in order and is accomplished as shown in Fig. 231. On the line 12 G in plan or the line obtained from point 12 in the normal profile A, establish any point as a, from which erect a vertical line, intersecting the roof line, 11-12 extended at a'. Then take a tracing of part of the plan, G F C D, includ-

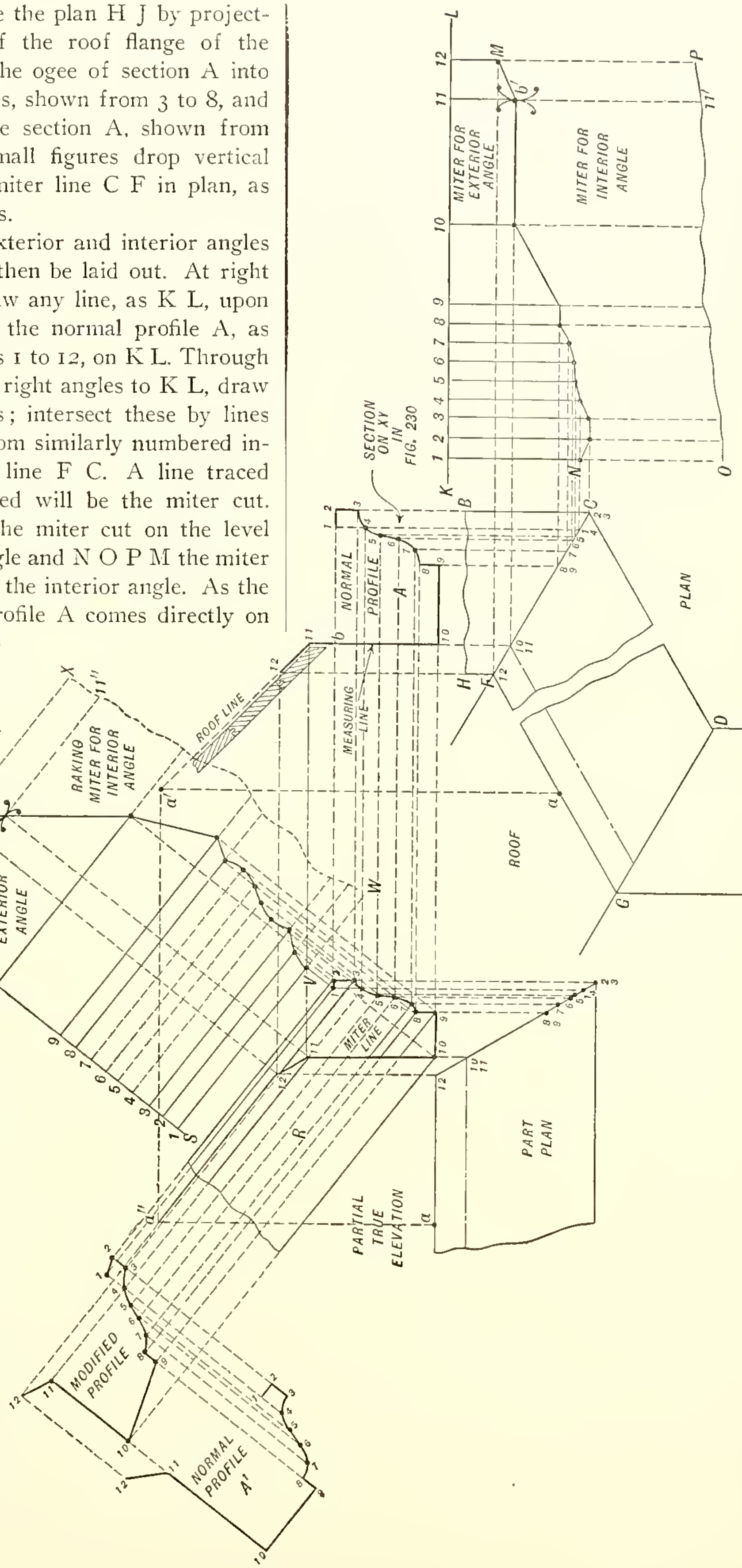


Fig. 231.—Patterns for Raking Gutters on Pitched Roofs, at Other Than a Right Angle in Plan

ing the point *a* and the various numbers on F C and place it in a horizontal position, as shown to the left and marked Part Plan. From *a* and from the various intersections 12 to 2 in the Part Plan, erect vertical lines which intersect horizontal lines carried to the left from the various intersections of similar numbers and letters in the normal profile. A line traced through points so obtained, as shown from *a″* to 12 to 1 in R, will show a partial true elevation giving the miter line of the exterior angle. From the various intersections, 1 to 12, in R, draw indefinitely, lines parallel to *a″* 12, as shown towards the left. Take a tracing of the normal profile A and place it at right angles to *a″* 12, as shown by A^1. Through the small figures 1 to 12 in A^1, draw lines perpendicular to *a″* 12, intersecting lines previously drawn parallel to *a″* 12. Trace a line through points so obtained, resulting in the raked or modified profile, shown from 1 to 12.

The pattern for the raked gutter may now be obtained by placing the girth of the modified profile on the line S T, which is drawn at right angles to a″-12; through these small figures 1 to 12, on S T lines are drawn parallel to a″ 12 and are intersected by lines drawn at right angles to a″ 12 from similarly numbered intersections in the miter line in R. Trace a line through these intersections, as shown by U V. Then T U V S shows the raking miter for the exterior angle, shown at the corner B in Fig. 230; and U V W X in Fig. 231 will be the raking miter for the interior angle, shown by A in Fig. 230. Upon laying out the length of the raking gutter, A B, measurements are taken on the raking pattern in Fig. 231 from *b″* towards 11, for the outside or exterior angle; and from *b″* towards 11″ for the inside or interior angle. The modified profile shown is to be used when forming up the raking gutter, while the normal profile is used when forming up the two horizontal gutters. Laps for riveting and soldering should be allowed on the miter patterns, placing the laps so that the water will not run against the seams, but over them. In other words, laps should be allowed on the horizontal molding or gutter at the corner A in Fig. 230 and laps on the raking gutter at the corner B. This will provide for the water running over the seam, not against it.

PANELED CONDUCTOR OFFSET

Solution 45

When a leader or conductor is to offset over a projecting wash on a building, whether the pipe be square, rectangular, or paneled, it is customary and proper that the area of the three pieces of pipe making the offset should be alike, that is, it is poor practice to modify the profile of the middle section, thereby reducing its area and preventing the free flow of water.

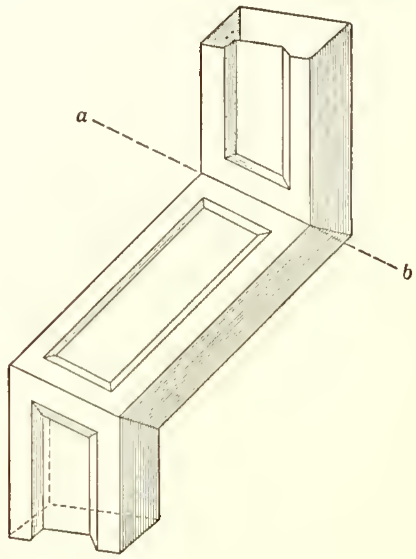


Fig. 232.—View of Paneled Conductor Offset

Fig. 232 is a perspective view of a paneled leader offset whose area is equal in each of the three pieces, thereby giving the formation of the panel heads shown. If the line of the panel head were required to be level or horizontal along *a b*, a change of profile would in that case be required, in the oblique piece; this would reduce the area of that piece and should therefore be avoided. Fig. 233 shows how the patterns are developed for the three pieces or arms, as well as for the panel heads. In preparing the patterns, we will so develop them that the arms miter together, as if no panel heads were sought, as shown at the miters *a b* and *c d* in Fig. 234. After these miters are joined water tight the panel heads A and B are set in separately, as shown in the diagrams at the left and right. The procedure set forth in connection with and illustrated in Fig. 233 is applicable to any size or profile of pipe, without respect to the angle required in either plan or elevation.

Let A B C D represent the slope of the wash over which the offset is to fit at an angle indicated by 1-1 in plan, (in this case 45 degrees). From C in the slope, draw the horizontal line C E, meeting the line A B extended at E. E B then gives the vertical hight of the wash, whose base is C E. In its correct position, as shown in plan, draw the pro-

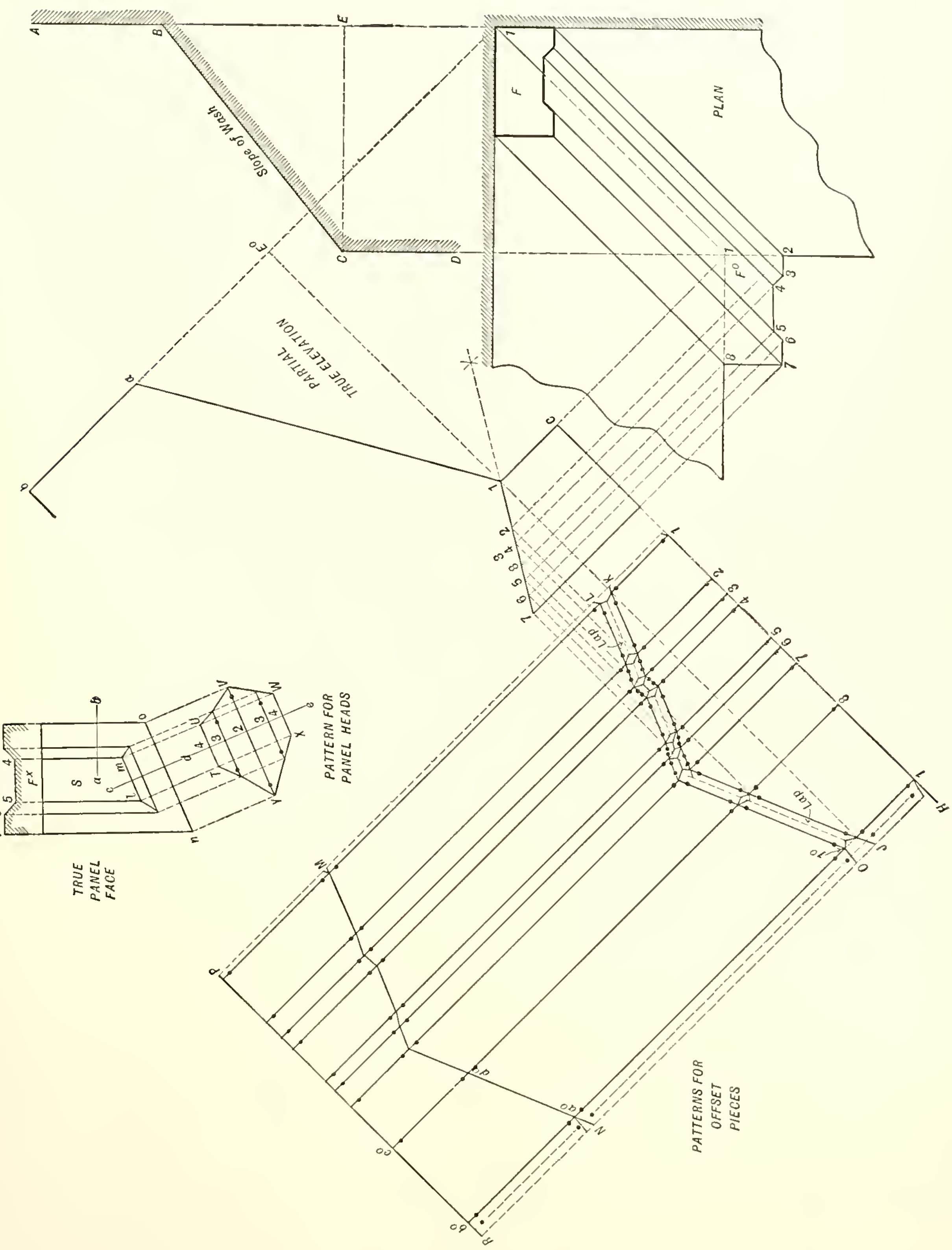


Fig. 233.—Patterns for Paneled Conductor Offset

file of the paneled leader, indicated by F, take a duplicate of F and place it in accurate position, shown by F°, so that the corner 1 in profile F is set at the corner 1 in the lower angle. Number the various corners in F°, as shown by the small figures 1 to 8 and, if desired, connect lines to corresponding corners in the profile F, as shown. Upon any line in plan, as 1-1, construct a true elevation as follows: Equal to and parallel to 1-1 in plan draw any line, as 1 E°, at right angles to which, from E°, draw the line, E° *a*, equal in hight to E B. A line drawn from *a* to 1 will give the true length of the line 1-1 in plan. From point 1 in the true elevation and at right angles to 1 E° draw 1 *c*, as desired. Also set off *a b*. As the angle *b a* 1 is alike to the angle *a* 1 *c*, the pattern for one arm will serve for the three arms required in the construction of the offset and but one miter line will be required. Therefore, bisect the angle, *c* 1 *a*, by the miter line 7-1, as shown. From the various corners, 1 to 8, in the profile F° in plan and at right angles to 1-1 in plan erect lines intersecting the miter line, 7-1, in the true elevation, as shown by similar numbers. From *c* draw parallel to E° 1 the line *c* H, upon which place the girth of the profile F° in plan, as shown by similar numbers on H *c*. From these small figures 1 to 1, and at right angles to H *c* erect lines indefinitely, as shown, and intersect them by lines drawn parallel to *c* H from similarly numbered intersections on the miter line, 7-1. Trace a line through points thus obtained, as shown by J K; 1 J K 1 will be the pattern for the lower arm, edges to which have been allowed for seaming and soldering, as indicated by the dotted lines. Allow for two sets of laps above K J in the pattern, as indicated from K to L and set off this distance K L, above the miter cut K J; draw L O, a reproduction of K J, and allow laps below L O as indicated by the dotted lines. Take the distance from 1 to *a* in the true elevation and set it off in the pattern, as shown from L to M and 1° to *a*°, and draw the miter cut M N corresponding to K J. L M N O then constitutes the pattern for the middle piece. Take the distance from *a* to *b* in the true elevation, which represents a line on the corner 1 in the profile F in plan and set it off on the lines 1 and 1 in the pattern, as shown from M to P and *a*° to *b*°, and draw a line from P to *b*°. a° b° P M then represents the pattern for the upper arm. This gives the three patterns from one rectangular piece of metal. It will be observed that the upper miter cut along M N has no laps, while the lower miter cuts, K J and O L, each have laps, for soldering purposes. Laps are allowed throughout the three pieces for double seaming the corners, as shown.

If these three patterns were formed up and soldered together, they would appear as shown in Fig. 234, but as a panel effect is desired, as shown in Fig. 232, the pattern for the panel heads must be obtained. Preparatory to this a true face must be obtained, from which the development can be

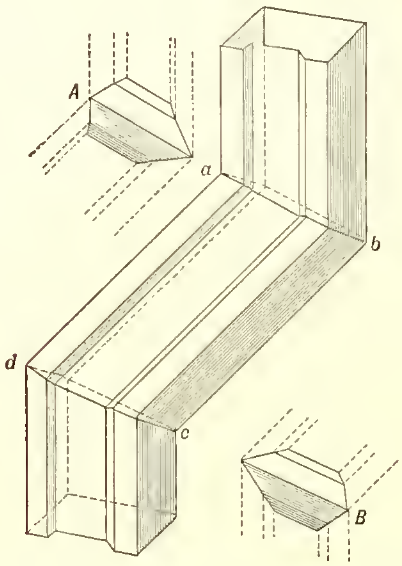


Fig. 234.—Joining the Offset Minus the Panel Heads

made. The true face is shown by *a*° *b*° *c*° *d*° in the pattern in Fig. 233 and it is reproduced by S at the top of the cut. Above this diagram, S, place a tracing of the panel profile in F° from 2 to 7, as shown reversed by F^x above the diagram S. From the small figures 3 to 6, in F^x, drop perpendicular lines in S as shown. Take the various widths on *a b* in S and set them off at right angles to *n o* on *d c*. Complete the true elevation of the panel lines, as shown. Extend *c d* as *c e* and upon this place twice the girth of 4-3-2 in F^x, as shown by 4-3-2-3-4 on *d c*. At right angles to *d e* and through the small figures draw lines, which intersect lines drawn parallel to *d c* from similarly numbered intersections on the miter lines, *n l* and *m o*. A line traced through these points, as shown by T U V W X Y, will be the pattern for the two miter heads.

Construction

When in the process of making up these paneled leader offsets, as well as of the leaders, which are usually constructed of copper, care must be exercised in forming up the paneled formation as well as the corner lock. Detailed explanation is provided in the text and illustration of Fig. 235.

Let diagram *a* represent the formation of the right and left lock at bends marked 1, making a slight bend at *x* between 8 and 1. After the locks the locks at 1 and close them tightly in the jaws of the brake, as indicated in diagram *e*. The lock is now closed on a mandrel stake or steel bar A, as shown in diagram *f*, using the mallet to make a tight seam, but exercising care that the pipe will not twist. The offset can now be set together to

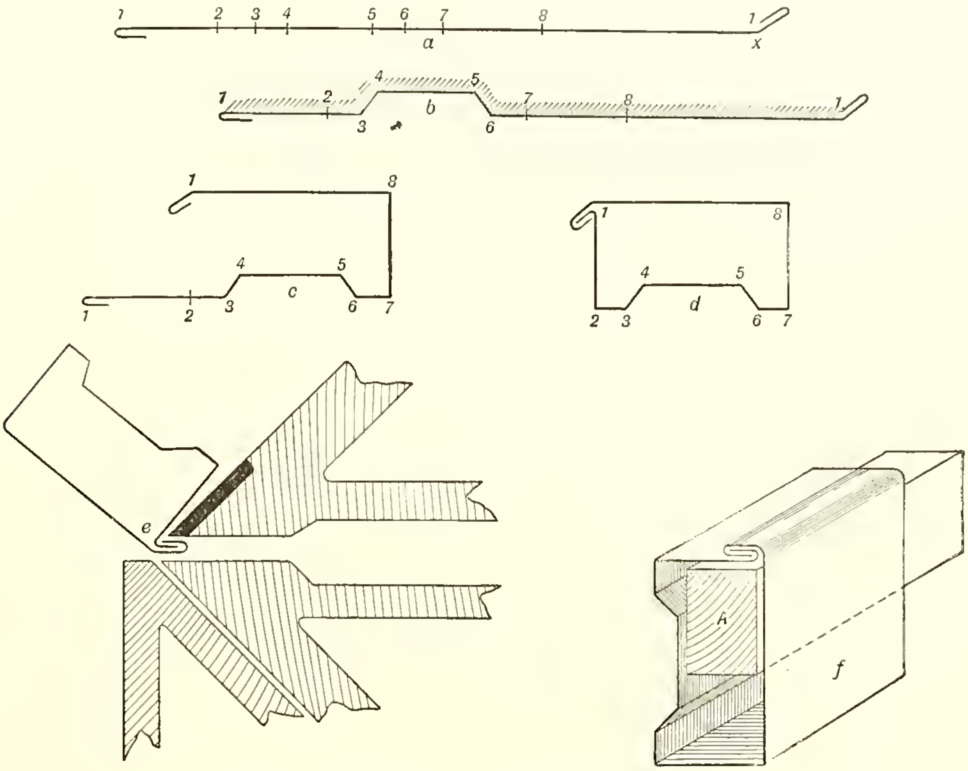


Fig. 235.—Forming and Seaming the Paneled Pipe

have been bent in the brake form the panel sinkage at 3, 4, 5, and 6 after the profile, so that the formation will appear as shown in diagram *b*. Next, make square bends on dots, 7 and 8, as shown in diagram *c*, after which the final bend is made on dot 2, to bring it to the desired shape, as shown at *d*. Spring the correct angle, as shown by *a b* and *c d* in Fig. 234. Thereafter the panel heads are soldered in position, shown at A and B. In bending the panel heads the *center bend* on each is formed to correspond to the desired exterior and interior angles, all as shown in the view of Fig. 232.

PART VI

RAKING MOLDINGS AND BRACKETS FOR ANGULAR AND SEGMENTAL PEDIMENTS

THE present part is devoted to a class of development termed "raking miters," which occur at the angles of a pediment or in any position where a level mold is required to miter with an inclined mold at any angle in plan.

The chief characteristic of this class is the "raking" or changing of the profile of one arm of the miter before the patterns can be developed. By far the greater number of cases are those in which the inclined mold on the face of a pediment is required to miter with a square or right angle return, in which case the miter is described as a "square raking" miter. Sometimes, however, the return or level arm of the miter may be at a more obtuse angle, as an octagon angle or one even greater, thus requiring a further complication of operations, all of which will be illustrated and explained in due course.

Briefly stated, when an inclined mold is required to miter with a level mold at any angle in the plan, it becomes necessary to change the profile of one of the arms. The reason for this can best be explained by following out the operation of obtaining the new profile.

In the case of any raking miter, two courses are open to the pattern cutter: The profile of either the inclined or the level mold may be changed, the choice being determined by conditions which may arise.

Let us take up first the case in which the change of profile is made in the inclined mold, the level return remaining normal.

RAKING CROWN MOLD IN ANGULAR PEDIMENT

Solution 46

Fig. 236 is a view of an angular pediment. A, represents the profile of the level molding which will form a raking miter with the inclined molding. B represents a face miter, while C shows a butt miter on the wash D.

Fig. 237 shows in the center a front elevation, at the left a side elevation, and at the right a section on the center line of the pediment, such as may be used in a door or window cap. In constructing this elevation it is necessary to follow very closely the directions here given. Draw first the normal profile A B C D. The profile here shown is the simplest form of crown mold and the one most commonly used. In practical work any other profile of crown mold may be used instead; but in shop work the profile must of course be drawn in accordance with the specifications or architect's requirement as regards size, shape and number of the members, etc. From the points B C and D only, draw horizontal lines as shown at the right and, having ascertained the required width of the pediment, draw the vertical center line E F.

Now from point A draw A E at the required pitch and from points 2 and B, draw lines parallel to A E to reach the center line as shown.

To obtain the raked profile or true section of the inclined mold, first draw the line G H at any convenient position, at right angles to A E, and upon G H extended above or below, place a duplicate of the curved portion of the normal profile A B C, so turned that its vertical line shall coincide with G H, all as shown at X. Divide the curved portions of both profiles into the same number of equal spaces,

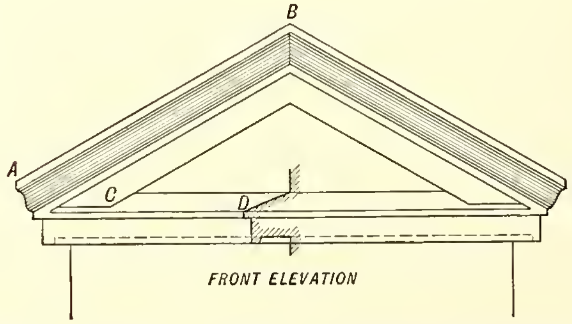


Fig. 236.—View of Angular Pediment, Requiring Raking Molds

numbering the points in each to correspond as shown. Now from all the points in that part of the profile from A to B, draw lines parallel to A E. These lines may be extended, as a matter of convenience, to cut the center line for further use when laying out the pattern for the upper miter. From the several points in the profile X carry lines parallel to G H to cut lines of corresponding number previously drawn. A line traced through these intersections as shown from K to L will be the correct profile for the curved part of the mold.

This profile must now be completed by the addition of the part B to D of the first profile, as shown from L to H. This part of the profile is added without change since it will not be required to miter with B D of the return, but will be mitered down upon the narrow roof shown by *a c* of the sectional view.

The miter from A to D therefore becomes a compound miter having really three arms; one arm being the plain return shown separately in the side elevation at the left, another one being the entire inclined crown mold shown by A E J P B of the front elevation, while the third is the level mold consisting only of roof, fascia and fillet shown by B P Q F D, the two last named arms of the miter coming together from B to R and forming a separate miter which is exactly the same in principle as that shown in Fig. 178. In order to complete the miter from B to R, in Fig. 237, it will be necessary to determine first the pitch of the roof whose profile is *a c* as shown in the sectional view at the right in the engraving.

To construct this view draw first the profile A^2 D^2, which is the same as A B D of the front view, placing the point A^2 at the required distance from the wall line. This determines the width of the two roofs E^2 S and *a c*, and of the planceers T V and J^2 W.

We may here mention that the bed mold is usually

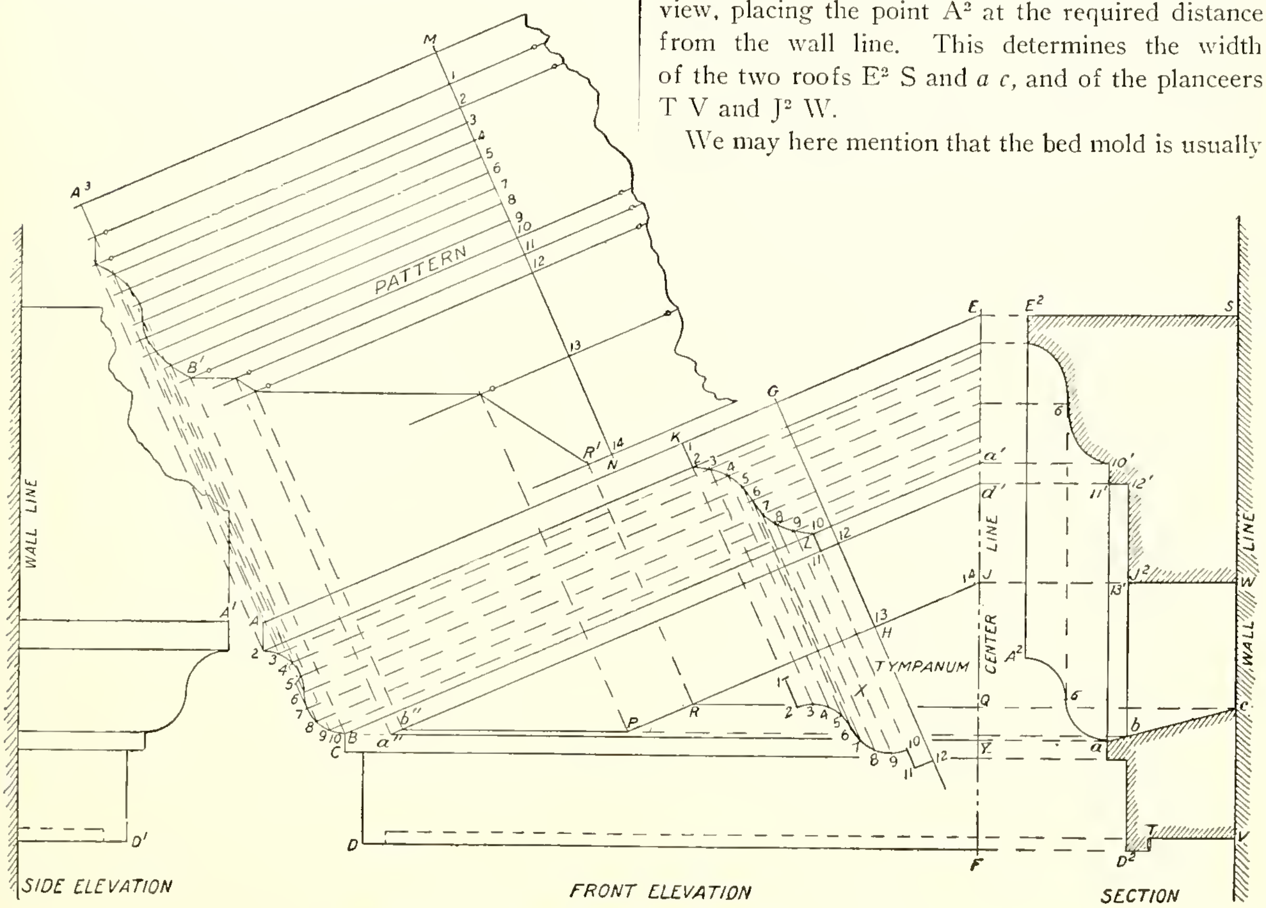


Fig. 237.—Developing Pattern for Raking Crown Mold

included in the design filling the angles at W and V, but it has been omitted here because the problem being here considered is that of crown mold miters only. Reference to Fig. 178 above mentioned will show the bed mold in position in the pediment cornice and indicated in the level cornice below.

Having drawn in Fig. 237 the profile A^2 D^2 and the wall line V S at the correct distance away, draw the vertical line A^2 E^2 to meet a horizontal line projected from E and continued to the wall line at S. Complete the lower part of the section by outlining the drip D^2 T and the planceer T V. Now locate the point *c* at a sufficient hight to give the necessary pitch to the roof, and draw *a c*. It is apparent from an inspection of the elevation that the surfaces of the fascia and of the fillet of the inclined cornice, the part shown in the new profile by points 10, 11, 12 and 13, must be flush (i. e., must lie in the same vertical plane) with those of the level cornice below, and shown by B C D in the profile A B D. Therefore erect lines from points *a* and D^2 of the section, to meet lines brought over from *a'*, *d'* and J on the center line of the elevation, as shown at 10^1, 11^1, 12^1 and J^2. This determines a portion of the section through the upper cornice, on the center line. The continuation of the line J J^2 to W, will give the planceer in this view, after which all that remains to be completed of the section is the mold shown from E^2 to 10^1. This section, although on a vertical plane, is an oblique section of the inclined cornice, because the line E J is not at right angles to A E and is therefore longer than the line G H, which is the plane of a right section. The curve of the molding shown between E^2 and 10^1 will therefore be an elongated ogee. Extreme accuracy in obtaining this curve is not really necessary since no use is made of it beyond showing in connection with the lower part of the section just how the pediment would appear if cut through the middle.

If desired this curve can be accurately obtained by first dividing the profile A^2 *a* into the same number of equal spaces as profile X, then erecting lines from each of the points of division, to intersect horizontal lines of corresponding number projected from the points on the center line between E and *a'* already obtained. The drawing shows that operation in only one point, the middle point 6.

The intersection of the line of the fascias, 12^1 D^2, with the roof *a c*, at *b*, in the sectional view, determines the bottom line of the fascia of the inclined cornice to be at *b''* P in the elevation, also that lines projected from *b* and *c* to intersect P J of the elevation, will show that P R is the line of intersection between the roof of the level cornice and the planceer of the inclined cornice.

Having thus determined the points upon that part of miter from B to R, we are now able to lay out a pattern for the crown mold. Therefore on any line drawn at right angles to A E, as M N, set off a stretchout of the profile K H, as shown from M to 13. To this must be added the space 13 14 which is the width of the planceer and is equal to J^2 W of the section. The spaces from K to L upon the profile must be measured individually and set off successively from M, since by the operation of obtaining the new or raked profile these spaces have become unequal, and in all considerably greater than those shown from A to B of the normal profile. From the several points on M N draw the measuring lines, after which lines may be projected at right angles to A E, from the several points used in the original division of the profile A B to intersect lines of corresponding number in the stretchout, all as shown from A^3 to B^1 of the pattern. Continuing from this point, the remaining points 11, 12, 13 and 14 of the profile K H, which fall upon the sloping roof, are projected from the points *a''*, *b''*, P and R respectively as shown from B^1 to R^1 of the pattern. A line drawn through the points of intersection thus obtained will give the pattern for the lower end of the pediment mold.

It is usual, as a matter of convenience, to conduct the operation of laying out the pattern for the miter on the center line at the same time, which is done by continuing the stretchout lines upward to the right and intersecting them with projections from the points proviously obtained on the center line between E and J.

The pattern for the return piece, shown in the side elevation, is in this case a simple square miter and does not differ in principle from that already shown in preceding solutions of *return miters*. The miter for the level cornice of the front will be a duplicate of the return miter from B to the bottom, having enough metal to equal the space *a c*, added at the top. It is not considered necessary to continue this miter to contain the points b'', P and R.

RAKING MOLDS IN A BROKEN ANGULAR PEDIMENT

Solution 47

In the preceding solution it was stated that in the case of a raking miter, choice might be made be-

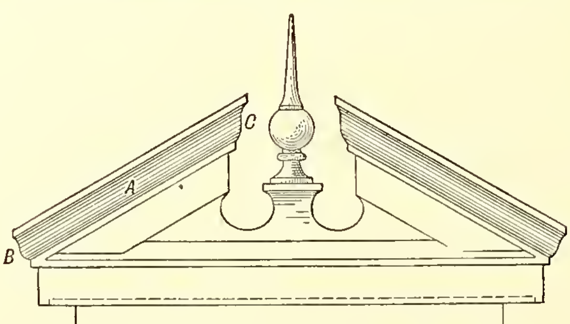


Fig. 238.—View of Broken Angular Pediment

tween changing the profile of the inclined mold and that of the return, and the operation of changing the inclined mold was there shown. Fig. 238 is a view of a broken angular pediment, in which the given profile will be placed in the inclined mold A; then the lower return at B and the upper return at C will be modified to form a perfect miter at right angles in plan.

In Fig. 239 is shown how the return mold may full profile of the mold as shown at P, which represents a true section at right angles to the line D F.

To obtain the profile of the return at the foot of the pediment, first draw a vertical line through the point A or 10′, forward of which, at any convenient position, draw a duplicate of the ogee of the normal profile as shown, of which the points *a* and *b* are the centers corresponding with *a* and *b* of profile P. In placing this curve in position,

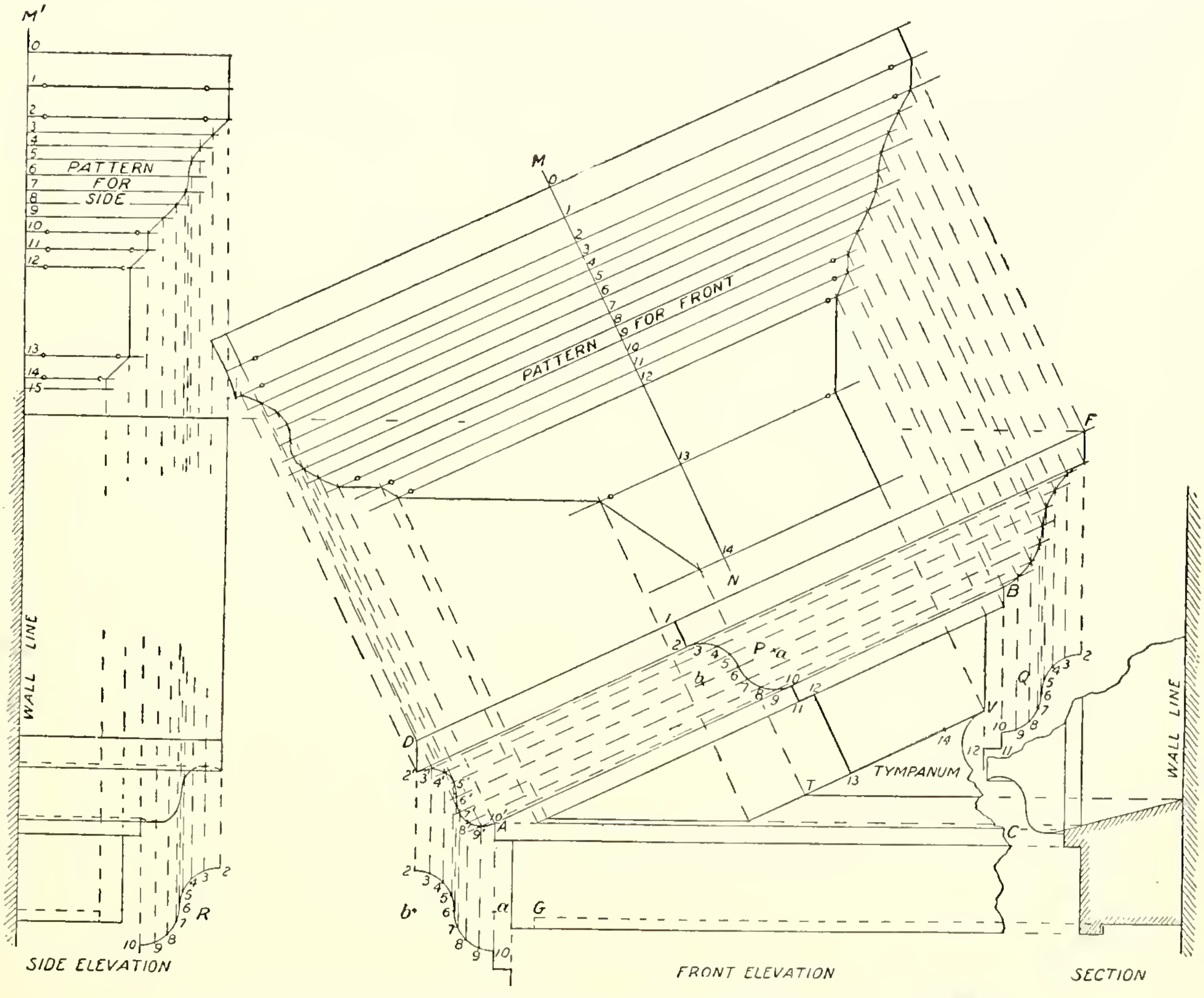


Fig. 239.—Raking the Returns of a Pediment and Obtaining Patterns for all Molds

be raked or changed so as to make a perfect miter, while the face or inclined mold is kept normal. In this case, as before, we shall ask the reader to follow the directions very carefully. Construct first the angle B A C, making A C horizontal, drawing A B at the required pitch, and add the fascia and fillet below each, making those members the same width as measured at right angles to A C and A B in each case; then add the profile of the mold proper above the inclined fascia and fillet, completing the note that the line A 10 is perpendicular, and that points *a* and *b* are on a horizontal line, which is also true in profile P, if it be supposed that the inclined line D F is also horizontal. Now divide both curves (ogees) into the same number of equal spaces, as indicated by the small figures, and from the points of division in profile P, carry lines parallel to D F indefinitely to a position between D and A, and intersect them with lines of corresponding number drawn vertically from the points of division in the other curve, when a line traced through the points of intersection will give the desired curve, as shown by the small figures with primes, from D to A, which, taken in connection with the part from A to G, already drawn, will constitute the profile of the entire return piece.

The outline shown at D G is also a view of the miter and will consequently appear the same in both the front and the side elevations, except that in one view, it will appear in a position reversed from that which it occupies in the other. Following the usual rule for laying out the pattern for the return, we will therefore draw the stretchout line at right angles to the lines of the mold in elevation, which, in this case is the side elevation. This may most conveniently be done by extending the wall line as shown toward M[1], upon which we set off a stretchout of the profile D G, this being the newly developed profile of the return piece. Care must be exercised to take the spaces separately and consecutively, beginning at either end, for as explained in the former solution, the spaces have become unequal, owing to the process of raking. To follow the rule for all miters still further, we must now project the points from D G to the miter line, otherwise the outline which we have transferred to the side elevation. But since there is a chance of error in doing this, and since the new profile, D G, was obtained by projections from the normal profile below it, it will be quite as easy, and probably more accurate to place below the side elevation another duplicate of the normal profile, as shown at R, which may be divided into the same number of equal spaces as before, and to project lines from the points thus obtained into the measuring lines of the stretchout, thus obtaining the pattern, all as shown above the side elevation. In actual practice, the process can be somewhat abbreviated by projecting the pattern for the return directly from the profile D G, upon a stretchout placed immediately above or below that profile, thus bringing the pattern in a position the reverse of that shown above the side elevation. This does away entirely with the construction of side elevation.

For the pattern of the front or inclined mold, the only requirement is to first set off its stretchout taken from profile P, *on any right line,* as M N, and draw the measuring lines as shown, intersecting them by lines drawn from the profile D A into the measuring lines of corresponding number in the stretchout as shown, completing also the miter from A to T, all as explained in the preceding problem, and as already fully shown.

In the case of a broken, or, as it is sometimes termed, an open pediment, it becomes necessary to finish the inclined mold at the top with a level return in a manner similar to that used at the bottom. When such a design is called for, the profile of the return at the top may be obtained by a method which is the same in principle as that already explained, and as shown at the right. Place a duplicate, Q, of the normal profile in a position exactly below or above the position intended for the return and divide it into the same number of equal spaces as profile P. Erect lines from the points of division thus obtained, to intersect lines of corresponding number from profile P, all as shown, when a line traced through the points of intersection, as shown from F to V, will be the required profile. It should be noted that, in this case the entire profile is raked while in the case of the return at the bottom, only the ogee was changed. In obtaining the pattern for the return at the top, the stretchout must, of course, be taken from the newly obtained profile F V. This operation can also be very much abbreviated as explained for the return at the bottom, by projecting lines from the points on the new profile into measuring lines drawn horizontally above or below the profile.

RAKING MOLDS IN A BROKEN SEGMENTAL PEDIMENT

Solution 48

Fig. 240 presents a view of a broken segmental pediment, in which we will place the given profile in the curved molding A and find the modified or raked profiles in the lower and upper horizontal

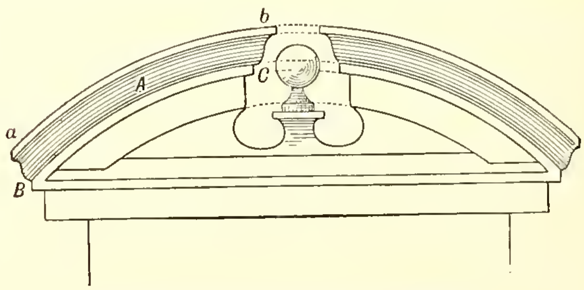


Fig. 240.—Broken Segmental Pediment

returns at B and C respectively. We will also develop the miter cuts for the curved molding at *a* and *b*. Should the segmental pediment be closed, that is, should it be without the broken part, as indicated by the dotted lines, the method described

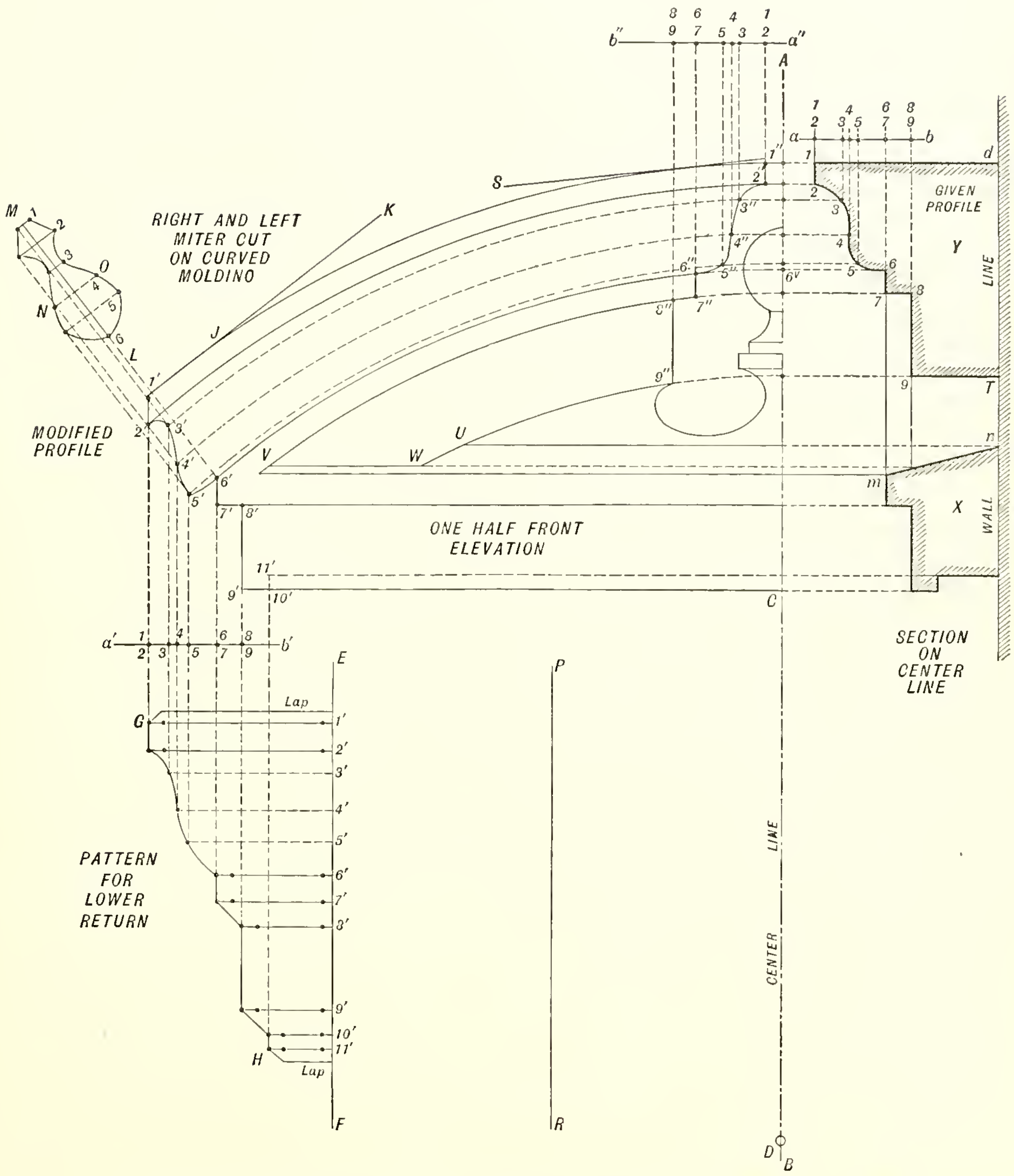


Fig. 241.—Raking the Returns of a Broken Segmental Pediment and Patterns for All Molds

in connection with Fig. 241 should be followed. In this figure the method of raking the returns in a broken or unbroken pediment, together with the patterns for all molds, is shown.

The first step is to draw the one half front elevation as follows: First draw the center line A B and from any point upon it, as C, draw the horizontal line C 9′, of the desired length. Complete the profile shown from 9′ to 6′ and add the drip from 9′ to 11′. With the desired center D upon the center line A B and using D 6′ as radius, draw an arc, until it intersects the center line at 6^v. At right angles to A B from the intersection 6^v draw a line, as shown from 6^v to 6, placing 6 at the desired distance from the wall line, as shown. Complete the profile from 6 to T, as shown, making certain that the profile from 6 to 9 is alike to that shown from 6′ to 9′ in the half elevation. As the given profile in this case is to be placed in the curved molding, complete the ogee shown from 6 to 1 and proceeding in this manner, complete in line with the front elevation, the section of the horizontal mold indicated by X. Y and X then represent the true section of the curved and of the horizontal mold respectively, on the center line A B. From this given profile Y the modifications of the upper and lower returns must be made. Space the ogee in the given profile Y into a number of equal divisions, as indicated by the small figures 1 to 6. From the small figures 1 to 9 in Y, draw lines at right angles to the center line A B until they intersect A B, as shown by the heavy dots. With D as center and with the various heavy dots on the center line A B, representing the points, 1 to 9, obtained from the given profile Y, to mark the radii, describe arcs to the left to any length, as shown. Parallel to 1 *d* in Y draw any short line, as *a b*, and from the various points 1 to 9, in the given profile, erect perpendicular lines cutting the line *a b*, thus obtaining the intersections marked 1 to 9. Take a duplicate of *a b* and place it, as indicated, below the half elevation as *a′ b′*, so that the point 8-9 will come directly below the line 8′-9′ in the profile, as shown. From the various intersections on *a′ b′* erect vertical lines, cutting arcs drawn from similarly numbered intersections on A B, thus obtaining the intersections marked 1′ to 6′ in the lower return. This represents the raked profile of the ogee at the bottom.

Should a broken segmental pediment be sought as indicated, establish the point 1″ at any point, and take the divisions on *a b*, reversing them, as indicated on the line *a″ b″*, so that the point 1-2 comes directly over 1″ in the elevation. From these divisions on *a″ b″* drop vertical lines until they intersect similar arcs, thus obtaining the points of intersection, marked 1″ to 9″, these representing the modified or raked profile at the top.

The intersection of that part of the mold, indicated by 8-9-T in the given profile Y upon the wash of the horizontal mold X, is found in elevation as follows: From the various intersections upon the wash *m n* previously obtained from 8-9 and T in Y, carry lines horizontally to the left meeting curved lines, struck from the center D, at V W and U respectively, all as indicated by the dotted lines and as explained in a preceding problem.

Proceeding to the development of the patterns that of the lower horizontal return is obtained as follows: Below the elevation draw any vertical line, as E F, upon which place the girth of the modified profile shown from 1′ to 10′. Measure the divisions separately, since all are unequal. This is shown by the corresponding numbers on E F. Through these small figures and at right angles to E F, draw lines and intersect these by lines drawn parallel to E F from similarly numbered intersections in the modified profile. Trace a line through points thus obtained, as indicated by G H, and make the distance from G to 1′ equal to 1 *d* in the given profile Y. G-H-1′-11′ becomes the pattern for the lower horizontal return. That for the upper horizontal return is obtained by procedure corresponding to the foregoing. The girth of the upper modified profile from 1″ to 9″ is placed upon any vertical line, as P R, and the pattern is obtained in the manner just applied in procuring that of the lower return.

The method of obtaining the patterns for the flaring strips for the curved molding is omitted for the present but will be described under *Circular Work* in another part. We will take up the method of obtaining the miter cuts for the lower and upper ends of the curved molding. The right and left miter cut on the lower end of the molding, shown in the illustration, is obtained as follows: Draw a line through the top curve on the lower end of the molding, as indicated by 1′ K, drawing the line at such an angle, that the portion of the curve 1′ J thus covered appears as a straight line. At right angles to K 1′ draw any line, as L M, and upon this place the girth of the curved mold, from 1 to 6 in the given profile Y, as indicated by like numbers, 1 to 6, on L M. Through these small figures and at right angles to L M, draw lines and intersect them by lines drawn parallel to M L from similar numbers in the lower modified profile, 1′ to 6′. Trace a line through these points as indicated by N. Using the dividers and measuring in each instance from the center line M L, take the various projections to the intersections in the cut N and transfer them on similar lines to the right of M L; trace a line through points so procured, thus obtaining the miter cut O. This small miter cut should be made no wider than is absolutely necessary, for then, when it is formed to the profile Y, it may be slid along the curved molding, so as to mark the miter cut at each lower end of the mold thus forming a junction between the lower horizontal return. The line, 1″ S, at the top of the curved molding is drawn, as shown, and the right and left pattern is obtained in precisely the same manner as set forth in connection with N O. The curved mold can be made either by hand or machine. Both methods will be described in their appropriate place.

ANGULAR PEDIMENT HAVING RETURNS AT OCTAGONAL ANGLES

Solution 49

Fig. 242 illustrates an angular pediment with octagonal horizontal returns. In this example we will introduce the modified profile in the pediment mold A, the normal or given profile being placed in the horizontal mold B. When it is required to construct a pediment in which the inclined mold rises from an octagonal or any other angle instead of from a square return, as was previously illustrated (as in the case where a building having an octagonal corner is designed with a pediment either on the front or over the oblique side as in Fig. 242), the method of laying out the patterns for such a pediment is shown in Fig. 243.

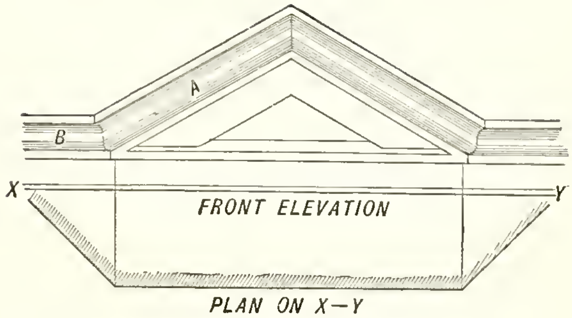


Fig. 242.—Angular Pediment Having Returns at Octagonal Angles

In this case it is necessary to first obtain the plan and elevation of the octagonal miter. Draw first the plan as shown at A B, and place the normal profile in either arm, as shown. Next draw the elevation of the level part of all the moldings, placing the normal profile in that part of the elevation

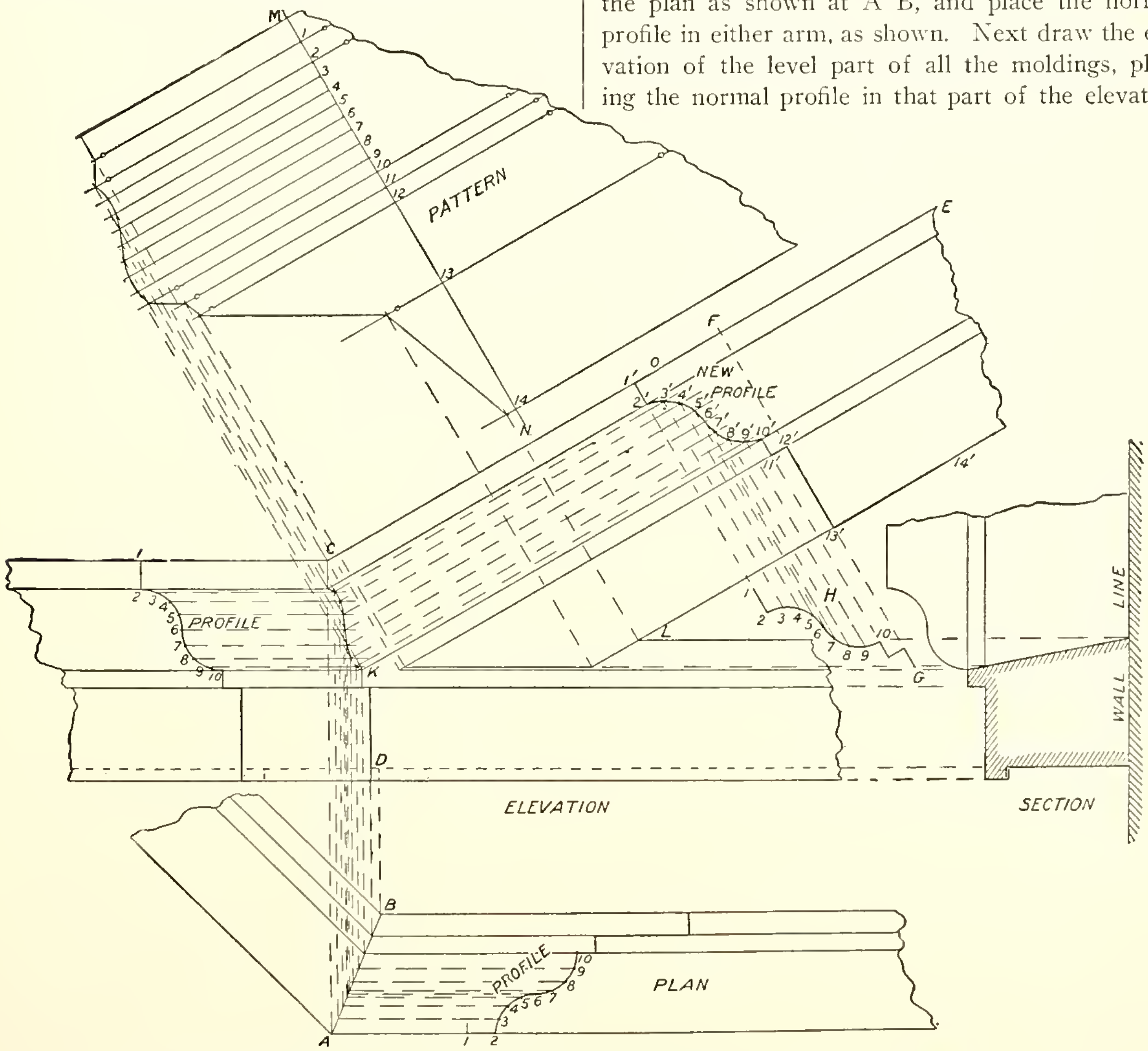


Fig. 243.—Elevation and Patterns for a Pediment Having an Octagonal Return

which is to remain level, as shown at the left of the octagon miter C D. Divide the curved portion of both profiles into the same number of equal spaces as shown by the small figures and project the points from the profile in plan horizontally to intersect, first, the miter line A B, thence vertically into the elevation to intersect lines drawn horizontally from corresponding points in the profile of the elevation, all as shown from C to D. This gives the elevation of the octagon miter. Now from C draw C E at the required angle of the pediment, and at any convenient position draw F G at right angles to C E. Upon F G, above or below the space required for the new profile to be obtained, draw a duplicate of the normal profile, so placed that its vertical lines shall be parallel to F G, as shown at H. Divide the curved portion of profile H into the same number of equal spaces as were used in dividing the other two profiles, and from the points of division carry lines parallel to F G, to intersect lines of corresponding number drawn from the intersections previously obtained in the octagon miter between C and K, carried parallel to C E, all as shown from 1′ to 10′. A line traced through the points of intersection will give the profile of the inclined mold, to which the profile of the fascia fillet and planceer must be added, as shown by points 11′ to 14′. That part of the elevation, including the miter from K to L, must now be completed with the aid of the sectional view shown at the right, all as explained, in preceding problems.

In laying out the pattern for the pediment mold, the stretchout must, of course, be taken from the newly obtained profile, remembering that the spaces thereon are unequal, and set off on the line M N, when the pattern can be completed in the usual manner.

It is possible in a pediment springing from an octagon miter to have the inclined mold of normal profile if desired, changing instead the profile of the level mold, as in the case of the pediment with square return illustrated in Fig. 239. To accomplish this result, draw first in Fig. 243 the plan and the elevation of all that part shown below K L, as before explained, and from K draw a line at the required inclination of the pediment. Place the normal profile in position upon the line F G instead of the one previously obtained by intersection. Divide the curved portions of this and the one in the plan into the same number of equal spaces and from the profile in plan carry lines to the miter line A B, as before, thence vertically to intersect with lines of corresponding number brought from the normal profile in the inclined mold, thus obtaining a view of the miter between C and K.

To obtain the new profile, in this case the profile of the level or oblique side, it will be necessary to place a normal profile at any convenient position above or below the level mold, shown at the left of the miter C D, divide it into spaces as before, and from its points draw vertical lines to intersect with those of corresponding number drawn horizontally from the points previously obtained by intersection between C and K.

The operations described in the previous paragraph are not fully shown upon the drawing, but are worked out in the problem that follows; the only variation is that the pediment is curved instead of angular. The operations, however, are alike whether the pediment be curved or angular.

SEGMENTAL PEDIMENT, HAVING RETURNS AT OTHER THAN A RIGHT ANGLE, FORMING BUTT MITERS AGAINST WALL

Solution 50

Fig. 244 shows a finished elevation, plan and pattern of a segmental pediment having returns at other than a right angle, the returns butting against the wall and forming what is known as *butt miters*. In this case the full elevation is drawn; this however, is not necessary in practical work as the half or part elevation of the curved molding serves requirements. First, draw the center line A B, on either side of which draw the semi-plan of projecting pediment or lower line of the horizontal mold, as indicated by 12°, 12, 12^a, 12^x. Bisect the angle 12°, 12, 12^a, by using 12 as a center and describing any arc, as C D. Using C and D as centers, with any desired radius, intersect arcs at E. Draw a line from E through 12 to any length. As the given profile in this case is to be placed in the curved molding, place it also in plan in the position indicated by F^1; space this into a number of equal divisions between 3 and 8 and number all the bends as shown from 1 to 12. Through these small figures, draw lines parallel to $12\text{-}12^a$ cutting the miter line E, 2, previously drawn, as shown by corresponding numbers. From these divisions and parallel to 1-1° draw lines cutting the wall line between 1° and 12°, shown by the heavy dots. Draw any horizontal line in elevation, as K K^1, which intersects at K, H, H^1 and K^1 lines

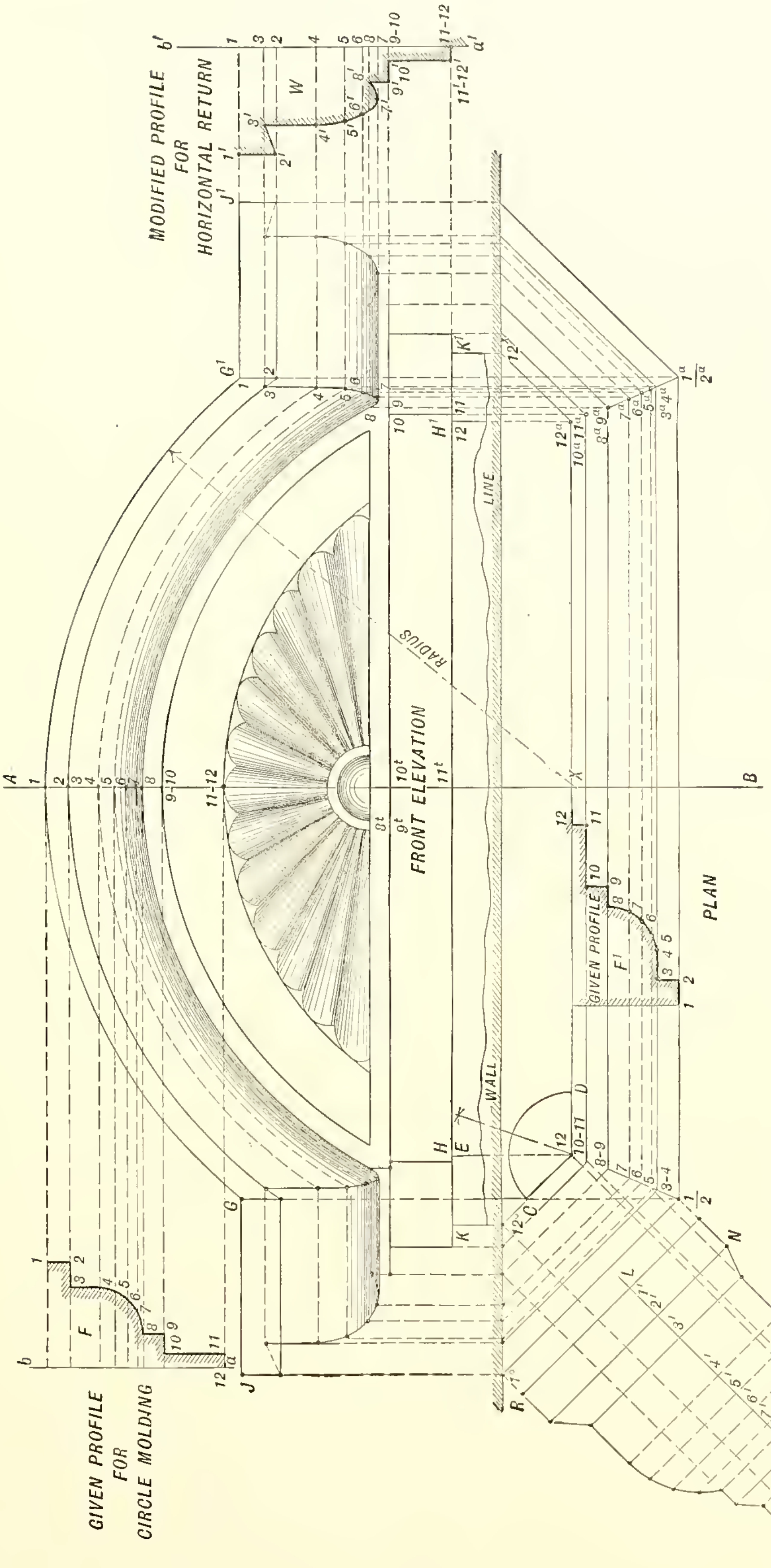


Fig. 244.—Elevation and Patterns for a Segmental Pediment Having Returns at Other Than Right Angles

erected vertically from 12°, 12, 12^{a} and 12^{x} respectively. Make the hight of the lower parts of the mold, 11^{t}-10^{t} and 9^{t}-8^{t} in elevation, equal respectively to 11-10 and 9-8 in the profile F^1 in plan. Through these points, 10^{t} to 8^{t} in elevation, draw lines parallel to K K^1 and intersect them by lines drawn at right angles to K K^1 from similarly numbered intersections in plan, all as shown. Establish the hight of the panel from the line 8^{t} to 11-12 on the center line in elevation, and, using the desired center as X, draw an arc cutting the upper line 8^{t} of the fillet, as shown. At right angles to A B, from the point 11-12 on the center line, draw a line to the left to any length. Upon this place a duplicate of the profile F^1 in plan in the position there shown by F. From the various intersections, 1 to 12, in F draw lines at right angles to A B, cutting the center line A B from 1 to 12. Using X as center, with radii equal to the various intersections on A B between 11 and 1, draw arcs, as shown, which intersect vertical lines erected from similarly numbered intersections on the miter line in plan at the right, thus obtaining the miter line in elevation, indicated by the traced line from 1 to 8.

G^1 H^1 and G H then give the miter lines, from which the true profile of the horizontal molding is found as follows: From the various small figures, 1 to 12, in the miter line, G^1 H^1, in elevation, draw horizontal lines to the right as shown. Erect any vertical line as a' b'. Also erect from 12 in the profile F any vertical line as a b. Measuring from the line a b take the various projections to the small figures, 1 to 11, and place them to the left of the line a' b' on similarly numbered lines previously drawn. Trace a line through points so obtained, as shown from 1′ to 12′; this becomes the modified profile for the horizontal angular returns.

If desired, the joint line between the angular returns in plan and wall can be projected to the elevation, as indicated by the dotted lines, although this is not necessary in the development of the pattern. Should, however, a flat head be desired, to solder along the wall line, 1°-12° in plan, the joint line shown by J K or J^1 K^1 in elevation would be the desired pattern.

The pattern for the horizontal returns is obtained as follows: Take the girth of the modified profile W from 1′ to 12′ and place it on the line L M drawn at right angles to 1°-1 in plan. Through these small figures, 1′ to 12′, and at right angles to L M drawn lines, which intersect lines drawn parallel to L M from similar intersections on the wall line, 1°-12°, and the miter line, 1-12. Trace a line through points so obtained; N O P R will be the desired pattern. N O is the miter cut joining the curved molding and P R the butt miter against the wall. To obtain the right and left miter cut for the lower part of the curved mold, proceed according to explanation given with Fig. 241. The method of obtaining the patterns for the circular molds in Fig. 244, whether made by hand or on the machine, are considered under "Curved Moldings."

GABLES ON A SQUARE PINNACLE

Solution 51

Following in logical order after pediment miters —that is, miters in which an inclined molding is required to miter with a level molding at the corner of a building—comes that class wherein two inclined moldings are required to meet under the same conditions, or in other words, the case of gables or pediments upon adjacent sides of any structure, as a tower, pavilion or pinnacle as shown by A B C in Fig. 245, such structure being a square, hexagon, octagon or other polygon in plan. Such cases occur in Renaissance architecture, in the finish of towers and pavilions in which the moldings used are of the profiles usually employed in pediments, and also upon pinnacles of Gothic form having moldings of the profiles peculiar to that style.

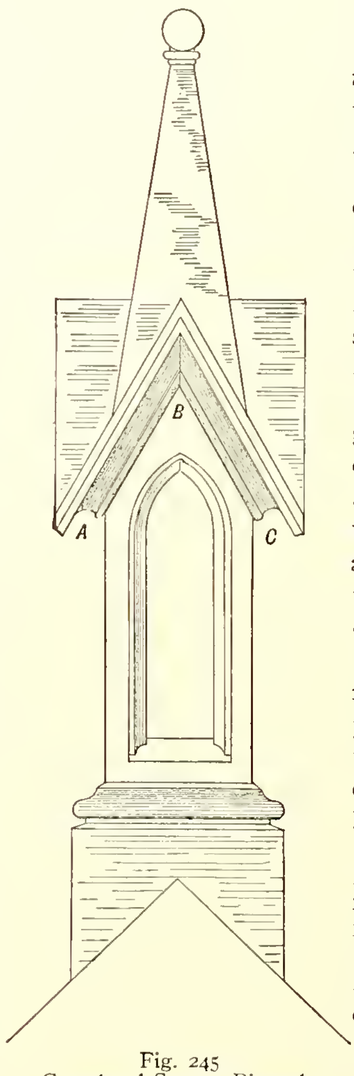


Fig. 245
Completed Square Pinnacle

It has been explained in the problems immediately preceding that when an inclined mold is required to miter with a level mold at any angle in the plan, the profile of one arm of the miter must undergo a change termed "raking." It can readily be seen that when both arms of the miter are inclined, as when both are level, both will be cut by the miter plane under exactly the same conditions, provided both arms have the same degree of inclination, and therefore no change of profile will be necessary for either arm. Should one arm, however, differ from the other in the angle of inclination, it then becomes necessary to change the profile of one arm. This last named condition constitutes a problem in itself, which will be taken up later, but for the present we shall consider the miter between moldings of the same inclination upon adjacent sides of a structure, such joint being commonly termed a pinnacle miter.

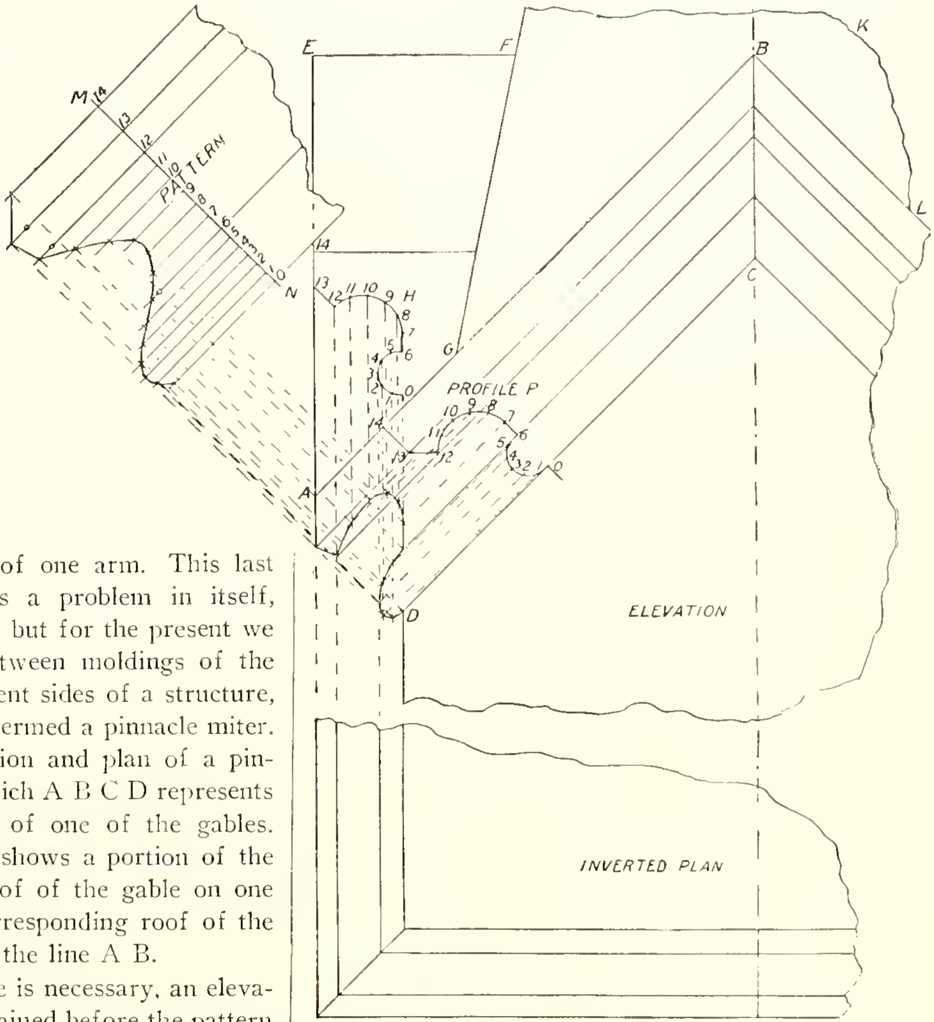


Fig. 246.—Method of Obtaining the Pattern for a Pinnacle Miter

Fig. 246 shows an elevation and plan of a pinnacle of Gothic design in which A B C D represents the mold forming one-half of one of the gables. In the elevation, G F K L shows a portion of the spire, and A E F G the roof of the gable on one side of the pinnacle, the corresponding roof of the front gable being shown by the line A B.

While no change of profile is necessary, an elevation of the miter must be obtained before the pattern can be developed. To do this, it is necessary to place a profile of the mold in position in the elevation, as shown at P, also another profile in its proper position in relation to the gable mold with which that of the gable on the front is to miter, as shown at H. First divide the curved portions of both profiles into the same number of equal parts, numbering the points of division correspondingly, and carry lines from each of the points in profile P, parallel with the mold, toward the miter, to be intersected by vertical lines dropped from points of corresponding number in profile H, all as shown between A and D. A line traced through these intersections will give the elevation of the miter. The stretchout of the profile P or H must then be set off on any line drawn at right angles to A B, as shown by M N, and the customary measuring lines drawn. Projections made from the points of intersection in A D, into measuring lines of corresponding number of the stretchout, will give the required pattern, all as shown at the left. To this pattern may be added, if desired, the pattern of the roof of the gable, which can be obtained quite simply. Its length is of course equal to A G B and its width is obtained by measuring the distances of the points F and G from the line A E.

The miter cut for the joint B C at the top of the gable is obtained by extending the lines in the profile P until they intersect the miter line B C; from these intersecting points they are projected to the measuring lines, drawn at right angles to M N, in the customary manner.

GABLES ON AN OCTAGONAL PINNACLE

Solution 52

When the plan of a pinnacle form an octagon, and when eight gables, as A in Fig. 247, are to miter together at octagonal angles in plan, the pattern for the gable mold may be obtained with the least amount of labor by the method shown in Fig. 248. Let A B represent the center line of the pinnacle drawn through the elevation and plan. Using any point, C, as a center construct a one-quarter plan of the shaft line, as indicated by C R S T U. On the shaft line U T, place the profile of the gable mold in its correct position, as shown by D, and draw the extreme projection of the mold parallel to the shaft lines; all as indicated. Draw the miter line *a* to C and C to S.

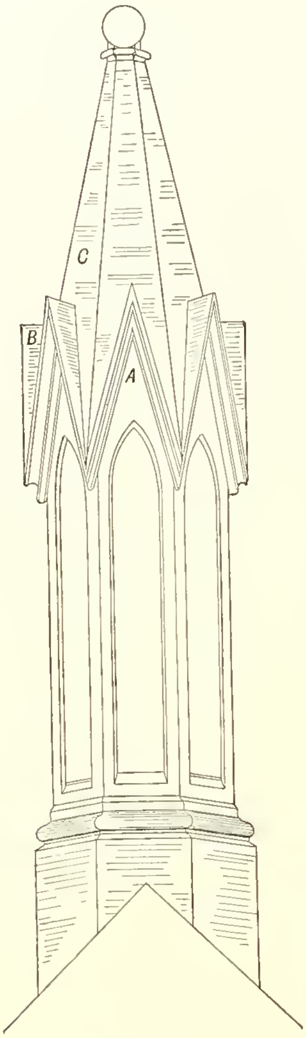


Fig. 247
Completed Octagonal Pinnacle

Space the curve in the profile, D, in a number of equal divisions, as indicated by the small figures 1 to 7; through these points draw, parallel to U T, lines intersecting the miter line, T *a*, as shown. From T, the corner of the front shaft line, erect a vertical line in elevation, as G F, and from any point on this line, as F, draw the pitch of the gable, intersecting the center line A B, at E. E F G P then represents the one-half true elevation of one side of the shaft face.

As the eight sides composing the octagon are alike, a half elevation serves all requirement for developing the pattern of the gable molding. Take a duplicate of the profile D in plan with the various intersections on same and place it in the position shown by D in elevation having the line 6-7 of the profile on and parallel to the gable line E F. Through the various points of intersection in the profile D, draw lines parallel to E F and intersect them by lines erected from similar points on the miter line T *a* in plan, parallel to A B, thus obtaining the miter line in elevation, indicated between F and V.

The pattern may now be developed in the usual manner. At right angles to V W draw any line, as H J, upon which place the girth of the profile D, as shown by the small figures, 1 to 7, on H J. Through these small figures and at right angles to H J draw

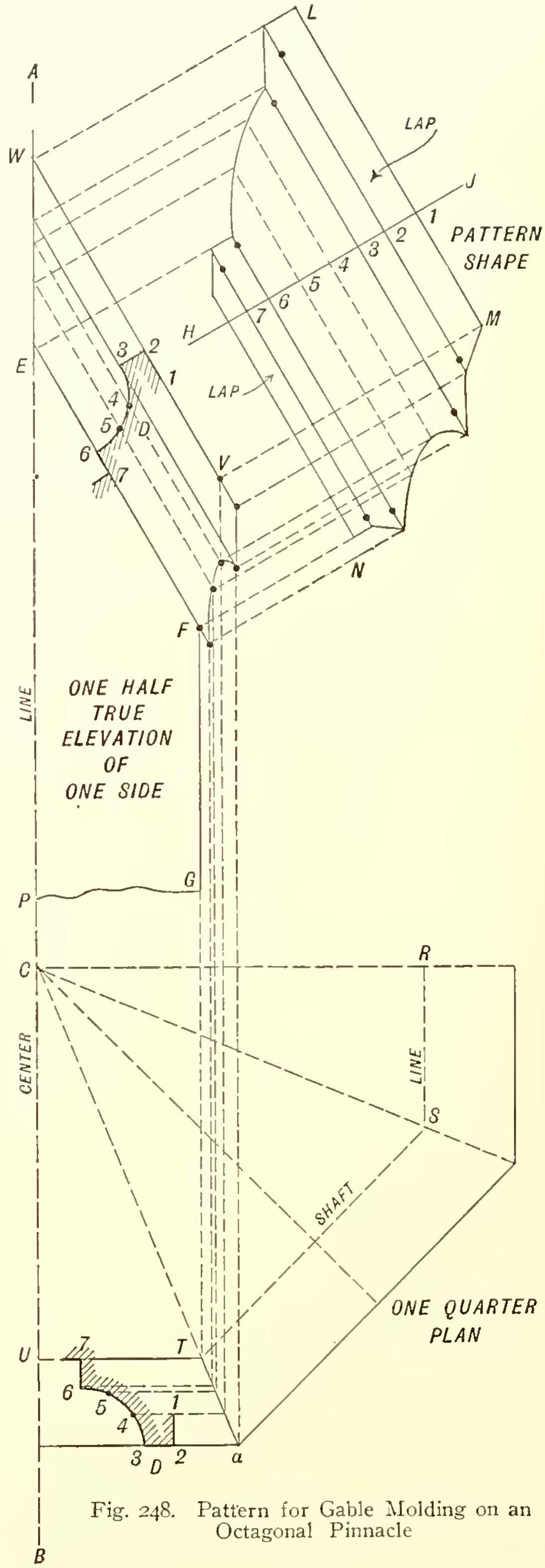


Fig. 248. Pattern for Gable Molding on an Octagonal Pinnacle

lines and intersect them by lines drawn parallel to H J from similar intersections on the miter line V F, at the bottom and E W at the top. A line traced through points so obtained, as shown by L M N H, will be the desired pattern, sixteen of which will be required, eight formed right and eight formed left, to make up the eight gables. Laps have been allowed at top and bottom. The method of developing the gable roof, indicated by B in Fig. 247, as well as the spire roof C, will be considered later.

PEDIMENTS HAVING UNEQUAL PITCHES, MITERING AT RIGHT ANGLES IN PLAN

Solution 53

Pediments or gables designed to miter, as upon the adjacent sides of a building having alternate wide and narrow sides at right angles in plan, present a case requiring the gables to rise to a corresponding hight at their apexes, necessarily causing the moldings to be of different inclinations. This condition applies likewise to pediments upon adjacent but unequal sides of a pavilion, tower or gable roof, in which, while the profiles, as well as some other details, are different from those usually found upon a pinnacle, the method of obtaining the pattern is the same. In Fig. 249 is given a perspective view of gable moldings or pediment crown

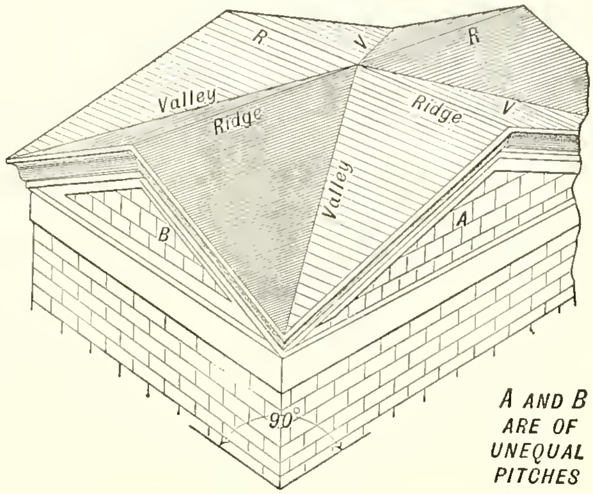


Fig. 249.—Gable Moldings Having unequal Pitches, Mitering at Right Angles in Plan

molds having unequal pitches, mitering at right angles in plan. It will be noted that the ridge lines are on one line; that is, the apexes have corresponding hights, forming valleys in the roofs, as shown.

In Fig. 250 is shown the method of obtaining the

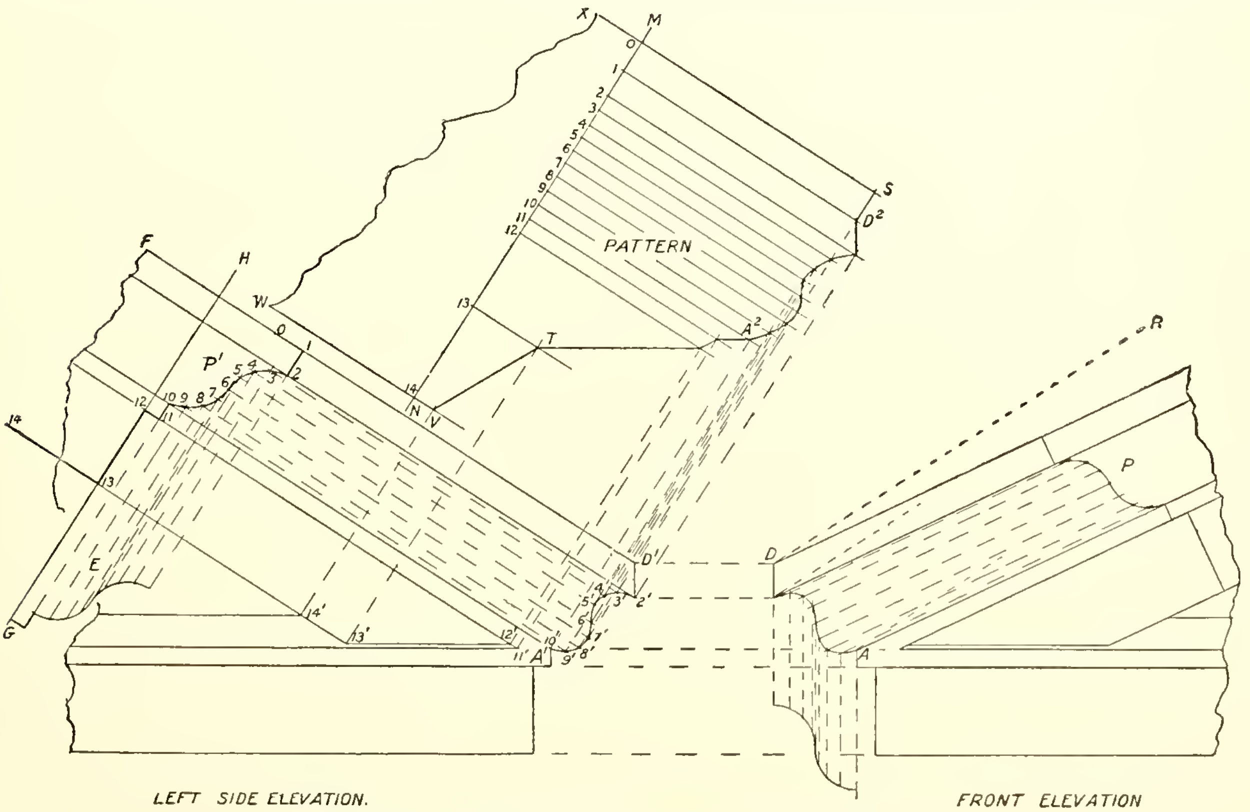


Fig. 250. Miter Between Pediments of Unequal Pitch

miter between the crown moldings of adjacent pediments having unequal pitches. The first operation consists in getting the elevation of the miter, as already described in Fig. 246 which operation, it will be seen by comparison, is also the same as obtaining the profile of a raked return, illustrated in Fig. 239. Attention is called here to the difference between the miter as it appears in the elevation and the profile of a return molding. D A of Fig. 239 is both, because the molding on the return is level, as shown by the side view in that figure, while D A of Fig. 246 shows only the miter, since the molding on the return is inclined. Referring now to either Figs. 239, 246 or 250 lines are carried from profile P, to intersect with vertical lines of corresponding number drawn from a duplicate of the normal profile, placed in an erect position, either above or below the required miter, with the result shown between A and D. After this point has been reached, it will be best to make a duplicate or tracing of D A, and transfer it to a reversed position in line with A D, as shown at the left by D^1 A^1, being careful to preserve the positions of all of the points, as 2′, 3′, 4′, etc., as found in D A.

This is the first step in the construction of an elevation of the adjacent left side, in which the pitch has in this case been made greater than that shown in the front elevation.

The elevation of the level mold, constituting the lower part of the pediment, can be completed as has been described in preceding problems, all as shown. In constructing the elevation of the inclined mold, a line is first drawn from D^1 at the required inclination of the pediment, as shown by D^1 F, when lines may now be carried from each of the numbered points in the miter D^1 A^1, parallel to D^1 F, and continued a sufficient distance for the construction of a new profile shown at P^1. First draw any line, as G H, at right angles to D^1 F, upon which, as a vertical line, place a duplicate of the normal profile at any convenient position above or below, as at E.

Divide the curved portion of E into the same number of spaces as were used in dividing the normal profile P, and from these points of division erect lines parallel to G H to cut lines of corresponding number previously drawn from the miter at D^1 A^1, all as shown at P^1. A line traced through the points of intersection will be the modified profile of the inclined mold.

From this profile the stretchout, taken space by space in the order in which the spaces occur, can be set off upon M N in the usual manner, and the measuring line extended to a position above the miter D^1 A^1. Lines drawn at right angles to D^1 F from the numbered points in D^1 A^1 can now be intersected with measuring lines of corresponding number to obtain the miter pattern, all as shown at D^2 A^2. The full pattern, S D^2 A^2 T V W X, may be extended at the left to include the top pediment or gable miter according to size and convenience.

As a labor saving expedient in shop practice, the operations above described can be very much shortened by constructing the elevation of the side shown at the left, on top of the elevation at the right, that is, by drawing the line D^1 F from D instead, at the required angle to the right, as shown by the dotted line D R, after which lines can be drawn parallel thereto from the numbered points in D A, and the new profile constructed all as explained. This method will avoid the transferring of the miter D A to another position, as above directed, and the consequent liability to error in so doing, but will of course incur another liability to error in the confusion of lines which will result from drawing one elevation over another. Great care must be exercised if the advantage to be gained by this method is made available. The use of pencils of different colors is recommended.

In the case of an octagonal tower, the elevation of the miter D A must be obtained from projections made first from a plan, all as shown at T *a* and V F of Fig. 248, when the miter V F can most conveniently be transferred to a reversed position, all as just explained in connection with the miter D^1 A^1 of Fig. 250. From this point the operation will go on all as above described and shown at the left in Fig. 250.

RAKING BRACKET IN PLAN, AS IN THE SOFFIT OF A BAY WINDOW

Solution 54

In Fig. 251 is presented a view of a right and left raking bracket in the soffit of a bay window, as shown in the soffit plan. The bracket marked A in both plan and elevation is the regular or normal bracket, while those marked B are the raking brackets, whose development is shown in detail in Fig. 252. The method of procedure is as follows: First, draw the wall line in plan as A B, on which in its proper position place the profile of the normal side of the bracket, as indicated by C. From any point D, on the wall line A B, at the desired angle

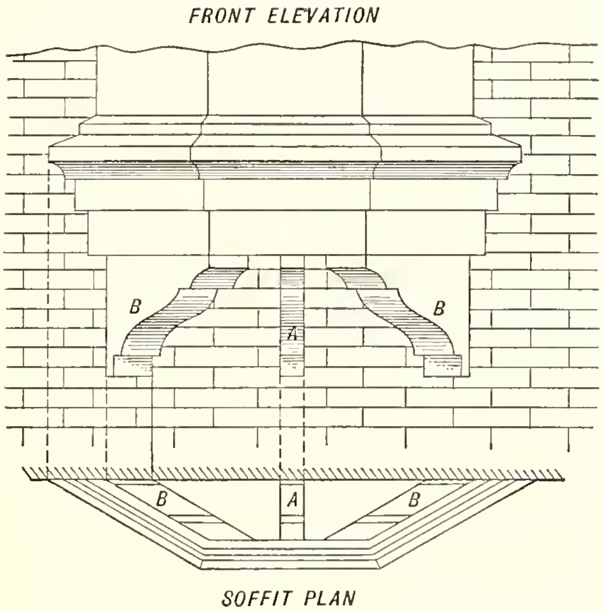


Fig. 251.—Raking Brackets in Soffit of Bay Window

draw the line D E representing the one side of the raking bracket in plan, and intersect this side at E by a line drawn parallel to A B from the extreme projection 1-2 in the normal side of the bracket. Establish the width of the face of the raking bracket as shown by E F and from F and parallel to E D draw the line F G. D E F G then represents the plan view of the raking bracket.

The patterns may then be developed as follows: Space the normal profile C in any desired number of equal spaces, and from these small figures, 1 to 12, draw lines parallel to A B until they intersect the plan of the raking bracket, as shown by similar numbers 1 to 12, on the left side. At right angles to A B, draw any line, as H J, on which place the stretchout of the normal side C, as shown by similar numbers 1 to 12, on H J. Through these small figures and at right angles to H J draw lines and intersect them by lines drawn parallel to H J from similar intersections 1 to 12, on the left side of the raking bracket D E, in plan. Trace a line through points so obtained; K L will be the miter cut. Set apart the dividers at a distance equal to that of the face of the raking bracket, as E F in plan; step off this distance from every point along the miter cut K L; and through points so obtained

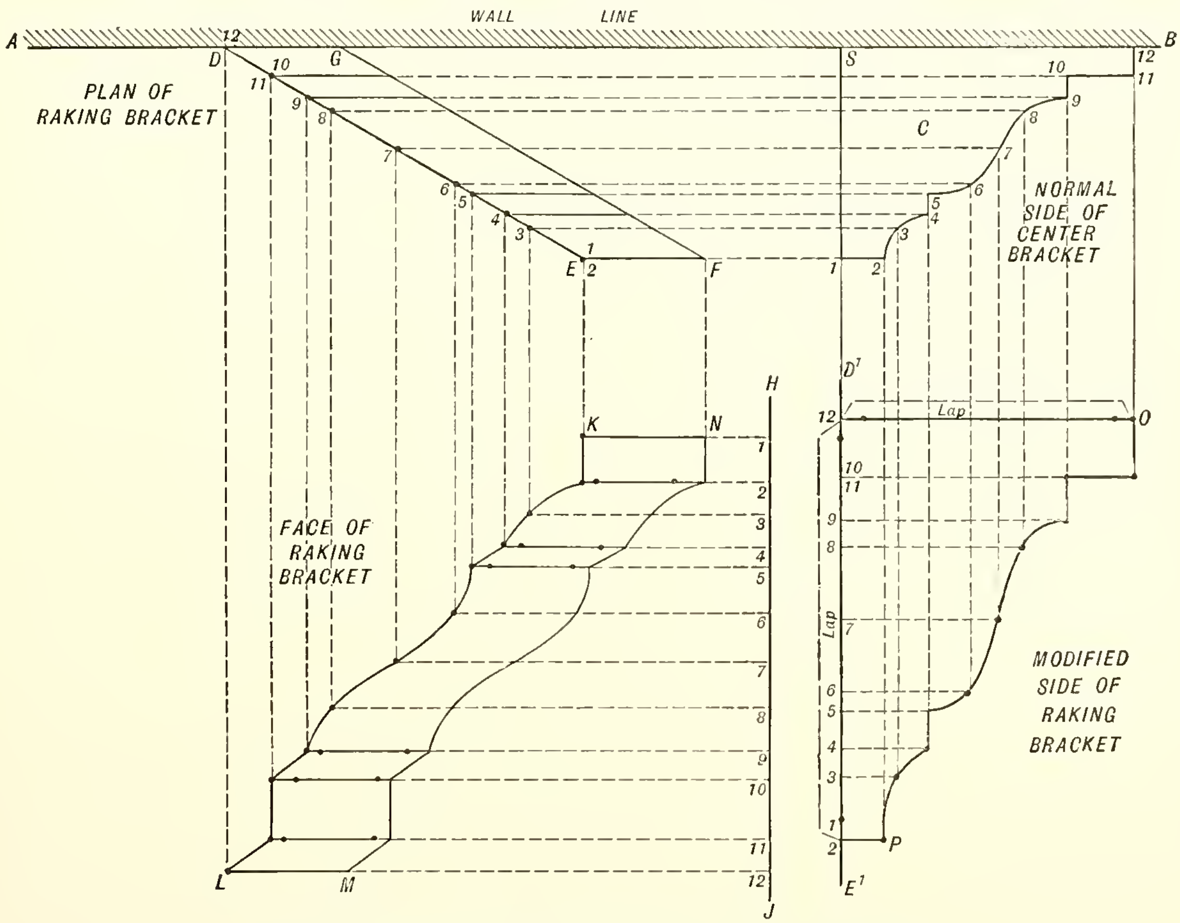


Fig. 252.—Pattern for a Raking Bracket in Soffit of Bay Window

trace the miter cut M N. K L M N represents the pattern for the face of the raking bracket.

For the pattern of the sides of the raking bracket, extend the upper line S, 1 of the normal side C, as shown by $D^1 E^1$; on this place the various divisions on D E in plan, as shown from 12 to 1 on $D^1 E^1$. At right angles to $D^1 E^1$ and through the small figures draw lines and intersect them by lines drawn parallel to $D^1 E^1$ from similarly numbered intersections in the normal profile C. Trace a line through these points, then O, P, 2, 12 will be the pattern for the modified side of the raking bracket, to which laps are allowed, as shown. If the patterns for both the front and side have been accurately developed, the spaces along the miter cut K L, of the face, will correspond to the spaces in the pattern for the modified side, O, P, 2.

CORNER BRACKET UNDER THE SOFFIT OF A HIPPED ROOF

Solution 55

Another form of corner bracket requiring raking in its development is shown in Fig. 253. Here the detail of construction as well as the soffit plan is shown.

In the constructive section, *a* shows the wall on which the plate *b* is set, followed by the rafter *c*. Below the rafters the blocking *d* is put in position to receive the metal cornice, all as indicated. Before the roof sheathing *e* is placed in position the metal cornice from *f* to *g* is secured to the wall and roof, the profile of the normal bracket being indicated by A, which is shown as butting against the cap mold. Below the sectional view, a soffit plan is drawn, in which A A show the normal brackets and B shows the corner or hip bracket, which is to be developed.

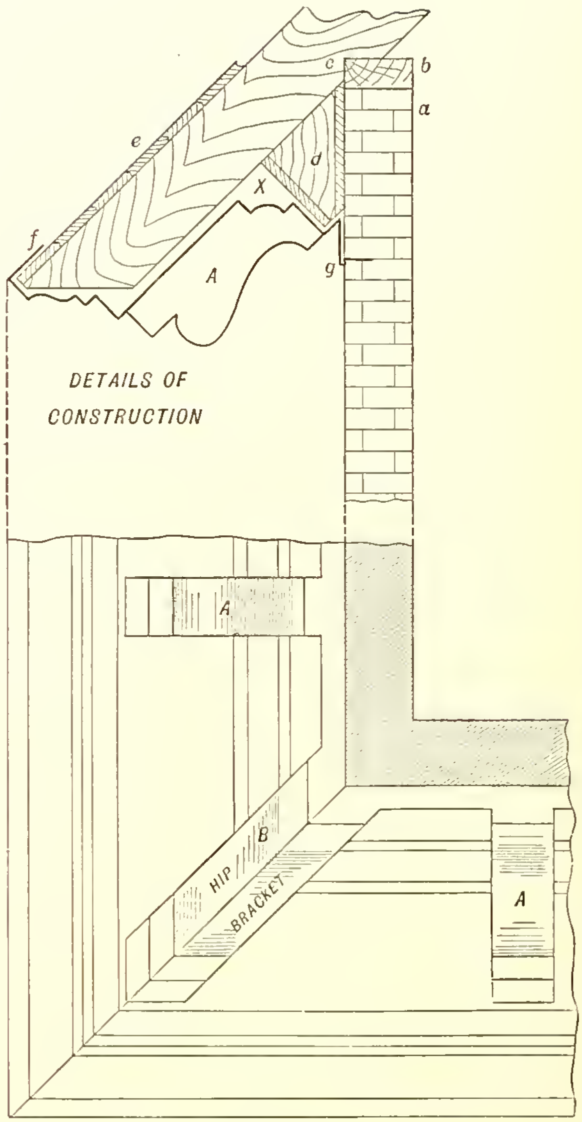


Fig. 253.—Constructive Section and Soffit Plan of Hipped Raking Corner Bracket

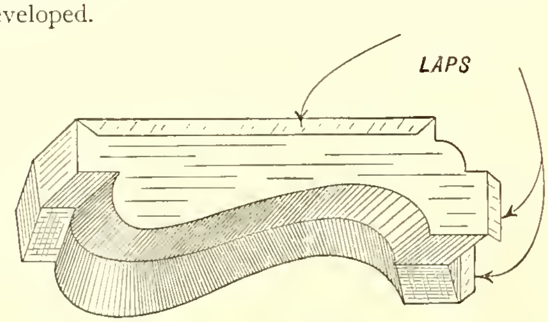


Fig. 254.—View of Hipped Raking Corner Bracket Laid Horizontally on Its Side

Fig. 254 presents a perspective view of this hipped raking bracket, laid horizontally on its side, so as to show its general appearance and to give a clearer understanding of the object indicated in Fig. 255 and now to be developed. The first step is to draw a section of the soffit molding at its proper angle, as indicated by A B, and in this mold construct the profile of the normal bracket C. Below this section draw a plan view of the corner bracket, as shown by D E F J G H. The building, at D E F, presents a right angle and therefore the miter line E G will be drawn at 45 degrees or the bisection of a right or 90 degree angle. Should the angle D E F be other than a right angle, it would be bisected and the miter line obtained, after which the face width of the corner bracket would be set off from G to H and G to J and from H and J lines would be drawn parallel to the miter line, G E, intersecting the wall

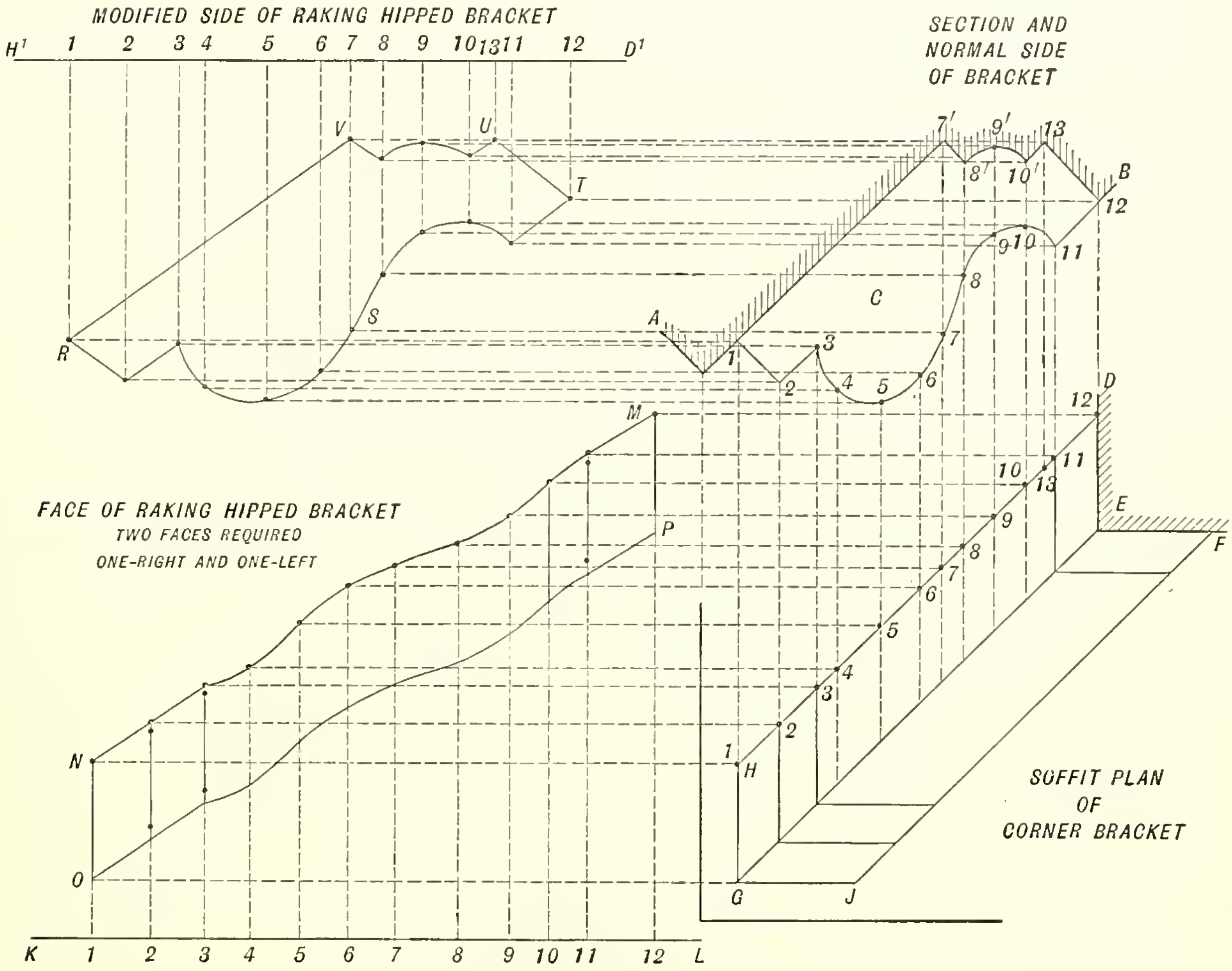


Fig. 255.—Patterns for Raking Corner Bracket

line D E F, at D and F respectively. In this case, a right angled corner, the full plan of the corner bracket is shown; in practice, however, it is necessary to draw only the half plan indicated by D E G H, as the halves are alike.

After carefully drawing the section and plan, the pattern for the face is the first subject for development. Space the normal profile C into an equal number of divisions, as shown by the small figures 1 to 12, from which points and parallel to D E in plan drop lines cutting the side of the corner bracket H D, as shown by similar numbers. At right angles to D E draw any line, as K L, and upon this place the girth of the normal side of bracket C, as shown from 1 to 12 on K L. Through these small figures and at right angles to K L draw lines, and intersect them by lines drawn parallel to K L from similar intersections on the side of the corner bracket H D in plan. A line traced through points so obtained, as indicated by M N, will be the desired cut. The width of the corner face being equal to H G in plan, set the dividers apart at a distance equal to this width, and step off on every line measuring from the miter cut N M, thus obtaining the opposite cut O P. M N O P gives the pattern for the face of the corner bracket, two of which will be required to complete the angle. C of the normal side represents the side of the normal bracket, set at right angles to the lines of the molding.

As the sides of the corner bracket run at an oblique angle, as indicated by H D and J F in plan, and as these sides cut the molding obliquely, they will become longer and the pattern may be best laid out as follows: From the intersections between 7 and 10 in the normal side C extend lines upward until they intersect the cap mold as indicated from 7′ to 10′. From the corner 13 drop a vertical line, cutting the side H D in plan at 13. Take the various divisions on H D in plan and place them on any horizontal line, as H^1 D^1, as shown by similar numbers. From these small figures and at right angles to H^1 D^1 draw lines; intersect these by lines drawn parallel to H^1 D^1 from similarly numbered intersections in the normal side C as well as in the cap mold from 7′ to 13. Trace a line through points so obtained. R S T U V gives the pattern for the modified side of the corner bracket. Laps must be allowed to all patterns, for joining and riveting.

RAKING BRACKET IN A PEDIMENT

Solution 56

Fig. 256 illustrates raking brackets occurring in a pediment. The method of development of this example is alike to that of the preceding problems. In the view, A shows the normal side of the bracket, when the brackets join the horizontal cornice, as indicated by B. C C show two raking brackets, the patterns for which are obtained from dimensions given in the normal side and front A and B. D indicates a center raking bracket placed in the apex of the pediment. The method of obtaining these various patterns is shown in detail in Fig. 257.

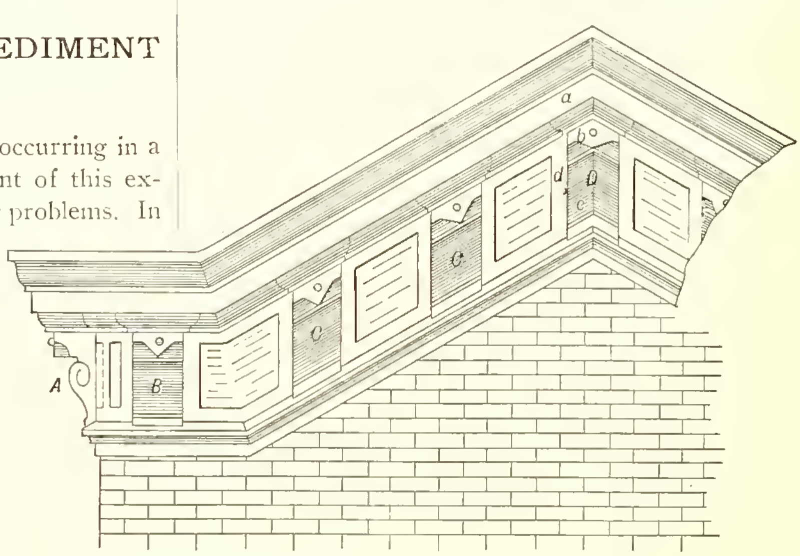


Fig. 256.—View of Raking Brackets in a Pediment

First, draw any line representing the pitch or rake of the pediment, as shown by A B. At right angles to this line draw the profile of the cornice, as partly indicated by A F G C; then, in its proper position, draw the normal side of the bracket, shown by A and B in Fig. 256, as indicated by D in Fig. 257. Add the cap mold, all as shown. As the bracket in this case has an angular drop, draw the normal face of the drop in its correct position next to the normal side D, as shown by E. In the center of the angular drop a raised disc is placed, as shown by *c d c f*, the hight of the disc being indicated by 2 in the normal side. Through the various members of the cornice A F G C draw lines parallel to A B, as shown, and draw any vertical line, as 1—15, in the front elevation, which intersects lines drawn parallel to A B from 1 and 15 in the normal side of the bracket. This side 1—15 then represents the left side of the raking bracket. Extend 15—1 indefinitely as 15 *a*.

Obtaining Pattern for Raked Face of Drop

Take a tracing of the normal face of drop E and place it, as shown by E^1, above the front elevation; place carefully the line *a b* in E^1, horizontally and having the corner *a* meet the line 15—1 previously extended. Divide the circle in both E and E^1 into a number of equal spaces, as shown in both views by *c d e* and *f* (more numerous divisions are used in practice). From the spaces in the circle in E draw lines parallel to A B, and intersect them by drawing vertical lines from similarly lettered spaces in the circle in E^1. This produces an elliptical figure, shown in the front elevation by *c d e f*. In like manner, from the corners in the face E, draw lines parallel to A B, intersecting them by lines drawn vertically from similar corners in the face E^1. 5^v *i d f c i′* 5″ gives the pattern for the raked drop.

Drawing Elevation of Raking Bracket

From 1′ in the front elevation and parallel to 1-15 draw the line 1′-15′, intersecting a line drawn from 15 parallel to A B. Divide the normal side of bracket into equal spaces as shown by the small figures 1 to 15, and from these small figures draw lines parallel to the pitch of the pediment A B, intersecting the sides of the raking bracket in front elevation as shown. In a corresponding manner space the cap mold F in the normal side into equal divisions, indicated from 1 to 5, and from these divisions and parallel to A B draw lines to any length, as shown. Take a tracing of the normal cap mold F with its various divisions thereon and place it vertically alongside the left and right sides of the raking bracket in front elevation, as shown by F^1 and F^2 respectively. From the various divisions 1 to 5, in F^1 and F^2, erect vertical lines intersecting those previously drawn from the profile F. Trace lines through points so obtained. The profiles from 1^v to 5^v and 1″ to 5″ will represent respectively the

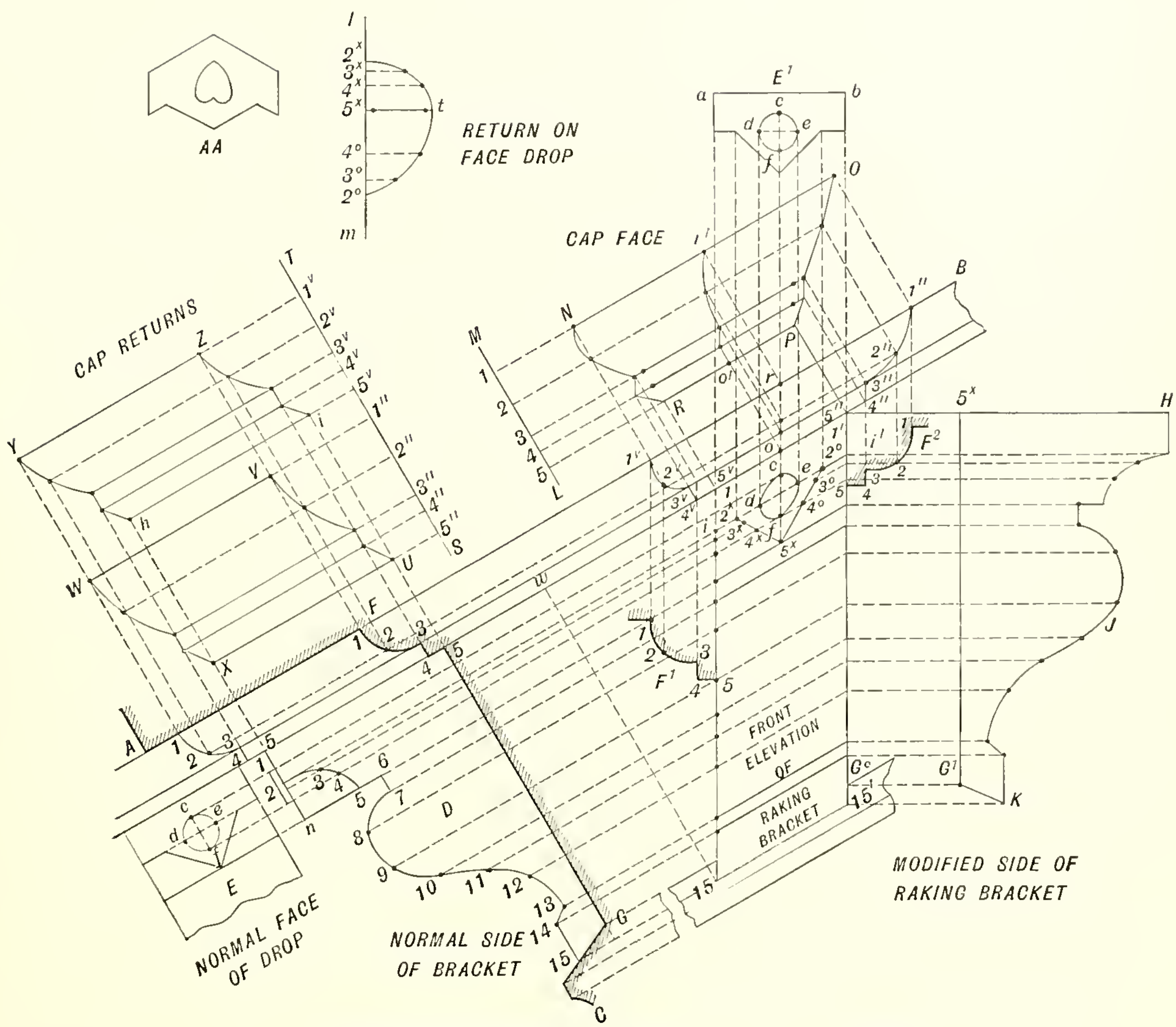


Fig. 257.—Patterns for Cap, Side and Face Drop, of Raking Bracket

modified returns of the lower and upper cap molds of the raked bracket. The various patterns are now in order and the face of the cap mold will be developed first.

Obtaining Patterns for Raked Cap Mold

Therefore, at right angles to A B, draw any line, as M L, on which place the girth of the normal cap mold F, as shown by similar numbers 1 to 5, on M L. From these small figures and at right angles to M L draw lines and intersect them by lines drawn parallel to M L from similarly numbered intersections in the front elevation of the raked cap mold. Trace a line through points so obtained. N O P R will be the pattern for the cap face.

The patterns for the raked returns of the cap, are found by taking the girths of the profiles, shown from 1^v to 5^v and 1″ to 5″, and placing them on the line S T drawn at right angles to A B, as shown by similar figures. From these small figures and at right angles to S T, draw lines; intersect these lines by lines drawn parallel to S T from similarly numbered intersections in the cap molds A and F in the normal side of bracket. A line traced through points so obtained, as shown by U V W X and Y Z *i h*, will be the patterns for the upper and lower cap returns respectively. If the patterns have been correctly developed, the cut W X will correspond in girth to the cut O P of the cap face, and the cut Y *h* will correspond in girth to the cut N R of the cap face, which parts must miter together.

Return of Raked Face Drop

To obtain the pattern for the return of the raked face drop, shown from 2^x to 5^x to 2° in the front elevation, take the girth of 2^x, 3^x, 4^x, 5^x, 4°, 3° and

2° and place it on any vertical line, as *l m*, shown by similar numbers. Through these small figures and at right angles to *l m*, draw lines to any length, as shown. Measuring from the line 1 *n* in the normal side of bracket, take the various projections to points 3, 4 and 5 on the curve 2-5 and place them on corresponding lines in the pattern, measuring in each instance from the line *l m*. Through points so obtained, trace the line 2° *t* 2^x, thus obtaining the pattern sought.

Obtaining Pattern for Modified Side of Raking Bracket

To obtain the pattern for the raking side, draw any line as 5^x G^1 parallel to $1'$-$15'$ and from the various intersections on $1'$-$15'$ (the right side of the raking bracket), previously obtained from points 1 to 15 in the normal side, draw to any length lines at right angles to $1'$-$15'$. Measuring in each instance from the line 5-G in the normal side of the bracket, take the various projections to points 1 to 15 in the normal side and place them on similar lines, measuring in each instance from the line 5^x G^1. Trace a line through points so obtained; 5^x H J K G^1 gives the desired pattern to which laps must be allowed.

Obtaining Pattern for Face of Raking Bracket

For want of space, the pattern for the face of the raking bracket is shown developed in Fig. 258. The method of procedure is as follows: Take the girth of the normal side of the bracket from 1 to 15 in Fig. 257 and place it on any vertical line, as A B, in Fig. 258, as shown by similar numbers Through these small figures and at right angles to A B draw lines to any length as shown. At right angles to A B in Fig. 257 and from the corner 15 in the front elevation of the bracket draw the line 15-*w*. Measuring in each instance from this line 15 *w* take the various projections to the intersections on the left side of the raking bracket, which were previously obtained from points 1 to 15 in the normal side of bracket, and place these projections, in Fig. 258, measuring in all instances from the line A B, upon lines having similar numbers. Trace the miter cut, as shown from C to 15. Set the dividers a distance apart equal to the face of the raking bracket in Fig. 257 from 15 to 15′ and set off this distance in the pattern, measuring from the miter cut C 15 in Fig. 258, thus obtaining the cut D E. C D E 15 then represents the face pattern for the raking bracket.

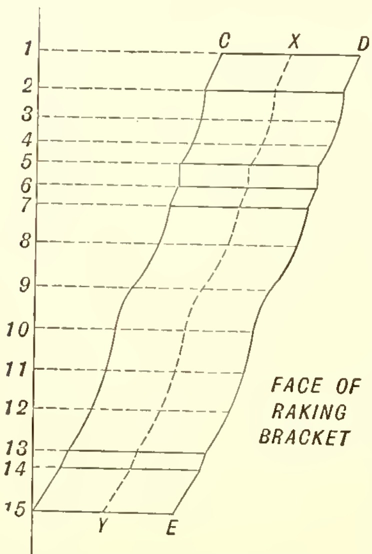


Fig. 258.—Pattern for Face of Raking Bracket

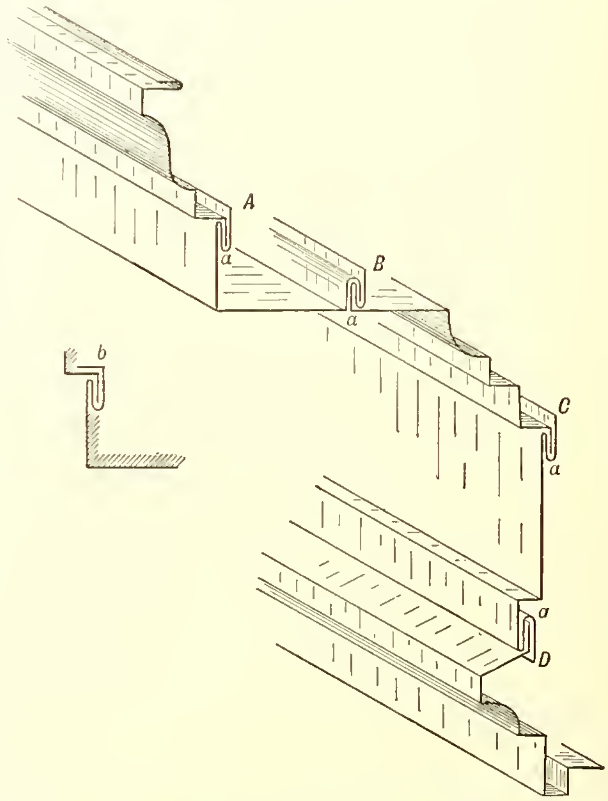


Fig. 259.—Construction of Locked Seams in Sheet Metal Cornice Construction

Patterns for Raking Bracket in Apex of Pediment

Should a raking bracket be placed in the apex of the pediment, as shown by D in the finished view in Fig. 256, the patterns already obtained may be used with slight modification.

The pattern for the cap marked *a* is obtained as follows: From the various intersections on the center line *r o* in the front elevation of raking bracket in Fig. 257, lines are drawn at right angles to A B until they intersect similarly numbered lines in pattern for cap face, as shown by the miter cut r' o'. N R o' r' then represents the pattern for the cap, shown by *a* in Fig. 256. The center drop face *b* is obtained by taking a tracing of 1 *o* 5^x 3^x *i* in the front elevation of drop face in Fig. 257 and reversing this on the center line *o* 5^x, making the pattern appear as shown in diagram marked AA in the upper left hand corner of the cut.

To obtain the pattern for the face *c* in Fig. 256 it is necessary only to divide the pattern for face in Fig. 258 into two parts, as indicated by the center dotted line X Y. These two half patterns, C-X-Y-15 and X Y E D, are formed right and left to make up the center bracket. The side of the bracket indicated by *d* in Fig. 256 is alike to the pattern for the modified side of the raking bracket shown in Fig. 257. The pattern for the return on the raked face drop *b* in Fig. 256, is obtained by reversing the part pattern of return on face drop, shown in Fig. 257, by 2^x, 5^x, *t*, opposite the line 5^x, t.

Construction of Locked Seams in Sheet Metal Cornices

Should the construction of pediment or horizontal cornices require large girths of metal, wider than the usual stock sizes, the seams may be made as shown in Fig. 259. The method applies to horizontal as well as pediment or gable cornices. Assuming that joints are required at A, B, C and D, the locks are turned as shown by *a* in the four joints and then turned over, as shown in the small diagram *b*. This is a simple joint requiring no rivets or solder.

PART VII

REDUCED MITERS FOR HORIZONTAL AND INCLINED MOLDINGS AND OF INTERSECTIONS OF MOLDS OF DISSIMILAR PROFILE

REDUCED MITERS IN RAISED DIAMOND PANEL

Solution 57

FIG. 260 is a view of a raised diamond, which requires change of profiles preparatory to developing the patterns. In other words, the profile of one of the sides being given, the other side must be modified to admit of mitering the corners. Fig. 261 shows how this is accomplished. Let B A D 2′, rep-

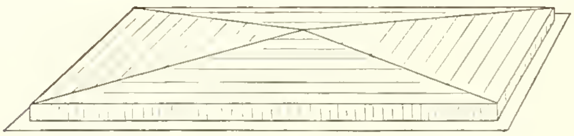


Fig. 260.—View of Raised Panel or Diamond

resent the elevation of the panel, wherein the miter lines have been drawn from A to 2′ and from D to B intersecting each other at 1′. Through 1′ draw the vertical line F E and the horizontal line H G indefinitely. Parallel to and equal in length to A B draw the line 3^v-3° and on the center line F E extended, place the desired hights *a*, b, and 1° and complete the profile 3^v, 1°, 3°, representing the true section on H G. In a similar manner construct the section on E F as shown taking care to have the hights *a′ b′* 1 alike to *a b* 1° in the section on H G.

The patterns may then be developed as follows: Take the girth of 1°-2°-3° and place it on any vertical line, as shown by similar numbers on H° G°, and through these points draw lines at right angles to H° G°, as shown. Measuring from the line H G in elevation take the distance to 2′-3′ and place it on either side of the line H° G° on similarly numbered lines, as shown. Connect points so obtained; 1° J K will be the pattern for the short sides of the panel. Now take the girth of 1-2-3 in the section on E F, and place it on the vertical line E° F°, as shown by similar numbers; through these points and at right angles to E° F° draw lines indefinitely. Measur-

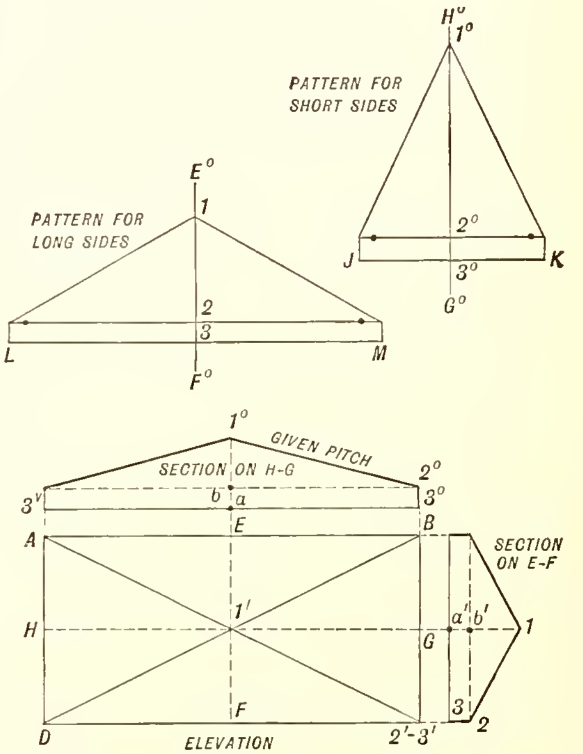


Fig. 261.—Patterns for Reduced Miters in Raised Diamond

ing from the line E F in elevation, take the distance to 2′-3′ and place it on either side of the line E° F° on similarly numbered lines, all as shown. 1 L M then represents the pattern for the long sides. These principals are applicable to any shape, whether it be simply a single pitch, as here shown, or a complicated series of molds, such as are considered in the next succeeding problem.

REDUCED MITERS IN A MOLDED ORNAMENT

Solution 57A

Fig. 262 presents a view of a molded ornament having reduced miters wherein the ends have more

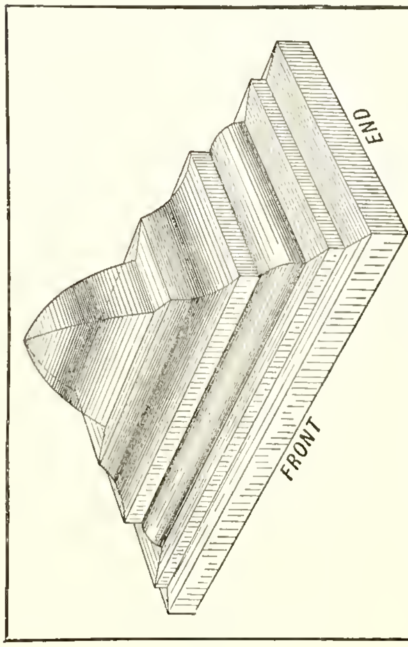


Fig. 262
View of Molded Ornament Having Reduced Miters

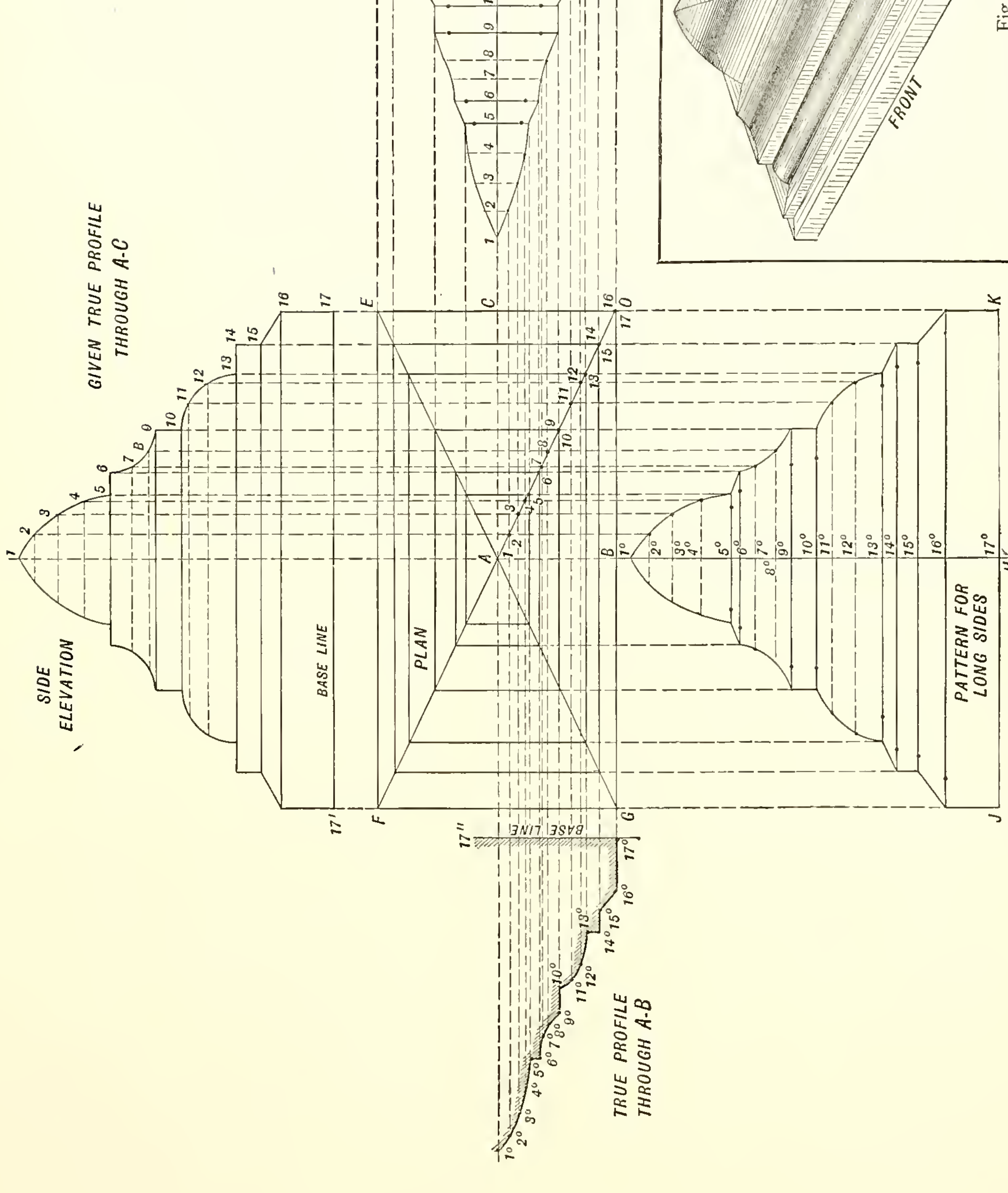


Fig. 263.—Patterns for Reduced Miters in a Molded Ornament

projection than do the front and rear. The method of developing the patterns is shown in detail in Fig. 263. First, draw the plan of the ornament as shown by F E D G and from corner to corner draw the diagonal lines intersecting each other at A. Through A draw the vertical center line, as shown. Parallel to F E in plan draw the base line 17-17′ and construct the side elevation of the ornament, as shown. In practical work it is necessary only to draw the one-half elevation as well as one-half of the plan. The true profile through A C having been drawn, the various molds are divided into equal spaces, as shown by the small figures from 1 to 17, and from these intersections, lines are drawn at right angles to F E, until they intersect the miter line A D, as shown by similarly numbered intersections. The girth from 1 to 17 in the side elevation is now placed on a line drawn at right angles to E D in plan, as indicated by similar numbers on the girth line C L. Through these small figures and at right angles to C L, the usual measuring lines are drawn, and intersected by lines drawn parallel to C L from similarly numbered intersections on the miter line A D in plan. Trace a line through points so obtained, as shown by 1 M, and trace this miter opposite the line 1 L, as shown. 1 N M then gives the pattern for the short ends of the ornament. Before the pattern for the long sides can be developed a true or modified profile must be found on the line A B in plan, since the projection A B is less than the projection A C. Parallel to G D, from the various intersections on the miter line A D, draw lines indefinitely as shown; and parallel to G F draw any base line as 17° to 17″. Now, measure from the base line 17-17′ in the side elevation and take the various vertical hights to points 1 to 16 in the profile, placing them on lines having corresponding numbers, measuring in each instance from the line 17°-17″, thus obtaining the points of intersections marked 1° to 17°. Trace a line through these points; this will give the true profile through A B in plan. It should be understood that the given profile can be placed at pleasure. While the given profile is here placed in the side elevation representing a section through A C in plan and the section or profile through A B is modified therefrom, the method has no advantage over placing it on the line A B in plan and obtaining from it the modified profile on A C, by reversing the operations. On A B, extended as B H, place the girth of the true profile through A B; take pains to measure each space separately, as they are all unequal, as shown by similar numbers, 1° to 17°, on B H. Through these small figures, the usual measuring lines are drawn and intersected by lines drawn parallel to B H from similarly numbered intersections on A D. Trace a line through these points of intersections, as shown from 1° to K, and transfer this half pattern opposite the line B H. J K 1° will be the pattern for the long sides. Laps should be allowed for joining and soldering.

PATTERNS FOR ORNAMENTAL DROP WITH REDUCED MITERS

Solution 58

In the construction of ornamental sheet metal fronts, as over the entrances of a theatre, ornamental drops are sometimes employed, as indicated by A in

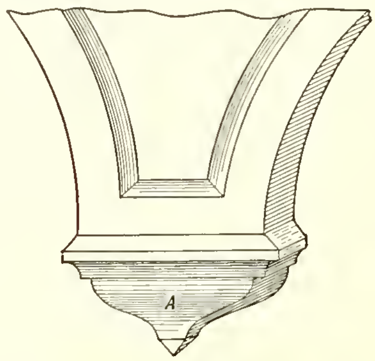


Fig. 264
View of Ornamental Drop Having Reduced Miters

Fig. 264, where the ends have more projection than the front or rear. The method of development relating thereto may also be applied to the bottom of molded soffits of a bay window. In Fig. 265, let C, 1, 1°, D, be the plan of the ornamental drop. Bisect C D, obtain A and from A draw the miter lines, A 1 and A 1°. In line with C D construct the front elevation of the drop indicated by 1-12-1″. The mold placed above the line 1-1″ will have square return miters. The profile shown from 1 to 12 in the front elevation is now divided into any desired number of equal spaces, as shown, and from these divisions, vertical lines are dropped until they cut the miter line A 1 in plan, as shown by intersections having similar numbers. From these intersections lines are carried to the right indefinitely, crossing the center line A B and the miter line A 1°, as shown. As the projections through the center line A B is less than the projection on A C, a true profile must be found through A B, in this way: Extend the line 1-1″ in elevation, as shown by B^1 A^1, and upon this place the various divisions shown on A B in plan, as in-

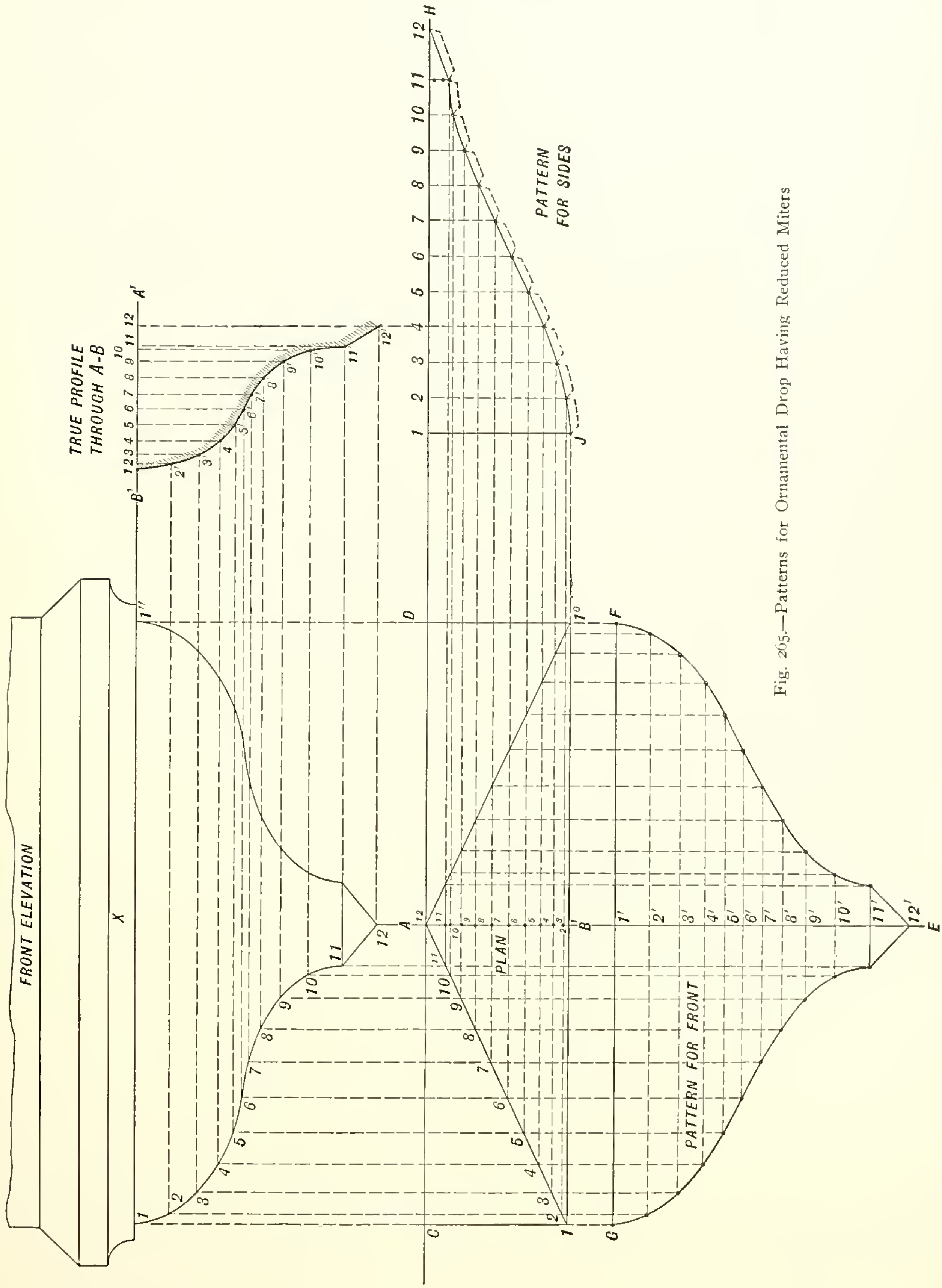


Fig. 265.—Patterns for Ornamental Drop Having Reduced Miters

dicated by similar numbers on A^1 B^1. Through these small figures and at right angles to A^1 B^1 draw lines and intersect these by lines drawn parallel to A^1 B^1 from similarly numbered divisions in the profile 1-12 in elevation, thus obtaining the points of intersection marked 2′ to 12′; through these points a line is traced, forming the true profile on A B in plan. The patterns are now in order of procedure. To obtain the pattern for the front, indicated by 1 A 1° in plan, take the girth of the profile through A B and place it on the line A B, extended as B E, as shown by similar numbers. Through these small figures and at right angles to B E draw lines, and intersect them by lines drawn parallel to B E from similarly numbered intersections on the miter line A 1 in plan. Through these points trace the miter cut G 12′. The opposite half can be traced or the intersecting points obtained from the miter line A 1° in plan. G, F, 12′ then shows the full pattern for the front piece. The pattern for the sides is obtained by taking the girth of the profile, shown from 1 to 12 in the front elevation, and placing it on the line C D in plan, extended as D H, as shown by similar numbers; through these and at right angles to D H, lines are drawn intersecting lines previously drawn, parallel to 1-1° from similarly numbered intersections on the miter line A 1. A line traced through points so obtained, as indicated by 1-J-12, will be the pattern for the sides. Laps are allowed on the sides as shown by the dotted lines. Above the line J 1 in the pattern for sides and above the line G F in the pattern for the front must be added the square miter patterns for the mold indicated by X in the front elevation..

REDUCED MITER ON A RIGHT ANGULAR RETURN IN A CORNICE

Solution 59

A view of a reduced miter on a right angular cornice return is shown in Fig. 266. This figure presents a sketch of the subject of the problem which is to be developed. In this case it is assumed that the main cornice A has a projection of 14 in., and that the projection of the return miter is but 8 in., thus requiring a reduction of 6 in. The method of working out patterns of this nature is shown in detail in Fig. 267 where A B C D E indicates the formation of the wall line. On the wall line D E place the given profile of the main cornice in the position shown and space the profile into a convenient number of divisions, as shown by the small figures 1 to 22. Through the intersections 2-3, and parallel to D E, draw a line and intersect it at F by a line drawn from B at right angles to B C, and then draw the miter line from F to D. Then, from the various intersections in the given profile and parallel to F G draw lines indefinitely to the left intersecting the miter line D F as shown.

The pattern for the miter cut of the main cornice may now be laid out by drawing any girth line, as G H, at right angles to F G, on which the girth of the main cornice is placed, as shown by similar numbers on G H. Through these small figures the usual measuring lines are drawn and intersected by lines drawn parallel to G H from similar intersections on the miter line F D. Trace a line through these points; then G H J K will be the miter pattern for the front. Before the pattern for the return can be developed, a true profile must be found on B C in plan, since the projection B C is less than the projection of the main cornice. From the various intersections on the miter line F D project lines upward parallel to F B indefinitely. Through the points 1 and 2 in the given profile of the main cornice draw the line *a b* at right angles to F G. Draw above the plan any line parallel to B C, as shown by *a′ b′*, intersecting the lines previously erected. Measuring from the line *a b* in plan take the various distances to points 1 to 22 and place them on similarly numbered lines, measuring in each instance from the line *a′ b′*, resulting in the intersections 1′ to 22′. A line traced through these points will be the modified profile for the return.

The pattern for the return may now be laid out. Take the girth of the modified profile, taking care to measure each space separately, as they are all unequal; place these divisions on B L drawn at right angles to B F. At right angles to B L and through the small figures on B L draw lines and intersect them by lines drawn parallel to B L from similar intersections on the miter line D F. When a line is traced through points so obtained,

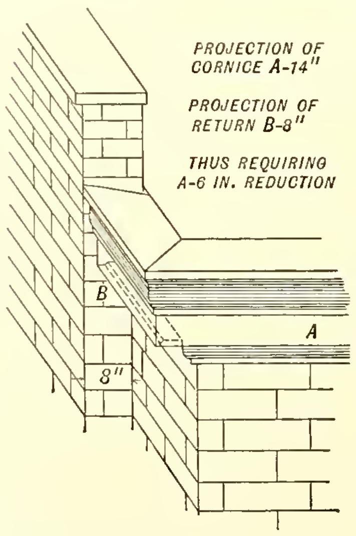


Fig. 266.—View of a Reduced Miter on a Right Angular Return in a Cornice

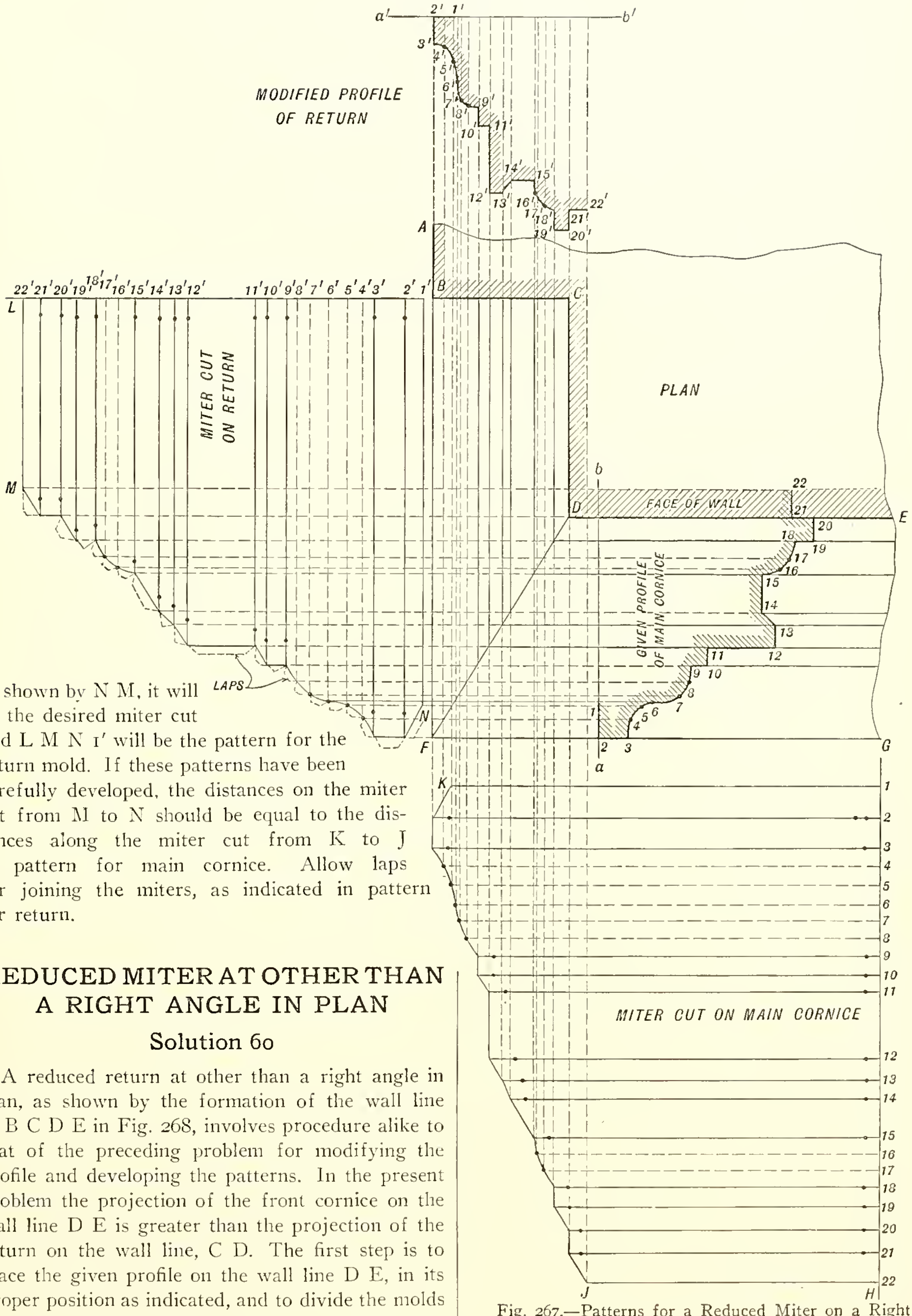


Fig. 267.—Patterns for a Reduced Miter on a Right Angular Return in a Cornice

as shown by N M, it will be the desired miter cut and L M N 1′ will be the pattern for the return mold. If these patterns have been carefully developed, the distances on the miter cut from M to N should be equal to the distances along the miter cut from K to J in pattern for main cornice. Allow laps for joining the miters, as indicated in pattern for return.

REDUCED MITER AT OTHER THAN A RIGHT ANGLE IN PLAN

Solution 60

A reduced return at other than a right angle in plan, as shown by the formation of the wall line A B C D E in Fig. 268, involves procedure alike to that of the preceding problem for modifying the profile and developing the patterns. In the present problem the projection of the front cornice on the wall line D E is greater than the projection of the return on the wall line, C D. The first step is to place the given profile on the wall line D E, in its proper position as indicated, and to divide the molds therein into equal spaces, as shown. Number the

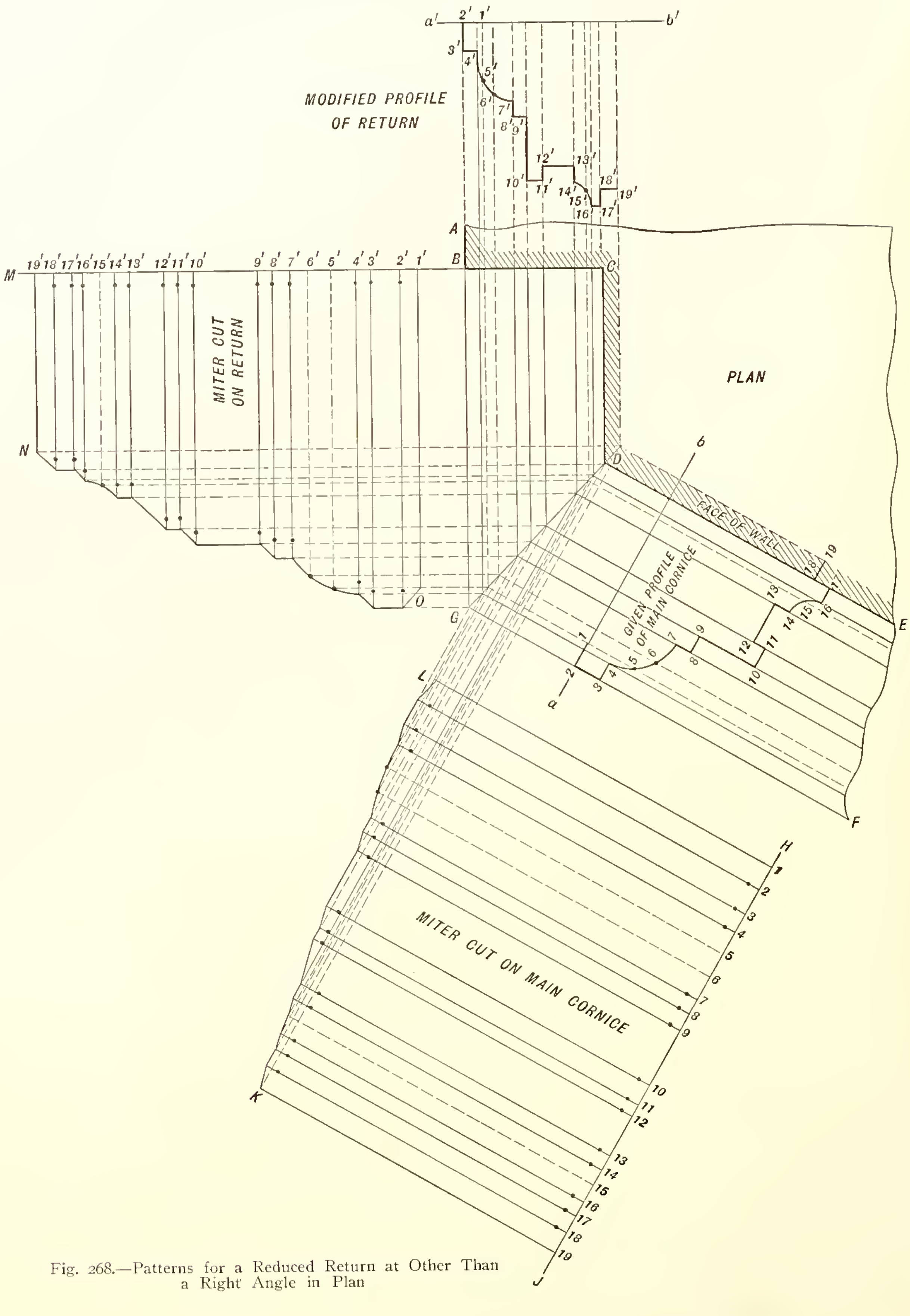


Fig. 268.—Patterns for a Reduced Return at Other Than a Right Angle in Plan

bends and divisions in the profile, as shown from 1 to 19, and through points 2 and 3 draw a line parallel to D E intersecting it by a line drawn parallel to C D from the corner of the wall B, thus obtaining G. Draw the miter line from G to D. Parallel to D E and through the various divisions 1 to 19 in the profile draw lines until they intersect the miter line G D as shown, and from these divisions draw lines indefinitely toward the top and parallel to D C.

The true profile on the line B C in plan is found as follows: At right angles to D E in plan and from the corner 2 in the given profile, draw the line *a b*. Parallel to B C in plan draw any line, as *a' b'*. Measuring in each instance from the line *a b* in plan, take the various distances to points 1 to 19, and place them on similar lines, previously erected, measuring in each case from the line *a' b'*, thus obtaining the points of intersection marked 1' to 19'. A line traced through these intersections will show the modified profile of the return. The patterns are now in order.

For the pattern for the main cornice, take the girth of the given profile in plan and place it on the line H J drawn at right angles to G F, as shown by similar numbers. Through these small figures and at right angles to H J draw lines and intersect them by lines drawn parallel to H J from similar intersections on the miter line G D in plan. Trace a line through points so obtained; J K L H will be the miter cut desired.

The miter cut for the return is obtained by taking the girth of the modified profile and placing it on the line C B extended as B M, as shown by the small figures 1' to 19'. Through these small figures and at right angles to B M draw lines and intersect them by lines drawn from similar intersections on the miter line G D and parallel to B M. When a line is traced through these divisions as shown, O N M B will be the desired pattern.

REDUCED MITER IN A GABLE MOLDING HAVING A RIGHT ANGULAR RETURN

Solution 61

In Fig 269 is given a perspective view of a gable molding having a return at right angles in plan. In this case it is assumed that the gable molding A has a 15 in. projection, while the return molding B has only an 8 in. projection, thus requiring a reduction of 7 in. The method to be employed is shown in detail in Fig. 270, where K J H G F indicates the formation of the wall line in plan, while C D 13°-13' shows the elevation of the pitch of the gable wall. At right angles to the gable line 13'-13° place the given profile A in its proper position, as shown, that is, at right angles to the gable line. Divide the profile into an equal number of spaces, as indicated by the small figures 0 to 14. Take a tracing of the profile A with the various divisions thereon and place it on the wall line in plan in the position shown by A^1, placing the drip 12-13 on the wall line as there indicated. Through the point 1-2 in the profile draw the line L M parallel to F G, intersecting it at M by a line drawn from the corner J parallel to H G, and draw the miter line M G in plan. Through the various intersections 0 to 14 in the profile A^1 and parallel to F G draw lines cutting the miter line M G from 0^v to 14^v; from these divisions erect vertical lines and intersect them by lines drawn parallel to 13'-13° in elevation from similarly numbered intersections in the profile A, thus obtaining the miter line as well as the modified profile of the return, shown from 0' to 14'.

The pattern for the gable molding may now be laid out as follows: At right angles to the lines of the gable molding draw any line, as N O, on which

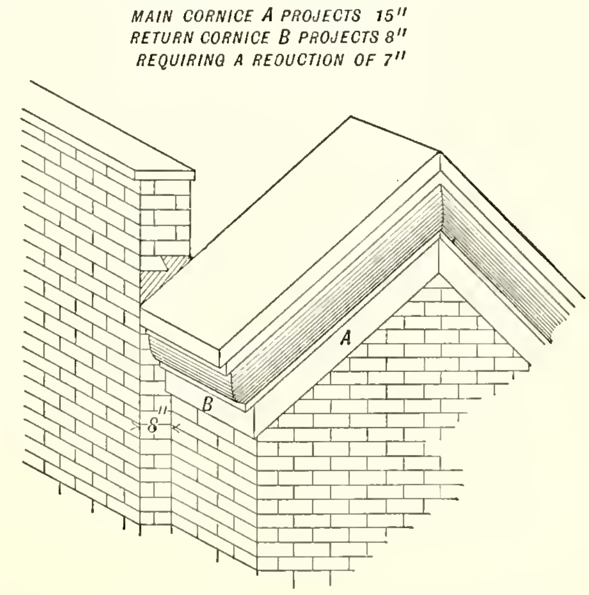


Fig. 269.—View of a Reduced Miter on a Gable Molding Having a Right Angular Return

place the girth of the given profile A, as shown by the small figures 0 to 14. Through these small figures and at right angles to N O, draw lines and intersect them by lines drawn parallel to O N from similarly numbered intersections on the miter line at the eave, 0' to 14', and at the ridge 0° to 14°.

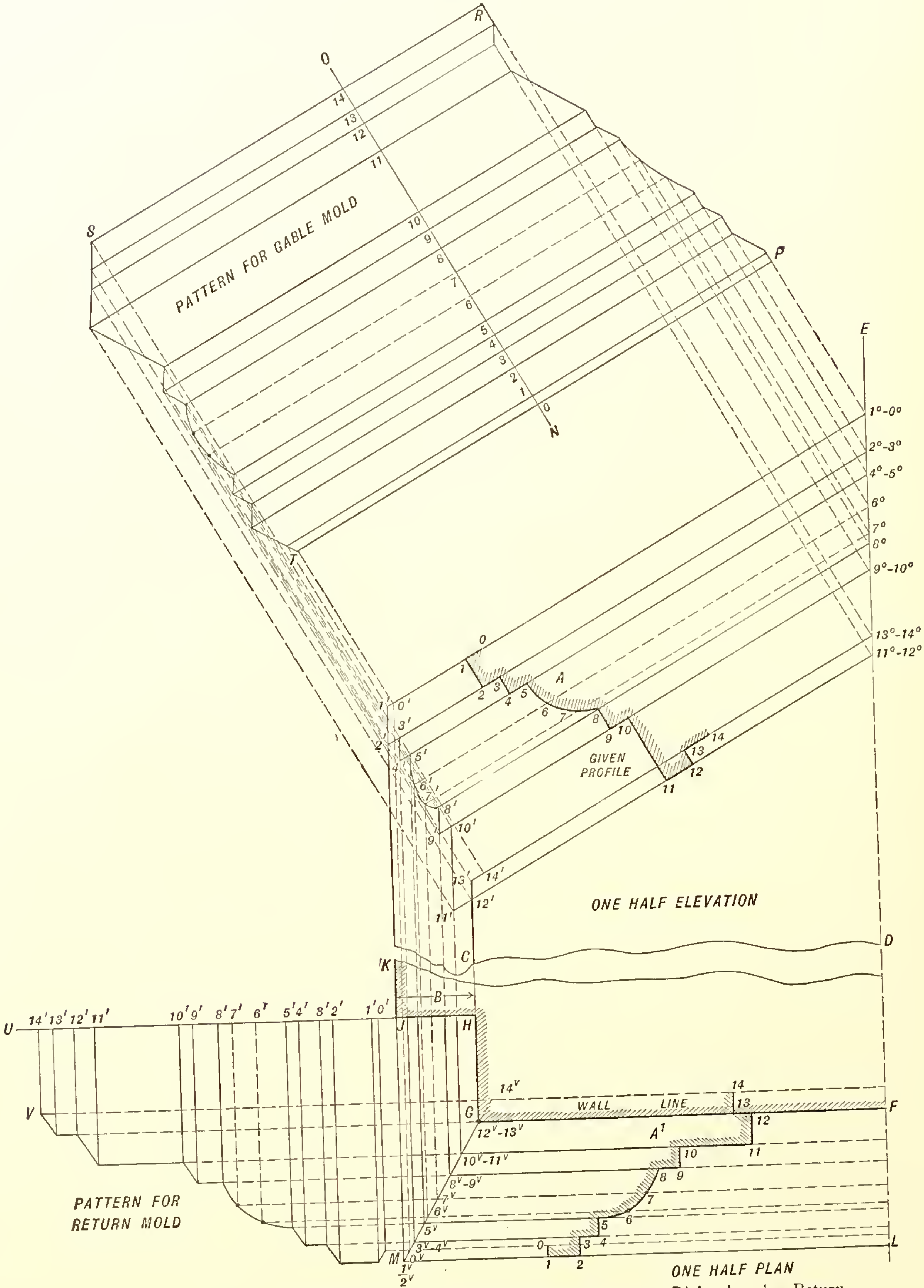


Fig. 270.—Patterns for Reduced Miters on a Gable Molding Having a Right Angular Return

Trace a line through points so obtained; P R S T is the pattern sought.

The pattern for the return is laid out by extending the line H J in plan as J U; upon this is placed the girth of modified profile, shown from o′ to 14′ in elevation, as indicated by similar numbers on J U. Through these small figures and at right angles to J U, draw lines and intersect them by lines drawn parallel to J U from similarly numbered intersections on the miter line G M in plan. A line is traced through points so obtained as shown by U V M J; this is the desired pattern. Allow edges on miters for joining.

REDUCED MITER ON A GABLE MOLDING, HAVING A RETURN AT OTHER THAN A RIGHT ANGLE

Solution 62

If a gable mold has a return other than a right angle, as shown in Fig. 271, where the formation of the wall in plan is as indicated by C D G H, the method of procedure is quite different from that given in the preceding problem.

Having established the angle of the wall line C D G H in plan, erect a vertical line from G to the elevation, as shown by E 13°, and from 13° draw the pitch of the top of the gable wall, as shown by 13° 13^v, intersecting the center line X J at 13^v. On this line 13° 13^v place the given profile A, setting the corner of the drip 13 upon the wall line 13°-13^v as indicated. Divide this profile A into an equal number of spaces, as shown from o to 14. Take a tracing of the profile A with the various divisions therein and place it in the plan in the position shown by A^1, taking care to place the drip line 12-13 on the wall line G H, as shown. Through the points 1 and 2 and parallel to G H draw the line J K and intersect this, at K, by a line drawn from the corner C and parallel to D G. From K draw a line to G. G K represents the miter line in plan, between the return and gable molding. As the projection of the return is less than the projection of the gable molding, a modified profile must be found, as indicated by B in elevation. Before this can be done, the miter line in elevation must be drawn; this is accomplished as follows: Through the various intersections in the profile A^1 in plan, draw lines parallel to H G until they intersect the miter line G K, as shown by similar numbers. From these intersections o to 14 on G K erect vertical lines and intersect them by lines drawn through the small figures in the profile A in elevation and parallel to 13^v-13°, resulting in the points of intersection marked O° to 14°; through these is traced a line, which represents the miter line in elevation. Extend the lines drawn through the small figures in the profile A to the right, cutting the center or miter line of the gable from O^v to 14^v. From the intersections O to 14 on the miter line G K in plan, draw lines parallel to G D, until they cut the wall line C D, as shown. From these intersections on C D erect vertical lines to the elevation, and intersect them by lines drawn parallel to the horizontal line 1° Y in elevation, from similarly numbered intersections in the miter line 1°-14°. Trace the outline shown from Y to Z; this indicates the outline of the return butting against the wall surface, shown by C D in plan.

The modified profile of the return may now be developed. At right angles to D G in plan draw any line, as *a b*, crossing the lines previously drawn, as shown from o to 14. Take these various divisions on *a b* and place them on a line drawn parallel to Y 1° in elevation, as indicated by *a′ b′*. At right angles to Y 1° and from the various intersections on *a′ b′* draw lines intersecting those previously drawn from similar numbers in the miter line 1° 14°. Trace a line through points so obtained, as indicated from o to 14 in the modified profile B. Take the girth of this modified profile B and place it on the line S o drawn at right angles to C K in plan. Through these small figures on S o draw lines parallel to C K and intersect them by lines drawn parallel to S o from similarly numbered intersections on the miter line G K and intersections on the wall line C D. Trace a line through points so obtained; C T U K is the pattern for the return.

For the pattern for the gable mold, take the girth of the given profile A and place it on the line L M drawn at right angles to 1° 1^v. Through these small figures on L M draw lines parallel to 1°-1^v and intersect them by lines drawn parallel to L M from similarly numbered intersections on the miter lines O° to 14° and O^v to 14^v. Trace a line through points thus obtained, when N O P R constitutes the desired pattern.

It should be noted that the angle 12, 13, 14, in the modified profile gives the true modified angle, but in practice this angle should be bent to a right angle so that it will set upon the wall. Therefore in making the bend on dot 13 upon forming up the returns, it should represent a right angle.

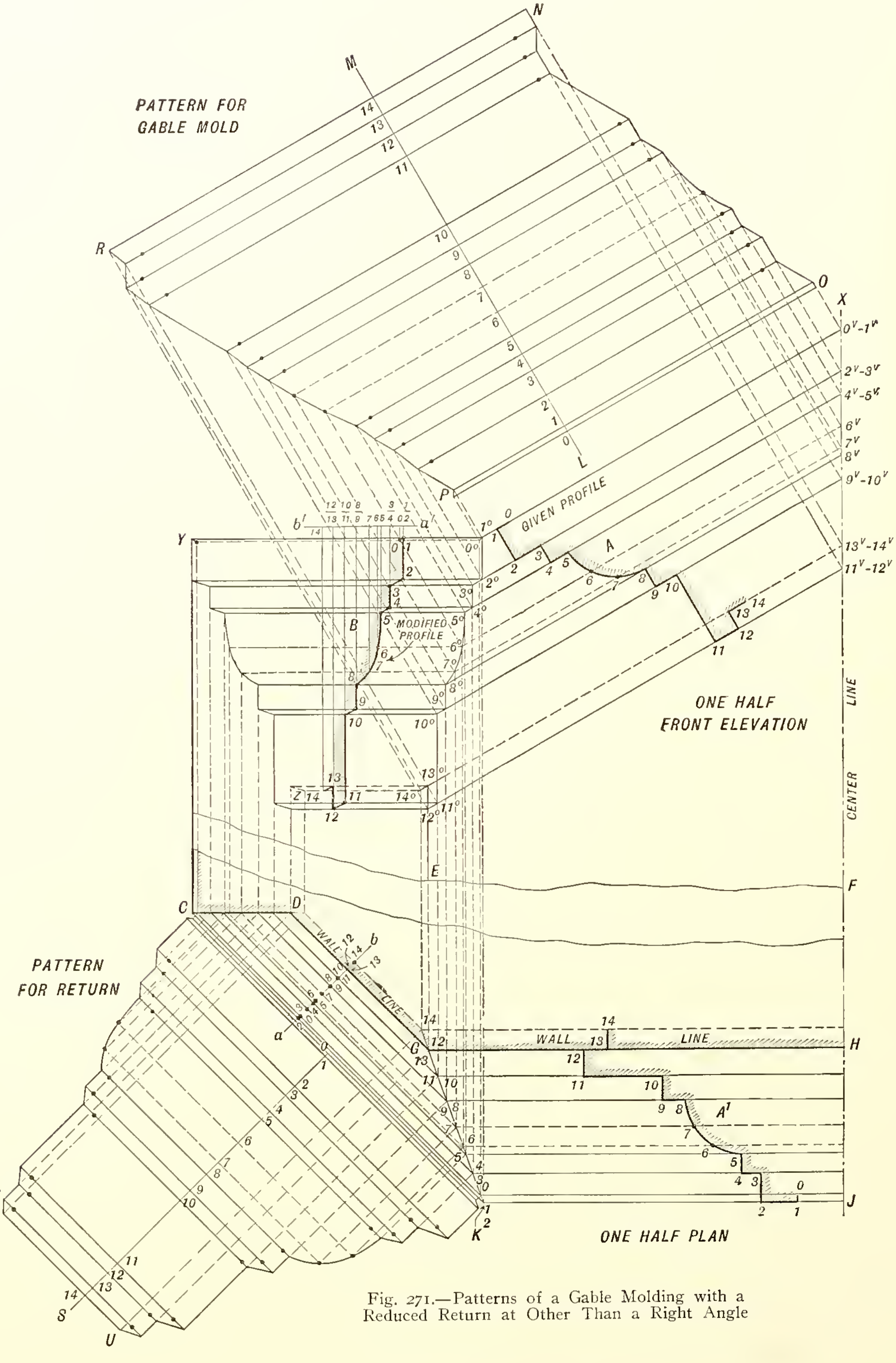


Fig. 271.—Patterns of a Gable Molding with a Reduced Return at Other Than a Right Angle

DISSIMILAR MOLDINGS, MITERING AT AN INTERNAL RIGHT ANGLE IN PLAN

Solution 62A

Fig. 272 is a view of two dissimilar moldings mitering at an internal right angle in plan, the joint of intersection being shown at *a b*. It will be noted that the mold on the old building has a profile, as at A while that on the new building is shown to be similar to B. It will be seen that the principles employed in developing these patterns can be applied to a mold of any shape, whether the angle be internal or external or of 90 degrees or less.

Fig. 273 shows the method of procedure. Let A represent the profile of a mold having an ogee and fillet; B contains a quarter round and cove. Either mold may then be divided into an equal number of spaces. In this case we will use profile A, as shown by the small figures 1 to 13. From these points draw horizontal lines to the left, cutting the profile B, which has been placed in its correct relation to the profile A, as shown, thus obtaining the points of intersection 1′ to 13′ in B. Note that the corner 3 in profile A intersects the profile B at 3′ and 3″. Divide the cove in B into equal spaces, as shown by *a, b,* and *c,* and from these points draw horizontal lines to the right cutting the profile A at *a′, b′,* and *c′*. Having found these points of intersection in both profiles, the pattern may now be laid out.

For the pattern for the molding A butting against the mold B, take the girth of the profile A and place it upon the vertical line C D drawn above the profiles as shown, as indicated by the small figures 1 to 13 on C D. Through these small figures and at right angles to C D, draw lines and intersect them by lines drawn parallel to C D from similar intersections in the profile B. Trace a line through points so obtained; G H C D is the pattern for the ogee mold. For the pattern for the mold B draw the vertical line E F and upon this place the girth of the profile B, as shown from 1′ to 13′ on E F. At right angles to E F draw the usual measuring lines and intersect them by lines drawn parallel to E F from similar intersections in the profile A. E L M F then constitutes the pattern for the quarter round mold. When the two patterns, just obtained, are shaped after their respective profiles, they will form an interior angle, indicated by *a b* in Fig. 272. Should an exterior angle be desired, of the same dissimilar profiles, as shown in Fig. 273, it is necessary only to use the reverse cut of the miter patterns just developed, as indicated by the dotted line patterns G H J K at the top and L M N O at the bottom. The double dots, marked *l m n o* in the lower pattern do not indicate a bend; but show where the cove stops, as at *c* in the profile B, and serve as a guide when forming the molding in the brake. The metal is drawn over the former in the brake, until the double dot is reached.

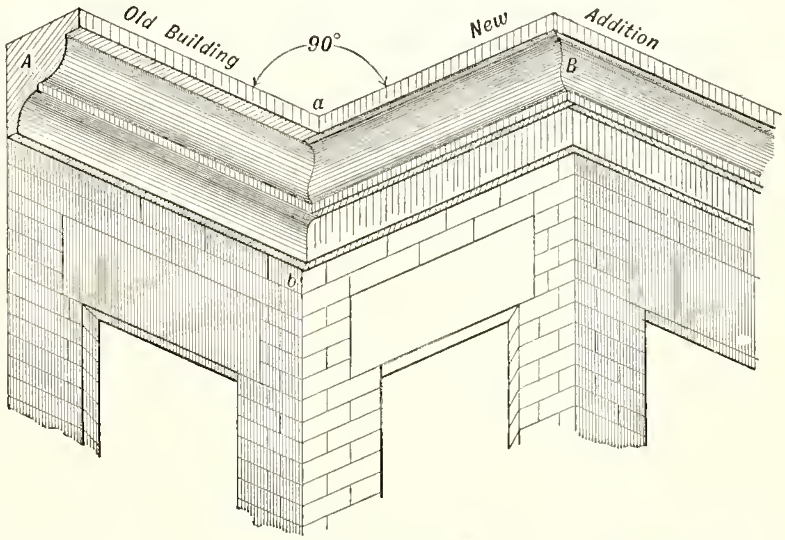


Fig. 272.—View of Dissimilar Moldings Mitering at an Internal Right Angle in Plan

DISSIMILAR MOLDINGS, MITERING AT AN INTERNAL ANGLE IN PLAN, AT OTHER THAN A RIGHT ANGLE

Solution 63

When two moldings are to miter at *other* than an internal right angle, the method employed is that shown in Fig. 274. Here the profiles, A and B, are to miter at an internal angle of 45 degrees, as shown in the plan. The first step is to obtain the divisions in the profiles, as shown in the lower right hand corner, where the profiles A and B are placed in line with each other, as shown, making the distance between them, as from 2 to 2′, as desired. Either of the profiles may be divided into an equal number of spaces. In this case we will employ the profile A, as shown by the small figures 1 to 15; from these points draw horizontal lines to the right, cutting the profile B as shown by intersections having similar numbers. As the space between 8′ and 10′ in the profile B remains to be divided, establish the points *a*, *b* and *c* and carry these points horizontally to the left in the profile A, thus obtaining the intersections *a′*, *b′* and *c′*. In practice more numerous divisions should be employed in spacing the profiles. Draw the desired internal angle, as shown by C 3^v D in plan; take a tracing of the profiles A and B with the various points of intersections thereon and place them, as shown respectively by A^1 and B^1 in plan, placing the member 2-3 of the profile A^1 and 2′-3′ of the profile B^1 upon the lines C 3^v and 3^v D, respectively, all as shown. From the various intersections in the profile A^1 draw lines parallel to C 3^v and intersect these by lines drawn parallel to 3^v D from similarly numbered intersections in the profile B^1, resulting in the points of intersection in plan, marked 1°, 2°, 3°, 3^v, 4°, 5°, etc., up to 15°. If a line were traced through these points of intersection, it would represent the plan view of the miter line or joint. The tracing of the miter line has been omitted to avoid a confusion of lines which would occur in so small a drawing, as also because the points of intersection are sufficient for obtaining the patterns.

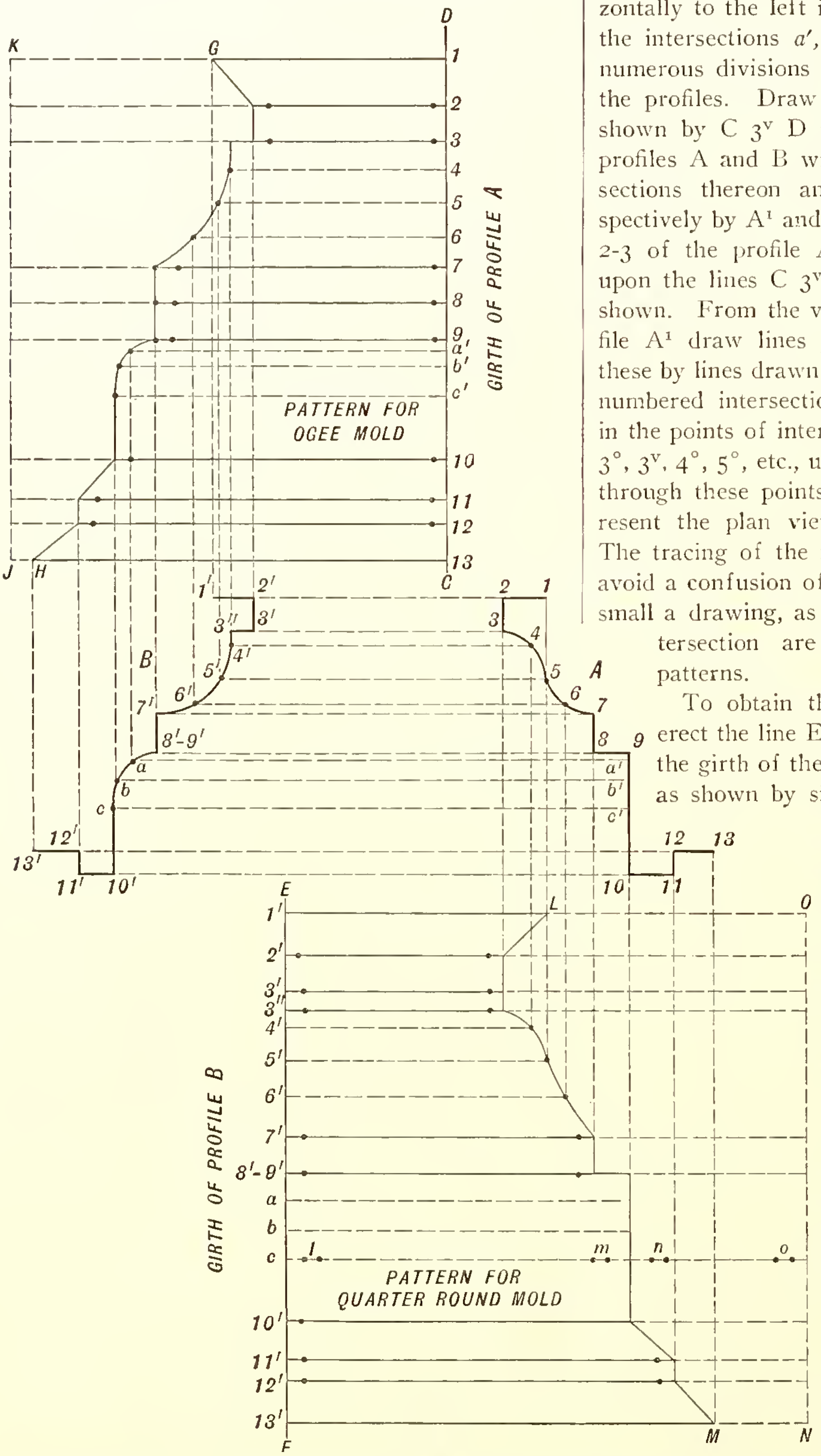


Fig. 273.—Patterns for Dissimilar Moldings, Mitering at an Internal Angle at Right Angles in Plan

To obtain the pattern for the ogee mold, erect the line E F at right angles to C 3^v; take the girth of the profile A^1 and place it on E F, as shown by similar numbers; through these numbers draw lines at right angles to E F and intersect them by lines drawn parallel to E F from similarly numbered intersections in the miter line in plan. A line traced through points so obtained, as shown by E F G H, will be the pattern for the ogee mold.

In a similar manner, obtain the pattern for the cove mold, shown by the profile B^1 in plan. Take the girth of the profile B^1 and place it on the line J K, drawn at right angles to 3^v D. Through these small figures and letters on and at right angles to J K, draw lines and intersect them by lines drawn parallel to J K from similarly numbered intersections in the miter line in

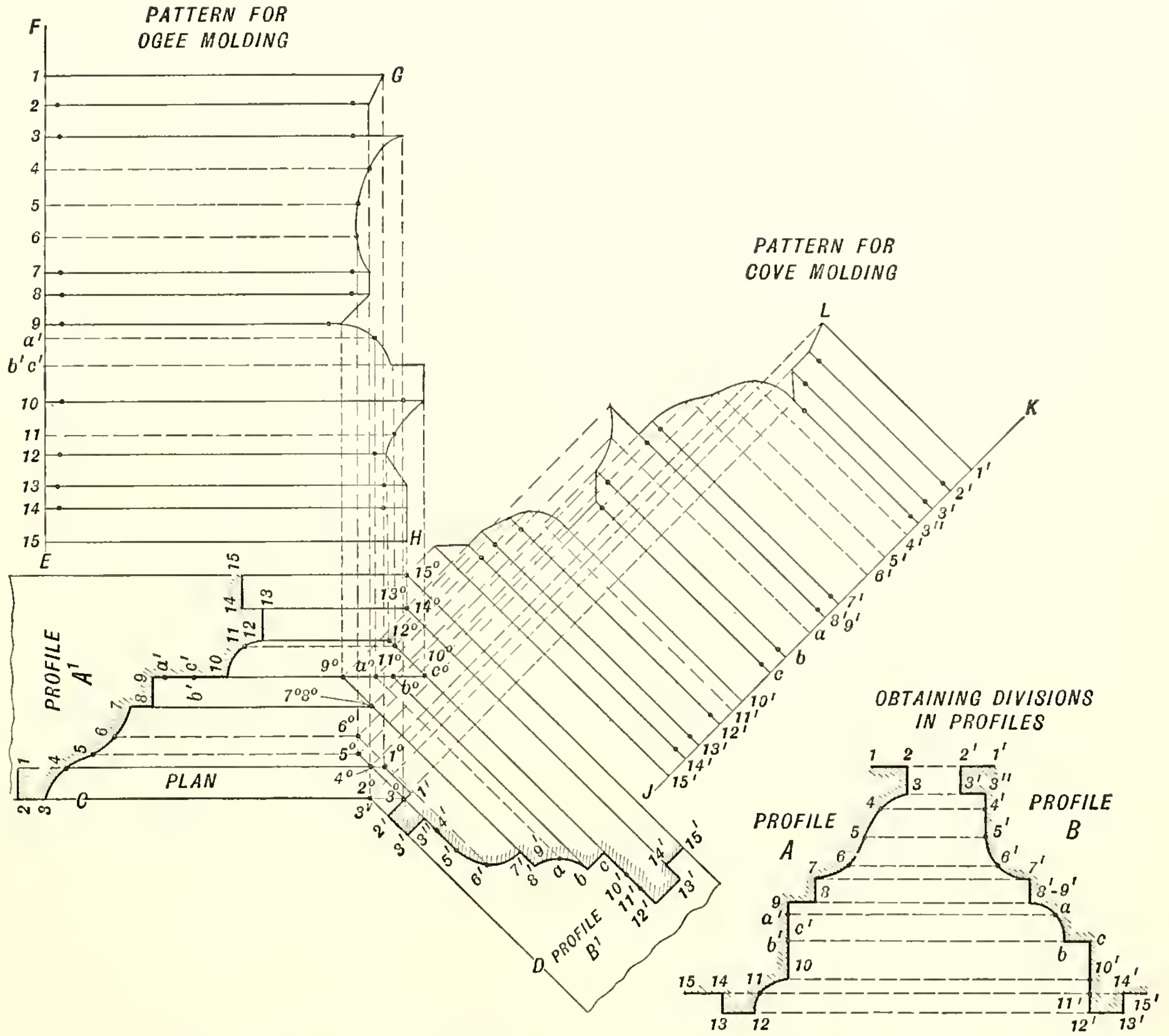


Fig. 274.—Patterns for Dissimilar Moldings, Mitering at an Internal Angle at Other than a Right Angle in Plan

plan; when a line is traced through points so obtained, we have the miter cut H L. J K L H is the desired pattern.

When the two patterns shown, are formed after their respective profiles, they will constitute an interior angle as shown in plan. If an exterior angle, alike to C 3^v D in plan be desired, the reverse of the pattern cuts should be used, as was explained in connection with the dotted portion of the patterns in Fig. 273.

PART VIII

PATTERNS FOR ROOF FLANGES, COLLARS, VENTILATOR BASES AND HOODS

ROOF FLANGE AND CYLINDER INTERSECTING SINGLE PITCHED ROOF

Solution 64

A VIEW of a cylinder or pipe and roof flange intersecting a single pitched roof is shown in Fig. 274[a], where the roof flange is indicated by A and the pipe or cylinder by B. The method of developing patterns of this nature, regardless of the pitch of the roof, is shown in detail in Fig. 275.

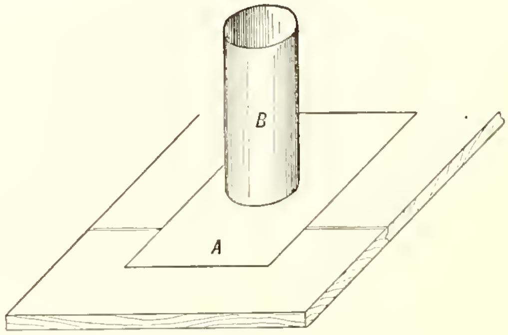


Fig. 274a.—View of Roof Flange and Cylinder on Single Pitch Roof

Let A B represent the pitch of the roof and D C 5′ 1′ the elevation of the cylinder. Above the line D C, draw the profile of the cylinder in its proper position, as indicated by E, and through its center draw the horizontal line *a b*. Divide the profile E into an equal number of spaces, as shown by the small figures 1 to 5 to 1; from these points drop perpendicular lines until they cut the roof line A B, as shown by similar numbers 1′ to 5′. Having obtained these points of intersection, the pattern for the cylinder may be laid out as follows: Extend the line C D in side elevation as D F; upon this place the girth of the profile E, as shown by similar numbers 1 to 5 to 1 on D F. At right angles to F D and through the small figures thereon, draw lines and intersect these lines by lines drawn parallel to F D from similarly numbered intersections on the roof line A B. Trace a line through

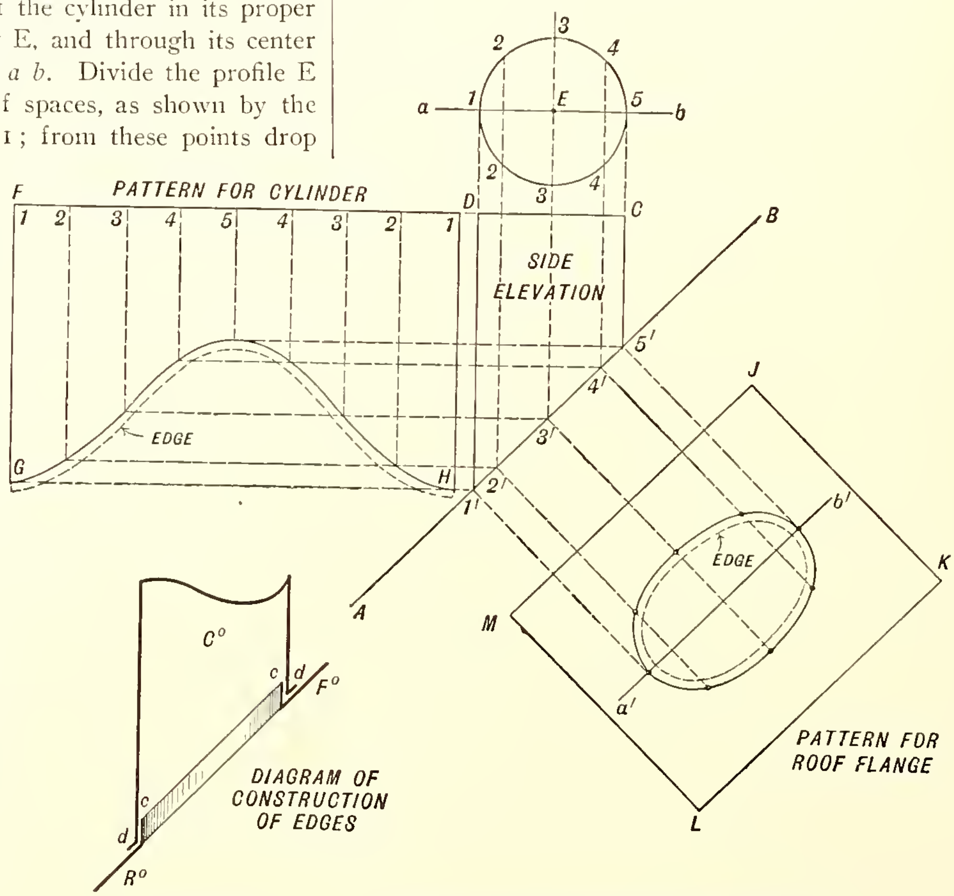


Fig. 275.—Patterns for Roof Flange and Cylinder on Single Pitch Roof

points thus obtained; D F G H outlines the pattern for the pipe or cylinder. It will be noted that the seam in the cylinder has been placed along D 1′ in the side elevation; this arrangement prevents the water from flowing against the seam.

The pattern for the roof flange is laid out as follows: At right angles to A B from the various intersections 1′ to 5′ draw lines indefinitely, as shown. Then, parallel to A B, draw any line, as *a′ b′*, crossing the lines drawn from points 1′ to 5′. Then, measuring in every instance from the line *a b* in the profile E, take the various distances to points 2 to 4, and place them on either side of the line *a′ b′* on similarly numbered lines, as indicated by the heavy dots. Trace a line through points so obtained, as shown by the elliptical figure. Around this elliptical figure place sufficient material for the flange, as shown by the rectangle J K L M, which completes the pattern. When these collars and flanges, as they are commonly called, are assembled, they can be joined by soldering, edges being allowed as indicated in the diagram of construction. Here R° F° indicates the roof flange with an upturned edge at *c c*, while C° shows the collar, with an outward flange at *d d*. The method of adding these edges to the two patterns is shown by the dotted lines on each. These edges are thoroughly sweated with solder. This method of construction may be applied to the seven examples of work to follow.

ROOF FLANGE AND CYLINDER INTERSECTING A DOUBLE PITCHED ROOF

Solution 65

Fig. 276 illustrates a cylinder or pipe passing through the ridge of a double pitched roof. A, being the flange and B, the pipe. The method employed in laying out the pattern is shown in Fig. 277. Here the pitch of the roof is shown in the end elevation by A 3′ B, in the center of which the elevation of the cylinder is drawn as indicated by

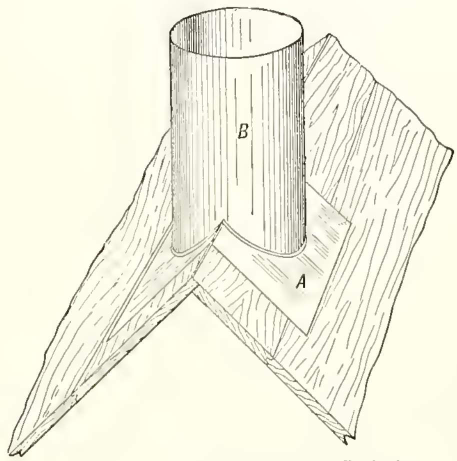


Fig. 276.—View of Roof Flange and Cylinder on Double Pitch Roof

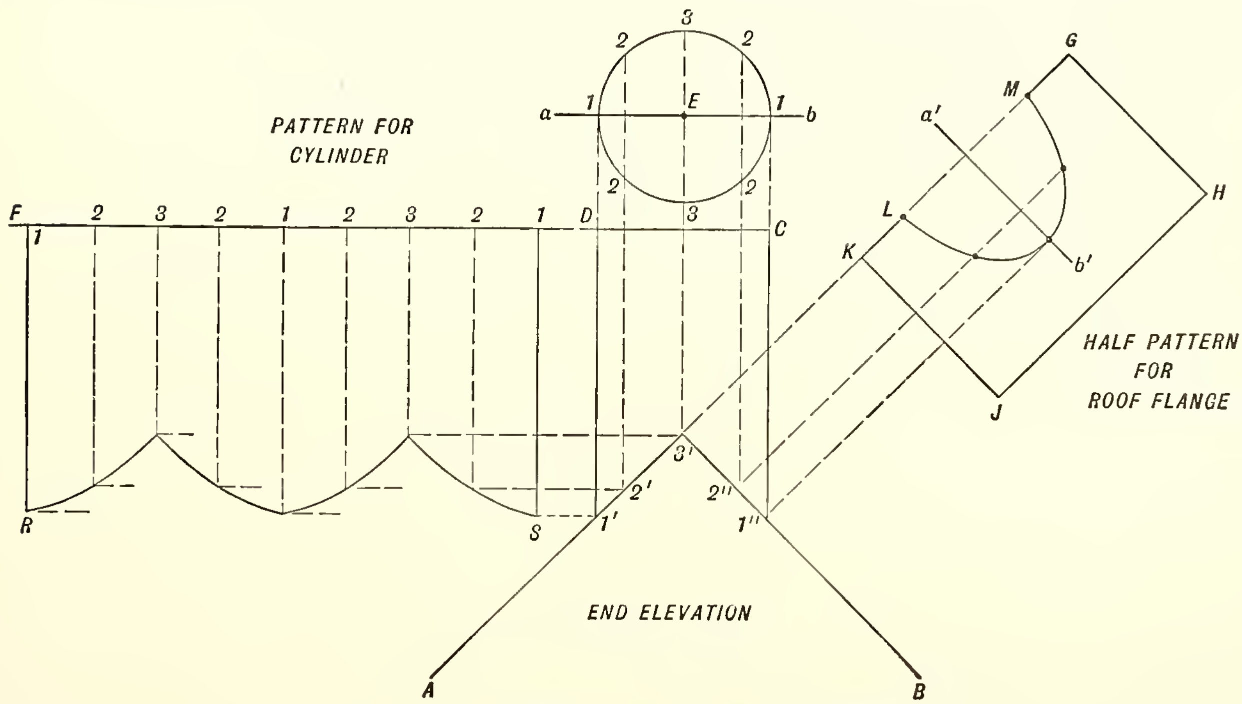


Fig. 277.—Patterns for Roof Flange and Cylinder on Double Pitch Roof

C-D-1′-1″. Above the line D C and in its proper position draw the profile E, with diameter equal to D C and through the center of the circle E draw the line *a b*. Divide the circle E into any number of equal divisions as indicated by the small figures 1 to 3 to 1 to 3 to 1; through these points and parallel to the lines of the cylinder drop lines cutting the roof line A 3′ B, as shown by similar numbers. Having found these points of intersection, the pattern for the cylinder may be laid out as follows: Extend the line C D or a line drawn at right angles to D 1′, as shown by D F and upon this place the girth of the circle E, as shown by similar numbers on D F. Through these small figures and at right angles to D F draw the usual measuring lines; intersect these by lines drawn parallel to D F from similarly numbered intersections on the roof line. A line traced through points so obtained, as shown by 1 R S 1, will be the desired pattern. As the cylinder sets in a central position over the ridge of the roof and as the pitch of both sides of the roof is similar, a pattern for one side of the roof flange can be used for the other. Therefore, at right angles to the roof line 3′-B and from the various intersections, 1″, 2″ and 3′, draw lines indefinitely, as shown; at right angles to these lines draw the line *a′-b′*, cutting the lines previously drawn, as shown. Then measuring in each instance from the line *a b* in the profile E, take the distances to the several points 2 and 3 and place them on either side of the line *a′ b′* on similarly numbered lines, as shown by the heavy dots. Trace a line through these points of intersection; L *b′* M is the semi-elliptical cut, around which the desired flange is added, as indicated by G H J K. This half pattern may also be used for the opposite side, or the roof flange may be made in one piece by placing the half pattern shown opposite the line G K. Edges are to be allowed, as explained in the preceding problem.

ROOF FLANGE AND CYLINDER INTERSECTING THE RIDGE AND HIPS OF A HIPPED ROOF

Solution 66

In Fig. 278, A represents the roof flange and B the pipe or cylinder intersecting the ridge and hips of a hipped roof. The development of these patterns is somewhat more difficult than that of the two preceding problems but a short and accurate method is set forth in Fig. 279. The patterns may be laid out *without* the usual procedure of first finding the miter lines in elevation by an operation in projections. This method saves time, but precaution is to be taken to number the points in plan accurately, according to the procedure set forth hereinafter. First draw the pitch of roof, as indicated by A 1′ B, and in the center of the ridge, draw the elevation of the cylinder, as shown by 5′ K J 5″. Draw the horizontal line A B and below it, draw a part plan, as shown by C D E F. From the corners D and E and at angles of 45 degrees draw lines intersecting each other at H, from which point draw the ridge line H 1. Using H as center, with a radius equal to one half the diameter of J K, draw the plan of the cylinder, as shown, cutting the ridge line at 1 and the hip lines at 3 and 3°. A J K B then represents a section on the line *b c* in plan. To avoid the operations in projections before mentioned, draw a line from the center H in plan and at an angle of 45 degrees, as indicated by H X. H-X-3° in plan will be similar to H-3-3° in the front part of plan, because the pitch of the roof on all three sides is alike. Divide the arc between 1 and 3 in plan into equal parts, in this case two, also the arcs between X and 3°, also 3° and 3, both into the same number of spaces, as shown from 3 to 3° to 3 in both arcs. Starting at the ridge, number the points 1, 2 and 3 up to X, then continue on the next arc to 4 and 5, then back from 5 to 4, to the hip line or 3° and number the front arc, 3°, 4, 5, 4, 3 to correspond to the side between 3° and 3. By following the numbers in this order, no mis-

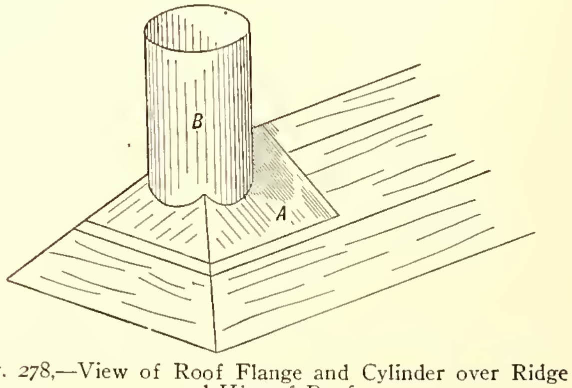


Fig. 278,—View of Roof Flange and Cylinder over Ridge and Hips of Roof

take will occur in laying out the pattern. From these divisions between 1 and the hip line at 3°, carry up perpendicular lines as shown, cutting the roof line 1′ B in the section, as indicated by 1′, 2′, 3′, 4′ and 5′.

The pattern for the cylinder cutting the three sides of the roof, may now be laid out. Extend

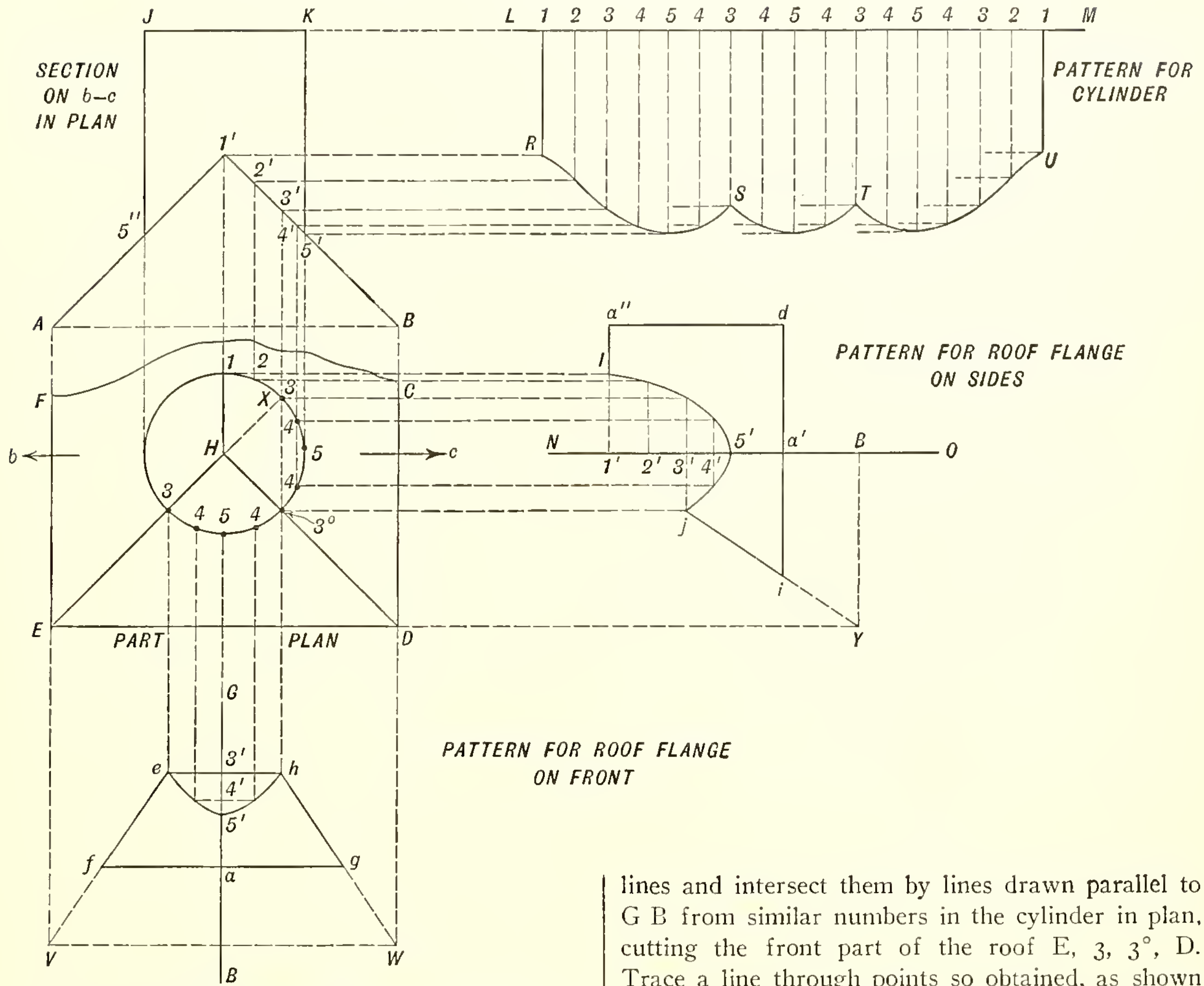


Fig. 279.—Patterns for Roof Flange and Cylinder over Ridge and Hips of Roof

J K in the section, as indicated by L M, and upon this place the girth of the full circle in plan, as shown by corresponding numbers on L M, or 16 divisions in all. From these divisions and at right angles to L M draw the usual measuring lines and intersect these by lines drawn parallel to L M from similarly numbered intersections on the roof line 1′ B. Trace the miter cut as shown; the part from R to S and from T to U represents the cut on the sides of the hip roof, and the part from S to T represents the cut on the front of the hip roof. 1 R S T U 1 represents the full pattern. As the roof flange for the front part in plan takes up only the points 5, 4 and 3, on the roof line 1′-B, take the girth of the roof pitch where these numbers intersect, as from B to 5′ to 4′ to 3′ in the section, and place these divisions on any vertical lines below the plan, as shown by similar numbers on G B. Through these small figures and at right angles to G B draw lines and intersect them by lines drawn parallel to G B from similar numbers in the cylinder in plan, cutting the front part of the roof E, 3, 3°, D. Trace a line through points so obtained, as shown by V *e* 5′ *h* W. Establish the width of the flange 5′ *a* and through *a* draw a line parallel to V W cutting the sides *e* V and *h* W at *f* and *g*, respectively. *e f g h* 5′ is then the pattern for the roof flange on front. As the roof flange for the sides takes up all that part of the circle between 3° and X, and also between X and 1, take the girth of all the spaces contained on the roof line 1′ B in the section and place them on the line N O drawn at right angles to D C in plan, as shown by similar numbers 1′ to 5′. Through these small figures and at right angles to N O, draw lines and intersect them by lines drawn parallel to N O from similarly numbered intersections in plan, all as shown by the dotted lines. Trace a line through points so obtained, as shown by *l* 5′ *j* Y. Make the distance 5′ *a*′ equal to 5′ *a* in the front roof flange pattern, and through *a*′ in the pattern for side roof flange, draw a line parallel to Y B, cutting the line *j* Y at *i*. Make the distance *l a*″ equal to 5′ *a*′ and from *a*″ draw a line parallel to N O until it intersects *i a′* extended at *d*. *l a″ d i j* 5′ *l* is then the pattern sought. Edges are to be allowed, as heretofore specified.

ROOF FLANGE AND OCTAGONAL SHAFT INTERSECTING A SINGLE PITCHED ROOF

Solution 67

When a large ventilator with octagonal bases intersects a single pitched roof, the development of the patterns is performed after the methods previously described. Fig. 280 presents a view of an octagonal shaft, B, intersecting the single pitched roof, with roof flange indicated by A. The method of laying out the patterns is shown in detail in Fig. 281. Here A B gives the pitch of the roof, D C 4′ 1′ the side elevation of the octagonal shaft and E the section or profile of the octagon. Through the center of the octagon E draw the line *a b*. Number both halves of the octagon alike, as shown from 1 to 4; from these points vertical lines are projected until they cut the roof line A B from 1′ to 4′, as shown. Take the girth of the octagon E and place it on the line C D extended as D F, as shown by similar numbers; through these numbers and at right angles to F D, the usual measuring lines are drawn and intersected by lines drawn parallel to F D from similarly numbered intersections, 1′ to 4′, on the roof line, A B. Trace a line through these points; F G H J D is the desired pattern.

The roof flange is laid out by drawing lines indefinitely at right angles to A B from the various points of intersection, 1′ to 4′; parallel to A B draw any line, as *a′ b′*, cutting the lines just drawn, as shown. Measuring from the line *a b* in the octagon section E take the various distances to the corners 1, 2, 3 and 4, and place them on either side of the line *a′ b′* on lines drawn from the intersections 1′ to 4′ on the roof line A B, thus obtaining the points of intersections, 1″ to 4″, on both sides in the roof flange pattern. Around this irregular figure, place the size of the flange required and draw the rectangle *c d e f*.

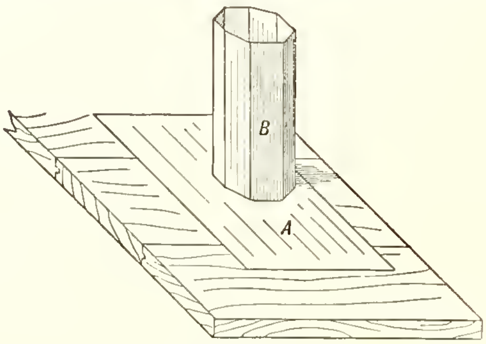


Fig 280.—View of Roof Flange and Octagonal Shaft on Single Pitch Roof

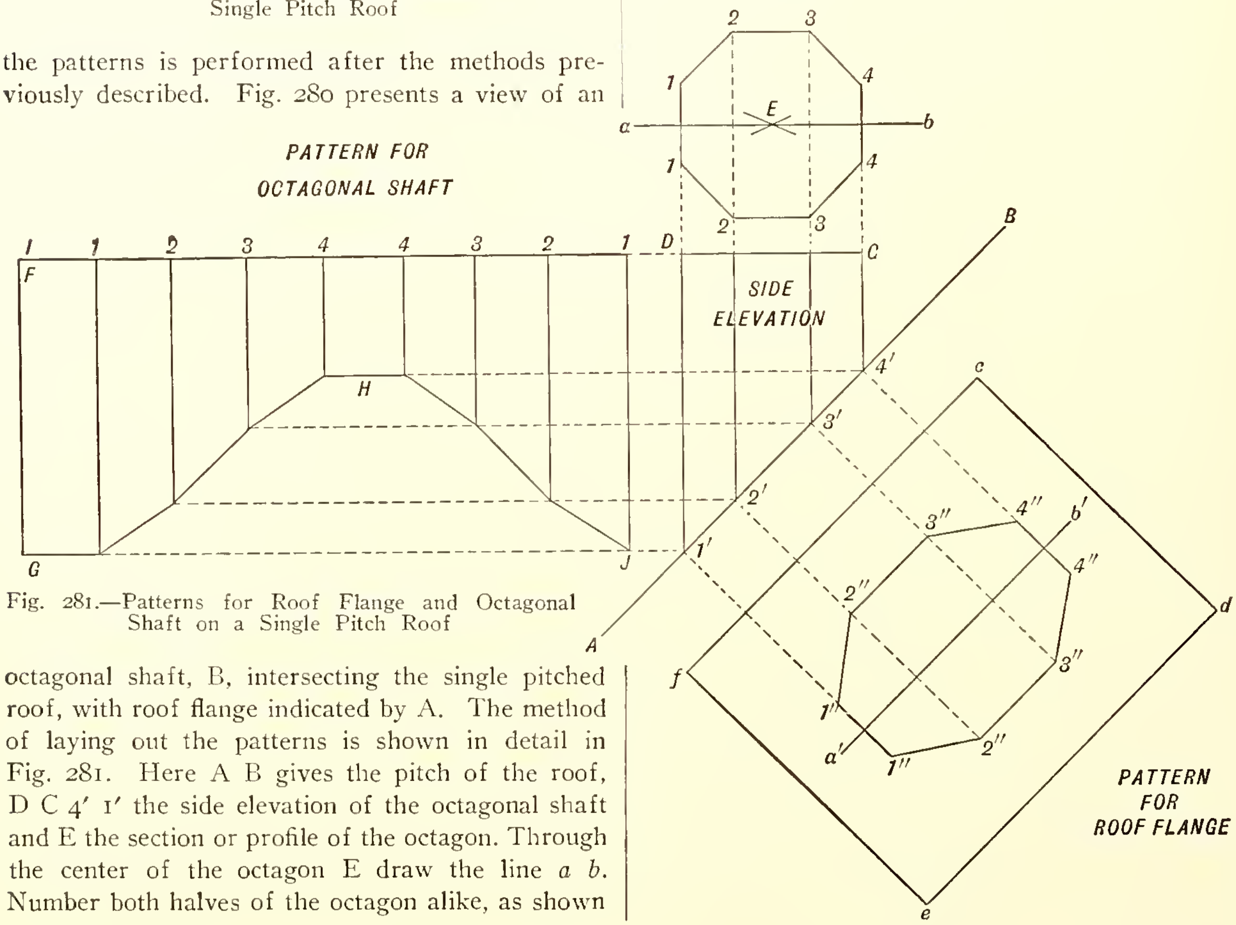


Fig. 281.—Patterns for Roof Flange and Octagonal Shaft on a Single Pitch Roof

ROOF FLANGE AND OCTAGONAL SHAFT INTERSECTING A DOUBLE PITCHED ROOF

Solution 68

Fig. 282 presents a perspective of a roof flange, A, and an octagonal shaft, B, intersecting a double pitched roof, affording an idea of the manner in

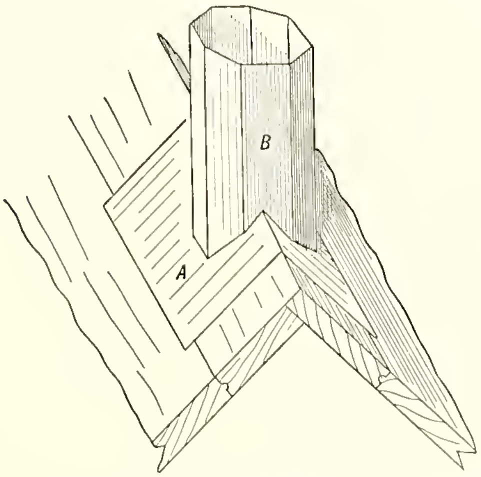


Fig. 282.—View of Roof Flange and Octagonal Shaft on Double Pitch Roof.

which large octagonal ventilation bases intersect the ridges of double pitched roofs. The method of developing the patterns is shown in Fig. 283, in which the double pitch is first drawn, as shown by A *a′* B; in the center of this the elevation of the octagonal shaft is drawn, as shown by 1′ D C1′. Above the line D C place the profile of the octagonal shaft E, as shown, and number the corners in the manner indicated. Through the center E of the octagon draw the horizontal line *a b,* and from the various numbered corners drop lines intersecting the double pitched roof line A *a′* B, as shown by similar numbers. From the ridge *a′* in elevation erect a vertical line cutting the side of the octagon 2-2 at *a*. This point *a* will be used when developing the pattern.

For the half pattern of the shaft, take the girth from 1 to 1° or the half octagon, as shown by the diagonal dotted line drawn from corner to corner, and place it on the line C D extended as D F, as shown by similar numbers; from these numbers and at right angles to D F, draw lines and intersect them by lines drawn parallel to D F from similarly numbered intersections on the roof line *a′* A. A line traced through points so obtained, as indicated by J H G, will be the desired cut, and 1 J G 1 will be the desired half pattern.

The pattern for the roof flange for one side is laid out by drawing lines of indefinite length from points 1′, 2′ and *a′* on the roof line and at right angles to *a′* B, as shown. Parallel to *a′* B draw any line, as *a″ b″*, crossing the lines just drawn from *a′* 2′ and 1′ on the roof line *a′* B. Measuring in each instance from the line *a b* in the profile E take the various distances to points 1 and 2, and place them on either side of the line *a″ b″*

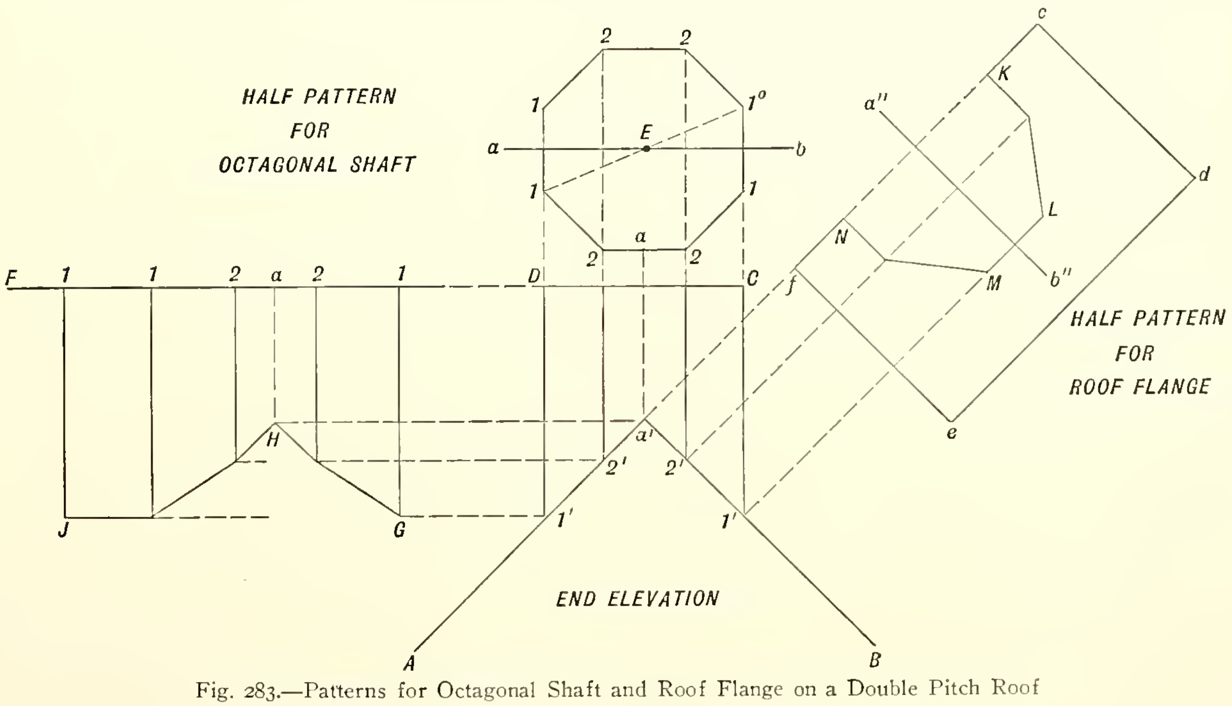


Fig. 283.—Patterns for Octagonal Shaft and Roof Flange on a Double Pitch Roof

in the flange pattern, thus obtaining the outline indicated by K L M N. Around this outline add the required width and length of the flange, as indicated by *c d e f;* this completes the half pattern. This half pattern can be duplicated opposite the line *c f*, if the full pattern is desired.

When these ventilator bases are of large size, each side is made separately, riveted along the corners 1 and 2 in profile E. In that case each side of the pattern requires to be laid out separately.

ROOF FLANGE AND OCTAGONAL SHAFT INTERSECTING HIPS AND RIDGE OF A HIPPED ROOF

Solution 69

The present example is that of an octagonal ventilator shaft setting on the ridge and hips of a roof, as indicated by B, in Fig. 284, and requiring a roof flange, A, as shown in the perspective. The laying out of these patterns may be accomplished as shown in the drawing in Fig. 285.

As in the preceding problems, first draw the roof line A 1′ B, in the center whereof draw the elevation of the shaft, as shown by J, 3′, 3″, H. Draw a

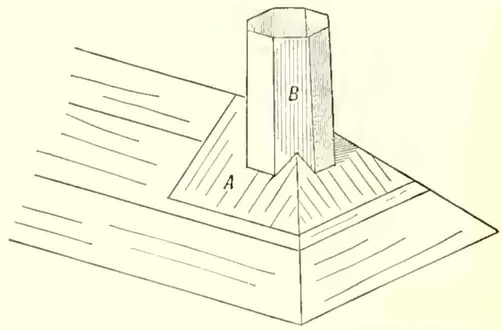


Fig. 284.—View of Roof Flange and Octagonal Shaft over Ridge and Hips of Roof

plan view on the line A B, as shown by C D E F. From the corners E and D draw the two hip lines meeting at G; from G draw the vertical line G 1 representing the ridge line. Using G as a center, construct the plan of the octagonal shaft to equal in width H J in the elevation. As the pitch of the front part of the roof E D G in plan will be similar to that of the sides, the patterns for the shaft and flange may be developed without having recourse to projections. Otherwise these would be required for finding the miter lines showing the intersections between the shaft and roof. Therefore, from the center G in plan and at an angle of 45 degrees draw the line G $a°$ cutting the side of the octagon 2-3 at $a°$. $a°$, 3, 3, *a*, will be similar to *a*, 3, 3, *a*, in the front in plan. Number the ridge intersection 1 and the following corner 2 and from the numbered points erect perpendicular lines, cutting the roof line 1′ B, as shown by similar numbers 1′, 2′, *a*′ and 3′.

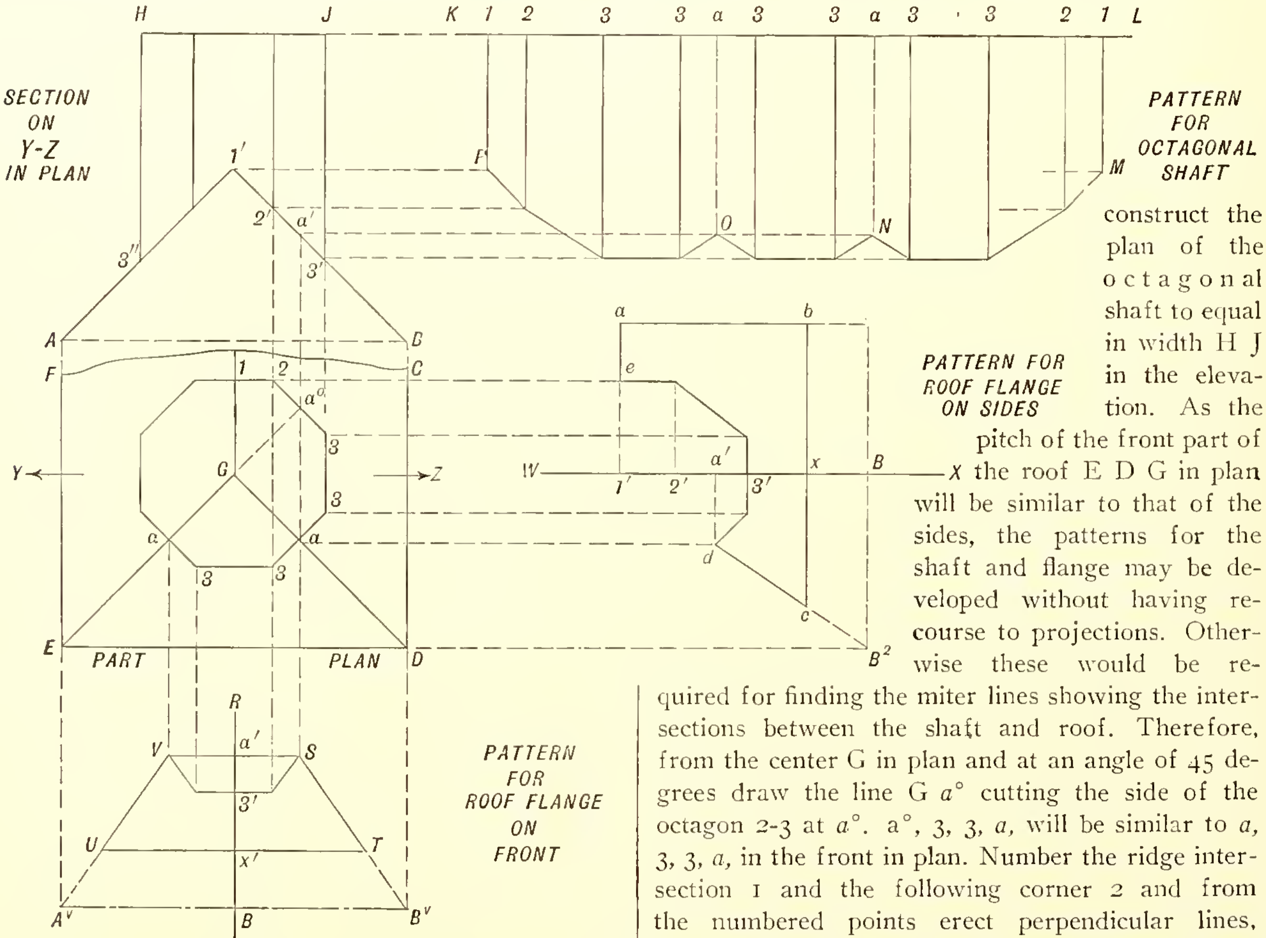


Fig. 285.—Patterns for Roof Flange and Octagonal Shaft over Ridge and Hips of Roof

The pattern for the shaft may now be laid out, as follows: Take the girth of all the spaces contained in the profile G and place them, as shown by similar numbers, on the line K L drawn at right angles to J 3′. From these small figures and letters on K L and at right angles thereto draw lines and intersect them by lines drawn parallel to K L from similarly numbered points, 1′ to 3′, on the roof line 1′ B. Trace a line through these points, as shown by P O N M; 1 P O N M 1 gives the pattern desired, the angular cuts at O and N being the cuts over the hips at *a* and *a* in plan.

To obtain the pattern for the roof flange on sides, take the various divisions, 1′ to B on the roof line in the section, and place them on the line W X, drawn at right angles to C D in plan, all as shown by similar numbers. At right angles to W X and through the small figures and letters, 1′ to B, draw lines as shown; intersect these lines by lines drawn parallel to W X from similarly numbered intersections in the octagonal figure in plan. Trace the miter cut, *e*, 3′, *d*, B^2, as shown. Establish as desired the distance *e a* and 3′ *x* and draw a line through *x* parallel to B B^2 cutting the miter cut at c and meeting the horizontal line drawn from *a* at *b*. *a b c d 3′ e a* then represents the pattern for the side roof flange.

As the front part of the plan E D is intersected by the part octagon *a* 3 3 *a*, take the various divisions B 3′ *a′* in the sectional view and place them on the girth line R B, which is drawn at right angles to E D, as shown by similar letters and figures on R B. Through these points *a′*, 3′ and B draw lines at right angles to R B, and intersect these lines by lines drawn parallel to R B from similarly numbered inintersection in the plan. Trace the outline through points so obtained; A^v B^v S 3′ V gives the miter cut.

Make the distance 3′ X^1 equal to 3′ X in the pattern for side flange and draw a line through X′ parallel to A^v B^v, cutting the miter cuts at U and T, as shown. V U T S 3′ represents the pattern for the roof flange on front.

SQUARE TAPERING SHAFT AND ROOF FLANGE INTERSECTING THE RIDGE AND HIPS OF A ROOF

Solution 70

Occasionally large ventilators are built with square tapering bases mitering down on the ridge and hips of a hipped roof, as shown in the perspective in Fig. 286, in which A and B show respectively, the roof flange and tapering shaft. These shafts or bases are sometimes round, sometimes octagonal, in either case tapering. The octagonal base will be taken up in the next succeeding problem,

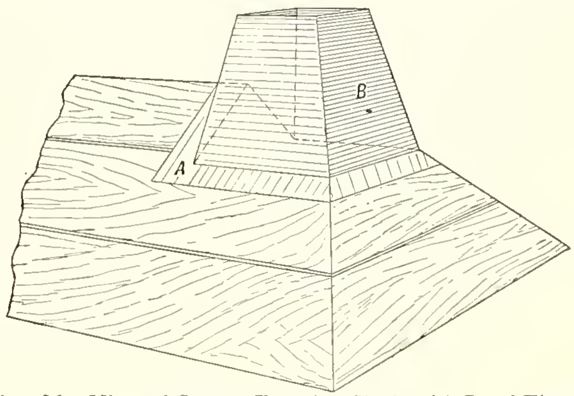


Fig. 286.—View of Square Tapering Shaft with Roof Flange over Ridge and Hips of Roof

while the round base will later be explained in the consideration of radial line developments. To lay out the square tapering shaft refer to Fig. 287, which illustrates the operations in detail. First draw the end elevation of the roof, which indicates the pitch, B A C. Below B C draw the plan view, indicated by D E F G, and draw the hip lines, F U and E U, also the ridge line, U *a″*. Construct the elevation of the base, as shown by 1, 2, 2′, 1′, from which the plan view of the top is projected, as indicated by H J K L in plan, also the plan view on the bottom line 2-2′ in elevation, as shown by P O N M in plan. As the rear side of the shaft, P O J H in plan, sets over the ridge of the roof and as this side is also tapering, the intersecting line between the shaft and roof line is found as follows: From the apex A in elevation and parallel to B C, draw a line cutting the side of the shaft 1′-2′ at *a*; from this point a perpendicular line is projected to the plan, cutting the miter line of the shaft at *a′*. From this point, *a′*, a line is drawn parallel to P O cutting the ridge line at *a″*, the desired point. Draw the miter lines P to *a″* and *a″* to O, as shown.

Having completed the plan and elevation, the patterns are now in order. Assuming that the shaft is to be made in four parts and the corners double seamed, the patterns may be developed as follows: Take the distance of the taper 1′-2′ in the end elevation and place it on any vertical line, as R S, shown by similar numbers; through these and at right angles to R S draw lines of indefinite length as shown. Take one-half of the distance $1\text{-}1^1$ and 2-2′ in the end elevation and place it on either side

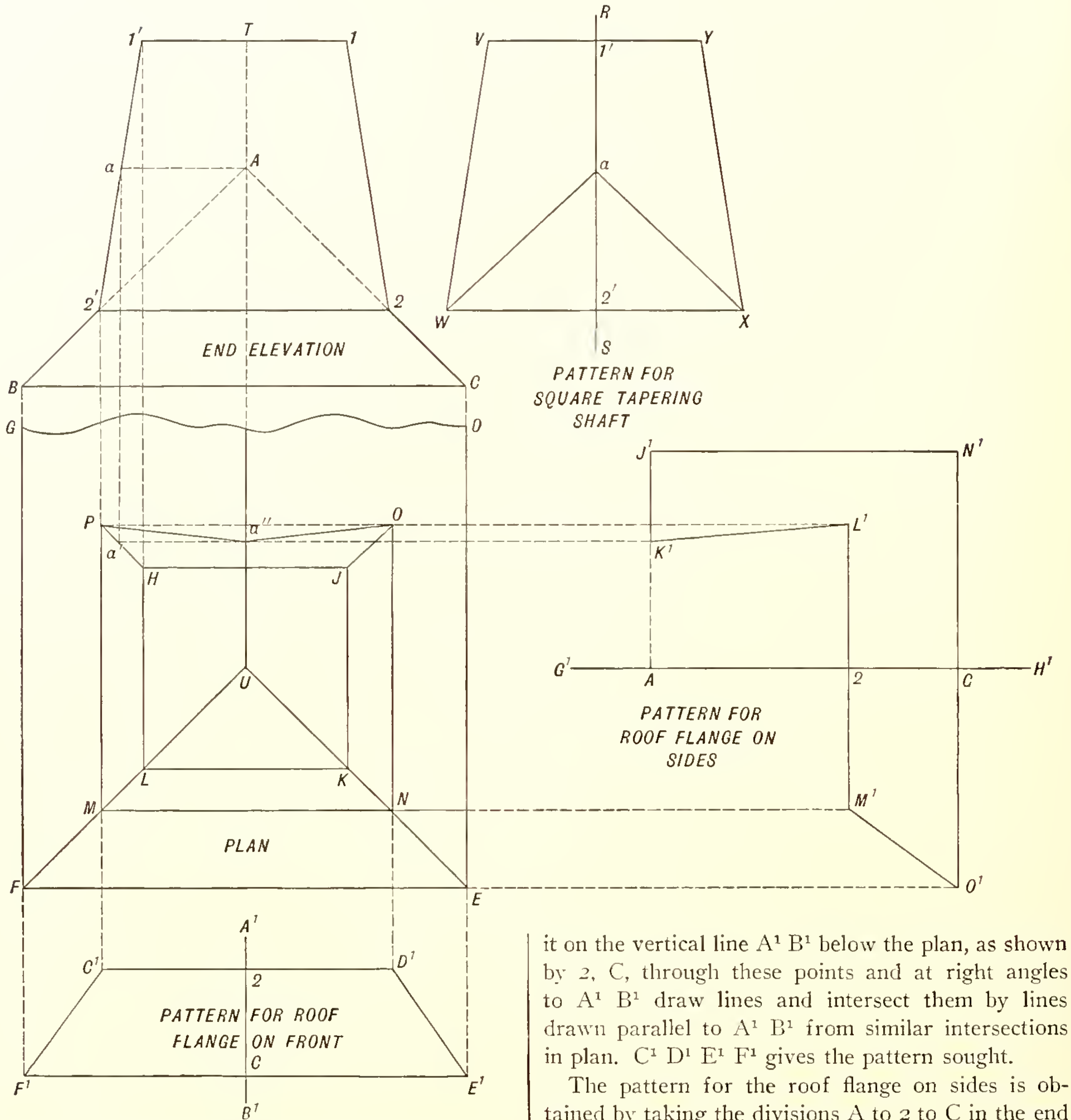


Fig. 287.—Patterns for Square Tapering Shaft and Roof Flange on Ridge and Hips of Roof

of the line R S, thus obtaining the points V and Y at the top and W and X at the bottom. Connect lines from V to W and Y to X. V W X Y will be the pattern for three sides of the tapering shaft.

Take the distance from 1′ to *a* in the end elevation, and set it off on the center line R S in the pattern from 1′ to *a*, and draw lines from *a* to W and X. V W *a* X Y will be the pattern for the shaft cutting the double pitch roof at the ridge.

For the pattern for the front roof flange, take the distance from C to 2 in the end elevation and place it on the vertical line A^1 B^1 below the plan, as shown by 2, C, through these points and at right angles to A^1 B^1 draw lines and intersect them by lines drawn parallel to A^1 B^1 from similar intersections in plan. C^1 D^1 E^1 F^1 gives the pattern sought.

The pattern for the roof flange on sides is obtained by taking the divisions A to 2 to C in the end elevation and placing them on the line G^1 H^1 drawn at right angles to D E in plan, as shown by A, 2, C, on G^1 H^1. At right angles to G^1 H^1 and through A, 2 and C draw lines to any length, as shown, and intersect these lines by lines drawn at right angles to D E in plan from the points of intersection marked *a*″, O, N, and E in plan. Connect points thus obtained in the pattern, as shown by lines drawn from K^1 to L^1 to M^1 to O^1. Establish the distance K^1 J^1, and from J^1 draw the horizontal line meeting the line drawn through C at N^1; this completes the pattern. Laps are to be allowed, as specified in preceding problems.

OCTAGONAL TAPERING BASE; INCLUDING ROOF FLANGE, INTERSECTING THE HIPS AND RIDGE OF A HIPPED ROOF

Solution 71

An octagonal ventilator base and roof flange intersecting the ridge and hips of a hipped roof is shown

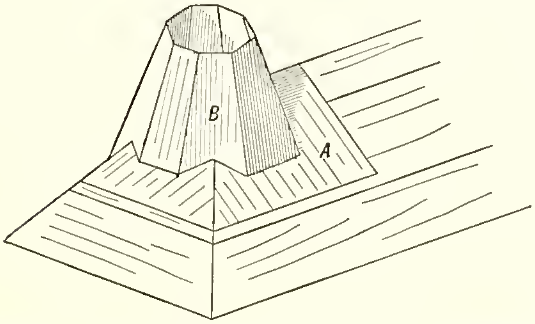


Fig. 288.—View of Octagonal Tapering Shaft with Roof Flange over Ridge and Hips of Roof

in perspective in Fig. 288, where A is the flange and B the base or shaft. This problem presents an interesting study in projections and intersections and should be carefully followed as outlined in Fig. 289. In this connection we will take up also the method of laying out, all on *one* pattern, the various patterns for the shaft.

As in the preceding solutions, first draw the pitch of the roof, as indicated by B A C in the end elevation. Establish at any point the width of the octagon base as K L, the vertical hight as L° H° and the width of top as J H. In line with and below B C draw the plan of the roof, as indicated by D E F G, and draw the hip lines, E A^2 and F A^2; also the ridge line, A^2 A°. Using A^2 as a center, construct a horizontal section on the line L K in elevation, as shown by the octagonal figure, *a b c d e f g h*, in plan. In like manner, using A^2 as center, construct the octagonal section *i j k l m n o p*, representing the horizontal section on H J in elevation. Connect the corners of the octagon in plan as *a* to *j*, *b* to *k*, *c* to *l*, etc., as shown. It is now necessary to find the miter or intersecting lines between the tapering octagonal shaft and hipped roof. Referring to the plan, it will be noted that the sides of the shaft marked I intersect on horizontal lines; those marked II intersect the hips; those marked III intersect the double pitched roof, while the one marked IV intersects the ridge.

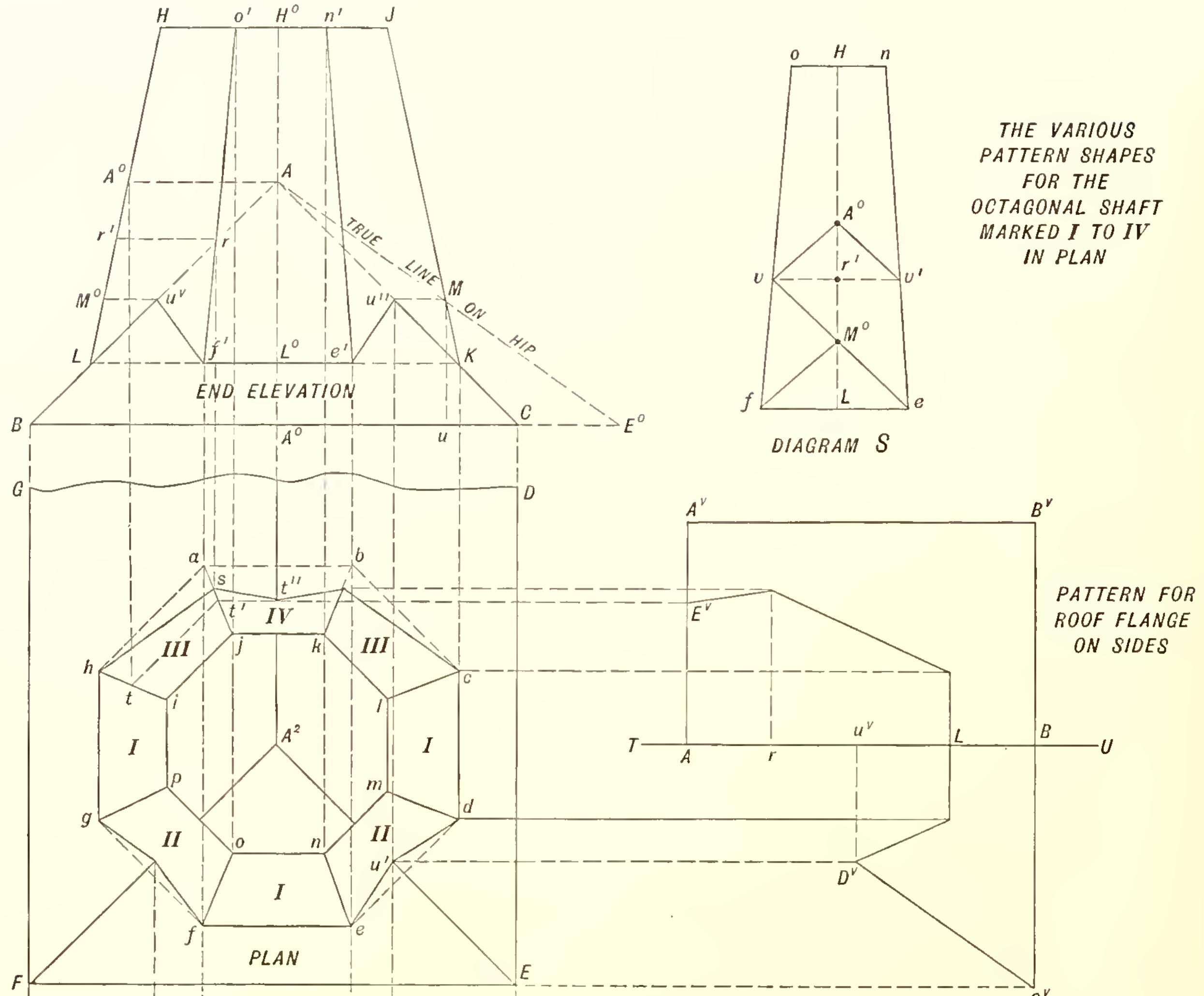
To find the intersection on the hip, take the distance of the hip line A^2 E in plan, and place it, as shown from A° to E° in elevation, and draw a line from E° to A, which shows the true length of the hip line. Where the flare of the octagonal base J K intersects this hip line at M, draw a line parallel to B C from this point M until it intersects the pitch of the roof A C at u''; from this point project a vertical line in the plan intersecting the hip line at u', the desired point. Draw a line in plan from *d* to u' to *e* and reproduce on the opposite side, as shown. The same point, u', in plan, could be obtained by projecting a vertical line from the intersection M on the hip line in elevation until it meets the base line B C at *u*, then taking the distance from E° to *u* and setting it off in plan on the hip line from E to u'. From *o* and *n* in plan erect vertical lines in the elevation, cutting the top line of the shaft at o' and n'. In like manner, from the corners *f* and *e* in plan erect perpendicular lines cutting the bottom line of the shaft at f' and e'. Connect lines from o' to f' and n' to e'; *from* u'' draw a line to e', another from e' to f' and another from f' to u^{v}. This completes the end elevation of the shaft intersecting a hipped roof.

To find the line of intersection in plan, where the sides of the shaft marked III meet the roof line, simply project a vertical line from the intersecting point between the miter line o' f' and the roof line A B in elevation, indicated by *r*, into the plan, cutting the miter line *a j* at *s*, and draw a line from *s* to *h* which can be traced to the opposite side, if desired.

The intersection between the side of the shaft IV in plan and the ridge line is found by drawing a horizontal line from the ridge A in elevation until it cuts the pitch of the shaft H L at A°. From this point a perpendicular line is projected in the plan cutting the miter line *h i* at *t*. From *t* a line is drawn parallel to *i j* to cut the miter line *a j* at t' and from this point a line is drawn parallel to *j k* to cut the ridge line at t'' the desired point. Draw a line from *s* to t'' and reproduce on the opposite side, if desired. This completes the plan view and the patterns are now in order.

By referring to the plan it will be seen that four separate patterns will be required for the shaft, which we will proceed to lay out on one pattern, as is done in the practical work of the shop.

From the various intersections *r* and u^{v} in the end elevation draw horizontal lines cutting the pitch of the octagonal shaft at r' and M°, respectively. Take the various divisions in the end elevation from H to A° to r' to M° to L and place them on the vertical line in diagram S, as shown by similar



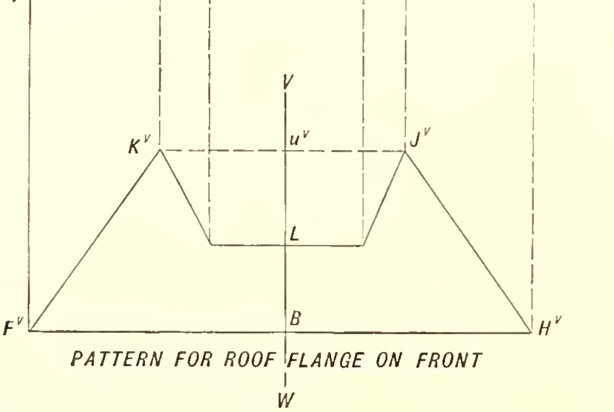


Fig. 289.—Patterns for Tapering Octagonal Shaft and Roof Flange, over Ridge and Hips of Roof

letters. Through these letters H, *r′* and L and at right angles to H L draw horizontal lines to any length as shown. Measuring from the center line H° L° in the end elevation take the distances to points *e′* and *n′* and place them in diagram S on either side of the line H L, as shown by *e* and *f*, also by *n* and *o*, respectively. Draw lines from *o* to *f* and *n* to *e*. *n o f e* will be the pattern for the three sides of the shaft, marked I in plan.

From the corners *e* and *f* in diagram S draw lines to M°. *o f* M° *e n* will be the pattern for the sides of the shaft, marked II in plan.

Where the line drawn through *r′* in diagram S cuts the line *o f* at *v*, draw a line from *v* to *e*; *o v e n* will be the pattern for the sides of the shaft, marked III in plan.

From *v* and *v′* in diagram S draw lines to A° when *o v* A° *v′ n* will be the pattern for the side, marked IV in plan.

Thus it will be seen that the four patterns have been laid out as one. In cutting out these patterns from sheet metal, the proper method of procedure is as follows: Assuming that the necessary laps have been allowed for double seaming and soldering, first cut three, alike to *o n e f* in diagram S. Then cut away *e* M° *f*, allowing laps, and cut two alike to *o n e* M° *f*. Then cut away M° *v*, allowing laps, and cut two alike to *o n e v*. Again cut away *v* A° *v'*, allowing laps, which leaves that for the side intersecting the ridge.

The roof flange is now laid out, for the front part of which take the girth of B L u^v in end elevation and place it on the vertical line V W drawn at right angles to F E in plan, as shown by similar letters; through these letters horizontal lines are drawn and intersected by lines drawn parallel to V W from similar points in plan, all as shown by the dotted lines. Connect the intersections thus obtained in the pattern, by lines; when K^v F^v H^v J^v L K^v will be the pattern sought.

The pattern for the roof flange on sides is obtained by taking the girth of A *r* u^v L B in the end elevation and placing these distances on the line T U drawn at right angles to E D in plan, as shown by similar letters on T U. Through these letters at right angles to T U draw lines and intersect them by lines drawn parallel to T U from similar intersections in plan, all as shown by the dotted lines. Connect lines through points of intersection thus obtained, as shown by E^v L D^v C^v. Establish as desired the width of the flange E^v A^v and draw the line A^v B^v parallel to T U intersecting the line drawn through B at B^v. A^v B^v C^v D^v L E^v A^v is then the desired pattern. Allow laps for soldering purposes, as specified in preceding solutions.

CONICAL ROOF FLANGE ON ROOF HAVING ONE INCLINATION.

Solution 72.

Fig. 290 presents a view of a conical roof flange, indicated by A, while *a b c d* shows a roof plate or

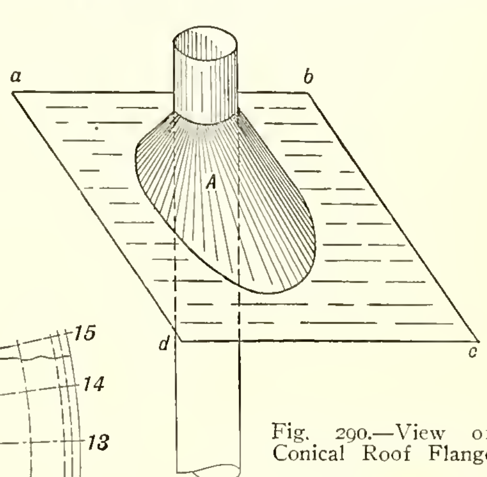


Fig. 290.—View of Conical Roof Flange

flashing. The method of finding the opening in the roof plate will be taken up in a later succeeding problem. The development of the conical flange A is illustrated in Fig. 291 where a quick, accurate method is shown.

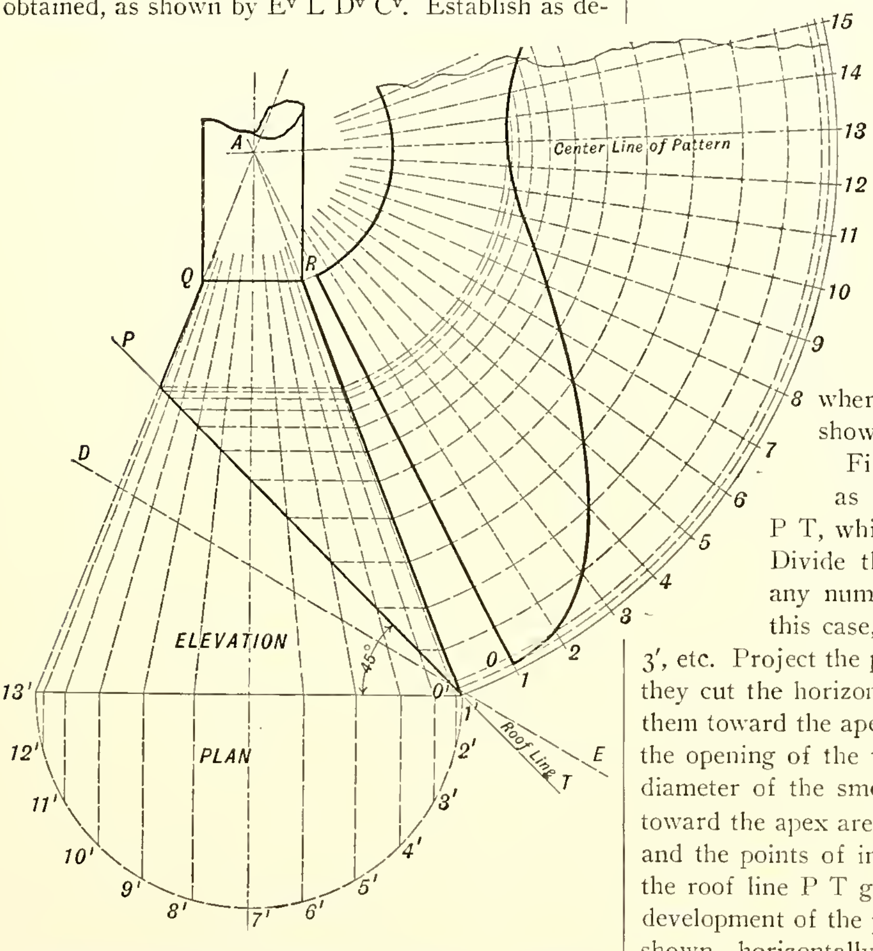


Fig. 291.—Method of Laying Out Pattern of Conical Roof Flange

First draw a half plan and eleva- as shown, and draw the roof line P T, which in this case is at 45 degrees. Divide the half circle of the plan into any number of equal spaces, twelve in this case, as shown in the figures, 1', 2', 3', etc. Project the points of division vertically until they cut the horizontal line 13' 1' and thence carry them toward the apex of the cone at A. Q R shows the opening of the top of the flange or the outside diameter of the smokestack. The lines just drawn toward the apex are called the elements of the cone, and the points of intersection of the elements with the roof line P T give the points to be used in the development of the pattern. Project those points, as shown, horizontally toward the right to cut the outer edge line of the cone R 1'.

For half the pattern, set the dividers to the length A 1′ and describe an arc as shown by 1′ 7 13, which divide into twelve spaces, each equal to one of those on the half plan, and from these points draw the elements toward the apex A, as shown. Now set the dividers to the length of the spaces from A to each of the points on R 1′, and draw arcs to intersect the lines of like number drawn from points 1, 2, 3, 4, etc. The intersection of these arcs with the lines of corresponding number gives the points on the pattern. A line drawn through the points thus obtained gives the lower side of the pattern or the part which rests on the roof. With a radius A R describe the arc from R, which gives the upper part or opening in the top of the pattern.

If the pitch of the roof were the line D E, the process of developing the pattern would be the same. The horizontal lines in this case would be drawn from the points on the line D E instead of from those on the line P T.

The half pattern is indicated from the line A-1 to the line A-13.

ROOF PLATE AND CONICAL BASE ON A DOUBLE PITCHED ROOF

Solution 73

The method of obtaining the patterns for a conical roof base on a double pitched roof, the conical base setting to one side of the center of the ridge or comb, is as follows: Referring to Fig. 292, we have a double pitched roof whose angle is indicated by C S D. Through the apex of the roof at S draw the vertical line S, *a*, as shown. Draw the elevation of the conical base in its proper position as shown by E-F-7-1′ being part of the frustum of a right cone, shown by E F 7°-1. Extend the sides of the cone until they meet the center line at X. Below the elevation draw the half plan, 1-4-7 representing a half section on the line 1-7° in elevation. Space this

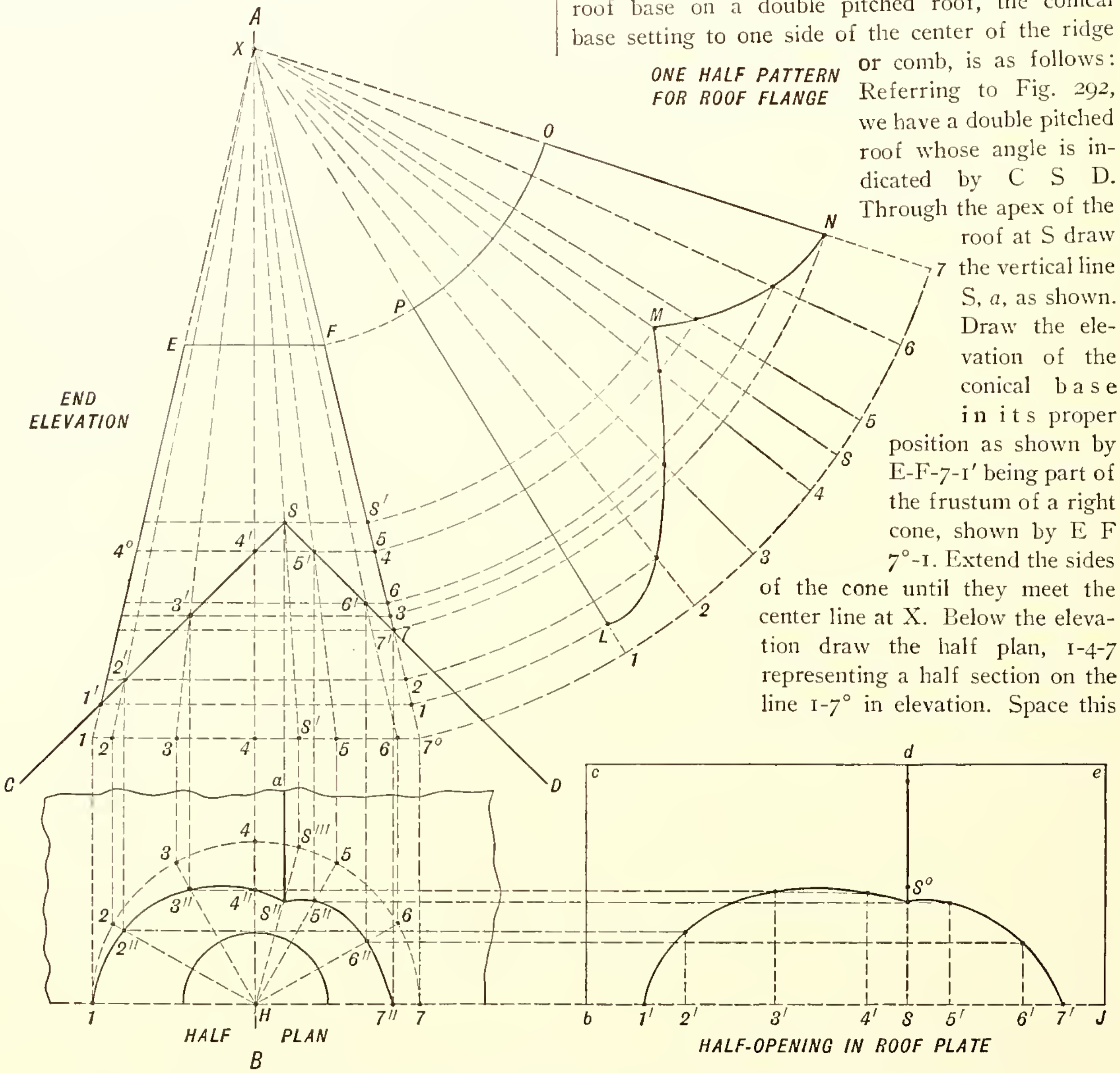


Fig. 292.—Patterns for Roof Plate and Base, Setting to One Side of Ridge on a Double Pitch Roof

semi-circle into an equal number of divisions, as shown by the small figures 1 to 7, from which figures draw radial lines to the center H. From similar points 1 to 7 in the semi-circle erect vertical lines cutting the base line 1-7° in elevation, as shown by similar numbers 1 to 7°, from which radial lines are drawn to the apex X, crossing the double pitched roof from 1′ to 7′. As none of these elements or radial lines just drawn pass through the apex S of the roof, then draw a line from the apex X of the cone through the apex S of the roof, extending it until it meets the base line of the cone at S′; from this point a line is dropped vertically until it cuts the half plan of the base at S‴. From S‴ draw a radial line to the center H, meeting the ridge line *a* in plan at S″, the point desired.

To complete the half plan of the intersecting line between the cone and roof, project vertical lines from the intersections 1′ to 7′ on the roof line C S D, until they intersect similarly numbered radial lines in plan at 1, 2″, 3″, 4″, 5″, 6″ and 7″. Trace the miter line from 1 to S″ to 7″, as shown. This miter line is used only for obtaining the opening in the metal roof plate, as will be described.

The one-half pattern for the roof base is now in order. Using X as center, with radius equal to X 7°, draw the arc 7°-7. Take the girth of the semi-circle 1 to 7 in plan and place it as shown by similarly numbered divisions from 1 to 7 in the pattern. From these points draw radial lines to the apex X. Take the distance from 4 to S‴ in the half plan and set it off from 4 to S in the pattern and draw a radial line from S to the apex X. From the intersections 1′ to 7′ on the double pitched roof line C S D draw lines at right angles to the center line A B until they intersect the side of the cone F-7°, as shown from 1 to 7 including S′. Using X as center, with radii equal to the various divisions on F 7°, draw arcs which intersect similarly numbered radial lines in the pattern. Again using X as center, with X F as radius, describe the arc P O, intersecting the radial lines drawn from 1 and 7 in the pattern. Trace a line through points already obtained, as indicated by L M N. L M N O P gives the one half pattern for the roof base.

The pattern for the roof plate is obtained as follows:

Extend the line 1-7 in plan as 1 J, upon which place the girth of the intersection 1′ to S to 7′ on the double pitched roof C S D in elevation, as shown by similar numbers and letters on 1 J. At right angles to and from these points 1′ to 7′ on 1 J, draw lines; intersect these lines by lines drawn parallel to 1 J from similarly numbered intersections 1 to S″ to 7″ in the miter line in plan. A line traced through points so obtained, as shown from 1′ to S° to 7′, will be the half opening to be cut in the roof plate to miter with the cut L M N in the half pattern for roof base. Add sufficient material around the roof plate opening, as indicated by *b c d c* J. Flanges should be allowed along the miter cut L M N of the roof base and along 1′ S° 7′ in the plate opening.

TAPERING BASE AND ROOF FLANGE ON THE RIDGE AND HIPS OF A PITCHED ROOF

Solution 74

In Fig. 293 is given a finished view of a circular ventilator with a tapering base, which is to set over

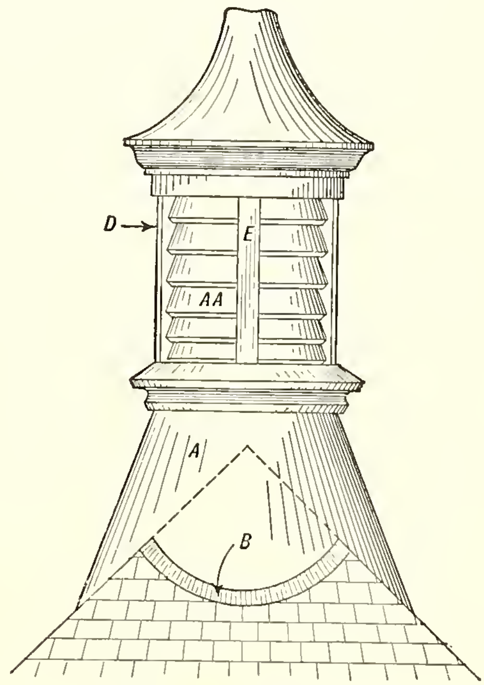


Fig. 293.—Round Tapering Ventilator on Ridge and Hips of Pitched Roof

the ridge and hips of a pitched roof. The pattern for the base A as well as for the roof flange B will be developed as shown in Fig. 294. In this figure A B C D gives the outline of the roof plan, A E and E B representing the hips and E 1 the ridge line. F 1′ H in elevation shows the pitch of the roof, while I K J 4′ shows the elevation of the tapering base. In practice it is necessary to draw but one half of the plan and elevation here shown. The method, as illustrated, for obtaining the patterns is a short one, inasmuch as the side elevation is omitted. Extend the sides of the base until they meet in the apex L, through which the center line L E is drawn. Using E in plan as center, describe the large dotted circle representing a section on the line I 4′ in elevation, while the smaller circle in plan shows a section on the line K J in elevation. In this case, where the large circle crosses the hip line B E, number that intersection 6, as shown. Space the large circle in plan in an equal number of divisions, as shown by the small figures, 1 to 8, from these points draw radial lines to E and from similar points, 1 to 8, erect vertical lines cutting the base line I 4′ in elevation, also shown by the small figures 1 to 8. From these points lines are drawn to the apex L, cutting the roof line H 1′ at 1′ to 8′, as shown. From these intersections, 1′ to 8′, horizontal lines are drawn to intersect the slant line of the base 4′-J at 1^x to 7^x. As that part of the base, shown in plan by 6-7-8, intersects the front pitch of the roof, it will be practicable to obtain the miter line in elevation if it be desired, by projecting horizontal lines from 8′ and 7′ on the roof line H 1′ to intersect similarly numbered radial lines as shown, thus obtaining the miter line shown by 6′-7^o-8, but this miter line is not essential to the pattern for the base.

The half pattern for the base may now be laid out. Using L as a center, with radii equal to L 4′ and L J, draw the arcs 4′-8 and J O, respectively, and on the arc 4′-8, set off the same number of divisions as are contained in the large semi-circle in plan, shown from 1 to 8, all as shown by similar numbers 1 to 8 in the pattern, from which radial lines are drawn to the apex L. Then, using L as center with radii equal to the various intersections between 1^x and 8′, draw arcs to intersect similarly numbered radial lines in the pattern, thus obtaining the intersections 1^v to 4 to 6^v to 8, through which the miter cut is traced. N O 8 6^v 4 1^v N will be the desired pattern, for which laps should be allowed for soldering and riveting. In using this method no side elevation is necessary; but care must be taken to follow the numbers closely, since the numbers

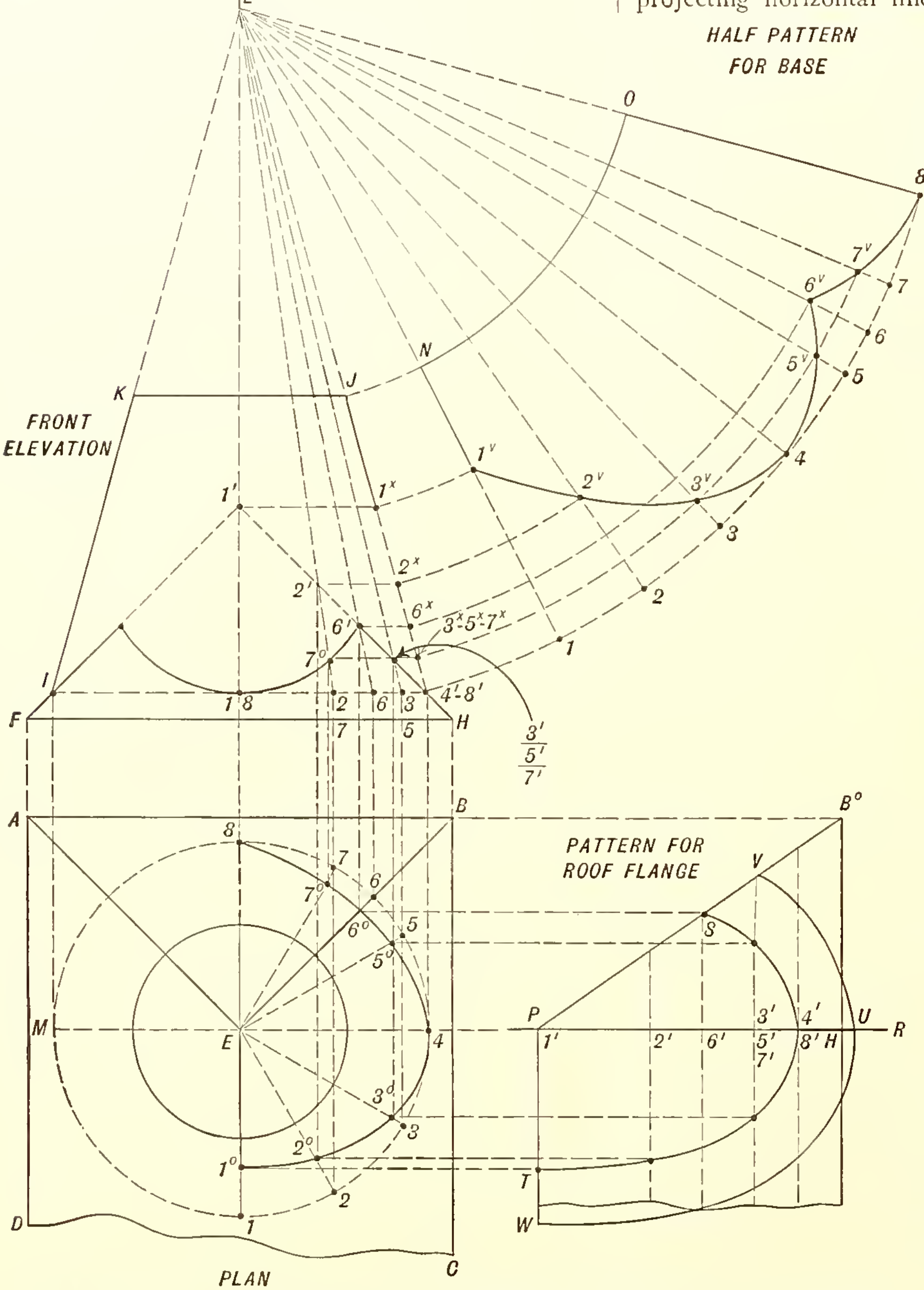


Fig. 294.—Patterns for Tapering Base and Roof Flange on Ridge and Hips of Pitched Roof

1 and 8, 2 and 7, also 3 and 5 are on one line in plan.

ROOF FLANGE FITTING AROUND A TAPERING BASE INTERSECTING THE RIDGE AND HIPS OF A PITCHED ROOF

Solution 75

To obtain the pattern for the roof flange on the front and sides of a pitched roof, indicated by B in the view of Fig. 293, the line of intersection between the tapering base and roof must be found in plan, as shown in Fig. 294. From the various intersections 8, 7° and 6′ in elevation, lines are projected vertically in the plan, cutting radial lines having corresponding numbers, thus obtaining the intersection points 8, 7° and 6°, as shown; these points represent the miter line of the base and one half of the front of roof in plan, as shown. Where the various radial lines in elevation, shown by 5, 4′, 3, 2 and 1 on the line I 4′, cross the roof line H 1′, vertical lines are projected into the plan, to intersect similarly numbered radial lines at 5°, 4, 3°, 2° and 1°; the point 1° being obtained by taking the horizontal distance from 1′ to 1^x in elevation, and setting it off on the ridge line in plan from E to 1°. A line traced from 6° to 4 to 1° in plan gives the miter line between the base and side of roof.

The pattern for the flange may now be laid out as follows: Extend the line E 4 in plan as P R and upon this place the girth of the spaces contained on the roof line 1′ H in elevation, as shown by similar numbers on P R. At right angles to P R and through these small figures, draw lines and intersect them by lines drawn parallel to P R from similarly numbered intersections in the miter line from 8 to 6° to 4 to 1°. Trace a line through points so obtained, as shown from S to 4′ to T. Set the dividers apart a distance equal to the width of the flange required and draw a line parallel to S 4′ T, as shown by V U W. S 4′ U V then gives the pattern for one half the flange on the front of the roof, and S 4′ T W U V the pattern for the flange for the sides of the roof. Allow laps for soldering and riveting.

HOOD OVER VENTILATOR

Solution 76

Fig. 295 presents a view of a ventilator hood. The method of development of the patterns is alike in the case of both square and rectangular work. Referring to Fig. 296, first draw the section of the hood, as indicated by A, and in line therewith to the right draw the plan view, as shown by B C D E. In this case the full plan has been drawn; this however, is not necessary in practical work, all that is required being the one miter end, making the hood as

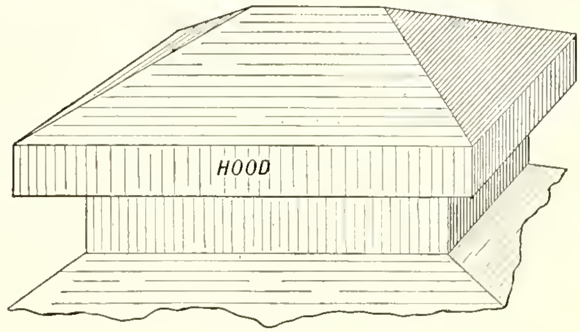


Fig. 295.—View of Ventilator Hood

long as desired by reversing the miter cut to the opposite end. From each of the four corners in plan draw lines at angles of 45 degrees, intersecting at F and G, as shown. Connect the ridge line F G. At right angles to E D draw the girth line *a b;* on this place twice the girth of the half section A, as shown from 1 to 4 to 1 on *a b*. Should the full girth of the hood A take up more material than the stock sizes of the sheets will allow, only the girth from 1 to 4 is employed. At right angles to *a b* and

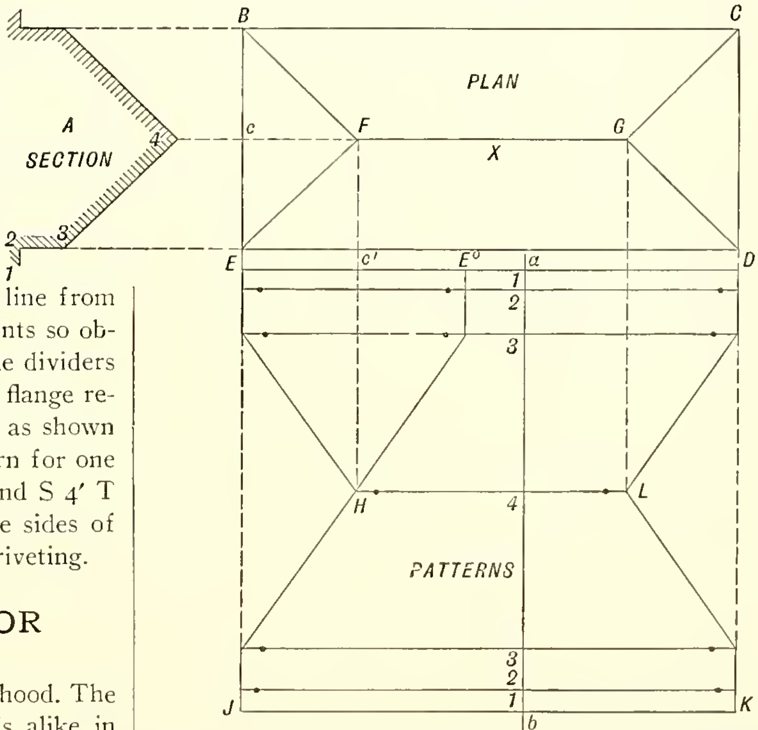


Fig. 296.—Patterns for Diamond Panel and Ventilating Hood

through the small figures 1 to 4 to 1, draw lines and intersect these by lines drawn from similar points on the miter lines E F and G D in plan and parallel to *a b*. Trace a line through these points; the resulting E D L K J H E will be the full pattern.

For the pattern of the miter heads at the ends, take the distance from *c′* to E in the pattern and place it, as shown, from *c′* to E°, completing the cut E° H alike to E H. This miter head can be thus obtained, since *c′* E in the pattern is similar to *c* E in plan, which latter is one half of B E. Allow laps for riveting or soldering.

PART IX

PATTERNS FOR COPINGS, HEAD BLOCKS, HIP RIDGES, FINIALS AND SPIRES

MOLDED HEAD BLOCK, INTERSECTING PEDIMENT COPING.

Solution 77.

FIG. 297 is a view of a molded head block intersecting a pediment coping and mold, as along *a b c*. These copings are usually made of sheet copper and give dependable service. They do not leak at the joints as does stone. The method of laying out these

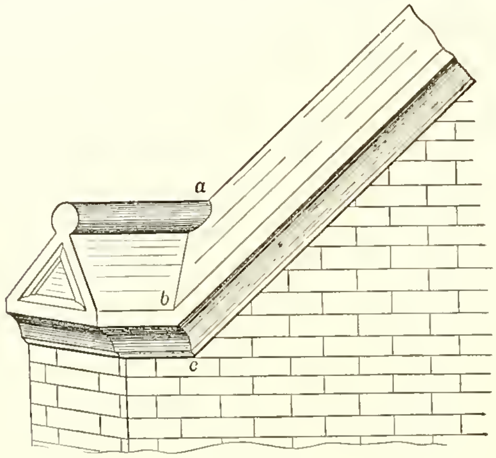


Fig. 297.—View of Molded Head Block Intersecting Pediment Coping

patterns is shown in Fig. 298, where A represents the end view of the head block (only one half of which is it in practice necessary to draw), and 9°-8-B the bevel of the pediment. At right angles to the pediment pitch 8-B, draw a section through the coping, as indicated by D, taking care that the width from 6″ to 6″ is equal to 6-6′ in the end view, and that the profiles 6″ and 6″ in the side view are similar to the profile shown in the end view. Draw the bevel of the coping between 6″ and 6″ in the section as shown. Bisect the angle of the pediment 9°-8-B as follows: Using *a* as center with any radius, describe the arcs cutting the angle lines at *b* and *c*. Using *b* and *c* as centers with any desired radius, intersect arcs at *d*. Draw the miter line *d* 5′. Divide the mold from 5 to 11 in the end view into an equal number of spaces and from these points project horizontal lines to the right until they cut the miter line *d* 5′, as shown. Divide the bead in the head block in the end view into an equal number of divisions, as shown in the right half from 1 to 4. Take a tracing of this upper bead and place it in central position over the coping in the section D, as shown by similar numbers from 1 to 4; from these points lines are projected at right angles to the lines of the coping until they cut the beveled coping also from 1 to 4. From these divisions and parallel to the lines of the coping, lines are drawn and intersected by lines drawn parallel to the lines of the head block, from similar intersections 1 to 4 in the end view, thus resulting in the miter line shown between 1′ and 5′. Finding this miter line is the principal and most difficult part of the operation; after this is achieved the patterns are in order.

To obtain the one half pattern for mold and roof over head block, draw any line at right angles to X 1′ in the side view, as shown by O N, and on this place the girth of the half top and mold shown in the end view from 1 to 11, as shown by similar numbers on N O. Through these small figures and at right angles to N O draw lines; intersect these lines by lines drawn parallel to N O from similarly numbered intersections in the miter lines, between 1′-5′-11 and 5^T-9° in the side view. A line traced through points thus obtained as shown by T, S, U, R and P, 6, 1 will be the desired pattern.

To obtain the pattern cut for one half the coping and mold for the pediment, draw any line, as G H, at right angles to F E. Take the girth of the pediment mold in the end view from 11 to 5 and place it on the line G H, shown from 11 to 5; to this add the girth of the intersections obtained on the coping from 5^a to 1 in the section, as shown from 5 to 1 on G H. Through these small figures and at right angles to G H, draw lines and intersect them by lines drawn parallel to G H from similarly numbered intersections in the miter line in the side view, all as

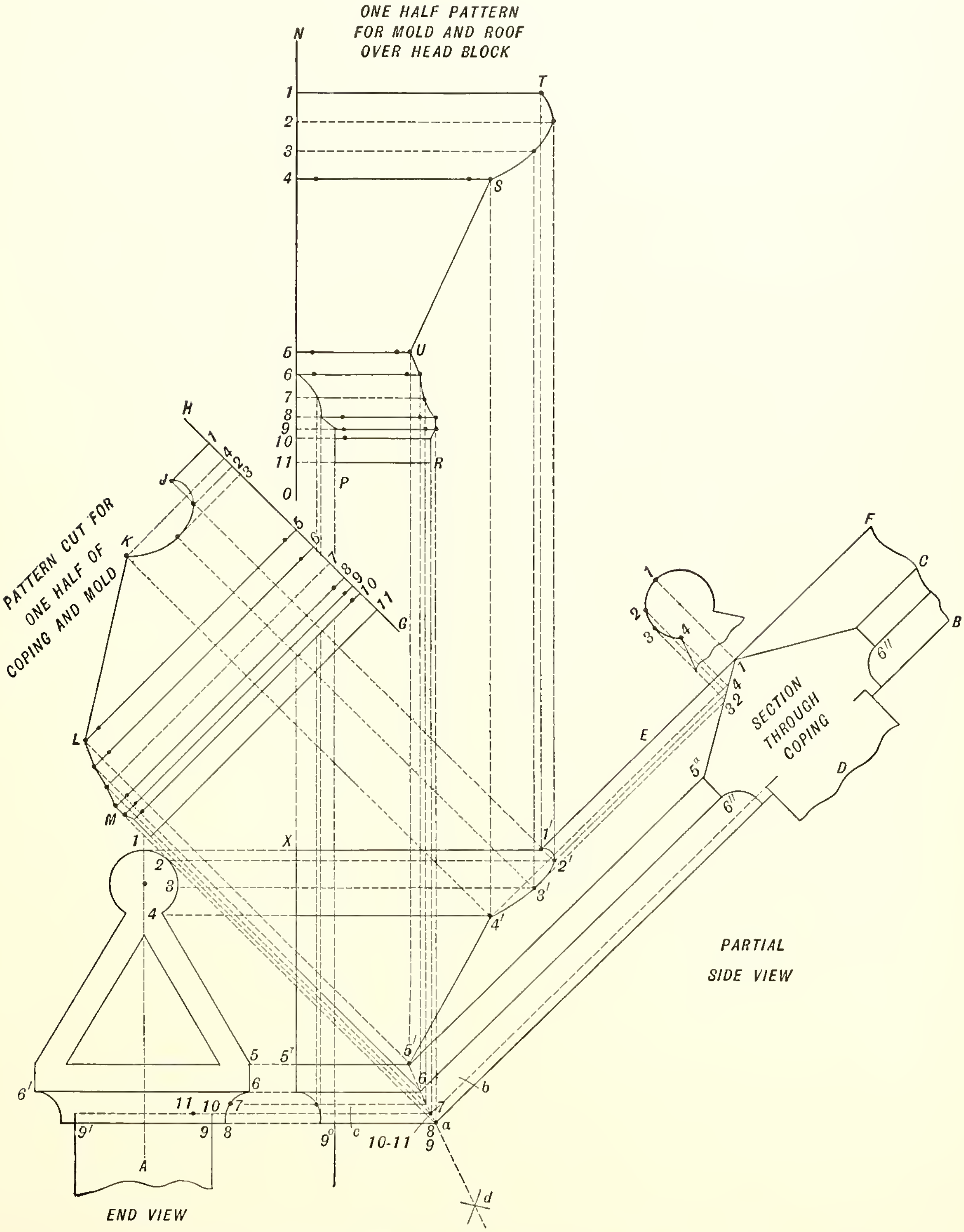


Fig. 298.—Pattern for Molded Head Block Intersecting Pediment Coping

indicated by the dotted lines. Trace a line through points thus obtained; J K L M will be the desired miter cut. Laps should be allowed for seaming the apex of the coping and riveting the miters.

Securing Metal Coping to Brick Wall.

Fig. 299 demonstrates how metal copings are best secured to a brick or other kind of wall. The use of 18 oz. cold rolled copper is recommended for the

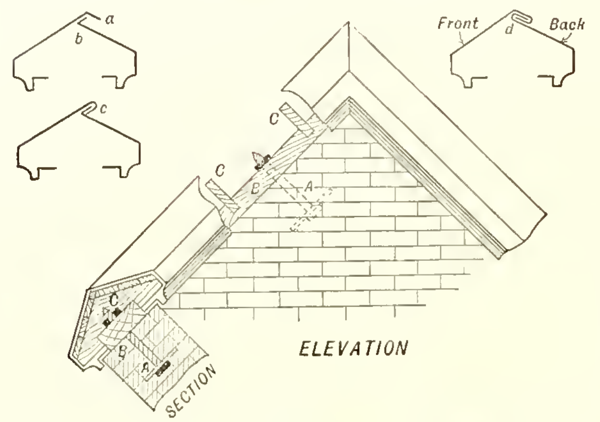


Fig. 299.—Constructive Details of Securing Metal Coping to Wall

coping and head, as far superior to stone, since the mortar is subject to cracking, softening and washing out from the joints of a stone coping while the latter permits ice to form therein occasionally forcing the stone out of position, while any unevenness in the surface of the wall becomes visible because of the depth of the mortar under the stone coping required to provide a level surface when it is set. A metal coping obviates these disadvantages, since the wall is protected against snow, rain, or ice leakage by means of the drip at the bottom of the molding, which also conceals uneven wall lines. The section at the left of the illustration shows the wall in which the bolt A is built in and is used in securing the wooden plate B. After this plate is bolted in position, wooden brackets are cut, as indicated by C, spaced about 3 ft. apart and sheathed on the top, as shown. An elevation of this wood framing is indicated by the broken view A B C C in the elevation. In fitting the coping over the frame work, the former is made in two parts with a drip, as shown, and a locked joint along the apex of the coping. The drip should be so bent that it will spring tight against the wall when it is set in place and the lock bent towards the rear so that it cannot be seen from the front. This lock should be bent in the brake as indicated by *a* and *b* in the upper diagram to the left, so that when the two halves are set on the wall, and over the coping, it can be turned over, as shown by *c* in the lower left diagram; after those operations it is double locked as shown by *d* in the right diagram.

RIDGE CAPPING REQUIRING RETURN HEAD AND BUTT MITER

Solution 78

Fig. 300 illustrates a ridge capping, placed on the wing of a hipped roof, requiring a square return miter, at A B, and butt miter against the main roof, at C. The method of laying out miters of this nature, regardless of the pitch of the roof, is found in Fig. 301.

First, draw the section through the ridge roll, as indicated by A, and space one-half of its profile into an equal number of divisions, as shown by the small figures, 1 to 9. Draw the pitch of the main

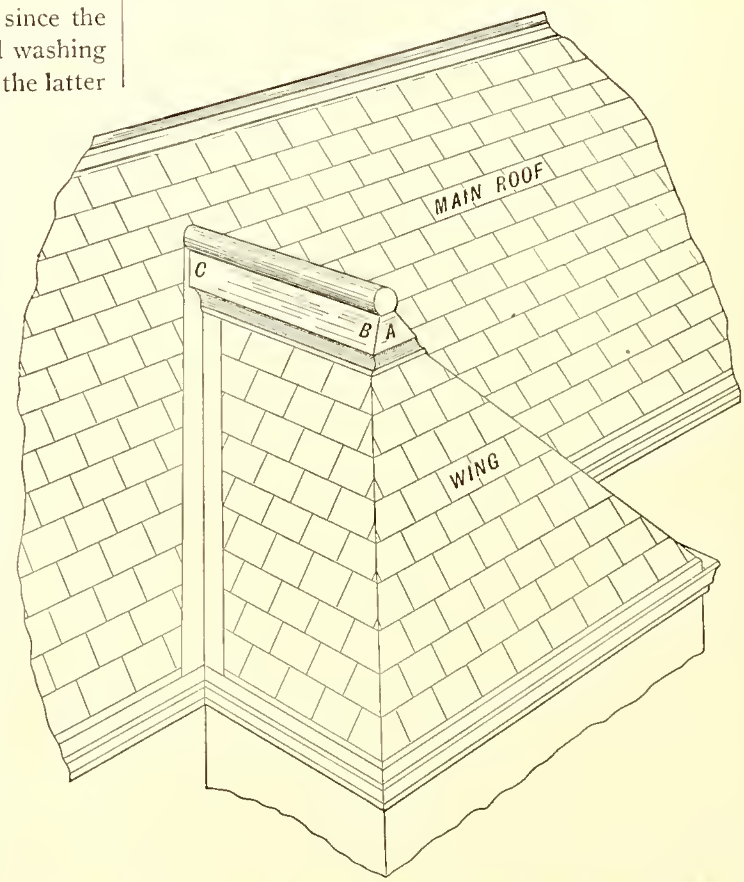


Fig. 300.—View of Ridge Capping Having Return Head and Butt Miter

roof B C and draw a partial side elevation of the wing, as shown, the pitch D in this case being similar to the pitch in the section A. Take a reproduction of the half profile 1 to 9 in section and place it, as shown from 1′ to 9′ in the side elevation, the line 9-*a* and 9′ *a*′ in either view being placed vertically on the line drawn through the apex X and X^1 respectively. Through these small figures 1 to 9 in the section draw lines horizontally to the left cutting the main roof B C from 1 to 9.

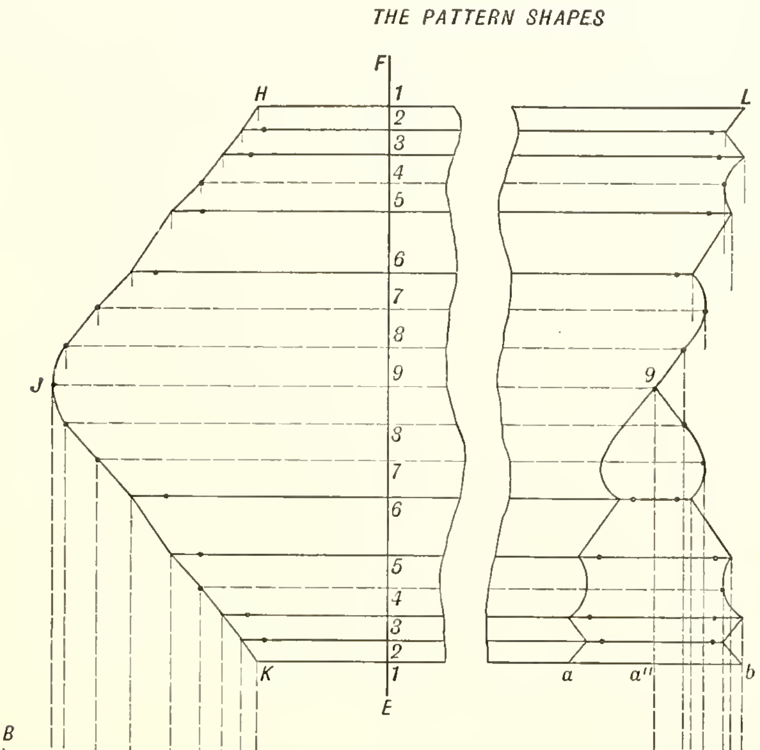
For the pattern for both miters, take the girth of the half section in A and place twice this girth on the line E F drawn at right angles to 9-9′ in the side elevation, as shown by the small figures 1 to 9 to 1 on E F. Through these small figures and at right angles to E F draw lines and intersect them by lines drawn parallel to E F from similar points of intersection on the roof line B C and the profile 1′ to 9′. A line traced through points thus obtained, as shown by H J K, will give the butt miter cut, while L 9 *b* will give the square return miter cut.

If a vertical line is drawn from point 9 in the pattern until it cuts the edge line of the pattern at *a*″, and, measuring from this line *a*″ 9, the various projections are taken to the various points along the miter cut 9 *b* and placed opposite the line 9 *a*″, as shown from 9 to *a*, then 9 *a b* will be the pattern for the return head, shown in the sectional view. This method avoids the making of a separate pattern, since the miter cut 9 *b* is similar for both the front and side patterns. Edges should be allowed along the pattern 9-*a b* for soldering purposes.

INTERSECTION BETWEEN HIP RIDGE AND RIDGE CAPPING

Solution 79

Fig. 302 presents a view of two hip ridges mitering with a ridge capping, at *a* and *b*. In laying out these patterns it is necessary to obtain only short miter cuts about 6 in. long, when the desired length can be laid out directly on the metal



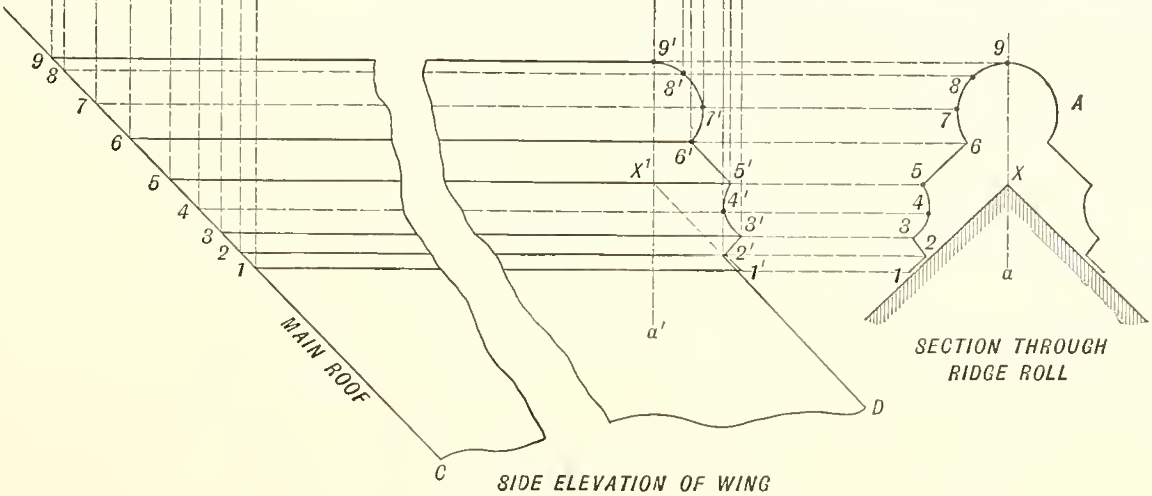


Fig. 301.—Patterns for Ridge Capping Requiring Butt Miter and Square Return Head

sheets. The first step is to obtain the correct pitch of the roof, either from the architect's drawing, or by the use of a bevel and spirit level directly from the building. In using the bevel one arm is laid directly on the roof rafters as shown by A, while the other arm, B, is raised until the small spirit level shows true, as at C. The distance between the inner edges of the arms is now measured, as indicated by the arrows. Assuming that it measures 8 in., the bevel is closed, until the patterns are to be developed, when it is opened again to the 8 in. distance between the inner corners and placed on the drawing board, so that the upper arm will be horizontal, as shown by the dotted bevel in Fig. 303. The line through the lower arm of the bevel is now extended to any distance desired, say 18 in., as shown from 1 to 2; from these points the horizontal lines 1 A and 2 B are drawn, thus representing a partial side elevation. Below the elevation draw the plan of the corner, as indicated by C D 2′ E F 1′, and draw the hip line in plan 1′-2′. As the bevel of the end of the roof 1-2 is similar in this case to the two sides, 1 N is then drawn at a corresponding bevel to 1-2. N 1 2 becomes a partial front elevation, whose purpose we will explain in due course. Preparatory to developing the patterns a true face of the roof is to be drawn; this will show the true angles of A 1 2 and N 1 2 in the elevation.

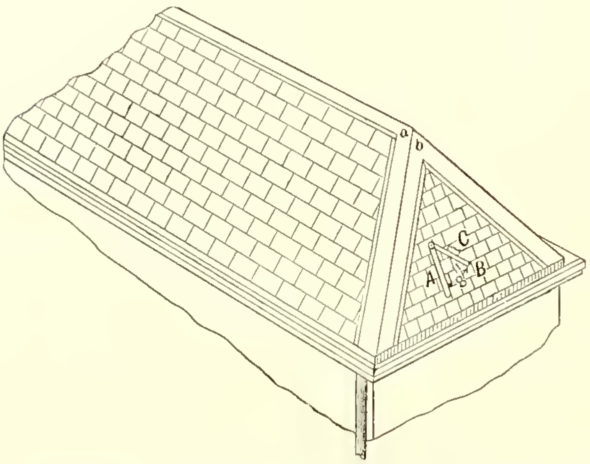


Fig. 302.—View of Hip Ridge Mitering With Ridge Capping

Extend the line C 1 to any length as C 1″; and on this line set off the distance 1-2 in elevation, as indicated by 1″ 2″ in the true face. Through these two points draw horizontal lines and intersect them by lines drawn parallel to C 1″ from similar numbers in elevation. J 1″ G H shows the true face desired and J 1″ G the true angle of A 1 2 in elevation. The angle J 1″ G in the true face is now bisected by means of the arcs *d e* and *f*; the miter line 1″ *f* drawn, as shown, forms the joint line between the hip and ridge in the side elevation. As N 1 2 in the side elevation forms a partial front elevation and as the angle or pitch 1-2 in the elevation is alike on the three sides, the joint line between the two hip molds shown by *b* in Fig. 302, is determined by the perpendicular line 1″ *i* in the true face in Fig. 303.

The pattern for the ridge capping is laid out as follows: Place the half profile of the ridging, whatever may be its shape, in the position shown by X to the left of the true face; space the half profile into equal divisions, as shown from 1 to 5. Through these small figures and parallel to J 1″ draw lines to the right until they intersect the miter line 1″ *f*, as shown; from these points and parallel to 1″ G lines are drawn until they cut the miter line 1″ *i* and the base line G H. At right angles to J 1″ draw the line J K; on this place double the girth of X, as shown from 5 to 1 to 5 on J K. At right angles to J K draw the usual measuring lines, and intersect them by lines drawn parallel to J K from similar intersections on *f* 1″ in the true face. A line traced through points thus obtained, as shown by L *a* M, will be the desired miter cut for the cap ridging.

The pattern for the hip ridge, is obtained by placing twice the girth of the half profile X upon the line O P drawn at right angles to 1″ G in the true face, as shown by the small figures 5 to 1 to 5. At right angles to O P draw the usual measuring lines, intersecting them by lines drawn parallel to O P from similar intersections on G H, 1″-*i* and 1″-*f*. Trace a line through points thus obtained; Y *c* X° will be the miter cut at the bottom, V *b* the miter cut joining the ridge capping at *a* in Fig. 302 and *b* W in Fig. 303 the miter cut where the two hips join, as at *b* in Fig. 302.

Should a pattern for the lower head in Fig. 303 be desired to close the opening of the hip ridge along G 5 in the true face, this may be laid out by drawing lines at right angles to H G in the true face from points 1 to 5, as shown; then, measuring from the finished roof line, extended in profile X, take the various horizontal projections to points 1 to 5 and place them on similarly numbered lines, measuring in each case from the line H G in the true face. A line traced through points thus obtained, as indicated by X^2, will be the desired pattern.

All that portion from 1 to 5 in the ridge and hip patterns will be formed after the stay shown by X, bending the hip pieces right and left. But preparatory to making the bend along the line *b c* in the pattern for hip ridge, the true angle is

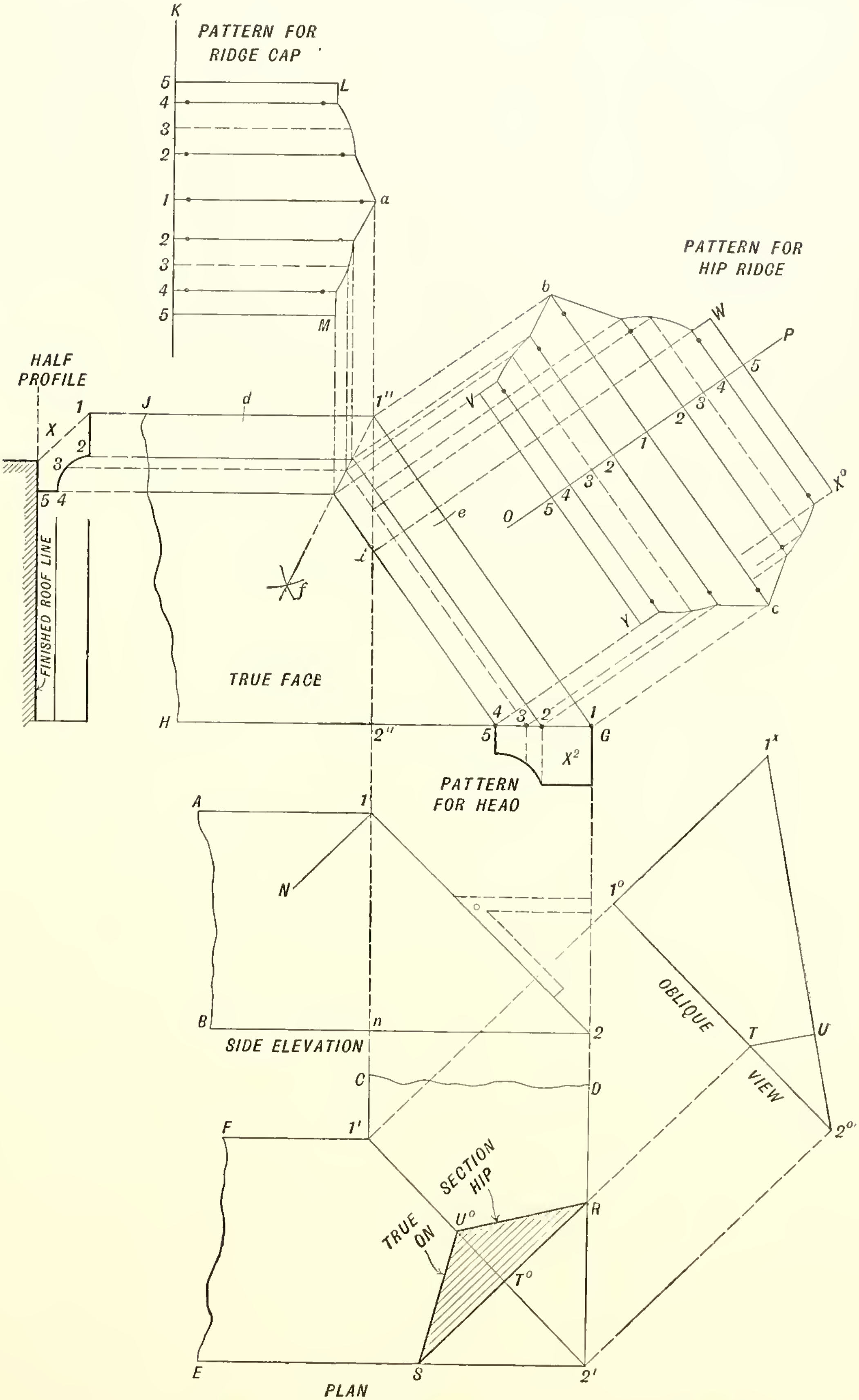


Fig. 303.—Patterns for Intersection Between Hip Ridge and Ridge Capping

first to be found, in the following manner: At any desired distance between and on the hip line 1′ 2′ in plan draw at right angles to 1′ 2′ any line, R-S, cutting the right angle D 2′ E at R and S. Construct an oblique view on the line 1′ 2′ in plan by drawing the line 1° 2° equal to and parallel to 1′-2′ in plan. From 1° erect the perpendicular line 1° 1^x equal to *n* 1 in the side elevation and draw a line from 1^x to 2°, the oblique view desired. Extend S R in plan until it cuts the base in the oblique view 1° 2° at T and from T and at right angles to 1^x 2° draw a line cutting the slant line at U. Take the distance T U and set it off in plan from the line R S, as shown from T° to U°, and draw the lines R U° S, the true section on the hip line, also the true stay; after this stay, the bend on the line *b c* in the pattern is formed. Should the angle of the roof in plan be other than a right angle, the same methods are employed, care being taken, however, that the miter line 1′-2′ in plan always constitutes the bisection of the angle of the desired outline.

HIP RIDGE INTERSECTING A VERTICAL PLANE AT A RIGHT ANGLE

Solution 80

A hip ridge butting against a vertical surface, as against the base of a square ventilator or cupola is

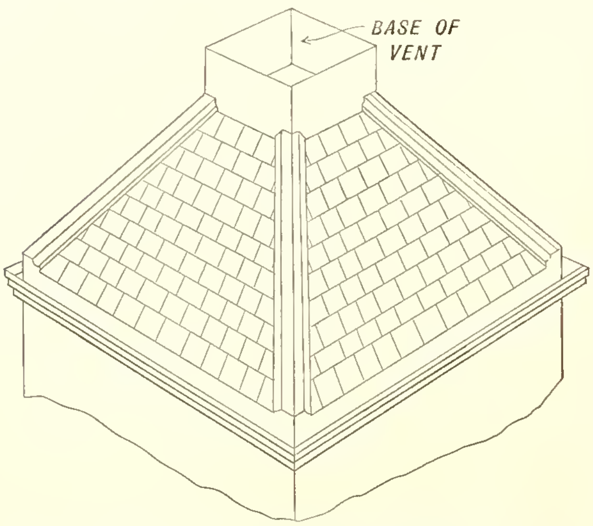


Fig. 304.—View of Hip Ridge Intersecting the Base of a Square Ventilator or Other Object

shown in Fig. 304. The development of the pattern is shown in detail in Fig. 305. Here A B C D indicates the elevation of part of the roof and E F G H J K the plan of one corner or hip. As explained in the solution just preceding, the length of B C in elevation need not be any greater than required to get the miter cut, say about 18 in., the full size measurements being laid out on the 8 ft. sheets.

The first step is to find the oblique view on the line J F in plan, as follows: Draw J^1 F^1 equal to and parallel to J F in plan, as shown, and from J^1 erect the perpendicular J^1 *b* equal to *a* B in elevation. Draw a line from *b* to F^1 in the oblique view; this shows the true length of the hip on J F in plan. From any point on the line J F as *c′* draw a line at right angles to J F cutting the right angle E F G at *c* and *d*. Extend *c d* until it cuts the base line in the oblique view at *e*; from this point and at right angles to *b* F^1 draw a line cutting the line *b* F^1 at *f*. Take the distance from *e* to *f* and place it from *c′* to *f′* in plan; draw lines from *d* to *f′* to *c*, which give the true angle through the hip, at right angles to the hip line *b* F^1 in the oblique view. On this true angle in plan, place the profile of the hip ridge, as indicated by X, one half of which space into equal divisions, as shown by the small figures 1 to 5. Through these divisions draw lines parallel to J F cutting the line J K at the top and E F at the bottom. Through the apex *f′* in the true angle in plan draw a line parallel to *c d*, as shown by *h i*. Take a tracing of the profile X with the various divisions thereon, and place it in the oblique view, placing the apex *f′* in X directly on the line *b* F^1 in the oblique view, so that the line *h i* in plan will rest on the line *b* F^1 in the oblique view. Through the small figures 1 to 5 in *f°* draw lines parallel to *b* F^1 and intersect them by lines drawn at right angles to J F in plan from the various intersections 1 to 5 on J K and F E, thus obtaining the miter lines Y and F^1 respectively in the oblique view.

The pattern for the hip ridge may now be laid out. Take the full girth of the profile *f°* and place it on the line L M, drawn at right angles to *b* F^1. At right angles to L M and through the small figures 1 to 5 to 1 draw lines and intersect them by lines drawn parallel to L M from similar points of intersection in the miter line Y at the top and F^1 at the bottom. Trace a line through points thus obtained; N O P R S T will be the desired miter cut.

For the pattern for the corner head used to close up the opening at the bottom of the ridge extend the line J^1 F^1 as F^1 U; on this place twice the number of divisions contained on the line E F in plan between 2 and 5, as shown from 2 to 5 to 2 on F^1 U. Through these small figures and at right angles to F^1 U erect lines and intersect them by lines drawn

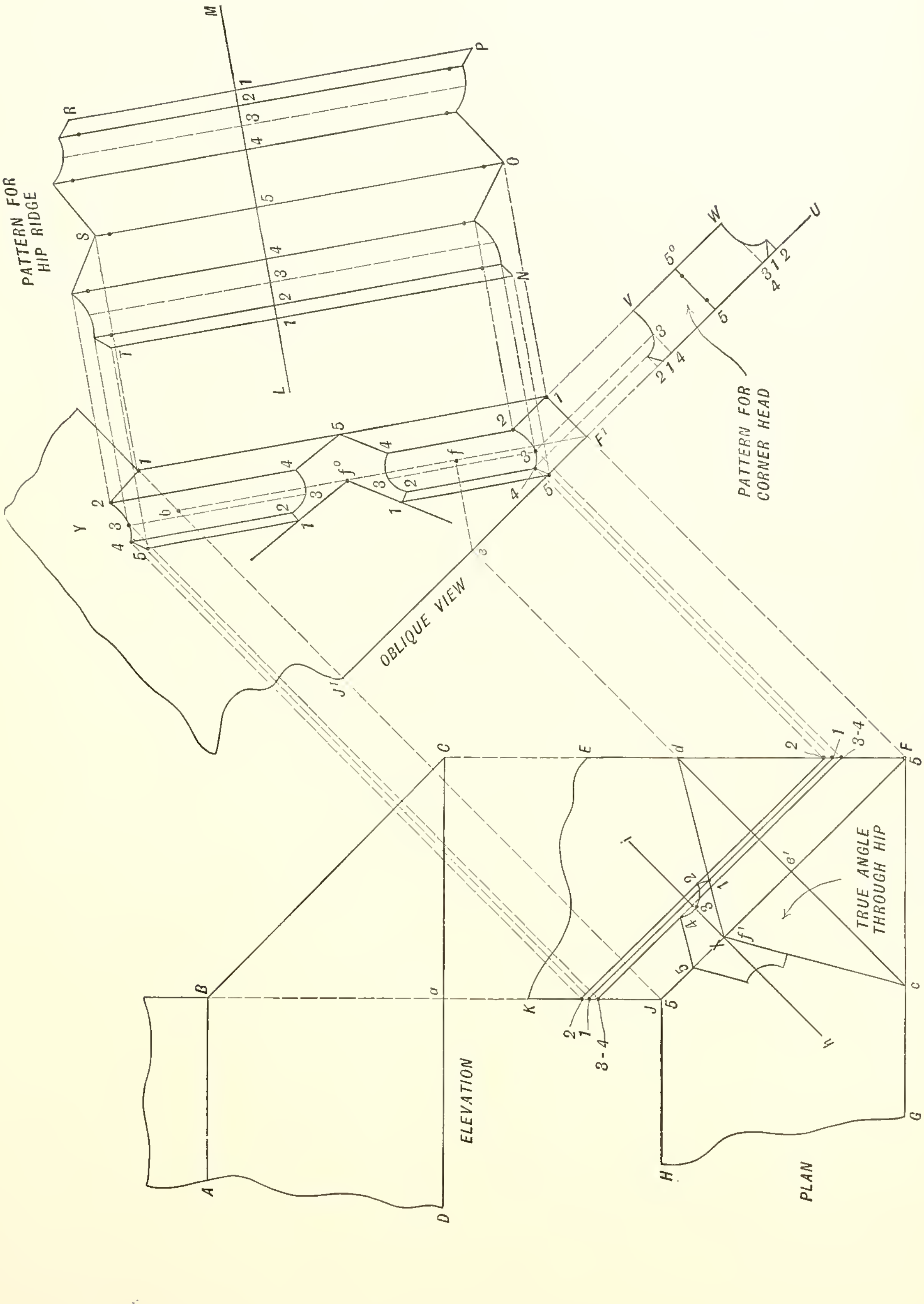


Fig. 305.—Hip Ridge Intersecting a Vertical Plane at Right Angles in Plan

parallel to F^1 U from similarly numbered intersections in the miter line F^1 in the oblique view. 1 V 5° W 1 shows the full corner head pattern.

A square bend is made along the line 5-5° in the corner pattern, while the ridge pattern will be formed after the profile X in plan or *f*° in the oblique view.

RIDGE AND HIP FINIAL WHEN ALL ROOF PITCHES ARE EQUAL

Solution 81

Fig. 306 presents a view of a ridge and hip finial, when the end roof, A, and side roofs, B, are of

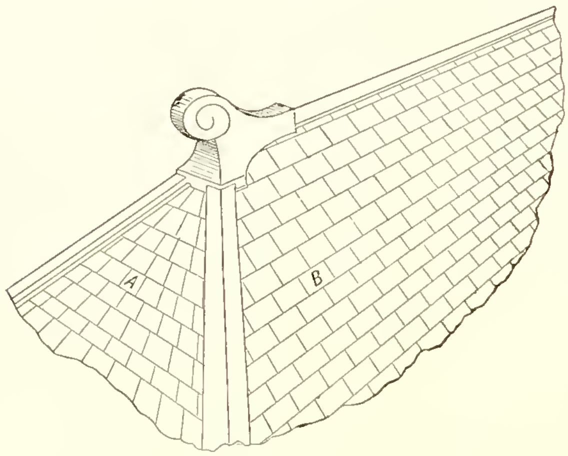


Fig. 306.—View of Ridge and Hip Finial

equal pitch. The method of procedure in laying out finials of this formation is shown in detail in Fig. 307.

First draw the front elevation, A B C, giving the pitches of the sides of the roof, from which the side elevation, D E F G is projected and giving the pitch of the front roof as shown by D E. Draw the desired side elevation of the finial to whatever intended shape it should have, taking pains to have a symmetrical curve sloping down the incline of the roof E D. In line with the side, draw the front elevation of the finial, again having the curves slope symmetrically to the line of the pitch of the roof B C. While the full front elevation is shown, it is necessary to draw only one half, as the halves are symmetrical.

Having drawn the elevations in their correct relative positions the patterns may be developed. Beginning at 1 in the side elevation, divide the entire outline up to 16, as shown by the small figures 1 to 16; through these points draw horizontal lines to the left, cutting the outline in the front elevation as well as the center line M N, as shown by the small figures 1 to 16. As all that portion of the finial between 5 and 16 in the side elevation stands vertical, as shown by the vertical line 16-10 in the front elevation, it will not be necessary to project the points 5 to 16 from the side elevation to the front. Take the girth of the front and top of the finial, shown from 1 to 16 in the side elevation, and place it, as shown, on the line M N by similar numbers. Through these small figures and at right angles to M N draw lines and intersect them by lines drawn from similar numbers in the front elevation parallel to M N. Trace a line through points thus obtained, as shown from V to R, and transfer this cut opposite the center line N M, as shown by W P. Take a tracing of 5^x, 5, *a*, *a*″, B, a^x 5^x in the front elevation, which represents a true section on line 16-*a* in the side elevation, and place it in a reversed position, as shown by W V S O W. Then will P R S O represent the full pattern for front, top and back combined.

For the pattern for the sides project lines to the right from points 1, 2 and 3 in the side elevation, cutting the outline 1′-*a* at 2′ and 3′. Establish an extra space between 3′ and *a* and call it *a*′. Project *a*′ horizontally to the left, cutting the outline in the front elevation at *a* and the roof line at *a*″, extending the line to the center line M N, as shown. Take the girth of 1, 2, 3, *a*, 4, 5 in the front elevation and place it on the vertical line drawn above the side elevation as H J, as shown by similar numbers. Through these small figures, draw lines at right angles to J H, and intersect them by lines drawn parallel to H J from similarly numbered intersections in the side elevation. As the side elevation between 5 and 16 lies in a vertical plane, indicated by 16-10 in the front elevation, take a tracing of 5, 6, 8, 10, 13, 16 in the side elevation and place it as shown by L, 8″, 10″, 13″, 5, in the side pattern, carefully placing the line 5-16 in the side elevation on the line L, 5, in the pattern. K, L, 10″, 5, *a* K, is the desired pattern.

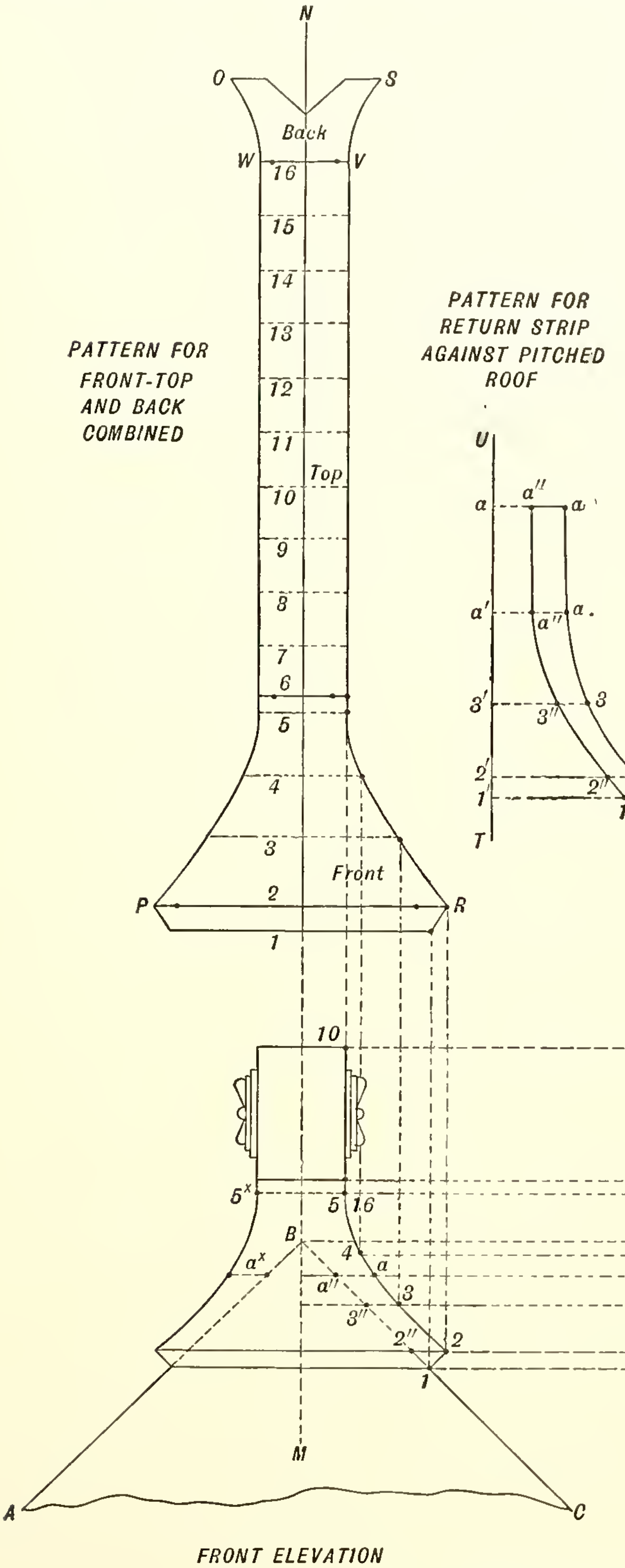
If a scroll is desired at Y this can be added and then raised by means of a strip soldered to the proper projection, or a rosset can be put into position as shown in the side elevation.

Another pattern will be required for the return strip against the main roof from *a* to 1′ in the side elevation. Take the girth of 1′, 2′, 3′, *a*′ *a* in the side elevation and place it on any line, as T U, as shown by similar numbers. Through these small figures and at right angles to T U draw lines to any length as shown. Measuring from the line M N in the front elevation take the various projections to points a'', $3''$, $2''$ and 1, also from the center line M N to points a, 3 and 2, and place them on similarly numbered lines, measuring in every instance from the line T U, thus obtaining similar points a'', a'', $3''$, $2''$ and 1, also a, a, 3 and 2. When a line is traced through these points a'' a 1 will be the pattern for the return strip against the pitched roof, shown in the side elevation by a 1′.

PATTERN FOR HIP AND RIDGE FINIAL, WHEN THE ROOF PITCHES ARE UNEQUAL

Solution 82

In Fig. 308 is shown a type of hip and ridge finial, which sets on a roof whose pitches on the sides as at A are unlike that on the front B. We will develop



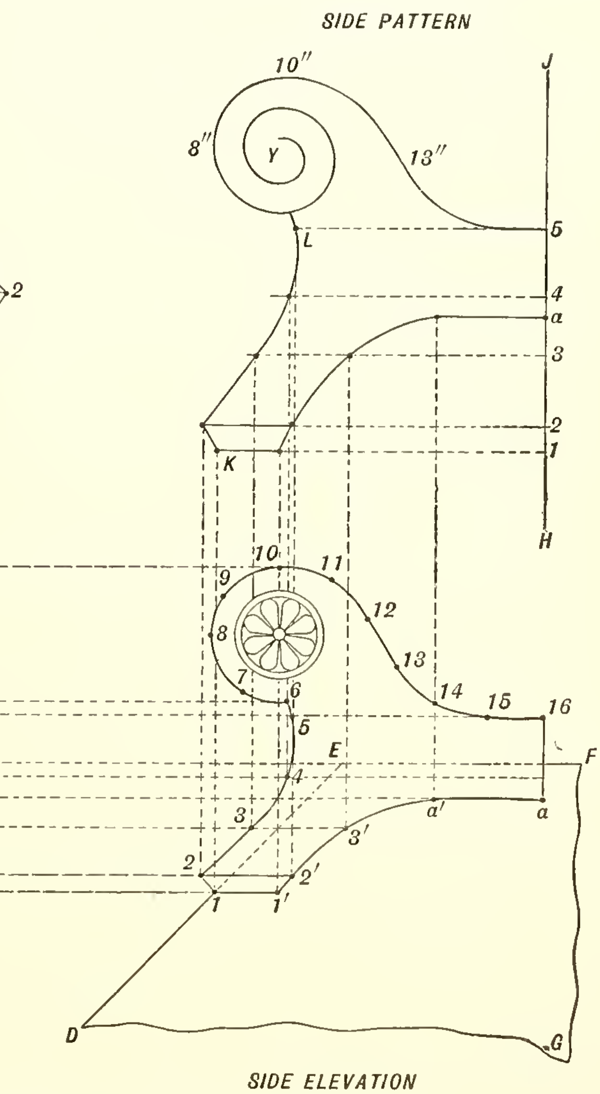


Fig. 307.—Patterns for a Ridge and Hip Finial, when all Roof Pitches are Equal

only the patterns for that part shown to the arrow point. The portion above the arrow, C, consists simply of square return miters and above C is the sphere D.

Fig. 309 shows how the four patterns are laid out. First, draw the front elevation giving the pitch of the side roofs, which, in this case, is 60 degrees, as

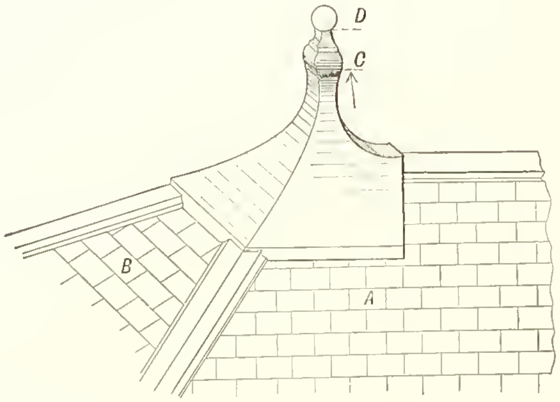


Fig. 308.—Another Type of Hip and Ridge Finial, in which the Roofs Have Unequal Pitches

shown by B A C. From this front view, draw the side elevation G D E F, indicating the pitch of the front roof, which is 45 degrees, as shown by G D. In drawing the two elevations of the roof, care must be taken that the ridge line E D corresponds to the similar ridge line A in the front elevation, as shown by the dotted construction line. In making the details in practice, only a half elevation of the front is necessary. Draw the front and side elevations of the finial in their proper positions as shown, drawing well rounded curves in both views to follow the pitches of the roofs, so that no breaks will show. Set off the curve in the side elevation into an equal number of divisions, as shown by the small figures 1 to 7, and continue to 8 and 9 where the flat area lies parallel to the roof. Through these small figures 1 to 9, draw lines to any length cutting the right outline in the side elevation from $1'$ to $5''$ and the right outline in the front elevation from 1^a to 9^a. The method followed here is to use but one set of lines, taken from the equal divisions in one profile, thus making the divisions in all other profiles unequal. This method obviates a confusion of lines which would occur if each profile were spaced equally and separately.

To obtain the pattern for the front piece take the girth of the profile 1 to 9 in the side elevation and place it on the center line A P extended in the front elevation, as shown by similar numbers 1 to 9 on P R. At right angles to P R and through these small divisions draw lines and intersect them by lines drawn parallel to R P from similarly numbered intersections in the front elevation. Trace a line through these points, as shown by U V, and trace this miter cut opposite the center line P R as shown by S T. U V S T gives the desired pattern.

For the pattern for the back, shown from $1'$ to $5''$ in the side elevation, take this girth (including the extra point *a* which has been introduced between $4'$ and $5'$, because of the width of this space) and place it on the center line P R above the front elevation, as shown by similar numbers $1'$ to $5''$. Through these small figures draw the usual measuring lines and intersect them by lines drawn parallel to P R from similarly numbered points in the front elevation. Trace a line through points thus obtained, as shown by X Z, and trace this miter cut opposite the line P R, as shown by W Y. W X Z Y gives the pattern for the back.

The pattern for the flat head along the line $5''$ 9^2 in the side elevation can be pricked direct from the front elevation as shown by 9^a, 8, 5, 5^a, 8^a, 9^b, A, 9^a; or it can be made in two pieces with a seam along the center at A.

The pattern for the sides is now in order. Take the girth of the various unequal spaces between 1^a and 9^a in the front elevation and place it on the vertical line H J, located above the side elevation as shown by similar numbers. Through these small figures and at right angles to H J draw lines and intersect them by lines drawn parallel to H J from similarly numbered intersections in the side elevation. Trace a line through points thus obtained; K L M N O is the pattern for the sides. Laps should be allowed on the sides, excepting along M N, but none are required on the front or back. Laps are also allowed on the flat head.

ROOF PATTERNS FOR SPIRE AND GABLES, WHEN A SQUARE SPIRE INTERSECTS FOUR GABLES

Solution 83

In Fig. 310 is given a finished view of a square spire intersecting four gables in a turret. The subject of this solution is that of obtaining the pattern for the spire A and for the gable roof B. For detailed procedure see Fig. 311.

First, draw the center line A B, on either side of which draw the elevation of the spire and gables. The

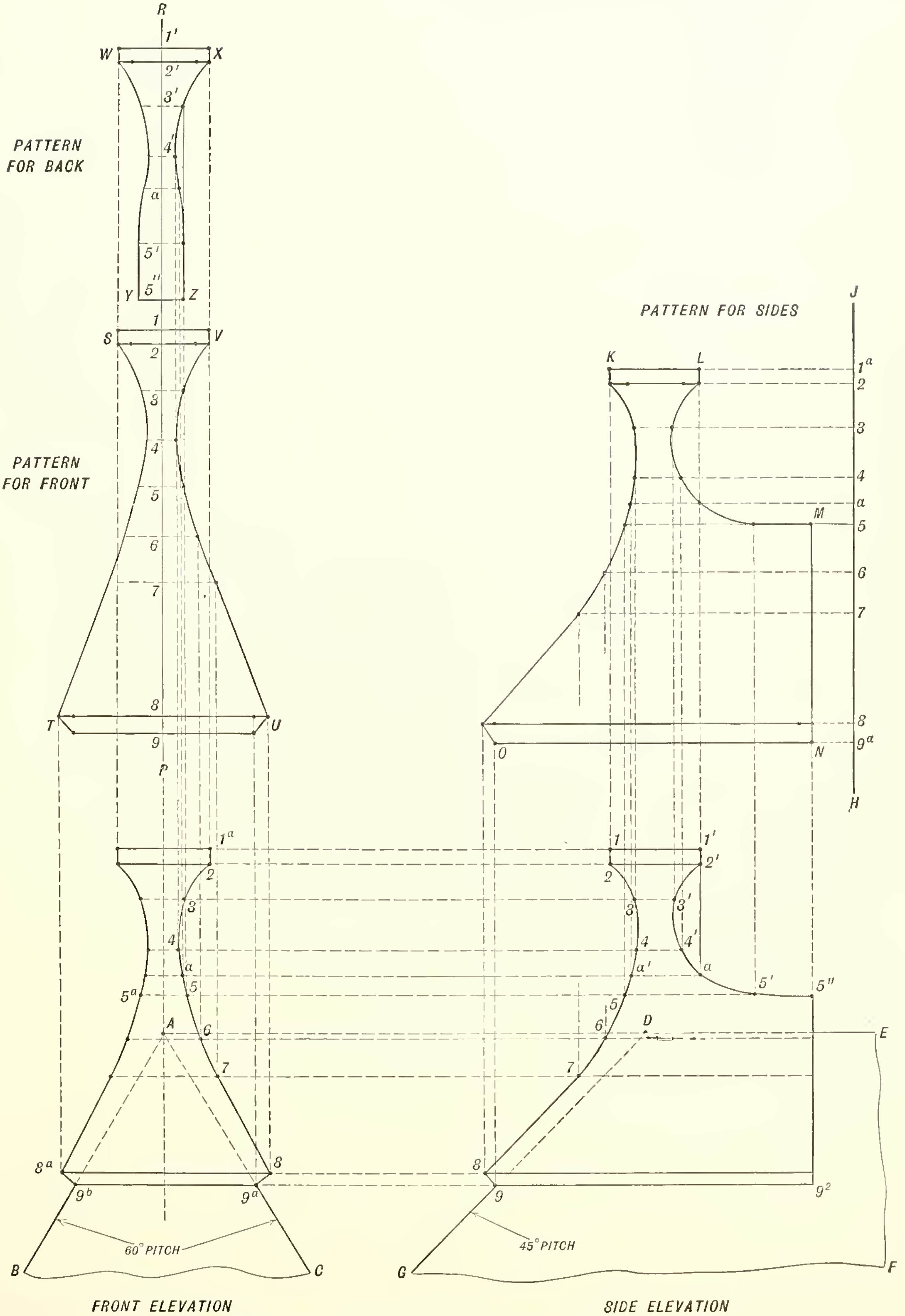


Fig. 309.—Patterns of Hip and Ridge Finial for Roofs of Differing Pitches

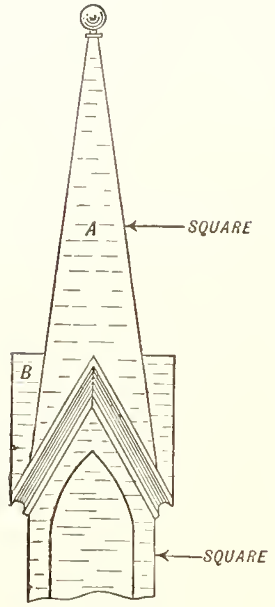


Fig. 310.—View of Square Spire on Four Gables

continuation of the mold 4 in the gable is omitted as this pattern has been treated in a preceding solution. After the elevation of the front gable 4′, 2′, 4 has been drawn, establish the lowest point of the spire, as 3, and then draw the pitch of the spire, as 3 to 1. In practice it is necessary to draw only a one-half elevation. From the point 3 draw a line at right angles to A B cutting this line at *e*.

The patterns are now in order and that for the spire is considered first. Draw any line, as A° B°, and on it place the pitch 1, 2, 3 in elevation, as shown by 1, 2 and 3 on the line A° B°. Through points 1 and 3 draw lines at right angles to A° B°, as shown. Measuring from the line A B in elevation take the various distances to points 1 and 3 and place them on similar lines on either side of the line A° B° in the pattern, thus obtaining the points *a a* and *b b*, respectively. Connect lines on both sides from *a* to *b* to 2, thus obtaining the net pattern for one side of the spire. Laps should be allowed for riveting, as shown by the dotted lines.

For the pattern for one side of the gable roof extend the line 4 C in elevation, as shown by C D; on this place the girth of 2′-3-4 in the front gable, as shown by similar numbers on C D. Through these small figures and at right angles to C D, draw lines and intersect them by lines drawn parallel to C D from similarly numbered intersections 2, 3 and 4 in the front elevation. Trace a line through points thus obtained. 4, *c d* 2′ represents the desired pattern. Laps are to be allowed wherever required.

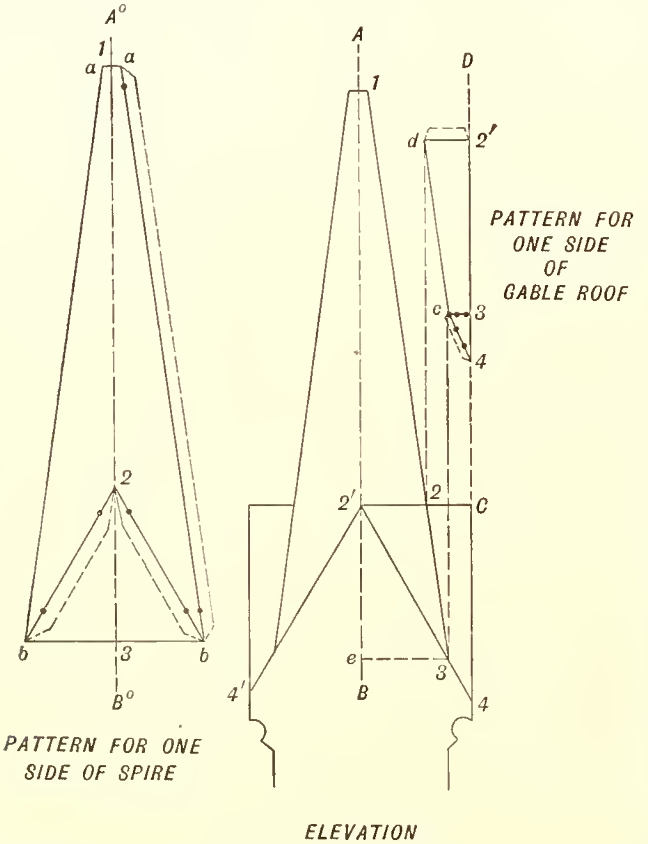


Fig. 311.—Patterns for Spire and Gable Roofs in a Square Spire Intersecting Four Gables

SPIRE AND GABLE ROOFS, WHEN AN OCTAGONAL SPIRE MITERS ON FOUR GABLES

Solution 84

In the case of an octagonal spire intersecting four gables, as shown in Fig. 312, the method of obtaining the pattern for the spire roof piece, A, as well as for the gable roof piece, B, corresponds to that explained in the preceding solution, but presents a more complicated problem in projections. This example is fully set forth in Fig. 313 where a full elevation is drawn, although only a half elevation is actually necessary. As in the preceding solution first draw the center line A B, construct the front elevation of the gable, as shown by D 2′ D°, and below the elevation draw the square plan, representing a section on the line D, D°. Draw the two diagonal lines in plan, representing the valley lines between the gables, less the spire, and through the center B^1 draw the horizontal and vertical lines rep-

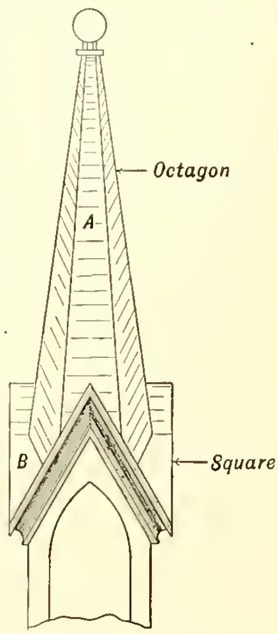


Fig. 312.—View of Octagonal Spire on Four Gables

resenting the ridge lines of the gables, less the spire. Establish the extreme width of the spire at its base as *a* in the elevation, which is usually placed vertically over the shaft line X. Project this point to the plan and obtain *a′*. Then using B^1 as a center,

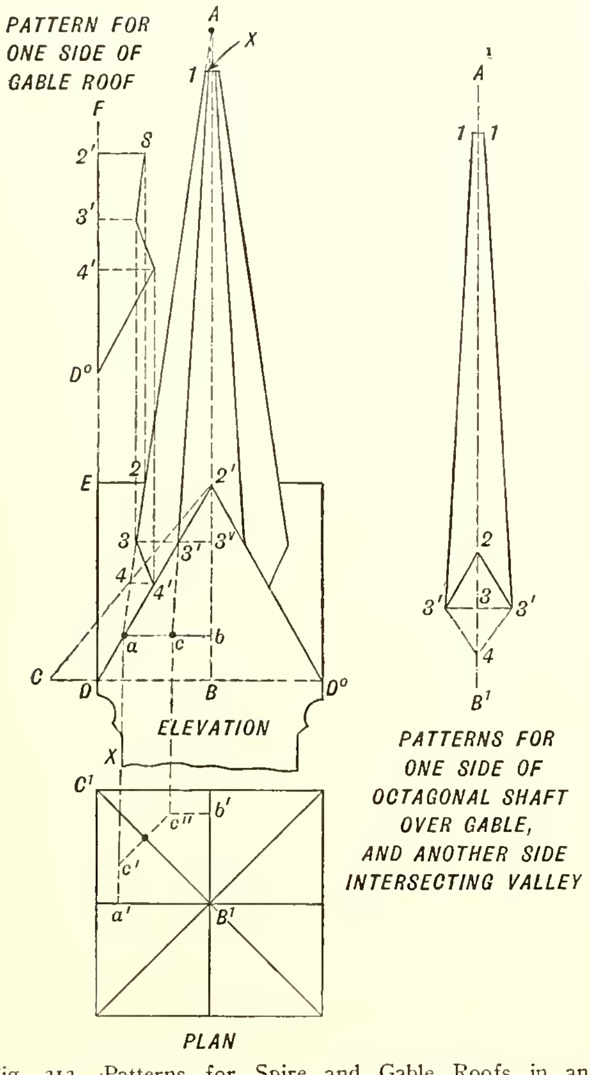


Fig. 313.—Patterns for Spire and Gable Roofs in an Octagonal Spire Intersecting Four Gables

construct the quarter plan *a′ c′ c″ b′* of the octagonal spire on the line *a b* in elevation. This quarter plan between C^1 and B^1 serves all requirements in practice, the full plan here shown being employed for clearness of treatment. Establish the apex of the spire at A and draw a line from *a* to A, cutting the horizontal top at 1. It now becomes necessary to ascertain where the octagonal side *c′ c″* in plan will intersect the valley line in elevation between the two gables. This point of intersection is found by taking the distance B^1 C^1 in plan and setting it off from B on the center line in elevation, indicated from B to C, and from C drawing a line to the apex 2′, cutting the spire line 1 *a* at 4; from there a line is drawn parallel to C B cutting the valley line in elevation at 4′, the desired point. From *c″* in plan erect a vertical line, cutting the base line of the octagonal shaft at *c* in elevation; from this point a line is drawn to the apex A cutting the gable at 3′ and horizontal top at X. From 3′ parallel to B C draw a line cutting the spire line *a* 1 at 3 and draw the miter line 3-4′. 2′, 3′, 4′, 3, 2 represents the line of intersection between the octagonal shaft and gables in the half elevation, which is reproduced on the opposite side.

The patterns can now be laid out. Take the girth of 1, 2, 3 and 4 of the spire and place it on any vertical line A^1 B^1, as shown by similar numbers. Through the figure 3 draw a line at right angles to A^1 B^1, as shown. Take the horizontal distance from 3^v to 3′ in the elevation and place it on line 3 on either side of the line A^1 B^1 in the pattern, thus obtaining points 3′ and 3′. From these two points 3′ draw lines to 2. Make the distances from the center line A^1 B^1 to points 1 and 1 equal to the distance of measurement taken from the center line A B in elevation to the intersection X. Connect lines in the pattern. 1-3′-2-3′-1 will be the pattern for the four sides of the spire intersecting the gables.

For the pattern for the four sides of the shaft cutting into the valley simply draw lines in the pattern, shown dotted from 3′ to 4 to 3′. 1-3′-4-3′ 1 is the desired pattern.

For the pattern for one side of the gable roof, extend the line D E in elevation as D F and on this place the girth of the one side of the gable, shown in the front elevation by 2′-3′-4′-D, as shown by similar points on F E. Through these points and at right angles to F E draw lines and intersect them by lines drawn parallel to E F from similar intersections 2, 3, 4′ and D in the elevation. Connect lines, as shown in the pattern; 2′ D° S is the desired pattern.

SPIRE AND GABLE ROOFS WHEN AN OCTAGONAL SPIRE MITERS ON EIGHT GABLES

Solution 85

Fig. 314 gives a completed view of an octagonal spire mitering on eight gables. The problem for solution is the development of the roof pieces, A and B, shown in Fig. 315. In this example operations in projections are required before the patterns can be

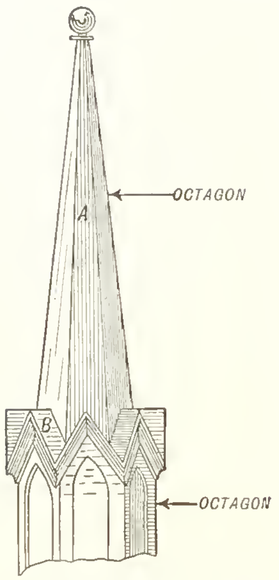


Fig. 314.—View of Octagonal Spire on Eight Gables

developed, and it is to these operations that special attention must be given. As mentioned in the preceding problem, in practical work, it is necessary to draw only a half elevation and a quarter plan, while here a full elevation and plan is given to make each operation clear. First draw the center line A B, and, using C upon it as a center, describe an octagon D E F G H J K L representing a horizontal section on the line M N in elevation. From these various corners in plan draw lines to the center C. From the corners E and F in plan extend vertical lines to the elevation, cutting the base line M N at E° and F°. Establish the hight of the gable on the center line as *i* and draw the front elevation of the gable for one of the octagonal sides shown by E° *i* F°. Bisect D E in plan this obtaining *a*; project this point *a* vertically, cutting the horizontal line drawn through the apex *i* of the gable at *a'*. Draw lines from *a'* to M and E°, thus getting a foreshortened view of the gable on the line D E in plan. Draw a line from M to *i* in elevation; this represents a vertical section of the valley line D 2' extended in plan as D C, when viewed parallel to D L. Establish the width at the base of the spire where it intersects the valley line at 2, and from 2 and parallel to M N draw a line cutting the front gable at 2° and 2°. From the apex of the gable at *i* draw a line parallel to M N meeting at X a vertical line erected from M. Where the line X *i* intersects the spire line 1-2 at *a'* drop this point in plan, parallel to A B, cutting the line *g* C in plan at *a''*. Take the distance from C to *a''* and set it off from C to *a*°, and from *a*° project a vertical line in the elevation cutting the line X *i* at a^x. Connect the concealed line from 2 to a^x and the exposed line from a^x to 2°. This can be repeated on the right side of the elevation if desired. The full plan is shown, the lines drawn from *a b c d e* B *f* and *g* representing the ridge lines of the gables, while *a*° 2' *a''* shows a partial intersection between the spire and gable, which is fully completed in the plan. The projections 1 and 3 in elevation are projected from the plan as shown by the dotted lines and a line is drawn from 3 to 2° to complete the elevation of the spire.

To obtain the pattern for one side of the spire roof take the girth of 1 *a'* 2 in the elevation and place it on the line P R, as shown by similar numbers. Through 1 and 2 and at right angles to P R draw lines as shown. Measuring from the line A B in elevation take the distances to points 2° and 3 and place them on similar lines, measuring on either side of the line P R in the pattern. Connect lines from U to S to *a'* to T to V, thus obtaining the pattern for one side of the spire roof.

The pattern for one of the gable roofs is obtained by taking the girth of E° 2° *i* 2° F° in the elevation and placing it on the line M X extended, as shown by similar divisions on X Y. Through these small figures and at right angles to X Y draw lines and intersect them by lines drawn parallel to X Y from similar points M, 2 and *a'* respectively, in eleva-

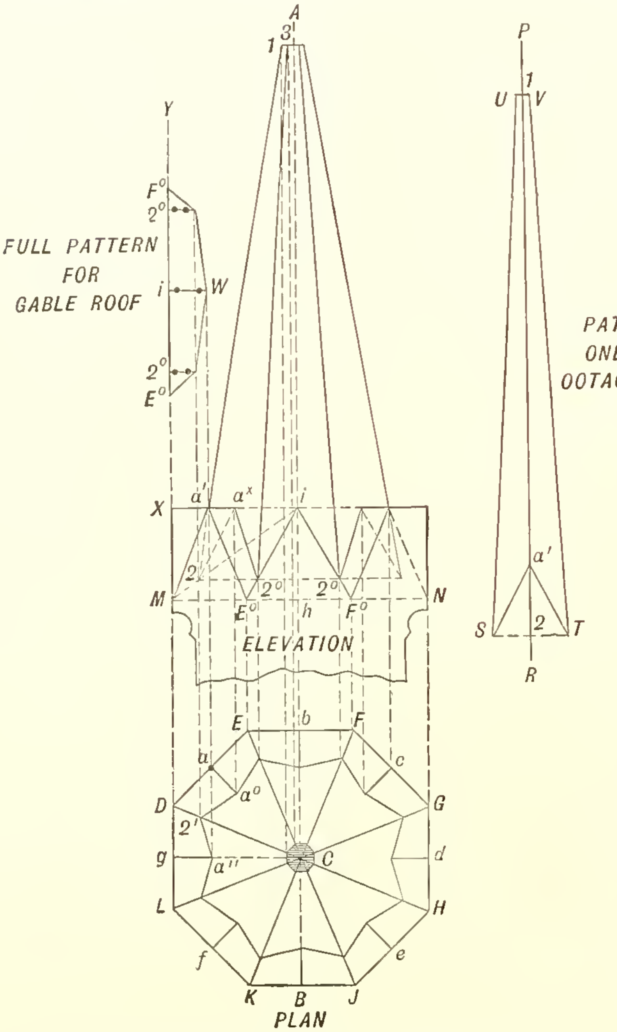


Fig. 315.—Patterns for Spire and Gable Roofs in an Octagonal Spire Mitering on Eight Gables

tion. Lines connected to points so obtained, as indicated by F° W E°, will give the desired pattern.

CIRCULAR SPIRE MITERING ON FOUR GABLE ROOFS

Solution 86

Fig. 316 indicates at A, a round spire which in this demonstration is to miter on four gable roofs on a square turret or other object. The method of procedure is outlined in detail in Fig. 317. First; draw the plan of the gable outlines, as shown by A B C D. Draw the two diagonal lines representing the valleys and the vertical and horizontal lines through J, representing the ridges. In line with the plan draw the elevation of the gable E 1″ G. As the diameter of the base of the spire usually has the width of the square shaft, make *a* 1 equal to the width of the shaft as shown, intersecting the gable lines at *a* and 1, from which points draw the pitch of the spire to meet the center line drawn through J in plan, at H. In practice it is necessary to draw only the one-half elevation and the one-quarter plan; from these all necessary projections are obtained, as shown. Draw a plan view of the spire on the line *a* 1 in elevation as shown by 1′-1-X-Y and space the one-quarter plan into any desired number of equal spaces as shown by 1, 2, 3, 2′, 1′. From these points vertical lines are erected to cut the base line of the spire in elevation at 1-2-3-2′-1′. From these points lines are drawn toward the apex H as shown. The point where the radial line drawn from 3 on the base line *a* 1, intersects the gable line at 3″, gives the correct point of intersection between the spire and valley line. Where the radial lines drawn from 2′ and 1′ on the base line *a* 1 cross the gable line at 2″ and 1″, draw horizontal lines from these points of intersection to the right, to intersect similarly numbered radial lines drawn from 2 and 1 on the base line *a* 1 at 1° and 2ᵛ. A line traced through 1°-2ᵛ-3″ will show the miter line between

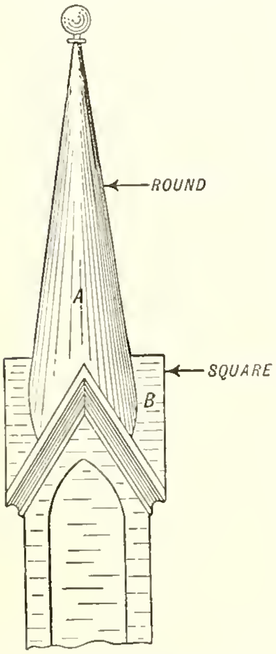


Fig. 316.—View of Round Spire on Four Gables

one-eighth of the circumference of the spire intersecting one side of the gable. Extend the horizontal lines drawn from 2″ and 3″ until they cut the side of the spire 1-H at 2° and 3°, respectively. After this procedure the half pattern for the spire can be developed. Using H as a center, with radii equal to H 1 and H L, draw the arcs 3-3 and L M, respectively. Take double the number of divisions contained in the quarter circle in plan, and place

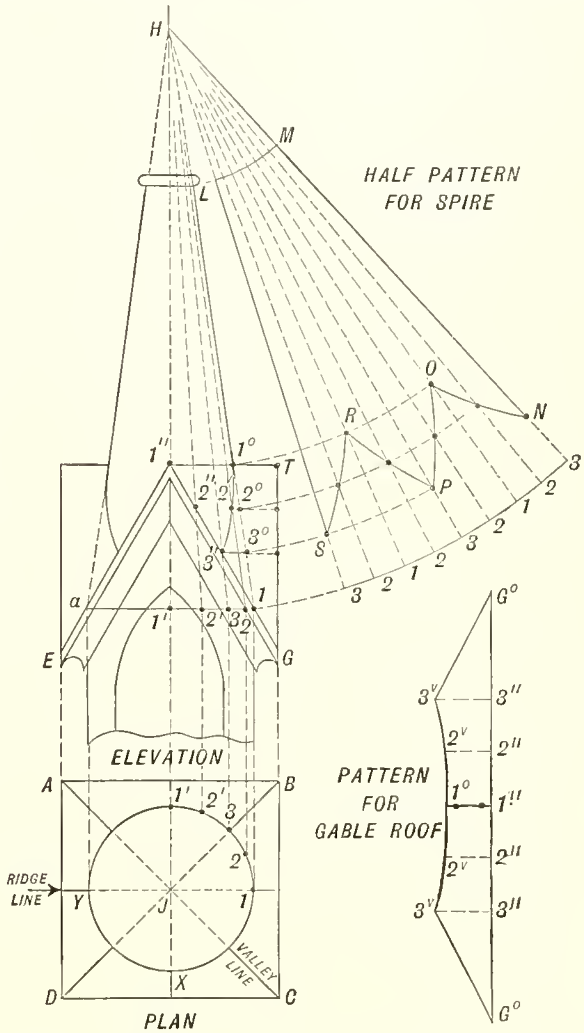


Fig. 317.—Patterns for Round Spire and Gable Roofs

them on the outer arc, as shown by similar numbers 3 to 1 to 3 to 1 to 3; from these points lines are drawn to the apex H and intersected by arcs struck from H as center with radii equal to the various intersections marked 1°, 2° and 3°; in this way are obtained the points of intersection on similarly numbered radial lines in the pattern, through which the miter cut N O P R S is traced. L M N S L then shows the one-half pattern for the spire, to which laps must be added.

The pattern for the gable roof joining the round spire, indicated by B in the finished view in Fig. 316, is obtained as shown in Fig. 317. Draw any vertical line, as G° G°, on this place the girth of the divisions on the gable line G 1″ in elevation, as shown by similar letters and numbers on the girth line G° G°. Through these small figures and at right angles to G° G° draw lines to the left to any length, as shown. Measuring from the line T G in elevation, take the various projections to points 1°-2v and 3″ and place them on similarly numbered lines in the pattern, measuring in every instance from the line G° G°, thus obtaining the points of intersection marked 1°-2v-3v. Draw a line from G° to 3v (which represents the square inside miter or valley line between G and 3″ in elevation), and trace the curve from 3v to 1° to 3v in the pattern. G°-3v-3v-G° then becomes the pattern for the gable roof.

ROUND SPIRE MITERING ON EIGHT GABLE ROOFS, IN AN OCTAGONAL TURRET

Solution 87

When a circular spire is to join on eight gables, as shown by A in Fig. 318, the development is similar to that in the preceding problem, except that in this example closer study must be given to projections. This will be brought out in detail with the aid of Fig. 319. Here A B C D E F G H shows the outline plan of the eight gables. All lines drawn from the corners to the center *a* form the valley lines between the gables and all lines from the bisection of the gable outlines, indicated by the letters *b*, to the center *a* form the ridge lines of the gables. Above the plan draw any horizontal line as J P equal to the width in plan, as shown by the dotted lines erected from *b* and *b*. From the center *a* in plan erect the center line *a d* to any length. On this center line and measuring from the line J P set off the hight of the gable as K 1. From 1 in elevation draw to any length the horizontal line 1 R. From C in plan, representing the foot of the gable, erect the perpendicular line cutting the base of the gable in elevation at N. From *b*° in plan, representing the apex of the gable, erect the perpendicular line, cutting the apex line in elevation at *b*′. Draw the gable lines 1 to N to *b*′ to P and erect a perpendicular line from P to intersect the apex line at R. In practice it is necessary to draw only a one-quarter plan and a one-half elevation. Assuming that the diameter at the base of the spire, where it intersects the valley lines of the gable, as at 1 in Fig. 318, is to be as great as the width of the octagonal shaft or body L L° in elevation in Fig. 319, a true elevation on the valley line H *a* in plan must first be found before this extreme point of intersection can be determined. The procedure is as follows: Take the distance of the valley line *a* H in plan and place it as shown on the line K J extended in elevation, as from K to H¹, and from H¹ draw the true length and pitch of valley line to 1. Extend a perpendicular line from L in elevation until it intersects the valley line H¹ 1, at M, the desired point. It will be noted that if L M is extended it will meet the apex of the gable at b″; this is merely a coincidence. Take the half distance of the base *a*′ M and set it off on the opposite side as *a*′ M° and from M and M° draw lines to the desired apex O. With a radius equal to *a*′ M and using *a* in plan as center, describe the horizontal section of the base of the spire, as shown by the true circle in plan. As one quarter of this full circle serves all requirements and as this quarter circle is again divided into four parts or one-sixteenth division of the full circle, divide each division in the quarter plan into a similar number of spaces, as shown by 1-2-3, 3-2-1, 1-2-3 and 3-2-1. In actual practice a greater number of spaces are required. From these small figures in plan, erect perpendicular lines to intersect the base line of the spire in elevation, as shown by the heavy dots. The points 3 and 3′ in elevation show their true positions, as proved by the horizontal line projected from point M on the true valley line. From the various intersection dots on the base line *a*′ M° in elevation, draw radial lines to the apex O, as shown. Where the radial lines intersect the true elevation of the gable at 1, 2 and 3, draw horizontal lines to the right intersecting similarly numbered radial lines at 2°, 1°, 2v, 3′, 2′ and 1″, also cutting the side of the spire at 1″, 2″ and 3″. Trace a line through points thus obtained; the miter line 1″-3′ represents the spire cut against the roof of the gable R P; the miter

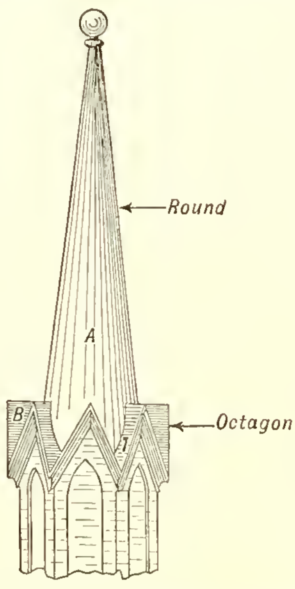


Fig. 318.—View of Round Spire on Eight Gables

line 1°-3′ against the roof of the gable P b′; the miter line 1°-3 against the roof N b′ and the miter line 1-3 against the roof N 1. In practice the only necessary miter line for obtaining the roof of the gable is that shown by 1″-2′-3′. So far as concerns the pattern for the spire, no miter lines are necessary, the only requirement being the intersections against the spire line at 1″-2″ and 3″.

The one-quarter pattern for the spire may now be laid out as follows: Using O as center with radii equal to O-3″ and O-Y° draw the arcs T-S and W respectively. On the arc T S, set off the girth of the quarter circle in plan, as shown by similar figures on T S; from these points, radial lines are drawn to the apex O, and intersected by arcs drawn from similarly numbered intersections 1″-2″ and 3″, struck from the center O. Trace lines through points so obtained; W, V, 3, & 3, U, gives the desired quarter pattern.

The pattern for the gable roof, of which eight will be required, is developed as follows: Erect any vertical line as R^1 P^1 and upon this place double the number of the spaces on the front elevation of the gable N, 3, 2, 1, as shown by similar letters and figures on R^1 P^1. Through these small figures and at right angles to R^1 P^1 draw lines to any length, as shown. Measuring from the line R P in elevation take the various projections to 1″, 2′ and 3′ and set them off on corresponding lines in the pattern, measuring in each instance to the left of the line R^1 P^1, thus obtaining the points of intersection marked 1″, 2′ and 3′. Trace a line through points thus obtained. N-3′-1″-3′-N gives the pattern for the gable roof, to which laps should be allowed.

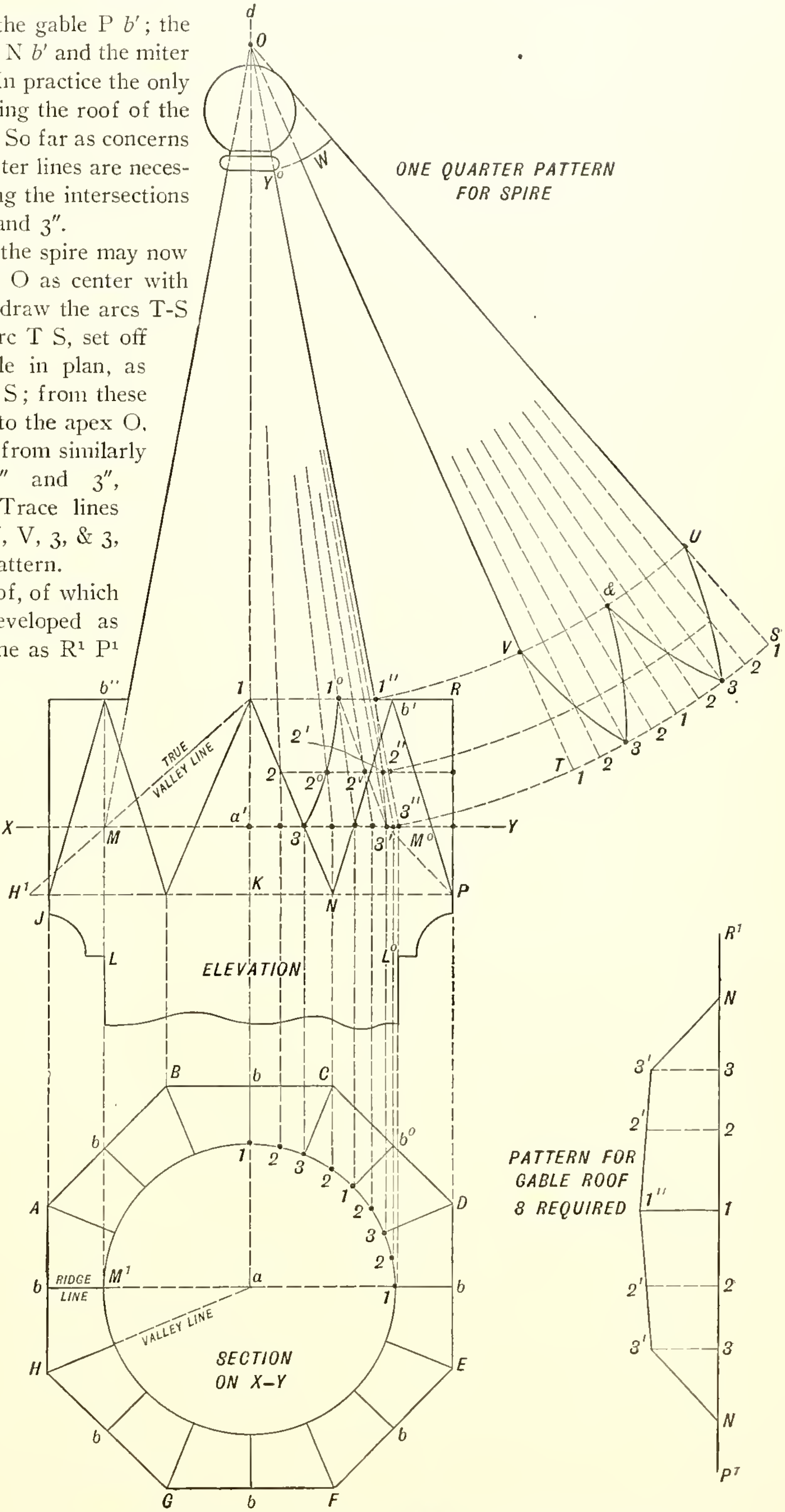


Fig. 319.—Patterns for Round Spire, Mitering on Eight Gable Roofs

PART X

CIRCULAR SHEET METAL WORK

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

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

SPHERE OR BALL, HAVING HORIZONTAL ZONES

Solution 88

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

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

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

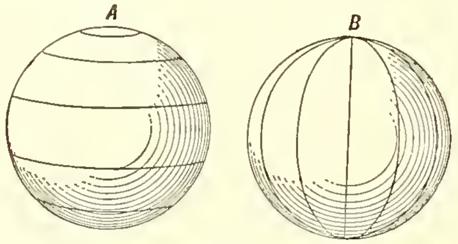


Fig. 320.—Sheet Metal Spheres

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

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

SPHERE MADE UP IN VERTICAL GORES

Solution 89

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

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

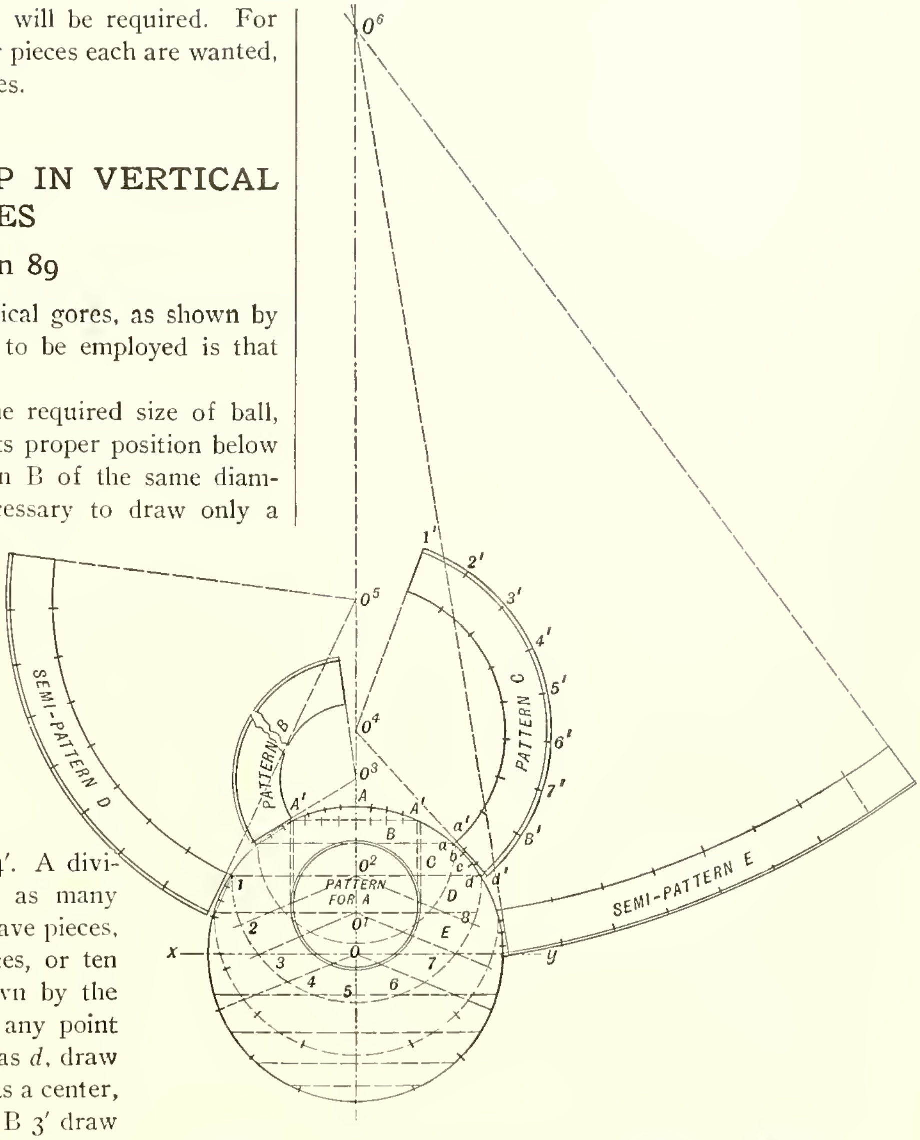


Fig. 321.—Patterns for a Ball in Eighteen Pieces. Made in Horizontal Zones

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

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

CONSTRUCTION OF A BASEBALL

Solution 90

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

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

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

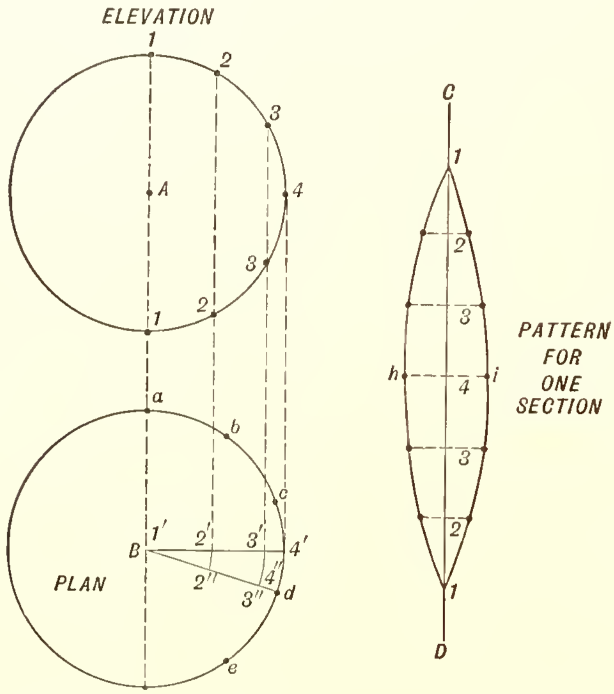


Fig. 322.—Pattern for Ball in Ten Pieces Made in Vertical Gores

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

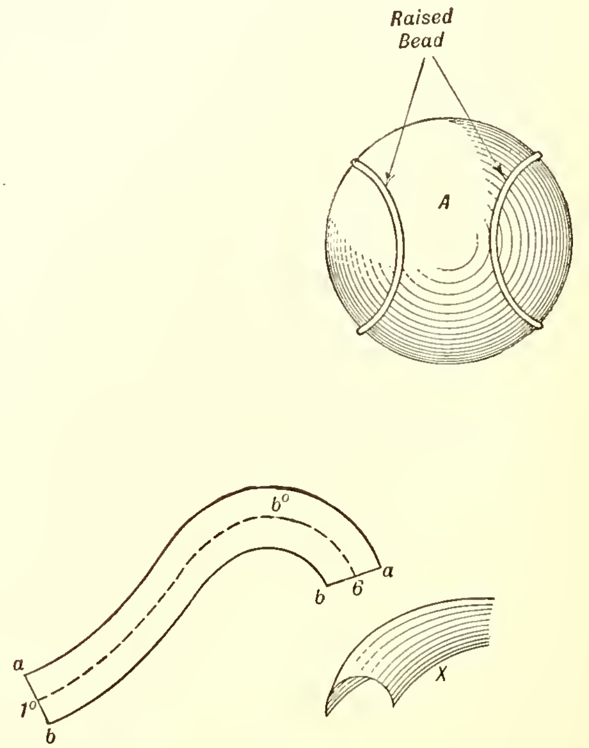


Fig. 324.—Method of Raising the Beaded Seam for Ornamental Purposes

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

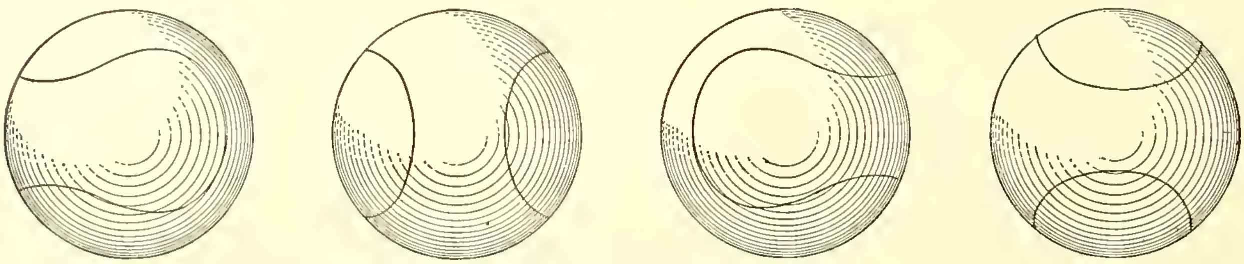


Fig. 323.—Four Views of a Baseball Showing the Seam Line Which Makes a Quarter Revolution in Each View

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

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

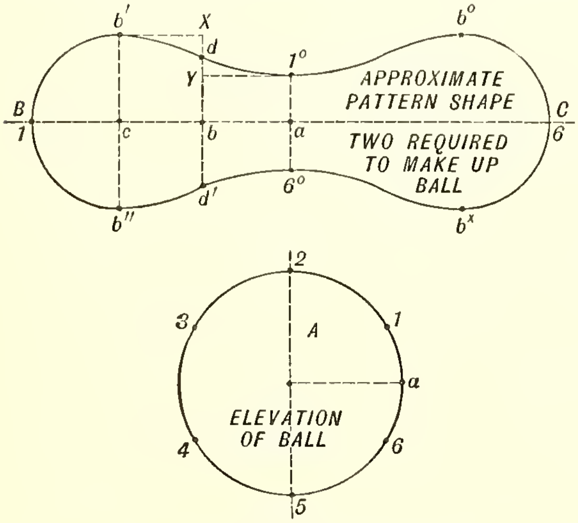


Fig. 325.—Elevation of Ball with Method of Obtaining an Approximate Pattern

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

CIRCULAR LOUVRES

Solution 91

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

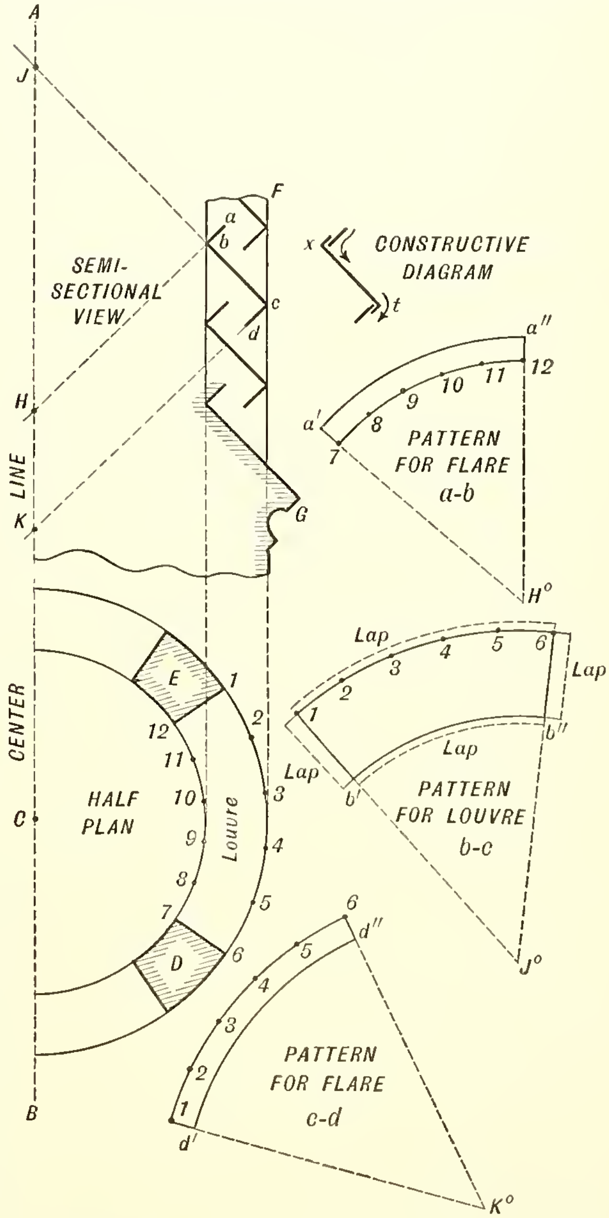


Fig. 327.—Patterns for Louvres in a Circular Ventilator

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

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

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

COVE MOLD IN A CIRCULAR PANEL

Solution 92

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

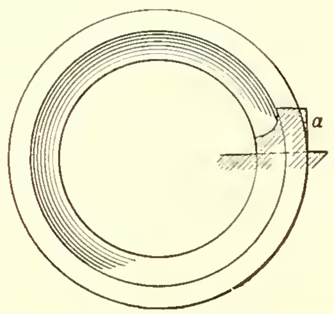


Fig. 328.—Front View of a Circular Panel with Section of Cove Mold

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

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

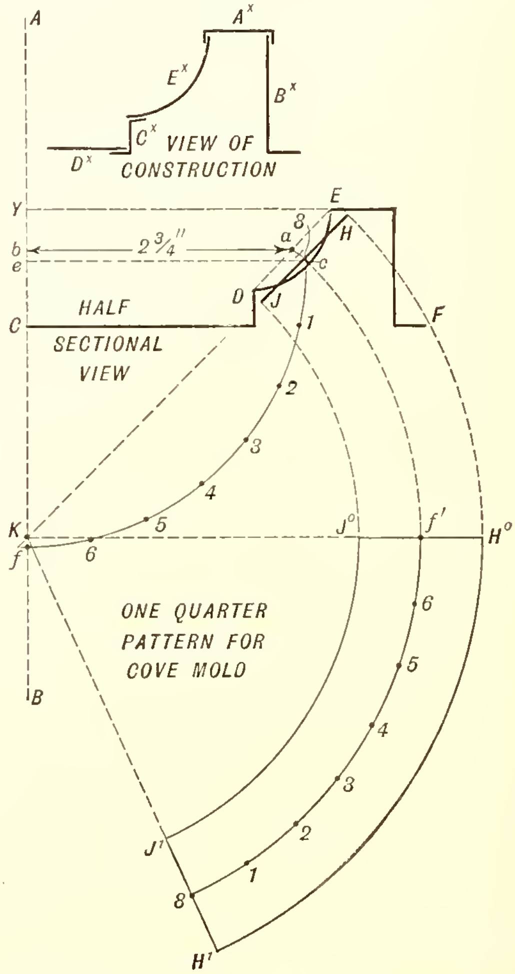


Fig. 329.—Pattern for Cove Mold in a Circular Panel

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

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

QUARTER ROUND MOLD IN A CIRCULAR PANEL

Solution 93

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

Drawn a line from E to D, bisect it and obtain *a*. From *a* and at right angles to E D draw a line intersecting the mold at *b*. Through *b* and parallel to E D draw a line, until it meets the center line A B at H. Take the girth of the mold from *b* to E and from *b* to D and set it off from *b* to K and from b to J. From *b* draw a horizontal line to intersect the center line at *c*. Using *c* as center, with radius equal to *c b*, draw the quadrant *b* H; space this into equal divisions, as shown from 1 to 7. This quadrant then represents a quarter section on the line *b c*. Using H as center, with radii equal to H J, H b and H K, draw the arcs as shown. Starting from any point on the center arc, as b′, lay off the girth of the quadrant *b* 4 H as shown by similar numbers and letters in the pattern. From the center H draw radial lines through *b′* and H° cutting the inner and outer arcs as shown. J^1 K^1 K° J° then represent a quarter pattern. In reference to the stretching of the mold, point *b* in the profile remains stationary, while *b* K and *b* J are stretched over the blow horn stake until it has the shape indicated by *b* E and by b D, respectively. The method of constructing the panel is alike to that explained in the preceding problem.

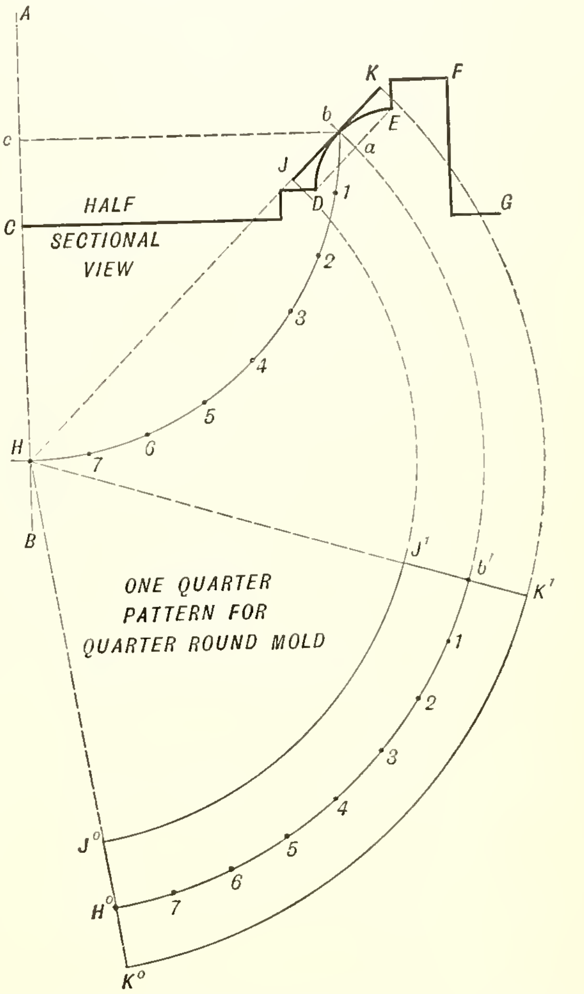


Fig. 330.—Pattern for Quarter Round Mold in a Circular Panel

REVERSED OGEE IN A CIRCULAR PANEL

Solution 94

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

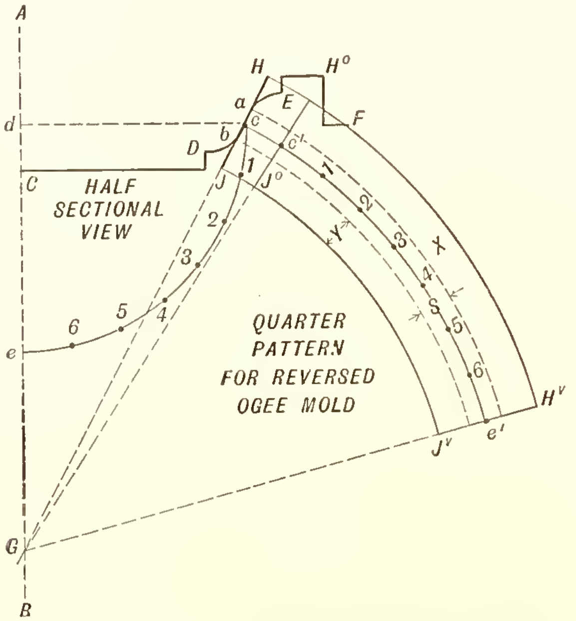


Fig. 331.—Pattern for Reversed Ogee Mold in a Circular Panel

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

ROUND FINIAL FOR CIRCULAR TOWER

Solution 95

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

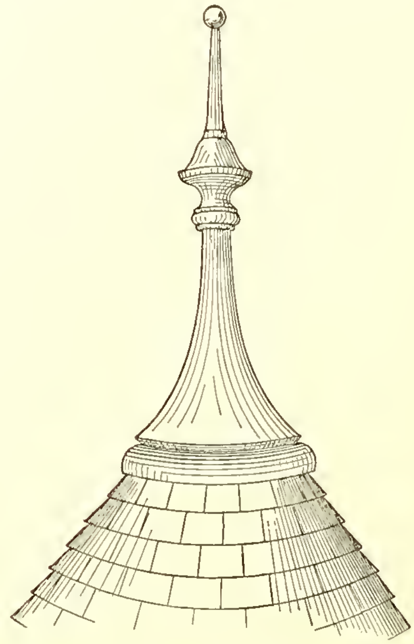


Fig. 332.—View of a Finial on a Circular Tower Roof

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

Pattern for Flare

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

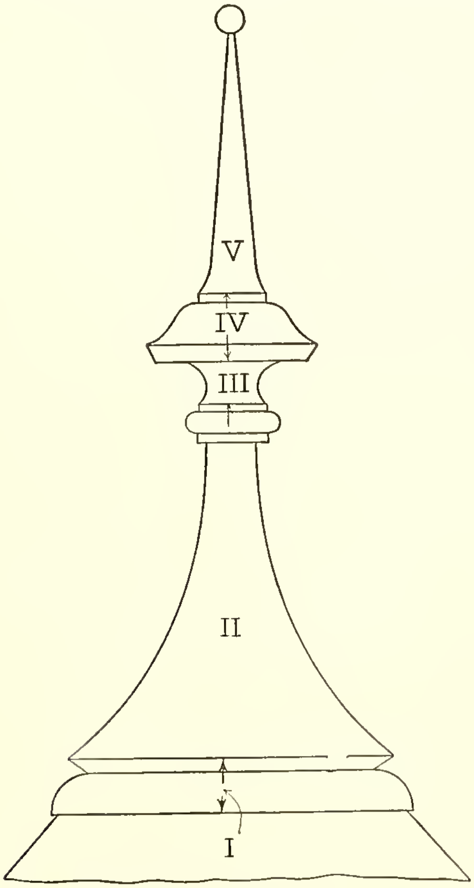


Fig. 333.—Front Elevation of Finial

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

Pattern for Quarter Round

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

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

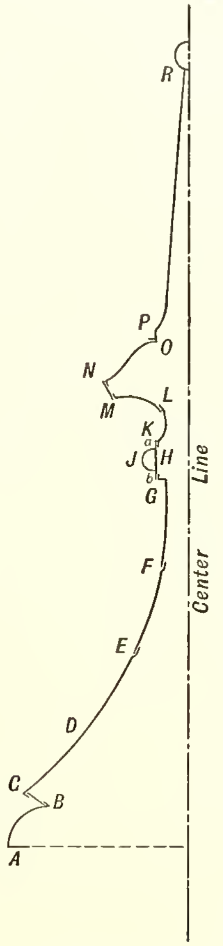


Fig. 334.—One Half Construction Drawing, Showing Location of Seams and Method of Lapping

Pattern for Curved Shaft on Bead

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

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

The method hereinafter given to obtain the pat-

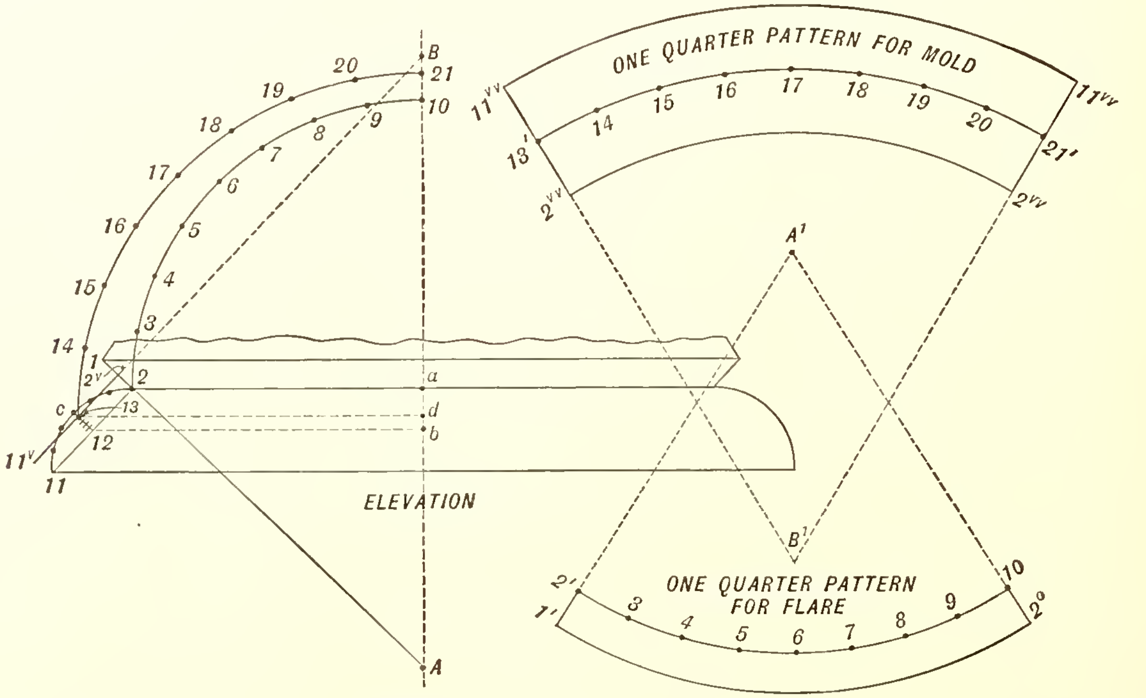


Fig. 335.—Patterns for Base Mold

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

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

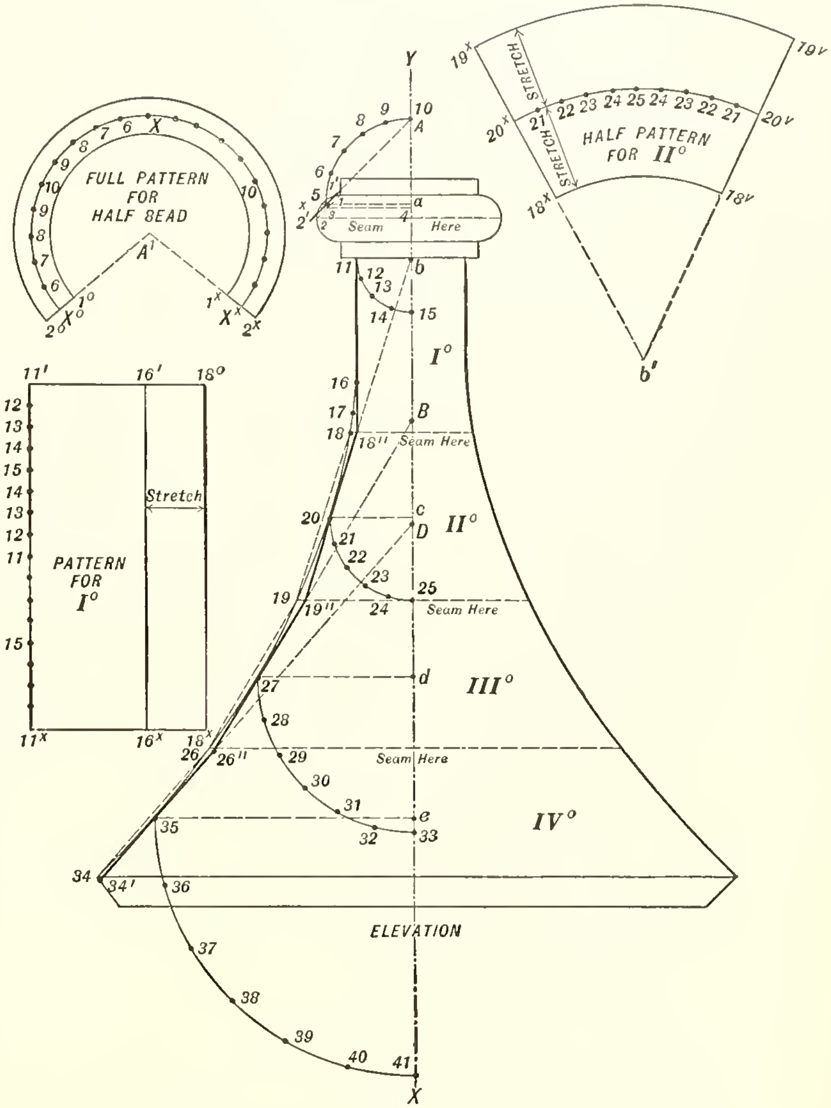


Fig. 336.—Obtaining Radii and Patterns for Bead and Shaft

Gothic Mold

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

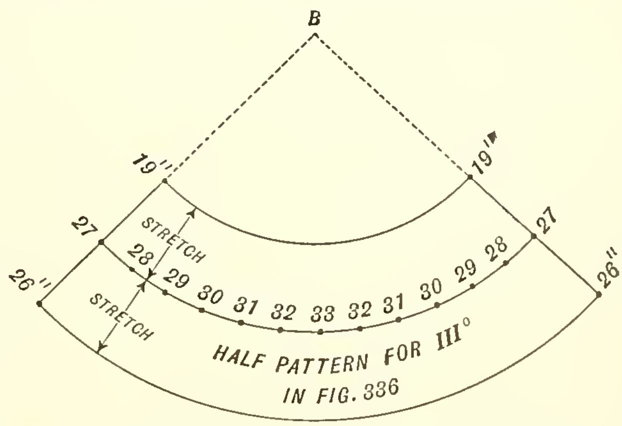


Fig. 337.—Half Pattern for Portion of Shaft III° in Fig. 336

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

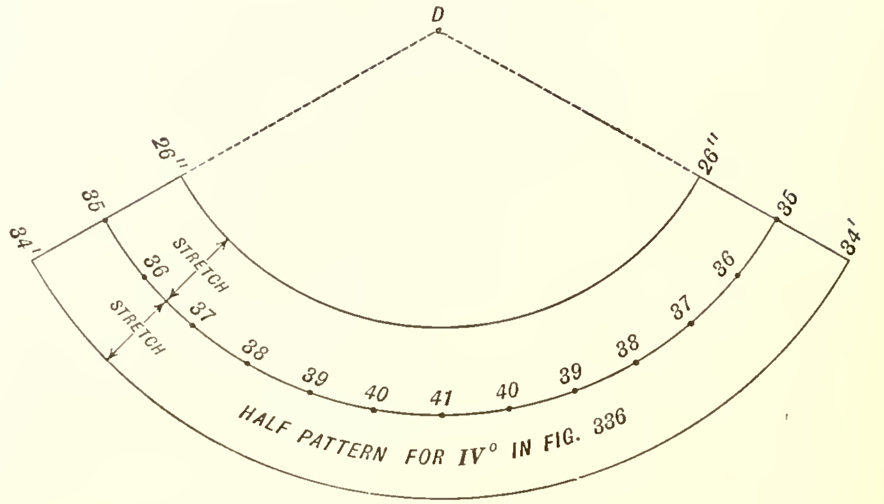


Fig. 338.—Half Pattern for Portion of Shaft IV° in Fig. 336

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

Pattern for Reversed Ogee and Flare

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

The pattern for the ogee, no matter what its

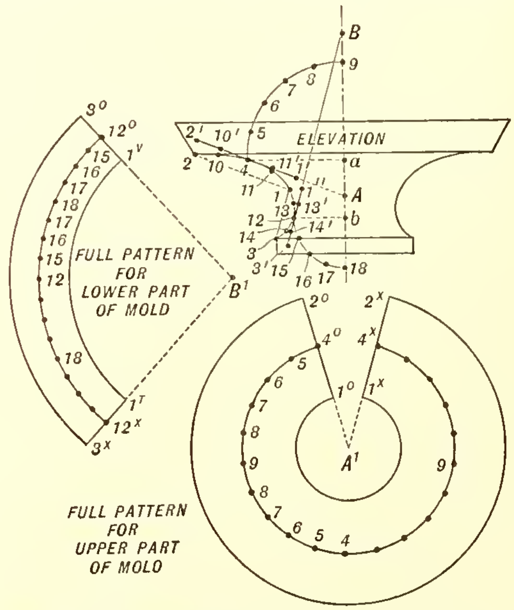


Fig. 339.—Patterns for Lower Part of Cap

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

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

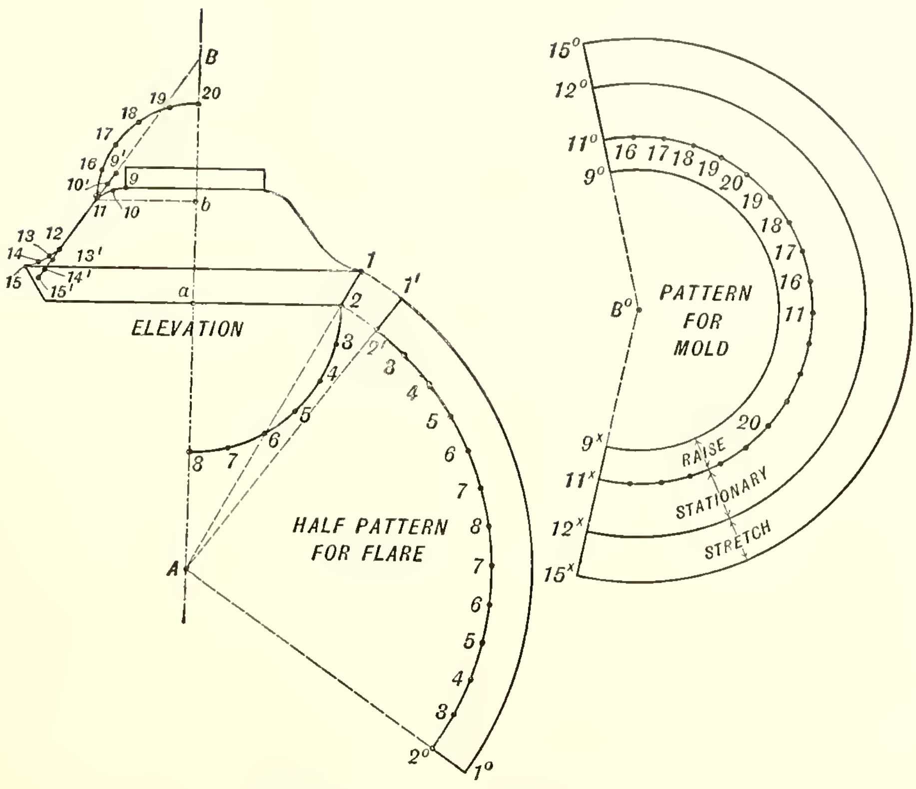


Fig. 340.—Patterns for Upper Part of Cap

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

Pattern for Spire

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

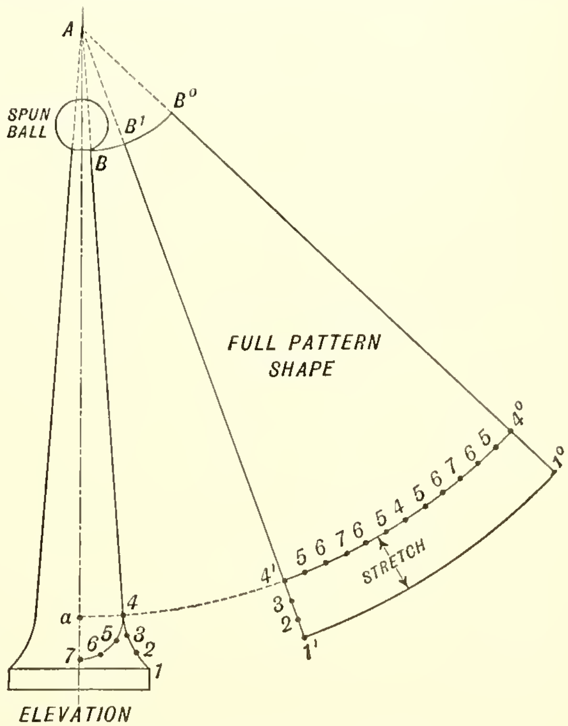


Fig. 341.—Pattern for Spire

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

Cases which Arise in Laying Out Circular Moldings Made by Machine

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

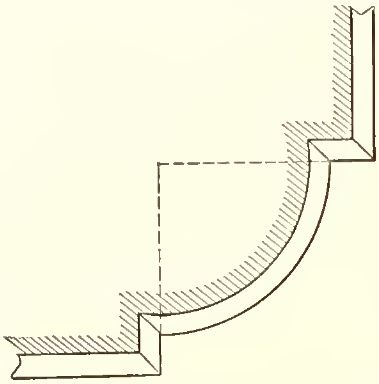


Fig. 342.—A Molding Curved in Plan, as Required when a Horizontal Cornice Sets Over the Rounded Corner of a Building

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

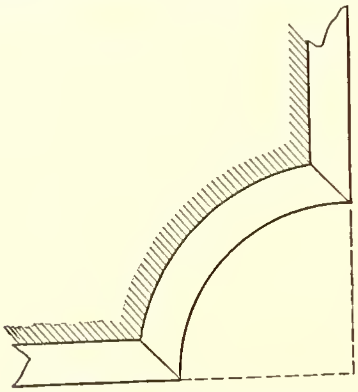


Fig. 343.—A Molding Curved in Plan, but in an Opposite Direction.

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

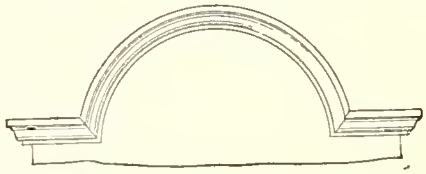


Fig. 344.—A Molding Curved in Elevation, as in a Circular Pediment

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

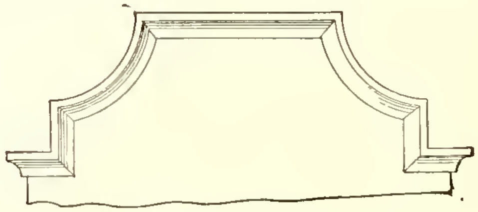


Fig. 345.—A Molding Curved in Elevation but in an Opposite Direction

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

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

Solution 96

Fig. 346 presents a view of a dormer window,

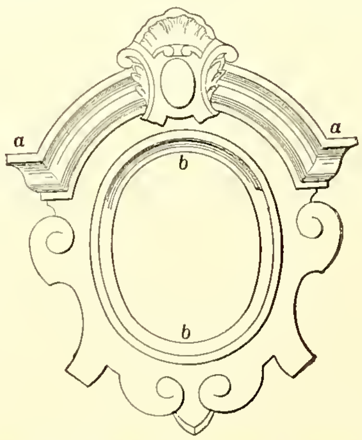


Fig. 346.—View of Dormer Window

having a segmental top mitering to the horizontal moldings at *a a*. The window opening is to be elliptical, as indicated at *b b*. The method of averaging the profiles for this dormer is shown in Fig. 347, where a one-half front elevation is shown by A C D B. The center from which the segmental curve is struck is indicated by E, while the curves of the elliptical window opening are struck from the various centers E, P and O. As the profiles of the horizontal and curved molds are alike, take a of the profile, as shown by *c d*. Bisect the distance between the two lines, as at *e* and *i*, and draw the averaged line *i e*, as shown. The girth of the profile from *b* to *a* is now laid off on the line *e i*, starting invariably from a point nearest the lowest member *b*, as *f*. Assuming that this has been done in the profile F G, extend the averaged line J G until it meets the horizontal line drawn from the center E, at right angles to A B, at L. Take the girth of the mold from *r* to *s*

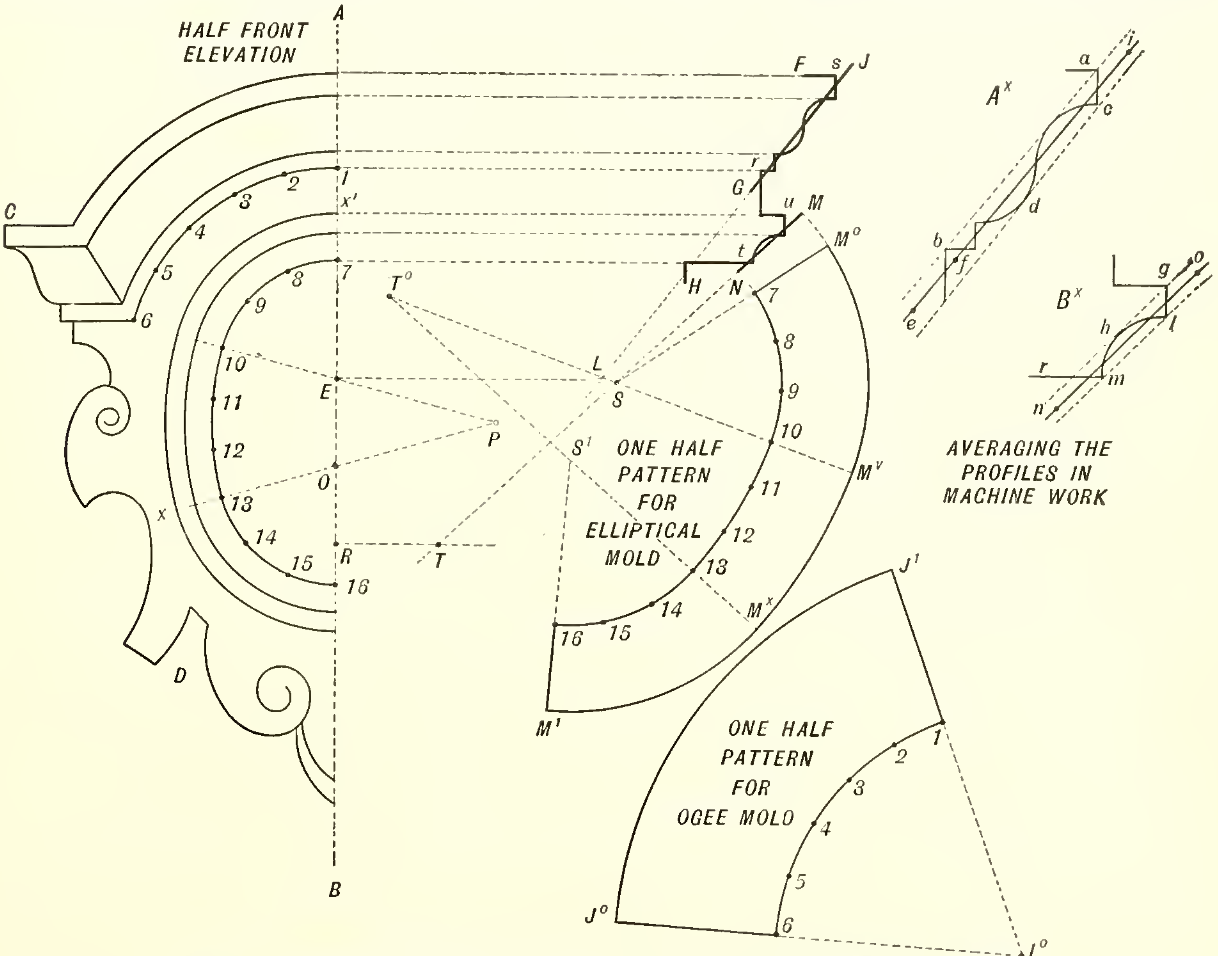


Fig. 347.—Averaging Profiles and Developing Patterns of Molds Made By Machine

tracing of the profile C, and place it in its proper position to the right of the center line A B, as shown by the dotted lines and as indicated from F to G. Below G draw the profile of the elliptical mold, as shown by G H. In averaging profiles for molds to be hammered by machine, the following method has afforded excellent service. Referring to the engraving, diagram A^x gives an enlarged view of the ogee and fillet for the dormer in question:

First, draw a line touching the extreme points inside of the profile, as shown by *a b;* then draw a line touching the extreme points of the outside and place it, as hitherto described, and allow a lap at top and bottom for joining, all as shown from G to J. With radii equal to L G and L J and using L° as center draw the arcs 1-6 and J^1 J°, respectively. Space the lower member of the curve in elevation, as shown from 1 to 6, and place these divisions on the lower curve in the pattern, also shown by similar numbers. J°-J^1-1-6 is then the one-half pattern. In practice more material is added to the pattern as allowance for trimming the miters on the curved mold.

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

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

Solution 97

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

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

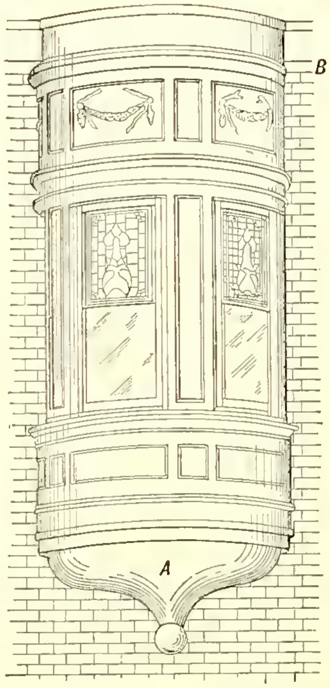


Fig. 348.—View of Circular Bay Window

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

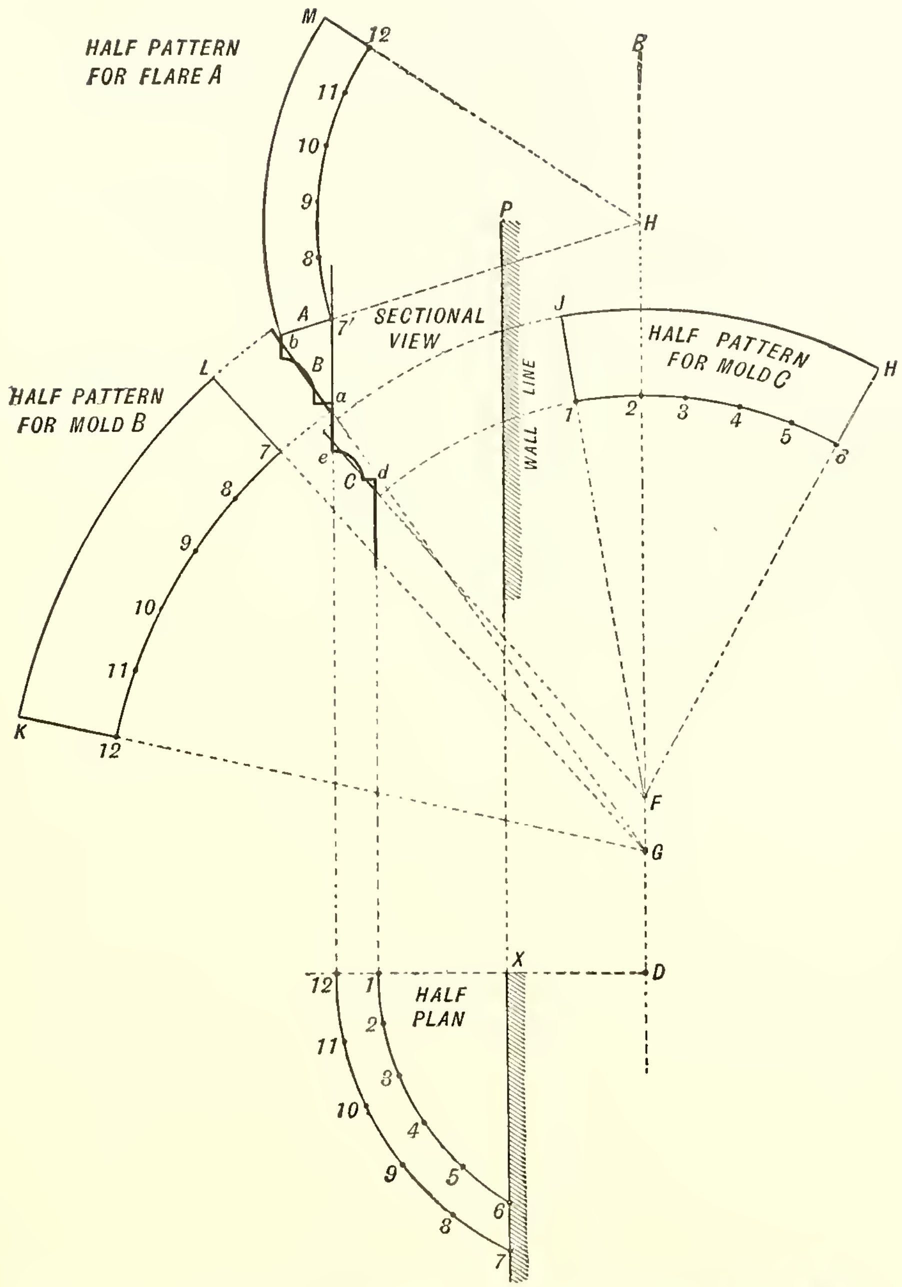


Fig. 349.—Patterns for Curved Molding in a Circular Bay Window Made by Machine.

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

MOLDED BASE IN A CIRCULAR BAY WINDOW

Solution 98

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

In this illustration A represents the center from which the arcs in plan are struck, while the distance from X to B shows the extreme projection of the base. Through X the vertical line C K is drawn, representing the wall line both in plan and sectional view. In its proper position, as shown, draw the outline or profile of the base, and locate at will the horizontal seams in same, as shown by D, E, F, H, J. The spaces between these seams should not be made so wide that they may not be hammered with ease. Through A, the center from which the arcs in plan were struck, erect the line L M. From the various seam lines D, E, F and H drop lines in the plan to intersect the center line B X at *a*, *c*, *e* and *h*. Using A as center draw the various arcs *a b*, *c d*, *e f*, and *h i*, which we will use in obtaining the lengths of the several patterns. Extend the averaged lines through the profile until they intersect the line L M, as follows: Draw a line through D E until it inter-

allowed. Draw the averaged line through the mold B until it intersects the line D E at G. Take the girth of the mold *a b* and set it off on the averaged line, as shown. Then, using as radii G *a* and G *b*, draw the arcs shown. Starting at 7 on the inner arc, lay of the girth of 7-12 in plan, as shown by similar numbers in the pattern. From G draw lines through 7 and 12 cutting the outer arc at L and K. 7-12-K-L then gives the one-half pattern for mold B in the sectional view. Allowance must be made at the ends of the pattern for trimming and fitting against the wall. J-H-6-1 shows the half pattern sects L M at L; through E F to intersect at P; through F H to intersect at N; and through H J to intersect at O. Using L as center, strike the pattern R, taking the girth of *a b* in plan and placing it along the outer arc in R. Using P as center, strike the pattern T, placing the girth of *c d* in plan along the outer arc in T. In like manner use N as center and strike the arc S, and take the girth along *e f* in plan and place it along the outer arc in S. O is used to strike the pattern M, taking the girth of *h i* in plan

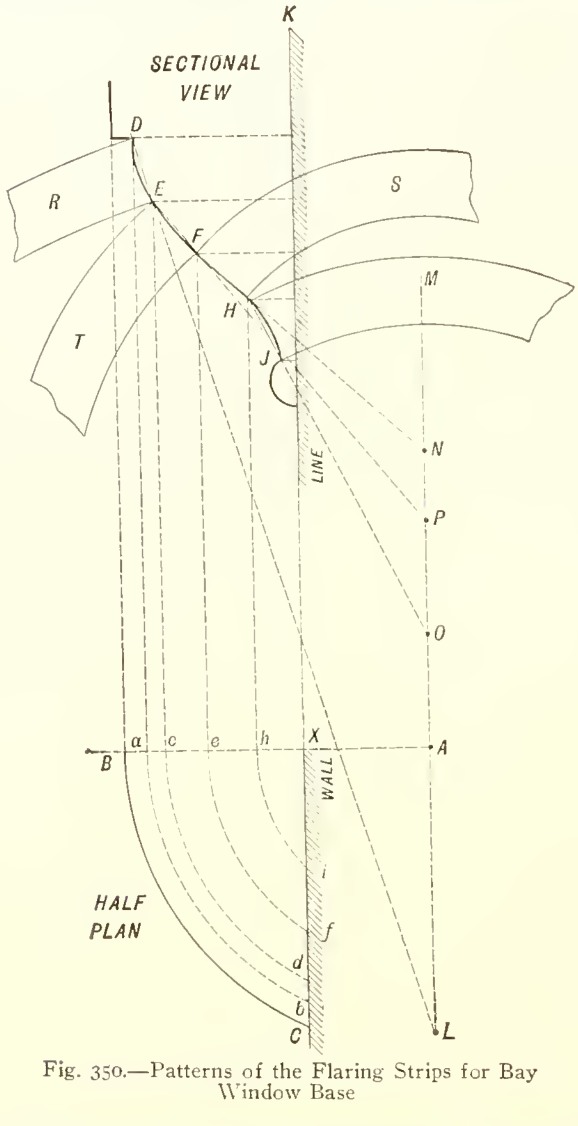


Fig. 350.—Patterns of the Flaring Strips for Bay Window Base

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

SEGMENTAL PEDIMENT MADE BY HAND

Solution 99

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

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

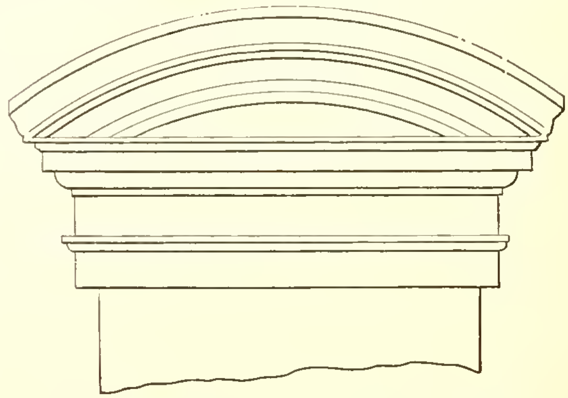


Fig. 351.—Front View of Segmental Pediment

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

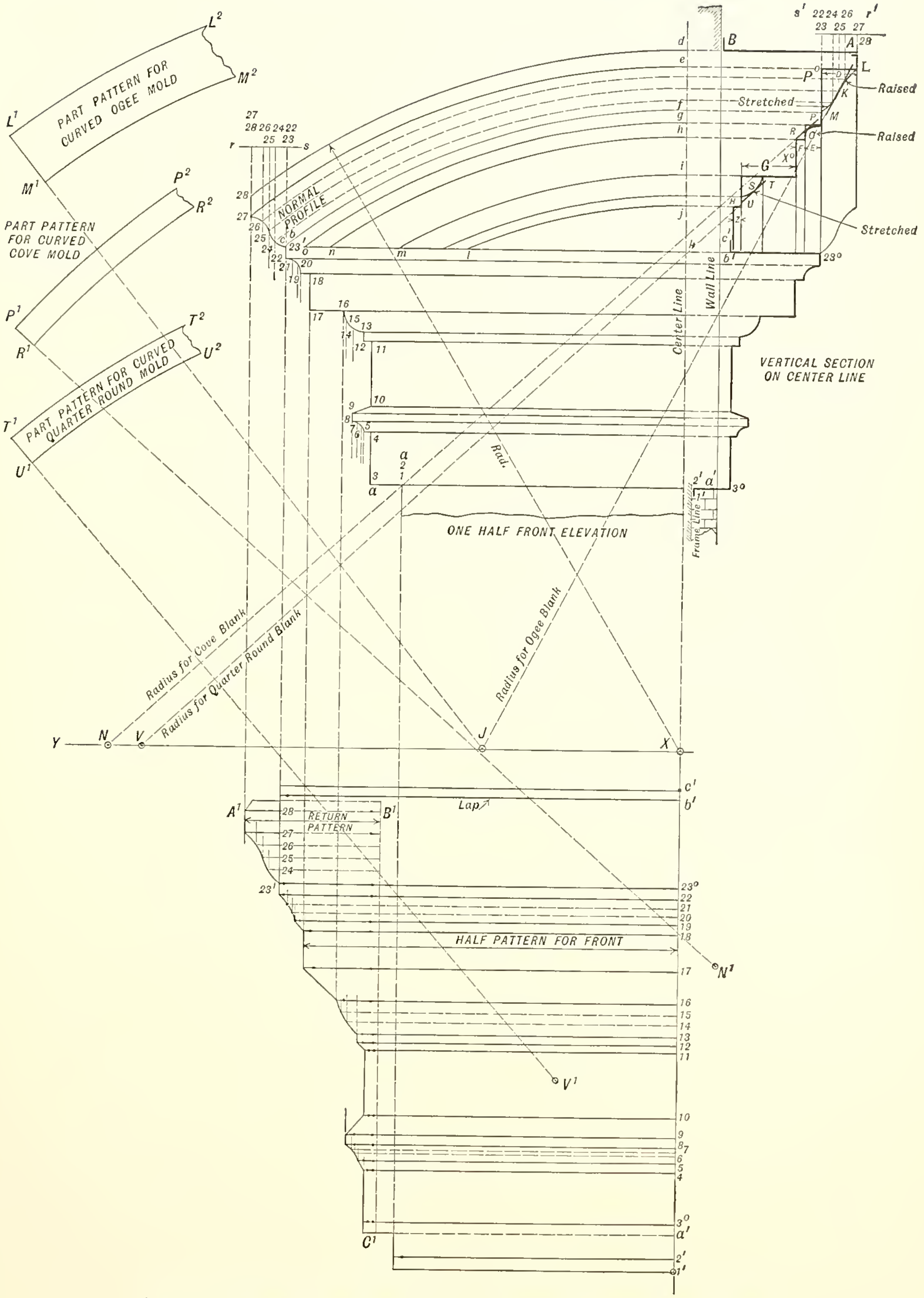


Fig. 352.—Working Drawing and Patterns for Segmental Pediment Made by Hand

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

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

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

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

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

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

CURVED DORMER WINDOW WITH CURVED ROOF AND ROOF FLANGE

Solution 100

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

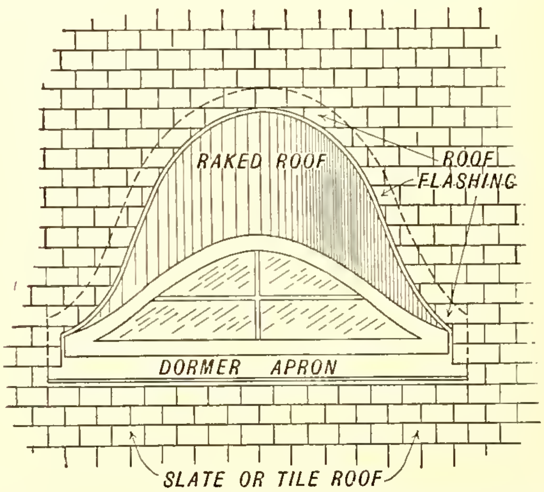


Fig. 353.—View of Curved Dormer Window, Requiring a Raked Roof and Roof Flashings

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

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

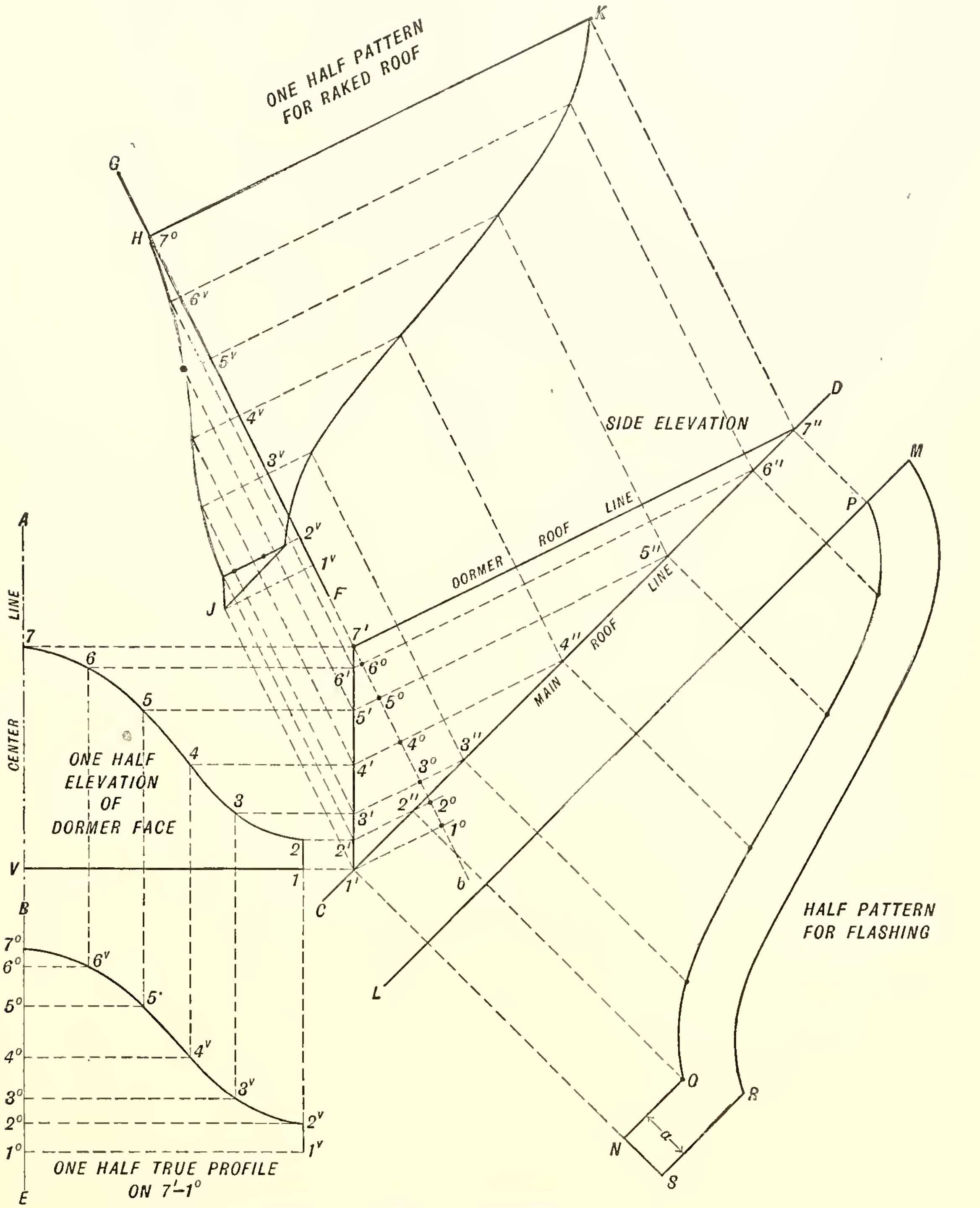


Fig. 354.—Patterns for Raked Roof and Flashings on a Curved Dormer

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

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

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

PART XI

ORNAMENTAL SHEET METAL WORK

PATTERNS FOR ORNAMENTS, BRACKETS, CHAMFERS, PANELS, MOLDED TRANSITIONS, GORES, KEYSTONES, URNS, SHIELDS AND SHAFTS

A TEN SIDED BALL

Solution 101

BALLS to be made of any number of sides, to represent a true circle in elevation but in the shape of a regular polygon in plan, involve the same principles as in developing bevel miters. As an example, we will consider a ten sided ball. The perspective of this ball, shown in Fig. 355, indicates a regular polygon when viewed in plan or, as so viewed, the geometrical figure known as the *decagon*. The number of sides possessed by the ball does not affect the application of the principles set forth in Fig. 356. The methods there shown are applicable to any regular polygon.

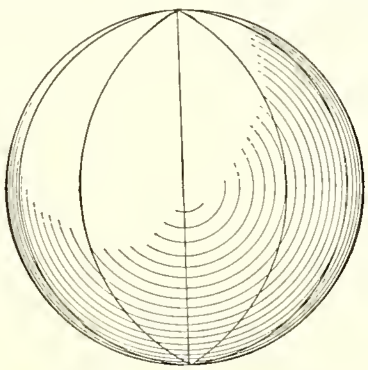
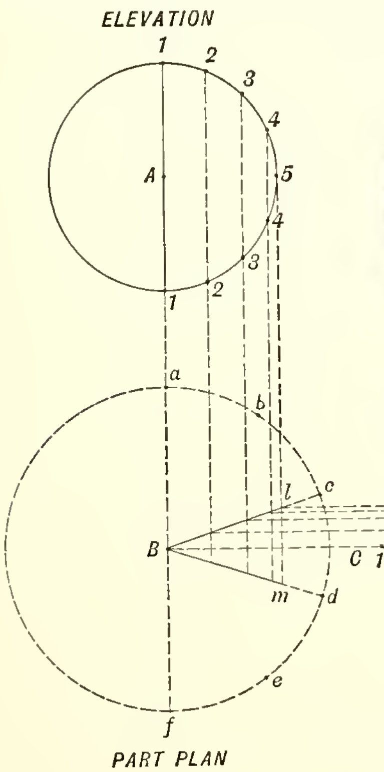


Fig. 355.—View of Ten-Sided Ball



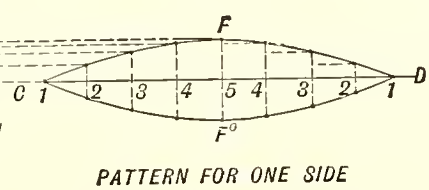


Fig. 356.—Pattern for Ten-Sided Ball

Let A represent the elevation of the ball, through the center of which draw to any length the vertical line 1 *f*. On this vertical line establish any point as B; using this point as a center draw a circle of any size, as shown. Since the ball is to have ten sides, divide one-half the circle into five spaces, as shown by the letters *a b c d e* and *f*. From *c* and *d* draw the miter lines to the center B as *c* B and *d* B. Divide the semi-circle in elevation into an equal number of parts, as shown by the small figures 1 to 5 to 1. From point 5 draw a line parallel to A B, crossing the miter lines *c* B and *d* B, as shown. *l m* B then represents the plan view of one side or one-tenth of the ball, constituting all that is necessary for developing the pattern.

The pattern may now be laid out. At right angles to *l m* draw the line C D; upon this place the girth of the semi-circle in elevation, as shown by similar numbers on C D, and through these points and perpendicular to C D, draw lines; intersect these lines by lines drawn parallel to C D from similar intersections on the miter line *l* B, which points were obtained by dropping perpendicular lines from the small figures in elevation. A line traced through points thus obtained, as shown by 1 F 1, will be the miter cut. Trace this curve below the line C D, as indicated by 1 F° 1, which completes the pattern for one side; ten of these, with an edge on one side will be required to complete the ball. It will be understood that the more numerous the addition of sides in plan the more nearly spherical will the ball become. Sometimes these developed sides are raised with the raising hammer; in such cases a true sphere is the result. This would require, however, a change in developing the pattern, a subject already considered in a preceding solution in the part on Circular Work.

TRIANGULAR MOLDED ORNAMENT

Solution 102

Molded ornaments required in cornice work, whose plans are regular polygons such as are shown in the perspectives in Figs. 357 and 358 are developed as is illustrated in Fig. 359, where the same profile or section is used for both the triangular and hexagonal plan. In laying out the triangular plan, care must be taken in obtaining the miter line. First, locate the length of one side of the triangle, as shown by the horizontal line, A B. As the three sides are equal, use A and B as centers, and with A B as radius, describe arcs intersecting each other at C. Join B C and C A and obtain the miter lines and center D as follows: Bisect the angle C A B

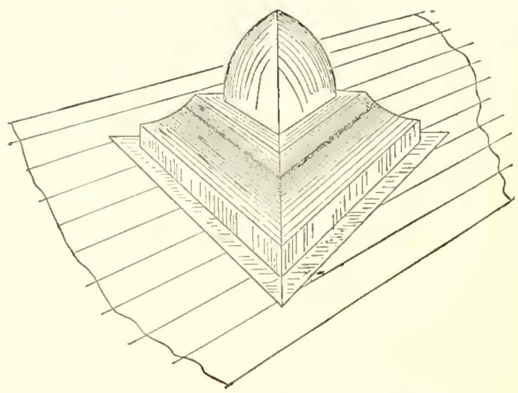


Fig. 357.—View of Triangular Ornament

in the usual manner by means of the arcs *a*, *b* and *c* and draw a line from A to *c*, intersecting this line at D by a vertical line dropped from the apex C; D is

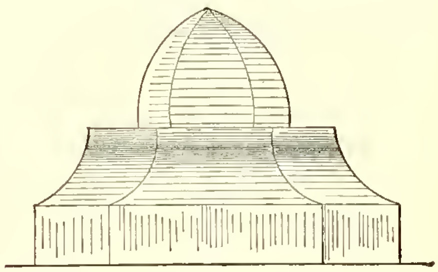


Fig. 358.—Shaded Elevation of Hexagonal Ornament

the desired center of the triangle. Draw a line from D to B, completing the three miter lines. Parallel to

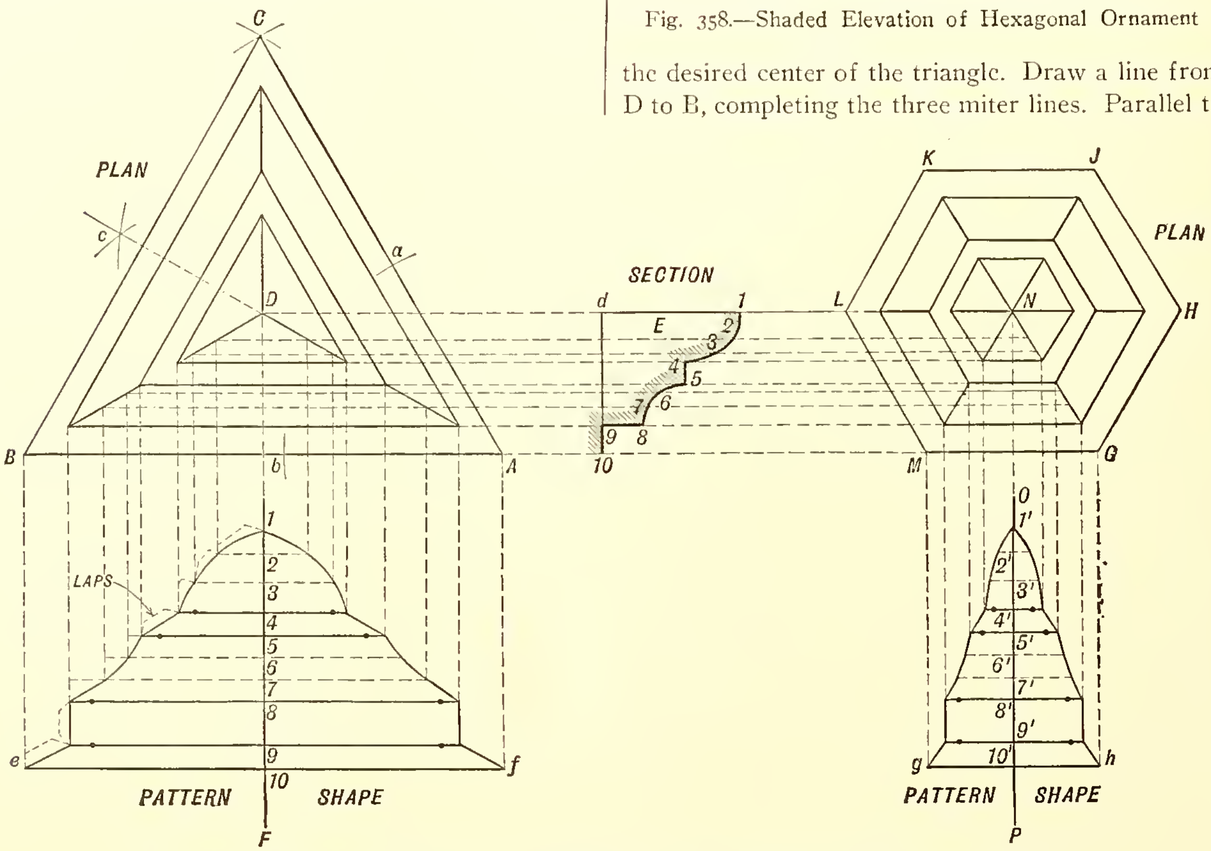


Fig. 359.—Patterns for Triangular and Hexagonal Ornaments Having the Same Profile

C D draw any line, as *d* 10, and from the center D in plan and parallel to B A draw the line D 1 to any length, cutting *d* 10 at *d*. Establish the hight of the section as *d* 1 and draw the desired profile from 1 to 10, as shown. Divide the curves in this section into equal parts and number all points, as shown from 1 to 10. From these small figures and parallel to A B draw lines, intersecting the two miter lines A D and D B in plan, as indicated. Extend C D in plan as C F and upon this place the girth of the section, as shown by similar numbers on C F. Through these divisions and at right angles to C F draw lines and intersect them by lines drawn parallel to C F from similar intersections on the miter lines B D A in plan. Trace a line through these points of intersection. *f* 1 *c* will be the pattern for all three sides. Laps are to be allowed on one side as shown by the dotted lines and then all sides are formed one way. In other words, all laps must face toward the one side. This permits joining together.

HEXAGONAL MOLDED ORNAMENT

Solution 103

To develop the pattern for the hexagonal molded ornament shown in the shaded elevation in Fig. 358, proceed as shown in Fig. 359. The hexagon plan, G H J K L M, is drawn and the six miter lines are drawn to the center N, although only two miter lines are necessary, as indicated by N M and N G. The profile, or section E, is placed in its proper position, as shown, spaced into equal divisions and from the small figures thereon lines are carried to the right, parallel to M G, intersecting the miter lines G N M, as shown. The girth of E is now placed on the girth line O P, as shown by the small figures 1′ to 10′; through these and at right angles to O P lines are drawn and intersected by lines drawn parallel to O P from similar intersections on the miter lines, G N M in plan. Trace lines through points thus obtained. *g h* 1′ will be the pattern for the six sides. Allow laps on one side of all six, as specified in the preceding problem.

A FIVE-POINTED STAR

Solution 104

Fig. 360 is a view of a five-pointed star, in the development of which triangulation is required. Fig. 361 illustrates the procedure involved, which may be applied to a star having any number of points or any hight at its apex. It is to be borne in mind that whatever the number of points the star may have, one of the points must lie on a horizontal line, as shown by A B in plan.

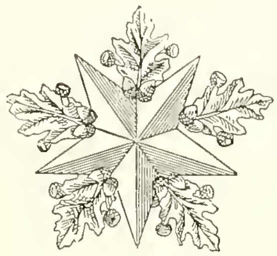


Fig. 360.—View of Five-pointed Star

To draw the plan of the star proceed as follows: Using A as center and with the desired radius draw the circle, as shown. From A draw the horizontal line A B intersecting the circle at B. From B divide the circle into parts, providing one for each of the five star points, as shown by B, C, D, E and F, from which, draw lines to the center A. Again using A as center and with the desired inner radius draw the circle shown, intersecting lines previously drawn at *b, c, d, e* and *f*. Bisect each of these spaces ob-

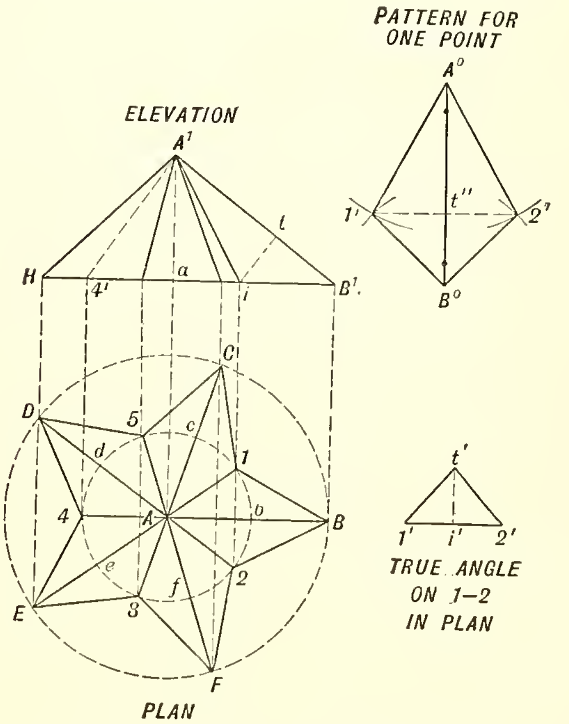


Fig. 361.—Pattern for Five-pointed Star

taining points 1, 2, 3, 4 and 5, and connect these points by lines, as shown. Establish the hight of the star on its center line in elevation as *a* A^1, and complete the elevation, as shown by the dotted construction lines. As one of the points A B in plan lies on a horizontal line, then A^1 B^1 in elevation will show its true length. B 1 in plan also shows its true length, while the true length of 1 A is found as follows: Since all lines from A 1 to A 5 are of corresponding length and as A 4 lies on a horizontal line, simply project, point 4 to the base line in elevation at 4′ and draw a line from 4′ to A^1, obtaining the true length sought. If 4 A in plan did not lie on a horizontal line, its distance would be measured and set off, as from *a* to 4′ in elevation. Having thus found the necessary true lengths the pattern may be laid out.

Take the distance of A^1 B^1 and set it off on any line, as A° B°. Using B 1 in plan as radius and with B° in the pattern as center, describe the arcs 1′ and 2′; intersect them by arcs struck from A° as center and with A^1 4′ in elevation as radius. Connect points in the pattern by straight lines; A° 1′ B° 2′ will be the pattern for one point, five of which will be required.

To obtain the true angle on the line 1-2 in plan, to be used in bending the points of the star on the line A° B°, extend the line 2-1 in plan until it meets the base of the star in elevation at *i*; from this point and at right angles to A^1 B^1 draw the line *i t*. Set off the distance 1-2 in plan, as shown by 1′-2′ in the true angle. Bisect 1′-2′ and obtain *i*′, from which point erect the perpendicular *i*′ *t*′ equal to *i t* in elevation. 1′ *t*′ 2′ gives the true angle or stay, and the girth of 1′ *t*′ 2′ will be equal to 1′ *t*″ 2′ in the pattern. If desired, two or more points may be joined to avoid soldered seams.

A MOLDED CHAMFER

Solution 105

Fig. 362 illustrates a chamfer or broken corner. We will obtain the pattern for the molded chamfer A. The method of developing the gore or chamfer is shown in detail in Fig. 363. First, draw the profile of the mold as viewed from one side, shown by A, 1, 7, B, C in the partial elevation. Below and in line with B C draw the plan D 7 E, representing a section on B C in elevation. Project 1 in elevation to cut the side 7 D in plan at 1, from which point and at an angle of 45 degrees draw the line 1-1°. Then D, 1, 1°, E in plan shows a section through the line 1 *e* in elevation. Divide the profile from 1 to 7 in elevation, into an equal number of parts; from these points of division, drop lines perpendicular to B C until they cut the line 7 D in plan, as shown by similar numbers. From these divisions on 7 D and parallel to 1-1° draw lines cutting the opposite side 7 E, as shown. From the corner 7 and at right angles to 1-1° draw the line 7-*a* crossing the lines previously drawn, as shown from 1′ to 7. Take these various divisions on 7-*a* and place them on any line drawn parallel to B C in elevation, as shown by similar numbers on F G. At right angles to F G and from the small figures thereon erect lines and inter-

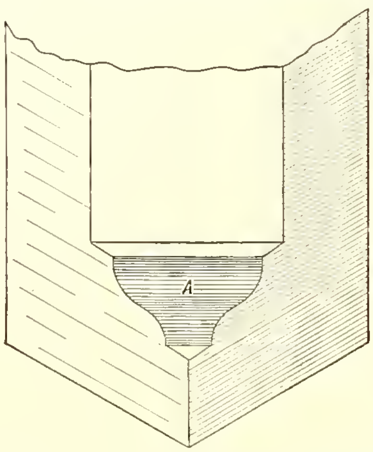


Fig. 362.—View of Chamfer on One Corner

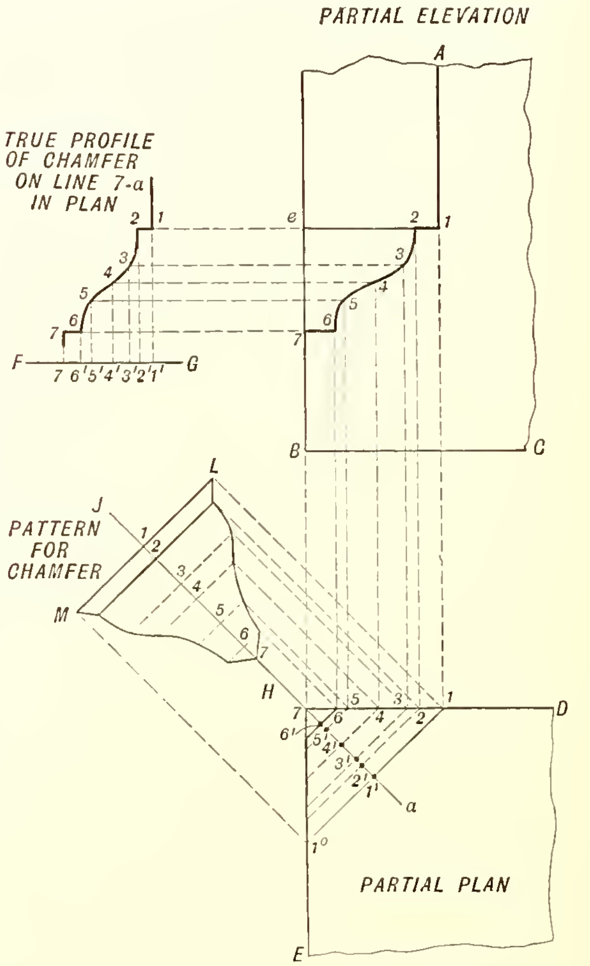


Fig. 363.—Method of Developing Chamfer Pattern

sect them by lines drawn parallel to B C from similarly numbered points in the profile in elevation. Trace a line through points thus obtained; this will give the true profile of the chamfer on the line 7-*a* in plan.

For the pattern, extend the line *a* 7 in plan as H J and on this place the girth of the true profile of the chamfer, measuring each space separately, since all are unequal, as shown by similar numbers on H J. Through these small figures and at right angles to J H draw lines and intersect them by lines drawn parallel to H J from similarly numbered points on the outline D 7 E in plan. A line traced through points thus obtained, as shown by L M H, will be the pattern for the molded chamfer. If the pattern has been accurately developed the girth along the miter cut L-7 in the pattern will be equal to the girth of 1-7 in the profile in elevation, to which it is soldered. Allow laps for soldering purposes.

MOLDED BASE, FORMING A TRANSITION FROM SQUARE TO OCTAGON

Solution 106

Taking up the subject of gore pieces on molded bases the illustration presented in Fig. 364 shows a design which may be used for a pedestal or base of a flagpole, cross or other ornament on the top of a building. The pedestal is made octagonal at the top

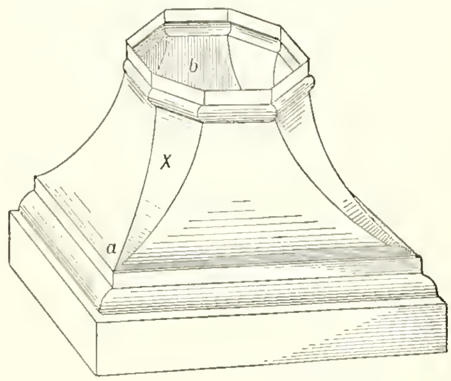


Fig. 364.—View of Molded Base, Forming a Transition from Square to Octagonal

and square at the bottom, the transition between the two shapes being accomplished by the gore piece shown, which differs somewhat in shape, but not in principle, from that found at the base of the vase shown in a preceding solution. X in Fig. 364 is known as a gore piece, forming a transition from the square corner at *a* to the octagon at *b*.

The patterns are shown developed in Fig. 365 which presents an elevation and half plan of the pedestal in which A D is the entire profile of one

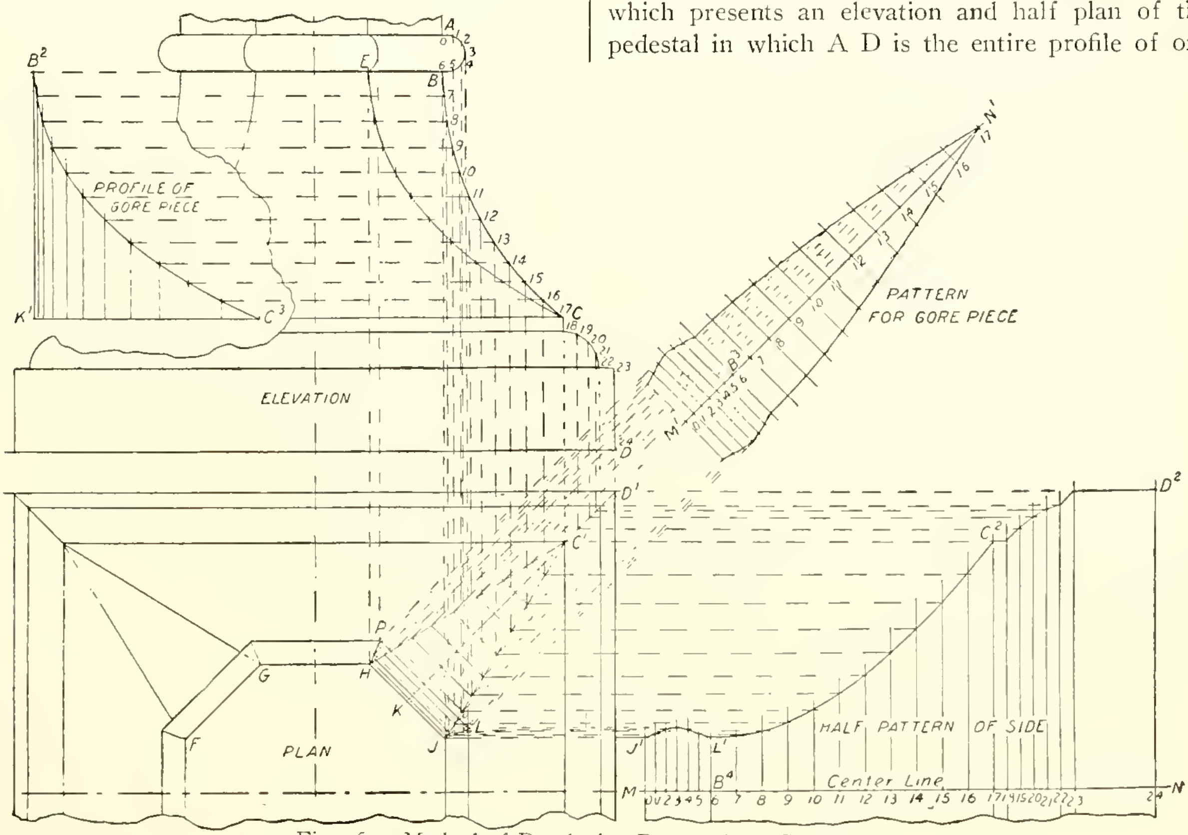


Fig. 365.—Method of Developing Pattern for a Gore Piece

of the four sides. The molding A B is carried around the top of the pedestal, forming a regular octagon, as shown by F G H J, etc., of the plan, while H J C^1 is the plan of the gore piece, shown in the elevation by E B C. In an analysis of the several parts it should be noted that since the molding A B forms a regular octagon its miter lines for one piece are shown on the plan by J L and H P, while J C^1 and H C^1 are the miter lines for the gore piece, and that the base mold of which C D is the profile forms regular square miters at the corners, the miter line being C^1 D^1 of the plan.

Therefore, to obtain the pattern for one of the four sides in one piece, divide the curved portions of the entire profile A D into any convenient number of spaces, as shown by the figures, and set off a stretchout of the same on any line, as M N, drawn at right angles to the side in plan.

Project lines from the points of division on profile A B to intersect the miter line J L, as shown, and carry them thence parallel with M N, to cut measuring lines of corresponding numbers, as shown from J^1 to L^1 of the pattern. Lines from that part of the profile indicated by B C are projected in a similar manner to cut the miter line J C^1, and from that part of the profile from C to D to cut the miter line C^1 D^1, when all are carried as before to cut the measuring lines of corresponding number, as shown by L^1 C^2 D^2. A line traced through these points, as shown from J^1 to D^2, will, with the center line, form a half pattern of the side piece.

Before laying out a pattern for the gore piece it will be necessary to construct a profile of the same or otherwise a section through the pedestal on the line K C^1 of the plan. This may be accomplished in connection with the laying out of the pattern by first carrying the points on the line J C^1 across to cut the other miter lines H C^1, cutting at the same time the center line K C^1 of the gore. The points thus obtained on K C^1 will give the projection of the points of the new profile, that is, their distances from the center toward C^1, while the hights of the several points will be the same as those of the profile B C of the elevation. We may therefore transfer the line K C^1 to a position at one side of the profile B C, as shown by K^1 C^3, keeping the spaces thereon respectively equal to those on K C^1, all as shown. Lines erected from the points on K^1 C^3 to intersect lines of corresponding number carried horizontally from the points on profile B C will give the required profile, as shown by B^2 C^3.

To obtain the pattern for the gore piece a stretchout of the new profile must be set off on the line K C^1, extended, as shown by M^1 N^1. Care must be taken to transfer the spaces one at a time, in consecutive order, from B^2 C^3 to M^1 N^1, since, in the construction of B^2 C^3, the spaces have become unequal. This having been done, lines may now be carried from the points on the two miter lines, J C^1 and H C^1, to cut measuring lines of the stretchout of corresponding number.

It will be noticed that the stretchout of the profile A B has been added to that of B^2 C^3, as shown by M^1 B^3, and that the projections have been carried from the lines J L and H P to meet them, so as to have the pattern for the oblique side or gore in one piece, as mentioned above, thus making this part of the pattern exactly the same as the corresponding part of the pattern of the side, whose stretchout is M B^4.

Projections carried back into the elevation from the points on H C^1 to intersect lines of corresponding number, already drawn from profile B C, will give the correct elevation of the gore piece, as shown by E C B, and lines similarly drawn from points on H P to meet the lines from points on A B (not shown), will give the elevation of the octagon miter in the mold around the top of the pedestal, thus giving with the gore piece the correct elevation of the entire pedestal.

In the illustration a number of the lines of projection have been omitted in order to avoid confusion.

MOLDED CAP, FORMING A TRANSITION FROM OCTAGON TO SQUARE

Solution 107

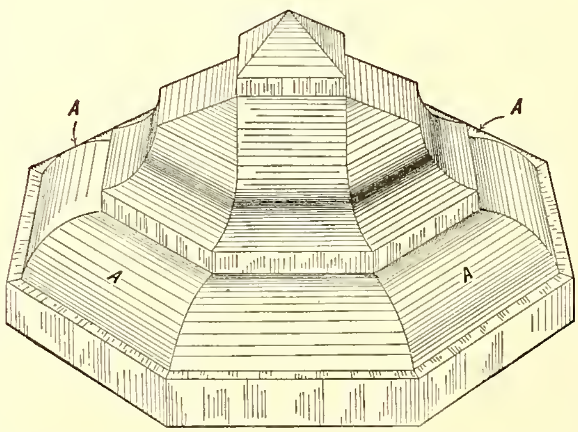


Fig. 366.—View of Molded Ornament or Cap, Forming a Transition from Octagon to Square

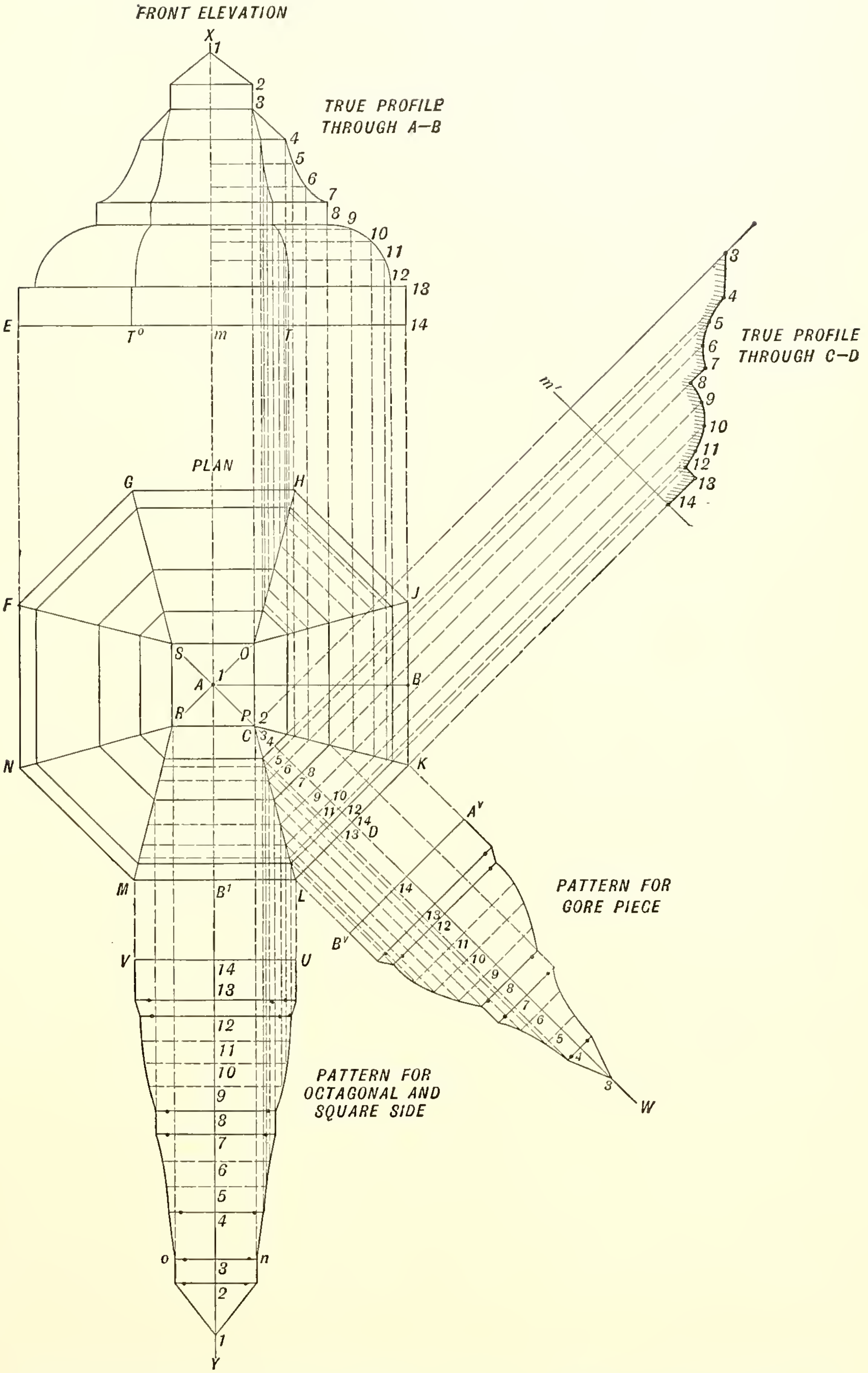


Fig. 367.—Patterns for an Ornamental Molded Cap Forming a Transition from Octagon to Square

Fig. 366 presents a perspective view of a molded ornament or cap from octagon to square. It will be noted that the top diamond is a true square, while the base is a true octagon. The alternate sides of the octagon, marked A, form the gores, which in turn form the transition from octagon to square. The method of obtaining the pattern shapes is shown in Fig. 367.

First, draw the center line X Y and, using A upon it as center, draw a regular octagon, as indicated by F G H J K L M N. From F and J erect perpendicular lines to meet the horizontal line drawn above the plan at E and 14. From E and 14 draw the profile of the cap, as shown from E to 1 and 1 to 14. Since the top portion of the cap, indicated by 1, 2, 3 in elevation, is to be treated as of square formation, drop a perpendicular line from 2-3 to the plan, as shown, and complete the square O P R S. From the corners H and J in plan draw lines to the corner O; from L and K to the corner C; from M and N to R; and from F and G to S. In practice it would be necessary to draw only the half elevation X *m* 14 and the one-quarter plan B A B¹, from which the patterns are obtainable as follows:

Divide the cove and quarter round in elevation into equal parts and number the entire profile from 1 to 14. From these small figures and parallel to the center line X Y drop lines cutting the miter lines J O and P K in plan, as shown. From the intersections on K P and parallel to K L draw lines cutting the miter line L C and from these intersections and parallel to L M draw lines cutting the miter line R M, all as shown. At right angles to K L from the corner P draw the line P D crossing the lines previously drawn, shown by the numbers 1 to 14. From these intersections, 1 to 14, on P D erect lines to any hight at right angles to P D, as shown. Draw the line *m′* 14 parallel to P D. Measuring from the line *m* 14 in the front elevation take the various hights from 3 down to 14, and place them on lines drawn from similar numbers in plan, measuring in each instance from the line *m′*-14. Trace a line through points thus obtained; the shaded profile 3 to 14, will be the true profile for the gore piece on the line C D in plan.

To obtain the pattern for the gore piece extend the line C D in plan as D W and upon this place the girth of the true profile through C D, measuring each space separately, as the spaces are all unequal, as shown by similar numbers on D W. Through these small figures and at right angles to D W, draw lines and intersect them by lines drawn parallel to D W from similar intersections on the miter line K C and C L. Trace a line through these intersections; A^v, B^v 3 is the pattern for the gore pieces.

To obtain the pattern for the side marked B or B¹ in plan take the girth of the normal profile, 1 to 14, in the front elevation, and place it on the center line X Y, as shown from 1 to 14. Through these small figures and at right angles to X Y draw lines and intersect them by lines drawn parallel to X Y from similar intersections on the miter lines A C L and A R M in plan. Trace a line through points thus obtained; V U 1 gives the desired pattern. That part of the pattern indicated by *o n* 1 forms the square diamond shown by 1-2-3 in the front elevation. The pattern could also have been obtained from the side A O J K P A in plan.

Should it be desired to project the miter lines in elevation, the method would be as follows: From the various intersections previously obtained on the miter line O J in plan draw lines parallel to J H until they cut the miter line H O, as shown, and from these intersections erect vertical lines cutting horizontal lines drawn from similar numbers in elevation, as shown. Through these points of intersection the miter line 3 T is traced, this if desired being reproduced on the opposite side at T°. It is to be understood, of course, that these miter lines are not necessary in the development of the patterns; they show, however, a completed elevation.

PITCHED RECTANGULAR PANEL

Solution 108

Fig. 368 is a view of a raised rectangular panel. The procedure of laying out the pattern by a quick and accurate method is shown in Fig. 369. Draw the plan of the rectangular panel 1-2-3-4, taking care that its corners will touch the circle struck from *a*,

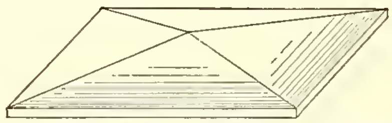


Fig. 368.—View of Pitched Rectangular Panel

the intersection of the two diagonal lines. At right angles to one of the miter lines, as *a*-2, erect the line *a*-A, equal to the desired hight of the panel, and draw a line, as A-2, showing the true length of the corner as also the radius with which to strike the pattern. Using A-2 as radius and from A° in the lower diagram as center, draw the circle X-Y. Assuming that a seam is desired along *a*-*b* in plan, take the distance of 4-1, 1-2 and 2-3 and, starting at any point on the circle in pattern, as 4, step off 4-1, 1-2 and 2-3; from these points draw lines to the center A°. Bisect the side 1-2 and obtain *b*. Using 1-*b* as

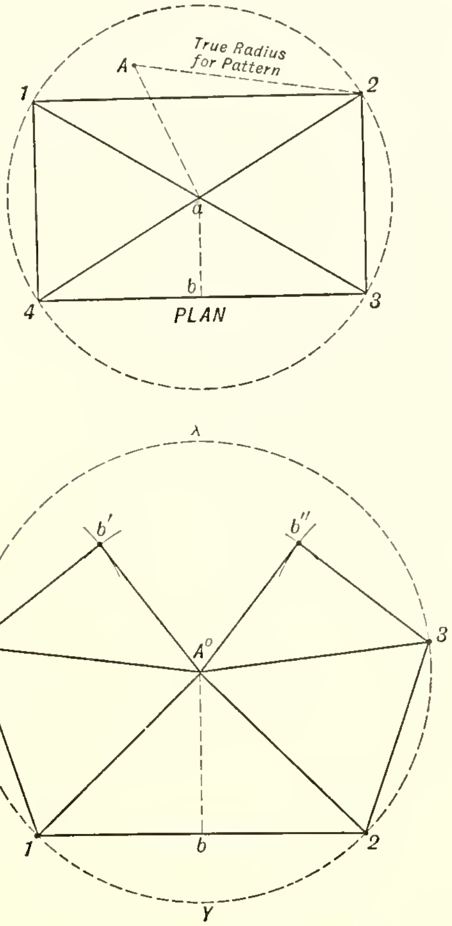


Fig. 369.—Pattern in One Piece

radius and with 4 and 3 as centers, describe arcs at *b′* and *b″* and intersect them by arcs struck from A° as center with radius equal to A°-*b*. Draw lines from 4 to *b′* to A° to *b″* to 3; the net pattern in one piece is thus completed.

TRIANGULAR PYRAMID

Solution 109

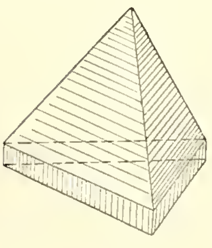


Fig. 370.—View of Triangular Pyramid

In Fig. 370 is given a view of a triangular pyramid, such as is often used in the ornamental design of cornice work. The development of the pattern which is alike in principle to that found in the preceding problem, is shown in Fig. 371. The circle in plan is struck from the

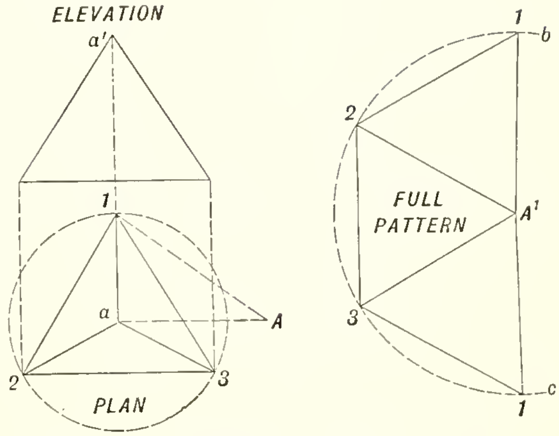


Fig. 371.—Pattern for a Triangular Pyramid

center *a* and the equilateral triangle is inscribed in the same, as shown by 1-2-3. From these three corners the hip lines are drawn to the center *a*. The elevation is shown above, although this is not a necessary procedure in the development of the pattern. The hight of the pyramid is equal to 1 *a′*, which is laid off at right angles to 1*a* in plan, as shown from *a* to A. Using A-1 as radius and with A^1 as center describe the arc *b c*. Set the dividers apart to a distance equal to one of the spaces in plan, and, starting from any point on the arc *b c*, as 1, step off three spaces, as shown by 1, 2, 3, 1. Connect lines as shown. These give the full pattern.

HEXAGONAL PYRAMID

Solution 110

Fig. 372 presents a finished view of a pyramid, whose base is hexagonal or six sided. The pattern is obtained as shown in Fig. 373. The outline or circle is first drawn, as shown in the plan, and the

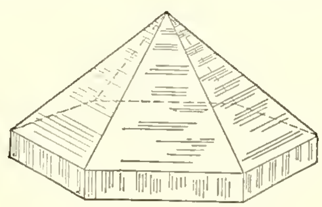


Fig. 372.—View of a Hexagonal Pyramid

hexagon is inscribed as shown. From the corners, 1 to 6, the hip lines are drawn to the center *a*. The elevation is omitted here as unnecessary. The vertical rise of the pyramid *a* A is set off at right angles to *a* 2 as shown, when A 2 will be the radius with which to describe the pattern. Using A 2 as radius and with A° as center describe the dotted circle, as shown. Take the width of 1-2 in plan, and, starting from any part of the circle in the pattern, as 1, step

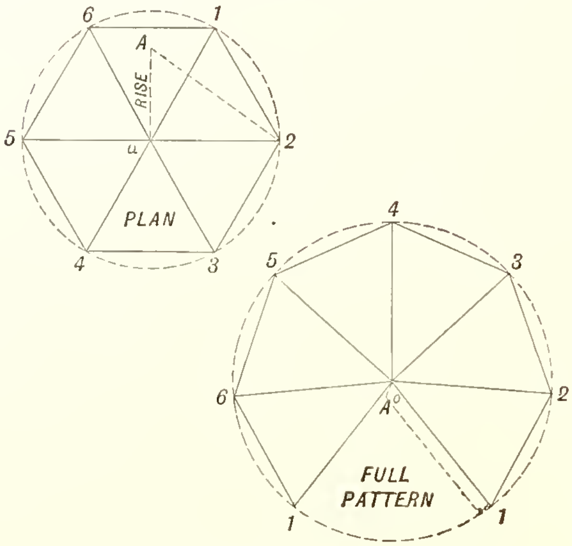


Fig. 373.—Pattern for a Hexagonal Pyramid

off six spaces, as shown from 1 to 6 to 1. Draw solid lines as shown, thus obtaining the full pattern.

DEVELOPING PYRAMIDS REGARDLESS OF THE SHAPE OF POLYGON IN PLAN

Solution 111

The methods of procedure contained in some of the preceding problems apply also to pyramids whose bases are irregular. Without respect to the formation of the outline of the pyramid's base the procedure indicated in Fig. 369 may be followed since there is no differing principle involved. It is required only that all corners of the outline or base touch the circle and that all hip lines drawn from these corners come directly over the center from which the circle has been struck. Thus in Fig. 374, we have a base whose angles are octagonal, but whose long and short sides alternate. Note that all corners inscribe the circle and that lines drawn from those corners come directly to the apex A, the center of the circle. Let us assume that the rise of the pyramid is A C, which is laid off at right angles to A B, thus that C B is the radius with which the pattern can be developed in the usual manner.

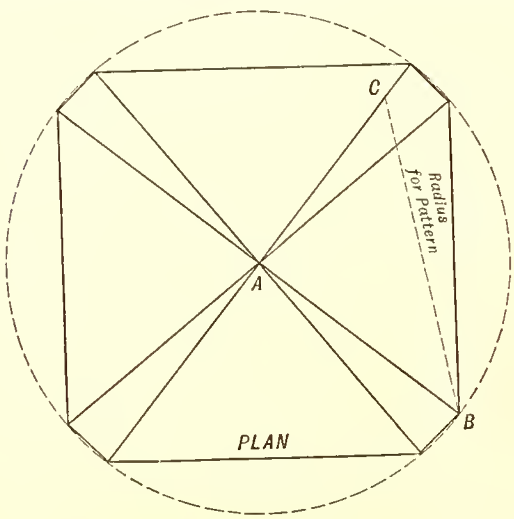


Fig. 374.—Alternate Long and Short Sides of Corresponding Angles

Another irregularly shaped base is shown inscribed in the circle in Fig. 375. Each side is of different length but each corner meets the circle, while lines drawn from these corners meet the center of the circle A or the apex of the pyramid, and make every hip line, 1 to 6, of equal length. As previously described the desired hight A *a* is laid off at right angles to any line, as 6 A, when 6 *a* becomes the radius from which to describe the circle in developing the pattern.

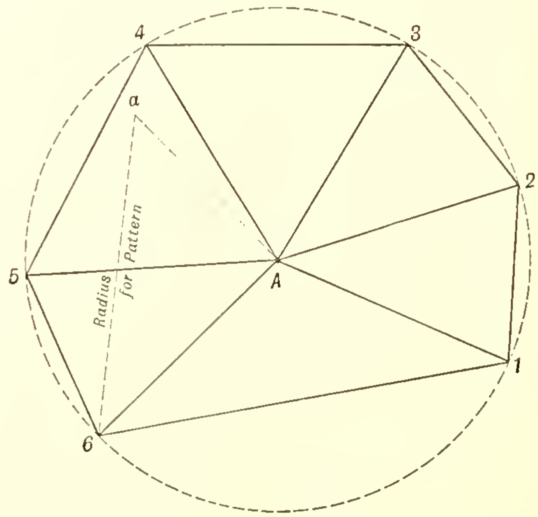


Fig. 375.—Irregular Pyramid Having Dissimilar Angles

TRIANGULAR DENTIL, INTERSECTING COVE MOLDING

Solution 112

Fig. 376 shows a partly finished front elevation of a window cap, in which triangular dentil enrichments are placed in the cove molding of the molded chamfer, indicated in the sectional view at *a*. The principle, to be explained, applying to the development of the pattern, is applicable whether the dentil

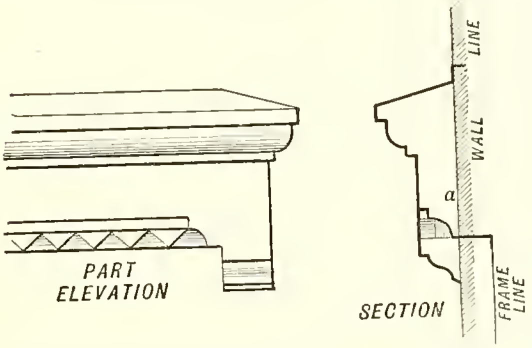


Fig. 376.—Part Elevation and Section of Window Cap, Showing Triangular Dentils Intersecting Chamfer Cove

has a triangular face or other shape, and whether it intersects a cove mold or mold of other shape. The method of developing the pattern shape is shown in Fig. 377, and comes under that class of developments known as *miters between dissimilar moldings.*

First, draw the profile of the chamfer, as indicated

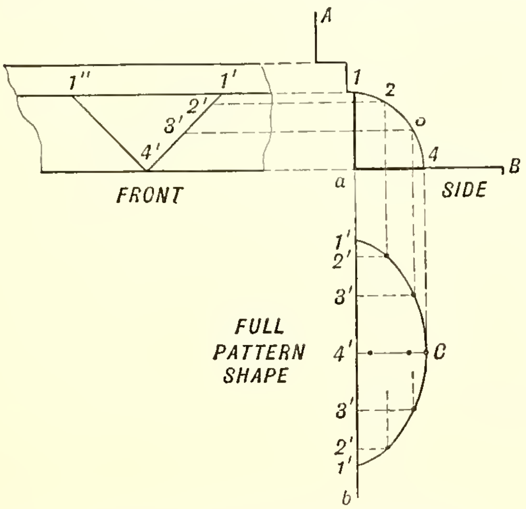


Fig. 377.—Pattern for Triangular Dentil Return on Chamfer Cove

by A B. Draw the side view of the dentil where it intersects the cove, as shown by 1 *a* 4. In line with the side, draw the front of the triangular dentil, shown by 1′-4′-1″. Space the intersection upon the cove between 1 and 4, in the side, as shown by the small figures 1, 2, 3 and 4; from these points draw horizontal lines to the left, until they intersect the side of the dentil 1′-4′ in the front, as shown by similar numbers. Take the girth of the unequal spaces between 1′ and 4′ in the front and place them on the line 1-*a* extended in the side as *a b*, as shown by similar numbers 1′ to 4′ to 1′. Through these small figures and at right angles to *a b* draw lines and intersect them by lines drawn parallel to *a b* from similar points of intersection in the cove molding. A line traced through points thus obtained, as shown from 1′ to C to 1′, will be the full pattern shape. The dots on the line 4′ C show where the bend will be made at an angle indicated by 1′ 4′ 1″ in the front.

PATTERN FOR RETURN OF BRACKET DROP

Solution 113

In Fig. 378 are presented the front and side elevations of a finished cornice bracket, on which a face drop, A, is introduced with a return, B, mitering

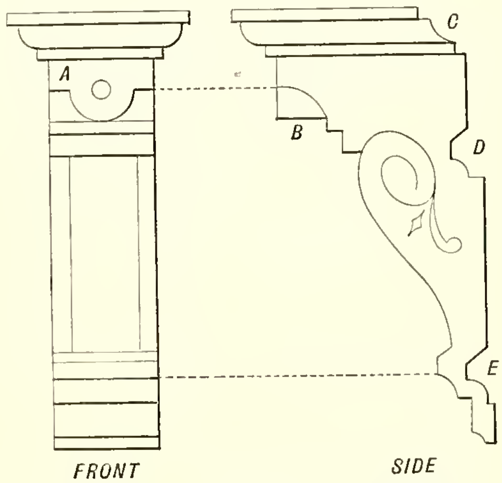


Fig. 378.—Front and Side View of Cornice Bracket, Showing Face Drop and Return

against the cove mold in the bracket, the pattern for which is to be developed. The molds or profiles marked C, D and E indicate the profiles of the cornice molds to which the bracket will be joined. The method of developing the return on the bracket drop is shown in detail in Fig. 379, where A B indicates the profile of the upper part of the bracket, and C D E F the front elevation of the upper part of the bracket. The face of the drop is shown by D, C, 1″, 1, 5, 1″, D; H represents the center from which the semi-circle of the face drop is struck. Divide one-half of the face into equal parts, as shown from 1 to 5, and from the small figures 2 to 5 draw horizontal lines to the right cutting the cove mold in the side elevation from 1′ to 5′. As the division between 1′ and 2′ is too great, bisect this division and obtain the point a′ and project this point back to the face in the front elevation and obtain point *a* between 1 and 2. Take double the number of spaces contained in the half face in the front elevation and place them on the line 1′ *b* extended as J K, as shown by similar numbers and letters, taking care to introduce the point *a* between 1 and 2, as shown. Through these small

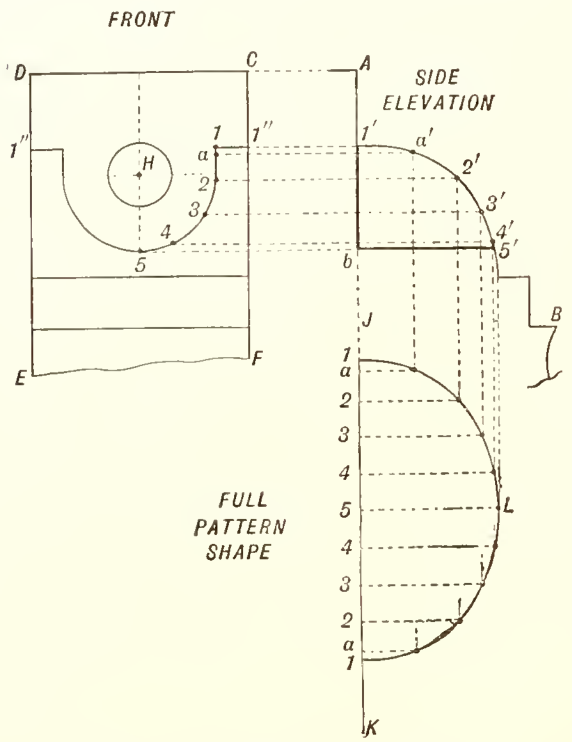


Fig. 379.—Patern for Return on Face Drop

figures and at right angles to J K draw lines and intersect them by lines drawn parallel to J K from similar intersections on the cove line 1′-5′ in the side elevation. Trace a line through points thus obtained, as shown by J L K; this represents the full pattern.

ORNAMENTAL DROP RETURN, INTERSECTING NUMEROUS MOLDS

Solution 114

Fig. 380 shows the front and side of an ornamental face drop, A representing the face and B its return, mitering on a succession of molds as indicated in the side. The profiles cut out on the side of the bracket at *a, b* and *c,* indicate the profiles of the cornice against which the bracket is to join. The method to be followed in obtaining the pattern for this ornamental return is indicated in Fig. 381.

First, draw the upper part of the front elevation of the bracket or other object, as shown by A B C D, and upon this draw the face of the drop, indicated by A B X 13 Y A, the curves being struck

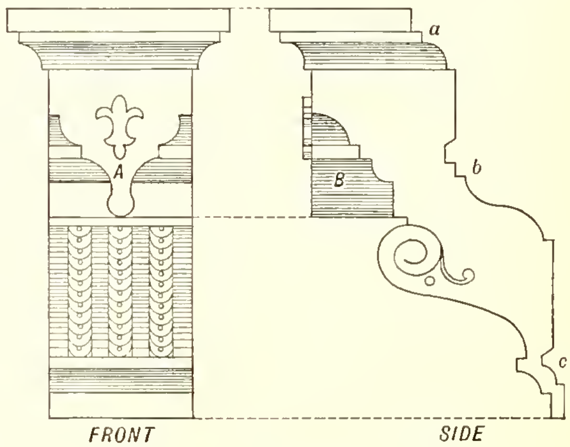


Fig. 380.—An Ornamental Face Drop

from the centers *a, b* and *c.* In line with the front elevation draw the side elevation of both the profile of the bracket and the return of the drop, as shown by B, 1′ 13′ and B F E, respectively. It will be noted that the bends 1, 4 and 5 in the front elevation are in line with the bends 1′, 4′, 4″, 5′ and 5″ in the side elevation. As the bend 8′ in the side does not run in line with any bend in the front, project 8′ to the left horizontally, thus obtaining the intersecting point 8 in the cove in the front elevation. Divide the molds in the front elevation into any convenient number of spaces, as shown from 1 to 4, 5 to 9 and 9 to 13. From these divisions draw horizontal lines to the right, cutting the profile of the bracket in the side from 1′ to 4′, from 5″ to 8′ and from 8′ to 13′. Where the lines drawn from 4 and 5 in the front elevation intersect the profile of the bracket in the side, indicate these points as 4′, 4″ and 5′-5″. As the distance between 1′ and 2′ and that between 7′ and 8′ are too great, establish an extra point in each, as *a*′ and *b*′, respectively, and from these two points draw horizontal lines to the left, cutting the profiles at *a* and *b,* respectively. Having thus found the various points of intersections in both elevations, the pattern may now be developed.

Extend the line B F, as shown by F J, on which place the girth of the semi-face 1 to 13 in the front elevation, taking care to include the points *a* and *b,* all as shown by similar letters and figures on F J.

Through these small figures and at right angles to F J draw lines, as shown, and intersect these lines by lines drawn parallel to F J from similarly numbered and lettered intersections on the profile 1′-13′ in the side elevation. Trace a line through points thus obtained; 1 H G 13 is the half pattern shape, with a seam along 13 G.

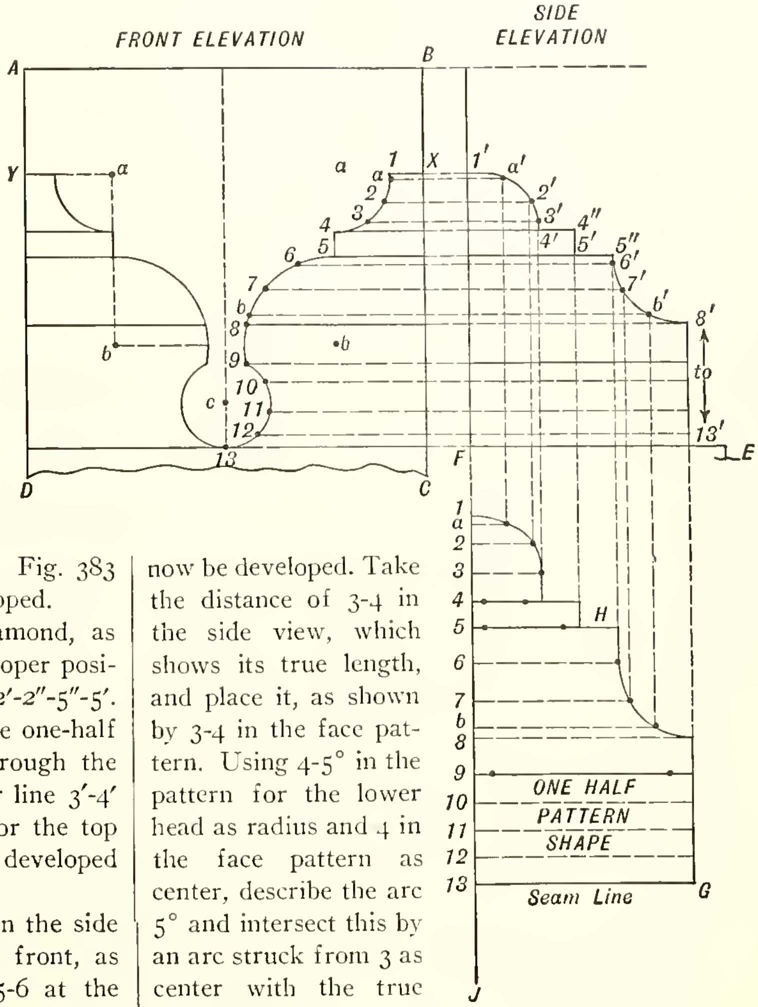


Fig. 381.—Pattern for Return on Ornamental Face Drop

TAPERING DIAMOND IN A KEYSTONE

Solution 115

Fig. 382 presents a view of the diamond in a tapering keystone, which requires triangulation in its development. Fig. 383 shows how the various patterns are developed.

First, draw the side view of the diamond, as shown by 1, 2, 3, 4, 5 and 6, and in its proper position draw the front view, as shown by 2′-2″-5″-5′. In practice it is necessary to draw only the one-half front view, the halves being alike. Through the center of the front view draw the center line 3′-4′ to any length, as shown. The pattern for the top and bottom of the diamond may now be developed by parallel lines, as follows:

Take the girth of 1-2-3 and of 4-5-6 in the side view and place it on the center line in front, as shown by 1-2-3 at the top and by 4-5-6 at the bottom. Through these small figures draw the usual measuring lines and intersect them by lines drawn parallel to the center line from similarly numbered intersections in the front view. Draw lines through points thus obtained; 2^v-3-2° will be the pattern for the upper head and 5^v-4-5° the pattern for the lower head.

The pattern for the two sides will be developed by triangulation, but, before doing so, the true length of 2″-5″ and of the dotted line 3′-5′ in the front view must first be found. To find the true length of 2″-5″ draw a line, 5″ *a*′, at right angles to 2″-5″, making 5″ *a*′ equal to the horizontal distance between the corners 2 and 5 in the side view, as indicated by 5 *a*. Draw a line from *a*′ to 2″, the true length sought. In like manner take the horizontal distance between the corners 3 and 5 in the side view, indicated by 5 *b*, and place this distance on a line drawn at right angles to 3′-5′ in the front view, as shown from 5′ to *b*′. Draw a line from *b*′ to 3′, the true length sought.

The pattern for the two sides in one piece may now be developed. Take the distance of 3-4 in the side view, which shows its true length, and place it, as shown by 3-4 in the face pattern. Using 4-5° in the pattern for the lower head as radius and 4 in the face pattern as center, describe the arc 5° and intersect this by an arc struck from 3 as center with the true length, 3′-*b*′ in the front view, as radius. With radius equal to 3-2° in the pattern for the upper head and with 3 in the face pattern as center describe the arc 2°; intersect this by an arc struck from 5° as center and with the true length, *a*′-2″ in the front view, as radius. Draw lines from 3 to 2° to 5° to 4 in the pattern and at right angles to 2°-5° from 2° and 5° draw the

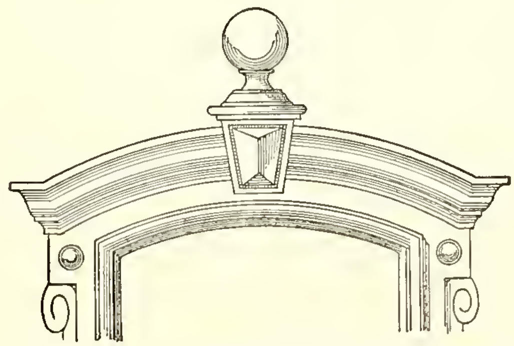


Fig. 382.—View of Triangular Diamond Panel on Keystone

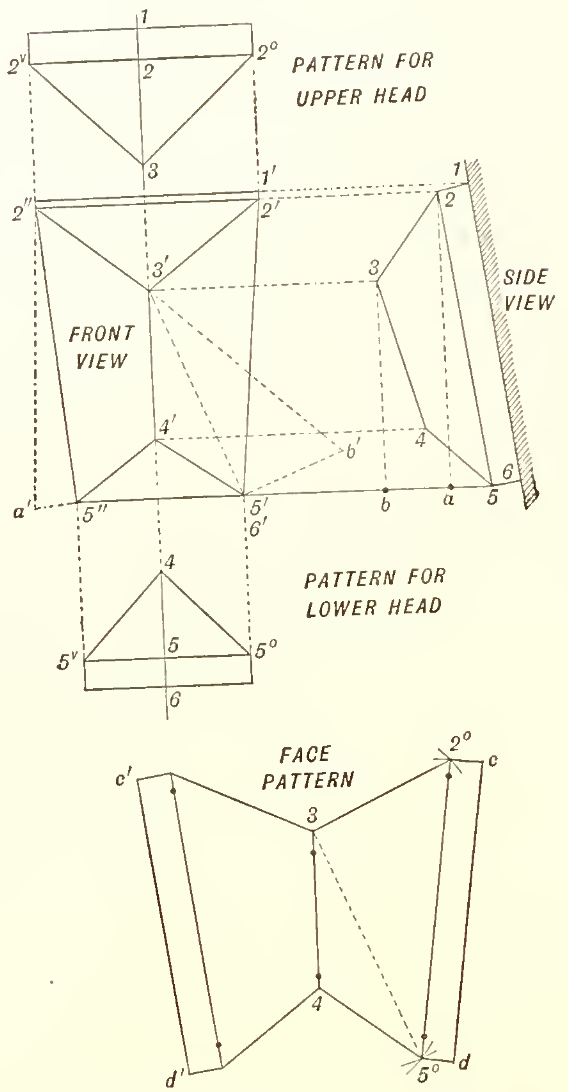


Fig. 383.—Pattern for Keystone Diamond

lines 2° *c* and 5° *d*, equal to 1-2 or 5-6 in the side view. Draw a line from *c* to *d* in the face pattern; this completes the half pattern. Trace this half opposite the center line 3-4, as shown by *c′ d′* at the left. *c d d′ c′* is then the full face pattern.

MOLDED KEYSTONE IN A CIRCULAR ARCH

Solution 116

Fig. 384 shows the front elevation of a keystone, A, in a circular arch, the sides of the keystone being drawn radially from the center *a*, as shown. At the right of the front elevation is shown the section of the circular mold as well as the keystone. The method to be employed in laying out the patterns for the sides and front is shown in detail in Fig. 385.

Here the center line A B is first drawn, and, using the desired radii with *a* as center, part of the circular arch is drawn, as indicated by C D E F. Establish the height of the key as A *d*, also its width at the bottom as *d b* and *d* 8′; and from the center point *a* draw radial lines through *b* and 8′; intersecting them by a horizontal line drawn through A in the keystone. From the various intersections of the arcs of the mold on the center line A B, draw lines to the right, as shown, and draw a section of the circular mold on the line A B, as shown by *e, f,* 6, 8, 9. From the intersection of the keystone upon the center line A B in the front elevation, draw lines to the right, intersecting the section of the circular molding at 1 and 9. Between these points 1 and 9 draw the desired profile of the keystone, as shown. Divide its curved part into an equal number of spaces, as shown from 1 to 8, and from these points draw horizontal lines to the left cutting the sides of the keystone in front elevation, as shown by similar numbers on the right side.

For the pattern for the front proceed as follows: Take the girth of the profile of the keystone from 1 to 9 in the section and place it on the line B A extended, as shown by similar numbers; through these and at right angles to 1 A draw lines and intersect them by lines drawn parallel to A B from

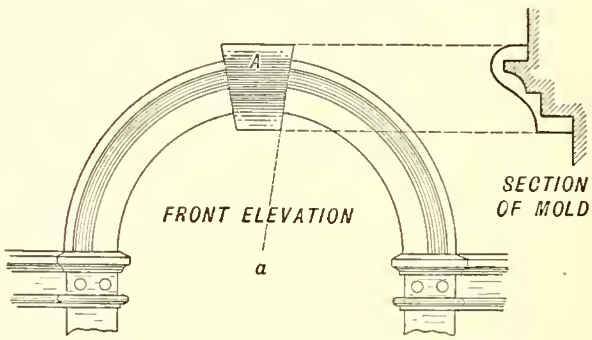


Fig. 384.—Keystone in Circular Arch

similarly numbered intersections on the side 1′ 8′, as partly shown by the dotted lines. Trace the miter cut through these points, as shown from J to K, and transfer this half pattern opposite the center line 1 A, as shown by G H. G K J H will be the full pattern for front.

The pattern for the side to miter with the front, also to join the circular mold, is laid out on the same principle. Take the girth of the various divisions on 1′-8′ in the front elevation and place these divisions on any perpendicular line, as L M, as shown by similar numbers. Through these small figures and at right angles to L M draw lines and intersect them by lines drawn parallel to L M from similar numbers in the profile of the keystone, thus obtaining the miter cut O P R *b′*.

As the sides of the keystone in front elevation run radially to the center point *a*, the section through the curved molding on this line will be the same as the section of the mold at the right and will constitute the shape to be cut in the pattern for sides. This is laid out as follows: Take the distance from the bottom of the keystone *b* in the front elevation to the lower line of the curved molding *c* and place it, as shown in the pattern for sides from *b′* to *c′*. Take a tracing of the section *c*, *f*, 6, 8, 9 and place it, as shown in the pattern by O T *c′*, which completes the pattern for the sides. Laps are to be allowed for joining the curved molding.

RAISED KEYSTONE

Solution 117

In the view of Fig. 386, A shows a raised diamond keystone, for which a pattern is required. This problem presents an interesting study in drawing and development, occurring frequently in relation to window work. The methods of procedure, which follow, are illustrated by means of the details given in Fig. 387. Draw the center line A B and construct a sectional view on this line, as indicated at the right, where the profile of the cornice is shown, and against which the various keys will miter. Complete the side of the keystone, from which the half elevation is drawn, all as indicated by the dotted lines.

The pattern for the top of the keystone is the first subject for development. Extend the center

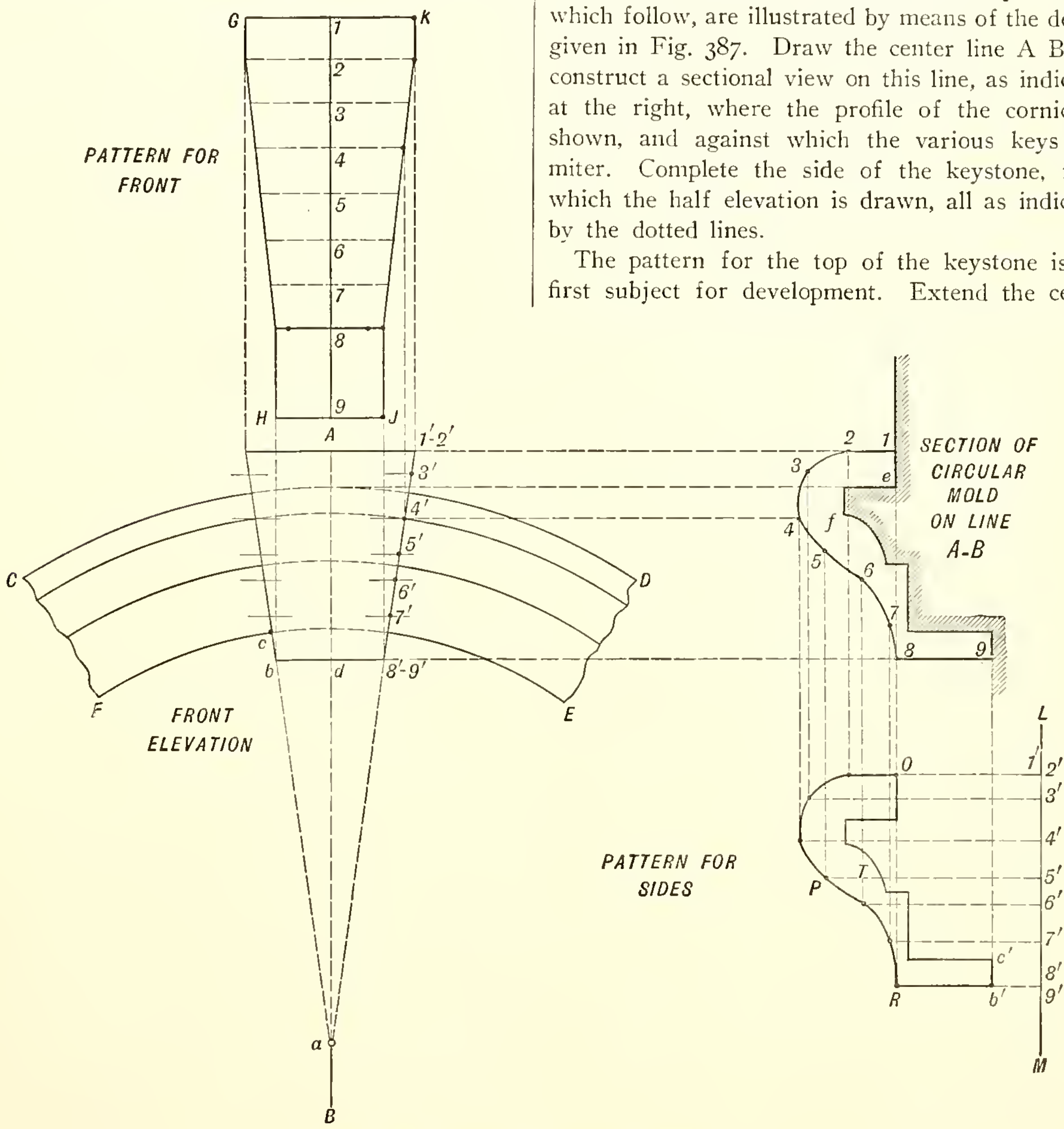


Fig. 385.—Patterns for Molded Keystone

line A B in the two directions, shown by A C and B F. Take the girth of the top, numbered in the section from 1 to 5, and place it on the girth line A C, shown by 1-2-3-4 and 5. Through these small figures and at right angles to A C draw lines, and intersect them by lines drawn parallel to A C from intersections 1, 2, 3, 4 and 5 in the half elevation. Trace a line through these points from D to 5 and transfer the half pattern opposite the center line A C, as shown from 5 to E. D E 5 shows the pattern for the top of the keystone. Take the girth of the bottom of the keystone in the section numbered 5 to 9, taking care to introduce the intersection at *a* between 8 and 9; place all these divisions on the line B F below the half elevation, as shown by similar numbers 5, 6, 7, 8, *a*, 9. Through these small figures 5 to 9 and at right

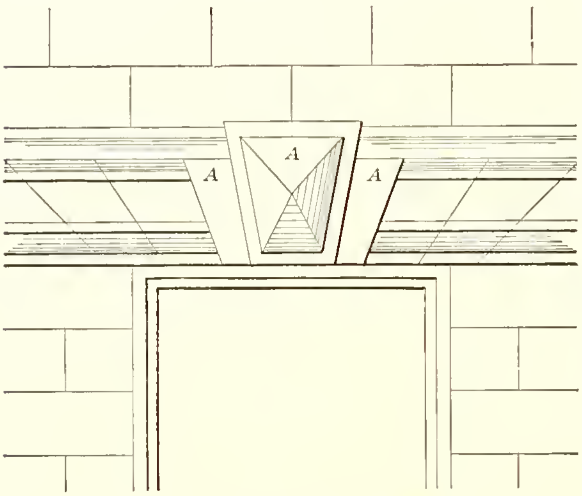


Fig. 386.—Raised Keystone in a Flat Arch

angles to B F draw lines and intersect them by lines drawn parallel to B F from similar numbers 5, 6, 7, 8, *a'*, *a*, 9, thus obtaining the miter cut, 5 to G in the pattern. Trace this half opposite the center line, as indicated from 5 to H. 5 G H will be the completed pattern of the lower part of the keystone.

For that part of the tapering face of the keystone, shown by 2, 3, 7, 8, in the half elevation, take the girth of 2, 3, 7, 8 in the section, and place it on the girth line A C, as shown by 2', 3', 7', 8'. Through these figures and at right angles to C A draw lines and intersect them by lines drawn parallel to C A from the intersections 2, 3, 7 and 8 in the half elevation. Draw lines through points thus obtained, as shown by P R S T.

For the pattern of the adjoining keystone, shown by *b a a' b'* in the half elevation, take the girth of *b a* in the section and place it, as shown by *b a,* on the vertical line J K. Through *b* and *a* and at right angles to J K draw lines and intersect them by lines drawn parallel to J K from the intersections *b b'* and *a a'* in the half elevation. Connect L M N O.

To obtain the pattern for the strip, shown by 3, 4, 6, 7, in the section, take the girth of 3-4, 6-7 in the half elevation and place it on any vertical line, as shown by 3-4, 6-7 on the line *c' d'*. From these two points and at right angles to *c' d'* draw lines to any length, as shown. In the sectional view draw any vertical line, as shown by *c d*. Measuring from this line *c d* take the various projections to points 3, 4, 6 and 7 and place them on similarly numbered lines, measuring in each instance from the line *c' d'*, thus obtaining the points 3" 4" 6" and 7"; this is the desired pattern.

For the pattern of the return on the center keystone on the line 1, 2, *a'*, 8 in the half elevation, with its intersection against the fillet and adjoining keystone, as shown in the section, take the girth of 1, 2, *a'*, 8, with its intermediate points, as indicated by the heavy dots, and place it, as shown by 1, 2, *a'*, 8 on the vertical line W X. Draw the usual measuring lines, as shown, and intersect them by lines drawn parallel to W X from similar points in the section, all as shown by the dotted lines. Connect points by lines, as shown; D^1 E^1 F^1 will be the desired pattern.

For the pattern of the return of the adjoining keystone on the line *b a* in the half elevation with its intersection against the horizontal molding, indicated in the section between *b* and 9, first divide the curves in the mold between *b* and 9 into equal parts, as shown; from these points draw lines parallel to lines of the molding, cutting the line *b a* in the half elevation, as shown by the heavy dots. Take the girth of *b a* in elevation with the various intersections thereon and place it on the vertical line U V, as shown by similar numbers and divisions. Through these points and at right angles to U V draw lines and intersect them by lines drawn parallel to U V from similar points in the section, all as shown by the dotted lines. Trace a line through points thus obtained, as shown by A^1 B^1 C^1, the desired pattern.

The pattern for the entire side of the keystone can now be joined into one, as shown in the full pattern for the sides. First, take a tracing of pattern marked I, to which add the pattern marked II. Add the patterns marked III, IV and V in the manner shown in the full pattern for sides. With

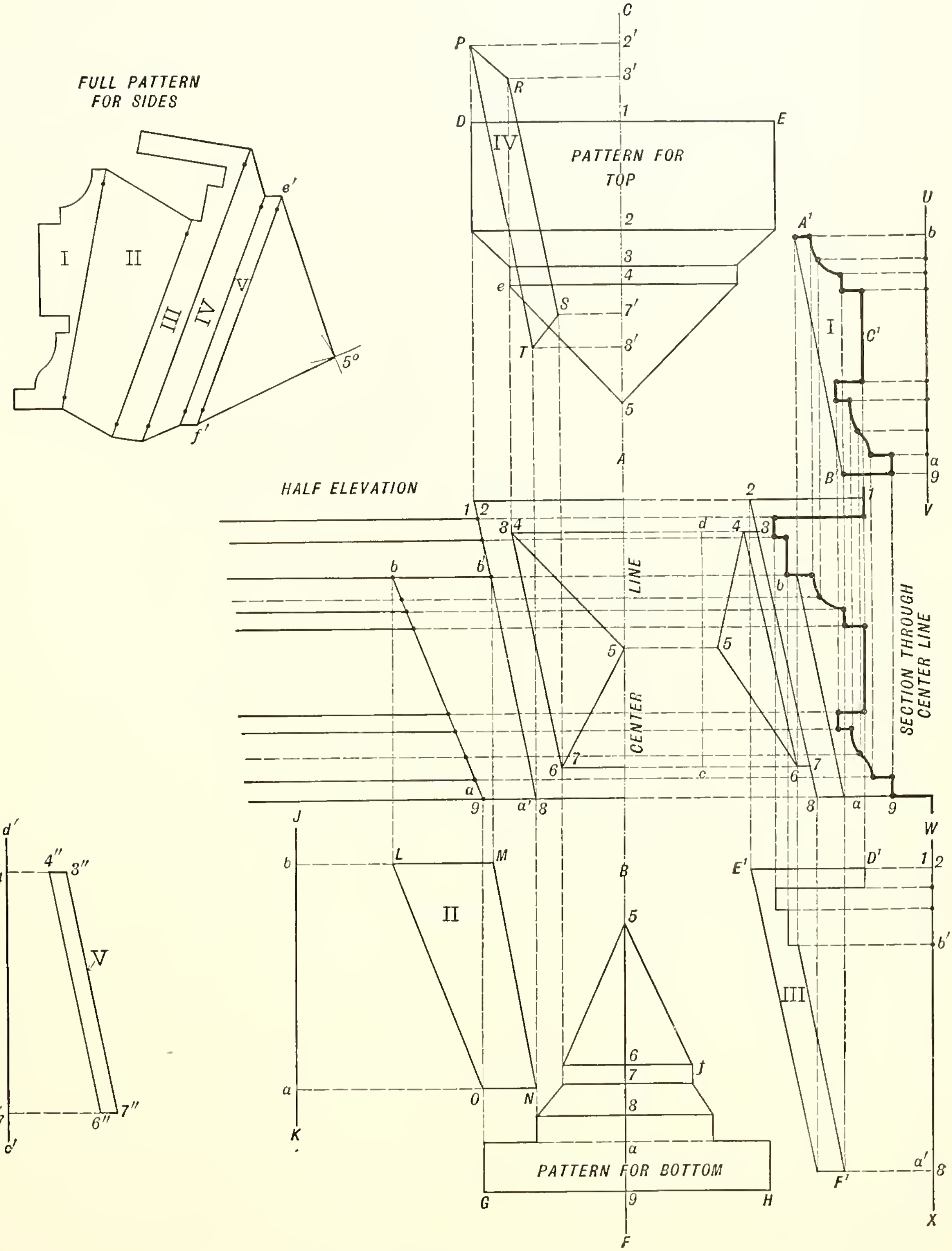


Fig. 387.—The Various Patterns for Raised Keystone

radius equal to *c* 5 in the pattern for the top and with *c′* in the full pattern as center, describe the arc 5°; intersect this by an arc struck from *f′* as center and with *f* 5 in the pattern for bottom as radius. Connect lines from *c′* to 5° to *f′* in the full pattern, as shown. Allow laps for soldering purposes on the sides only, providing no laps on the top or bottom patterns. In this way the keystone can be made in four pieces; that is, the top, the bottom and two sides are formed right and left.

ORNAMENTAL TRIMMINGS ON URNS

Solution 118

When stripped ornamental trimmings are to be placed on urns, as indicated in Fig. 388 by that portion marked A, they can be developed by means of parallel lines, whether the rest of the urn be round, square or octagon. In this case, the base

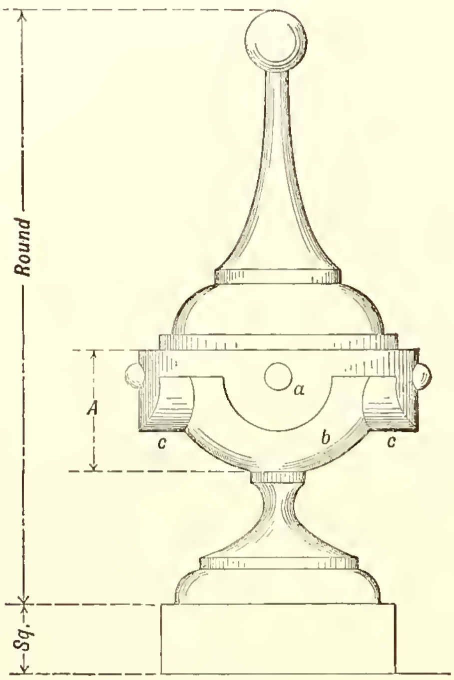


Fig. 388.—View of Round Ornamental Vase

of the urn is square and the rest of it round, the trimmings intersecting the semi-sphere *b*. The patterns for the circular work were taken up in another part on Circular Work.

Four semi-circles, like *a*, are placed around the circumference, with bands alternating. The semi-circles and bands are stripped, as indicated by *c c*, forming the intersection with the sphere. The method of developing the various patterns is shown in Fig. 389, where is found a part elevation of the urn; this, however, is not essential, all requirement being served by the semi-circle, on which the ornamental face and return strips miter.

Therefore, first draw any horizontal lines, as *c d*, and with A on the same line as center, describe the semi-sphere of the required size shown by B C D. Below the elevation draw any horizontal line, E F, and intersect it at G by the vertical line drawn from A, in elevation. Establish the projection of the face strips over the sphere line, as indicated by B *d* and D *c* in elevation. Using G in plan as center and with radius equal to A *c* or A *d* in elevation, describe the semi-plan, as shown by H 4^x J. As there are to be but four semi-circular faces around the circumference of the sphere, draw two lines at 45 degrees from the center G in plan, as shown by G *a* and G *b*. This gives one full and two half spaces in the half plan.

Should six semi-circles or other ornaments be desired to encircle the sphere in elevation, it will be necessary only to divide the half plan into two whole and two half spaces, thus finding the proper width of the semi-circle or ornament in elevation. This method applies to any number of face drops or ornaments. Having thus drawn the lines G *a* and G *b* in plan, to form an intersection with the face line H 4^x J in plan at *c* and *f*, erect from these two intersections vertical lines cutting the line *c d* in elevation at *g* and *h*. Establish the width of the band *h i* and between *i* and *r* draw the drop or semi-circle 1-4-1°, using K as a center. In practice it is necessary to draw only the one-half elevation, as well as the one-quarter plan. Divide one-half of the semi-circle in elevation into equal parts, as shown from 1 to 4, and from these points and parallel to B D draw lines to the right cutting the outline of the sphere at 1′-2′-3′ and 4′; from these intersections drop vertical lines in the half plan, cutting the center line E F at 1″, 2″, 3″ and 4″. Using G as center and with radii equal to G 1″, G 2″, G 3″ and G 4″, draw semi-circles as shown, and intersect them by vertical lines drawn from points 1 to 4 in the elevation, thus obtaining the intersections 1^v, 2^v, 3^v and 4^v and cutting the outer edge of the band in plan at 1^x, 2^x, 3^x and 4^x. From the miter line thus obtained in plan, the patterns can now be developed.

For the face pattern of the drop, take double the girth of *c*, 1^x, 2^x, 3^x and 4^x in plan and place it on the line *d c* extended in elevation, as shown by similar letters and numbers from *c* to 4^x to *c″*

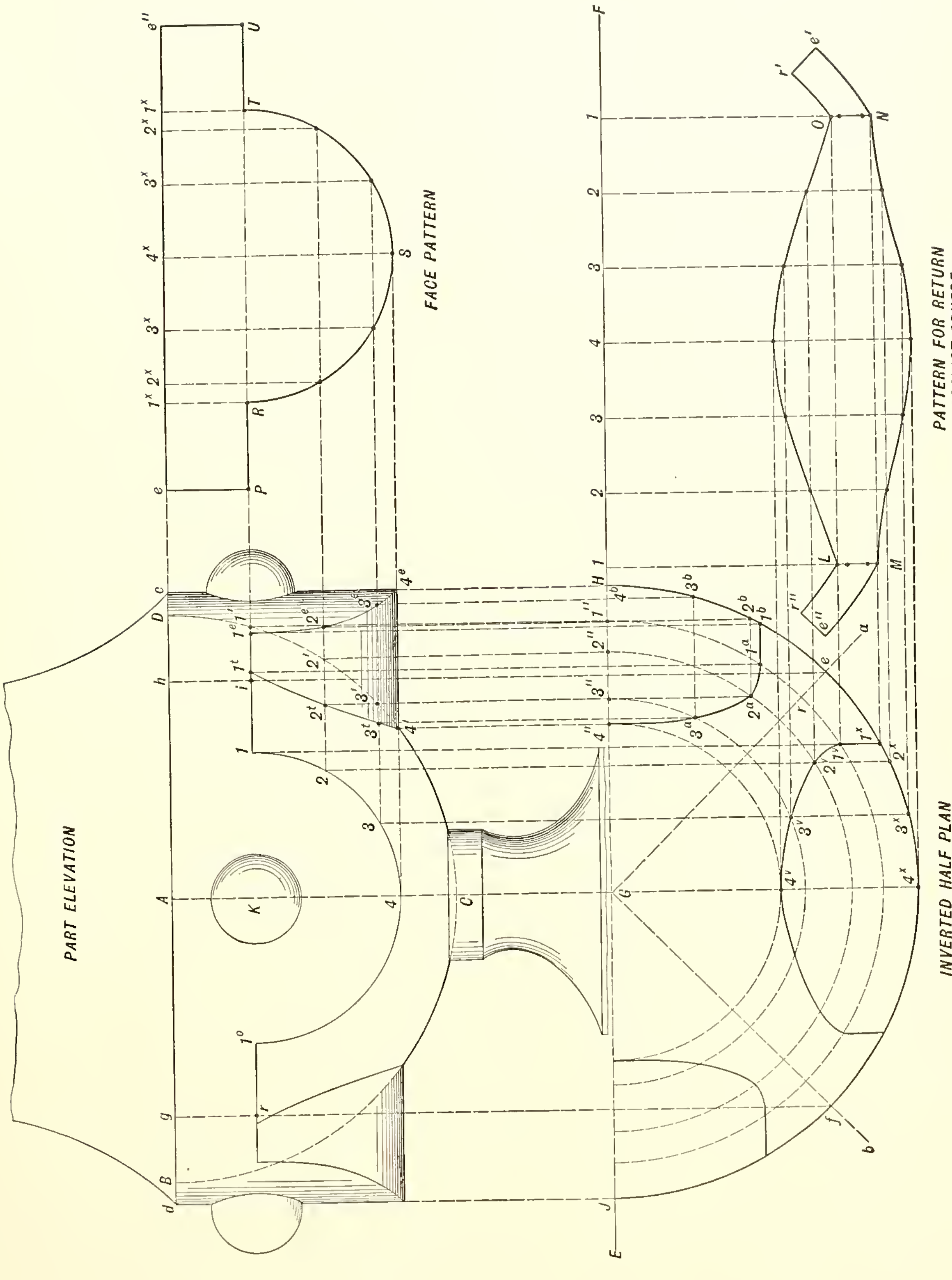


Fig. 389.—Patterns for Ornamental Trimmings on Sphere

From these small figures and at right angles to e c'' draw lines and intersect them by lines drawn parallel to e c'' from similar numbers in the drop in front elevation. A line traced through points thus obtained, as shown by c P R S T U c'', will be the pattern for one face, or one-fourth the circumference around the sphere.

The pattern for the return strip against the sphere is obtained by taking double the girth from 1 to 4 in the front elevation and placing it on the center line E F in plan, as shown by similar numbers, 1 to 4 to 1. From these small figures and at right angles to E F draw lines and intersect them by lines drawn parallel to E F from similarly numbered intersections in plan, as 1^v to 4^v and 1^x to 4^x. Trace a line through points thus obtained; L M N O will be the pattern shape.

On O N add a duplicate of 1^x, 1^v, r, e in plan, as shown by N O r' e' to the right of the pattern and M L r'' e'' to the left of the pattern. The cut r'' L O r' will miter against the sphere and the cut e'' M N e' will miter with P R S T U in the face pattern. To the right in the elevation has been demonstrated the way to project the various points, so as to show the intersection of the return strip mitering with the face drop and sphere; while this is not necessary in the development of the patterns, it is shown here to make clear the various operations, should this view be desired.

The first step is to take a reproduction of the various points of intersection in plan, as 4^v, 3^v, 2^v, 1^v, 1^x, 2^x, 3^x, 4^x, and place them in their proper positions to the right in plan, as indicated by $4''$, 3^a, 2^a, 1^a, 1^b, 2^b, 3^b and 4^b. This can be best accomplished by taking the various projections, measuring from the line 4^v 4^x to points 3^v, 2^v, 1^v, 1^x, 2^x and 3^x, and placing them below the line $4''$ 4^b on similar arcs, as there indicated. From the various intersections 1^b to 4^b and from 1^a to $4''$ erect vertical lines, cutting similarly numbered horizontal lines in elevation, thus obtaining intersections marked 1^e to 4^e and 1^t to $4'$, respectively; through these intersections the lines are drawn, as shown. These miter lines may be traced to the opposite side in both plan and elevation, as shown.

THE VARIOUS FLARING STRIPS AROUND A BEVELED SHIELD

Solution 119

Fig. 390 is a view of a beveled shield, the bevels or chamfers being indicated in the shaded section a b. The principles demonstrated in preceding problems may here be applied. In working out the full size detail it is necessary to draw only the half elevation, as shown in Fig. 391.

First, draw the center line A B, to the right of which design the half elevation of the shield, the various arcs being struck from the centers C, D, E, F and G. Where the outer and inner arcs intersect draw the miter lines a 1, b 5, c 7 and d 18. Space the inner outline of the shield into an equal number of divisions, as indicated by the small figures 1 to 18, and from the inner intersections at 1, 5, 7 and 18 draw lines to the centers from which the arcs were struck, at C, D, E and G, respectively. As the distance between points 10 and 11 in the shield is straight, draw a line from point 10 to the center E, and from point 11 to the center F. Since 15 represents the point of tangency between the two arcs struck from F and G, respectively, draw a line from the center F to the center G. $a°$ $b°$ $c°$ $d°$ is a section drawn at right angles to 10-11 and gives the bevel of the chamfer around the entire shield. The inner outline of the shield having been spaced into equal divisions, measurements must be placed on the inner outline in the patterns.

Three patterns will be required, as indicated by I, II and III in the half elevation. The first step

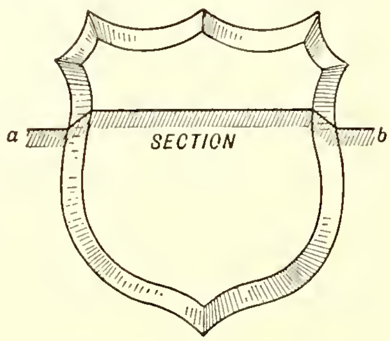


Fig. 390.—View of Beveled Shield

is to find the true radii for striking the various patterns. This is accomplished as follows:

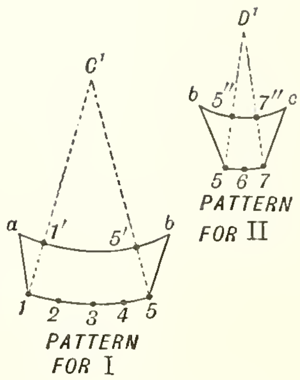
Take a tracing of the bevel $a°$ $b°$ $c°$ $d°$ and place it, as indicated by a' b' c' d'. Since the center F is on the inside of the curve 11-15 in the half elevation, take the distance from 11 to F and set it off on the line b' a' from b' to F. Through F and at right angles to a' b' draw the line X F°. Extend the flare c' b' until it intersects the vertical line just drawn at F°. Extend the flare b' c' to any length towards C°, as shown. As the centers C, D, E and

G in the half elevation are on the outside of the outline of the shield and as the radii C 1, E 7 and G 15 are alike, take the distance of any one, as C 1, also the distance of D 5 and place it on the line a' b' extended, as shown from b' to C, E, G and D, respectively, and from these points draw perpendicular lines to a' b' intersecting the flaring line previously extended at C° and at D°, as shown. This diagram, F° C°, then shows the various radii required for developing the various flaring or chamfer strips.

To obtain the pattern for the flare, marked I in elevation, proceed as follows: Using the radii C° c' and C° b' and with C^1 as center draw the arcs *a b* and 1-5. Take the girth from 1 to 5 in the half elevation and place the same number of divisions in the pattern for I, as shown by similar figures 1 to 5. From 1 and from 5 draw lines to the center C^1, intersecting the inner arc at 1′ and at 5′. Measure the distance from 1′ to *a* and from 5′ to *b* in the half elevation and set it off on the inner arc of pattern for I, as indicated from 1′ to *a* and from 5′ to *b*, and draw the miter lines *a* 1 and *b* 5. *a b* 5-1 shows the pattern for flare I, with the miters attached.

The pattern for flare II in the half elevation is obtained in like manner. Using the radii D° c' and D° b' and with D^1 in the upper diagram as center draw the arcs *b c* and 5-7. Take the girth from 5 to 7 in the half elevation and place the same number of divisions in the pattern for II as shown by similar figures, 5 to 7. From 5 and from 7 draw lines to the center D^1, intersecting the inner arc at 5″ and at 7″. Measure the distance from 5″ to *b* and from 7″ to *c* in the half elevation and set it off on the inner arc of pattern for II, as indicated from 5″ to *b* and from 7″ to *c*, and draw the miter lines from 5 to *b* and from 7 to *c*. *b c* 7-5 shows the patterns for flare marked II in elevation with miter cuts attached.

The development of flare III. involves four distinct patterns and is obtained as follows: Using the radii C° c' and C° b' and with C^2 in pattern for III as center draw the arcs *c* 10′ and 7-10. Take the girth from 7 to 10 in the half elevation, and place an equal number of divisions in the pattern for III as are shown by corresponding figures 7 to 10 on the outer arc. From points 7 and 10 draw lines to the center C^2, intersecting the inner arc at 7′ and at 10′. Measure the distance from 7′ to *c* in the half elevation and place it as shown from 7′ to *c* in pattern for III. Draw the miter line 7-*c*. As the line 10-11 in the half elevation is drawn at right angles to the radial line 10-E take the distance from 10 to 11 and set it off at right angles to 10 C^2 in pattern for III, as shown from 10 to 11 and from 10′ to 11′, and draw a line from 11′ through 11 indefinitely. As the radius for the flare between F 11-15 in the half elevation is indicated by F° b' in the true radii, take this distance and set it off in pattern for III. from 11 to F^1; using this same radius and with F^1 as center, draw the arc 11-15, equal in girth to 11-15 in the half elevation. From F^1 in the pattern for III. draw a line to any length through 15 towards C^3, as shown. Using F^1 as center and with F^1 11′ as radius describe an arc cutting the line F^1 C^3 at 15′. As C° b' in the true radii is the radius for the flare along 15-18 in the half elevation, use this radius and set off its length



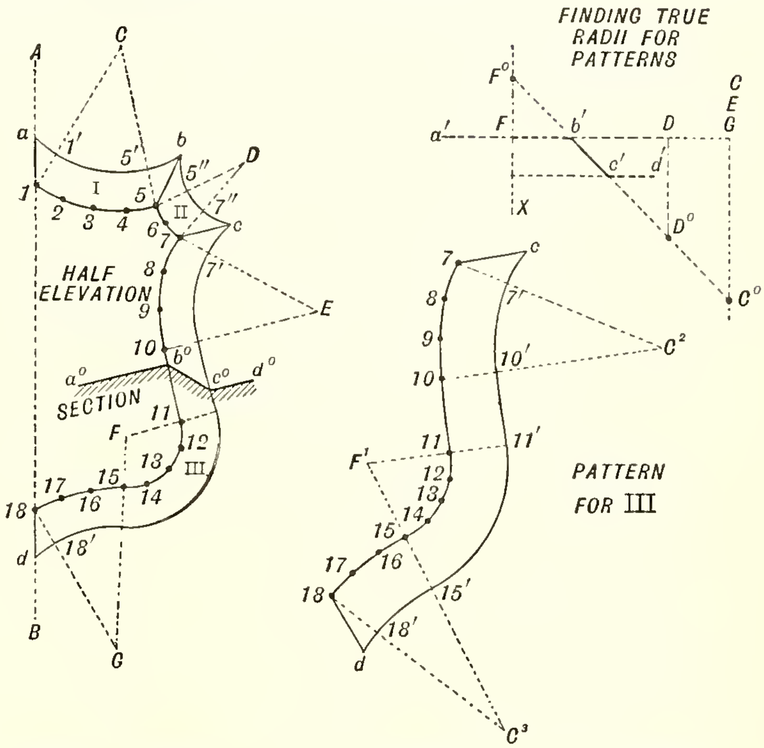


Fig. 391.—Patterns for the Various Flaring Strips Around Shield

from 15 to C^3 in pattern for III. Using the same radius and with C^3 as center draw the arc 15-18, equal in girth to 15-18 in the half elevation. Draw a line from 18 toward C^3 in pattern for III., crossing the inner arc drawn from 15′, at 18′. Take the distance from 18′ to *d* in half elevation and set it off on the inner arc in pattern for III from 18′ to *d*. Draw a line from *d* to 18. 7-18-*d c* will be the desired pattern for flare III in the half elevation. This method of joining the various arcs or flares may be applied to an ornament of any shape.

SQUARE SHAFT, INTERSECTING A SPHERE CENTRALLY

Solution 120

In ornamental sheet metal work, as in the construction of finials, ornaments, crosses, etc., spheres or balls are used, and they may be interesected by various shaped shafts.

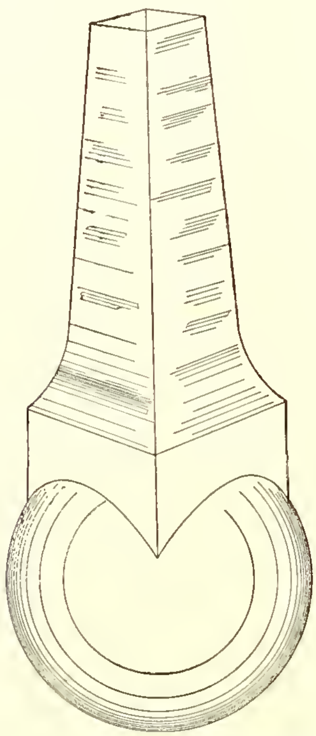


Fig. 392.—View of Square Shaft Intersecting a Sphere Centrally

Fig. 392 shows the square base of a finial intersecting a sphere or ball. If this shaft sets directly over the center of the ball the pattern development is simple, being accomplished as shown in Fig. 393. Here A represents the center from which the ball is struck. Through the center A draw the center line A B and construct a section of the square shaft, indicated by C D E F, although this section may be dispensed with in actual practice. One side of the shaft, as C F, is extended until it intersects the ball at *a*. From *a* a line is drawn at right angles

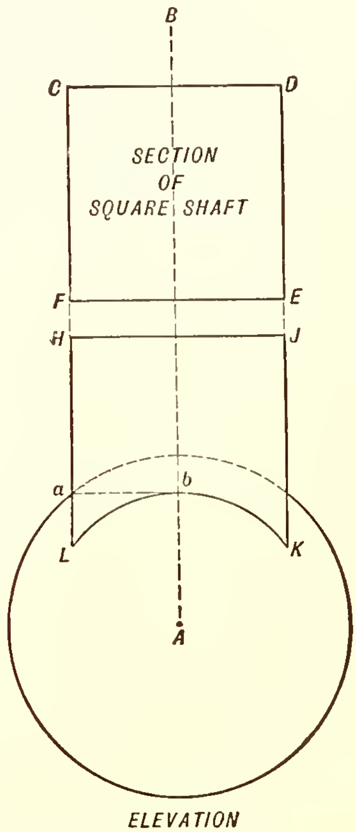


Fig. 393.—Pattern for Square Shaft Intersecting a Sphere

to A B until it intersects the center line at *b*. Using A as center and with A *b* as radius draw the arc K L and intersect it at K and L by the sides of the shaft extended. Establish the hight of the square shaft as L H and complete the elevation of one side of the shaft, shown by H J K *b* L H, which also becomes the pattern for one side. If the shaft is small in size, four of these patterns are joined in one to effect the full pattern.

ANOTHER METHOD OF DEVELOPING SQUARE SHAFT

Solution 121

A quick and accurate rule for developing the pattern is shown in Fig. 394. Using any point, A, as a center, describe the sphere of the desired size. Directly over A draw the plan of the square shaft, of the required dimensions, as shown by 1-2-3-4. Extend one of the sides, as 1-2, until it intersects the ball at *a* and *b*. Bisect *a b* and obtain *c*. *c a*

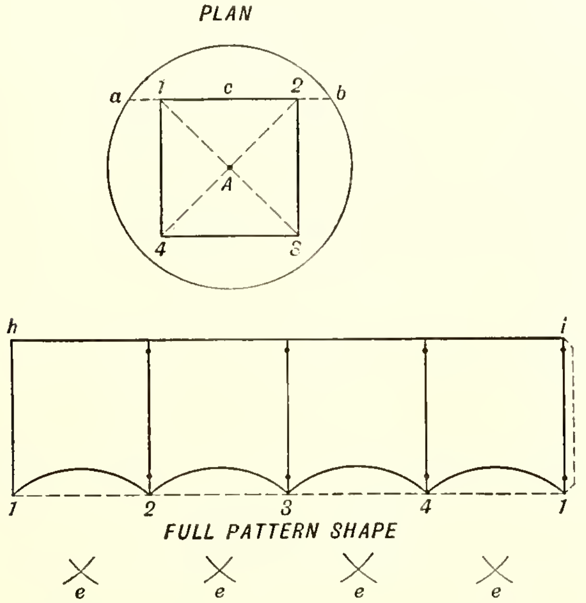


Fig. 394.—Short Method of Obtaining Pattern for Square Shaft Intersecting Sphere Centrally

or *c b* is then the radius for striking the pattern, as follows:

Take the girth of the square shaft 1 to 4 to 1 and place it, as shown in the pattern. Draw the hight 1-*h* and 1 *i* and complete the rectangle shown. With radius equal to *c a* in plan and with 1 and 2 in the pattern as centers describe short arc intersecting at *c*. Repeat this operation, using 2 and 3, 3 and 4 and 4 and 1 as centers. Then using the same radius and with *c* as center draw the arcs shown; this completes the pattern.

OCTAGONAL SHAFT INTERSECTING SPHERE

Solution 122

If a shaft be octagonal and intersects a sphere centrally, as shown in Fig. 395, the procedure found in the preceding problem is employed and applied as shown in Fig. 396. Using A as center draw the sphere and octagonal shaft, as shown in plan. Extend one of the sides of the shaft, as 1-2, cutting the sphere at *a* and *b*, bisect this extended side and obtain *c*. Take the girth of 8 times 1-2 in plan and set it off in the pattern, as shown. Make the hight 1-S in the pattern, as required. Using *c a* or *c b* in plan as radius and with 1 and 2 in the pattern as centers describe arcs intersecting each other at *i*, *i*, etc.

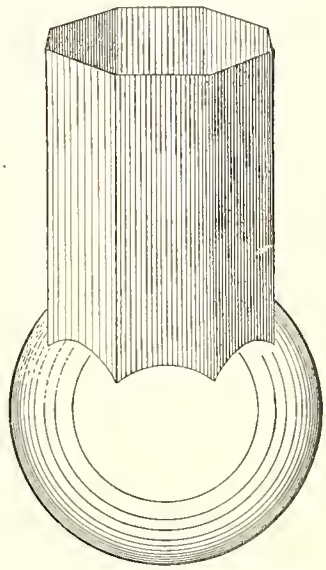


Fig. 395.—Octagonal Shaft Centrally over Sphere

Using the same radius and with *i* as center, describe the arcs from 1 to 2 as shown, completing the pattern.

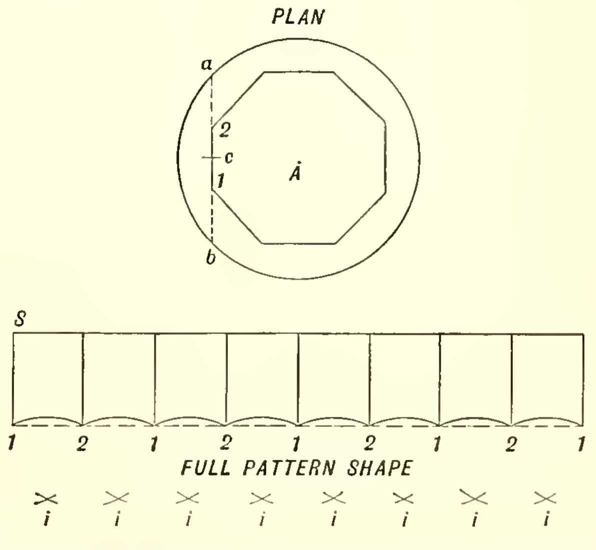


Fig. 396.—Quick Rule for Obtaining Pattern of Octagonal Shaft, Intersecting Sphere Centrally

ANOTHER METHOD OF DEVELOPING OCTAGONAL SHAFT

Solution 123

Another method of development is shown in Fig. 397, where the octagon intersects the sphere directly in the center as shown in plan. The pattern is developed as follows: A in plan represents the center from which the sphere is struck, as well as the octagonal section shown by the letters *a*. Through the center A draw the center line B C and using D upon it as a center describe a sphere of like size in elevation. From the left side of the octagon in plan drop a vertical line cutting the sphere in elevation at a'; from this intersection draw a horizontal line to the right to any length, cutting the center line B C at a''. Using D as center and with D a'' as radius describe a short arc; intersect this arc by perpendicular lines dropped from the corners a^v a^v in plan, thus obtaining the points of intersection, a^v a^v in elevation. Draw the horizontal line E F to the desired hight, thus completing the elevation of the upper line of the shaft.

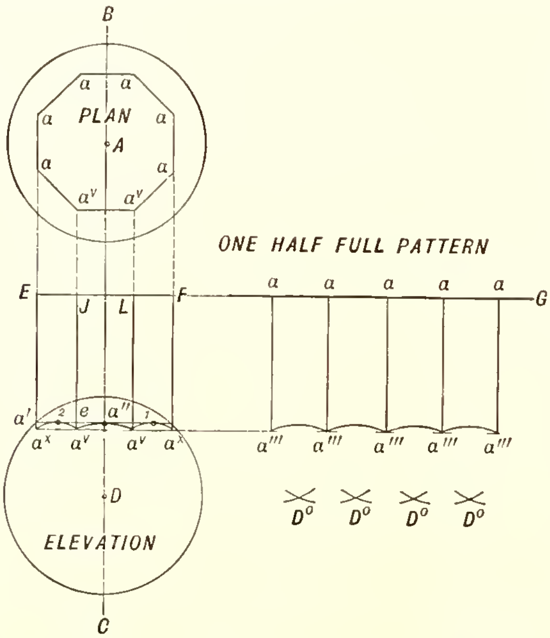


Fig. 397.—Pattern for Octagonal Shaft, Intersecting a Sphere Centrally

J L a^v a^v shows the true elevation and pattern for one side of the shaft.

If the foreshortened elevation of the two oblique sides of the shaft be desired, as shown by a a^v in plan, simply draw to the left from a^v in elevation a horizontal line, intersecting it by the line E a' extended at a^x. Bisect the line a' c, obtaining the point 2, and draw a symmetrical curve through the three points a^x, 2, a^v. In the same manner obtain the curve a^v, 1, a^x to the right.

The one-half full pattern may be reproduced from J L a^v a^v in elevation as follows: Extend E F as E G and place thereon one-half of the girth of the octagonal section, as indicated by the five letters marked *a* on F G. Through these small letters and at right angles to F G draw lines and intersect them by lines drawn from a^v in elevation, parallel to F G, thus obtaining the intersections marked a'''. With radius equal to D a'' in elevation and using all points a''' in the pattern as centers draw arcs intersecting each other at D°. With the same radius and D° as centers, draw the various arcs marked a''' to a'''. a''' a a a''' will be the half pattern sought.

SQUARE SHAFT INTERSECTING A SPHERE OFF THE CENTER

Solution 124

In the two last preceding problems the shafts intersect the spheres centrally. In the problem now under consideration, shown in Fig. 398, the square shaft intersects the sphere off the center, as shown in the plan, where A is the center from which the sphere is struck and 1, 2, 3 and 4 the position of the corners of the square shaft. Through the center A, the center line A B is drawn, and, with B as center, the same size sphere is struck in elevation as shown. It now becomes necessary to find the intersecting points in elevation of the corners of the square shaft, marked 1 to 4 in plan. The procedure is as follows: With A as center and using the radii A 1, A 2, A 3 and A 4, arcs are struck until they intersect the center line a $3'$ in plan, at $1'$, $2'$, $3'$ and $4'$. From these small figures $1'$ to $4'$ vertical lines are drawn downward, until they intersect the outline of the sphere from $1''$ to $4''$, as shown; from these intersections horizontal lines are drawn to the right indefinitely and intersected by vertical lines drawn downward from the corners of the square shaft 1 to 4 in plan, all as indicated by the dotted lines, resulting in the points of intersection 1°, 2°, 3° and 4° in elevation. As already mentioned, these represent only the points of intersection of the four corners of the shaft.

If the entire miter line were desired, showing the intersection between the full sides of the shaft and sphere, more numerous divisions would be placed in each side of the shaft and arcs drawn to the center line in precisely the manner described in Solution 125, Fig. 400, where a fluted shaft intersects a sphere.

Upon finding the intersections of the corners

1° to 4° in elevations in Fig. 398, the pattern may be laid out as follows:

Extend the line C D in elevation, previously drawn at will, as shown by D E; upon this place the girth of the square shaft in plan, as shown by similar numbers, 1 to 4 to 1 on D E. Through these small figures and at right angles to D E, draw lines, as shown, and intersect these lines by lines drawn parallel to D E from the intersections 1°, 2°, 3° and 4° in the elevation, thus obtaining the intersections 1^a, 2^a, 3^a, 4^a and 1^b in the pattern.

The next step is to find the radius for striking the various arcs in the pattern. Extend the several sides of the square shaft in plan as 1-2 until the outline of the sphere is intersected at *b* and *c*. Bisect *b c* and obtain *d*. Then *d b* or *d c* represents the radius of a circle, which would represent a section on the line *b c*. As this radius was obtained by a line drawn through 1-2 in plan, then using 1^a and 2^a in the pattern as centers and with the radius *d b* or *d c* in plan, draw arcs intersecting each other at d' in the pattern. With the same radius and using d' as center describe the arc 1^a 2^a. In like manner extend the line 3-2 in plan as 3-*e*; bisect this line and obtain *f*. Using *f c* as radius and with 2^a and 3^a in the pattern as centers, intersect the arcs at f'; use f' as a center and with the same radius describe the arc 2^a 3^a. Extend the line 3-4 in plan and obtain 3-*h*; bisect 3-*h* and find *i*. Use *i h* or *i* 3 as radius and with 3^a and 4^a in the pattern as centers, describe the arcs crossing each other at i'. Use i' as center and with the same radius draw the arc 3^a-4^a. Extend 4-1 in plan, cutting the sphere at *n* and *o*. Bisect this and obtain *l*. Using *l o* or *l n* as radius and 4^a and 1^b in the pattern as centers, describe arcs cutting each other at l'. With the same radius and l' as center describe the arc 4^a 1^b. This completes the full pattern.

In case the shaft were octagonal, as in Fig. 397, and were placed off the center on the sphere, there would be no change of principle involved than are found in the procedure of Fig. 398, the eight sides of the shaft being extended until they intersected the outline of the sphere, to find the true plane, as was done with the square shaft.

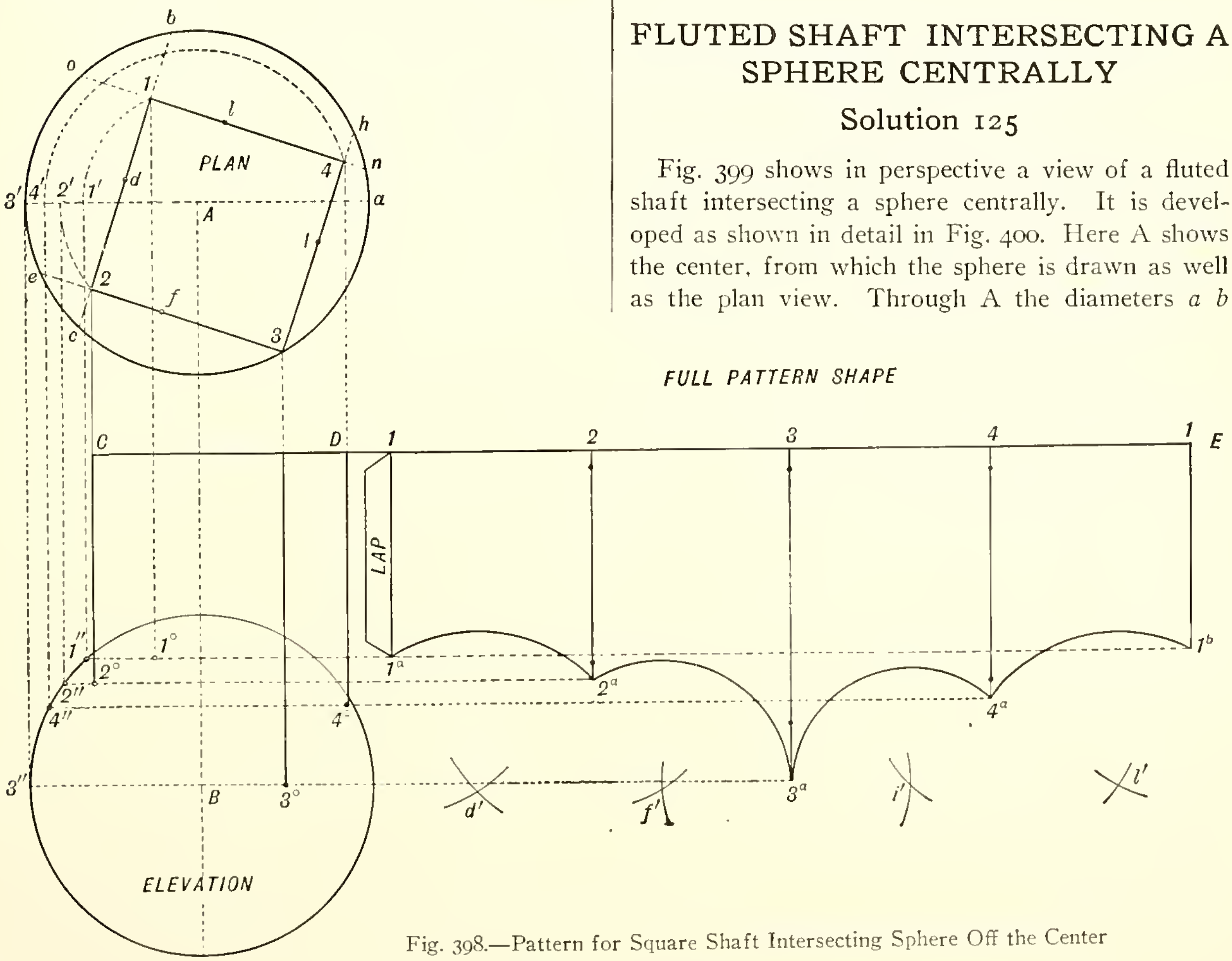


Fig. 398.—Pattern for Square Shaft Intersecting Sphere Off the Center

FLUTED SHAFT INTERSECTING A SPHERE CENTRALLY

Solution 125

Fig. 399 shows in perspective a view of a fluted shaft intersecting a sphere centrally. It is developed as shown in detail in Fig. 400. Here A shows the center, from which the sphere is drawn as well as the plan view. Through A the diameters *a b* and *c d* are drawn; upon these lines the centers *e, f, g* and *h* are placed, from which the section of the fluted column is drawn. Extend the center line *d c,* as shown, and upon it use B as a center to draw the elevation of the sphere alike in size to that in plan. At a proper distance above B draw the horizontal line C D representing the top of the column or flute in elevation. Since the four flutes in plan are alike, divide into equal parts, as indicated by the small figures 1 to 3, placing the figures in the manner shown. Using A as center and with radii equal to A-2 and A-3 draw arcs cutting the center line at 2′ and 3′. From these points 1, 2′ and 3′ drop vertical lines cutting the sphere in elevation at 1″, 2″ and 3″; from these points lines are drawn to the right, as shown, and intersected by vertical lines drawn from similarly numbered intersections shown in the fluted column in plan, resulting in the points of intersection 1° to 3° to 1″ in elevation, through which a line is traced showing the miter line.

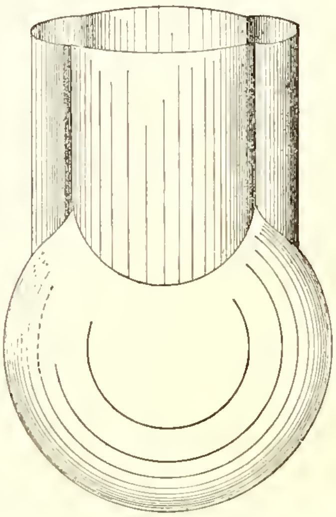


Fig. 399.—View of Fluted Shaft Intersecting a Sphere Centrally

The pattern is obtained by extending C D as E F, upon which the girth of two of the flutes are placed (for the half full pattern), as shown by similar numbers on E F. Through these small figures the usual measuring lines are drawn and intersected by lines drawn parallel to E F from similar numbers in the elevation. Trace a line through points thus obtained. E F G H J will be the desired pattern. In developing the pattern in practice more numerous spaces should be employed in dividing the flutes.

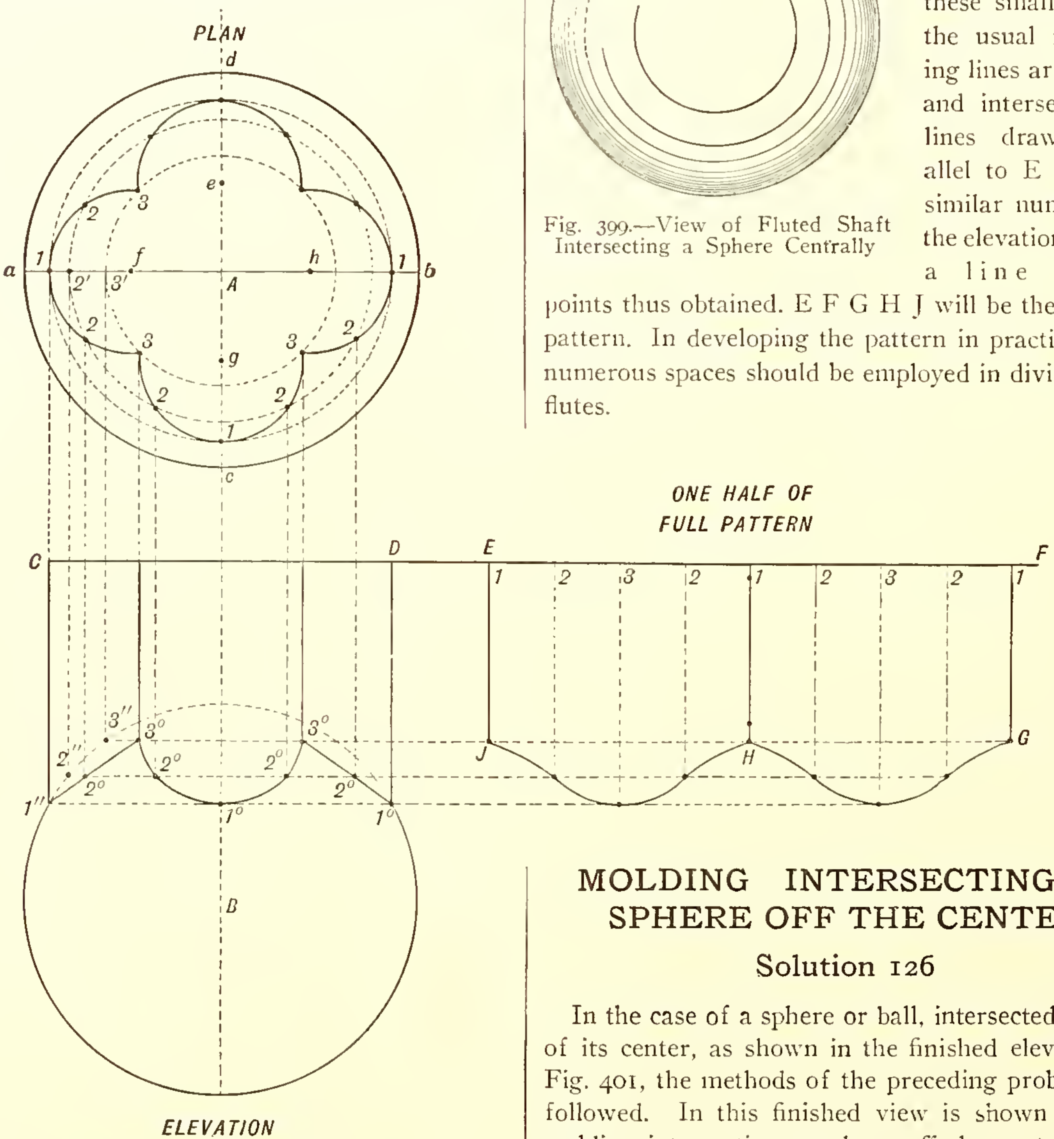


Fig. 400.—Pattern for Fluted Shaft Intersecting a Sphere Centrally

MOLDING INTERSECTING A SPHERE OFF THE CENTER

Solution 126

In the case of a sphere or ball, intersected outside of its center, as shown in the finished elevation in Fig. 401, the methods of the preceding problem are followed. In this finished view is shown a gable molding intersecting a sphere off the center. The same procedure applies, whether the molding intersects vertically, horizontally or at an oblique angle, as shown. If the mold intersects at an oblique angle, as indicated by *a b,* it is but necessary in developing the pattern to assume that *a* is a pivot and *b* is drawn over until the oblique line *a b* stands in a vertical position, as *a c*. Then the pattern can be developed as shown in Fig. 402. The sphere in plan is first drawn from the center A; through this the vertical center line A B is drawn; using B upon it as a center the elevation of the sphere is drawn, as shown, and of similar diameter, as in the plan. The section of the molding is now drawn in its desired position in plan, as shown, and the curved part is divided into equal spaces. As the halves of the molding are symmetrical, it is necessary to divide only one half into equal spaces, as shown by the small figures, 1 to 6. Using A as center and with the spaces in the upper half as radii draw the arcs from points 2, 3, 4 and 5 until they intersect the center line at 2′, 3′, 4′ and 5′, from which intersections carry vertical lines to the elevation, cutting the sphere in elevation at 1°, 2°, 3°, 4°, 5° and 6°. From these points of intersection, 1° to 6°, draw horizontal lines to the right and intersect them by vertical lines dropped from similar numbers in the profile in plan, as shown. Trace a line through points thus obtained, as shown from

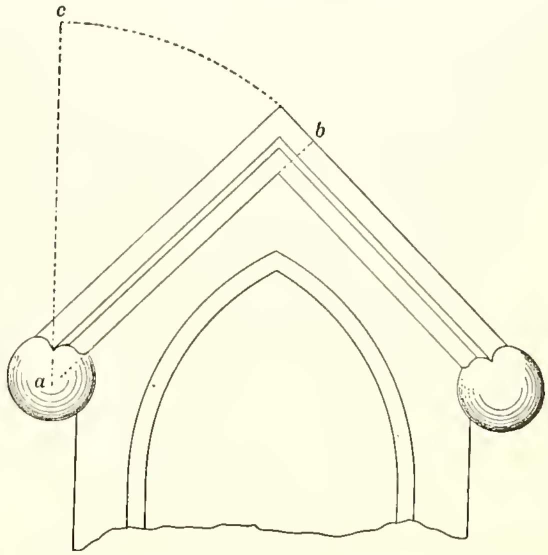


Fig. 401.—Finished Elevation of Gable Mold Intersecting Sphere Off the Center

2^v to 5^v in elevation. This will represent the miter line, between the ogee mold and sphere. It should be understood that, so far as the pattern is concerned, this miter line is not necessary, because the projecting points for the pattern could be taken as well from the intersections 1° to 6° on the sphere. To complete the elevation of the molding, draw the

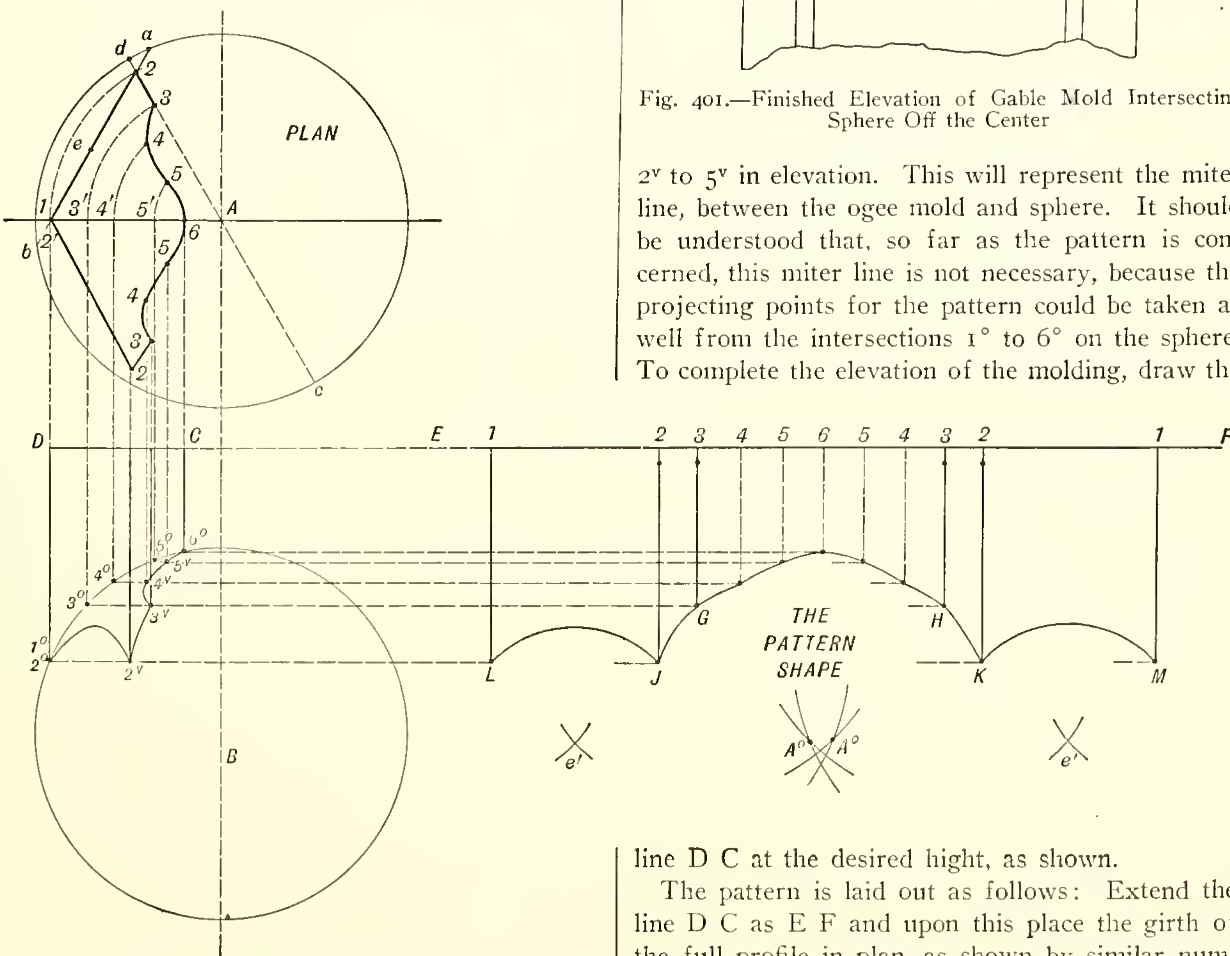


Fig. 402.—Pattern for Molding Intersecting a Sphere Off the Center

line D C at the desired hight, as shown.

The pattern is laid out as follows: Extend the line D C as E F and upon this place the girth of the full profile in plan, as shown by similar numbers on E F. Through these small figures and at right angles to E F draw lines and intersect them by lines drawn parallel to E F from similarly numbered points in the elevation. Trace a line through points thus obtained between 3, 6 and 3, as shown from G to H.

To find the pattern cut for the members 1-2, and 2-3 of the molding in plan proceed as follows: Extend the lines 1-2 and 2-3 in the plan until they cut the outline of the sphere at *a b* and *c d*, respectively. Bisect the line *a b* and obtain the point *e*. Also bisect the line *c d* and obtain A. Using A *c* or A *d* as radius, and G and J, also H and K in the pattern, as centers, describe arcs intersecting each other at A°. With A° as centers, with the same radius, draw the arcs G J and H K. Using *e a* or *e b* in the plan as radius and from L and J, also K and M, in the pattern as centers, describe arcs intersecting each other at *e′* Using *e′* as centers and with the same radius describe the arcs L J and K M. 1-L-J-K-M-1 then represents the full pattern shape.

PART XII

CONSTRUCTION OF ELECTRICALLY ILLUMINATED SHEET METAL SIGNS; WITH METHOD OF SECURING THE RECEPTACLES FOR WIRING

A PROFITABLE field of endeavor available to sheet metal workers occurs in connection with electrically illuminated signs, the construction of the framework of which brings into exercise the mechanical skill of the sheet metal worker as well as his equipment of material, tools and appliances.

It will be seen that the construction of such signs is essentially simple and although it may sometimes be necessary to engage the electrician to give attention to the wiring equipment the main function, that of the construction of the sign, involves chiefly the manipulation of sheet metal. In the case of orders for signs in quantity, it may prove the better part of economy to have the electrical contractor do his customary part of the work, preferably at the sheet metal shop in order that the sheet metal worker may put on the outside caps and turn in the laps properly so as to be assured of the best workmanship. In like manner if the painting is executed at his shop the sheet metal worker may be certain that the work is well done and frequently a saving of cartage will result.

Storekeepers, merchants and competent advertisers are making extensive use of illuminated signs to draw attention to their wares or locations so that it is but fitting that a well equipped sheet metal shop should be prepared to furnish such signs as they are likely to be called upon to make.

It may be well to mention that the laws of States and municipalities vary as to the conditions under which electric street signs may be hung and used. It is therefore wise to inquire of the local electric company regarding regulations and also concerning the laws and ordinances governing the character of sign that it is desired to erect, so as to avoid later difficulty, as it is unwise and costly to attempt the construction and erection of a sign that will meet some legal obstacle.

BLOCK LETTER SIGNS

Solution 127

While there are a number of types of illuminated signs of sheet metal we will take up the block letter sign as prominently typical of this class of work, proceeding with the word "HATS" as an example. The question of the suitable hight of the letters, a matter usually determined by the merchant, is governed by the distance to which it is desired to make the sign effective. If it is required that the sign may be read from a distance of 250 to 300 feet only, a letter 12 inches high is large enough. If it is to be read at a distance of 350 to 500 feet, it will be advisable to employ a letter at least 15 inches and preferably, 18 inches high. This letter will give the best results, and does not cost very much more.

Therefore let us proceed on the basis of the 18 inch letter. The next step is to determine the size of background which is a simple matter. Letters 18 inches high will require a background at least 24 inches high, and as electrical letters should never be crowded closely together we may allow the same

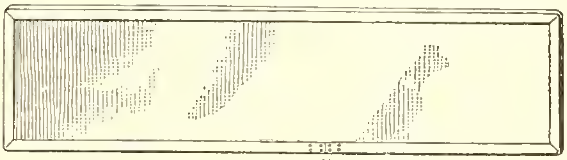


Fig. 403.—Frame and Background for Illuminated Sign

distance for width, that is, 24 inches for each letter. This will allow for the space on either end of the sign, giving a background 8 feet long.

The first step in the construction is the building of a frame, of 1½ x 1½ x ⅛ inch angle iron, 2 by 8 feet, as shown in Fig. 403. The ends are joined securely at *a*. After punching ¼ inch holes for stove bolts about 4 inches apart on the face of the angle iron frame, a piece of 20 gauge galvanized iron is bolted on the inside of the frame, placed inside to better protect it from damage. Upon this a draft of the letters is to be made. In this connection it is suggested that the reader refer to the chapter on Drawing and Lettering, where this branch of the subject is considered.

In constructing the letters, first cut strips of No. 20 gauge galvanized iron 1¼ inches wide and, after

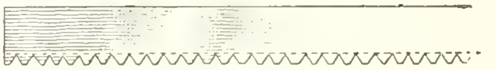


Fig. 404.—Strips for Forming Outlines of Letter

notching them ¼ inch deep, as shown in Fig. 404, bend them in the folder along the dotted lines. This is to allow the strips being bent into the shape of the letters, preparatory to being soldered to the background. Solder on first the strips, making the outside line of the letters and afterward filling in the

Fig. 405.—Outlines Completed

inside strip. This work when finished, will appear as shown in Fig. 405.

On completing the bottom part of the letters (that part coming against the background), next drill two holes ¾ inch in diameter through the background at a point near the bottom on the inside of each letter. These are for the wires to pass through when the sign is finished.

The faces of the letters are next cut from metal of the same gauge iron as the strips, when we are ready for drilling the holes for the lamp receptacles.

These can be punched, or drilled with an expansion bit in an ordinary brace. The holes must be the size of the receptacle used. There are several good receptacles on the market which are especially designed for electric signs. Different makes, however, differ slightly in size, so it will be impossible to state the exact size of hole to be drilled. It is approximately 1¾ inches in diameter.

There should be at least four receptacles in each perpendicular bar of the letter, and not more than five. The number of receptacles in the other bars must be determined by the shape of the letter. A good example is shown in Fig. 406.

Before placing the receptacles in the holes it will be necessary to cut additional 1¼ inch strips as before, and solder them around the edge of the face of the letter on its under side, being careful that sufficient allowance is made for the top to slip over the outline strips of the letters already soldered to the background, just as a cover slips over the top of a can.

When this is done we are ready for the electrical part of the work, which is very simple when one understands it.

The receptacles are screwed into the holes in the face of the letter, from the back, when No. 14 B & S gauge double braided, rubber covered wire

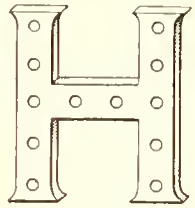


Fig. 406.—Spacing Receptacles

is connected under the binding posts on the back of the receptacles, as shown in Fig. 407. The ends of the wires are left about 12 inches longer than the letter. Each letter is treated the same, and the ends of the wires are then led through a separate battery bushing (standard in the electrical trade), for each wire and the bushings are then slipped through the holes between the outlines of the letters in the background. The face of the letter is then slipped over the outline letters and tacked down with a little solder on each side and at top and bottom.

The front of the sign is now ready for painting, which is a matter of individual taste. An especially good electrical effect is gained by a white letter on

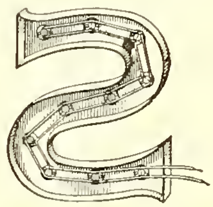


Fig. 407.—Back of Letter Showing Wiring

black background. Before otherwise painting, however, the entire surface should have two coats of red lead paint to prevent rusting.

Inspection of the back of the sign will now reveal a flat surface with a lot of wires coming through holes. As each letter contains enough receptacles to make a complete circuit it will be best to make four circuits for the whole sign. This is easily done by attaching a wire to each of the wires that come through the background from each letter and, wrapping each pair with insulated tape, leading them to one end of the sign, then into a piece of iron conduit and through the wall of the building to the cutout box containing the branch cutouts and fuses on the inside of the building.

If the sign is in a very much exposed place, it will be well to enclose the back of it with galvanized

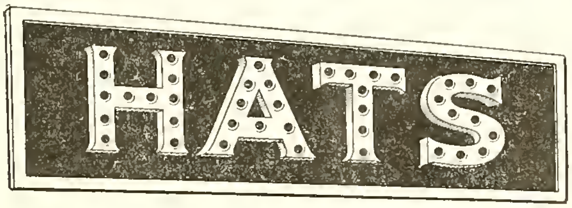


Fig. 408.—The Completed Sign

sheet iron to protect the wires. When the sign is complete it will appear as in Fig. 408.

If a double-sided sign is required, in order that it may be read from both sides, it is but necessary to make two like the one described and place them back to back.

The method of hanging the sign will vary with its size and weight. If it be a sign having only one side and is not too heavy, it can be hung by lugs, fastened to the angle frame. If it is large and heavy it may be necessary to use brackets or other supports as the circumstances demand.

CONSTRUCTION OF PANEL SIGNS

Solution 128

The construction of what are known as panel signs is illustrated in Figs. 409 and 410.

The use of panel signs is much more common than that of any other type because of the fact that

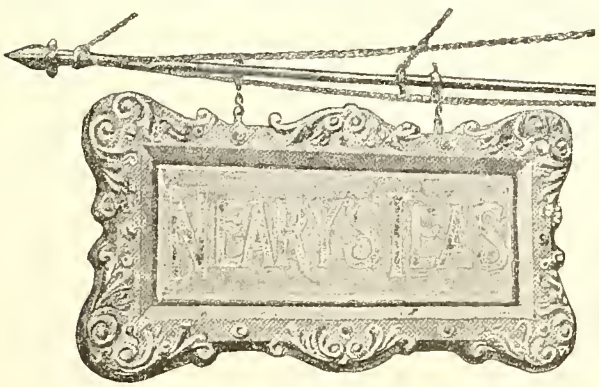


Fig. 409.—Panel Sign with Ornamental Border

electric lighting companies rent them out at a given price per month including the furnishing of current. Therefore, these signs can be sold most readily to electric lighting companies, and sheet metal workers should have no difficulty in securing the business in their localities.

The construction of panel signs is more simple in many respects than that of block letter signs. There are not letters to cut or form, these being painted on the panel in the center of the design. Many designs are made and sold, but the most

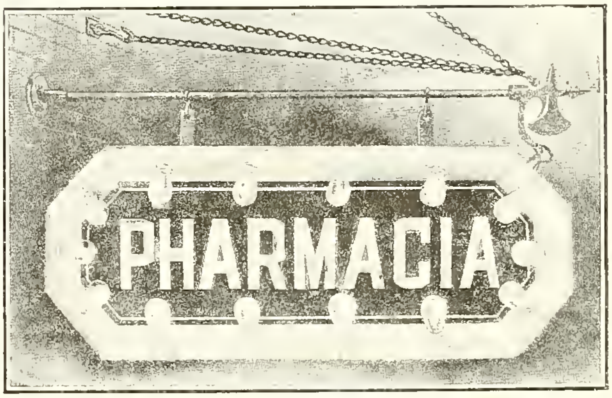


Fig. 410.—Panel Sign with Plain Border

popular style is the rectangular, whose size is about sixty inches long by thirty-two inches high, outside dimensions. The panel of this sign should be about 18 inches by 48 inches, depending on the size of the ornamental sheet metal border.

To construct a sign of this description it is neces-

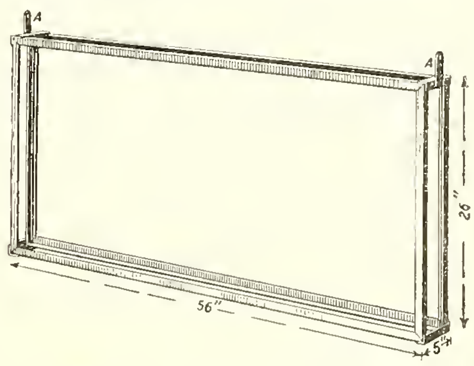


Fig. 411.—Angle Iron Frame for Double-Faced Panel Sign

sary first to build two angle iron frames. In the case of a sixty-inch sign the frame should be fifty-six inches long by twenty-six inches high, as shown in Fig. 411.

Angle iron ¾ inch by ¾ inch by ⅛ inch is heavy enough for this frame, as the body of the sign affords additional strength.

The next step is to procure the ornamental border which may be obtained of dealers in pressed metal work. Proceed to put the lamp receptacles in the borders in practically the same manner as in connection with the block letter signs, holes being punched or cut to admit the body of the receptacle which is passed through and fastened from the front by aid of two small screws.

After placing the receptacles, say twelve in number, at equal distances apart around the edge of the border, they are wired or connected together with No. 14 B and S rubber covered wire, care being

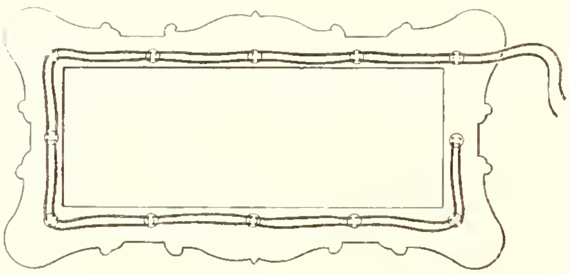


Fig. 412.—Wiring a Panel Sign

taken to have about three feet of wire extending from the last receptacle, as shown in Fig. 412.

After wiring the receptacles, it is next in order to fasten the border to the angle iron frame, which is usually done by means of stove bolts.

In placing the receptacles in the border, care should be taken to have them far enough toward the center so that they may readily pass the inside edge of the angle iron frame.

After securing the border to the angle iron frame, the other side of the sign should be prepared in the same manner and two sides fastened together with short pieces of angle iron placed about 5 inches apart at the four corners of the frames as shown in Fig. 411.

When this is finished the open space around the angle iron frames must be enclosed with sheet iron, preparatory to which a strip of band iron is placed on the two short angles at the top to serve as hangers, as shown at A and A in Fig. 411.

When the angle frame has been covered, the wires left extending from the last receptacle on each side in Fig. 412 should be passed through holes on the end of the sign which is to go nearest the building.

Finally, the panel on each side of the sign must be placed in position. This panel is merely a flat piece of galvanized iron cut to fit into the rabbet or flange on the inner edge of the border, and is fastened by means of solder, at several places around the edge. As it is sometimes necessary to change the lettering on the panel, it is advisable not to fasten it more tightly than is necessary to prevent its being blown from its place.

After proceeding to this point the sign is turned over to the painter, who will letter the panel and paint the border according to requirement.

Hanging the Panel-Sign

Panel signs are hung on outriggers of iron pipe fastened to the wall of the building by a pipe flange. They are supported either by wire or by chains, as may be desired, or as indicated in either Figs. 409 or 410.

The ornamental heads for the pipes can be procured from any first class hardware store, as may also the chains.

The sign is connected to the electric light wires in the same manner as in the case of block letter signs.

Two illustrations are given as being representative styles. In Fig. 409, the more ornate design, the lamps project squarely from a flat surface, while in Fig. 410 the receptacles are set in the beveling surface of the frame or molding around the panel, thus illuminating the letters more strongly.

ENAMELED LETTER SIGNS

Solution 129

The enameled letter sign is of the most simple construction. It embodies some of the features of both the block letter and the panel sign, as will readily be seen by comparing the construction of all three styles.

To serve the purpose of an example we have selected the name GRAND. Let us assume that the hight of the letters is to be 14 inches. As enameled letters should be much heavier than those of any other material, we will allow for letters of 12 inches a width, say 16 inches. This will afford ample space between the letters and make them stand out clearer both at night and in the day-time. Following the foregoing method of deciding upon the size of letter and the necessary space between, we find that this sign should be 8 feet long by 2 feet high.

The next step is to build a frame of angle iron in the manner already described. This frame should be of practically the same size as the sign, that is, 8 ft. × 2 ft. When the sign is to be double faced, a space of at least 6 inches should be left between the two faces in order to afford easy access to the wiring when assembling the parts.

The next step is to build a frame of angle iron for the faces of the sign. These should be punched at the edges so that they may be bolted to the frame, in which corresponding holes have been punched, when they are ready to be placed in position. Draft the letters on the faces of the sign and cut the holes in the sheet, for the lamp receptacles, as shown in Fig. 413.

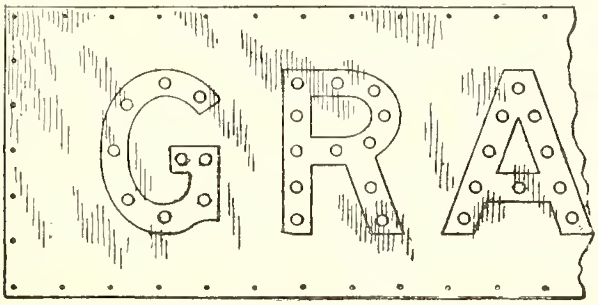


Fig. 413.—Placing Holes for Lamp Receptacles

When this has been done on both faces—for we are assuming that we are building a double face sign —the faces are turned over to the painter to paint the background and letters, which is done in the same manner as upon any other flat surface signs, the only difference being that in this case the letters are studded with electric lights.

While the painter is doing his work proceed to finish the sheet metal work, cutting pieces of sheet iron to enclose the edges of the frame. This is done as in the other forms of signs, care being taken to have pieces of band iron fastened to the frame to serve as hangers. The bottom edge should be removable, so as to allow access to the electric wires at any time. When the faces have been returned by the painter, the lamp receptacles are added in the manner previously described. When all receptacles are in position they are wired as heretofore indi-

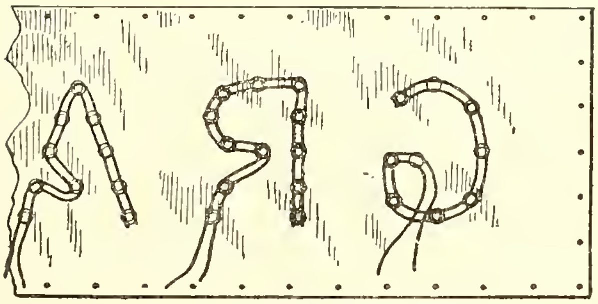


Fig. 414.—Back of Sign, Showing Wiring

cated, care being taken not to put more than one letter on a circuit. By bearing this in mind much trouble will be avoided. The back of each face should now appear as in Fig. 414. When both faces have been thus wired it remains only to fasten them to the frame. This is easily accomplished by the use of stove bolts, when the wires are carried through porcelain bushings in one end of the sign to the cut-out box, as in the other signs. When a final coat

Fig. 415.—The Finished Sign

of paint has been applied, the sign should appear as in Fig. 415, and is ready for erection.

If a more ornate design is desired it may easily be secured by adding regular moldings or special sheet metal ornaments.

The illustrations given herewith show some signs

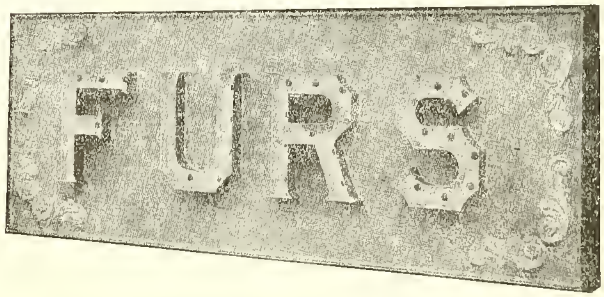


Fig. 416.—Channel Letter Sign.

now in use. Fig. 416 shows a very well designed block letter sign in channel form. It has letters in good proportion and the molding on the edge adds

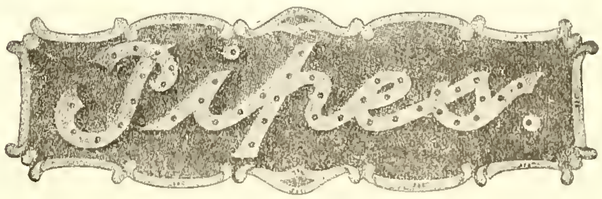


Fig. 417.—Scroll Design

much to its appearance. Fig. 417 shows a scroll effect, which is very ornamental as a sign in the day-time, but very poor at night. Since the main purpose of an electric sign is for advertising at night, effect is lost if it is not readable.

Fig. 416 shows a block letter sign with the slight variation that the sides of the letters are carried up beyond the faces of the letters, in other words a channel form, and are fastened to the face by means of a lock seam. The effect is very good, as the tendency is to thus concentrate the rays of light from the electric bulbs. The general design is also very good, presenting a dignified and substantial appearance.

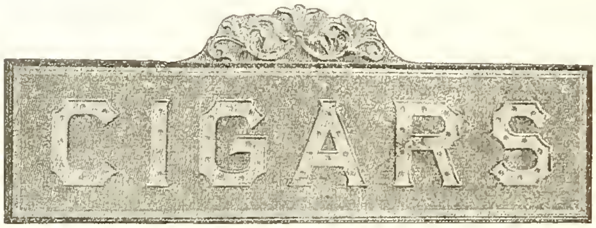


Fig. 418.—Another Design for Channel Letters

Fig. 418 shows a panel sign of great simplicity, which is its chief claim to recognition. It may be built in a manner both easy and inexpensive, so that it can be sold in many places where a more elaborate design would not be acceptable.

Fig. 419.—A Simple Design

The various styles shown in this discussion are perhaps as good illustrations of panel signs as can be found. They are the accepted styles of the large lighting companies, and are more commonly sold than any other. It is an easy matter, however, to create a design with a little time and study.

Experience has taught that the plain, straight, black and white work proves most effective from an advertising point of view.

DEVELOPING THE PATTERNS AND ASSEMBLING A SHEET METAL PANELED ELECTRIC ILLUMINATED SIGN, WITH METHODS OF HANGING

Solution 130

A sign, simple in construction, yet attractive, and at the same time furnishing exceptionally good street illumination, is shown in Fig. 420. It is entirely of sheet metal construction, and hangs from an iron pipe supported from the building. This sign is made to hold twenty-four incandescent lamps, twelve on each side.

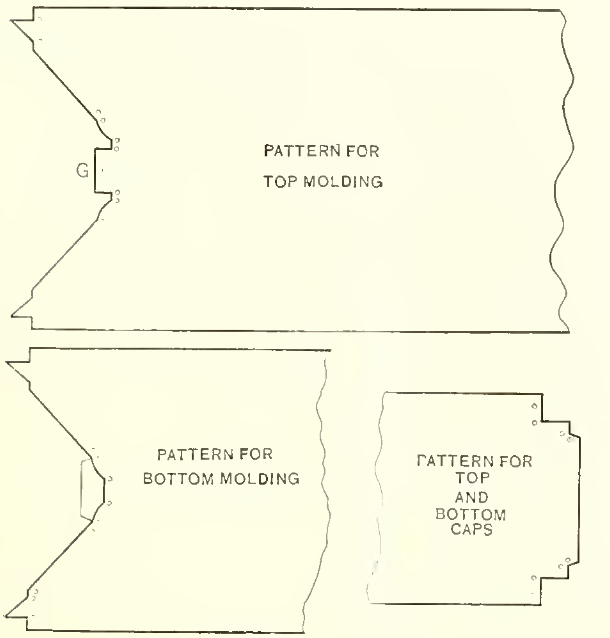
Drawings to indicate the necessary features in

Fig. 420.—Illuminated Sign

the pattern forms and assembling are reproduced in Fig. 421. The method of developing the patterns is so elementary that it does not require further demonstration than that given under Face Panel Miters. It is to be understood, however, that both the front and the back of the sign are the same. The end of the front elevation shows the general form of the sign, which when considered in connection with Fig. 420, and the vertical section through the center Fig. 421, gives a very good idea of its general form.

In the vertical section, Fig. 421, A represents the top cap; B, the bottom cap; C, the top frame or molding; D, the bottom frame or molding; E, the sheet on which the lettering is painted, or the sign board proper, and F, the stamped beading planted on the outer face of C and D. Care should be taken to have one edge of the stamping at the outside ends of the sign kept even with the end of the lock bend, so that when the caps are put on, they will slide freely over the projecting edges of the caps and touch the stamping, thus making a closed and continuous surface.

Make the pattern for the top molding in the regular way, erecting lines from the miter line in the end of front elevation to be intersected by lines on stretchout not shown, as in a panel miter. The measurements to be placed on the stretchout line should be taken from the drawing of the vertical section. Connect the proper points of intersection and the pattern for one end of the top molding is obtained as shown. This should be left without laps, except the one shown at G. In putting the dots in the patterns, it should be remembered that it will save trouble, and will be easier for the operator of the brake, if they are kept 3/16 inch away from the edge of the cut.



The pattern for the end moldings is made from the pattern for the top molding, but laps are added as shown. K is a lap that is about 1/8 inch

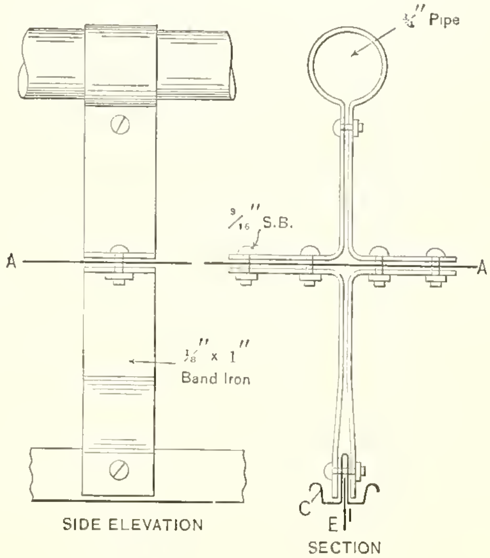


Fig. 422.—Details of Hanger

less than the depth of the pocket, so as to preserve a good clearance, that it may not interfere with the putting together of the miters. L suggests where

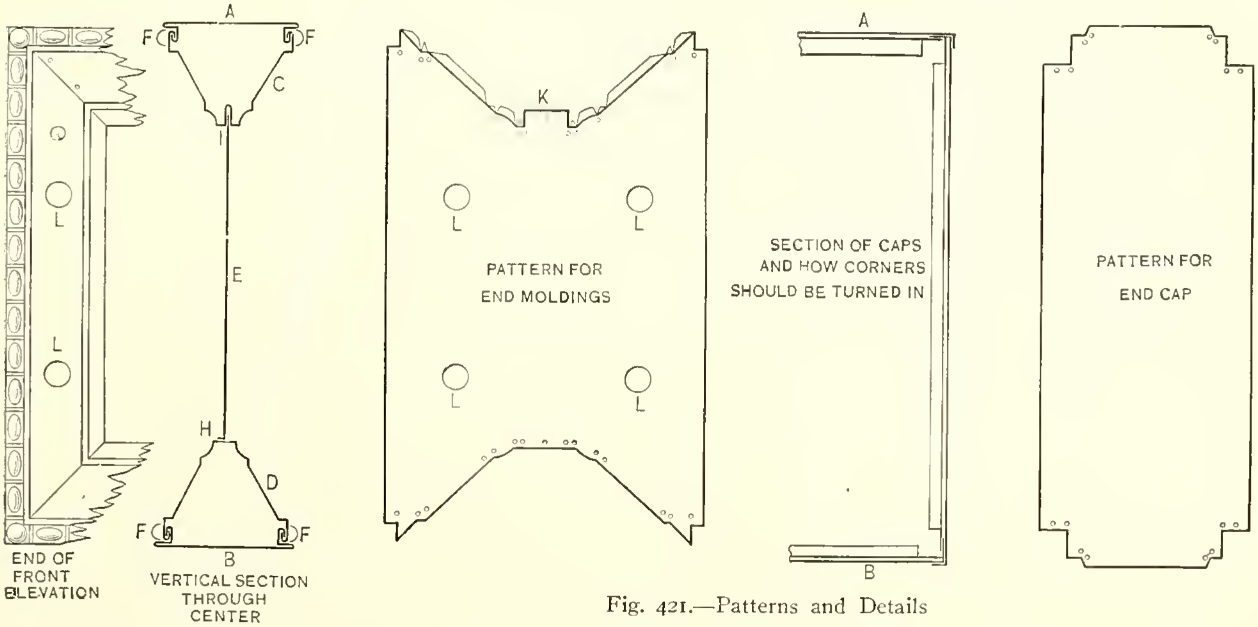


Fig. 421.—Patterns and Details

While the cuts and the face of the frames are all the same, there is a slight difference relating to the pockets, I, where E slides in and rests at the base. When making the pattern of the bottom molding, no pocket should be provided for at H, as is shown in the top molding at I. Laps should also be left as indicated on pattern for bottom molding.

holes may be punched in the metal for lamps. These, of course, should be of appropriate size for the electrical fittings and placed where desired on the special sign under construction.

The patterns for the top and bottom and end caps are developed in the regular manner. It is only necessary to determine one corner, for all corners are alike, on top, bottom and end caps. Care must be taken as to how the laps are turned, so that they will not run against water coming down from the top of the sign. The section of caps and how they should be turned in is shown clearly in the detail in Fig. 421 by A and B.

As to the size of the face E, we need only to remember to allow ¾ inch to the inside measurement of the hight to permit it to enter the pocket I, ½ inch and to turn out at the bottom ¼ inch, and to add 1 inch to the inside length to permit it to enter the side pockets in the end moldings ½ inch each.

The method of constructing hangers in such a manner as to combine rigidity and permanence is shown in Fig. 422, where the various letters A, C, E and I correspond to similar letters in the vertical section through the center in Fig. 421. Care must be taken to prevent rust from weakening the hanger, or where it is attached.

On a 5 ft. sign, two hangers, as shown in Fig. 422, should be used, one placed about 10 inches from each end. The hangers are made of ⅛ in. by 1 in. galvanized band iron, which should be bent and fastened with bolts as shown. A ¾ in. galvanized pipe will safely support the sign, and can be securely attached to a wooden part of the building with a floor flange, the street end being supported by galvanized iron chains as shown in Fig. 420.

PART XIII

CONSTRUCTION OF HOLLOW METAL WINDOW FRAMES, SASHES, FIRE DOORS AND SHUTTERS

HOLLOW metallic windows may be divided into six general types, namely: The Sliding, the Pivoted, the Casement, the Top Hinged, the Stationary, and the Tilting Window.

Sliding Windows are those having two sashes ordinarily designed to slide up and down. The motion of these sashes may be independent each of the other and be controlled by weights, in which case the type is designated the *double hung window;* or one sash may counter balance the other, in which case the window is called *counterbalanced.*

Pivoted windows are those having one or more sashes mounted on pivots, allowing each movable sash to be turned on an axis.

A Casement window is one having its sashes attached to the frame by hinges at a vertical edge, operated after the manner of a door. Top hinged windows are those which have the sash attached to the frame by hinges at the upper horizontal edge.

A Stationary window is one having the sash in a fixed position.

A Tilting window is one in which the sashes are attached to the frame and each to the other in such a manner that a sliding and tilting movement of the sashes is effected.

A Twin window is one whose sashes are mounted alongside, instead of vertically.

Some windows embody combinations of the foregoing types. For example, a window having a *Pivoted upper sash* and *Stationary lower sash* is called a *Pivoted upper, fixed lower sash, window.* A window having two sashes, each of which is pivoted, is called a *Double pivoted window.* A window having a top hinged upper sash and a double hung lower sash is usually designated a *Double hung window with top hinged transom.*

Frames and Frame Member

Hollow metallic windows of any type consist of a frame and one or more sashes. Frames formed with offsets or shoulders to receive the masonry as at *a* in Fig. 423 are called *rabbeted frames.* Frames not provided with rabbets are generally formed with metal *wings or flanges,* which are designed to be built into the masonry, as shown in Fig. 424. These are called *walling-in flanges.* When the frame is installed in an old wall, the flange of the frame is spiked to the brick work, as shown in Fig. 425.

The frames of all windows having a single sash and the frames of sliding sash windows having two

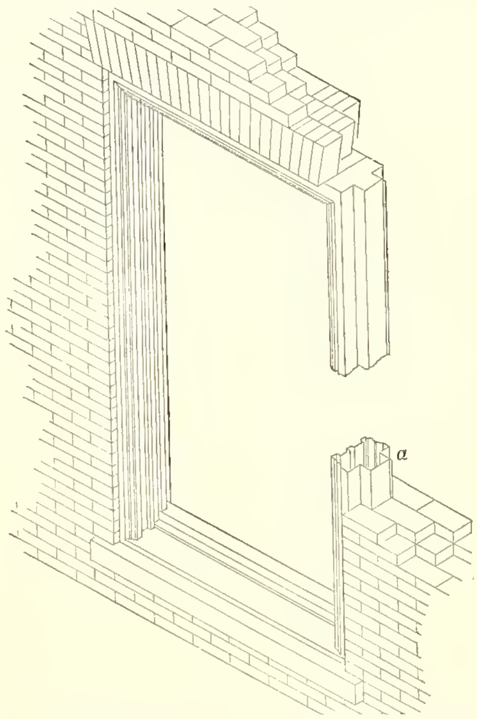


Fig. 423.—Jamb with Rabbets or Offsets to Receive Masonry

sashes are composed of two horizontal members called the *head* and *sill* and two vertical members called the *jambs.* The *head* is that portion of the frame which forms the top, the lower surface of the head being called the *soffit* and the upper surface the *top of the members.*

The *sill* is that portion of the frame which forms the bottom. The upper surface is called the *tread* and the lower surface the *base.* The *jambs* form the sides of the frame, the part in contact with the

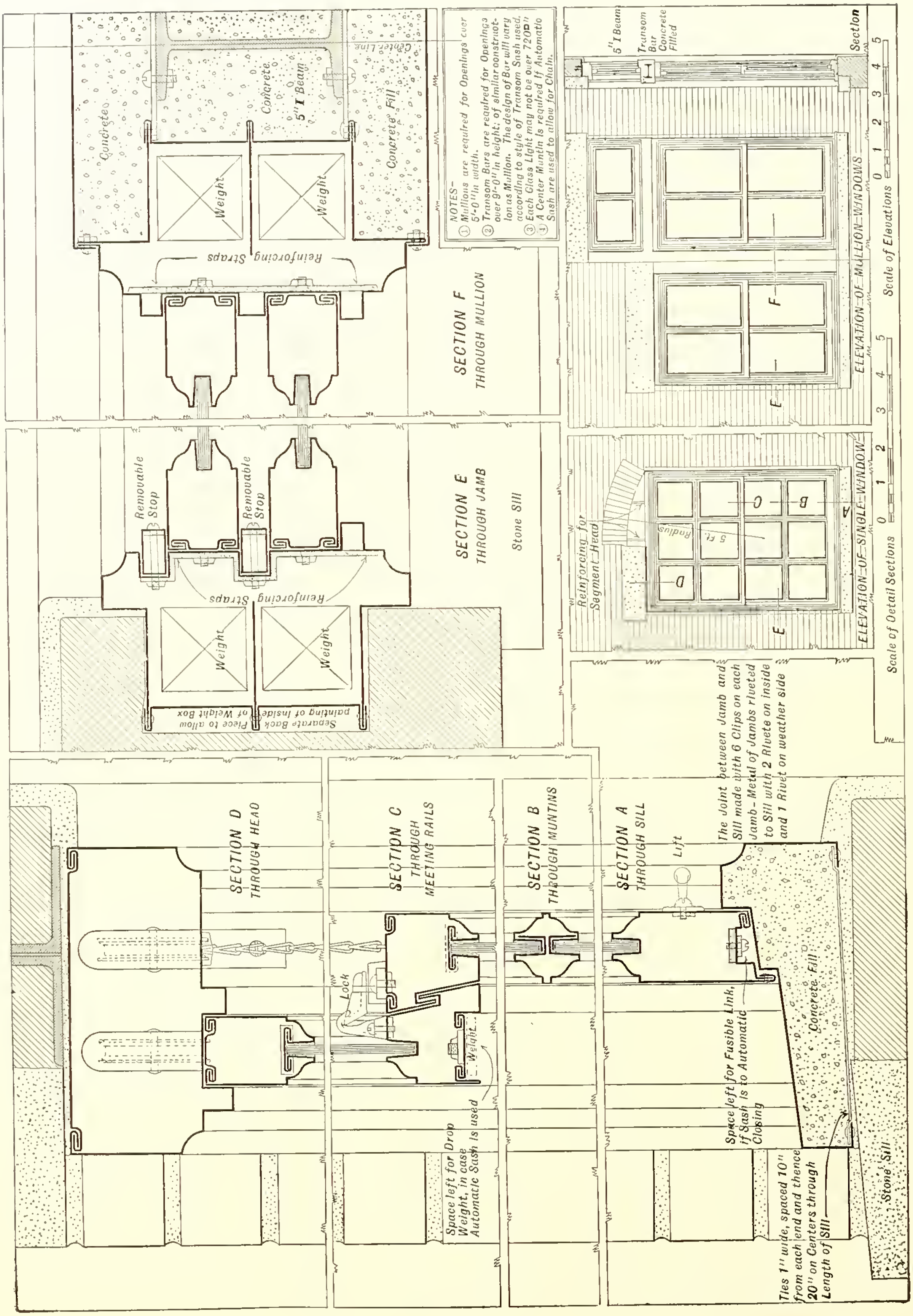


Fig. 426.—Regular Type of Double-Hung Window

masonry being called the *back of the jamb* and the part in contact with the sash the *front of the jamb.*

Projections on the front of the jambs, designed to limit the movement of a movable sash, are called *stops.* Sliding sash windows are frequently

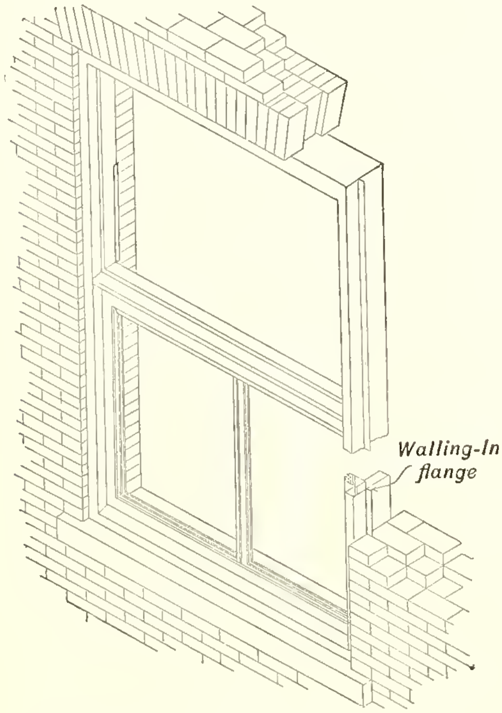


Fig. 424.—Frame with Walling-in Flange

equipped with stops which may be separated from the jamb· these separable strips are commonly referred to as *sash guide strips,* the strip dividing the two sashes being frequently designated *sash parting bead.*

The frame of a pivoted window having two sashes is composed of the same members as the frame of

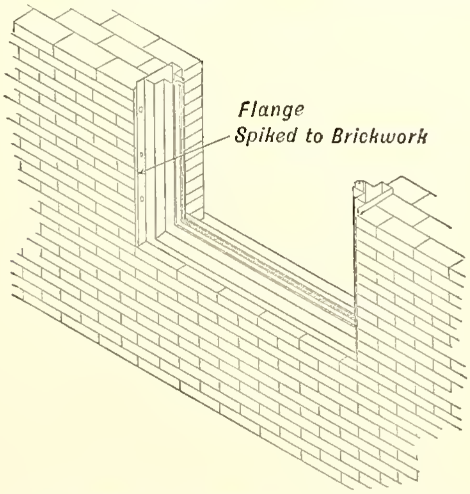


Fig. 425.—Frame Installed in Old Wall Opening

a sliding sash window and an additional horizontal member, which is called the *transom bar.*

The frame of a twin window is composed of a *head, sill, two jambs* and a *vertical division member* which separates the sashes.

That part of the wall structure between two windows is called the *mullion.* The mullion may be an integral part of the wall structure or it may be built in with the window.

Sashes and Sash Members

The *sash* is that part of the window construction which holds the glass. It may be permanently attached to the frame, in which case it is called a *fixed or stationary sash;* or it may be so constructed that its position can be changed, in which case it is called a *movable sash.* A sash is composed of horizontal and vertical sash members. The horizontal members at the top and bottom of the sash are called *rails.* In sliding sash windows the rails which join at the middle of the window when the sashes are closed, are called the *meeting rails.* The vertical members at the sides of the sash are called *stiles.*

In casement windows the stiles to which the windows are attached are designated *hinge stiles* and the stiles to which the locking mechanism is attached are called *lock stiles.* When casement windows are made in two parts, meeting at the middle, the stiles in contact are called *meeting stiles.*

The intermediate members separating the panes of glass are called *muntins.* If the muntin is installed in a vertical position, it is called a *vertical muntin,* if in a horizontal position, a *horizontal muntin.* Muntins which are so designed that one part may be removed for glazing are called *separabl3 type muntins;* muntins which cannot be taken apart for glazing purposes are designated *non-separable type muntins.* In architecture, the word "muntin" is employed to designate the vertical sash members separating the lights from one another, while the horizontal members are called bars. The commonly accepted shop term is "vertical and horizontal muntin."

CONSTRUCTIVE FEATURES OF REGULATION TYPE OF DOUBLE HUNG WINDOW

As Approved by the National Board of Fire Underwriters

Solution 131

In Fig. 426 is shown the elevation of a single window, also the elevation of mullion windows, including a section. Detailed working sections are given through A, B, C, D, E and F. Attention is particularly called to the explanatory notes given with the detailed sections in the illustration. These details have been reduced from full size sections and may be relied upon for substantial construction. They have been used extensively in practice and have been approved by the National Board of Fire Underwriters.

Hints on Glazing

All glass must be at least ¼ inch thick at the thinnest area. The wire mesh in the glass must be not larger than ⅞ in., and the wire used for such mesh must be not less than No. 24 B. & S. gauge. The plane of the wire mesh shall be practically midway between the two surfaces of the glass. The actual bearing of glass in grooves shall be at least ⅝ in. at all points. Since the maximum depth of the grooves is ¾ in., a space of ⅛ in. is allowed between the bottom of the groove and the edge of the glass. Careful glazing is necessary to prevent an edge of glass resting on the bottom of the groove, thus decreasing the bearing surface on

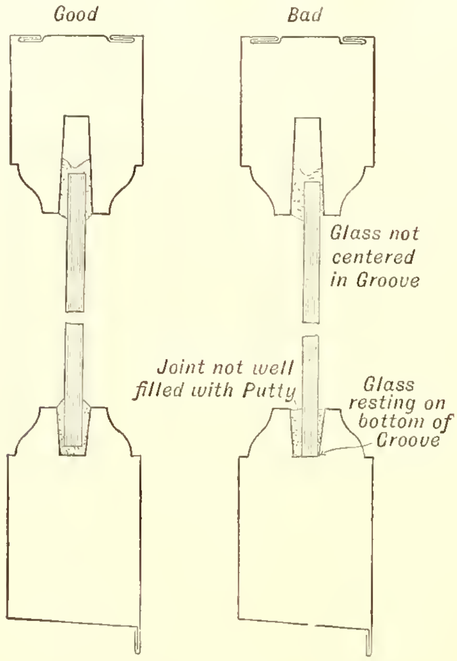


Fig. 427.—Proper and Improper Glazing

the opposite side, shown in Fig. 427. This figure also shows the correct and incorrect methods of glazing. In glazing it is required that the glass be set in putty and that all spaces between glass and metal forming the sides and bottom of grooves be well filled with the same material. The surface of putty should be flush with the top of the groove and

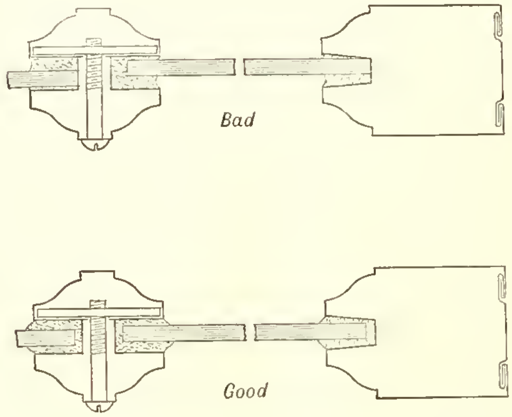


Fig. 428.—Another Example of Proper and Improper Glazing

should be finished smooth. Fig. 428 shows the correct and incorrect methods of glazing in connection with the stiles and muntins.

COMBINATION PIVOT HUNG AND STATIONARY FIRE PROOF WINDOWS

As Approved by the National Board of Fire Underwriters

Solution 131a

In Fig. 429 is shown the constructional features of a combination pivot hung and stationary window. An elevation of a single window, as also of mullion windows, is shown, together with a section. Detailed sections showing construction are given through A, B, C, D, E, F, G, H, and I, to which are appended explanatory notes: these should be read carefully. In sections C, D, E, and I the method of fastening the hardware is clearly shown. Section C shows where the fusible link is attached to the bottom lock. Note the construction of the mullion in section G, to the 5 in. I beam.

VARIOUS TYPES OF AUTOMATIC CLOSING, TIN CLAD FIRE DOORS, SHUTTERS, ETC.

Solution 132

To one not familiar with the various types of tin clad automatic closing fire doors and shutters some

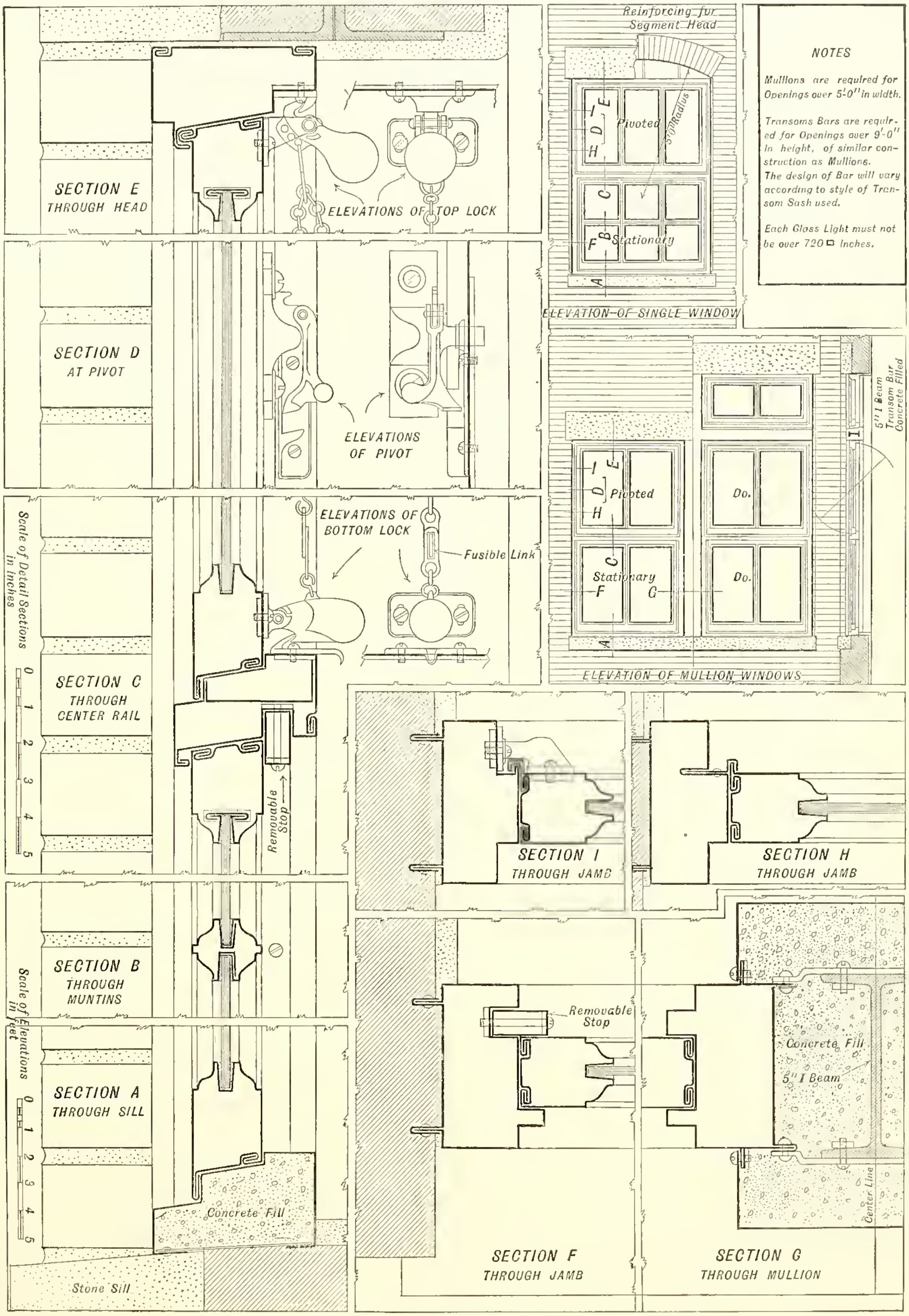


Fig. 429.—Combination Pivot-Hung and Stationary Fire-Proof Window

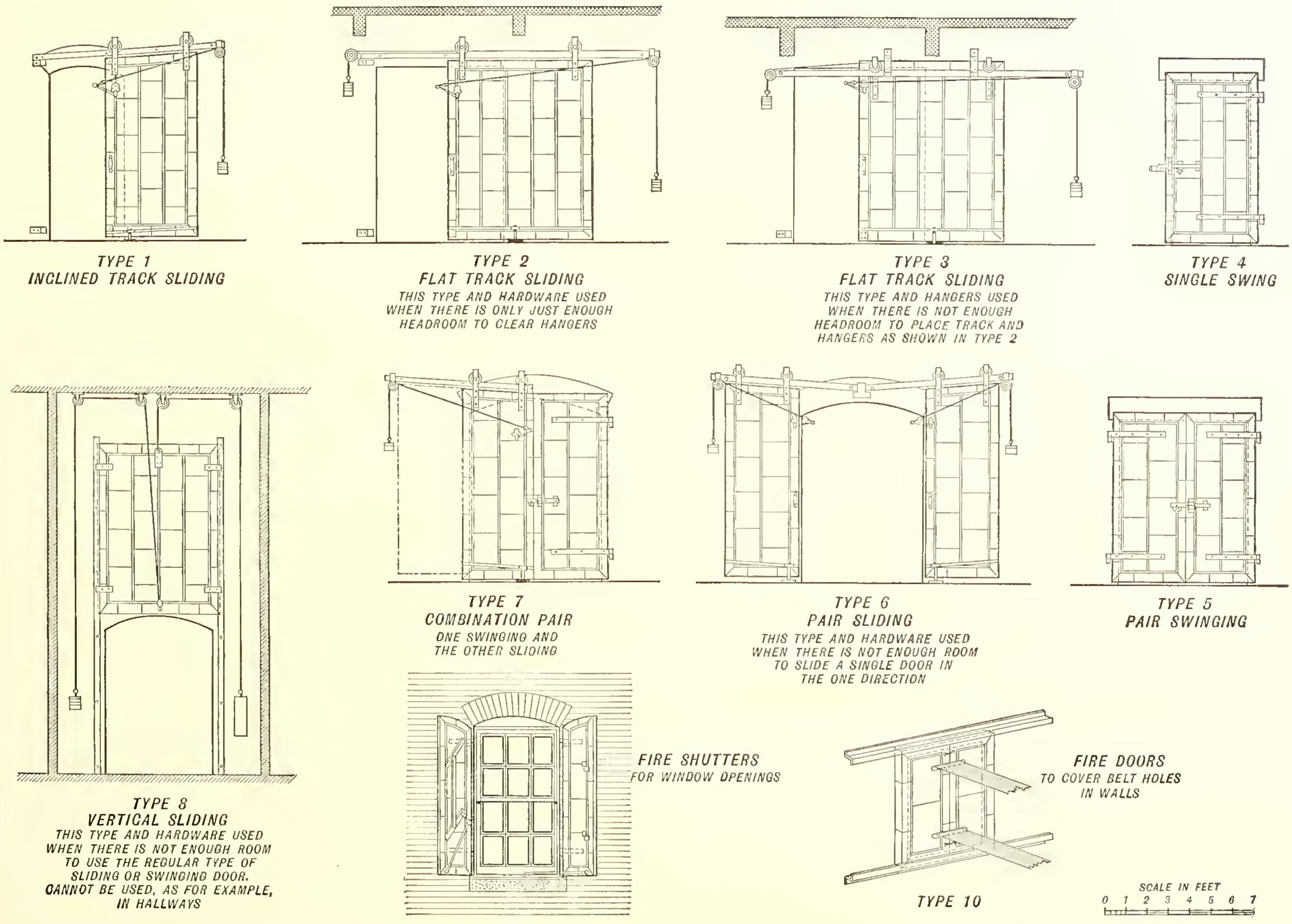


Fig. 430.—Various Types of Automatic closing, Tin-Clad Fire Doors, Etc. Approved by the National Board of Fire Underwriters

difficulty may be involved in becoming conversant with the various constructions, unless information, such as is indicated in Fig. 430, is available. In this illustration ten types of doors and shutters are shown. Types 1, 2, 3, 6, 7, and 8 are balanced by weights to facilitate and adjust opening and closing. They are also attached to fusible links, so that if the door be open in case of fire, the link will fuse or melt when the weight of the door will close it automatically. Types 4 and 5 show single and pair swinging doors. Type 9 shows double fire shutters, and type 10, a double fire door used to cover belt holes in walls, etc. The method of covering the doors or shutters with tin plate, the construction of the lock, and like information can be obtained from the Board of Fire Underwriters in any city.

The Boards have as a rule special booklets containing just such information. In this connection it may be helpful to call attention to the methods of laying out the pattern for metal corners with the miter fold, the pattern for the right hand sheets, for the center sheets, for the left hand sheets and for the finishing course at the top. All of these methods can be used for a fire door or shutter of any size.

PREPARING THE PATTERN SHAPE FOR CORNER MITER FOLD AND METHODS OF CONSTRUCTING LOCK AND FOLD

Solution 133

Perspective views of the corner miter fold are shown by A and B in Fig. 431. The method of laying out this pattern is illustrated in the diagram of Fig. 432. In covering any door or shutter the four

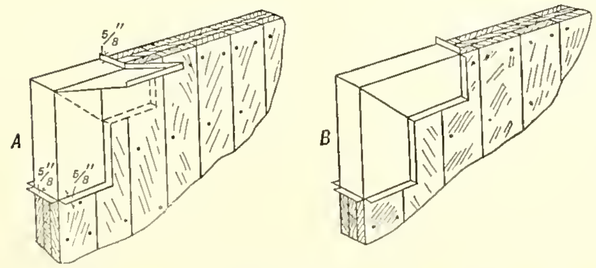


Fig. 431.—Method of Putting on Sheet Metal Corner with Miter-Fold

corners are first laid on with a full 14 x 20 in. sheet, without any cutting, making a miter fold instead of a mitered seam, prepared as shown in Fig. 432. Ascertain that the sheet is perfectly square on all four corners and scribe a 5/8 in. edge around the entire sheet. Through the center of the 20 in. length draw the line A-B. The thicknesses of the door to be covered being known lay off this thickness on the

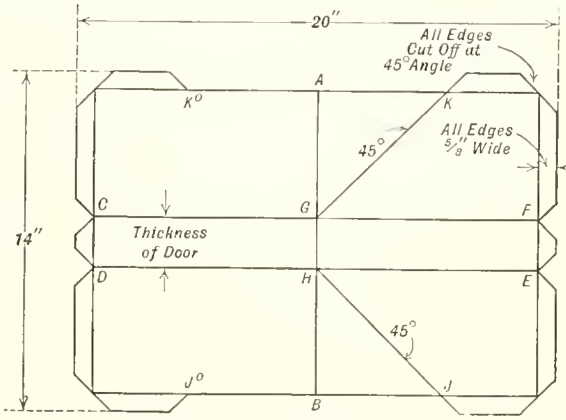


Fig. 432.—Pattern of Corner Miter Fold for Tin Clad Fire-Doors and Shutters

sheet, directly in the center of the sheet, as shown by C-D and E-F, crossing the center line A-B at G and H, from which points draw lines at angles of 45 degrees, intersecting the scribed edge lines at K and J, respectively. Take the distances from A to K and from B to J and set them off from A to K° and from B to J°; cut away the 5/8 in. edge between K and K°, also between J and J°, as shown. All edges on the entire sheet are notched off at 45 degree angles, as indicated. When a pattern is laid out as just described, it may be saved for future use, a change being made for the thickness of the door as required.

The edges on the sheet are now bent all one way,

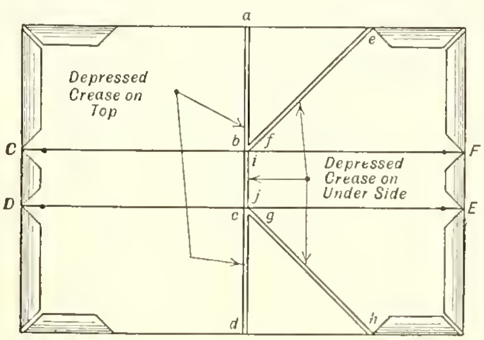


Fig. 433.—The Corner Miter Fold, Edged and Creased, Ready for Bending

as shown in Fig. 433. To facilitate the bending of the miter lock when these corners are made by hand, creases should be made along the top as shown, from *a* to *b* and from *c* to *d*; while creases along the bottom of the sheets should be made from *e* to *f*, from *i* to *j* and from *g* to *h*. These creases can be made quickly by hand, by means of the rounded point of a three-cornered file, laying the sheet on a number of folded papers, thus providing a soft layer into which the crease is impressed. The file point should be rounded, not sharp, to avoid cutting the metal. After the creases have been made, two right angular bends are provided along the lines C-F and E-D; then the creases *a-b* and *f-c*, also *d-c* and *g-h*, are turned right and left on the hatchet stake, the sheet being thus brought into the position, shown in

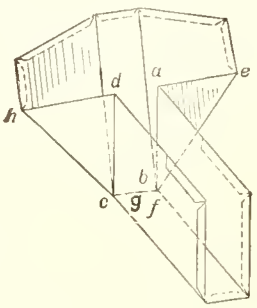


Fig. 434.—Bending the Corner Miter Fold

Fig. 434. When this sheet is slipped over the corner of the door it will appear as shown in diagram A in Fig. 431; after the miter fold is closed with the mallet it will have the appearance shown in diagram B in that illustration. The remainder of the sheets along the edges of the door are made of tin in 20

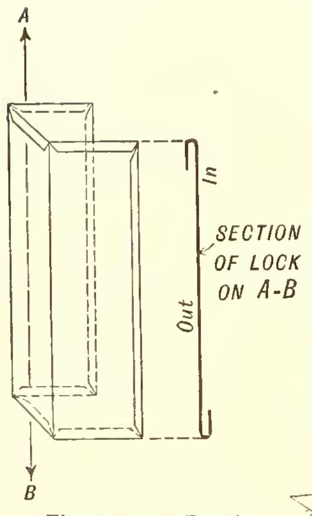


Fig. 435. — Bending and Edging the Stiles

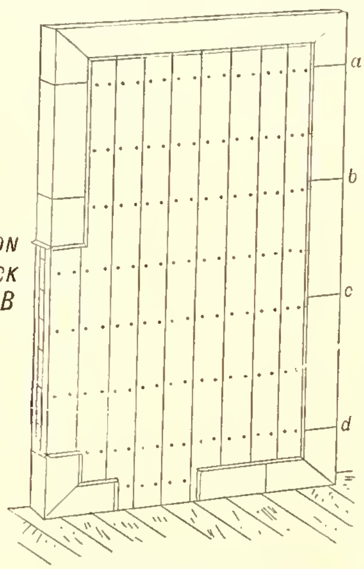


Fig. 436.—Method of Covering Around Edges of Door

in. lengths, formed and edged as indicated in Fig. 435, all edges being locked into one another, as shown in Fig. 436. No nails are used in fastening the locks of the stiles.

LAYING OUT PATTERNS FOR RIGHT HAND STARTING AND CENTER SHEETS AND THE METHOD OF APPLYING

Solution 134

The pattern for the right hand starting sheet may be laid out as shown in Fig. 437. This pattern is used also for all center sheets. Care must be taken to have all locks made ⅝ in. wide, for nailing under the seams; all nails are placed in the center of the joints, in the manner to be described. The formation

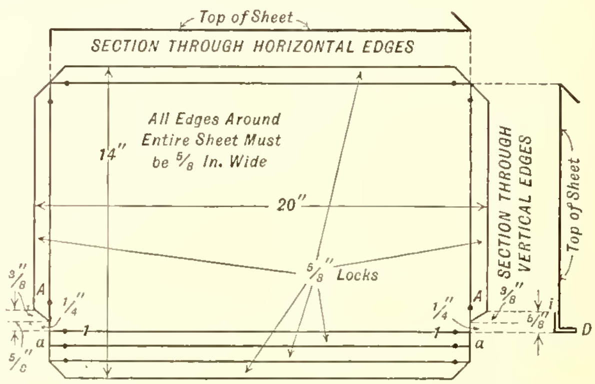


Fig. 437.—Pattern for Right-Hand Starting and Center Sheets

of the locks through the horizontal edges is shown at the top of Fig. 437, while the formation of the vertical edges is shown at the right in the diagram.

With the formation of the edges known, lay out the pattern for the right hand starters and center sheets for all courses as follows: On the one 20 in. side and the two 14 in. sides of the sheet scribe lines with the dividers ⅝ in. apart, as shown. On the opposite side of the 20 in. sheet, scribe three widths of ⅝ in. each and notch the corners carefully, as shown. To allow for the thickness of the metal, and to have the seams lie smooth, notch out the corners at A and A, according to the dimensions shown in the diagram. The required number of sheets are now cut from this pattern and the edges bent, as indicated in the sectional views at the top and to the right of the diagram. In forming the double lock at D, it is first bent on the line *a-a* in the pattern, thus giving it the appearance of diagram A in Fig. 438. Along the line 1-1 in A, which corresponds to 1-1 in the pattern in Fig. 437, a right angular bend is made, thus giving the formation shown in diagram B in Fig. 438. The operations just described are those required in edging the sheets by hand;

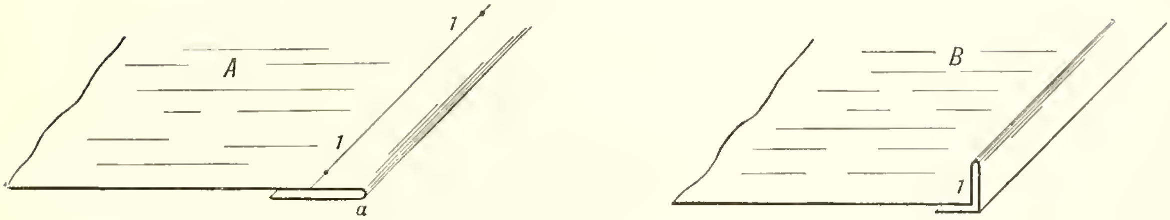


Fig. 438.—Bending Double Edge on Right Hand Side of Sheet

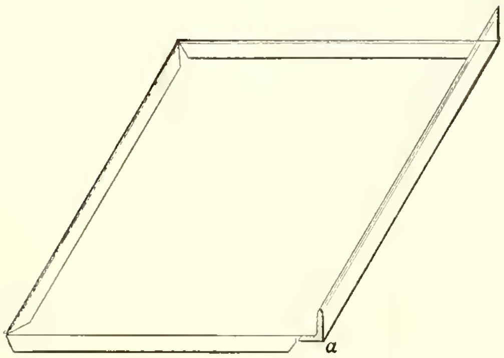
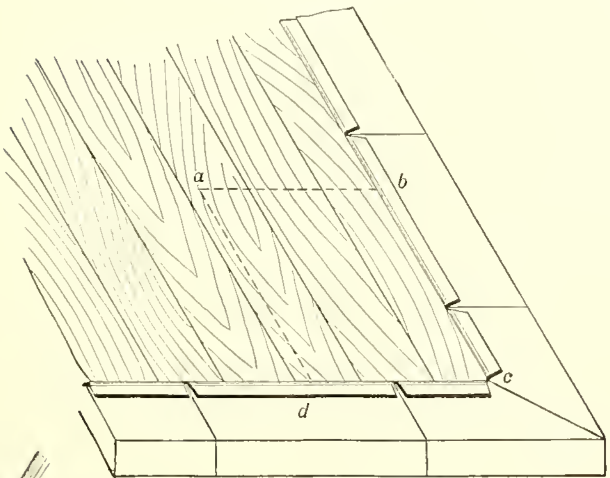


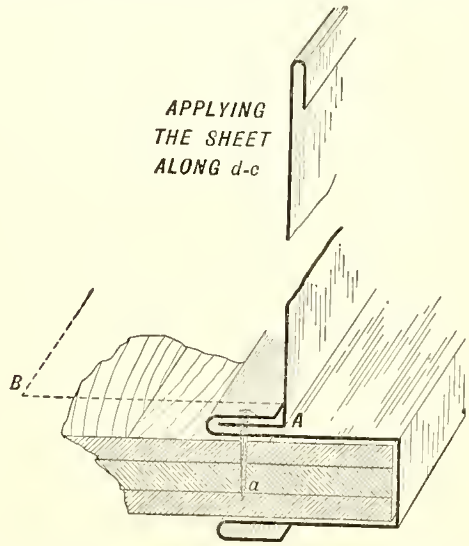
Fig. 439.—Finished Edged Sheet

where large quantities are required, special dies are used. These save time and labor.

The opposite three locks shown in Fig. 437 are bent as called for in the two sectional views, this completing the sheets, one of which is shown in Fig. 439.

The method of applying the right hand starter is shown in Fig. 440 where *a-b-c-d* represents such starter. The sheet is first hooked along the edge *d-c* of the metal stile in the manner indicated to the right by diagram A, nailing through the three thicknesses of metal as shown by *a*. The sheet is then turned down, as indicated by the dotted line B.





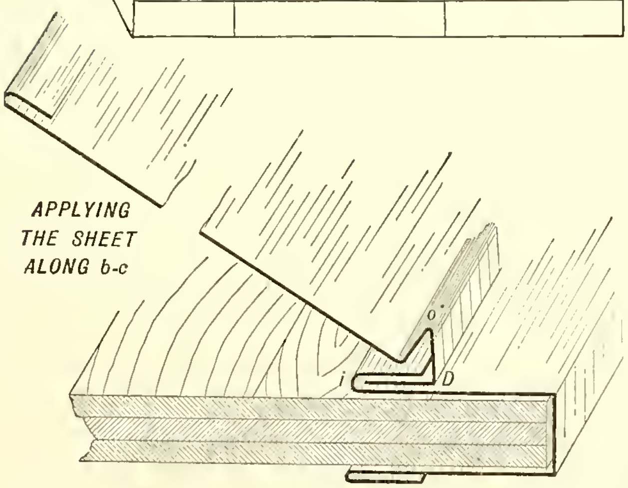


Fig. 440.—Method of Applying the Right Hand Starting Sheet

After the sheet has been so turned down the double lock *a* in Fig. 439 is sprung outward with the fingers, as shown in the diagram D in Fig. 440; the lower edge is sprung into the lock of the stile at *i*, as shown; then the lock at *o* is drawn tightly together and nailed through the four thicknesses of metal, as shown in diagram A in Fig. 441, and the standing lock *c* is turned down as shown in diagram B.

The operations described must be carried out in applying the middle sheets, until the finishing sheet at the left side of the course is reached. This requires a different pattern, which will be described in the next solution.

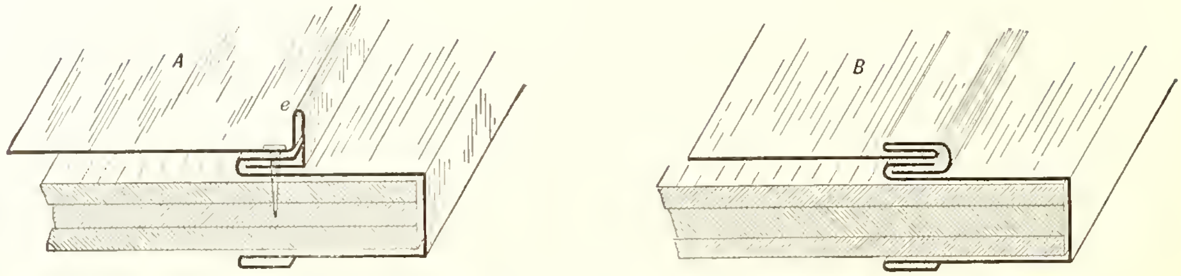


Fig. 441.—Final Operations in Closing the Lock

PATTERN FOR LEFT HAND FINISHING SHEET AND THE METHOD OF APPLYING

Solution 135

Fig. 442 shows how the pattern for the left hand finishing sheet is laid out. The entire length of a 20 in. sheet is used, its width being determined by the requirements, that is, the distance between the stile and the next middle sheet. Note that double locks are placed on the two long sides of the sheet, as shown in the pattern, while two single edges are placed on the narrow ends, also shown. The method of turning these edges is like that previously de-

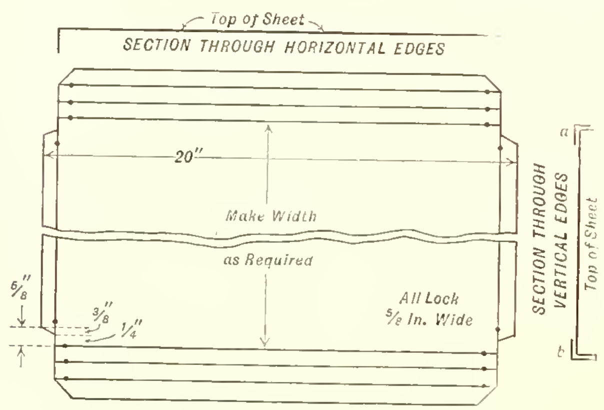


Fig. 442.—Pattern of Left-hand Finishing Sheet

scribed; the formation of the locks is indicated in the two sectional views. When springing in the double locks *a* and *b*, shown in the section through the vertical edges, they are drawn outward with the fingers, as already explained, and as illustrated in Figs. 439, 440 and 441. When the second course is started, in fact all courses, invariably break joints as in tin roofing, taking care that the sheets lie close against the door, in order to avoid the occurrence of air spaces. When the top or last course is reached, new patterns must be developed for the top course right hand starting sheet, the top course center sheet and the top course left hand finishing sheet.

LAYING OUT PATTERN FOR RIGHT HAND STARTING AND CENTER SHEETS FOR TOP OR FINISHING COURSE, AND METHOD OF APPLYING

Solution 136

Fig. 443 illustrates the method of developing the pattern for the right hand starting and center sheets for the top course. Note that a double lock is provided for along *a-b* and *b-c,* all corners being notched

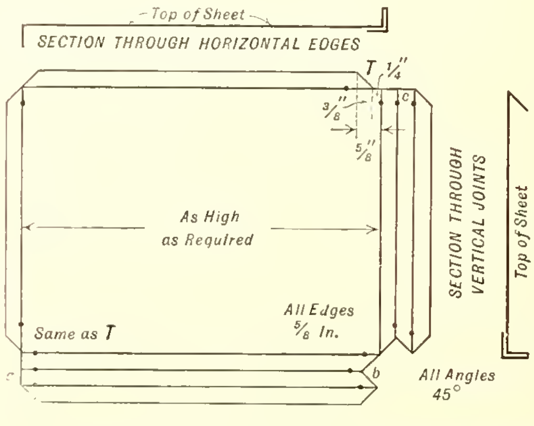


Fig. 443.—Pattern of Right-hand Starting and Center Sheets for Top Course

out at angles of 45 degrees, as shown, so that they will miter when flattened. Notches of the dimensions noted are also made at the corner T, in this way the thicknesses of the metal are provided for. The forming of the locks of the vertical and horizontal edges or joints is done as previously described. In laying these upper course starters, the double locks must be sprung into the edges on the stiles, both at the side and top. The same pattern is used for the center sheets, springing the double lock into the edge of the sheet to the right and into the edge of the stile along the top.

PATTERN FOR LEFT HAND FINISHING SHEET AT TOP COURSE AND METHOD OF APPLYING

Solution 137

Fig. 444 shows how the pattern for the upper left hand finishing sheet is laid out. In this case the sheet is notched, as indicated. The lower edge is bent at right angles downward, while the three remaining sides have double locks, as shown in each

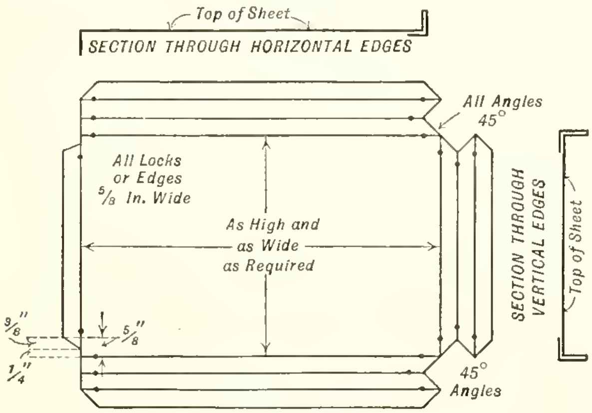


Fig. 444.—Pattern of Left-hand Finishing Sheet for Top Course

of the two sections, through horizontal and vertical edges. As stated in the preceding problem, these double locks must be sprung into the edge or lock of the center sheet at the right and into the lock at the stile both at the left side and at the top. This completes the full set of patterns for any size of fire door or shutter. Once developed, these patterns may be saved for future use, the thickness C-D of Fig. 432, being merely changed to conform to the thickness of the door under construction, or what is termed the wood core.

COVERING SEGEMENTAL HEADS IN THE CONSTRUCTION OF TIN-CLAD SHUTTERS

Solution 138

Fig. 445 gives a general view of a tin clad shutter. The operations of covering such shutters do not differ from those applied to fire doors. If shutters are made in pairs, the edges coming together should be slightly beveled, not rabbetted. This method permits the shutter to be readily opened and closed and aids in making a close fit. If the shutters have segmental heads, as shown by *a* and *b* in the illustration, the heads should be covered, as indicated in the three views A, B and C in Fig. 446. In the first operation at A, the main sheets on both sides of the shutter are flanged out a half inch, as shown by *a* and *a*; then they are nailed as shown by *b* and *b*. A cap covering

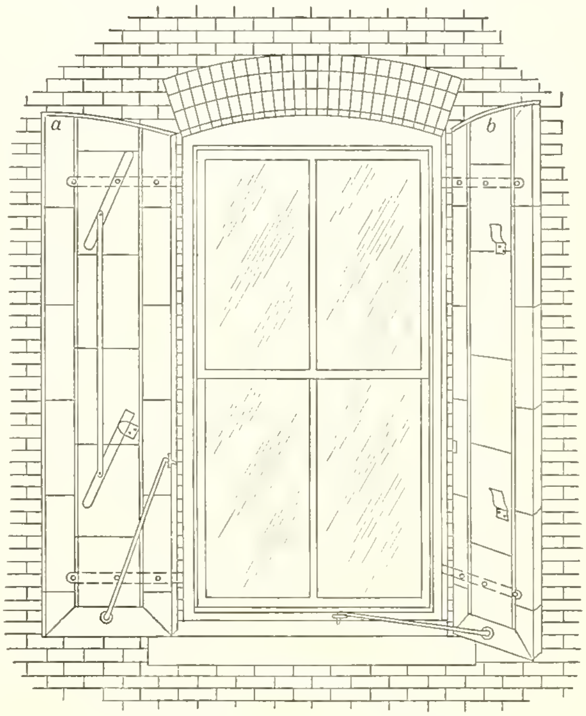


Fig. 445.—Tin-clad Fire Shutters with Segmental Heads

with a ⅝ in. lock is now slipped over *a-a*, as shown in diagram B. The locked edges are then turned down with the mallet, as shown in diagram C. It

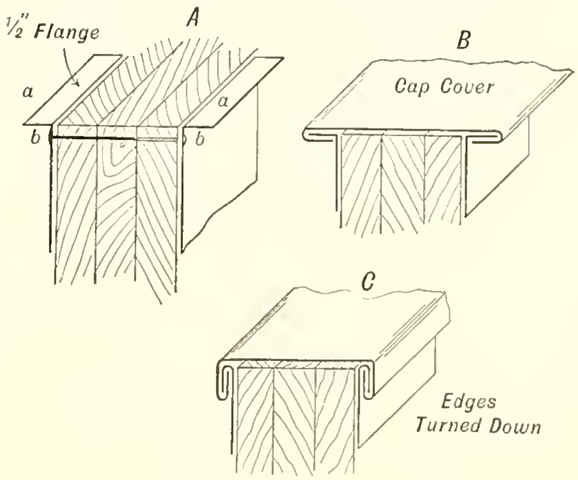


Fig. 446.—Covering Segmental Heads

will be understood that locks facing the weather must be laid so that rain will flow over the seam, not into it.

FIREPROOFING WOODEN WINDOWS IN OLD BUILDINGS

Suggested Methods Requiring Moderate Equipment

Solution 139

Where it is necessary to fireproof windows, as is often called for by state and municipal ordinances designed for protection against fire, it is not always expedient for the owner of a building to rip out the entire frame and sash and replace it with a modern hollow metal frame and sash. To do so would undoubtedly insure the best manner of fireproofing the window openings but the cost and the attendant inconvenience to tenants often prohibit such a substitution.

If some method could be evolved whereby these windows could be rapidly and economically fireproofed a way out of the difficulty would be found. Some have tried to cover the old frames, that is, the jambs, head and sill of the window, with light galvanized sheet iron such as in kalamein work. They have also tried to cover the sash in the same manner, replacing the usual thin window glass with heavy wired glass. This was a decidedly difficult procedure because of the poor condition of the woodwork and most of the work had to be done at the window, which involved unsatisfactory conditions for the tenant.

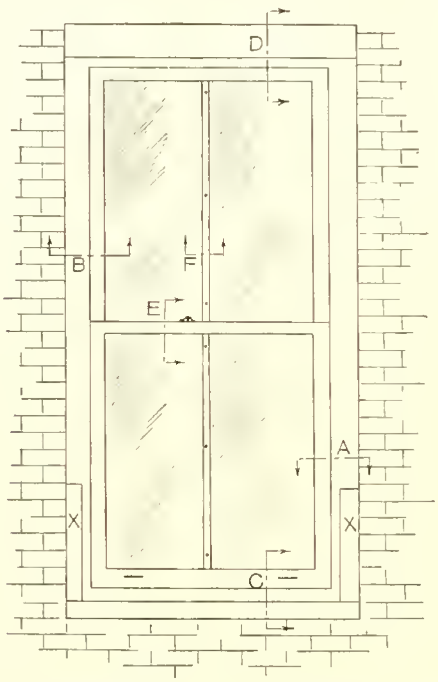


Fig. 447.—General View of Typical Factory Window

The following is a plan adopted by many. While there are probably variations in the different jobs, this outline of the procedure will perhaps be of service. In Fig. 447 is given a general interior view of a typical factory window. In a majority of cases there is no interior trim or embellishment, but if there be such, it is not difficult to either leave it intact or cover it with sheet metal. In general the procedure is to make a sleeve casing to cover the old wood sill, the two jambs and head and then to hang new sashes of hollow metal.

A horizontal section of the right hand jamb (facing the window while standing inside) is given in Fig. 448 with the stile of the lower sash. This is a section viewed on line *A* of Fig. 447. In Fig. 449 is given a horizontal section of the left hand jamb on line *B* of Fig. 447, and stile of upper sash. In Fig. 450 is a vertical section of the head and top rail of upper sash on line *D* of Fig. 447. Fig. 451 is a vertical section of the sill and bottom rail of lower sash on line *C* of Fig. 447. Fig. 452 is a vertical section of the meeting rails of the sashes on line *E* of Fig. 447. The horizontal section of the muntins on line *F* is given in Fig. 453.

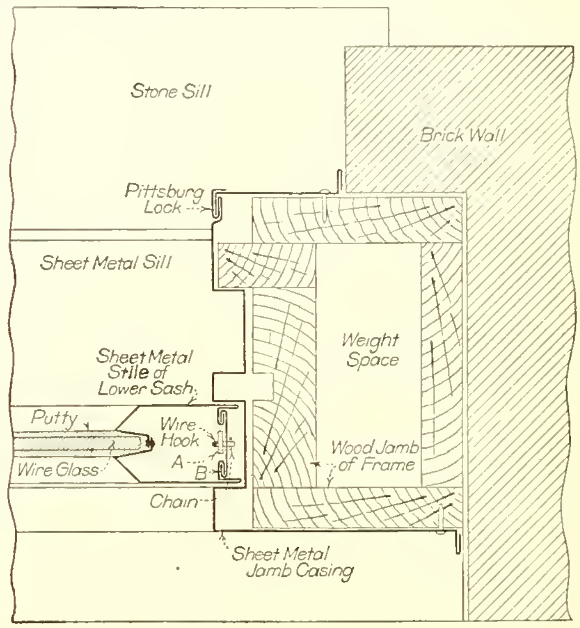


Fig. 448.—Section on Line A of Fig. 447

The pattern cutting requires more of a practical knowledge of construction than ability in scientific developing of surfaces of solids, because all patterns are simple, but the joints and miters must be designed to have positive strength, and the profiles and the like designed with the equipment of the shop in mind. The profiles or shapes of the various parts shown in the accompanying diagrams are designed with the limitations of the ordinary hand brake in mind, and cause no greater difficulties in bending than might be expected for such work. Of

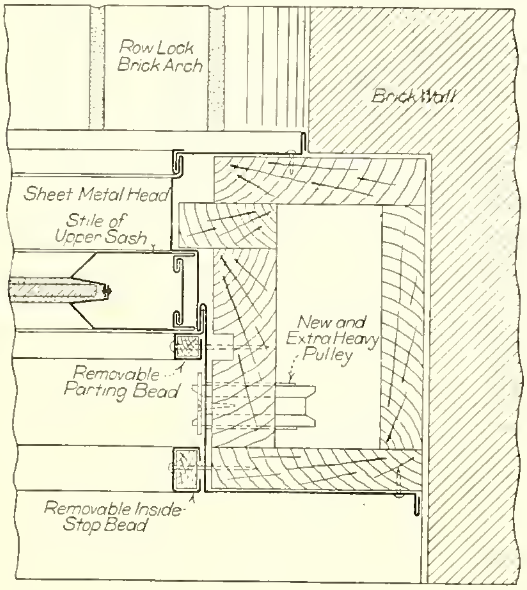


Fig. 449.—Section of Jamb on Line B, Fig. 447

course, with a modern power drop brake the bending operations would be greatly simplified.

From the diagrams it will be seen that the right hand jamb of sheet metal has the parting head and

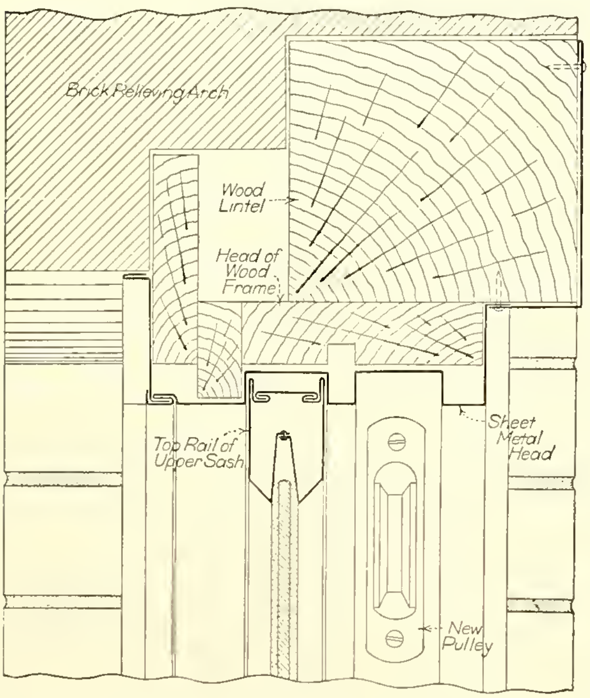


Fig. 450.—Vertical Section of Head on Line D of Fig. 447

the inside stop parts integral to the general part of the jamb, those on the left hand jamb being removable. One who has observed a carpenter remove and rehang sash has noticed that he only removes the stops on one side, usually on the left hand jamb. It is suggested to do the same with the sheet metal window, especially when it is desirable to conserve working time, material and the like.

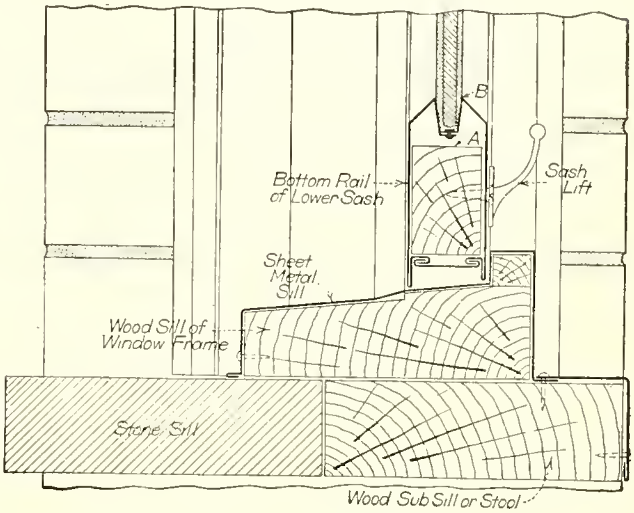


Fig. 451.—Vertical Section of Sill on Line C, Fig. 447

The diagrams show that all the sash rails or stiles are in three parts. This is necessary if only a hand brake is available to form these parts. However, if a drop press is available, the rivet joint in the glass pockets can be done away with. The pockets of the top rails of both the lower and upper sashes are very deep. The idea is to allow for pushing the glass up far enough to pass over say point *B*, Fig. 451, of the sash and then dropping it into that pocket.

A piece of wood is placed on the bottom rail of the lower sash, as shown at *A* so that the hand sash lifts may be fastened on with ordinary wood screws. Likewise wood is placed in the top meeting rails for the catch lock, as may be seen in Fig 452. Note the band iron knee *A*, riveted to the bottom rail of the upper sash. The upper sash usually is fixed rigidly in place so that it is always closed. This method of supporting and securing the upper sash in place is adopted by many. The wood screw *B* driven through the jamb—there being a knee at each jamb—is the medium of support for the knee. There are devices almost without number patented, or on which patents have been applied for, that allow the upper sash to slide, and a fusible link attached to a chain or cable which in turn is fastened to weights either in the sash itself or weight box of the frame parts in case of fire, and the upper sash immediately slides closed. That, however, is a matter for the individual shop or designer. So long as it is permissible to keep the upper sash fixed closed it seems that the knee method should be the most acceptable, as the more complicated the closing mechanism is the less will be opportunity for mishap and danger of the window not operating at a crucial moment.

It is primarily essential that the lower sash be self-closing. The method usually employed is to fasten a chain by a heavy wire hook to the slide or filler piece *B*, Fig. 448, say 6 in. from the top rail. This hook is inserted in a hole punched into the band iron strip *A*, which, of course, is riveted to the slide piece. The chain passes over the new pulley shown in Fig. 450 and is fastened to the weight in the jamb box. This is done on one side only. The chain on the other side of the sash, instead of being fastened to the side of the sash, is extended down to the bottom of the sash and fastened to a fusible link secured to the wire hook on the band iron about midway on the slide piece of the bottom rail of the lower sash. The fusible link is placed here so that should the window be open it is more accessible to the play of the flames than if it were placed, as many do, at the top rail of the lower sash and when but one weight is released the sash will not drop with force as it would if both weights were released.

In Fig. 453 is shown the muntin or center vertical bar of the sash. Part *A* is riveted and soldered to the sash while part *B* is removable, the screw plate and muntin pin joining the two after the glass and putty is set in.

Fig. 454 shows how a sheet metal case placed between the muntin pins acts as a truss member and stiffens or reinforces the muntin. These muntins are somewhat wide and heavy. Should the sash be narrow they would appear clumsy. They should then be made as shown in Fig. 455.

The method of fireproofing windows as here described comprehends making the sheet metal frame complete in the shop, riveting and soldering all joints or miters as strongly as possible, but leaving off the outside sheet metal casings. Also, the sash are made complete and glazed in the shop when all are shipped to the job.

At the job the wood sashes are removed, then all the stops on the jambs, head and sill, also the old pulleys. The sheet metal frame is then forced into the window opening and nailed here and there. Outside casings are then put in position, the Pittsburgh seam clinched over them and the new pulley screwed in place. It is to be understood that an opening for the pully has been previously cut in the sheet metal jamb, the old hole in the wood jamb doing service as before. And, again, openings are cut as at *X*, Fig. 447, for weight pockets. It is best to have the pockets here rather than in the old position or runway, in the jambs, for the lower sash. These pockets are covered with sheet metal suitably formed and held in place by two wood screws. If required, and as shown in the diagrams, the wood subsill and lintel are covered with sheet metal.

The upper sash is now put in position, shored up

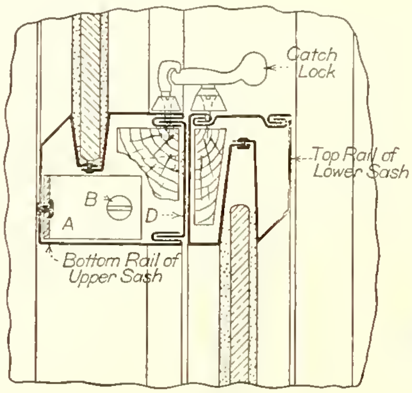


Fig. 452

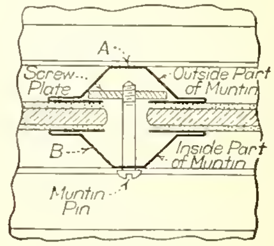


Fig. 453

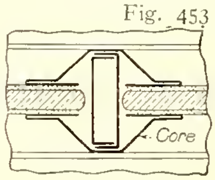


Fig. 454

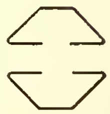


Fig. 455

Fig. 452.—Vertical Section of Meeting Rails of Sashes on Line E of Fig. 447
Fig. 453.—Horizontal Section of Muntins on Line F of Fig. 447
Fig. 454.—Core to Reinforce Muntin
Fig. 455.—Attenuated Muntins for Narrow Sash

tight to the head of the frame, and while held there the wood screws *B*, Fig. 452, are driven in. Then cover piece *D*, is put on and held by one or two wood screws as shown, and a tack of solder applied here and there on the pocket joints.

The parting bead or stop of the left hand jamb in Fig. 449 is inserted in the pocket of the jamb and securely nailed. Note the wood reinforcing core in the stops to stiffen them and to give a body for driving the nails. The chains are hooked to the lower sash, passed over the pulley and hooked to the weights—or vice versa. The inside stop is now nailed on and the job completed by attaching the hardware.

It very often occurs that the weight of the new lower sash equals the combined weight of the old upper and lower sashes, so that the four old weights will serve for the new sash. If not, they may be disposed of and new ones installed.

PART XIV

DEVELOPMENT AND CONSTRUCTION OF THE VARIOUS TYPES OF SHEET METAL SKYLIGHTS

IN taking up the developments applied to the construction of metallic skylights, it may be well to offer suggestions to the reader as follows:

All skylights should be constructed with the aim that they shall be watertight. For sash bars, curbs and ventilators, galvanized iron or sheet copper is required, the glazing to be of either hammered, ribbed or wire glass. Provision should be made for the escape of condensation, and consideration must be given to necessary allowances for expansion and contraction of the metal under the influence of changing temperature, to prevent breakage of glass. The curb or frame should be placed not less than five inches above the finished roof line. Flat skylights should have a pitch of at least three inches to the foot. Double pitch and hipped skylights should have a pitch of at least six inches to the foot or should be given the regulation pitch of eight inches to twelve inches, known as one-third pitch.

In glazing skylights make with putty a bed on rebate of the bar, to give the glass a level or even bearing, thus providing security against breakage. Allow a space of at least one-eighth inch on each side of the glass for expansion and contraction. The joints between the glass and metal bars should be covered with metallic caps and secured to the bar by copper clips or brass bolts, as was explained in the chapter on Terms and Definitions and as is considered further in the ensuing treatment.

In spacing the skylight bars in a large skylight care should be taken that the glass panes are not over eighteen or twenty inches wide and that each pane does not exceed 720 square inches in area, regardless of the size of the skylight. This is one of the regulations of the National Board of Fire Underwriters for the construction and installation of skylights, and we suggest that it will be to the advantage of the sheet metal worker to procure a copy of these regulations, obtainable on application to the National Board.

PATTERNS FOR A FLAT SKYLIGHT WHEN ROOF CURB HAS THE REQUIRED PITCH

Solution 140

Fig. 456 shows a view of a flat skylight, set on a curb already in the roof at the required pitch. Note in the lower curb under the center of each pane of glass, that small condensation or weep holes are

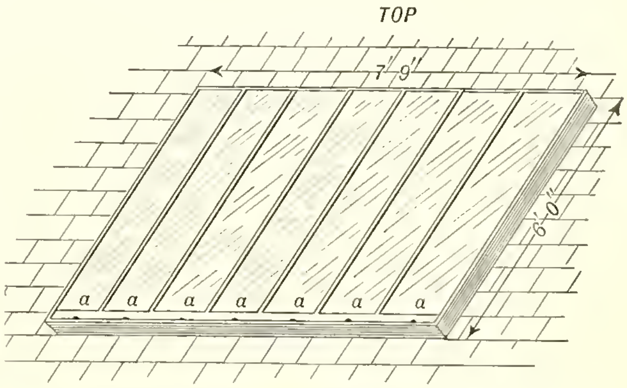


Fig. 456.—View of a Flat Skylight Set on a Pitched Curb in Roof

punched, to allow the drip to flow to the outside. The method of laying out the patterns for flat skylights of this nature is shown in detail in Fig. 457, where the skylight has been laid out in a horizontal position to facilitate development. In laying out the patterns it is necessary to make a drawing about only twelve inches long, simply to obtain the various miter cuts. The full size patterns of the required lengths can then be laid out directly on the sheet metal, employing the short miter cuts mentioned.

First, draw a sectional side view, as shown, making the formation of the top and two side curbs alike to the profile marked A. In line with this profile and at a distance of about twelve inches, draw the profile of the lower curb B. Note its formation and that the arrow indicates the position of the

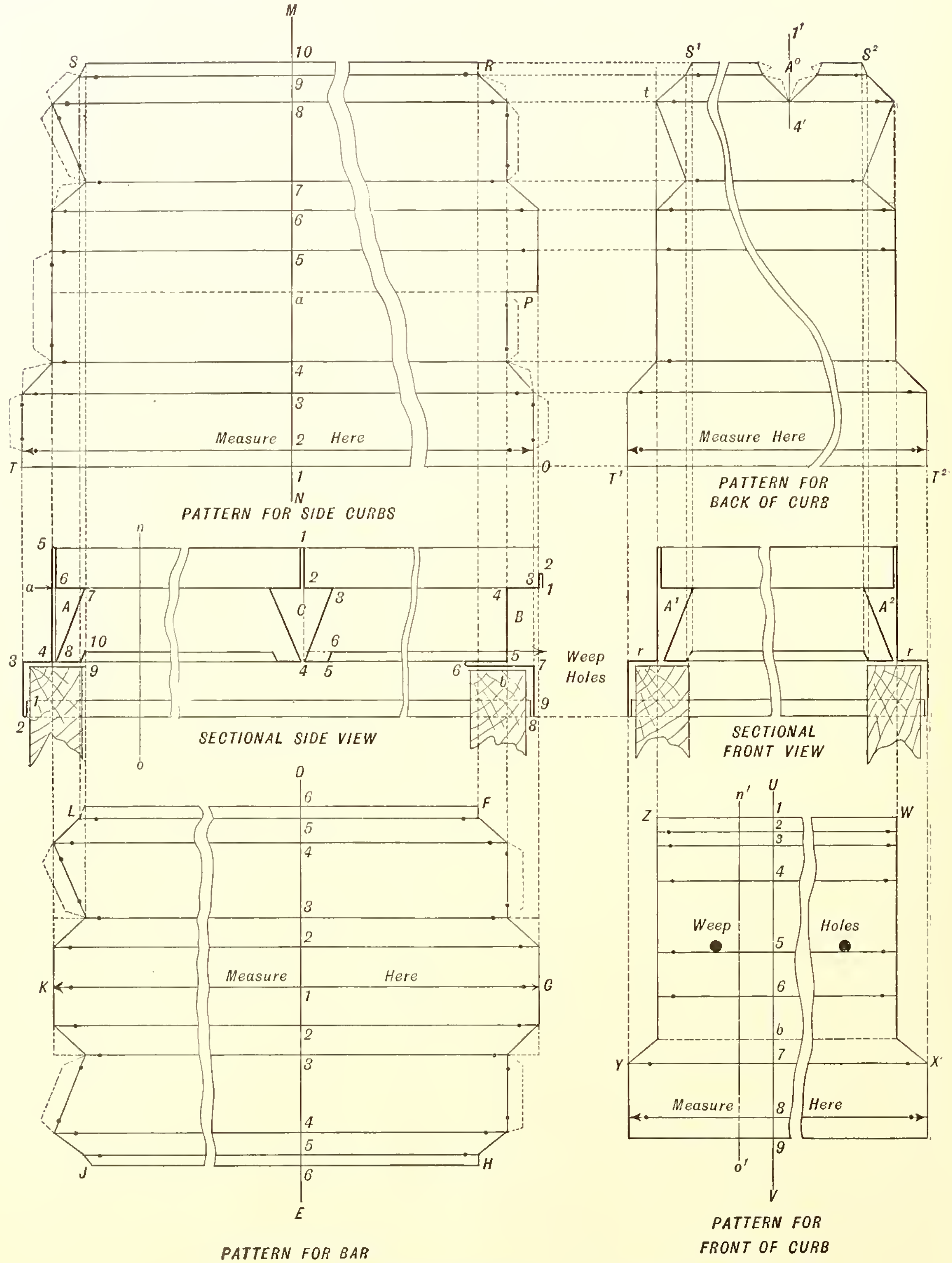


Fig. 457.—Patterns for Flat Skylight to be Set on a Pitched Curb

weep holes and the hem edge, 2-3, represents the thickness of glass. In line with the curbs A and B draw the profile of the bar marked C. This small sectional view serves the requirements for laying out all patterns, including skylights of the largest size. A sectional front view is shown which, however, is not essential in the development of the pattern but is presented only to make each step clear to the reader. It will be understood that where the runs of the rafters or bars are very long, the bars and curbs must be re-enforced to give strength and rigidity against snow and wind pressure. The construction of re-enforced bars will be considered in the progress of our treatment.

To obtain the pattern for the common bar C, number the one-half profile, shown from 1 to 6, and through this draw lines intersecting the curbs A and B, as shown. Take twice the girth shown from 6 to 1 in the profile C and place it on the vertical line D E, as shown by corresponding numbers 6 to 1 to 6. Through these small figures and at right angles to D E draw lines and intersect them by lines drawn parallel to D E from the points where the bar C intersects the curbs A and B. By following the dotted lines in the pattern the points of intersection can readily be found. Trace a line through points thus obtained. F G H J K L will be the desired pattern.

As the profile of the curb marked A is the profile for the top, as well as for the sides of the curbs, the pattern for the sides can be laid out as follows: Number the various corners in the profile A, shown from 1 to 10, and place this girth on the vertical line M N, as shown by like numbers. Through these small figures and at right angles to M N draw the usual measuring lines; intersect them by lines drawn parallel to M N from similarly numbered intersections in the profile A at the left and from the intersections in the profile B at the right, where lines drawn from 1 to 10 in A intersect the profile B; all as shown by the dotted lines in the pattern. Trace a line through these points. O P R S T will be the pattern for the side curbs, T S being the miter cut at the top and R O the miter cut at the bottom. If the girth lines drawn through M N are extended to the right and lines are projected vertically from the profiles A^1 and A^2 in the front view, the pattern thus obtained, as shown by S^1 T^1, and S^2 T^2, will be alike to the miter cut, S T, already obtained in the side pattern. Therefore the miter cut S T can be used for the top as well as for the side curbs.

The pattern for the front of the curb is obtained by numbering the corners in the profile B as shown by the small figures, 1 to 9, and placing this girth on the vertical line U V below the front view, as shown by the small figures, 1 to 9. Through these small figures and at right angles to U V, draw lines and intersect them by lines drawn parallel to U V from similar points in the profiles, A^1 and A^2. A line traced through points thus obtained, as indicated by W X Y Z, will be the right and left miter cut for the lower curb. As previously stated, the sectional front view is not essential in the development of the front or back curb patterns, since the profiles A^1 and A^2 are similar to A in the side view, and the miter cut S T in the side pattern can be used instead of S^1 T^1 or S^2 T^2 in the back pattern.

The pattern for the front of the curb may be obtained without the front view as follows:

In the sectional side view, draw any line, as *n o*, at right angles to the lines of the skylight; then, after the stretchout lines have been drawn in the front curb pattern, draw any line, as *n′ o′*, parallel to U V. Measuring from the line *n o* in the side view take the various projections to the proper points where the lines drawn from the profile B intersect the profile A and place them to the left of *n′ o′*, thus obtaining the miter cut Y Z, which is similar to the cut X W.

LAYING OUT FULL SIZE PATTERNS ON THE METAL

The arrow points marked on all patterns indicate the points from which measurements should be taken in laying out the full size patterns on the metal. Assuming that the flat skylight is to be 7 ft. 9 in. wide by 6 ft. run of bar, as shown in Fig. 456, and that the skylight is to have seven lights of glass, the various patterns are laid out as follows:

Using the pattern for the sides in Fig. 457, mark off upon the sheet the miter cut S T; then measure 6 ft. from the arrow point T to O, move the pattern over to point O, and scribe the cut O P R. Allow laps on the side pattern, as shown. Care must be taken that T O always remain on a horizontal line. In like manner lay off the pattern for the front of the curb, measuring from the arrow points below Y and X a distance of 7 ft. 9 in. taking care to place the weep holes above line 5, as shown, in the center of each light of glass. The same measurement of 7 ft. 9 in. is laid off for the pattern of the back curb, measuring from T^1 to T^2.

The length of the six common bars is obtained as follows:

Proceeding with the curb measurement as 7 ft. 9 in. and assuming that the shoulders 3-4 in A in side view and 5-7 in B each measure one inch or a total of two inches, we have 7 ft. 9 in. less 2 in which equals 7 ft. 7 in. Assuming that the distance 4-3 in profile B is 1¼ in., then 7 ft. 7 in. plus 1¼ in. equals 7 ft. 8¼ in., the length of the bars from the arrow points K to G in the bar patterns. Allow laps where indicated by the dotted lines.

As the condensation gutter of the bar C in the side view miters with the condensation gutter of the upper curb A, it will be necessary to obtain the miter pattern in the gutter of the curb A as follows:

In the pattern for the back of the curb draw any vertical line, as 1′-4′, as shown. Measuring from the line 1-4 in the profile C in the side view take the horizontal projections to points 6 and 5 and place these distances on either side of the line 1′-4′ in the back curb pattern on similarly numbered lines, as shown, thus obtaining the miter cut A°, as indicated. To this miter cut laps are allowed; they miter with the cuts L and J in the pattern for bar.

The distance that the cut A° should be spaced in the pattern for the back is computed as follows:

The width of the top is 7 ft. 9 in. less 2 in. for the shoulders *r* and *r* in front view, leaving 7 ft. 7 in. or 91 in. As the skylight is to have 7 lights, as shown in Fig. 456, 91 in. divided by 7 gives 13 in., the space between the bars *a a*, etc. This represents the distance sought from the corner *t* to the center 1′-4′ in the pattern for back in Fig. 457. The rule applies to a skylight of any size and to curbs of any shape.

CONSTRUCTING LARGE SINGLE PITCH SKYLIGHT AND THE METHOD OF FRAMING AND RE-ENFORCING THE BARS

Solution 141

For the development of large flat skylights the method of obtaining the various patterns is alike in principle to that considered in the preceding problem. In this case we will assume that a single pitch skylight, whose size is 20 ft. x 20 ft., as is indicated in Fig. 458, is to be constructed. We will indicate methods by which the bars may be reinforced and a watertight joint obtained between the panes of glass.

The dotted lines in the elevation, as indicated by *a a* and *b b*, show the rafters which should run through underneath the skylight, the width of the skylight being spaced in three equal parts, so that the beam will not come below a light of glass and thus throw a shadow. The skylight has been spaced for fifteen lights of glass, each 16 in. wide, thus bringing a skylight bar directly over the center of the beams *b b* as shown, but making the width of the end lights only 14½ in. each, because the

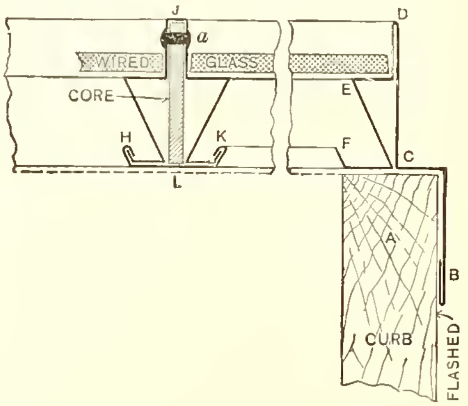


Fig. 459.—One-fourth Full-size Section

shoulder C in Fig. 459 takes up 1½ in. of space. As the length of the glass required will be 20 feet, as shown in the section in Fig. 458, this space should be divided into three equal parts, as shown by *c d*, *d d* and *d c*, and cross beams placed in position, on which the cross bars can rest, as shown also by *i i*

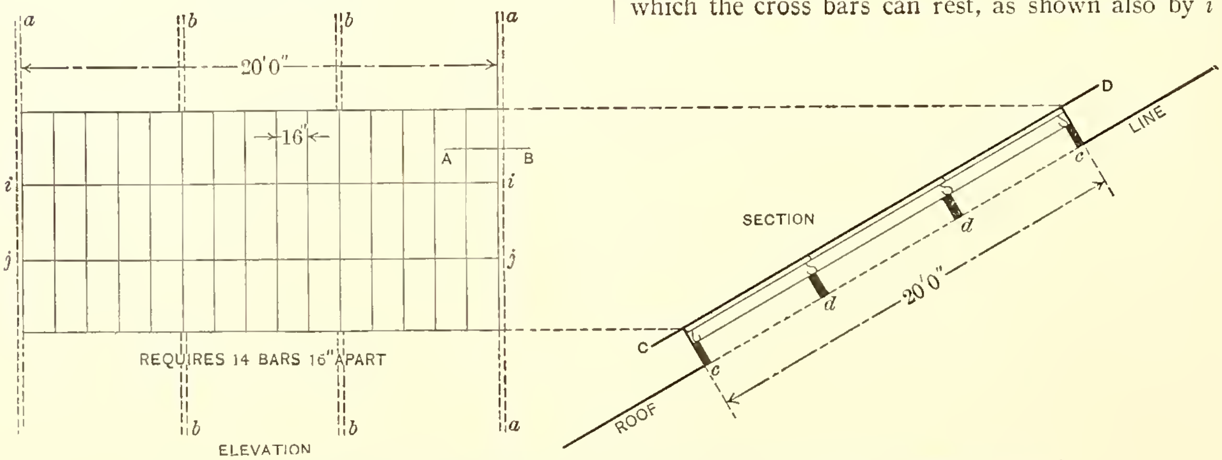


Fig. 458.—Section and Elevation of Single Pitched Skylight Showing Framing Required

and *j j* of the front elevation, while on the curbs *c* and *c*, the frame of the skylight can rest.

If the regulations of the Board of Fire Underwriters are followed, the spaces *cd*, *dd* and *dc* in the section will again be divided by a cross bar, to bring the area of each light of glass within the regulation area required, namely 720 sq. in.

It is important that not less than two beams be placed lengthwise and two crosswise under the skylight, which, in addition to the re-enforced core plates in the bars, will take care of the snow and ice load as well as the wind pressure.

In giving the details of the skylight, one-fourth full size sections are shown, which will need to be enlarged four times to obtain the full size detail. Thus in Fig. 459 is shown a one-fourth full size section through the skylight bar and curb on the line A B of the elevation in Fig. 458. A in Fig 459 represents the wood curb, which is flashed before the skylight curb is set over it. The metal curb is formed up in one piece from B to C to D to E to F. This formation brings the half bar C D E F directly upon the center of the wooden curb, as shown. The skylight bar is formed as shown by H J K, in which the iron core plate is riveted as shown at *a*. When the core plate is in position, the bottom of the condensation gutters is re-enforced by the metal plate K L H, locked at K and H as shown. This makes a rigid bar, which is secured to the upper and lower metal curbs *c* and *c* in the section in Fig. 458, the bottom of the bar resting upon the two cross beams at *d* and *d*. Where the skylight bar rests on the rafters *b b* in the elevation, they are, if made of wood, chamfered on each side as indicated by *a* and *a* in

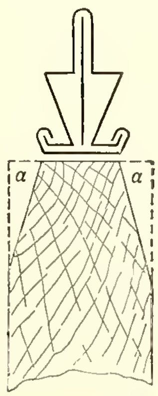


Fig. 460.—Chamfering the Wood Beam

Fig. 460. This makes a neat appearance from below and avoids shadows. If the framing of the building is of iron, then the side curbs are set on angle iron construction as indicated by A in Fig. 461, the rafters shown by *b b* of Fig. 458 and the cross beams *d d* in the section being then of iron, I shaped, as shown by B in Fig. 461.

A one-fourth full size section through C D of Fig. 458, showing the lower and upper curb as well as the cross bar or clip, is shown in Fig. 462, in which A and B show respectively the lower and

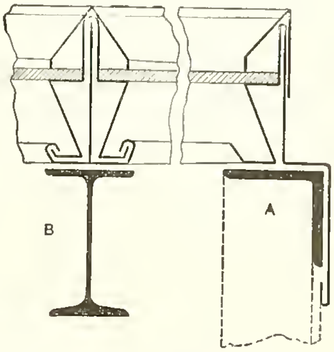


Fig. 461.—Setting Skylight on Iron Construction

upper wooden curbs. The formation of the upper curb is indicated by C D E F G and the lower curb by H J N K L M, both being similar to the curb shown in Fig. 459. By making the four sides of the curb alike, only one miter pattern is required and all four sides are formed up similar, excepting the lower curb in Fig. 462, which is bent down at N, a distance equal to the thickness of the glass in use, as indicated, thus bringing K in the position shown by K^1, which also answers as a drip. In the lower curb, copper condensation tubes are placed in the center of each light as indicated by *c*; these tubes are about ¼ inch in diameter, soldered water tight at *b* and extending beyond J of the curb on the outside.

P, represents the section of the common bar shown also in Fig. 459, and is shown in Fig. 462 so as to indicate how the cross bar R miters to the common bar. Attention is called to the formation of this cross bar, which is as indicated by S T U V X. The groove between S and U is made wide enough to allow the glass to slip in, well bedded in putty, and the flange T S acts as a cap flashing over the glass. The upper glass sets against the edge T and the shoulder V, also well bedded in putty. Should a leak occur in the cross joint, the water will drip into the condensation gutter, *f*, then follow into the gutter of the bar P at *a*, and in turn, follow along the gutter of the bar P, into the gutter of the lower curb at *b*, then out on the roof through the copper tube *c*.

CROSS-BAR FOR MAKING WATER-TIGHT CONNECTION BETWEEN PANES OF GLASS

Solution 142

The method of obtaining the pattern for the cross bar R in Fig. 462 is illustrated by the diagram in Fig. 463. Here A and A show the profiles of the two common bars, against which the cross bar B is to miter. The construction of this cross bar and its operation is alike to that already taken up and illustrated in Fig. 462, the pattern is developed as shown in Fig. 463.

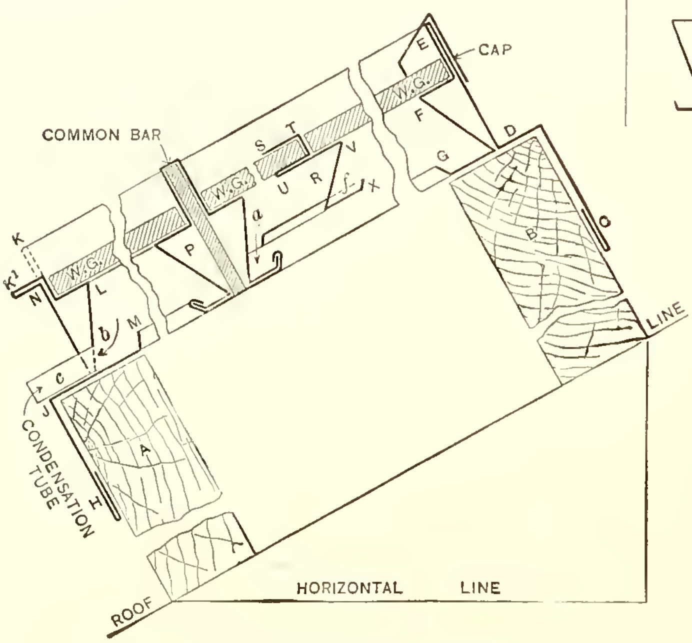


Fig. 462.—One-fourth Full-size Sections

Draw any vertical line, as C D, upon this place the girth of the profile B, as shown by similar numbers, 1 to 8. Through these small figures 1 to 8 draw lines at right angles to C D; intersect them by lines drawn parallel to C D from similarly numbered intersections, 1 to 8, on the bar A, which were previously obtained from the profile B of the cross bar. A line traced through points thus obtained, as shown by E F, will be the required cut; this is also used for the opposite side.

The method of laying out the cross bar is as follows:

As the main bars are 16 in. apart, as shown in the elevation in Fig. 458, use the miter cut in Fig. 463 and make the distance from the arrow point E to the opposite side 15⅞ in., using and reversing the same miter cut E F, allowing ⅛ in. less in length, in this case, for the thickness of the bars or core plates used. Any leakage from the cross bar B will follow the gutter along *a a*, draining in the main bar at either side, as shown by the arrow.

Glazing the Skylight and Securing the Caps to the Bar

In glazing a skylight of the kind shown in Fig. 458, the rabbets of the bars should be laid with soft putty, then the glass well bedded in. The surplus putty on the inside is cut off with a putty knife, while

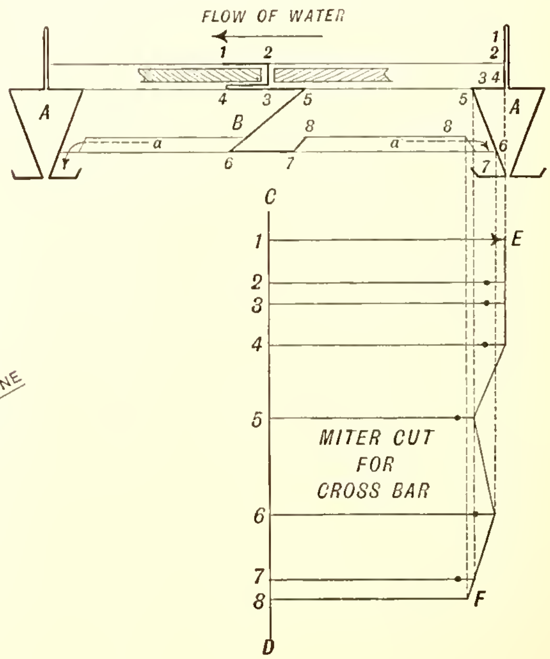


Fig. 463.—Pattern for Cross Bar

that on the outside is smoothed out and capped with metal capping, two styles of which are shown in Fig. 464. The first is by means of the copper clip,

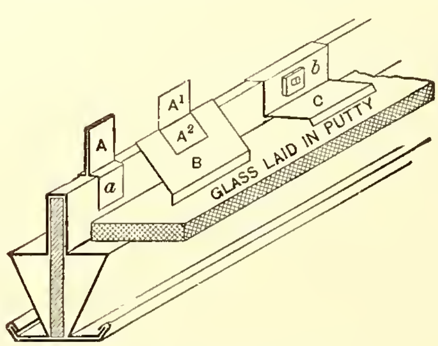


Fig. 464.—Securing the Capping

shown by A, which is soldered on each side at *a*. The cap is formed V shape, as indicated by B, in the top of which slots are cut, through which the copper clip passes, as shown by A^1. The folded edge at A^1 is then cut off and the clip turned over, one right and the other left, as shown by A^2. The cap can also be formed as shown by C. With this style of cap, holes are punched alternately with the rivet holes in the core plate and the cap fastened to the bar through these holes by means of brass bolts and nuts, indicated by *b*. By the use of brass bolts and nuts the nut can be easily removed if a new light is to be inserted, whereas an iron bolt would soon become tight from rust.

Skylights of this size are constructed direct on the framing at the building, planks laid upon the cross beams being used to obtain a footing.

ROLLING TOP THEATRE STAGE SKYLIGHT

Details Showing Construction as Required by the National Board of Fire Underwriters

Solution 143

In the construction of the theater stage skylights the specifications given by the Board of Fire Underwriters must be followed by the sheet metal worker. There are two types of these skylights. The first is known as the counterbalanced sash. This has two sashes hinged to the outer edges of the curbing or frame, which should be hipped shape, allowing the upper edges to come together when the sashes are closed and arranged in such a manner that one side of the skylight is provided with an overhanging lip or batten to keep out the rain, snow and sleet.

Each sash must have extension bars or angles at the lower hinged edge, projecting beyond the curb for a distance not less than the width of the sash, and to these bars weights not less than 50 per cent. heavier than the weight of the sash should be securely attached. The hinges must be of heavy brass bolted to the sash and curb and set well back from the edge of the frame. These weights at the bottom of the sashes permit the skylights to open when the cords which hold the skylights together at the ridge are loosened.

The second type of skylight, which is illustrated in Fig. 465, and described herewith, consists of two rolling sashes, fitted with brass wheels not less than 2½ in. in diameter and set inside of the outer edges of the sash and well secured to the angle iron frame of the skylight sash. The wheels roll on hard brass tracks properly secured to the angle iron curb, extending the full width of the skylight beyond the frame or curb and fastened to the roof. The frame is made preferably to pitch both ways and the slope should be sufficient for the sash to be inclined at an angle of not less than 30 degrees. The hight of the roof curb should be such that the lowest por-

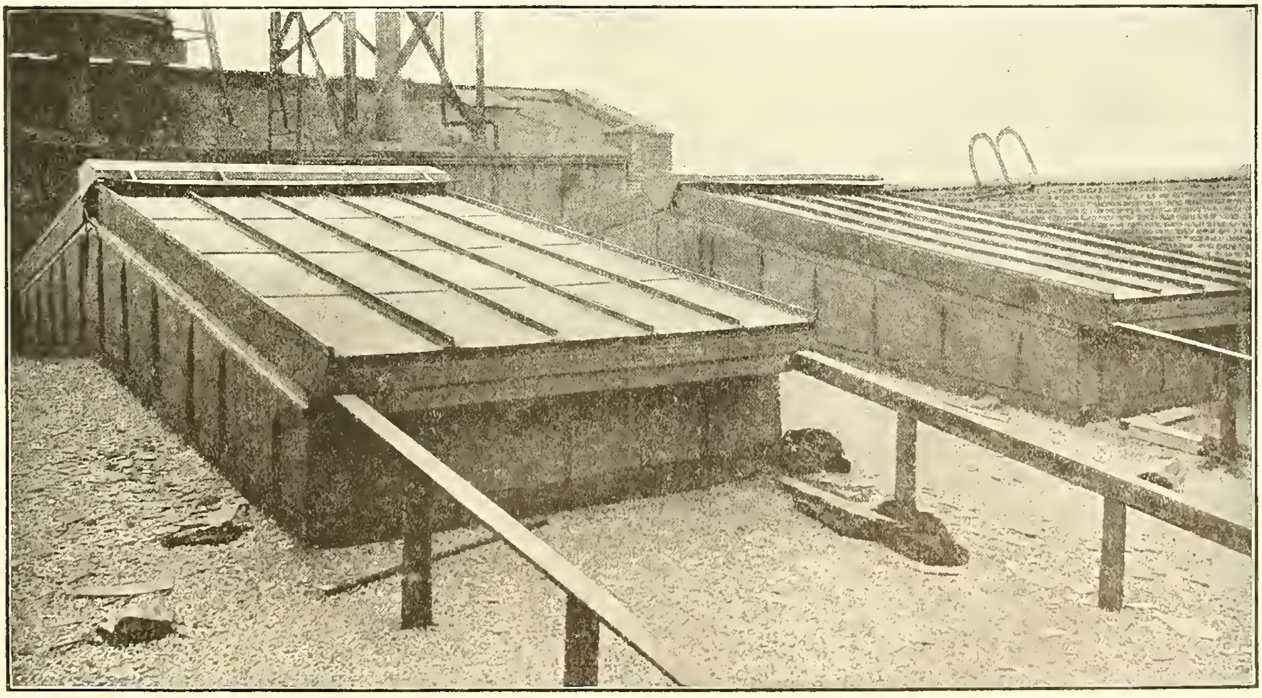


Fig. 465.—View of Two Rolling Type Stage Skylights

tion of the brass tracks will not be less than 12 in. above the roof, as indicated from *W* to *E* in Fig. 466.

A one-half sectional view of the rolling sashes is shown here; in this view *A B* represents the finished roof line and *G F B J* the half opening over the theater stage, constructed of angle iron with fireproof block fillings. The hight of the uprights from *F* to *G* must be such that the distance from *W* to *E* is not less than 12 in. when the pitch has an angle of 30 degrees. The length of the angle iron track frame *E X* must equal the length of the sash *H J* so that the entire opening of the shaft over the stage will be uncovered when the sashes are run down. The skylight illustrated had a pitch length of 7 ft. 6 in. and was 13 ft. 6 in. wide, thus giving an approximate opening over the stage of 13 ft. 6 in. x 14 ft.

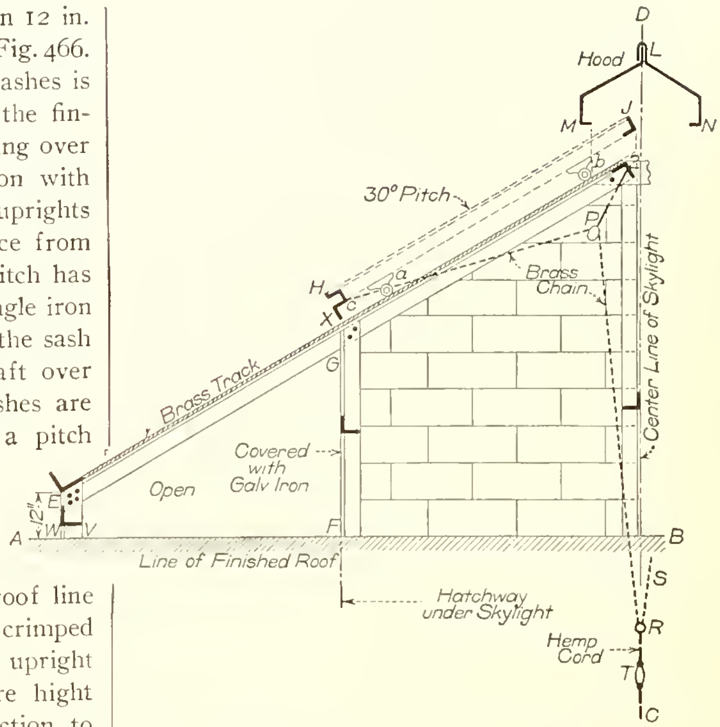


Fig. 466.—Half-sectional View through Rolling Skylight

The four sides of the walls of the curb were flashed with copper 8 in. above the roof line and the side walls covered with 24-gauge crimped galvanized iron. The angle iron *V* of the upright track support *W E* was flashed its entire hight with copper to make a water-tight connection to the roof. The brass track was run down the full length of the track frame from *b* to *E*. The bronze rollers which roll down the track when the cords are released are indicated by *a* and *b*. *E* being the guard against which the lower angle of the skylight *X* stops.

Sometimes the angle *E* at the bottom is fitted with steel buffer springs to take up the shock and prevent breakage of glass when the sashes are opened by being allowed to run down in case of fire or for cleaning purposes. When the two sashes of the skylight are closed they join at the ridge at *J*, over which a stationary ventilating hood is placed. This is formed to correspond to the pitch of the sash as indicated by *M L N*, and is made with a standing seam 2 in. high at *L* to give rigidity to the hood. This hood is fastened to the side walls and the heads come down a good distance at the side walls to secure rigidity. This hood also acts as a ventilator, as ventilation is possible between the two angles of the skylight at the ridge, the one angle being shown by *J*. By having the hood come down a good distance over the ridge leakage is avoided.

To conform with the requirements of the Board of Fire Underwriters, the skylight should be made in sub-divisions approximately 18 in. wide, glazed with single thickness sheet glass, with weather laps not less than 2 in., and should be putty set. By weather laps is meant that the glass panes should overlap one another a distance of 2 in., thus dispensing with the cross bars. Each pane of glass should measure not less than 300 sq. in. and should not exceed 720 sq. in. in area.

The operation of the skylight is as follows: A brass pulley, *P*, is fastened to the angle iron roof frame at 2. Through this pulley a brass chain is passed and secured to the lower angle of the skylight curb *c*. The chains must be of sufficient length to allow the skylight to open to the full width and are joined to one ring at *R*, from which a ⅜ in. cotton or hemp rope is attached to a fusible link at *T*. A chain can be continued from *C* to hold the skylight in position. The brass chain from the opposite side

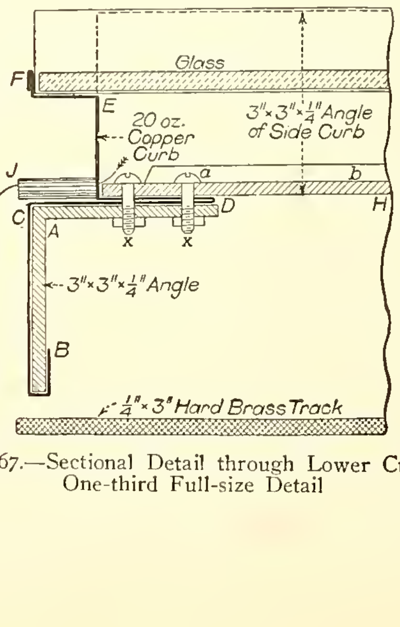


Fig. 467.—Sectional Detail through Lower Curb—One-third Full-size Detail

of the skylight not shown is indicated by *S*. In case of fire, the cord can be cut or the heat will melt the fusible link, which releases the two skylights, when they roll down the track to *E*, and open the entire hatchway.

The details showing the construction of the various curbs, bars, storm cap, rollers, tracks, angle iron framing, etc., are shown one-third full size or to a scale of 4 in. to the foot. While the sectional view shown is drawn at an angle of 30 degrees, the details are shown laid horizontally. A sectional detail through the lower curb is shown in Fig. 467, *A* indicating the 3 x 3 x 1/4 in. angle iron over which the copper skylight curb is formed as shown by *B C D E F*. The angle iron of the side curb *H* is bolted to the lower angle *A* at *X X*. These bolts are loosened to admit the double flange of the metal curb *D*, after which they are fastened down again.

Between each pane of glass a copper condensation tube is placed as indicated by *J*. This drains the condensation or leakage from the skylight bar gutter along *b a*. A good size rabbet or glass rest is provided from *E* to *F*. The hem edge at *F* should never be higher than the thickness of the glass in use; if too high it holds the water.

Fig. 468 presents a sectional detail through the upper curb, showing the ventilating hood, also the formation of the ridge curb *B C D E*. The angle iron of the side curb bolts to *A* of the top curb at *a* and *b*. After the glass has been putty set, the cap covering the putty joint is bent as indicated by *F G H* and is bolted through the angle iron as shown by the brass bolt *J*, holes being punched into the angle before being covered with copper. By using brass bolts for this purpose the thread of the bolt will not rust through the action of the weather and the bolt can be released in case of glass breakage. The one-half ventilating hood is indicated by 1 2 3 4, the standing seam at 4 not being shown. Note the formation of the hood at 1 2 for stiffening purposes.

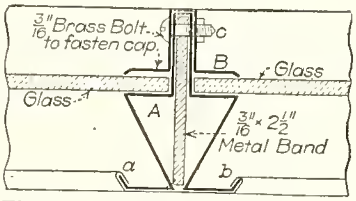


Fig. 469.—Sectional Detail through Common Bar

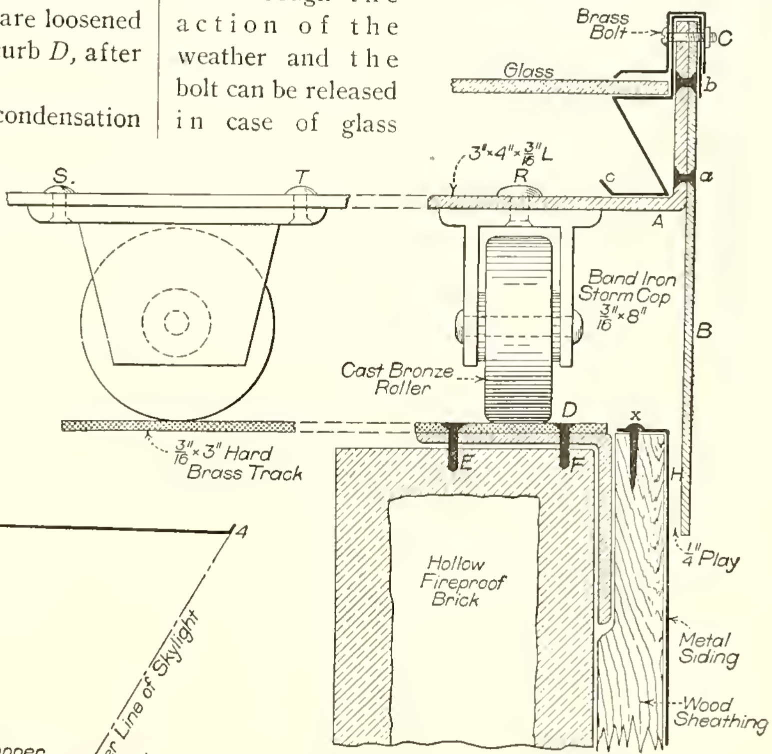


Fig. 470.—Sectional Detail through Side Curb, Showing Bronze Roller and Brass Track—One-third Full-size Detail

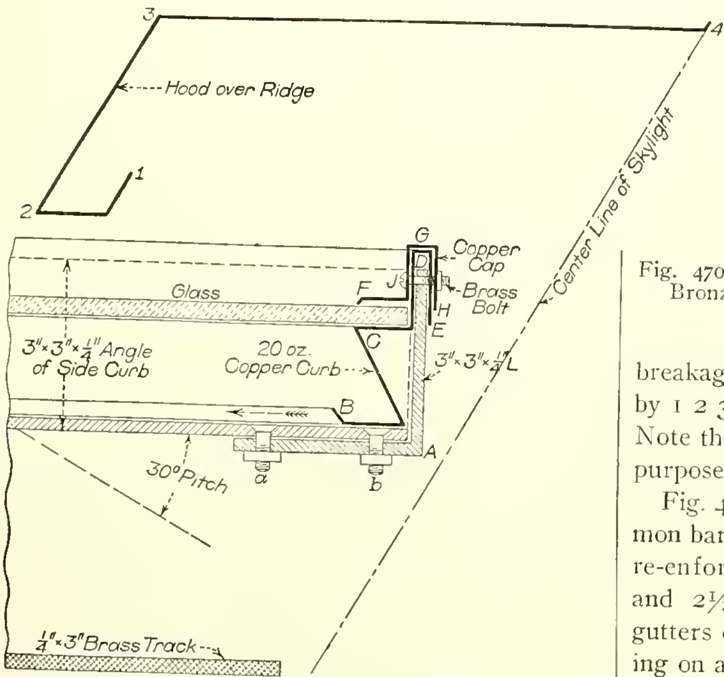


Fig. 468.—Section through Upper Curb—One-third Full-size Detail

Fig. 469 shows a sectional detail through the common bar. It is formed in once piece as shown, being re-enforced with a metal band core *A*, 3/16 in. thick and 2 1/2 in. wide as shown. The condensation gutters of the bar are further strengthened by locking on a separate metal strip indicated by *a b*. The copper capping *B* is secured through the core plates by the brass bolt *c*. These core plates are punched at intervals of about 20 in. and through them the brass bolts are placed.

Fig. 470 is a sectional detail through the side curb showing the construction of the bronze rollers and the hard brass tracks. After the wood sheathing has been secured to the hollow fireproof bricks it is covered with sheet metal, turned over at the top and nailed at *X*. The hard brass track *D* is now fastened to the angle iron roof curb at intervals of 18 in. with flat head machine screws shown by *E* and *F*. The end and side views of the bronze rollers are shown riveted to the angle *A* of the skylight in its proper position at *S* and *T* and *R*. These rollers are cast 1 in. thick with a ½ in. diameter axle. Before the copper curb *b c* is fitted over the angle iron frame *A*, the storm cap *B*, made of 3/16 in. x 8 in. band iron or of a size wide enough to cover or form a cap over the curb, as shown, is riveted to the side angle at *a* and *b* at intervals of 2 ft. or less, holes having been previously punched for this purpose, and also to receive the brass bolt *C* to secure the capping as previously described.

When the angle iron frame *A* and the storm cap *B* are being fitted, care must be taken to allow a play of ¼ in. at *H* to allow the rollers to work without any friction caused by the storm cap rubbing against the metal siding. The band iron storm cap here described makes a first-class job. If a cheaper construction is desired, one can be had by using, instead of the band iron storm cap *B*, a rubber or canvas storm check, lead weighted at the lower edges and fastened as before at *a* and *b*.

The Board of Fire Underwriters also requires that under the entire glass surface a protection of woven galvanized wire, 8 to 12 gauge, of diamond pattern mesh 1½ x 1½ in. be arranged in frames, to give protection against falling broken glass, and so that these protective screens can be taken out from below to give access to the glass for cleaning. Fig. 471 shows the arrangements made to receive these protective wire screens. Angle irons ⅛ x 1 x 1 in. in size were bolted at intervals to the angle in the side skylight curb at *B B*, and on these 1 in. angles the wire screen were laid as shown b *C C*.

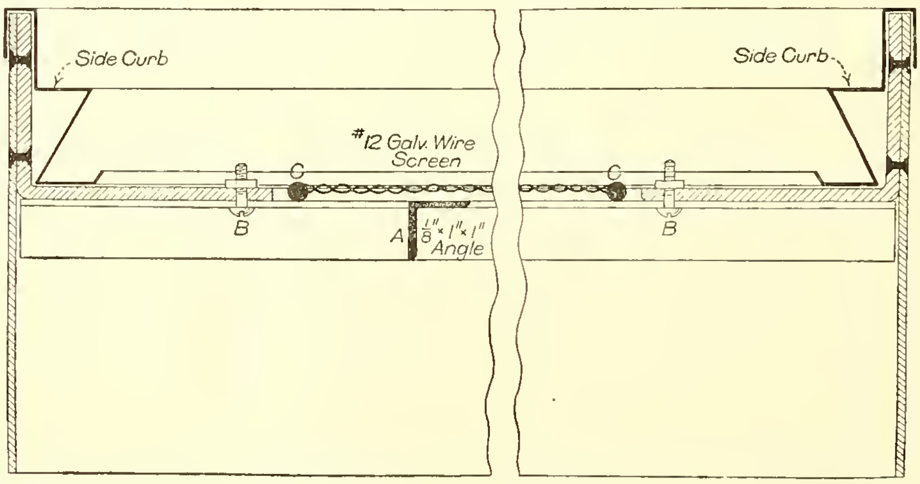


Fig. 471.—Method of Securing Protective Wire Screens under Skylight—One-Third Full Size Detail

This type of construction has given satisfaction in practical work and may be recommended. The development of the various pattern shapes does not differ in method from those already described under the section on Flat Skylights.

CONSTRUCTION OF A VENTILATED MARQUISE

Structural Details of a Copper and Wire Glass Marquise Erected on an Apartment House

Solution 144

The structural details of a marquise in which provision for ventilation has been made where it is attached to the wall of the building, are shown in the accompanying illustrations. The marquise, which is an example of construction that has taken place is 27 ft. 6 in. long, and was erected on an apartment building. In Fig. 472 is reproduced a photographic view of the marquise, and in Fig. 473 is given a scale drawing of it. In its construction angle iron, sheet copper and wire glass were employed. The arrangements for ventilation are shown in the construction details in Fig. 474.

In this case the entire framing of angle iron was erected by the iron contractor and it remained for the sheet metal worker to construct the ventilating hood as well as the copper gutter and moldings under the sheet copper skylight. The glass was laid on inverted T bars. Particular attention is requested to the constructional details.

It will be noted that the ridge curb is secured to the brick wall at the top by means of expansion

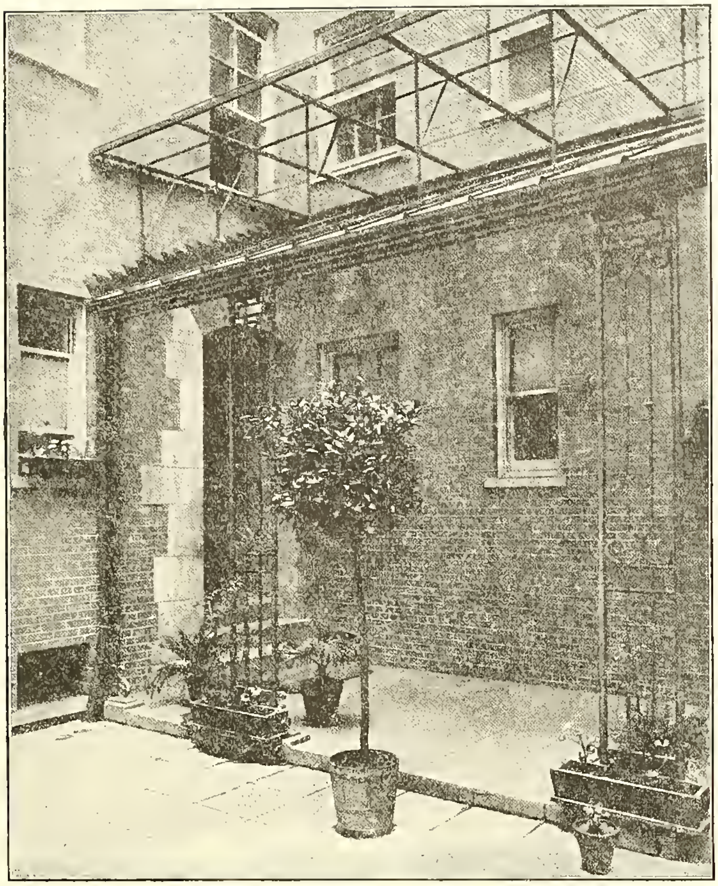


Fig. 472.—View of Marquise

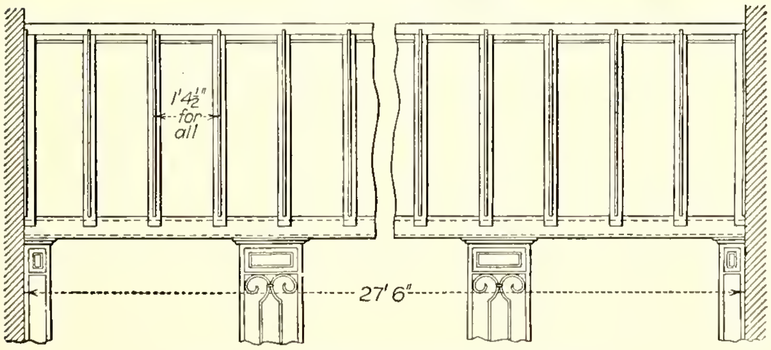


Fig. 473.—Front Elevation of the Marquise

bolts. The lower support or channel is bolted to the ornamental uprights as shown. Around this iron construction sheet copper was placed. The outer cornice *A* was formed as shown, flashed under the channel at *B* and with a flange at *X*. Inside of this cornice a gutter was laid hollow and was formed to shed the water as shown by C D E. After the gutter was set the flange *X* was turned down, as indicated by the arrow.

On the lower inner side of the marquise an ogee mold was placed to make a finish. This was flashed under the channel as at *G*, and covered the top by turning down from *H* to *J* before the gutter lining was set.

To hide the ridge angle and make a neat finish at the top or under side of the marquise, a mold was placed from *L* to *M*, and flashing employed in the brick joint at *M*.

To ventilate the under side of the marquise a three-inch opening was left along the entire length as shown, with a glass pocket and copper catch formed in the shape shown by *N O P*. The copper was doubled over at *O* and stiffened with a wire edge at *P*. To avoid leakage a copper hood was formed, as indicated by *R S T*. This hood was fastened as shown, and had a ⅜-inch rod running throughout the front edge the length of the marquise. The top of the hood was placed under the stone sill, which had a drip cut in it to prevent the water from following its bottom. Ventilation was thus secured as indicated by the arrow.

Before the wire glass was put in position a sheet lead cap, *F* was set over the edge of the angle iron so that the glass had a snug rest.

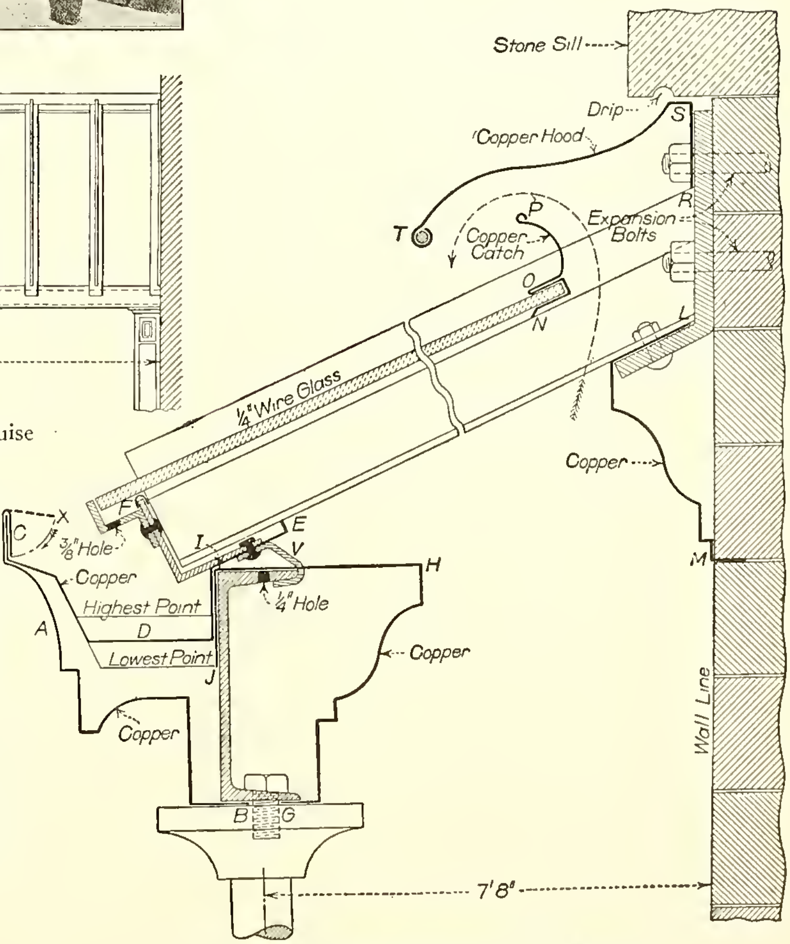


Fig. 474.—Structural Details of the Marquise

The skylight bars were of inverted *T* iron design, made of rolled steel. The clips used in fastening the lower angle curb or glass rest are shown in the illustration at *V*.

From Fig. 472, it will be noted that an angle iron guard was erected to protect the glass in the marquise. The frame supporting the wire mesh was constructed of angles and tees 1½x1½x¼ in. in size. The uprights were made of angles with inverted tee cross bars placed at the top and in these inverted tee irons the wire was laid.

This construction is equally suggestive and applicable in that it is representative.

CONSTRUCTION OF SKYLIGHT OVER PHOTOGRAPHIC STUDIO

Solution 145

Fig. 475 shows a type of skylight for erection over a photographic studio. It is an example taken from work successfully executed and is treated as from

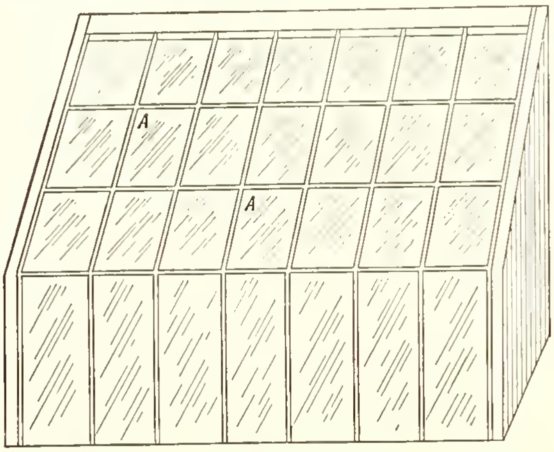


Fig. 475.—A Skylight for a Photographic Studio

the original subject since its design and construction are representative of and applicable to studio skylights of any dimensions.

It is essential in designing a studio skylight to give it the proper pitch or angle and if it be possible to have it facing to the north for securing the most favorable light.

This type of skylight should have two pitches. Figure 476 shows the angles usually employed and those that have given good service in the past. The base of the skylight should start about 3 ft. above the floor line as shown from A to B and from B it should slant at an angle of 10 degrees to the perpendicular, as shown from B to C.

The hight of B C will depend upon the hight of the studio.

In this case the hight of the studio was 10 ft., and the first pitch from B to C was made at 6 ft., or 9 ft. above the floor line, from A to C, thus bringing C, 1 ft. below the ceiling line of the studio. From C the upper skylight has a slope of 35 degrees, as

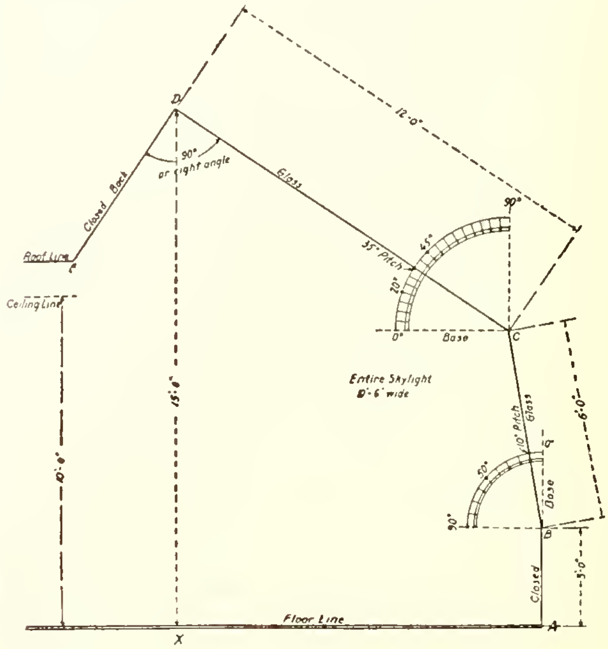


Fig. 476.—General Layout of a Photographic Skylight

indicated, and runs back 12 ft. from C to D, with a closed back placed at right angles to C D down to the roof line as shown at E. This brings the extreme hight of the skylight at D 15 ft. 6 in. above the floor line at X.

The width of the skylight as well as the hight of the front light B C and the depth of the top light C D, is, of course, regulated according to the width, hight and depth of the studio, respectively. This skylight was made 126 in. wide, divided into seven lights of 18 in. each.

After deciding on the size and pitches of the skylight, the constructive features are next in order. They are shown in Figs. 477 to 482 inclusive. These parts can be changed to suit conditions. It is seldom that two shops will use the same methods of construction, and the shapes of bars, curbs, etc., vary.

The accompanying illustrations show one of the many styles of bars and curbs in use. Where the run of the rafters is long they are usually reenforced and cross bars are inserted between them when the glass is put on in sections.

In Fig. 477 is shown the constructive section of the skylight at B in Fig. 476. Here we have a main cornice with a gutter, Fig. 477 the lining of which is locked in the main cornice at A to allow for ex-

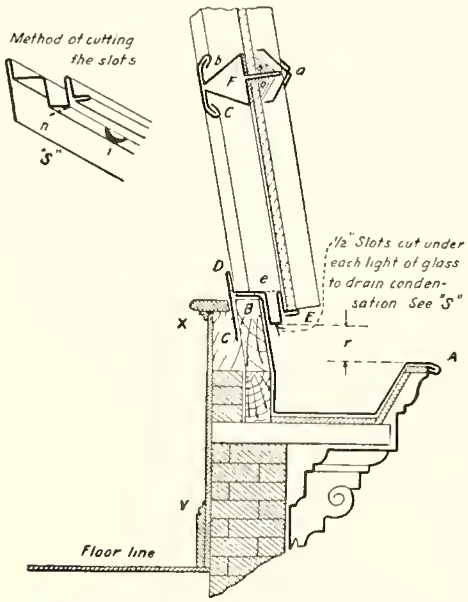


Fig. 477.—Constructive Section of Skylight at B, Fig. 476

pansion and contraction. The lining is carried up over the wood skylight frame at B. Over this frame B the lower metal curb of the skylight is placed. Note the formation of the curb from C to D to E. To allow for the escape of the condensation a gutter is bent below *e*, which catches the drip, and discharges it to the outside through ½-in. semi-circular slots cut below each light of glass at the bottom of the condensation gutter indicated by the arrow. Diagram S shows how these slots are cut.

A semi-circular cut is made with the small chisel or die, as shown at *i*, and this part is drawn downward as indicated at *n*, just enough to let the drip, if any, run out and keep the driving rain or snow from blowing in underneath.

The common rafter F also has condensation gutters at *b* and *c* which come down in front of the guard D and discharge any drippings in the gutter at *e*. In mitering the bar or rafter F to the curb, the bar should not enter the gutter at *c*, but should miter across the gutter as shown by the dotted line at *e*. Care must be taken that the top of the main gutter A is always lower than the bottom of the condensation gutter, as indicated between the arrows at *r*, to avoid any water entering the building should the main gutter overflow at any time.

The glass should be well imbedded in white lead putty on the rabbets of the bars, as shown by *o o* in F, and then capped with a metal cap and cleated as shown at *a* in this same illustration.

After the curb is set the inside wall can be completed as shown by *X Y*, providing sufficient wood work on which the light and dark rolling shades can be secured.

At the intersection between the two skylights at C in Fig. 476, a simple watertight curb can be con-

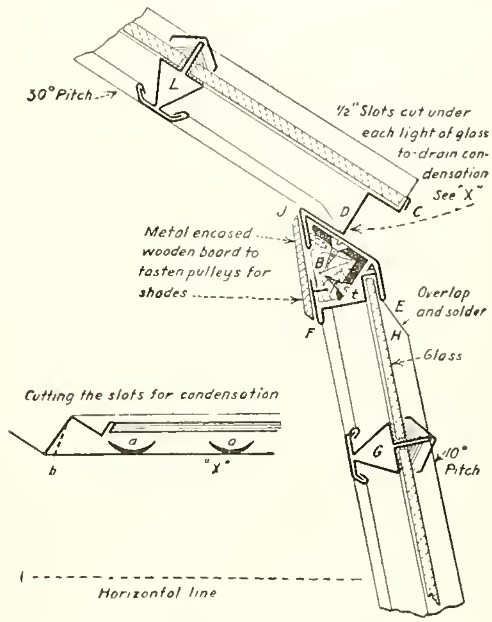


Fig. 478.—Constructive Section of Skylight at C, Fig. 476

structed as shown in Fig. 478. To support this curb an angle or channel iron must be run across the entire width of the skylight as indicated by A, the angle being placed at right angles to the upper or 35-degree pitch. Before this angle iron is encased with sheet metal a few holes should be punched in it to secure the wood blocking B by wood screws, as shown.

Proper measurements of the angle iron are now taken and the curb formed, as shown from C to D to J to E to A to F. Note that the metal is turned downward at J, which hooks on to the angle iron and prevents the upper skylight from sliding, and can be clinched around the angle iron, as shown by the dotted lines, while a solid bearing is obtained for the bars resting on the angle iron at D. Note the formation of the groove at A, into which the glass is placed, the overlapping cap E, making a weather tight joint.

In forming the groove A it is so arranged that the left corner *t* lies against the angle iron and forms a rigid construction for the glass rest. At the bottom of the condensation gutter at D semi-circular slots are cut, as previously explained, and as shown by *a a* in diagram X. The extent to which these slots are turned away from the body is shown by *b*—just enough to allow the drip to run through and still keep out the driving rain and fine snow.

The profiles of the rafters at the bottom and top respectively, with their capping in place, are shown by G and L. The gutter of the bar L is notched off at D to allow the drip, if any, to flow into the curb gutter.

Where the bar G miters with the curb E A F at E, the standing edge of the bar is cut off at an angle, as shown at H, which is capped and soldered watertight.

To make a finish on the inside a wooden board covered with sheet metal is secured to the wood blocking B. This provides for securing pulleys for

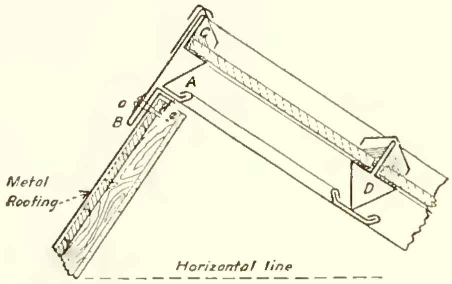


Fig. 479.—Constructive Section of Skylight at D in Fig. 476

rolling shades, etc. Fig. 479 shows the constructive section of the skylight at D in Fig. 476. The back of the skylight shaft being closed, it is covered with metal roofing, as shown in Fig. 479, and flashed up to the top and nailed at *e*. The formation of this half bar curb is indicated from A to B to C. It is locked together at A. This profile is used at the top, as well as along the sides of the skylight. The rafter D miters at A, thus conveying any condensation to the lower gutter.

The half bar is capped and cleated as indicated at C, and the lower cap flange B of the curb is secured to the back frame by means of brass screws and lead washers at *a*.

Referring to the photograph in Fig. 475, it will

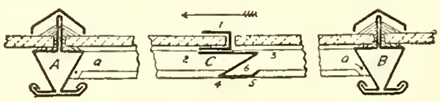


Fig. 480.—Section of Cross Bars Shown at A in Fig. 475

be noted that the 12 ft. run of the top skylight was divided into three panes, and where the joints take place, special formed clips or cross bars were placed at A, A, etc.

The method of constructing these cross bars is shown in Fig. 480. Here A and B represent the profiles of the common rafters and C the profile of the cross bar. Note its formation from 1 to 2 to 3 to 4 to 5 to 6, the line 2 3 being in line with the lower line of the glass. Note that the bottom of the cross bar comes slightly above the top edge of the condensation gutters of the common bars.

The water running in the direction of the arrow will require the cross bar to be placed in the position shown, with the lower glass slipping into the groove between 1 and 2 and the upper light setting on rabbet 3. Should any leak occur at 3 it will drain into the gutter 6, then run out at *a a* into the gutters of the rafters A and B.

Where the length of the rafter is over 6 ft. it is advisable to re-enforce the bars with core plates, as

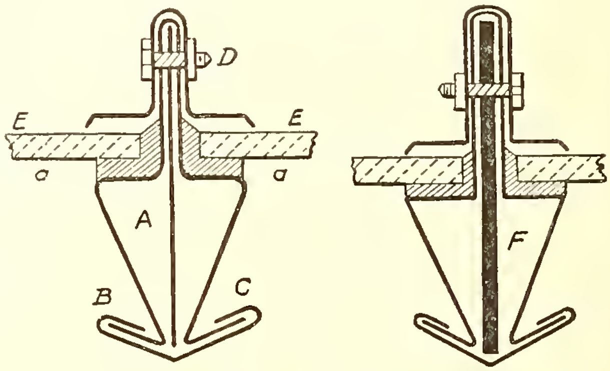


Fig. 481.—Full-Size Section of Re-inforced Bars

shown in Fig. 481, which give a greater sustaining power against wind pressure, snow, ice and sleet.

A section of common rafter is shown at A, the core plate being made of 22-gauge galvanized iron.

The walls of the bars are secured by the lower encasing B to C, and E E shows the glass imbedded in putty at *a* and *a*.

The capping of the bar is a little different from that shown in other cuts. It is bent as indicated with a brass bolt and nut securing the five thicknesses of metal.

Another style of re-enforced bar is shown at F, wherein the core plate F is of band iron, ⅛-in. thick by 2 in. wide. The sizes of these cores are usually specified in the specifications of the architect, who as a rule, figures their sustaining power.

When glazing studio skylights the best glass to use for this work is single thickness of clear hammered wire glass, which is also approved by the Board of Fire Underwriters.

Fig. 482 gives an interior view of the studio skylight, showing the arrangement of the shades, also the position of the tungsten lamps for night work. The equipment consists of one set of dark opaque shades and one set of white linen shades, which

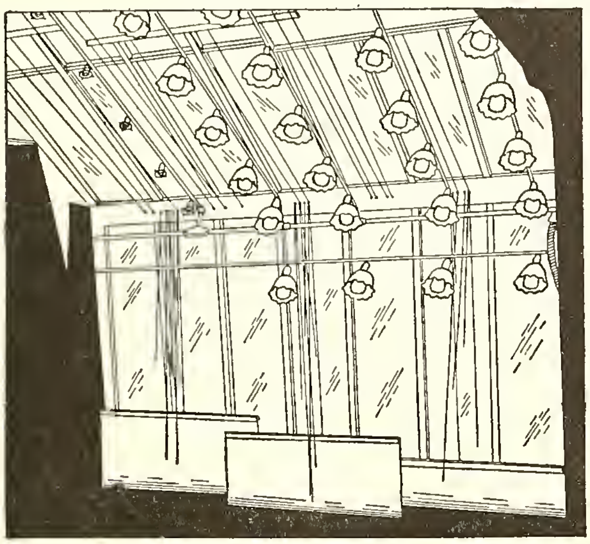


Fig. 482.—Interior View Showing Shades and Electric Bulbs

are used to regulate the lights and shadows. The electric lighting for night work consists of twenty-four 100-watt tungsten lamps placed in the position shown.

SINGLE PITCH SKYLIGHT, WITH PITCH FORMED IN THE METAL CURB

Solution 146

In Fig. 483 is shown what is designated a single pitch skylight, with the pitch or slope formed in the metal curb. As a rule, when the skylight is over

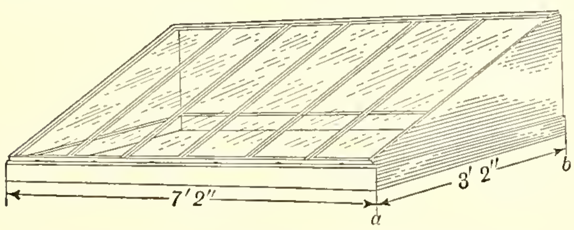


Fig. 483.—View of Single Pitch Skylight, with Pitch in Metal Curb

4 ft. wide from *a* to *b*, the side cheeks are made of wood, which is covered with metal, and over this framing the ordinary flat skylight is set. If the curb measurement from *a* to *b* is less than 4 ft., the side cheek can be formed directly on the lower curb and half bar at the side, which procedure will be taken up and illustrated in Fig. 484.

Here the sectional view shows all requirements in the development of the patterns. A partial front elevation is also shown, in order to make each step clear. This front elevation indicates as well, one of the weep holes, but in practice no front elevation need be drawn. After ascertaining the pitch of the skylight or the rise it is to have from R° to W° in the sectional view, draw the profile of the rear curb, as shown from 1 to 10 in the profile A. Ascertain the width of the skylight from 2 to 2 and draw the profile of the lower or front curb, B. Note the formation of this curb from 1 to 10. Also note that this lower curb B differs from the lower curb B given in Fig. 457. Curbs of various shapes will be taken up as we proceed with skylight work. From these the mechanic may select and obtain an understanding of curb formations. After drawing in its proper position, the curb B in Fig. 484, connect the glass line 6-7 in the curb A with the glass line 8-9 in the curb B. On this glass line draw the section or profile of the common bar, C; allow its condensation gutter to miter with the condensation gutter of the profile A, and lay over the condensation gutter of the lower curb B at 5-6, all as shown. The edge, 7-8, of the lower curb B should be no higher than the thickness of glass in use. At right angles to the pitch of the skylight draw the profile D, making D a one-half bar of the full bar C. At right angles to the curb line R° U° draw the profile of the side curb, indicated by E, taking care that the shoulder or rest, 3-4, in curbs A, B and E are equal, thus requiring only a square miter cut. The sectional view having been completed, the patterns may now be laid out.

The pattern for the common bar C is laid out by taking the girth of the bar C and placing it on the line F G, drawn at right angles to the pitch of the skylight, as shown by the small figures, 1 to 6 to 1. Through these small figures and at right angles to F G draw lines; intersect them by lines drawn parallel to F G from the various points where lines drawn through the profile C intersect the upper and lower curbs, A and B, respectively. Trace a line through points thus obtained. H J K represents the upper cut and L M N the lower cut. Where the glass rest, 8-9-10, in the lower curb B intersects 4-5 of the glass rest in the bar C, notches are to be made in the bar pattern to receive this glass rest, as indicated by the notches *c* and *c* in the bar pattern. These notches should be cut on the lines 5 in the pattern, then upward toward 6, about

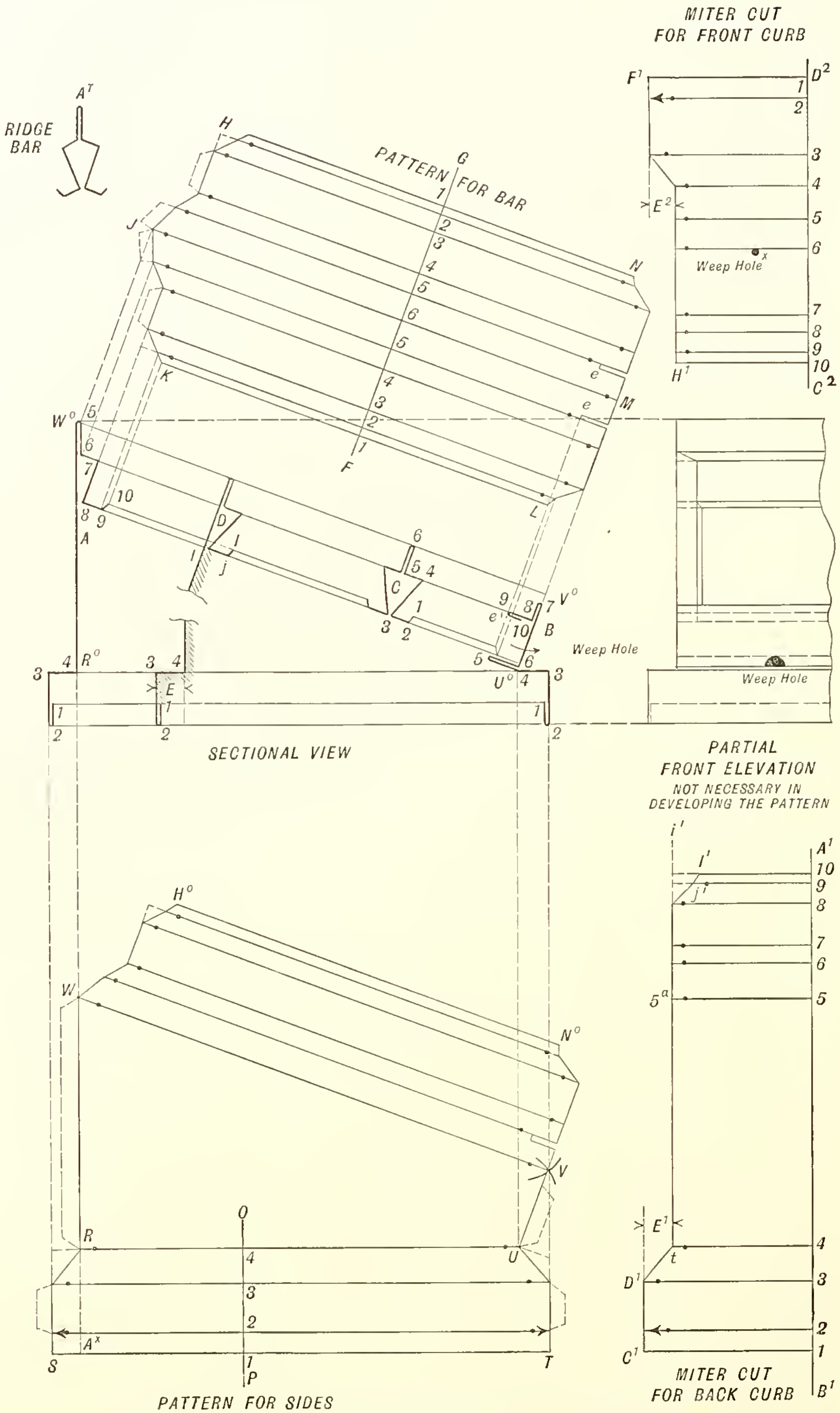


Fig. 484.—Patterns for Single Pitch Skylight with Pitch in Metal Curb

⅛ in. wide or just enough to allow the thickness of the hem edge, c' in the sectional view, to slip in easily.

The pattern for the side curb, cheek and half bar combined in one piece, is laid out as follows:

Take the girth of the side curb E from 1 to 4 and place it on any vertical line, as O P, as shown by similar numbers. Through these small figures and at right angles to O P draw lines; intersect them by lines drawn parallel to O P from similarly numbered spaces in the profiles A and B in the sectional view. Through the points thus obtained trace the miter cuts, R S T U in the pattern. Take a tracing of R° W° V° U° in the sectional view and place it, as shown by R W V U in the pattern.

If the skylight is of such size that a tracing or reproduction cannot be taken, this side cheek in the sectional view can be joined to the pattern in the following manner:

At right angles to U R in the pattern draw the line R W equal in length to R° W° in the sectional view. With W° V° as radius and W in the pattern as center, describe the arc V; intersect this arc by an arc struck from U as center, with U° V° in the sectional view as radius. Connect lines from W to V to U in the pattern. Take a tracing of the half bar pattern J M N H and place it in the pattern for sides, as shown by W V N° H°. N° T S H° gives the combined side pattern. Take the girth from 1 to 10 in the back curb A in the sectional view and place it on any line, as A^1 B^1, as shown by similar numbers. Through these small figures and at right angles to A^1 B^1 draw lines, as shown. Draw at pleasure the vertical line C^1 D^1 between lines drawn through points 1 and 3, as shown. Take the projection of the curb E in the sectional view and place it, as shown by E^1 in back curb pattern. From this point of intersection, t, erect the vertical line between lines drawn through figures 4 to 8, extending the line indefinitely as shown by i'. Measuring from the line i in the profile D in the sectional view, take the projections to points j and l and place them to the right of the line i' t in the pattern, thus obtaining the points j' and l' on the lines drawn through 9 and 10. This gives the miter cut of the condensation gutter of the upper curb A, mitering with the condensation gutter of the side curb D.

The girth of the front curb B from 1 to 10 is laid off on the vertical line C^2 D^2, as shown. Here, as before, the projection E^2 is obtained from the curb E in the sectional view, the miter cut, of course, taking place in the space between lines 3 and 4 in the front curb pattern. Note that the weep hole X is placed below the line 6 in the pattern, that is from 6 towards 7. C^2 D^2 F^1 H^1 represents the pattern for the front curb. Allow laps on patterns, as shown by the dotted lines in the side pattern and the bars.

Laying Out Full Size Patterns

Let us assume that a skylight is to be made up to a size of, say, 3 ft. 2 in. by 7 ft. 2 in., as shown in Fig. 483, the method of development will be as follows:

In the first place, the given curb distance of 3 ft. 2 in. will require to be laid out (in Fig. 484) in the sectional view from corner 3 in the curb A to corner 3 in the curb B; proceed then with the bar and side patterns, as already described. The distance of 7 ft. 2 in. in Fig. 483 will have to be laid out (in Fig. 484), measuring from the arrow point F^1 in the front curb pattern and the arrow point C^1 in the back curb pattern, as shown by the arrows, and then reversing the miter cuts to the opposite sides. Weep holes will be placed under the center of each light of glass. As six panes of glass are required, Fig. 483, the spacing of the panes can be found as follows: 7 ft. 2 in. = 86 in.; less 2 in. for shoulder rest on curb, = 84 in. This result divided by 6 gives 14 in. as the space of the panes required. The first weep hole will therefore be 7 in. from the end. Follow with 5 spaces of 14 in. each, leaving 7 in. space on the opposite end. Where the gutter of the bars miters with the top curb, the miter cuts in the top curb to receive the bars will be spaced 14 in. on centers and obtained by the method which was applied to the miter cut, A°, in the back curb pattern in Fig. 457. In forming up the various bars care must be taken that they are bent true to the stay or profile. This will save time in assembling the skylight.

A DOUBLE PITCHED SKYLIGHT

Solution 147

With double pitched skylights to be constructed, as shown in Fig. 485, the principles given in the preceding problem are employed. The present example is that of a skylight whose curb measures 6 ft. 4 in. by 8 ft. 11 in. In laying out a skylight of this description it is but necessary to divide 6 ft. 4 in. by 2, when we obtain the center line, which would be represented by the line W° R° in Fig.

484. Under such conditions all patterns would be obtained as described in connection with that illustration (Fig. 484), with the exception that the line W R in the pattern for side would be extended to A^x. Then W A^x T N° H° would be the one-half side pattern for a double pitched skylight, shown in

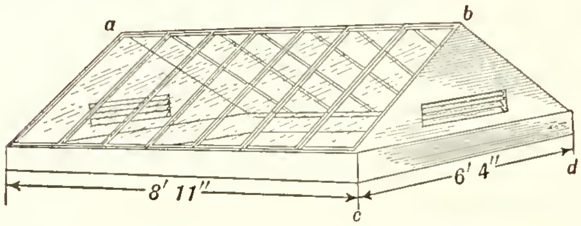


Fig. 485.—View of Double Pitch Skylight

Fig. 485, with a seaming through the center. A ridge bar *a b* would be necessary. This would be made 8 ft. 9 in. long, after deducting two inches, required for the curb rests on each side, using the pattern shown by $5\text{-}5^a\ l'\text{-}10$ in the pattern for back curb in Fig. 484, measuring from the point 5^a. As this pattern would be the pattern cut for the half ridge bar, shown from 5 to 10 in the curb A in the sectional view, the pattern would require to be reversed on the line $5\text{-}5^a$ in the miter cut for back curb, to complete the full ridge bar shown by A^T in the upper left hand corner. If the patterns shown in Fig. 484 were laid out for a skylight, whose width was 3 ft. 2 in., as is indicated in Fig. 483, these same patterns, Fig. 484, with the modifications above referred to, would be available for the skylight shown in Fig. 485, since its width is twice 3 ft. 2 in.,

Fig. 486.—Constructing the Cheek in Two Pieces

or 6 ft. 4 in. As the length is 8 ft. 11 in., or 107 in., the 7 panes would measure 107 in., less 2 in. for shoulder rests, or 105 in., which divided by 7 gives 15 in., the width of each pane. Without regard to the width from *c* to *d*, simply divide by two and proceed according to the method given in connection with Fig. 484.

Should it be desired to produce the side cheeks in two parts, make the joint as shown in Fig. 486, allowing to the half bar pattern an extra lap, as much as is shown at A. This can then be locked and riveted to the cheek, as shown. The construction of the louvres shown in Fig. 485 are taken up in connection with subsequent procedure.

Patterns for a Hipped Ventilating Skylight

The construction of a hipped ventilating skylight, such as is shown in the perspective in Fig. 487, requires five separate patterns, namely, the *curb, ventilator, common bar, hip bar* and *jack bar.* In some

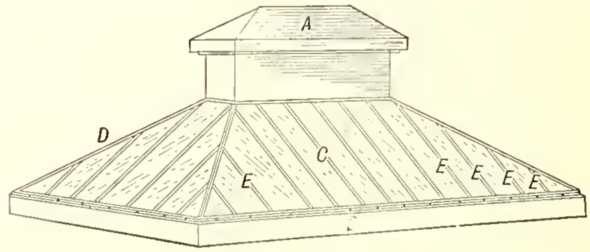


Fig. 487.—Hipped Ventilating Skylight

skylights, in addition to the above there would be required the *ridge bar, center jack bar, common jack bar* and *intersecting hip bar.* All these patterns will be taken up in their order. In the illustration of Fig. 487, A is the ventilator, B is the curb, C the common bar, D the hip bar and E E E E E are jack bars. In the perspective in Fig.

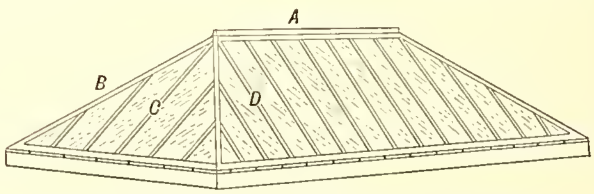


Fig. 488.—Plain Hipped Skylight with Ridge Bar

488, A is the ridge bar, C the center jack bar, D the common jack bar and B one of the intersecting hip bars.

The method of drawing the sectional view and obtaining the patterns is shown in the detail in Fig. 489. In this connection it may be well to remark that in laying out these various patterns, the sectional view need not be more than 12 in. wide, whatever be the pitch desired. In this case, a one-third pitch is drawn, that is, an 8 in. rise to a 12 in. base, since twice 12 represents 24, one-third of which is 8. Thus if a one-fourth pitch be required, 12 multiplied by 2 = 24 and one-fourth of 24 is 6. In other words, a 6 in. rise to a 12 in. base constitute a one-fourth pitch. In constructing the sectional view and one-quarter plan, first draw the center line A B and from any point upon it, as *b*, draw the horizontal line *b a* equal to 12 in. On the center line A B, set off a distance of 8 in. from *b* to *c* and draw the one-third pitch *c a*. This triangle, whose hypothenuse has a one-third pitch, forms the basis for obtaining all the patterns for the hipped skylight.

The line *a c* represents the glass line, at right angles to which the profile of the common and jack bars is placed, as indicated by A. In its proper position draw the profile of the ventilator frame B, whatever the shape desired, making the distance from the center line *c* to 1′ as desired. Draw the profile of the ventilator body C, making the space indicated by the arrow *n* about one-quarter inch, and over *C* draw the profile of the hood D. E represents the profile of the brace to sustain the hood D. Draw the profile of the curb *a*, taking particular pains that a vertical line drawn from the outer edge of the glass rest at 2′ will meet the curb line, as shown by the dotted line. When this lower edge of the glass rest 2′ is made to be perpendicular above the curb flange, as shown, the length of the skylight bar will be also the true length of the glass, so that all glass can be cut, long before it is used, thus saving delay in finishing the work at the building. The arrow in the curb *a* indicates where the weep holes are to be cut.

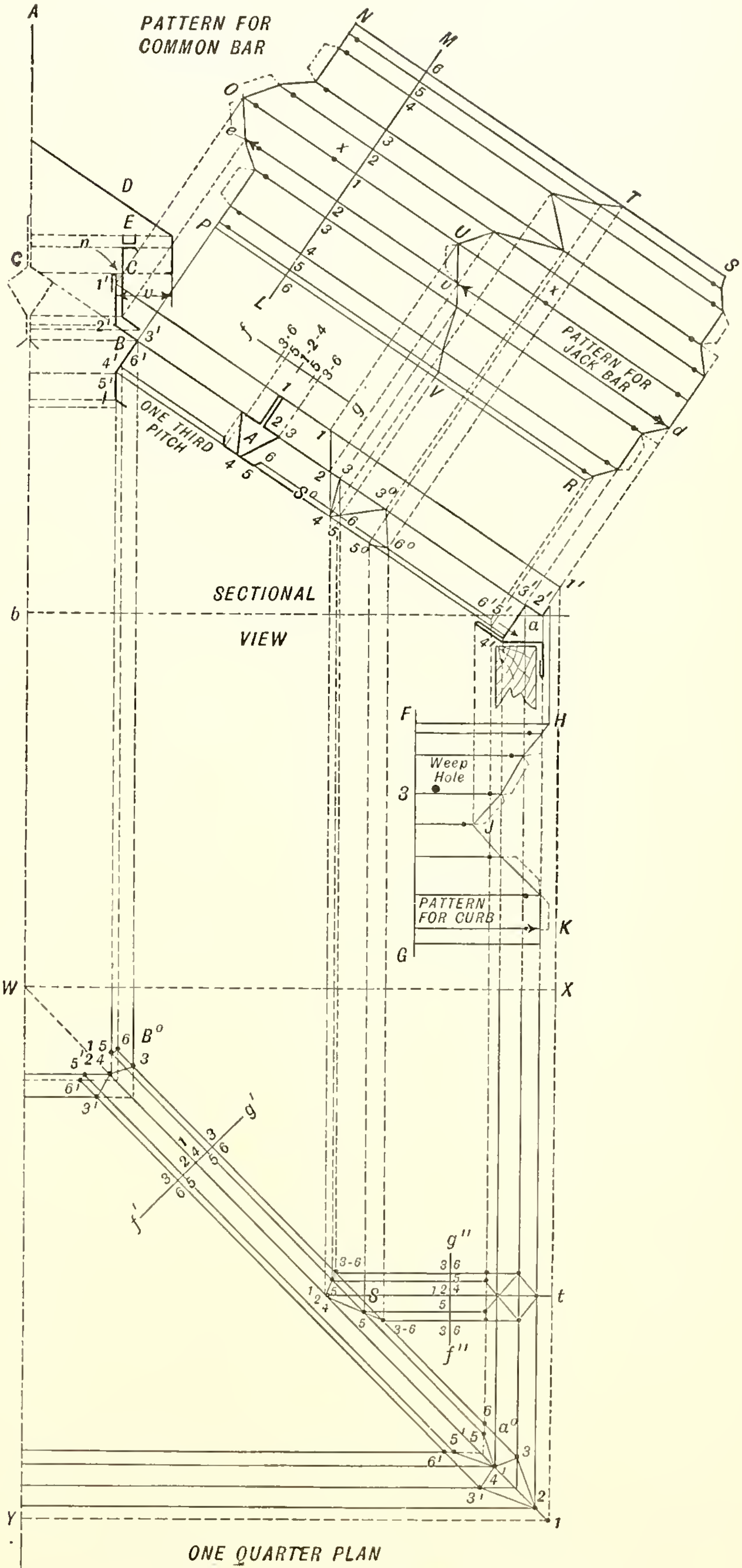


Fig. 489.—Patterns of the Curb, Common and Jack Bars

CURB IN HIPPED SKYLIGHTS

Solution 148

The sectional view having been completed according to the method in the preceding solution, the pattern for the curb may be laid out. Parallel to the line A B draw any line, as F G, on which place the girth of the curb *a*. To avoid a confusion of numbers, the bends in the curb *a* are not numbered, but measurements with the dividers will show whence the spaces were taken, when placed on the line F G. From the various points on F G and at right angles to this line draw the usual measuring lines and intersect them by lines drawn parallel to F G from similar points in the profile *a*. Trace lines through points thus obtained. F H J K G will be the curb pattern. In using this pattern for the curb, all measurements must be taken from the arrow point K. Note that the weep holes are placed *above* the third bend marked 3, as called for in profile *a*.

COMMON BAR IN HIPPED SKYLIGHTS

Solution 149

To obtain the pattern for the common bar, shown by C in Fig. 487, take the girth of the profile A in Fig. 489 and place it on a line drawn at right angles to *a c* in the sectional view, as shown by the small figures, 6 to 1 to 6 on the line L M. Through these small figures and at right angles to L M draw the usual measuring lines and intersect them by lines drawn parallel to L M from the several points where lines drawn through the profile A intersect the curb *a* at the bottom and the ventilator frame B at the top, all as shown by similar numbers, marked 1′ to 6′, in both profiles. A line traced through points thus obtained, as shown by N O P at the top and by R S at the bottom, will be the desired miter cuts. Since bend 2 in the bar profile A intersects the curb bend, which is perpendicular over the measuring point in the curb *a*, upon laying out the length of the common bars all measurements must be made on line 2 from the arrow points *e* to *d*.

JACK BAR IN HIPPED SKYLIGHTS

Solution 150

Preparatory to developing the pattern for the jack bars, marked E in Fig. 487, a partial plan view must be drawn, Fig. 489, from which the miter line can be obtained in the sectional view. From this the miter pattern is obtained.

It is customary to draw a one-quarter plan as follows: From any point on the center line A B draw the horizontal line W X. From W at an angle of 45 degrees (the skylight being a right angle, or of 90 degrees) draw the line, W 1; intersect this at 1 by a line dropped from 1′ in the lower part of the sectional view. From 1 in plan draw the horizontal line 1 Y. Parallel to *a c* in the sectional view draw a short line above the profile A, as *f g*, and upon this obtain the projections of the bar A at right angles to *a c*, as shown by the small dashes having similar numbers. Take a tracing of these spaces on *f g* and place them at right angles to W 1 in plan, as shown by *f′ g′*, being careful to place the point marked 1-2-4 directly upon the line W-1 in plan, as shown. Through these small figures 1 to 6 on *f′ g′* and parallel to W 1, draw lines; intersect these lines by lines drawn parallel to A B from similar numbers, 1′ to 6′, in the profiles *a* and B in the sectional view, thus obtaining the points of intersection, 1 to 6, at the bottom $a°$ and at the top B°, respectively, in plan. A line drawn through these points will show the miter lines, where the hip bar miters with the curb and ventilator frames, respectively. If desired, the opposite lower half of the hip bar in plan can be intersected, as shown by horizontal lines drawn parallel to W X, from intersections on the hip line W 1, thus obtaining intersections marked 1 to 6′. These miter lines are introduced in the development of the hip bar pattern in subsequent problem. From any desired point, as *t*, in plan, draw a line parallel to W X, meeting the hip line at 2. Again take the projection of the bar A in the sectional view, shown on the line *f g* and place it as indicated, at right angles to *t* 2 in plan, as shown by *f″ g″*; through the small figures thereon and parallel to *t* 2 draw lines, intersecting lines previously drawn through the hip bar. Through the points of intersection thus obtained, draw the two miter lines, shown in *S* between 1 and 6 on both sides. This gives the intersections of the long and short cuts of the jack bar; these points are projected vertically to the sectional view, intersecting similarly numbered lines, drawn through the profile of the bar A. Connect the points thus obtained. 1 to 6 in $S°$ will be the miter line of the short cut and 1 to 6° the miter line of the long cut. The pattern for the jack bar may now be developed. From the various intersections 1 to 6 and 1 to 6° in $S°$ draw lines at right angles to *a c*, intersecting similarly numbered lines previously drawn for the common bar. Trace a line through points thus obtained. T U will be the miter pattern for the long cut and U V the miter pattern for the short cut of the jack bar. The measuring point for the jack bars will also occur on line 2, as shown by the arrow points from *d* to *v*. Laps should be allowed on all patterns, as shown by the dotted lines.

RIDGE VENTILATOR IN HIPPED SKYLIGHTS

Solution 151

The patterns required for the ventilator, illustrated by A in Fig. 487, are shown developed in Fig. 490. Draw any perpendicular line as A B and on it place the girth of the profile of the ventilator frame B, in Fig. 489, as well as the girth of the profile of the ventilator body, C, the girth of the profile of the hood, D, and the girth of the brace, E, all as shown on the line A B in Fig. 490. In measuring the girth of the several profiles of the ventilator, numbers have been omitted to avoid a confusion of figures, in Fig. 489. At right angles to A B in Fig. 490, draw lines to the right as shown. Measuring in each instance from the line A B in Fig. 489, take the various *horizontal* projections to the various corners in the profiles B, C and D of the ventilator, as shown by the dotted lines, and place them on their proper lines in Fig. 490, measuring invariably from the line A B. Trace a line through points thus procured and obtain the miter pattern for the hood, ventilator body and ventilator frame. In laying out full size patterns, measurements are taken from *a*, *c* and *d*, in the hood, body and frame, respectively. The length of the brace is always made equal to the width of the hood, whatever that may be, as shown at *b*. The ventilator patterns here shown represent the half patterns for a given half width of ventilator, as indicated in the sectional view in Fig. 489. Assuming that this semi-width in the sectional view is 2 in., from the center line A B to *i*, the patterns shown in Fig. 490 are half patterns for that width. If, however, a ventilator whose full width is 8 in., be required, simply measure from the arrow point *d* a distance of 8 in. and reverse the cut for the full pattern. The other two patterns would then be increased in the same proportion, and the miter cut *h i* of the hood extended until it met the opposite miter line *h i*, also extended, at its apex. The acceptable rule for finding the accurate lengths of ventilators will be taken up in the course of this treatment. Laps should be allowed on the short sides of the vent patterns, as shown by the dotted lines.

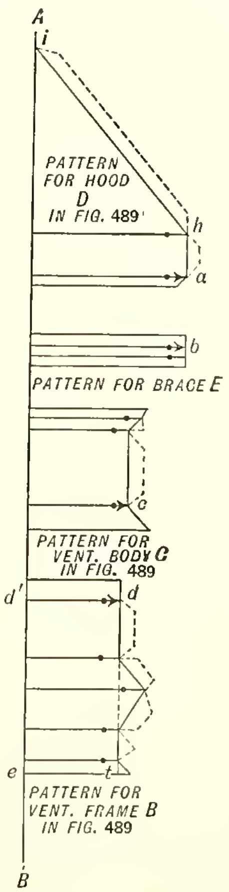


Fig. 490. — Various Patterns in Ventilator

HIPPED BAR IN HIPPED SKYLIGHTS

Solution 152

The pattern for the hip or corner bar, indicated by D in Fig. 487, is shown developed in Fig. 491. W 1, the plan of the hip bar, is a reproduction of W 1, the plan of the hip bar previously obtained, as shown in Fig. 489. Because of the limits of space, the plan of hip bar with its various numbered points of intersection has been traced to Fig. 491, where the hip bar is presented horizontally to facilitate the development of the pattern with the tee square.

Parallel to and equal in length to W 2 draw the line *b 2*. At right angles to *b 2* erect the line *b c* equal to 8 in., or equal to *b c* in the sectional view in Fig. 489. Draw a line from *c* to 2 in Fig 491; this is the true length of the hip bar on the line W 2 in plan. At right angles to W 1 in plan and from the various intersections, 1 to 6, at the curb X and vent frame Y erect lines to any hight, as shown. Measuring from the line *a b* in the sectional view in Fig. 489 take the various hights above and below this line to points 1′ to 6′ in the curb *a*, also to points 1′ to 6′ above the line *a b* in the vent frame B; place these hights above and below the line *a b* in Fig. 491 on similarly numbered lines, previously erected from similar numbers in the miter lines in plan. Trace the miter lines in the elevation of hip bar, through points thus obtained, as shown from 1 to 6 at bottom and top. Connect these points in the miter lines by lines drawn from 1 to 1, 2 to 2, etc., all of which will be parallel to line c 2 previously obtained. This gives the elevation of the hip bar.

Preparatory to laying out the pattern, a true profile of the hip bar must first be found as follows:

Take the various projections on the line $f\ g$ in the sectional view in Fig. 489 and place it in Fig. 491, as indicated by $f\ g$ drawn parallel to c 2. From the various intersections 1 to 6 on $f\ g$ and at right angles to c 2 draw lines which will intersect similarly numbered lines in the elevation, as shown. Through these points trace the modified profile of the hip bar, A. Take the girth of A from 6 to 1 and place it on the line B C drawn at right angles to c 2, as shown by the figures 6 to 1 to 6. At right angles to B C and through these small figures draw lines and intersect them by lines drawn parallel to B C from similar points of intersection in the miter lines in elevation, all as shown. Trace a line through points thus obtained. The miter D E F will be the cut against the curb at the corner and G H J the cut against the vent frame at the top. As the glass line is the measuring line, all bars are measured on line 2, indicated by the arrows.

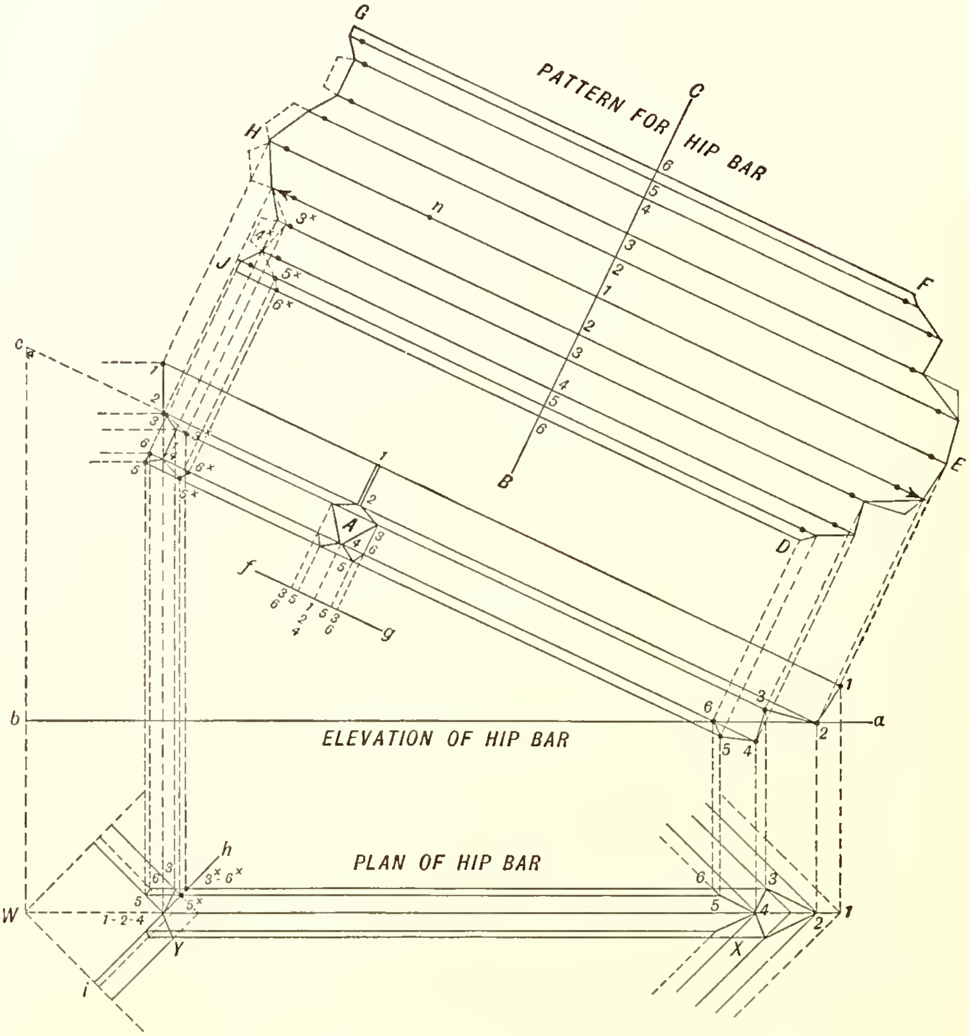


Fig. 491.—Pattern of the Hip Bar

OTHER BARS REQUIRED IN HIPPED SKYLIGHTS

Solution 153

A requirement occurring in skylight construction is that of a skylight on which the four hip bars intersect, as seen in Fig. 492, forming what is known as *intersecting hip bars,* shown by the intersecting lines $a\ b$ and $c\ d$. Reference to Fig. 491 shows also the method of developing this cut. Here the frame line of the ventilator, in plan, is extended, as shown

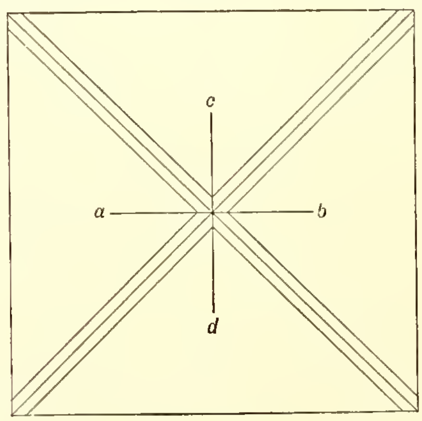


Fig. 492.—Plan of Intersecting Hip Bars

by the line *i h* and where this line intersects the various lines of the hip bar in plan, as at 1, 2, 3^x, 4, 5^x and 6^x, lines are erected at right angles to W 1, thus cutting similarly numbered lines in the elevation of the hipped bar indicated also by 1, 2, 3^x, 4, 5^x, 6^x. From these points, 3^x, 5^x and 6^x, lines are drawn at right angles to *c* 2, cutting the lines in the pattern, also at 3^x, 5^x and 6^x, and dotted lines are connected, as shown. This cut has been projected to only one-half of the pattern.

If a full pattern be desired for an intersecting hip bar, simply take a tracing of the cut *n* H 3^x 6^x in the

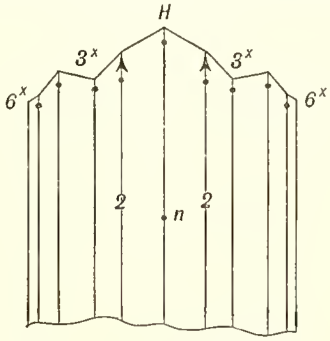


Fig. 493.—Miter Cut for Intersecting Hip Bars

hip bar pattern and place it, as shown in Fig. 493, on either side of the line H, *n*, as shown by *n* H 3^x 6^x. The lower cut on this bar will be the same as in the hip bar pattern in Fig. 491.

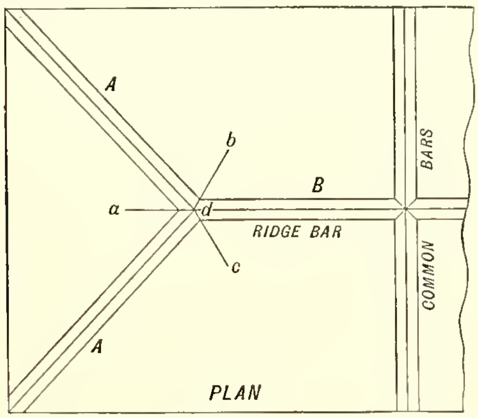


Fig. 494.—Intersecting Hip Bars, Joining to Ridge Bar

When hip bars intersect, as shown in Fig. 494, that is, the two hips intersecting along *a d* on the one side, and intersecting with the ridge bar at *d c* and *d b* on the other, the pattern is laid out as shown in Fig. 495. Here *n* H 3^x 6^x is a reproduction of corresponding letters and figures in the hip bar pattern in Fig. 491. Take a tracing of the upper part of the hip bar pattern *n* H G and place it, as shown by *n* H G in Fig. 495. The cut H 6^x in the pattern will be the miter pattern for the intersection *a d* in Fig. 494, and the miter pattern for the intersection *d b* or *d c* is shown by the cut H G in Fig. 495.

In the two patterns just developed, Figs. 493 and

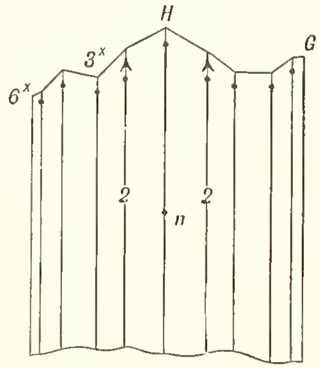


Fig. 495.—Miter Cut for Intersecting Hip Bar, One-half of which Joins the Ridge Bar

495, all measurements are laid out on line 2, indicated by the arrows.

The pattern for the ridge bar, shown by B in Fig. 494, will be twice the girth of *c d'* in the pattern for the vent frame B in Fig. 490, cutting off the miter *d t* and turning over on the line *d d'*. This bar would be formed as indicated in Fig. 489 in the sectional view at *c*. If bars are to be spaced

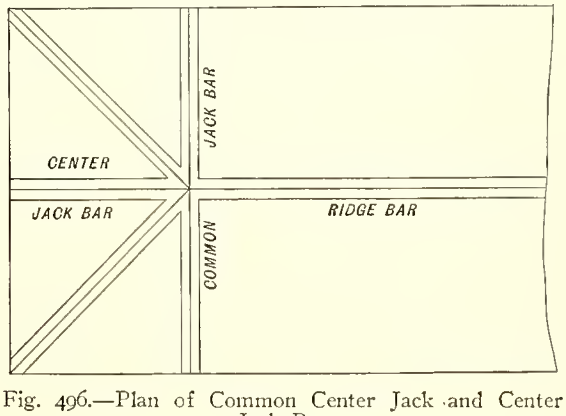


Fig. 496.—Plan of Common Center Jack and Center Jack Bar

as shown in Fig. 496, the resulting formations will constitute *center jack bars* and *common jack bars*.

The miter cut for the center jack bar is laid out as shown in Fig. 497. Take a tracing of the long cut in the jack bar pattern in Fig. 489, shown by *x* U T, and place it on either side of the line U V in Fig. 497, as shown by *x* U T on both sides. T U T is then the miter cut for the center jack bar, since the center jack bar, shown in Fig. 496, has a long miter cut on each side. The cut at the bottom of the pattern, shown in Fig. 497, is, of course, the same as the lower cut of the jack bar pattern shown in Fig. 489.

To obtain the miter cut for the common jack bar, which is so named for the reason that half of the

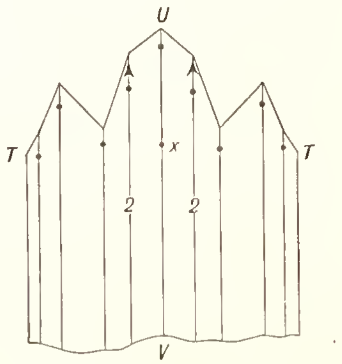


Fig. 497.—Miter Cut for Center Jack Bar

bar intersects the hip just as does a jack bar, while the other half intersects the ridge as does a common bar, Fig. 496, take a tracing of the cut *x* U T in the jack bar pattern in Fig. 489 and place it, as

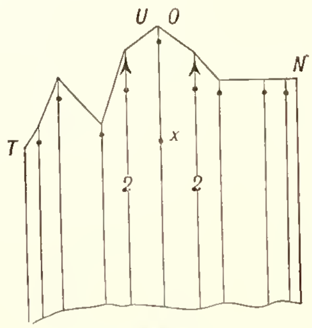


Fig. 498.—Miter Cut for Common Jack Bar

shown by *x* U T in Fig. 498. Take a tracing of the half upper cut of the common bar in Fig. 489, indicated by x O N, and place it on the line U *x* in Fig. 498, as shown by x O N. N O U T gives the miter cut for the common jack bar.

FINDING THE TRUE LENGTHS OF THE VARIOUS CURBS, BARS AND VENTILATORS IN HIPPED SKYLIGHTS

Solution 154

There are three methods of finding the true lengths of the several bars, curbs and ventilators required in hipped skylight work, namely, by means of a scale drawing, by computation and by the aid of triangles. To one versed in figures computation is the readiest method; to one not so apt the triangles will prove serviceable. As the use of the scaled drawing requires an expenditure of time to secure accuracy, the other two methods may be recommended and we will explain them by selected examples.

Let us assume that patterns have all been laid out for one-third pitch and that a skylight is to be made whose curb measure is 6 ft. 6 in. by 10 ft. 0 in., as

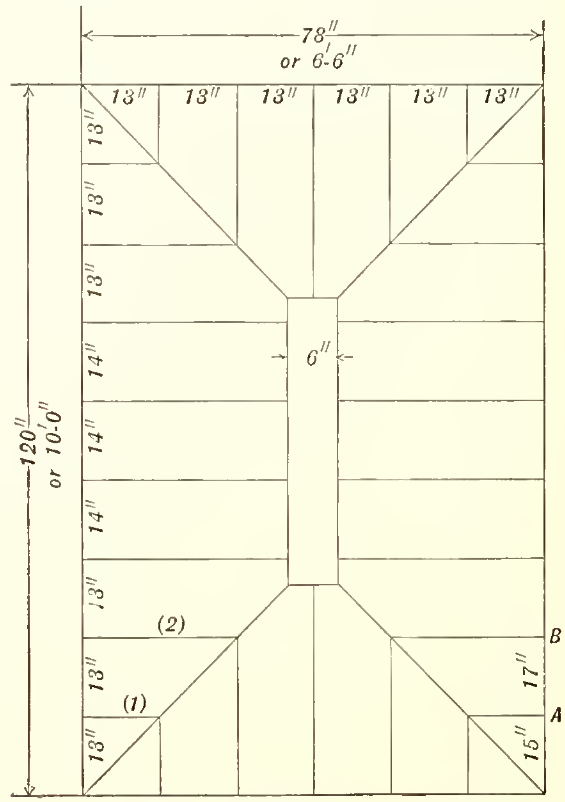


Fig. 499.—Example in Finding the True Lengths of Skylight Bars

shown in Fig. 499, with a ridge ventilator thereon whose width is 6 in., as indicated. The *size of the curb* and *width of the ventilator* determine the basis of the various lengths to be found by means of the triangles; the construction is as follows:

Take a tracing of the triangle *a b c* in the sectional view in Fig. 489 and place it as shown by *a b c* in Fig. 500. Since in obtaining the patterns this distance, *a b*, was drawn to 12 in. length, divide that length into inches, half inches, etc. (as they would appear a rule), and erect perpendiculars until they cut the slant line *c a*, as shown. This slant line or hypothenuse may be employed in determining the true lengths of the *common* and *jack bars*, its use, of course, being restricted to skylights whose pitch is represented in the sectional view, Fig. 489, from

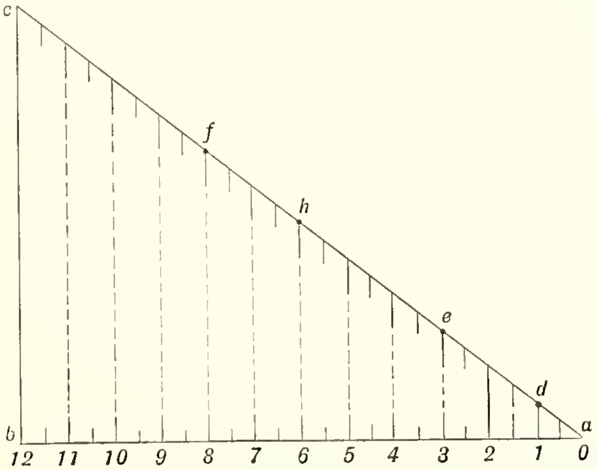


Fig. 500.—Constructing the Triangle used for Common and Jack Bars

which the patterns were obtained, namely, a one-third pitch. Any other pitch would require a different pattern and triangles to correspond. Fig.

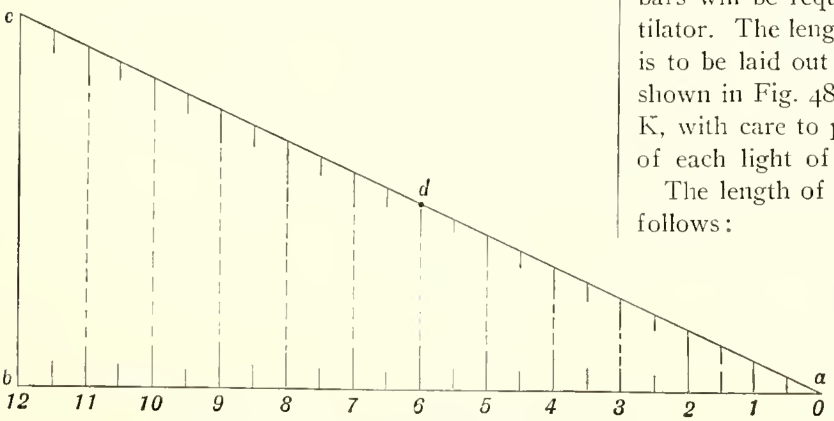


Fig. 501.—Constructing of Triangle Used for Hip Bar

501 shows the triangle required for determining the true length of the hip bar for one-third pitch; it is constructed by taking a tracing of *2 b c* in Fig. 491 and placing it, as shown by *a b c* in Fig. 501. Since we find that the distance, *a b*, represents the length of the diagonal or hip line in plan, whose sectional view is 12 in., as shown in Fig. 489, we divide the line *a b* in Fig. 501 into twelve equal parts and divide these again into halves, etc. From these divisions, 1 to 12, erect vertical lines, cutting the hypothenuse, *c a*, as shown. These triangles may be made on heavy cardboard and saved for repeated use for any size of skylight whose pitch is 8 to 12, or one-third.

The first step in finding the true lengths is to prepare a rough diagram, reducing therein all measurements to inches, so that the curb will measure 78 in. by 120 in. as shown in Fig. 499. Always divide first the narrow side of the curb. In the present case there are six lights of 13 in. each. Space the long side so that the jack bars will meet, thus obtaining six lights of 13 in. and 3 lights of 14 in. The rough sketch will show the number and kind of bars required and as well give the true dimensions for spacing the bars when the skylight is assembled.

In this connection it may be well to remark that glass is to be obtained only in uniform widths, as 10"-12"-14", thus graduating by multiples of two. While the size here given serves as an example for practice a skylight should be so spaced as not to occasion wastage of glass, and needless loss may be averted by careful preliminary attention to measurements and available stock sizes.

Referring to the rough sketch, we find that 4 hip, 8 jack number 1, 8 jack number 2 and 10 common bars will be required, as well as the curb and ventilator. The length of the curb, shown on the sketch, is to be laid out bringing into use the curb pattern shown in Fig. 489, measuring from the arrow point K, with care to place a weep hole under the center of each light of glass.

The length of the ventilator frame B is found as follows:

Deduct the narrow side of the curb from the long side and add the width of the vent frame. The narrow side of the curb is 78 in., as shown in Fig. 499, and the long side is 120 in. Thus, 120 in. less 78 in. leaves 42 in., which, plus 6 in. = 48 in. The inside vent frame will thus be computed as 6 in. by 48 in., measured from the arrow point *d* in Fig. 490. Measuring from the arrow point *c* in the pattern of the vent body, the lengths would be found to correspond to the inside vent frame, plus twice the projection of *n* in the sectional view, in Fig. 489. If this projection *n* were one-quarter inch, the vent body would measure 6½ x 48½ in. The hood pattern would be measured from the arrow *a*, in Fig. 490 indicating the same length as of the inside vent frame, plus twice the projection of *v*, in Fig. 489. If the projection *v* were two inches, the hood would measure 10 x 52 in. The length of the brace pattern E in Fig. 490 would be equal to the width of the hood, or 10 in., measured from the arrow *b*.

To find the true length of jack bar number 1 in Fig. 499, use the triangle shown in Fig. 500. As the width in Fig. 499 is 13 in. or 1 ft. 1 in., simply measure the distance of *a c* in Fig. 500 and add to it the true length of *a d*. Then 1 ft. on the horizontal equals *c a* on the slant plus 1 in. on the horizontal, which equals *d a* on the slant. With the two foot rule measure the length of *c a* plus *d a;* this gives the true length of the jack bar, which is measured from the arrow points *d* to *v* in the jack bar pattern in Fig. 489.

Whatever be the length of jack bar number 1 in Fig. 499, jack bar number 2 will be twice the length of number 1, since the two divisions of glass are equal. Should it occur that the divisions between the jacks are unequal, as shown in the lower right hand corner of the sketch, where bar A is spaced 15 in. and bar B 17 in., the length of bar A would be found by measuring the distance *c a* in Fig. 500 plus *c a,* which represents the true length of the horizontal 3 inches.

Since the second bar B in Fig. 499 is 17 in. from A, we find the true length of jack bar B by adding 15 in. and 17 in., resulting in 32 in. or 2 ft. 8 in. Use the triangle in Fig. 500 and add *c a* plus *c a* plus *f a,* which is the desired length.

To obtain the measuring lengths of the common and hip bars, the following method is used: *Deduct the width of the ventilator from the short side of the curb and divide the result by two.* The width of the vent in Fig. 499 is 6 in., the short side of curb is 78 in. Thus, 78 in. less 6 in. = 72 in., or 6 ft.; divide this by 2 and we have 3 ft. As the length *c a* of the triangle, in Fig. 500, is the true length on the 12 in. horizontal, 3 ft. will represent 3 times *c a,* the true length of the common bar, measured from *d* to *c* in the pattern for common bar in Fig. 489.

This 3 ft. is also used for finding the true length of the hip bar. Applying the triangle to the hip bar, in Fig. 501, multiply *c a* by 3, the true length of the bar, measuring from the arrow points on line 2 in the hip bar pattern in Fig. 491.

Fig. 502 indicates another example in skylight computation by the aid of the triangles. Here we have a skylight 5 ft. by 10 ft. with a ridge bar. The glass is spaced 15 in. all around, as shown. The length of the ridge bar is found by deducting the short side of the curb from its long side, leaving 5 ft. as the length, measured from *d* in Fig. 490, where the miter is cut off at *d t,* reversing on the line *d′ d* to obtain the full girth of the ridge bar. The cut is made along *d t* for the reason that the ridge bar is cut off square at the ends and requires no miter. Since the spacing between the jacks is 15 in., in Fig. 502, the true length is found by using the triangle, Fig. 500, and adding the sum of the distances *c a* and *c a.* To obtain the measuring lengths of the common, hip, center jack and common jack bars, divide the short side of 5 ft. by 2, which gives 2 ft. 6 in.

The true length of the common, common jack and center jack bars is found by the use of the triangle, Fig. 500, and finding the sum of *c a* plus *c a* plus *h a;* lay out this length full size, measuring from arrow points in the pattern for the common bar in Fig. 489 and the pattern for center jack bar in Fig. 497 and the pattern for the common jack bar in Fig. 498. The lower end cut for the two last mentioned patterns is alike to the cut against the curb, shown by R S in the bar pattern in Fig. 489.

The true length of the hip bar shown in Fig. 502 is found by the triangle, Fig. 501, adding together the distances of *c a* plus *c a* plus *d a,* this representing the true length on the 2 ft. 6 in. horizontal.

On finding the true lengths of the several bars, the glass is usually ordered, considerably in advance of setting up the work to anticipate the ordinary delays of delivery. The width of the glass will be equal to the dimensions given in either Fig.

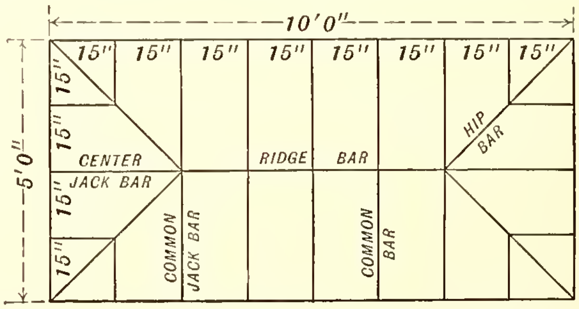


Fig. 502.—Another Example in Skylight Computation

499 or Fig. 502 and the length will be equal to the true lengths of the bars, less for expansion one-quarter inch in length and in width.

FINDING THE LENGTH OF THE BARS BY COMPUTATION

Solution 155

Another method of finding the true length of bars without the aid of triangles, Figs. 500 and 501, is to figure the various lengths, using factors which are found as follows:

With the length of the line *a c* in the sectional view in Fig. 489 known to be 14½ in.,* as nearly as it can be measured with a two-foot rule, divide 14.5 by 12, which gives 1.2, the factor to be used for the common and jack bars. Also with the length of the line *c 2*, in the elevation of the hip bar in Fig. 491 known to be 18.75 in.,† as nearly as it can be measured with a two-foot rule, divide 18.75 by 12. This gives 1.56, the factor for the hip bars.

If the patterns have been developed for skylights having a one-third pitch the lengths of the ventilator, common, hip and jack bars may be obtained quickly by a little figuring, according to the following method, without using drawings, diagrams, scales, triangles, etc.

The factors here given for obtaining the lengths of common, hip and jack bars are based on one-third pitch or 8 to 12. Should the reader be accustomed to employ some other pitch, it is an easy matter to find the factors. This subject will be taken up in due course.

Assume that a skylight is to be made of one-third pitch, the curb of which measures 4 ft. x 6 ft. 8 in.; the width of the ventilator to be 6 in., all as shown in Fig. 503. What must be the *length* of the ventilator?

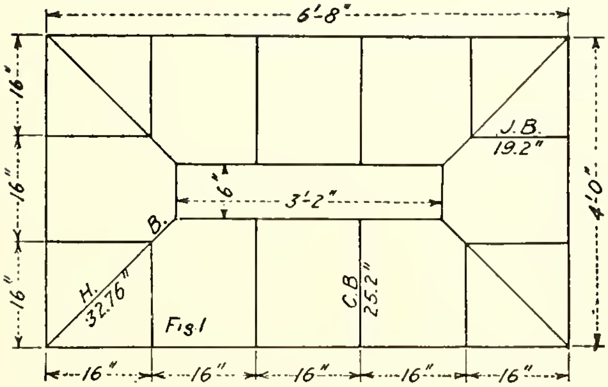


Fig. 503—Skylight, One-third Pitch, with Ventilator

The rule is to deduct the short side of the curb from the long side and add the width of the ventilator. Thus 6 ft. 8 in. less 4 ft. = 2 ft. 8 in.; and 2 ft. 8 in. plus 6 in. (the width of the ventilator) = 3 ft. 2 in., as shown in Fig. 503.

The factor to be used in obtaining the lengths of the common and jack bars on a one-third pitched skylight is 1.2, as already explained, and the following rule applies to all skylights of one-third pitch:

Deduct the width of the ventilator from the short side of the curb, then divide by 2, and multiply this by 1.2. The short side of the curb, 4 ft., less 6 in. (the width of the ventilator), leaves 3 ft. 6 in. Divide this by 2, thus obtaining 1 ft. 9 in., or 21 in. Now multiply 21 in. by 1.2, obtaining 25.2 in., the length of the 4 common bars in Fig. 503. Having found the width between the hips and jack bars to be 16 in., as shown, multiply 16 x 1.2, obtaining 19.2 in., which is the length of the eight jack bars.

The factor used for the hip bar is 1.56 on one-third pitches only, as explained. Using the same number (21) as was used in getting the length of the common bars, 21 x 1.56 = 32.76 in., the length of the four hips. The same factors can be used when the skylight is smaller or larger providing, however, that one-third pitch be employed.

Assume that a skylight is 3 ft. 3 in. x 5 ft. 5 in.,

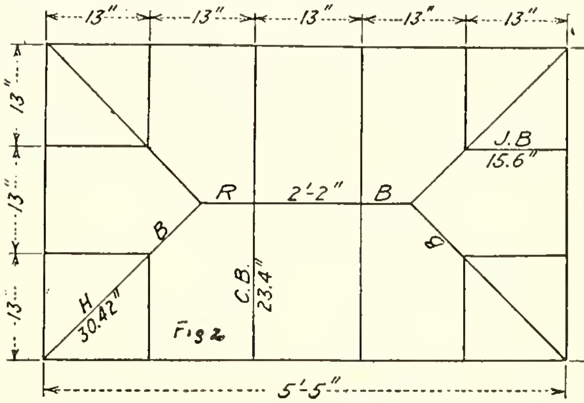


Fig. 504.—Skylight, One-Third Pitch, with Ridge Bar

with a ridge bar, as shown in Fig. 504. The rule for finding the length of the ridge bar is simply to deduct the short side of the curb from the long side. Thus 5 ft. 5 in. less 3 ft. 3 in. = 2 ft. 2 in., the length of the ridge bar. To find the length of the common bar, divide the short side of the curb by 2 and multiply by the factor 1.2. Thus 3 ft. 3 in. = 39 in. ÷ 2 equals 19.5 and 19.5 x 1.2 = 23.4 in., the length of the four common bars.

The width between the hip and jack bar is 13 in. 13 x 1.2 = 15.6 in., the length of the eight jack bars.

With the same figure (19.5) as was used for the common bars, find the length of the four hips by multiplying 19.5 x 1.56 (the factor for the hips), thus obtaining 30.42 in.

It will be seen that the use of the factor saves much of the time that is expended for finding the lengths of the various bars by charts or scale drawings.

*The accurate of *a c* is 14.42. $\sqrt{12^2+8^2}=14.42$.

†The accurate distance of *a2* is 18.76. $\sqrt{12^2+12^2+8^2}=18.76$.

FINDING THE LENGTH OF BARS FOR SKYLIGHTS OF ANY PITCH

Solution 156

The following method of finding the factors used in computing the true length of the various bars for skylights of any pitch is applicable to any skylight, regardless of its pitch.

In the preceding solution the pitch taken up was 8 to 12 or one-third. We will now show the method of application employed on an odd pitch, as 6¾ in. to 12 in. In other words, on every run of 1 ft. the rise is to be 6¾ in.

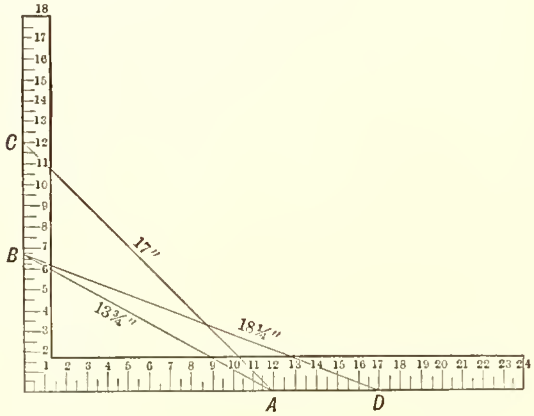


Fig. 505.—Diagram Showing How to Find Factor for Obtaining True Lengths

With a steel square, Fig. 505, set the rule from 6¾ to 12, as shown from B to A, and it will measure 13¾ in. There is a slight variation of a fraction of an inch, but the difference is so small that the measurements found in this case, as well as in those to follow, will be of sufficient accuracy for all practical purposes. As the run is 1 ft., divide the 13¾ in. by 12 thus: 13.75 divided by 12 = 1.14, which is the factor for obtaining the true lengths of the common and jack bars. The method applies also to finding the factors for single or double pitched skylights.

To obtain the factor for the hip bar in a skylight with a pitch of 6¾ to 12, measure the distance from 12 to 12 on the steel square, as shown from A to C, obtaining 17 in., which represents the dimension, in plan, of the hip bar. As the rise is 6¾ in. to the foot in this case, measure on the steel square the distance from 6¾ to 17, shown from B to D; this distance is found to be 18¼ in. Divide 18.25 by 12, obtaining 1.52, the factor for finding the true length of the hip bars.

The foregoing method applies to hipped skylights of all pitch. With the factor for the common and jack bars known to be 1.14, and the factor for the hip bar to be 1.52, in skylights having 6¾ in. rise to 1 ft. of run, the true lengths may be found as explained in the two examples illustrated by Figs. 506 and 507.

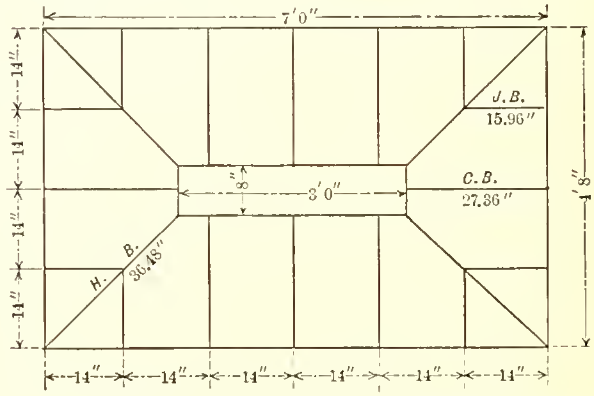


Fig. 506.—Example of Problem for Skylight with Ventilator

Fig. 506 is a skylight with a ventilator 8 in. wide, with a curb measuring 4 ft. 8 in. x 7 ft. The length of the ventilator is found by deducting 4 ft. 8 in. from 7 ft. and adding the width of the ventilator, thus: 84 in. less 56 in. = 28 in., plus 8 in. = 36 in., or 3 ft.

To obtain the length of the common bars, deduct the width of the ventilator from the shortest side of the frame and divide by 2, thus: 56 in. less 8 in. = 48 in. divided by 2 = 24 in. Multiply 24 in. by 1.14; this gives 27.36 in., which is the length of the common bar shown in Fig. 506. Multiply 24 in. by 1.52, which will give 36.48 in., or the length of the hip bars. As the space between the jack bars is 14 in., multiply 14 in. by 1.14, which will give 15.96 in., or the length of the jack bars.

If a skylight is desired without a ventilator, as shown in Fig. 507, say 6 ft. 6 in. by 9 ft. 9 in., the length of the ridge bar would be found by subtracting the short from the long side, as 9 ft. 9 in. less 6 ft. 6 in. leaves 3 ft. 3 in., which is the length of the ridge bar in Fig. 507.

In this skylight there are two jack bars, marked 1 and 2, a center jack bar marked Cen. J. B., also a common jack bar marked Com. J. B. To find the true length of the common bars, simply divide the narrow side of the curb by 2, thus: 6 ft. 6 in. divided by 2 gives 3 ft. 3 in., or 39 in. As every inch in the run is increased 0.14 in. in the pitch, multiply 39 in. x 1.14, which will give 44.46 in., the true length of the common, center jack and common jack bars. Using the same number, 39, as was employed in obtaining the length of the common bar, multiply 39 in. x 1.52, which will give 59.28 in., the length of the hip bars as shown in Fig. 507.

As the jack bars are 13 in. apart, use the proper factor 1.14 and multiply it by 13, resulting in 14.82 in., the length of jack bar No. 1. As the bars are equally spaced, namely 13 in., then bar No. 2 will

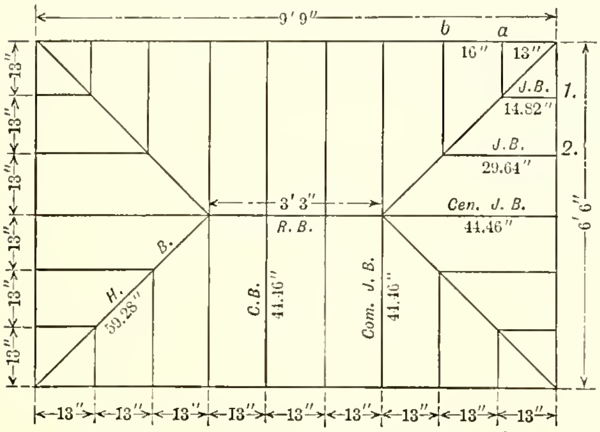


Fig. 507.—Example of Problem for Skylight without Ventilator

be twice 14.82 in., or 29.64 in. long. Should the bars be unequally spaced, as shown at *a* and *b*, the length of bar at *a* would be 13 times 1.14 in., and the length of jack bar *b* would be 13 plus 16, or 29 times 1.14 in.

The use of this simple method for obtaining measurements will upon practice demonstrate it to be the most effective means of saving time.

HIPPED OCTAGONAL SKYLIGHT

Solution 157

Fig. 508 presents a plan and elevation of an octagonal skylight of hip shape. The methods followed in developing these patterns are alike to those used in the hipped skylight discussed in the preceding pattern solutions. Hence the description given in connection with Fig. 509 is brief.

Let G H be the center line, and, using any point upon it, as C, describe the one-quarter plan of the octagonal skylight on its curb line, as indicated by D E F G. Draw the hip lines, E C and F C. Above this quarter plan draw a sectional view of the skylight on the line C D in plan, as follows: In line with the curb line E D in plan, draw the profile of the curb, indicated by A, from which the desired pitch of the skylight is drawn until it cuts the center line, G H, as shown. Draw the profile of the jack bar, indicated by B, and, parallel to the pitch of the skylight draw any short lines above the profile B, as X Y. From the various intersections or small figures, 1 to 6, in B, draw lines at right angles to the pitch of the skylight, intersecting the line X Y from 1 to 6, as shown. Parallel to the pitch of the skylight, from the intersections 1 to 6 in profile B, draw lines intersecting the curb A from 1′ to 6′, as shown. Take a tracing of the various numbered intersections, 1 to 6, on X Y in the sectional view, and place it at right angles to the hip line C E in plan, as indicated by X° Y°, taking care that the points 1, 2, 4 come directly on the line C E. Through these small figures, 1 to 6, in the upper half of the

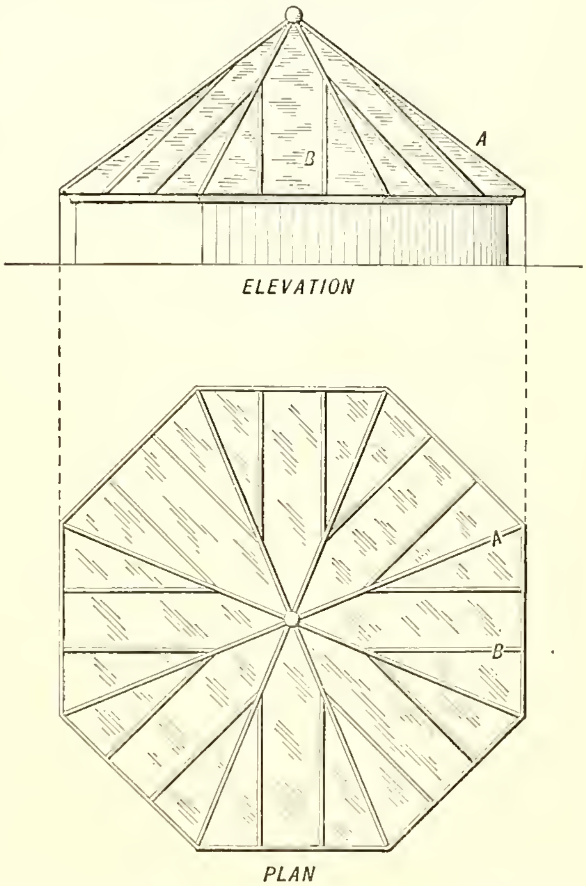


Fig. 508.—Plan and Elevation of Octagonal Skylight Having Intersecting Hips

bar, draw lines parallel to C E cutting the center line C D in plan from 1 to 6 and intersecting lines drawn vertically from similar numbers, 1′ to 6′, in the profile A, thus obtaining the miter line in plan, between the hip bar and curb, as shown from 1′ to 6′. From the intersections, 1 to 6, on the center line C D in plan erect perpendicular lines cutting similarly numbered lines in the sectional view, as shown from 1° to 6°.

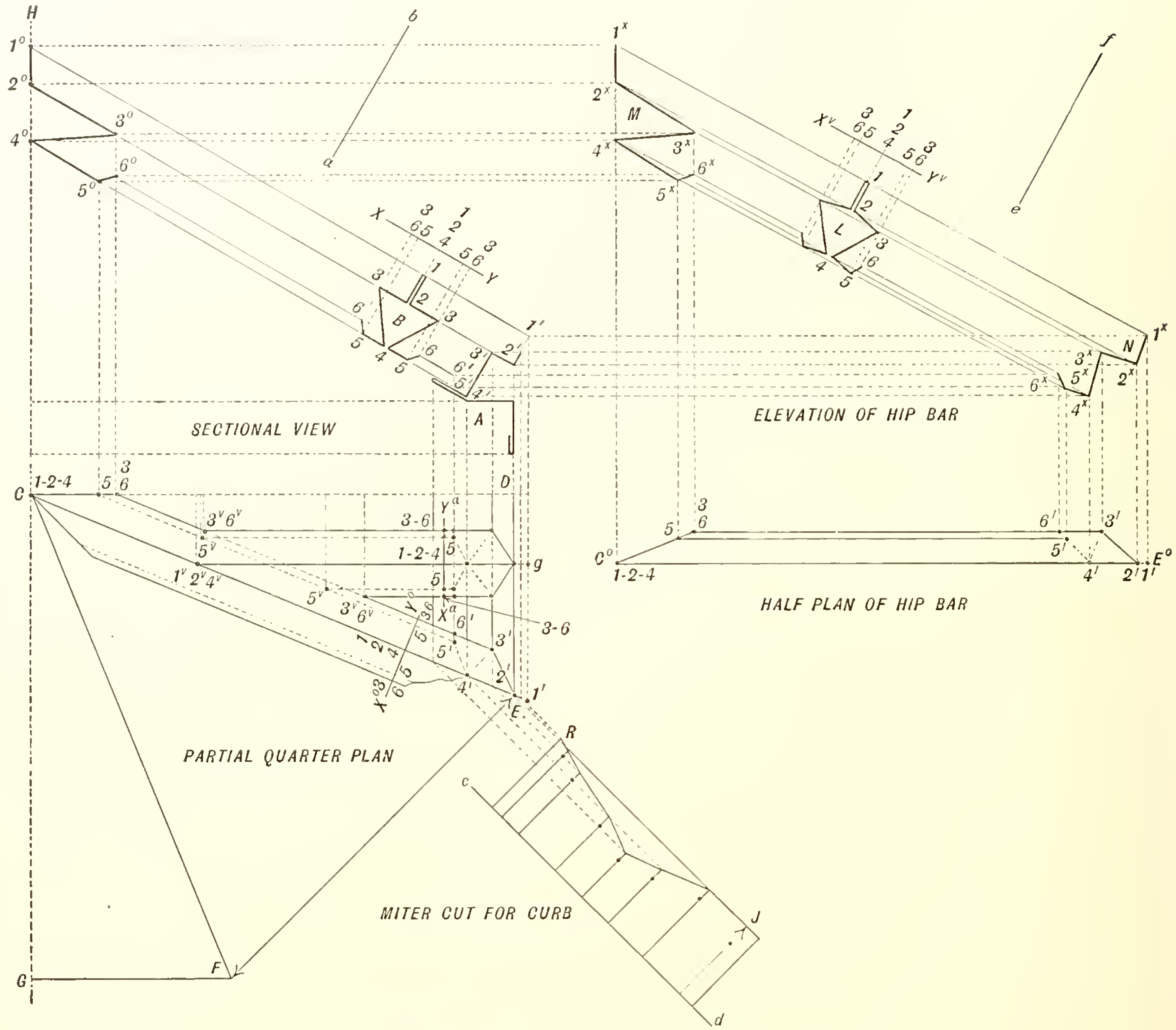


Fig. 509.—Patterns for Curb and Bars in an Octagonal Skylight

These points of intersection are used in obtaining the pattern for the hip bar, as follows: Take a tracing of the upper half of the hip bar as shown by C, 6, 3′, E and place it in a horizontal position, as shown by C°, 6, 3′, E° at the right. From the various intersections, 1 to 6 in C° and 1′ to 6′ in E°, erect perpendicular lines; intersect them by lines drawn parallel to C° E° from similarly numbered points, 1° to 6° and 1′ to 6′ in the sectional view, thus obtaining the intersecting points 1ˣ to 6ˣ in both M and N in the elevation of the hip bar. Connect similar points in the miter lines M and N, as shown.

Take a tracing of X° Y° in the plan view, with the various intersections thereon, and place it above the line 1ˣ 1ˣ in the hip bar elevation in the position shown by Xᵛ Yᵛ. At right angles to Xᵛ Yᵛ and from the small figures thereon draw lines cutting similar lines in the elevation of the hip. Trace a line through points thus obtained. The profile L will be the profile of the hip bar.

The pattern for the hip bar may be laid out as follows:

Take the girth of the hip bar L and place it on the line *e f* drawn at right angles to 1ˣ 1ˣ. Draw the usual measuring lines and intersect them by lines drawn parallel to $c\ f$ from similarly numbered intersections in the miter lines M and N, which will give the pattern for the hip bar, shown by A in plan and elevation in Fig. 508.

To obtain the pattern for the jack bar, marked B in plan and elevation, proceed as follows:

Take the divisions on the line X Y in the sectional view in Fig. 509 and place them, as indicated by the line $X^a\ Y^a$ in plan, which is drawn at right angles to C D, taking pains to place the intersection 1, 2, 4 upon the line $g\ 1^v$, which may be drawn at will. Through the small figures on $X^a\ Y^a$, draw lines parallel to $g\ 1^v$, thus obtaining the miter line between the hip and jack bars in plan, as shown from 1^v to 6^v. From the various intersections, 1^v to 6^v in plan, erect lines (partly shown) which should intersect similarly numbered lines in the sectional view in the same way that the miter line of the jack bar was obtained in the sectional view in Fig. 489. Then the pattern for the jack bar in Fig. 509 may be developed in the usual manner, laying off the girth of the profile B on the line $a\ b$ drawn at right angles to the pitch of the skylight.

To obtain the octagonal miter pattern for the curb A, take this girth and place it on the line $c\ d$, drawn at right angles to the curb line E F in plan. Draw the usual measuring lines and intersect them by lines drawn parallel to $c\ d$ from similar intersections on the miter line C 1′, all as shown by the dotted lines. J R then represents the miter cut, and all measurements must be taken from the curb line J in the pattern to the required length of one side of the curb, as indicated by the arrow points E to F in plan.

A VALLEY BAR

Solution 158

Fig. 510 gives a perspective view of a pitched skylight having an interior and an exterior angle. On the exterior angle a hip bar becomes necessary, while in the interior angle a valley bar is required. Note that in the hip, the jack bars intersect the hip bar from the bottom up, while in the valley bar the jacks intersect the valley from the top down. The method of constructing the valley bar and obtaining the pattern therefor is shown in detail in Fig. 511.

The ridge line C F is first drawn. Then the sectional view is constructed to show the profiles of the curb A, the ridge bar B and the common and jack bars E. Above this sectional view is shown the plan of the interior angle of the skylight, H C representing the center line of the valley bar. On either side of this center line C H in plan lay off about 3 in., making the width of the metal valley about 6 in., indicated by the arrows. Number one-half of the profile E in the sectional view, as shown by the small figures, 1 to 6, and above the profile E draw the short line $a\ b$ parallel to the pitch of the skylight. Project the points 1 to 6 to the line $a\ b$, as shown. Transfer the spaces on $a\ b$ to the line $a'\ b'$ in plan, which is drawn at right angles to C H, taking care to have the points 1, 2, 4 come directly on the line L, as shown. Through these small figures, 1 to 6, draw lines parallel to C H, intersecting lines erected from similarly numbered intersections between the bar and curb and ridge in the sectional view. Through points thus obtained draw the miter lines in plan, as shown from 1′ to 6′ at top and bottom. It will be noted that only the lower part of the valley bar in plan appears in the engraving. It serves all requirement, as the opposite or upper side is alike. Since the jack bars intersect the valley bar from the ridge down, draw any line at right angles to C F in plan, as c 2; on either side of this line, lay off double the projection of the spaces on $a\ b$ in the section view, shown by $a''\ b''$ in plan, taking pains to have the points 1, 2, 4 placed directly on the line c 2. Through

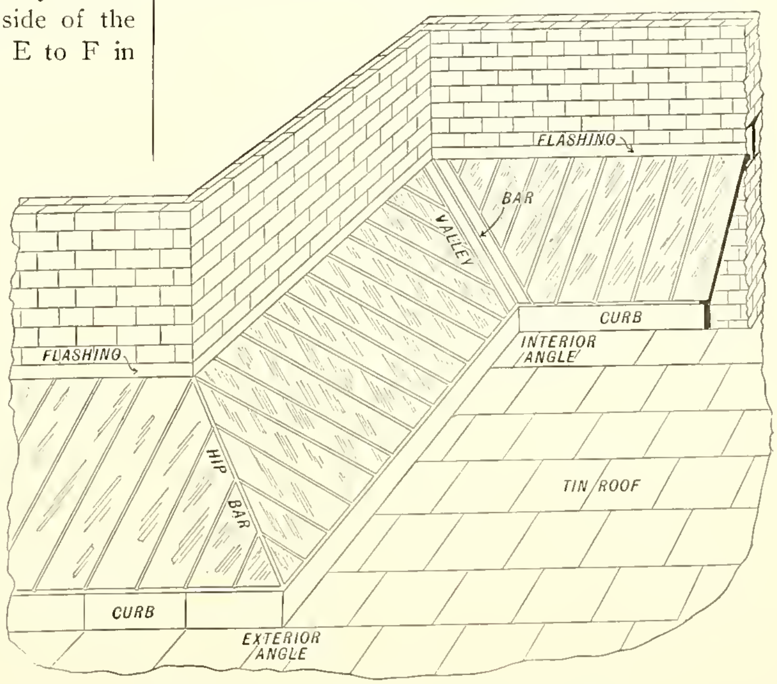


Fig. 510.—View Showing Location of Valley Bar

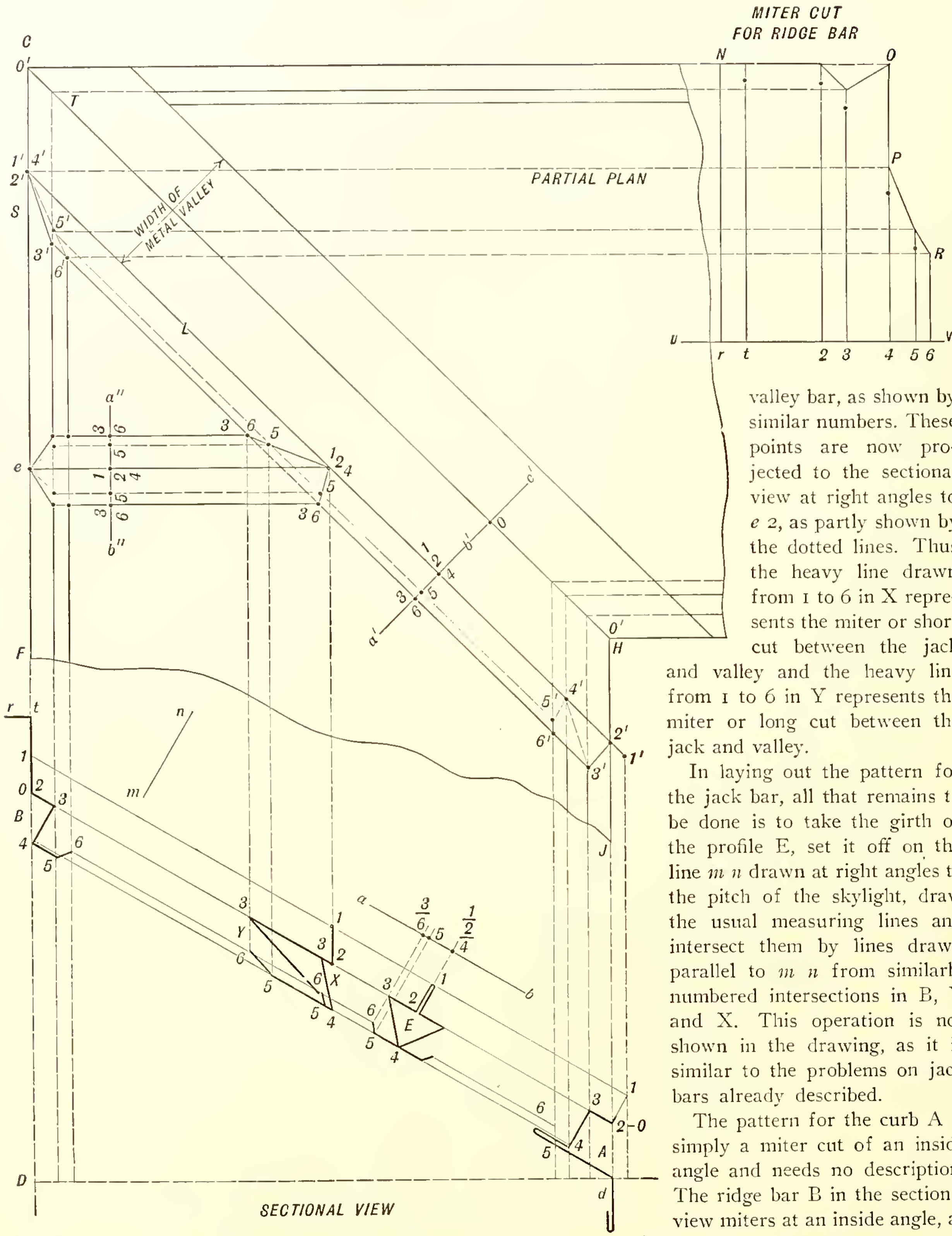


Fig. 511.—Obtaining Sectional View, Plan and Miter Lines for Jack, Common and Valley Bars

these small figures, 1 to 6, and parallel to *e* 2, draw lines which intersect similarly numbered lines in the valley bar, as shown by similar numbers. These points are now projected to the sectional view at right angles to *e* 2, as partly shown by the dotted lines. Thus the heavy line drawn from 1 to 6 in X represents the miter or short cut between the jack and valley and the heavy line from 1 to 6 in Y represents the miter or long cut between the jack and valley.

In laying out the pattern for the jack bar, all that remains to be done is to take the girth of the profile E, set it off on the line *m n* drawn at right angles to the pitch of the skylight, draw the usual measuring lines and intersect them by lines drawn parallel to *m n* from similarly numbered intersections in B, Y and X. This operation is not shown in the drawing, as it is similar to the problems on jack bars already described.

The pattern for the curb A is simply a miter cut of an inside angle and needs no description. The ridge bar B in the sectional view miters at an inside angle, as at C in plan, and the gutter of the ridge B miters with the gutter of the valley bar, as shown by the dotted lines 4′, 5′ and 6′ in the miter line S in plan.

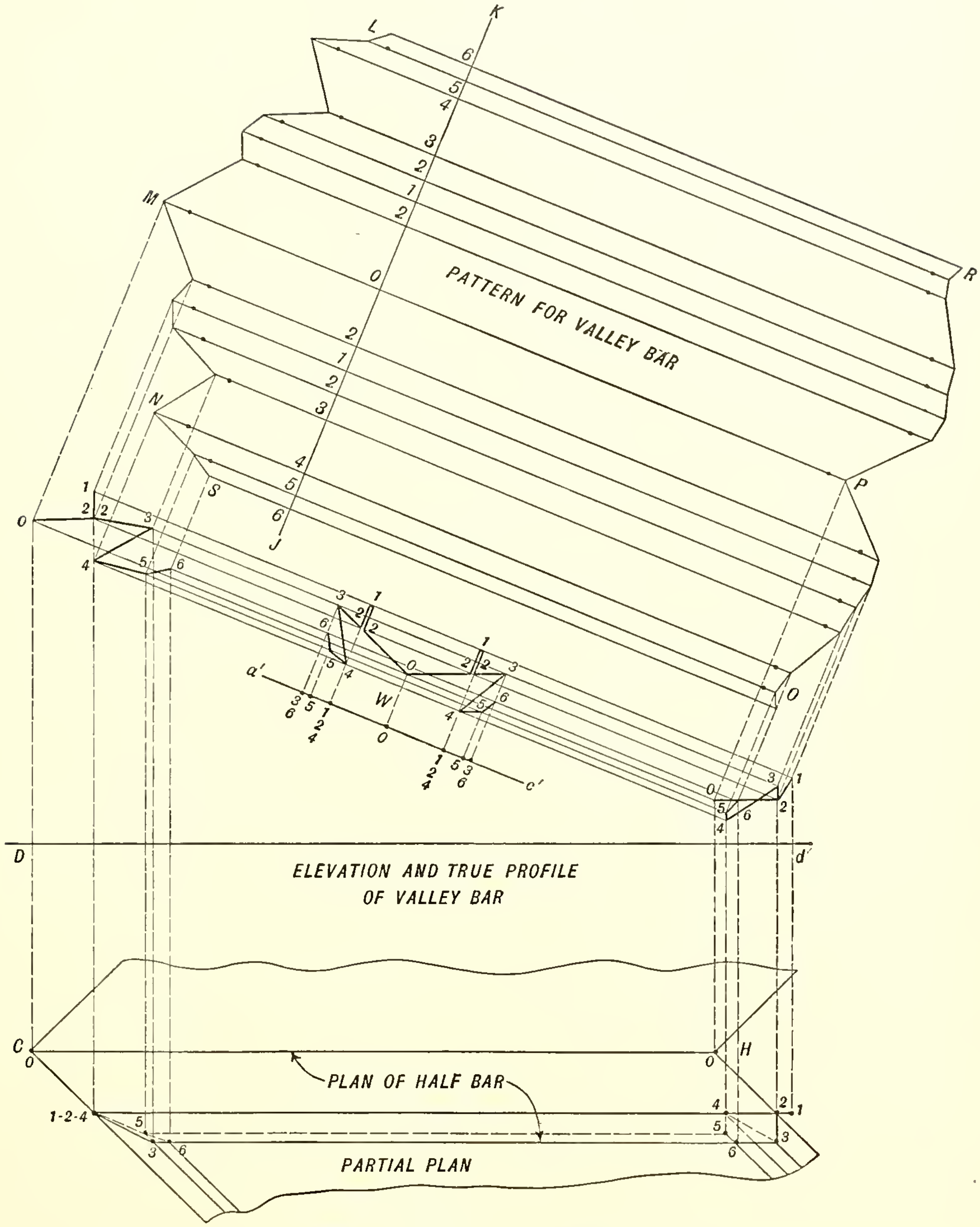


Fig. 512.—Pattern for Valley Bar

To obtain these two cuts proceed as follows: Draw any line at right angles to F C in plan, as shown by *u v*; on this place the girth of the ridge bar B in the sectional view, as shown by similar letters and numbers on *u v*. Through these small figures and at right angles to *u v* draw lines and intersect these lines by lines drawn parallel to *u v* from similar points of intersection on the miter line O′ T and S in plan. Trace a line through points thus obtained. N O P R will be the desired miter pattern.

Referring to the upper part of the jack bar where it miters with the gutter of the ridge bar, this miter cut is obtained, as was explained in connection with Fig. 457, where was obtained the cut A° in the pattern for back of curb.

The method of obtaining the pattern for the valley bar is shown in Fig. 512. Take a tracing of the half valley bar C H in plan in Fig. 511, and place it in a horizontal position, as shown by C H in Fig. 512; from the various points of intersection, 0 to 6 in H and 0 to 6 in C, erect perpendicular lines to any hight. Parallel to C H draw any line, as D *d*. Measuring from the line *d* D in the sectional view in Fig. 511 take the various distances to points 0 to 6 in the profile A, also to points 0 to 6 in the profile B, and place them in Fig. 512 upon lines drawn from similar numbers in plan, measuring in each instance from the line D *d* thus obtaining the points of intersection at the bottom or curb and at the top or ridge, both miter lines being indicated by the heavy lines drawn from 0 to 6. Connect these points by lines, as shown, thus obtaining the elevation of the valley bar.

The true profile of the valley bar must now be found, as follows: Extend the line *a′ b′* in plan in Fig. 511 as *a′ c′* and transfer the divisions from 0 to 6 on this line, as shown from 0 to 6 on both sides on the line *a′ c′* in Fig. 512, drawn parallel to the pitch of the valley bar. At right angles to *a′ c′* and from the various figures thereon, erect lines, which will intersect lines having similar numbers in the elevation. The lines are indicated also by the small figures 6 to 0 to 6, through which points the profile of the valley bar is traced. Note the formation of the bar and be careful to make the hight of the standing edge, 1-2 on either side, no more than the thickness of the glass to be used, thus allowing the water to flow off readily into the metal valley.

The pattern may now be laid out. Take the girth of the profile W and place it on the line J K drawn at right angles to the pitch of the valley bar. Through these small figures and at right angles to J K draw lines and intersect them by lines, drawn parallel to J K from similarly numbered points of intersection in both miter lines in the elevation of the valley bar. Trace a line through points thus obtained. L M S O P R will be the desired pattern.

The cut on the condensation gutter at N S will miter with the cut on the condensation gutter of the ridge bar, shown by P R in the ridge bar pattern in Fig. 511.

CONSTRUCTION OF A RAISING SASH

Solution 159

A perspective view of a raising sash is given in Fig. 513. A sash of this nature is used to provide for ventilation. When the sash is not too long, it is usually raised its entire length, as shown in the engraving, and is operated by means of gearings as explained under Terms and Definitions. If the sash be of such length that it cannot be raised in its entirety the upper part is arranged to open, as from *a′* to *b′*.

The method of developing the patterns for a sash of this nature is alike to that by which the patterns for a flat skylight are obtained, the consideration of main importance being the constructive features for avoiding leaks, to which relates the illustration of Fig. 514.

Here is shown a constructive section through *a b* in Fig. 513. A in Fig. 514 indicates the formation of the upper curb, so arranged as to rest upon the flange of the I beam. B shows the profile of the half bar or side bar of the raising sash, mitering at the top with the upper sash bar, formed in one piece from *a* to *b*. The formation of the weather cap is indicated from *c* to *d* and so arranged that

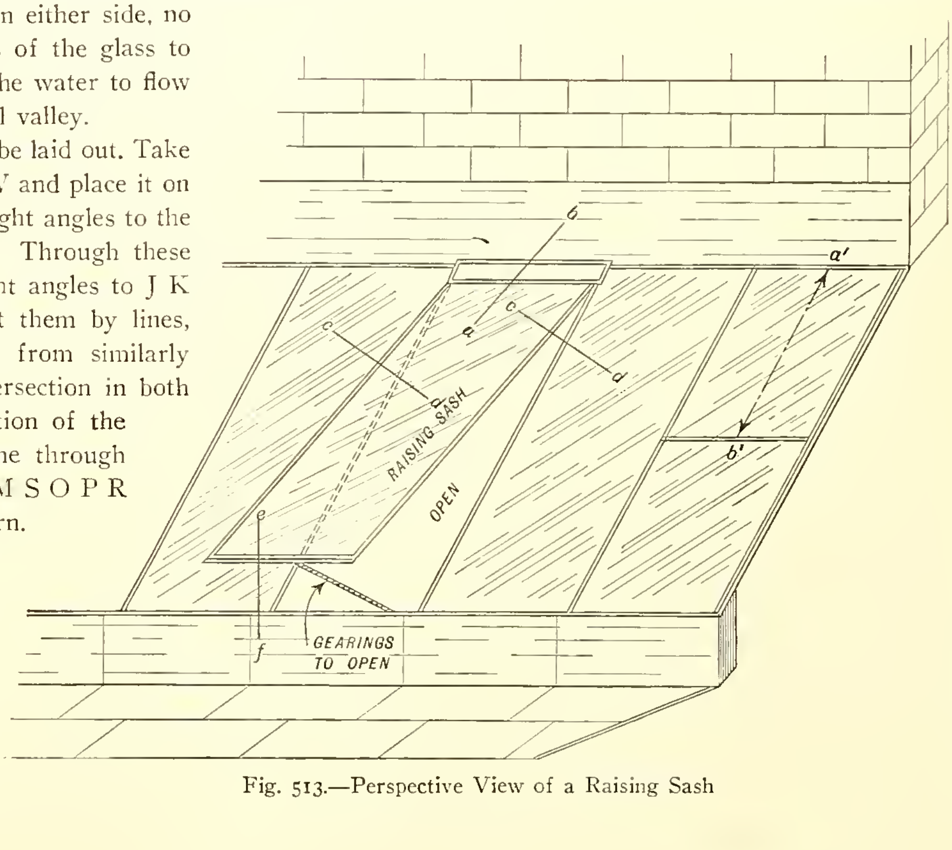


Fig. 513.—Perspective View of a Raising Sash

the cap enters the brick joint at *d* and with a hooked arrangement at *c*, so that when the sash is closed it locks at *a* and forms a weather-proof connection. Should fine snow or rain penetrate at *c*, the dripping runs out through small weep holes cut at the lowest part of the cap

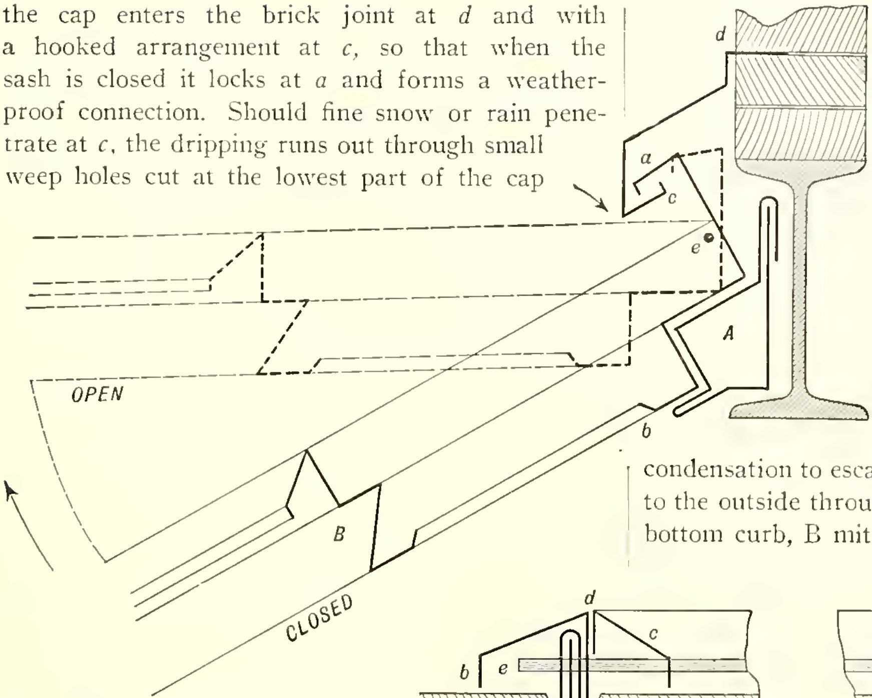


Fig. 514. — Constructive Section through *a b* in Fig. 513

hood, indicated by the arrow. The dotted lines and section indicate the appearance of the sash when open, swinging on the pivot *c*.

sash bars at *d* and *d*. *c c* indicates the pivot shown by *c* in Fig. 514 and is made of hard brass wire 3/16 in. thick.

A detailed working section through *e f* in Fig. 513 is shown in Fig. 516. A shows the main curb over which the sash curb B operates. It is formed as shown from 1 to 2, with weep holes cut in the corner *a* of the sash curb, permitting the condensation to escape to the curb A, where it passes to the outside through the weep holes cut at *b*. This bottom curb, B miters with the side sash bar, indicated by C, which overlaps the half bar D, as described in connection with Fig. 515.

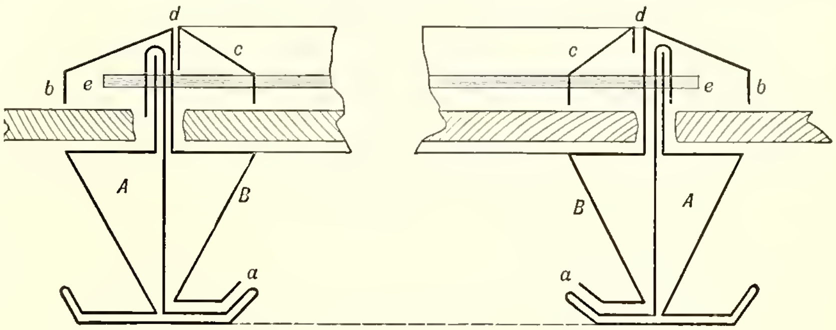


Fig. 515.—Constructive Section through *c d* in Fig. 513

A detailed section through *c d* in Fig. 513 is shown in Fig. 515. Here A and A show the two half bars, while B and B show the two sash bars, overlapping the glass laid in the half bars at *b* and *b*. On the bottom of the sash bars, gutters are formed, as shown by *a a*. *c c* shows the half caps, which are soldered to the

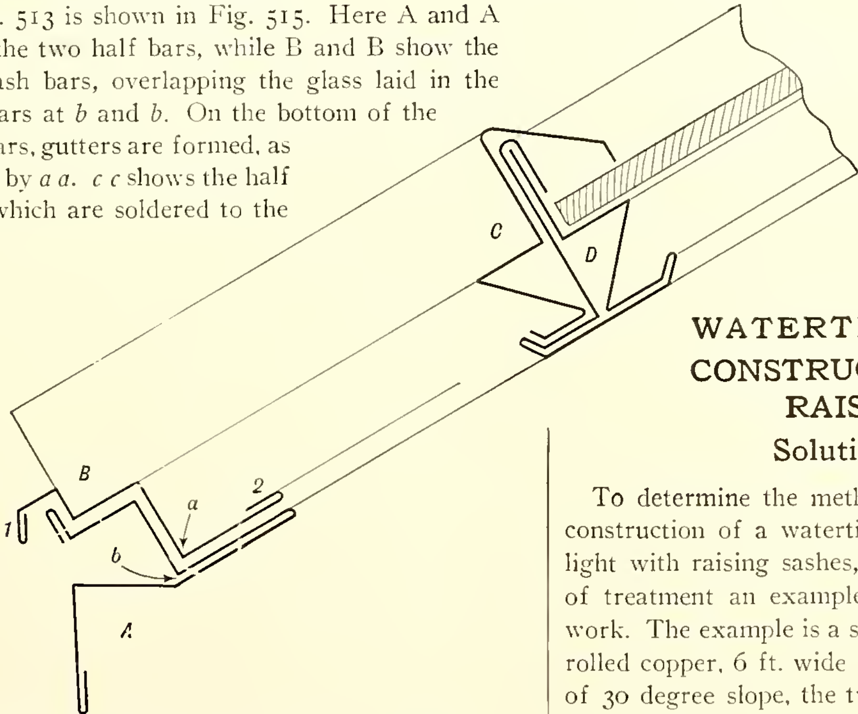


Fig. 516.—Sectional View through *e f* in Fig. 513

WATERTIGHT SKYLIGHT CONSTRUCTION INVOLVING RAISING SASHES

Solution 160

To determine the methods to be followed in the construction of a watertight and storm proof skylight with raising sashes, we may take for purpose of treatment an example of successfully executed work. The example is a skylight made of 18 oz. cold rolled copper, 6 ft. wide 14 ft. long, double pitched, of 30 degree slope, the two sides raised to the full 14 ft. length, see Fig. 517.

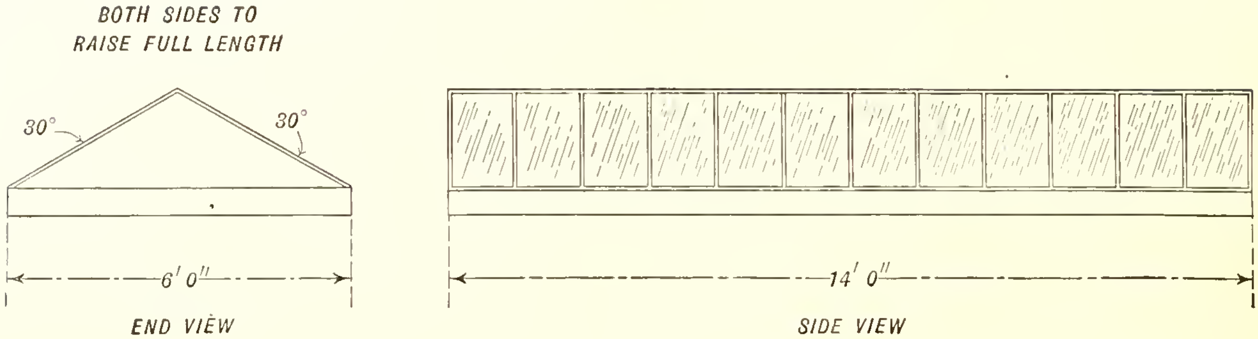


Fig. 517.—End and Side View of Skylight

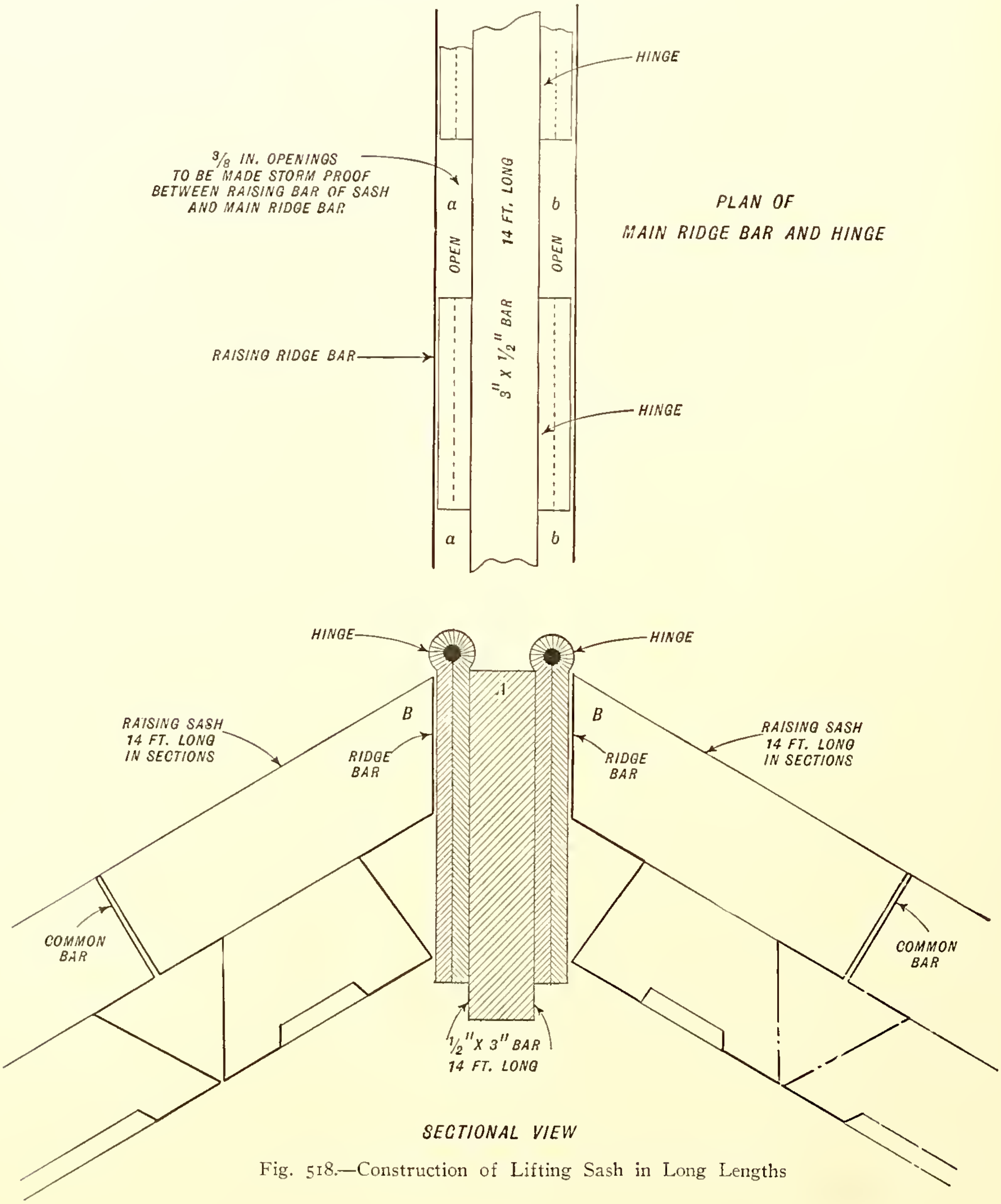


Fig. 518.—Construction of Lifting Sash in Long Lengths

The raising sashes on both sides of the sloping skylight were hinged to a main ridge bar made of 3 x ½ in. bar iron, shown in the sectional view in Fig. 518. The problem presented for solution is that of obtaining a tight connection against rain, snow and wind over the openings, which occur between the main ridge bar and raising sash bar, shown by the spaces between the hinges, and indicated by the arrows *a* and *b* in the plan of main ridge bar and hinge. Referring to the sectional view it will be observed that the hinges are riveted to the main ridge bar A and the raising ridge bar B. Two hinges are used for each light shown in the side view in Fig. 517, and between each hinge a ⅜ in. opening remains, as indicated by *a* and *b* in the plan view in Fig. 518. An ordinary ridge cap would prove of no value, because the raising of the sash would break it off.

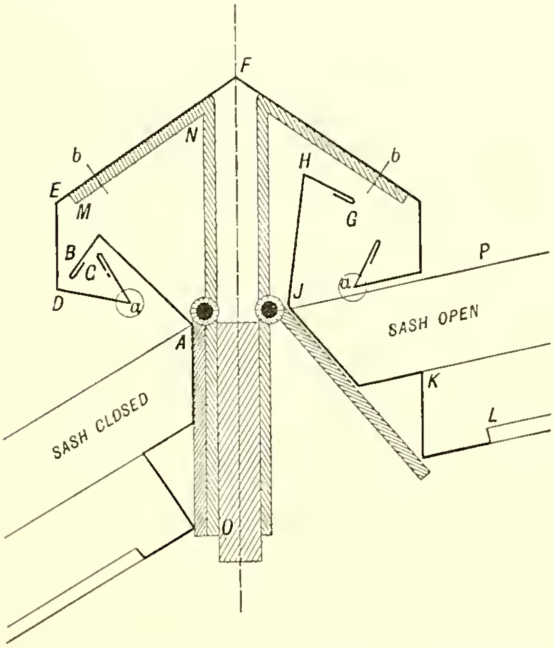


Fig. 519.—Operating Lifting Sash in Long Lengths

The method indicated in Fig. 519 has worked to the utmost satisfaction in practice. Simply add to the ridge bar at A the louvre formation shown by A-B. Over this form a hood, as shown by C-D-E-F, and secure the hood by putting a sheet metal head at each end, and at intervals of 24 in., rivet to the main ridge bar, ⅛ in x 1 in. band iron braces, as shown by M-N-O. The lower edge of the hood D-*a* should run at an incline and holes should be punched at intervals of 12 in. in the corner *a,* before bending, to allow for the escape of drip and driving rain or snow. A bolt in the hood brace at *b* secures the metal hood. Thus it will be seen that when the sash is closed, as indicated at the left, ventilation is secured through the ⅜ in. spaces between the hinges, along the 14 ft. ridge, and escape of air occurs along B-C and *a*. The right side of the cut shows the sash in an open position, as indicated by G-H-J-K-L. Care must be taken to adjust the operating gears of the raising sash so that they do not raise the sash above P, to avoid breakage of the hood.

CONSTRUCTION OF STATIONARY AND MOVABLE LOUVRES

Solution 161

Louvres are illustrated in the perspective view in Fig. 520. They are constructed to be stationary or

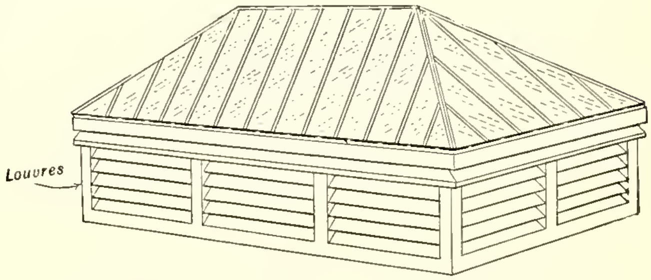


Fig. 520.—View of Stationary and Movable Louvres

movable. Movable louvres are operated by means of cord, chain and pulley, the larger sizes, however, by means of gearings, which are illustrated under Terms and Definitions.

The constructive details of stationary or fixed louvres are shown in Fig. 521. A, in plan shows the formation of the corner posts, made up in two pieces and locked at *a* and *b*. The center post indicated by B is bent in two parts and locked at *c* and *d*. Against this projecting flange *a d* and *c* the louvres are placed, as shown in the illustration. C indicates the formation of the curb setting over the roof frame. Note that a louvre is added to this curb, shown by *f*. The middle louvres are formed as shown by D D, care being taken that bend *f* lies in the same line as bend *e,* as shown by the dotted lines *e f*. If desired, the louvres may be set closer together. The upper louvre is shown by E, making the hight of *h* about ½ in. Over these posts, A and B in plan, the skylight curb is set, as shown by F.

Movable Louvres

Louvres to open and close are constructed as shown in Fig. 522. Note that the louvres are so

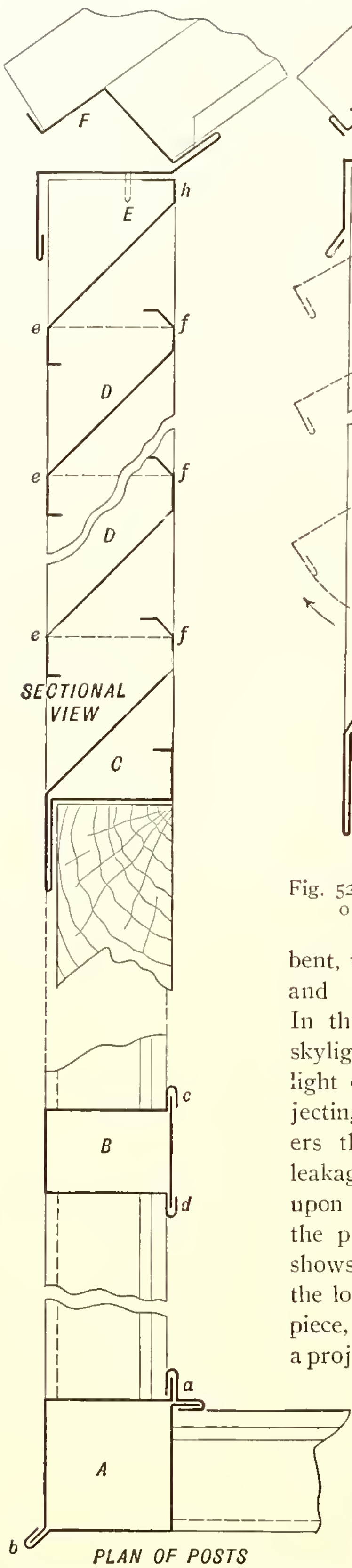


Fig. 521.—Constructing Stationary Louvres and Posts

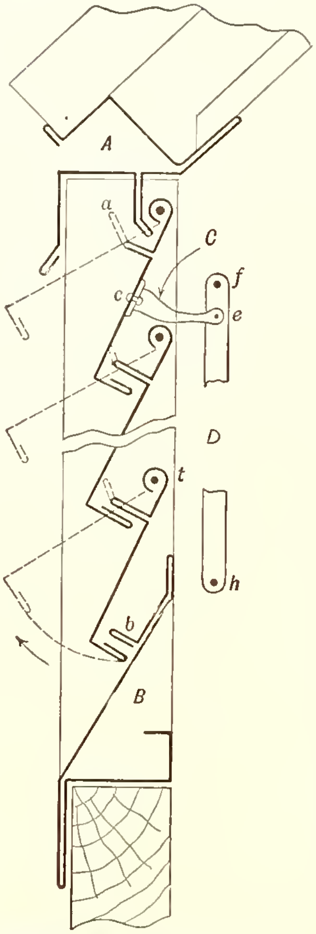


Fig. 522.—Constructive Section of Movable Louvres

bent, that they overlap well and are weather proof. In this case A shows the skylight curb of the skylight overhead with a projecting lip at *a*, which covers the pivot, to prevent leakage. The curb A rests upon posts illustrated in the preceding diagram. B shows the formation of the lower curb, bent in one piece, as indicated, with a projecting flange at *b*. The operating louvres are formed, as shown, with a pivot in the wired edge, indicated by the heavy dot. The solid lines of the louvres show them closed, and the dotted lines show them open. In operating the louvres, a band iron strip, D, is used; to this the arm C is pivoted at *e* and riveted to the louvres at *c*. The louvre is opened by raising strap D. The length of the arm C limits the action; when the strap D comes in contact with the beaded edges at *t*, the louvre will open no farther. If chain and pulley be used to open and close the louvre a hole is required in the strap D at *f* and *h*. If it be operated by gearings the hole at *f* is not requisite.

See Gearings in Terms and Definitions.

CONSTRUCTION OF MOVABLE SASHES IN A TURRET SKYLIGHT

Solution 162

Fig. 523 presents a perspective view of movable sashes in a turret skylight, whose upper light may be either flat, double pitched or hipped. The patterns

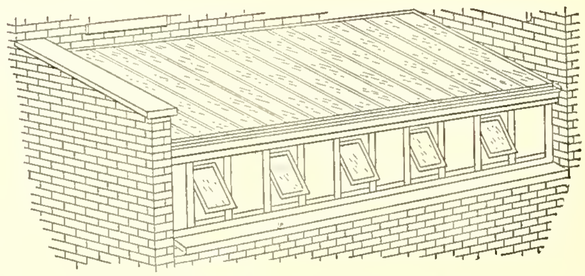


Fig. 523.—View of Skylight Equipped with Movable Sashes

for these operating sashes consist simply of square and butt miters which require no further attention than has been given.

The consideration of main importance is that of the construction. Shops employ various methods of constructing this movable sash, the determining principles being much the same in all cases.

An acceptable method of construction is shown in Fig. 524, which shows a carefully drawn constructive sectional view. In the diagram, X shows the curb, over which is set the lower metal curb, formed as indicated from A to B. On to the pitch of this lower curb A B, the posts indicated by C, C°, miter. Note that the post is made up in two sections, locked as indicated at 1 and 1 in the upper section C.° The post joins the upper rail D; it is made up in one piece, with a lock at 2 and a weather cap turned at an angle formation as at 3. Over this top rail D the combined skylight curb and gutter is set, bent as shown from E to F to G to H to J. Short leaders are connected to the bottom of the gutter, to conduct the water to the main roof, indicated by K. The for-

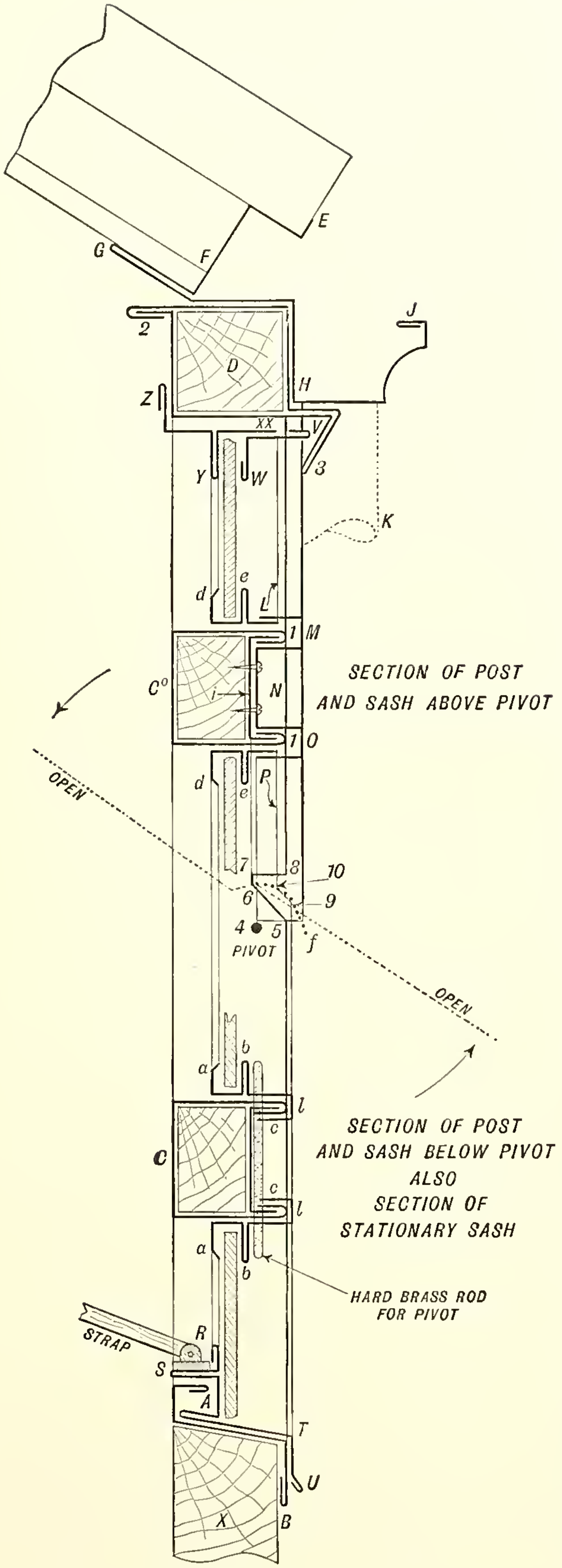


Fig. 524.—Section View Showing Details of Construction of Movable Sashes

mation of the sash below the pivot is shown on both sides of the lower post section C, by *a b c*. The edge *a* can be bent to accommodate the thickness of glass in use. *b* forms a rabbet for the glass, and *c* locks over the standing edges of the post, as shown.

The formation of the sash above the pivot 4 is alike to *a b c*, with the exception of the omission of lock *c*, as indicated by *d e* 1, on both sides of the upper post section C°. The pivot passes through the standing seams on the outside of the post and sash, as indicated by the hard brass rod *b b* in the lower section C. The rods are usually 3/16 in. thick.

In line with the center of the rod *b b* establish the pivot center in the post, as shown by dot 4. From the top of the pivot 4 draw a horizontal line to the right meeting the outer edges of the standing seam *c c* of the post C at 5. From 5 draw an angle of 45 degrees cutting the line of the post *i* in C° at 6. Make the vertical distance 6 to 7 not to exceed ¼ in. and draw the horizontal line 7-8, cutting the standing edges of the posts 1-1 in C° at 8. 5-6-7-8 shows how the standing edges of the posts are cut out. Using the pivot center 4 as center, with a radius equal to 4-6, draw the dotted arc 6 *f*, intersecting the line erected from the outer edge of the sash *l l* in C at 9, and the outer edge of the sash *d-e* in C°, as P and L at 10. Draw a line from 9 to 10.

If the sash turn on the pivot 4, the sash angle 9 comes in contact with the post angle at 6 and leaves the sash open in the position shown by the dotted line.

The perspective view in Fig. 525 makes this clear and shows the right side of the sash, indicating its formation, its angle cut 9-10, and pivot hole. To prevent leakage between the sash and post at the pivot, a capping is set over the upper part of the post C°, Fig. 524, forming it as shown by L M N O P in the upper post section C°; it is fastened with two brass screws, as shown, and should reach down slightly below the top of the pivot, as indicated by *f*.

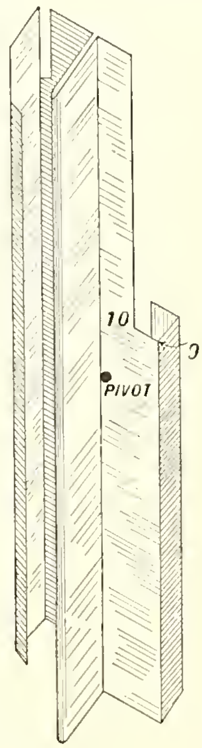


Fig. 525. — View Showing Right Side of Sash

R S A T U shows the formation of the lower part of the sash, indicating at A, its lock to the flange of the main curb A B. A hinge is fastened to the double flange at S; to this the straps are pivoted. At the top, V W is a plain angle, capping the glass at W; when the glass is in position, this angle V-W is tacked with solder, at intervals along XX to the upper part of the sash X-X-Y-Z. When the sash is closed the projecting lip V enters the V shaped formation at 3 and the rear flange Z lies against the upper rail D, thus making a snug joint.

If sashes are to remain fixed or stationary, the entire side is bent in the same way as the section C below the pivot, shown by *a b l c*.

In the turret skylight here shown, no special corner posts are provided. All are bent, as shown by section C. If a corner be made, two posts are set

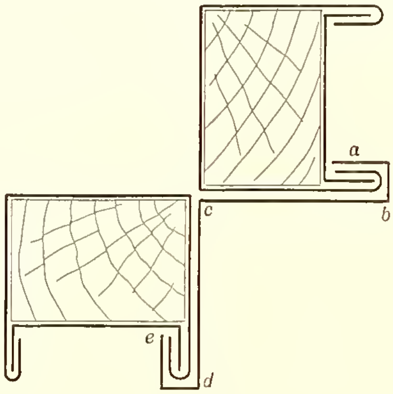


Fig. 526.—Obtaining a Weather Tight Joint between Corner Posts

together, as shown in Fig. 526, and a water protected corner is obtained by forming a tight angle at *a b c d e* locking this on the standing seams of the post, as shown.

BENDING THE TOP RAIL

The formation on the brake of the top rail D in Fig. 524, including the lock 2 and the V groove 3, is shown in Figs. 527 and 528. This rail is first formed, as shown by A in Fig. 527. Then the angle

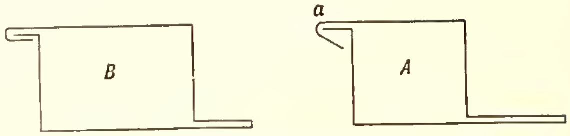


Fig. 527.—Bending the Top Rail D in Fig. 524

a is pressed down between the jaws of the brake, giving it the appearance indicated by diagram B. This finished rail B is then reversed, placed in the

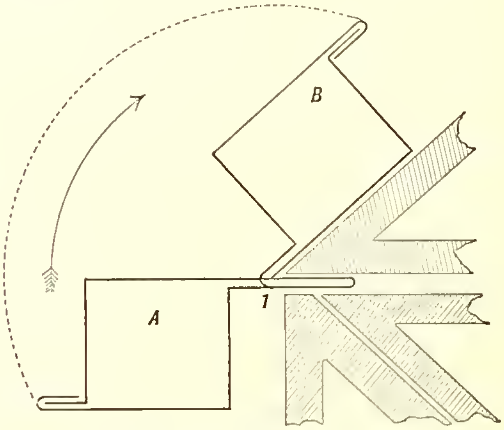


Fig. 528.—Bending the Weather Cap

brake, as shown in Fig. 528, and at the proper position 1, A is turned over as far as the brake action permits, bringing A into the position shown by B; this completes the bending.

The various other bends required on these turret lights must be carefully formed to their respective profiles. If accurately formed, the assembling of the various sashes, curbs, posts, etc., will be facilitated.

CONSTRUCTION AND PATTERNS OF CURBLESS FLAT SKYLIGHT

Solution 163

For a skylight constructed without a curb, similar to that shown in Fig. 529, the method of detailing the various sheet metal frames is unlike that applied to the shapes generally used. This style of skylight is usually employed where the roof covering is of metal, and

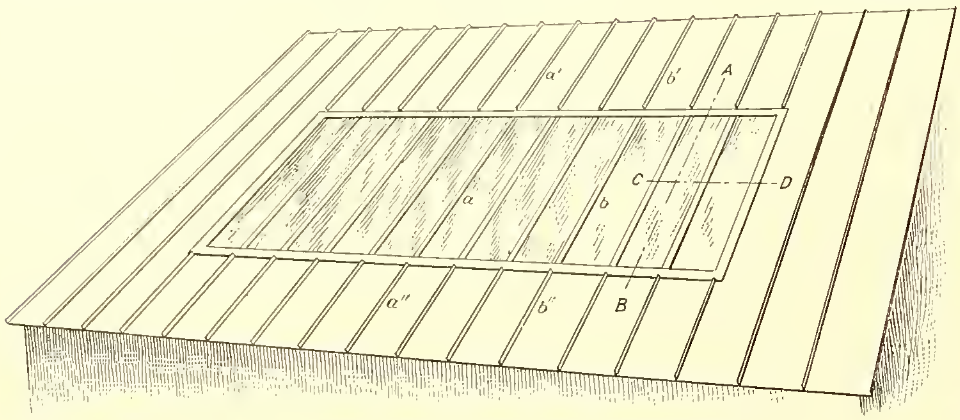


Fig. 529.—General View of Roof with Curbless Skylight

particularly so when battens or standing seams occur, when the bars are spaced to correspond to the widths of the battens or seams, giving the effect, when viewed from below, of the ribs and seams continuing in one line. This will be better understood by referring to the illustration, where the skylight bars are spaced so as to be in line with the standing seams of the roofing. Thus a and b are in line with the seams a' a'' and b' b'' respectively.

The first step in constructing a skylight of this kind is to obtain measurements at the building. This

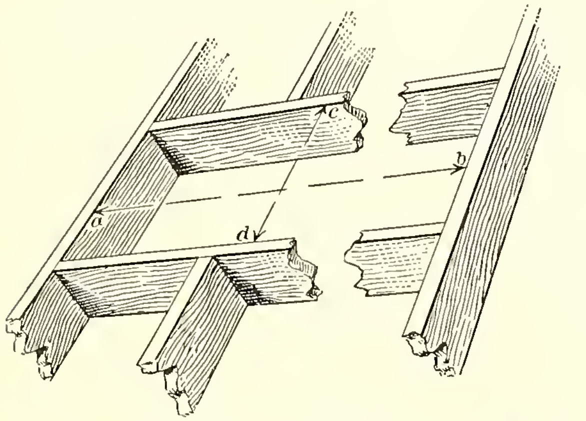


Fig. 530.—Showing How a Curbless Skylight is Measured

may be accomplished as shown in Fig. 530, where the framing on the roof is ready for measurements. With the corners forming right angles, measurements are taken from inside to inside, both ways, as from a to b and c to d. If, for example we have a measurement of 20 ft. × 6 ft., then in laying out the pattern for the metal frame the measurement would be considered as 19 ft. 11½ in. × 5 ft. 11½ in. This gives one-half inch play either way and allows the skylight to slip in easily between the beams.

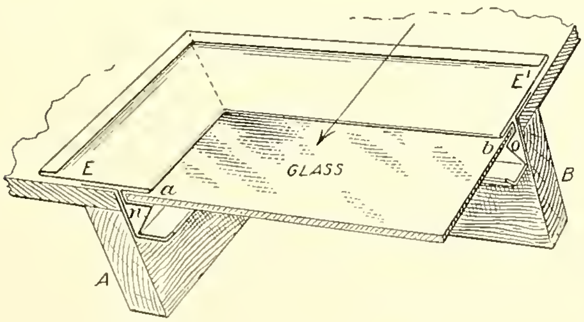


Fig. 531.—View of Top and Side Frames

Fig. 531 is a perspective view, showing the formation of the top and side metal frames. A shows the side frame with a lock at E, while B is a similar shape used for the top frame with a lock at E^1. The formation of these frames is such as to give a hem edged cap, under which the glass is placed as at a and b. The water coming down in the direction of the arrow passes over this cap and thus prevents leakage.

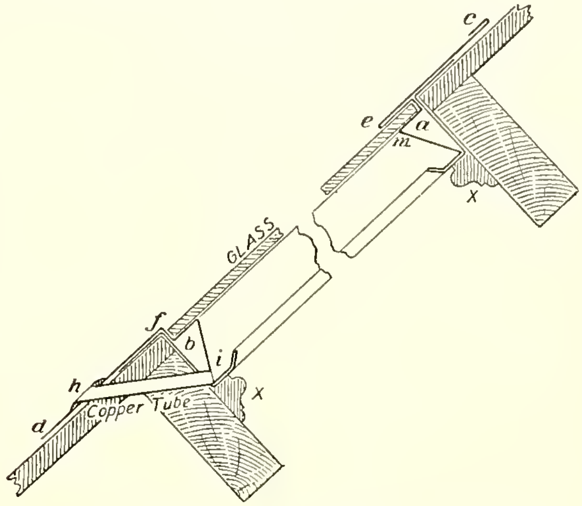


Fig. 532.—Sectional Detail through *A B* in Fig 529

Fig. 532 is a sectional detail through A B of Fig. 529 and shows the method of construction. In Fig. 532, a is the profile of the top frame with a folded edge cap flashing at c and a lock at c to which the metal roofing is connected. In the groove formed between a and e, the glass is placed, it being well bedded in white lead putty, which makes a tight joint. Any putty projecting on the inside, as at m, should be cut off smooth with the putty knife. b shows the formation of the lower skylight frame, sufficient material being allowed from f to d that connection can be made to the metal roofing by locking and seaming. Again at f, the glass should be bedded into a good layer of white lead putty; should a leak occur at this joint or should condensation take place on the inside, it is received in the drip gutter at i and is carried to the outside by means of the copper tube h. These tubes are usually placed under each alternate light of glass. The holes are punched in the metal frame b before bending; then the frame is set in the wooden frame and the position of the holes is marked. The metal frame is then removed and holes are bored through the wood work by the carpenter. When the metal frame is set in position, the copper tubes are passed through from the outside. Care must be taken to solder tightly around the roof at h and inside of the drip gutter at i. If required to prevent snow blowing in at h, a small shield is soldered over the opening at i. Underneath the drip gutters on all four sides a wooden mold is placed as at X and X.

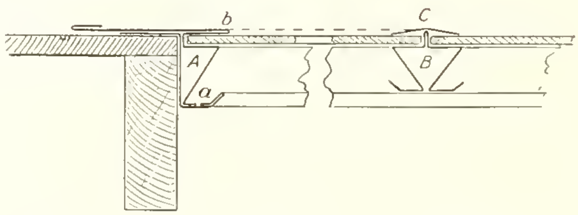


Fig. 533.—Sectional Detail through *C D* in Fig. 529

Fig. 533 shows a sectional detail through C D in Fig. 529. A in Fig. 533 shows the profile of the side frames which is similar in shape to that of the top *a* in Fig. 532. B in Fig. 533 shows the profile of all the common bars. It should be noted that the top of the bar between B and C is made only so high as to pass under the groove *e* in Fig. 532 while the bottom of the bar B in Fig. 533 passes over the drip gutter *i* in Fig. 532 and is flush with *f*. The glass is also bedded to the common bar B in Fig. 533 and over these joints a metal cap C, is fastened, the upper edge of the cap passing under the hem edged cap *e* at the top in Fig. 532. The fastening of the cap C in Fig. 533, is accomplished as shown in Fig.

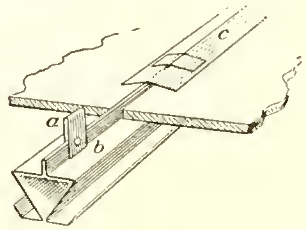


Fig. 534.—Fastening Cap on Bar

534, in which *a* shows a soft copper clip, one-half inch wide and about one inch long, doubled over as shown and riveted through the bar at *b*. These clips are placed about 18 in. apart. After the glass has been laid in putty, slots are cut through the top of the cap C, as shown; then the cap is set over the clip *a*, pressed down firmly, the bent edge of the clip is cut off with the shears and the parts are turned right and left over the cap, as shown, and well soldered.

When the patterns are laid out for a skylight of this kind, only one pattern is required for the four sides; it is developed as shown in Fig. 535. A is the profile for the side and top frame and is so placed that the line 11-12 will be vertical, as shown. All the bends in the profile should be numbered, as shown from 1 to 13. Parallel to 11-12 draw the line B C, upon which place the girth of the profile A, as shown by similar numbers. Through the points indicated by the small figures draw the usual measuring lines at right angles to B C and intersect them by lines drawn parallel to B C from corresponding numbers in the profile A. A line traced through points of intersections thus obtained, as shown by D E, will be the miter cut for the top and sides of the flat skylight. As the profile of the bottom of the frame is similar to the sides and top with the exception that at the bend 4 in A the metal turns over towards the roof as indicated in Fig. 532 at *f*, the same pattern may be used for the bottom, by simply extending the line 4 in the pattern until it intersects the vertical line dropped from D, making the distance *a* D of the desired length. Then D *a b* E will be the miter cut for the bottom of the frame.

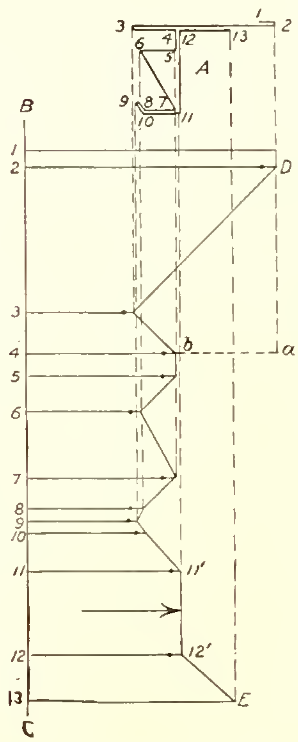


Fig. 535.—Obtaining the Patterns and Measuring Point

The measurements of 5 ft. 11½ in. × 19 ft. 11½ in. are taken from the arrow point or from the line 11′ 12′ in the pattern, which corresponds with the line 11 12 in the profile and represents the rear wall of the metal frame, placed inside of the wood frame at *n* and *o* in Fig. 531.

CONSTRUCTION OF A SINGLE PITCH SKYLIGHT

Over Elevator and Stair Shafts

Solution 164

The following example of skylight construction is one drawn from actual practice as indicating how a flat skylight of the single pitch type is made and erected. This skylight is approximately 26 feet long and 16 feet on the pitch, containing seventeen lights of glass 18 inches wide in the length and two lights 96 inches long to the width, is illustrated in Fig. 536. Four brick walls built above the roof form a

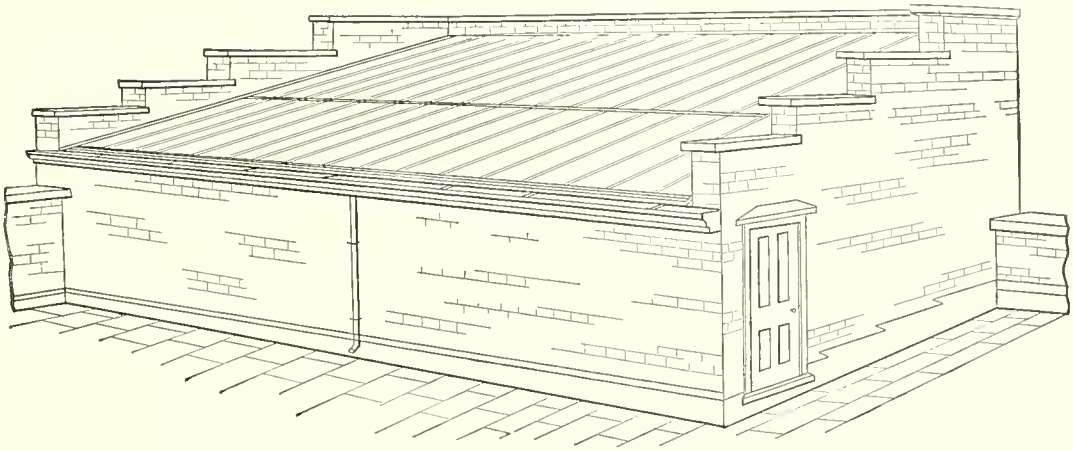


Fig. 536.—Construction of Skylight over Stair and Elevator Wells

penthouse for the housing of the elevator machinery, and these four walls surround the skylight, the two side walls being stepped to rise above the high point of the skylight, since considerable pitch must be given to a roof of glass.

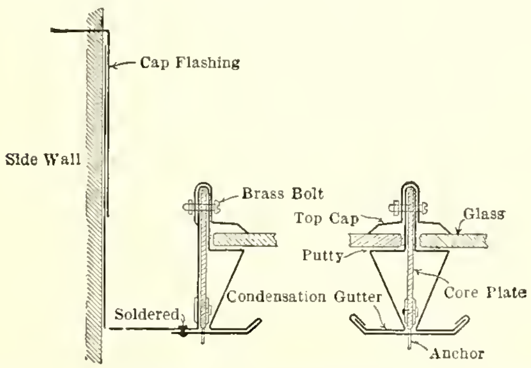


Fig. 537.—Longitudinal Section Showing Profile of Bars and Construction of End Bar with Stepped Cap Flashing

A cross section is given in Fig. 537, which shows that the usual custom of forming a half bar to finish against the wall and capping the glass with the flashing was departed from in this design. The half bar was kept about 2 inches from the wall, the back of the bar being bent out and up the wall to form a base flashing, which is step capped. This arrangement provides for the removal of the cap in case of need for changing the glass, thus obviating the disturbance of the flashing; further, by this arrangement the wash from the wall does not fall on the glass but into the gutter in the side of the bar and thence into the main eaves gutter. Further description of the bar for that side is unnecessary, its good features being apparent.

The main bars are conventionally designed except that a more generous gutter for condensation drip and possible leakage through the putty was formed on them, as shown in Fig. 537. In this connection the average designer makes a serious mistake in endeavoring to get the bar out of a certain girth of material, sacrificing the width of the gutter and making it so narrow as to be useless.

As will be observed, these bars have the usual reenforcing core of plate iron. In this case the plate is 3-16" thick by 3" in depth. The cap for covering the glass is likewise of conventional tee shape and is bolted to the bar at intervals of 4 feet.

In Fig. 538 a transverse section at the eaves is presented. The gutter, it will be noted, is of a simple contour, pitched from the ends to the center where the leader is located. To overcome the unsightly appearance of the slanted bottom a leveling shell is riveted thereto, as indicated by the section. Undue spreading and sagging of the gutter is prevented by means of braces spaced 3 feet apart, formed and riveted and bolted on as shown.

The girth of the gutter is such that the curb of the skylight could not be cut from a single sheet of material, hence the joint. Attention is now called to the scupper, which is merely a good sized hole punched in the curb between the bars. To keep out beating rain or snow a small guard, formed to the shape shown, is soldered to the curb.

The top of the wall being level and the curb pitched, it was necessary to provide some sort of bolster required by this type of curb. This design of curb is regarded as superior to that style which lies flat on the brick wall, as the last mentioned prevents adequate drainage of water, shedding from the glass.

The extra strut piece bolted to the bolster anchor is so constructed as to transmit the thrust of the bar and glass in a more or less downward pressure. Another reason for this shape of strut is to add

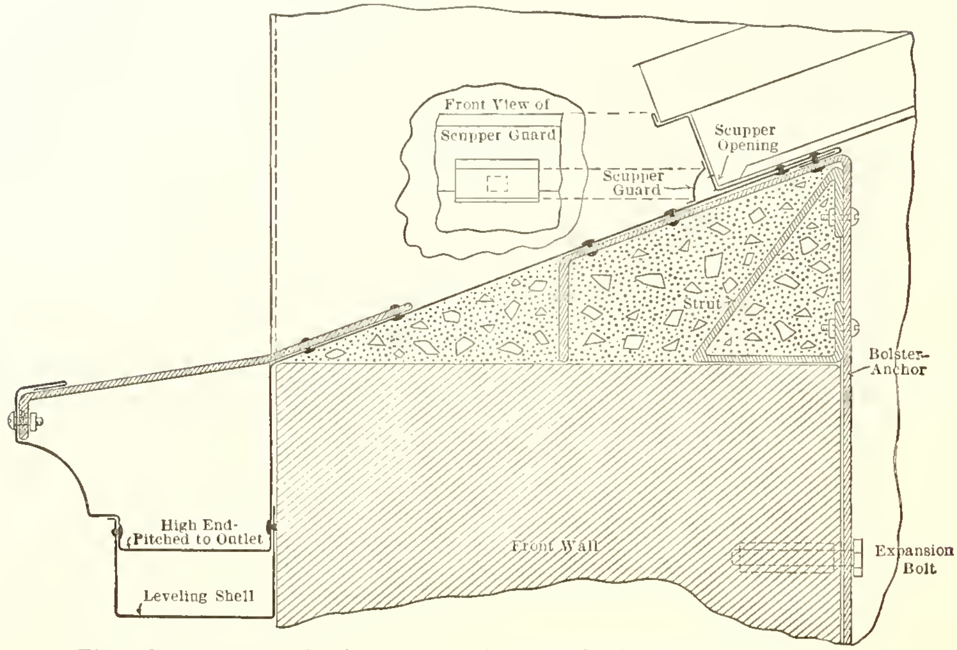


Fig. 538.—Transverse Section at Eaves, Showing the Construction of Gutter and Skylight Curb

superfluous were it not that experience has taught, that no matter how heavy a skylight may be, the wind sliding over it creates a partial vacuum, which draws up the skylight, causing it to rise and fall like the pulsating of a huge diaphragm. The constant upward and downward movement and the consequent shock from the impact of the bars striking on the purlin, even though that movement be slight, will eventually disturb the set of the putty, causing leaks and the breakage of glass.

At the top and at the bottom of the skylight it was necessary either to block up the bars (or the anchors of the curb) or to chip away the bricks, in order to align the bars; for in skylight work it is essential that the glass rabbets of all bars lie in one plane at top, center and bottom. Then, too, the opening of the walls is sometimes considerably out of square, requiring that the 2 inch gutter of the side bars be made in such a way as to provide for any inequality; that is to say, the gutter at one end

rigidity to the anchor and thereby prevent its bending at the point of contact with the wall. These anchors are of light band iron and one is placed directly under each bar. They are fastened by expansion bolts to the wall and will hold down the skylight. Two light expansion bolts are employed, though only one is shown. The concrete, which was slushed under the curb after it was set, formed a sill for the support of the curb.

It will be seen in Fig. 539 that the top wall was channeled to give a seat for the bars, which were simply set in the depression. The cross clips, which were tacked to the bars about a foot from the top, kept the bars spaced correctly; then the channel in the wall was pointed up with cement.

The top cross clips shown in the drawing were then soldered in position, the flashing piece hooked on and riveted thereto, after which the center cross clips were moved down to their correct positions, this being indicated on the bars by heavy dots punched with the scratch awl. This marking was done when the bars were laid out. The same method applies also to the top clip.

The purlin shown in the drawing is a deep I beam set centrally with respect to the width of the skylight from bottom to top, giving support to the skylight throughout its center so that the span of the bars is really but 8 feet. The anchor strap is fastened to the core plate and wrapped around a flange of the purlin. These straps would appear to be

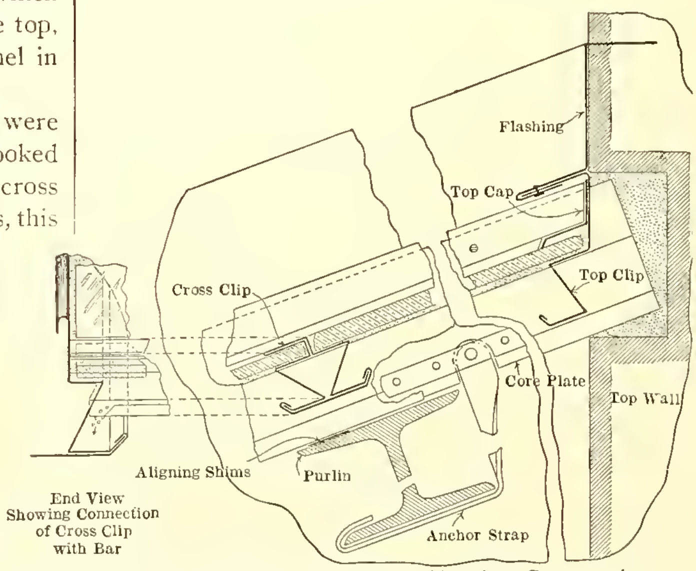


Fig. 539.—Transverse Section at Ridge Showing Construction at Top Wall; and Section at Center Showing Cross Clip Joint

of the skylight may be 2 inches wide at the bottom and 4¼ inches at the top, while at the other end of the skylight this gutter is 3½ inches at the bottom and 1¾ inches at the top.

In conclusion, it may be well to state that the sheet metal used on work of this kind, is usually 18 oz. copper. The glass was ¼ inch plain ribbed and the entire skylight was covered with an extra heavy diagonal mesh screen, which is supported on angles independent of the skylight (not shown in the drawings.)

All of the methods here described are in accordance with underwriters' and building department regulations.

CONSTRUCTION OF THE SAW TOOTH SKYLIGHT

A Practical Description of this Form of Roof Light; with Helpful Hints

Solution 165

In buildings of modern construction increasing attention is being given to light and ventilation. The so-called "saw-tooth" type of skylight is at present being used extensively in factory construction. One of these is illustrated in Fig. 540.

The details as given herewith are for a method that is economical and still practical, weathertight and proof against condensation trouble. In Fig. 540 is a general view of one tooth. It is understood that usually there are more than one of these lights to a roof—a series like the teeth of an inverted saw.

In Fig. 541 various details, or rather sections, are presented of the stationary parts of the skylight; *A* is the curb or section on line *A* of Fig. 540. Note that the shape of the sheet metal work is such that no difficulty should be experienced in bending it on the brake. This is true indeed of all the shapes of this skylight. Furthermore, the shape is such that all condensation flowing into it from the bars will readily drain to the outside through the scuppers. These scuppers can be of either square or round tubing, and one should be placed between all of the bars.

The curb is carried through the entire length of the skylight, as is also the top rail, which is indicated as *B* in Fig. 541, and is a section on line *B* in Fig. 540. The part marked 2 is cut away over the raising sashes; otherwise there is no change at these sashes.

As a rule a crown mold like that shown in Fig. 540, caps these skylights. This can merely lap over the flange of the top rail, as shown in Fig. 541. Note the shoulders 3 and 4 in both the curb and the top rail. The purpose of these is to act as a glass rest and as a means of securing the bars without doing a lot of soldering, because in erecting these skylights the top rail and curb are set in place first and then the bars.

The section of the bar is *C* of Fig. 541; that is, on line *C* of Fig. 540. This is an ideal shape of bar, inasmuch as the generously large condensation gutters 5 provide a sure means of catching the drip from the bars and conveying it to the curb. Also, the straight part 6 enables a better connection to be made with the cross clip.

The customary T cap 7 covers the putty joint of the glass with the bar. This cap is secured to the bar by a small round head bolt, and the putty joint at the top rail is protected by a half T cap, 8, which is held in place only by the thrust of the cap 7.

One of the essentials not to be forgotten in de-

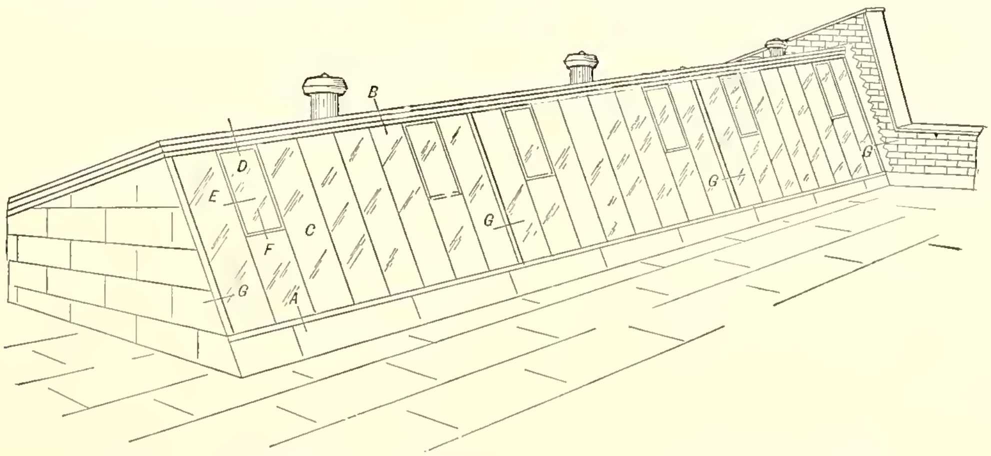
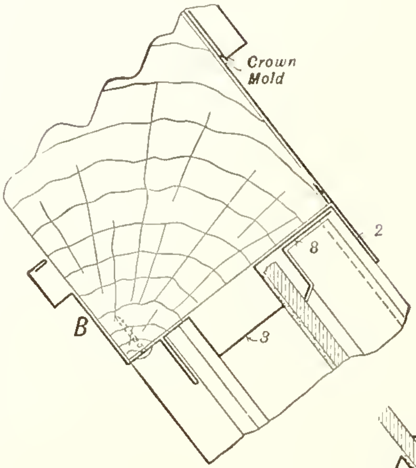
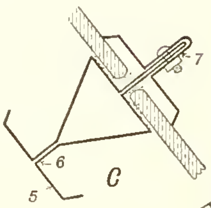


Fig. 540.—General View of One Tooth of a Saw Tooth Roof or Skylight

signing these skylights is the demand for plenty of ventilation. For that reason it is generally specified that a certain number and size of ventilators are to be set on the ridge of the saw-tooth, and that some of the lights are to be so arranged that they may be opened either their entire length or, more likely, their upper half.



In Fig. 542, *D* is a section on line *D* of Fig. 540. The part 2 of Fig. 541 is removed so that the weather-cap, 2 of Fig. 542, may be inserted in the resulting slot, this of course to be soldered water-tight at 3. Note the shape of the top rail, 4, of the raising sash and how its upper part moves within the weather-cap when being opened or closed. A 3/16 in. rod is the pivot about which this top rail revolves, this rod to be passed through holes in the bars on either side of the raising sash and through holes in the sides of the top rail of the lifting sash. This rod should be soldered to the top rail of the sash, so that it will not shift out of place and will turn on the side bars. The holes of the side bars are therefore reenforced by soldering small washes, 6 in *E* of Fig. 542.



The *E* mentioned is a section on line *E* of Fig. 540 looking up toward the top rail. Note the shape of the bar on either side of the sash. The bar at this place is made in two parts—the shape of *C* in Fig. 541 from the curb up to the bottom rail of the sash, then the shape *E* of Fig. 542 up to the top rail. Also, the cap from the curb up to the bottom of the sash is like that in Fig. 541, then the upper half is as in Fig. 542. This cap is not bolted on, but tacked with solder at 7, in *E* Fig. 542.

Note the shape of the sides of the lifting sash, and how part of it forms over the stationary bar to make a weathertight joint and still permits the sash to lift. Note also that the putty joint is capped by a simple half V cap, which is tacked with solder, at 9 to the side of the sash.

A section on the line *F* in Fig. 540 is given by *F* in Fig. 542. The lower half or stationary part of the light is topped out by an ordinary cross-clip 10, the lower rail of the sash, 12, being shaped so that it rests on the cross-clip in a manner that assures the shedding of the water from the glass of the sash onto the glass of the lower or stationary part, a hole at 15 draining condensation in the gutters of the sash into the cross-clip, then into the gutter of the bars and thence into the scuppers. Should it be required that the entire light be movable, the lower rail of the sash would have the same shape, part 16 of Fig. 542 lapping onto part 16 of Fig. 541.

Although the sheet metal worker may not be concerned with the method of framing these roofs, it should be remembered that struts are usually placed at the ends, whether

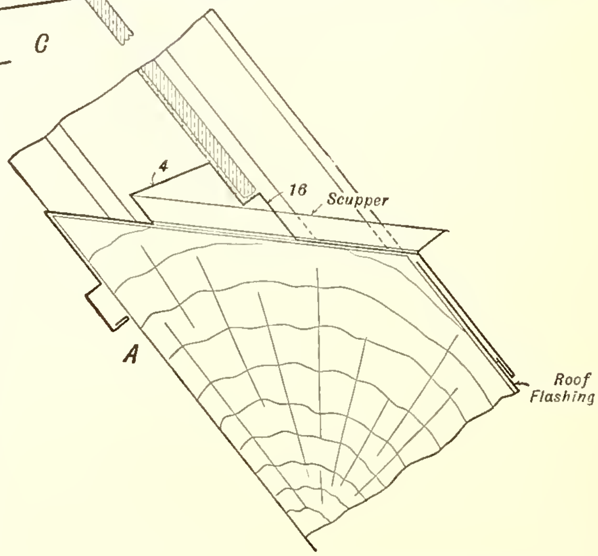


Fig 541.—Details of the Parts of the Stationary Sections of the Skylight

the end butts against a wall, as shown at one end in Fig. 540, or if a framed-in end as shown at the other end in Fig. 540, and again intermediate struts occur at intervals, as at *G* in Fig. 540. Consequently, in this method of making a skylight, a special bar is required like *G* in Fig. 543, which is a section on line *G* of Fig. 540.

Part 2 of Fig. 543 for the ends is turned around the side to lap over or be connected to the tin, or to whatever other material covers the bulkhead and roof proper. At the wall end this part is bent out upon and stepped into the joints in the wall and cemented tightly with elastic cement. For the intermediate struts part 2 simply caps the strut, and is the connecting medium of a bar *G* on both sides of the strut.

Various means and devices are employed to raise the sashes. However, should gearing be specified, it would be necessary to make a different side bar at the sashes, but almost always a simple arc, 25 of Fig. 542, of band iron, riveted to the sash and actuated by the pull of a cord is the means of opening the sash. A band iron is riveted to the side bars, at 28. At the center of this band iron, knees 35, are riveted, to which the arc 25 is riveted. A heavy piece of band iron is riveted to the bars (not to the cross-clip, which would fail to provide sufficient strength), and to this band iron a damper-pully, 42, is riveted. Then a sash cord is tied to a ring in the arc, passed through the pulley and wrapped about an awning cleat, which is placed conveniently somewhere below.

The ventilators shown in Fig. 540 may be of any type desired, but they should be provided with dampers, and a drip pan should be placed inside under the opening to catch the condensation, inasmuch as these ventilators sweat excessively on this type of roof.

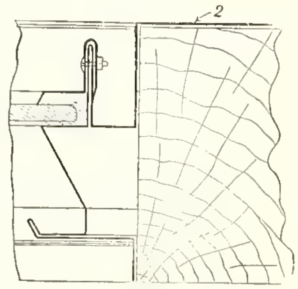
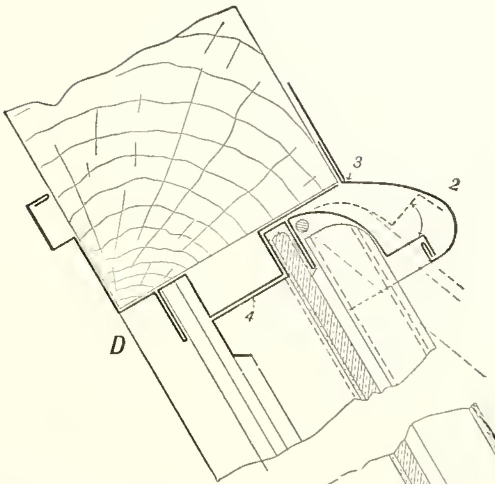


Fig. 543.—Section of the End Bar and One-half Section of the Bar at the Struts



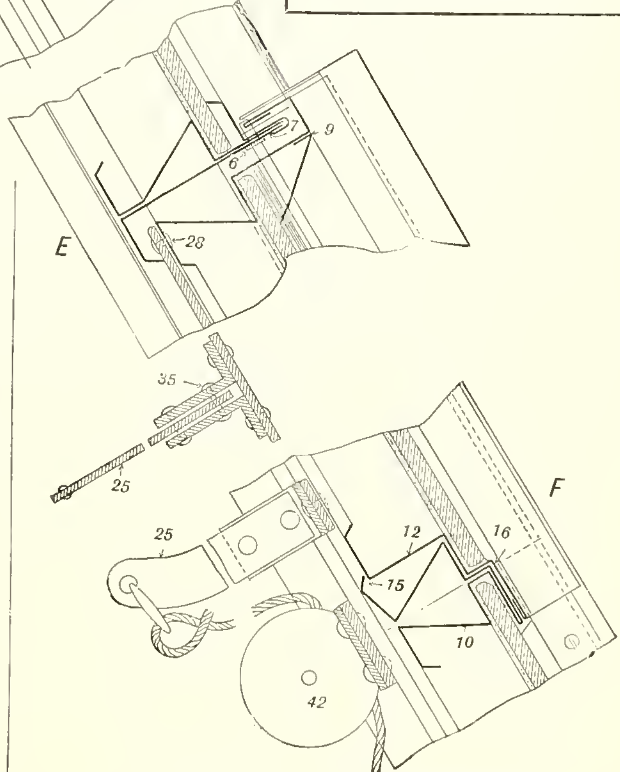


Fig. 542.—Details of the Raising Sash

CONSTRUCTION OF SKYLIGHT ON STRUCTURAL STEEL FRAMING

Solution 166

When skylights are placed over large openings, having long spans, their frames are usually made of angle and tee irons by the structural steel contractor, and later made water and storm proof with either galvanized iron or copper by the sheet metal worker. Fig. 544 gives a typical sectional view of a structural steel frame having stationary louvres at the sides, as usually placed over buildings of fireproof construction.

The following description of the structural steel work, as well as of the concrete base and wood blocking over which the sheet metal worker is to place his metal, presents a typical job from which measurements must be taken by the skylight maker. A plan of the corner is shown in the lower part of the illustration, and illustrates the angle which supports the upper tees, placed at intervals, between which stationary louvres (in this case) are to be set.

Wood blockings are placed around the angle in plan forming panels as indicated. In this construction the sheet metal worker should note that the metal covering is so constructed that three standing seam locks as placed at *A*, *B* and *C* can be locked with the least amount of labor. The locks *A* and *B* are so placed that they form a flange, against which the back of the louvres are set as indicated, while the standing lock at *C* comes directly on the corner at the outside. Where there are middle mullions the same construction is employed.

The base of the curb above the roof line indicated by *X* in the section view is made of concrete around the angle. Over this a wood sill has been placed. At

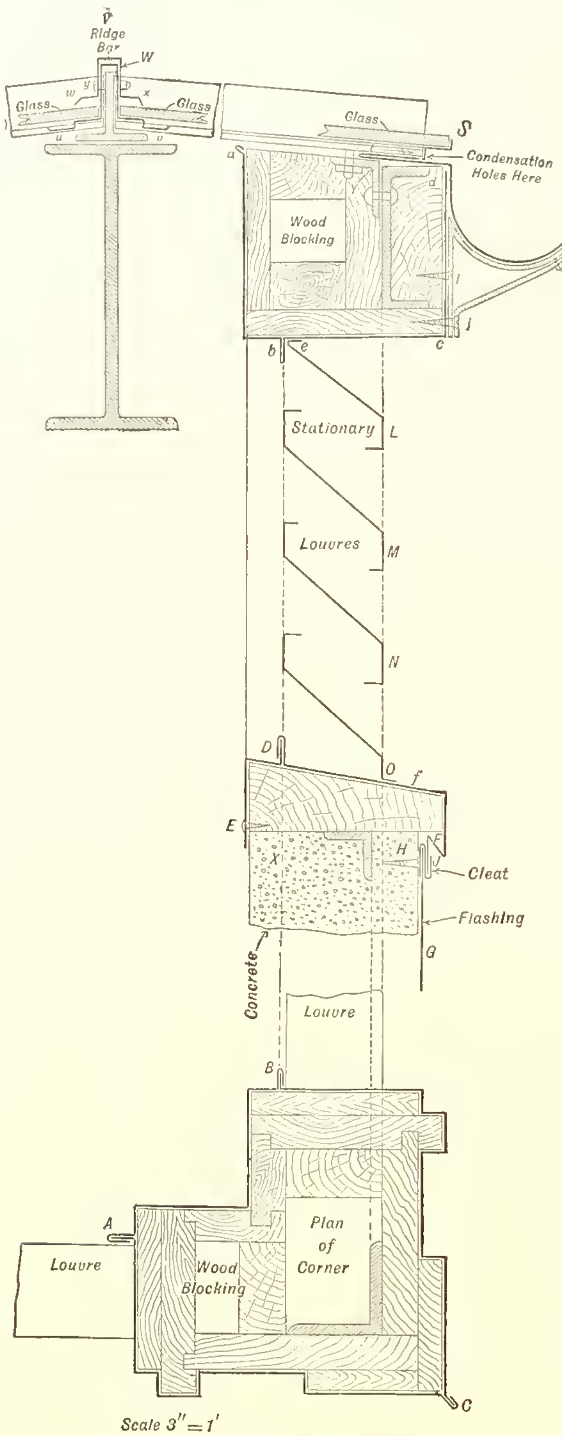


Fig. 544.—Sectional View of Structural Steel Frame Showing General Details of Construction

the eave of the frame blocking has again been introduced. This is fastened around the angles and channel as shown.

The ridge of the skylight is supported by an I-beam, over which the T is placed. The common bars are also made of T irons, as shown in the sectional view Fig. 545.

The method of covering the blocking, tees, channels, etc., will now be taken up in detail. Starting at the base flashing *G* of the roof, as seen in Fig. 544, it will be seen that this flashing, as well as the

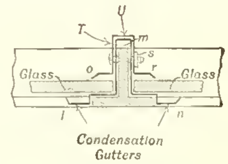


Fig. 545.—Section of Common Skylight Bar

bottom of the sill, is secured by means of copper cleats about 1½ in. wide in the following manner: The cleat is first nailed to the concrete by means of the nails *H*, placing them at intervals of 12 in. or more, and bending them as shown in the diagram

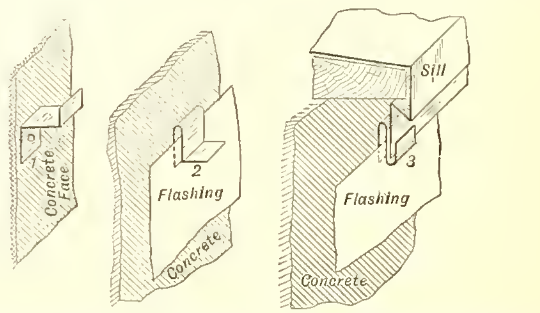


Fig. 546.—Securing Flashings and Lower Parts of Sills by Means of Cleats

marked 1 in Fig. 546. The base flashing shown by *G* in the sectional view Fig. 544 is now set in position as shown in diagram 2, Fig. 546, and the cleat turned down as indicated. The sill is next covered in sectional view, Fig. 544, and the back is formed as shown by *D-E*. The front and drip flange are made as indicated from *D* to *F* and an acute drip is made at *J*. The sill is locked at *D*, care being taken to have this lock come directly behind the lock *B* in plan.

The lower flange of the drip of the sill at *J* is now set over the cleat as indicated in diagram 3, Fig. 546, and the cleat turned against this flange as shown. Thus it will be seen that this cleat secures the base flashing as well as the sill flashing and still allows for the expansion and contraction of the metal.

The upper part of the blocking is covered with sheet metal as shown in Fig. 544 from *a* to *b* to *c* to *d*, making a double edge at *b*. This edge should be bent so that it will set on the outside of the lock shown by *B* in plan. The entire covering *a-b-c-d* can then be pressed up from below and fastened at *a* and *d*.

If a gutter is desired at the eave, which is the proper construction, light band iron brackets indicated by *P* are screwed at intervals of 24 in. on the wood blocking at *i*. The supporting bar is then bolted at *h*, the hole being countersunk on the inner side of the brace to receive the gutter as shown, after which the bar and brace are secured at *j*. The gutter with curb combined can next be set, but care should be taken to see that the iron worker has bolted the tees to the horizontal channel in the manner shown by the angle *Y*, allowing a space in which to slip up the condensation gutter flange *t*.

The curb and gutter are bent in one piece from *S* to *t* to *R*. A wired edge is formed at the front and the distance at *S* should be equal to the thickness of glass in use. At the bottom of the condensation gutter *t*, holes must be punched for the escape of any inside condensation, as indicated by the arrow.

The common bar is indicated in Fig 545 and bent as shown from *l* to *m* to *n*, allowing the condensation gutters at *l* and *n* and allowing for the thickness of the tee at *m*. This method permits the metal covering to slip over the tee from the top, and the mitering of the bar to the curb at the bottom, to allow the escape of the condensation.

The glass is now set in white lead putty, and care must be exercised to keep the putty from filling the condensation gutter on the inside. Over the glass, caps are placed, forming them as shown by *o r*. Through holes, previously punched in the tee bars by the iron worker, 3/16 in. brass bolts with round heads are passed through the cap, sheet metal bar and tee bar and secured by nuts indicated by *s*.

In a similar manner the ridge bar *V* in Fig. 544 is formed. The condensation gutters placed at *u* and *v* miter with gutters in the common bar. When the glass has been set the ridge cap *W* is bent as shown by *w-x* and secured with the brass bolt *y*.

This method of construction is simple and effective. When the span of the bar is long and the glass cannot be obtained in long lengths, instead of using a cross bar the glass is overlapped 3 in., using a twisted strand made of oakum, which allows for a soft rest and tight joint.

The stationary louvres are indicated by L, M, N and *O*. *L* and *O* are false louvres, flanged out at *e* and *f*. Of course, these louvres are spaced as desired, according to the hight required between *c* and *f*. Sometimes the louvres are made movable, so that they can be closed or opened as desired. In that case a pivot will have to be placed through the center of each louvre and into the wood or iron work at the sides. Then by means of skylight gearings they can be operated by pole, wheel or chain as described in preceding solutions.

PART XV

SHEET METAL ROOFING, GUTTERS AND SIDING

Constructive Features of the Various Forms of Metal Roofing in Flat Seam, Standing Seam and Batten Roofing, By the Medium of Tin Plate, Galvanized Sheet Iron, Copper or Zinc as Roof Covering; the Methods Employed in Allowing for the Expansion and Contraction of the Metal; Also the Method of Applying Corrugated Galvanized Iron or Copper Roofing and Siding and Obtaining Water-tight Joints at the Eave, Wall, Valley and Ridge.

SHEET metal roofing may be laid on any surface, whether flat, inclined, curved or vertical. There are four forms of construction in which the sheet metal worker is interested. These are known as flat seam, standing seam, that form of roofing employing wood battens and finally corrugated roofing and siding, chiefly used on piers and storage structures. Flat seam roofing is adaptable to all conditions, while standing and batten seams should be laid on roofs whose pitches are not less than four inches to the foot or in other words a one-sixth pitch. Preparatory to applying metal roofing it is important to select wood sheathing of well seasoned dry lumber, of even thickness and free from holes. The roof as well as the gutters should have sufficient slope to shed the water and thereby prevent gathering of dirt in shallow accumulations. If steam, fumes or gases are likely to reach the under side of the metal, water-proof sheathing paper is an effective protection for placing beneath the metal. Tar paper is not adapted to this purpose.

LAYING FLAT SEAM ROOFING

Solution 167

The following methods are applicable to laying both tin and copper flat seam roofing. While the expansion of copper roofing varies in greater extent than that of tin plate, the methods of allowing for the expansion and contraction of the metal at the walls and in fastening the sheets, do not differ. Upon selecting the suitable size of sheets for use, the first step is to properly notch the corners of the sheet, as shown in Fig. 547. If, for example, a 3/8-inch lock is desired simply set the dividers at 3/8 inch and scribe a line around the entire sheet, as partly shown in the upper right hand corner; where the lines intersect at *a* draw a line at an angle of 45 degrees as shown by 1-2, in other words the distances from *b* to 1 and *b* to 2 must be alike. On finding the amount required to be notched, as 1-2, the gauges on the tin plate notcher are set accordingly. The edges of the sheets are next folded, or edged, on the edging machine, as shown in Fig. 548, the long and short sides of the sheet being turned right and left, as indicated. The sheets are then ready for flat seam roofing. If a valley occurs in the roof, the sheets therefor are notched as in Fig. 547, but are edged as shown in Fig. 549, where the two narrow sides of the sheet are shown as turned one way and the long sides as turned right and left. If so required the two long sides may be turned one way, and the two narrow sides to the right and left. For wall flashings, to be laid, the sheets are notched

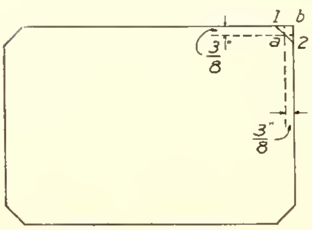


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Fig. 547.—Proper Method of Notching the Sheet Previous to Edging for Flat Seam Roofing

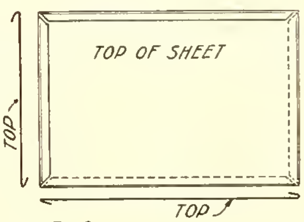

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Fig. 548.—Sheet Edged for Flat Seam Roofing

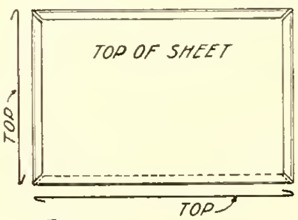

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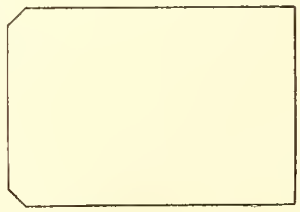
Fig. 549.—Edged Valley Sheet for Flat Seam Roofing



550

Fig. 550.—Notching the Sheet for Wall Flashings for Flat Seam Roofing

on the narrow end, as shown in Fig. 550 and are edged as indicated in Fig. 551, the unedged end being placed under the cap flashing when the base flashing is laid. On beginning work upon a flat seam tin roof the wall flashings are first installed. The

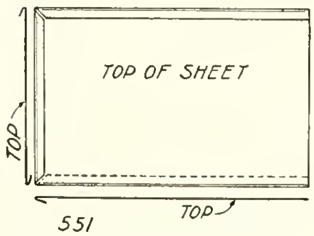
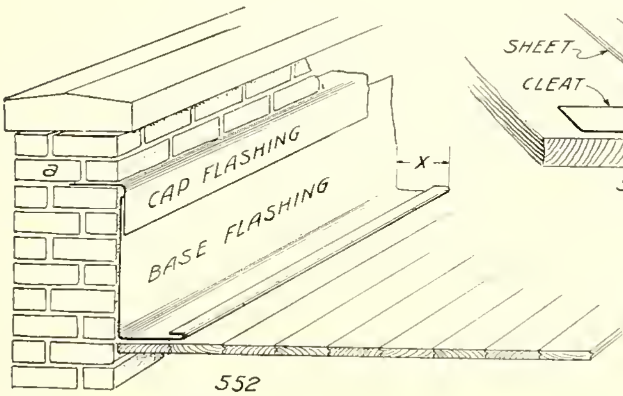


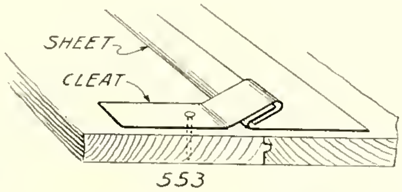
Fig. 551.—Edged Sheet for Wall Flashing in Flat Seam Roofing

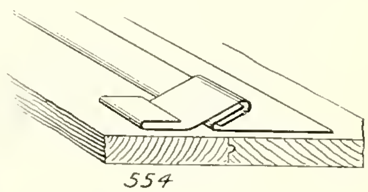
sheets are locked together to the required length, with care to make them up right and left, that is, for each side of the roof, so that drainage will not flow against the seam. When the required number of sheets have been so locked they are turned up, under the cap flashing, as shown in Fig. 552, with care that part X is of equal width throughout the flashing. The cap flashing *a* should be given a sub-

The back and bottom of the tin base flashing as well as the outside portion that underlaps the cap flashing should be coated with durable metallic paint or a layer of one ply oiled paper may be placed behind the base flashing to prevent the moisture in the wall or, lime in the mortar, from attacking and destroying the tin plate.

On fastening the lock of the base flashing, as well as of the edged sheets, cleats should be employed as shown in Fig. 553. Such cleats may be made about 2½ in. long x ½ in. wide; they are locked and nailed as shown. The cleat is turned over the nail head as indicated in Fig. 554. This serves to prevent the nail from raising and consequent rusting of the underside of the upper sheet. Only the 1 in. tinned barbed wire nails are successfully used for this purpose. Over the cleat the next sheet is locked as shown in Fig. 555 when the seam is closed down with a smooth faced mallet. If the question of expense is not of the first consideration and a superior class of work be desired, the roof boards are covered with a layer of oiled paper before the metal roofing is applied. Thus, moisture or fumes are prevented attacking the tin plate from underneath. Fig. 556







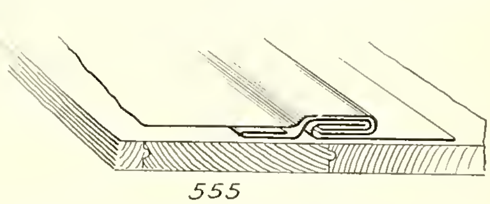


Fig. 552.—Method of Building in Cap Flashing and Setting Base Flashing

Fig. 553.—Securing the Metal Sheets with Cleats

Fig. 554.—Covering the Nail Head

Fig. 555.—Locking the Adjoining Sheet and Closing the Seam

stantial coat of metallic paint, and be permitted to dry before delivery of the flashing to the mason who builds it into the brick wall. These cap flashings are usually made up in the shop during slack season, the method being to lock together and solder five sheets of 14x20 in. tin and to edge the 14 in. sides of the sheets only. They are then cut through the center, each strip being 7 in. wide by five sheets long. They are next bent in the brake, through the center, thus providing 3½ in. on each side. Upon being well painted and thoroughly dried they are ready for delivery to the mason; see *a* in Fig. 552.

illustrates the laying of a flat roof with the outlet in its center, at the wall. The outlet box *a-b-c-d* has locks on three sides; it is cleated as shown and as previously described. The water flowing in the direction of the arrows, requires a valley, along 1-2-3-4 for which purpose, valley sheets are employed, as shown in Fig. 549; they are cleated as indicated on the sheets 1-2-3 and 4 in Fig. 556. Only by proper care in all cases to break joints in the tin plate, as indicated, may the work be successfully executed. Thus starting with the half sheet 5, continue with 6 and 7, then with a full sheet at 8-9,

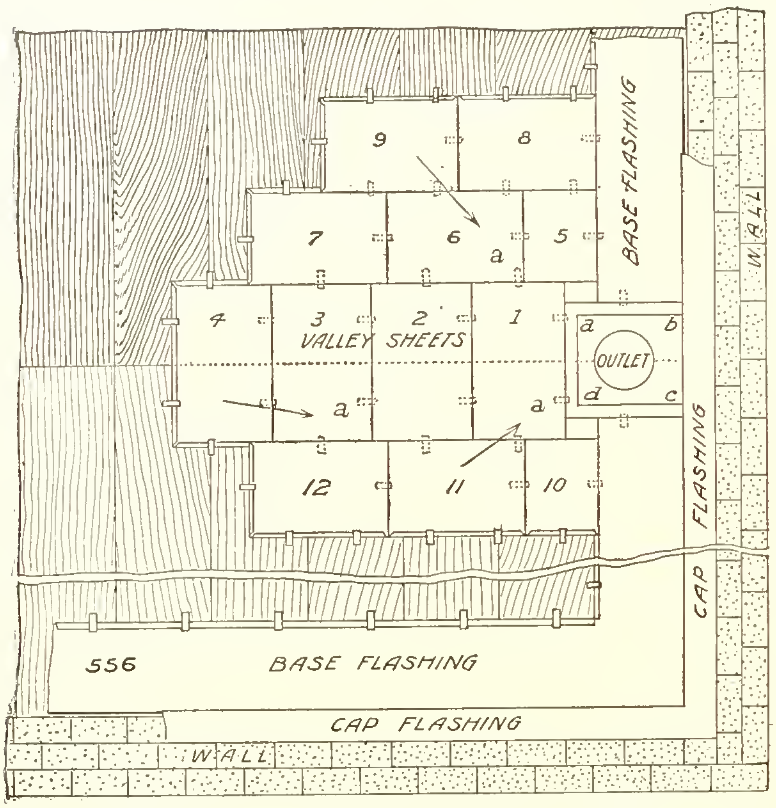


Fig. 556.—Plan View of Roof Through Line of Cap Flashing in Wall, Showing Cap Flashing, Base Flashing, Outlet Box, Valley Sheets and Method of Laying and Cleating the Sheets

etc.; invariably use three cleats to the sheet, as indicated by the letters *a-a,* etc. Since the roof drainage flows the two ways, the opposite side of the valley is also started with a half sheet, at 10, continuing with full sheets 11-12, etc. The main consideration is, always to lay the roof from the outlet without regard to where the latter is situated, in order that water will flow over the seam and not against it. When the roof has been laid and the seams well malleted to effect a smooth surface, rosin is used as a flux and the seams are thoroughly "soaked with solder"; for this purpose the 10 lb. to the pair soldering coppers, known as "roofing coppers," are brought into use. The soldering coppers should be given the proper heat and be permitted to rest over and upon the lock so that the seam may be sweated throughout, as indicated at *b* in Fig. 557. Haste in applying the soldering copper over the edge of the lock, results in the solder sweating in only to a limited extent, as shown by the shaded part *a,* in Fig. 558. On frame buildings having shed roofs, the eave line of the roof is sometimes finished as shown in Fig. 559. A lower strip is formed as shown from C to A; it is nailed at A and the lock is hammered flat to prevent the nails from drawing outward. Over this upper edge, the tin sheets are locked, at C, and the lock B is cleated, as at D. Should the roof, X, have but little pitch and there be danger of drainage penetrating between the lock, at C, the lock C may be turned down with a mallet as indicated in diagram Y, to the right. If no parapet wall runs above the line of the roof, a ledge strip may be used, as shown in Fig. 560; this is nailed below at *a,* with a drip at *b,* a standing ledge at *c* and the lock *d* which is cleated as has been described. After completion of the metal roofing, all rosin should be scraped off and the roof given three coats of metallic or red lead paint.

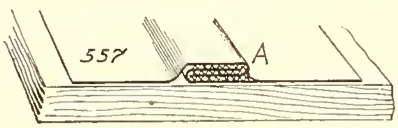


Fig. 557.—A Thoroughly Soldered Seam

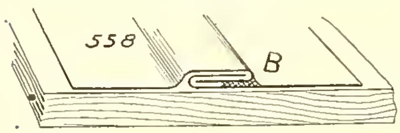


Fig. 558.—Improper Method of Soldering Seam

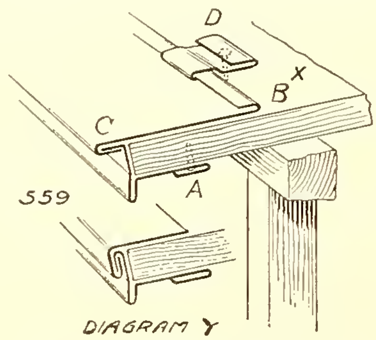


Fig. 559.—Finishing Metal Roof at Eave

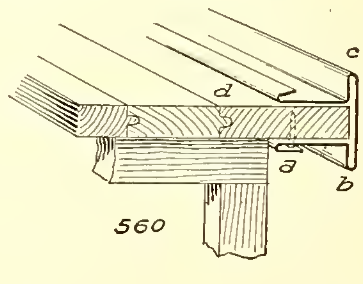


Fig. 560.—Finishing Roof at Sides

LAYING METAL ROOFING OVER WOODEN STRIPS OR BATTENS

Solution 168

When a tin or galvanized iron roof is to be laid over wooden strips to give a prominent ribbed effect to the roof, something after the fashion of a copper roof, it can be accomplished as herein described and illustrated. The first step is to prepare the tin in strips or the galvanized iron in sheets. For this purpose either 14 in. × 20 in. or 20 in. × 28 in. tin, as shown in Fig. 561, can be used or sheets 8 or 10 feet long, of galvanized iron. The proper width of sheet to use is determined by the spacings between the wooden strips and the amount that the metal is to turn up on either side as will be shown.

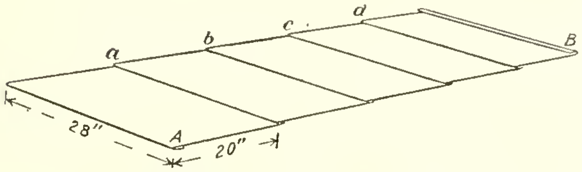


Fig. 561.—Laying the Tin Sheets in Strips

Having determined the required size of the sheets, they are laid in strips of the desired length, soldering the cross seams *a b c d* of Fig. 561. As will be noticed, only the long sides of the tin sheets, or the narrow sides of the galvanized iron are edged, right and left, to admit the locking of the sheets. Care should be taken to have the sides of the strip from A to B straight and true. This can best be accomplished be either striking a chalk line on the floor, to act as a guide, or a straight strip of wood can be nailed to the floor, against which the sheets are laid when they are being locked together. The required quantity of roofing is prepared, after which care should be taken that the wooden strips, known to the carpenter as "battens," are nailed in their proper positions as shown by B and C in Fig. 562. When nailing these strips the roofer and carpenter should consult, so that the proper dimensions are obtained, and to avoid error a wooden template should be used, as shown.

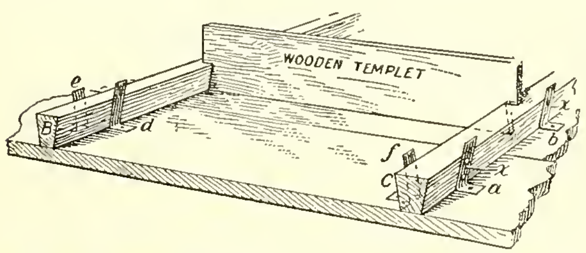


Fig. 562.—Spacing the Wooden Strips and Fastening the Cleats

The battens, which are usually about 2 inches high by 2 inches wide on top, taper toward the bottom, to allow for expansion of the metal, as will be explained. After the battens have all been nailed in position, cleats approximately 1 inch wide and of sufficient length are nailed at intervals of about 12 inches along the batten, as shown by *a, b, d, e,* and *f,* pressing them snugly against the slanting sides of the battens, as shown. The metal strips are now turned up square at either side at the required hight with the roofing tongs, after which they are placed between the battens, as shown in Fig. 563. These strips having been bent up square, their width is thus made equal to the distance between the upper part of the battens, and thereby provides a space on either side for expansion, as indicated at *d* and *d*. Without this the sheets would buckle upward when heated, there being no room for the metal to expand.

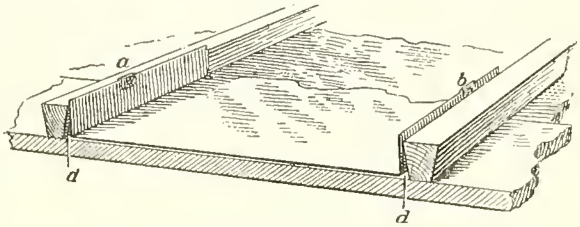


Fig. 563.—Reason for Beveling the Wooden Strips and Method of Fastening the Metal Roofing

The strips are now pressed down firmly and the cleats turned over, as shown at *a* and *b*. These cleats hold the roofing in position and nailing through the sheets is thus avoided. Under no circumstances should a roof of this kind be nailed. Every strip should be allowed to contract and expand freely by using the cleats, as just mentioned. If any objection should be raised to nailing the cleats to the roof surface, as at *a* and *b* in Fig. 562, it can be overcome by the use of two nails, each on the side of the battens, as indicated by *x* and *x*. After the strips have been fastened to the roof in this way, an edge must be turned thereon, to which the capping of the batten can be secured, in a manner indicated in Fig. 564. A wooden strip B, about 3 feet long and as high as the batten, is placed on the inside of the tin strip, as shown, and by means of a mallet a half inch edge is turned over, as shown at C. Over these edges the capping is to be slipped.

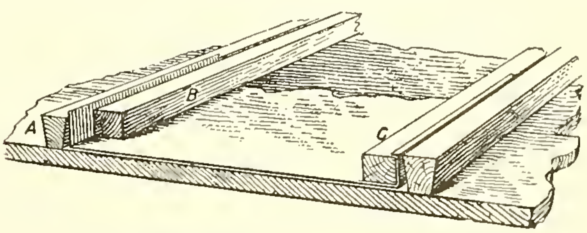


Fig. 564.—Bending the Edges on the Standing Seam

Measurements are now taken for this capping, which can be formed up in the brake in 8 feet lengths, as shown in Fig. 565, where the edge *a* is bent acute and *b* is bent at right angles. The bends

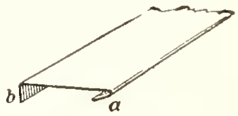


Fig. 565.—Method of Bending the Cap

are made in the manner shown, to allow them to slip easily over the edges of the metal roofing. Where no brake is at hand, the capping may be bent with a roofing tongs.

The method of fastening the capping and obtain-

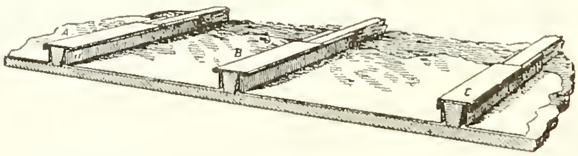


Fig. 566.—The Three Operations in Fastening the Cap and Obtaining Watertight Joints over the Wooden Strips

ing a watertight joint between the wooden strips and roofing is shown in three operations in Fig. 566. The first operation, A, shows the cap in position, the edge *a*, having the acute angle, being slipped in position first. B shows the cap with the edges pressed together with the tongs, while C shows the edges turned down with the mallet. Thus it will be seen that, by using this method of construction, no nail is driven through the tin plate, thereby giving free movement for expansion caused by the heat of the sun, or contraction caused by snow or ice. At the eaves, heads must be soldered at the front of the battens, and the cross joints of the capping are soldered where necessary. At the ridge of the roof a batten is also employed, making a finish

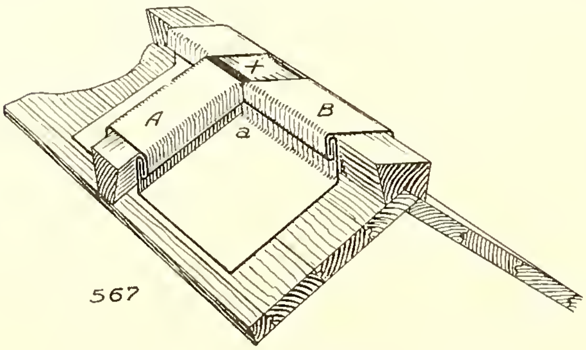


Fig. 567.—Finishing the Battens at the Ridge

along the ridge alike to the illustration in Fig. 567. Before the caps A and B are put in position, the upright corner of the sheet at *a* is soldered, and after the caps have been locked, a square piece of metal is soldered over the opening at X.

Laying Sheet Copper Roofing and Gutters; with the Methods Employed in Providing for the Expansion and Contraction of the Metal

One of the main considerations arising in the application of all metal roofing sheets, whether of copper, tin, galvanized iron or zinc is that of allowing for the expansion and contraction of the metal. Of these metals zinc is subject to the greatest expansion, under the influence of heat, copper is next and iron is the least influenced by changes of temperature. Familiarity with copper roofing indicates how it will readily expand with the heat from the sun's rays during the day, and will contract in the cool of the nights. Thus the variation in temperature from the summer's heat to the winter's cold is so marked that construction of the various joints and seams to allow free movement of the metal is a positive essential. Results of failure to provide for the expansion and contraction of metal roofing causes the joints to burst or in the case of large sheets, cracking in their centers. The accompanying illustrations show how the joints and locks are prepared, cleats are fastened, and expansion joints in the gutters (where lies the chief source of trouble to the mechanic) are made and placed, also how stone and terra cotta gutters may be lined.

LINING GUTTERS WITH SHEET COPPER

Solution 169

The first question to dispose of is the selection of the gauge of copper to be used for gutter linings. While gutters are frequently lined with 16 oz. soft copper, the requirements of reliable permanent work demand 20 oz. cold rolled copper, that is, hard rolled copper weighing 20 oz. to each square foot or 12 in. $\times$ 12 in. The content is 4 oz. more of weight to the square foot assuring a secure, durable job.

On first class work the cornices are sometimes of stone or terra cotta, cut as in Fig. 568, in which A represents the stone or terra cotta cornice having a gutter with the proper pitch cut in it as shown. The top of the cornice A, slopes toward the gutter, to prevent the water dripping down the front. The plate F and rafter H forms the rear part of the gutter after the sheathing is put on, as shown. In this case dovetailed holes as shown in detail X, ½ in. in diameter, are drilled in the stone work 1 in. deep, 9 in. apart, or are modeled in the terra cotta clay before it is baked hard. The holes are filled with molten lead, then a hole is punched in the center of the cooled lead about ¼ in. deep with a prick punch. This hole is used as a starter in screwing in the brass screw.

A copper ledge of 20 oz. cold rolled copper of the shape indicated in the section A is bent in 8 foot lengths and these ledges are screwed to the lead plugs previously cast in the small holes, with flat head brass screws, as indicated by *a*. By placing the holes 9 in. apart the ledge is secured, and on to this ledge the gutter lining B is locked at *b*, and the lining is flashed on the roof as indicated by C. The back of the lining has a lock attached by which it is fastened to the roof with the cleat D. These cleats are made about 1½ in. wide by 3 in. long and are secured to the roof with a brass or copper nail.

Note that the metal lining has sufficient play all around the back, bottom and front, so as to allow for expansion without buckling the metal. Failing to make a proper allowance in the lining will cause broken seams and cracks in the center of the sheet. Occasionally a mechanic will make the gutter fit snugly into the gutter proper which is not good practice. We have noted cases where the metal has been forced into the gutter proper with the aim of securing a tight fit but by this method the metal cannot "move." If there be expansion the metal buckles in the center of the sheet and eventually cracks.

The cross seams in the gutter should be tinned 1½ in. wide on each side; then a ½ in. lock is turned on it and cleated as shown by D. The seams are then malleted flat and thoroughly sweated with half and half solder. Under no circumstances should the nails be driven through the sheets. Thus in the gutter described the entire lining is free to move in any direction.

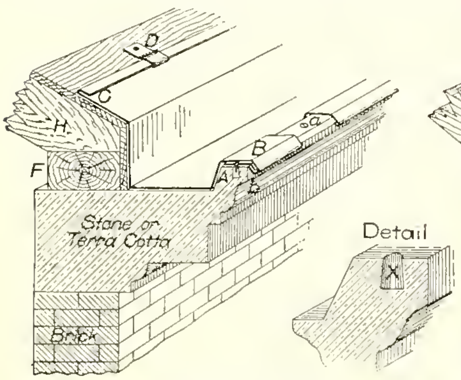


Fig. 568.—Fastening Copper Lining to Ledge Strip in a Stone or Terra Cotta Gutter

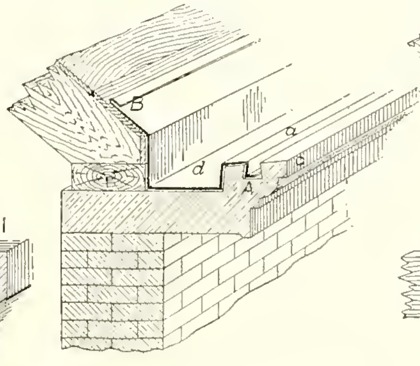


Fig. 569.—Securing Copper Lining in Raggle

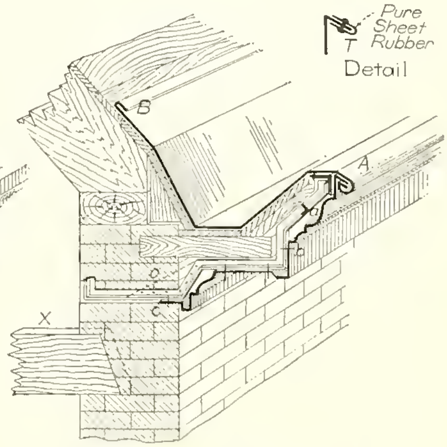


Fig. 570.—Securing Lining to Metal Cornice and Wood Base

On very long gutters, expansion joints are placed in the cross seams as described hereinafter. On gutters having short runs architects sometimes specify that the lining at the front edge be caulked direct to the stone or terra cotta base. While the method just explained is recommended, Fig. 569 was prepared to show how the specifications are followed. A raggle is cut in the stone or modeled in the clay as indicated at A, with a sloping top constructed from *c* to *d* to shed the water toward the gutter. In this raggle and gutter proper, the lining is laid as shown, with a lock B on the rear flange to be cleated, as before described. After the lining is set the raggle at *a* is either filled with molten lead or sulphur. Lead is usually employed on stone, because it can be caulked into the raggle with a hammer and caulking chisel, a method desirable in the case of cornices of stone. In respect to cornices of terra cotta, caulking is likely to split the terra cotta and therefore sulphur is used, because it expands when cooling and fills the raggle. The cross seams are made as before explained.

Cornices of sheet copper should be constructed so that the lining can be locked in as indicated in Fig. 570. In this case and in first class work, the inner braces or lookouts are made of angle iron, *a*, painted with red lead before insertion and bolted in five places indicated by the short dashes as *b*. The holes in the braces should be countersunk on the outer side and bolted to the copper cornice with flat head brass stove bolts. This angle iron brace extends back the thickness of the wall as shown, with a reinforced angle riveted in the corner at *o*. When the wall has been carried as high as *c* the molding or cornice is set, being secured temporarily with wire to the wood beam or to the iron beam at X, until the balance of the wall has been carried up and the plate and rafters set. This will hold the cornice in position, when the wires may be removed from the beams.

The framer now lines out the gutter to the proper pitch in connection with which procedure care is re-

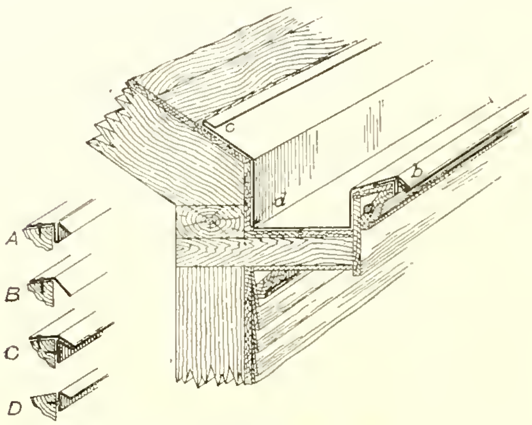


Fig. 571.—Section of Wooden Gutter and Lining

quired to have the front sheathing come directly under the angle iron, which is bolted to the front edge of the cornice as shown. The iron braces in work of this kind are usually spaced 30 in. apart, which insures a good solid base. The gutter lining is now locked to the projecting ledge of the upper member of the main cornice as shown by the beaded formation A. This bead can be formed on the gutter beader, making a clean, neat finish, or if it be preferred an ordinary lock may be used.

It is advisable, when the gutter linings require a large girth, to compute requirements before the job is ready and order the extra wide copper direct from the mill. While this extra width will cost a trifle more, it is less expensive than running a long seam in the bottom of the gutter as is usually done, which seam is likely to open and leak if not properly laid. In fact it is always advantageous to order copper in correct widths so that there will be no unnecessary waste. A lock is placed at B, for securing the cleats and the cross seams are made as usual.

With cornices of galvanized iron, it is not good practice to connect the copper lining to the cornice for it is well known that copper coming into contact with galvanized coating creates an electrical action, which, with the addition of moisture, starts corrosion of the iron or steel sheet. In some cases galvanized iron cornices are specified with copper linings, so that some form of construction must be devised to avoid this electrical action. This may best be done by insulating the galvanized iron with sheet rubber, as shown in detail T. Pure sheet rubber $\frac{1}{8}$ in. thick is formed V-shape over the ledge of the cornice and is riveted at intervals to take a firm hold. Over this rubber the copper may be locked with safety. Some mechanics use oiled canvas, but this will rot with the action of the weather.

With gutters and cornices made entirely of wood, the methods of securing the front ledge strips vary. Fig. 571 shows the section of a wooden gutter and the lining. Particular care should be taken that the top of the cornice at *a* is planked to shed the water to the rear as destruction of the paint on the outside of the cornice is often caused by the rain running down the front from the top of the cornice when the top is laid level. After the wooden linings are all in, a ledge strip of copper is nailed with copper or brass nails as indicated, at intervals of 9 or 10 in. This ledge strip is more clearly shown in diagram A. Over this ledge strip the copper lining is locked at *b*, with a lock on the back at *c* for cleating purposes. Note the allowance for expansion at *d*, which must not be overlooked in connection with the bending of the lining. In diagrams B and D two simple ledge strips are shown, while diagram C indicates the most substantial of the four.

EXPANSION JOINTS IN COPPER LINED GUTTERS

Solution 170

Copper lined gutters of great length, require expansion joints, to be placed at the high ends of the gutter, as shown in Fig. 572. This device consists

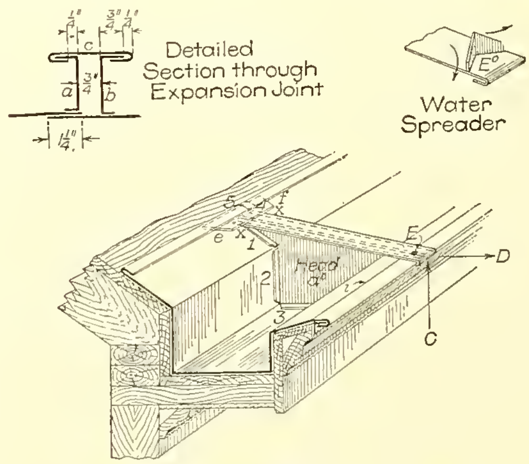


Fig. 572.—Expansion Joint in Gutter

simply of a lapped joint, with a flat head soldered to each end and covered with a locked sliding cap. The gutter is locked to the front ledge, as shown, and cleated at the rear lock, in the usual manner. The cross seam of the gutter at the expansion joint is made as shown in the detailed section indicated above the cut, where the joint is lapped 1¼ in; it is not nailed or soldered. Preparatory to soldering in position the expansion heads indicated by *a* and *b* it is necessary to compute the distance apart at which the heads are to be placed, first ascertaining the length of the gutter. Let us assume that the entire gutter will be 75 ft. in length, with a leader at each end, in which case expansion heads are soldered to the highest point of the gutter, in the center, or 37 ft. 6 in. from each end. The accepted coefficient of linear expansion or contraction for copper, per foot of length is .0000095 for each degree of temperature. Assuming zero to be the minimum of winter and 90 degrees the warmest weather of the summer, the expansion or contraction is calculated by multiplying the number of feet in the length of the gutter by the variation in temperature and multiplying by the coefficient.

Thus: $75 \times 90 \times .0000095 = 6750 \times .0000095 = .0641250$ ft. By referring to a table of decimal equivalents we find that .0641250 ft. equals $\frac{77}{100}$ in. or say ¾ in. for practical work. In other words when the temperature is zero the 75 ft. length of copper gutter will contract so that the two heads *a* and *b* will stand ¾ in. apart. If this gutter were lined in a temperature of 90 degrees the heads would require to meet. As gutter lining is seldom installed during either extremes of temperature, it is necessary to exercise judgment, to deciding according to the prevailing temperature, how much allowance should be made for expansion or for contraction. Thus if a gutter were lined when the temperature was 45 degrees, equal provision for expansion and for contraction would be made and in soldering the two heads, *a* and *b* in position, they would be placed ⅜ in. apart; this would give an allowance of ⅜ in. for further expansion and ⅜ in. for further contraction. Assuming that the heads are soldered in position, with the temperature at 45 degrees, the one head *a* is soldered flush with the edge of the sheet, while the head *b* is soldered so that there will be a ⅜ in. space between the two heads, which allows fully for expansion as above explained. These two heads *a* and *b* are partly shown by head a° in the perspective view. On the upper side of the heads a ¾ in. flange is bent outward as shown in the detailed section, over which a locked cap is placed as indicated by *c*, with about ¼ in. play between the edges and locks as shown. The heads have laps for soldering purposes on both sides, as indicated by the numbers 1, 2 and 3 in the perspective view.

The front part of the expansion head is carried to the extreme line of the gutter indicated by the arrow at *i* while the rear part of the expansion head runs flush with the outer edge of the gutter lock at 4. When these heads have been soldered in position as indicated in the detailed section, the cap, indicated by *c*, is slipped over the projecting edges of the heads, and locked under the front edge of the gutter shown in the perspective view by *C* and *D*.

To protect from leakage the 1¼ in. lapped joint at the lock from 4 to 5, a gore piece indicated by *c f* is cut off diagonally so water will flow over without getting into the seam; it is slipped under the flange lock as shown by the dotted lines and is soldered only along the top of the locked cap from *x* to *x*. This combines the locked cap and gore in one but allows free movement of the main gutters.

Sometimes when the roof is laid flat seam, this style of expansion joint shown in the detailed section is carried throughout the pitch of the roof, with the sides *a* and *b* bent direct on to the roofing sheets. To avoid the water running down the top of the expansion cap over the front edge of the cornice, there can be placed in the position shown by the arrow *E* a water spreader, as shown by E°. This throws the water to each side into the gutter where otherwise it would wash down over the front.

These expansion heads serve in connection with any shaped gutter, and when placed in position as described relieve the metal of the strain caused by expansion and contraction. This, if carefully done, prevents the cracking of the soldered joints.

PROVIDING FOR EXPANSION AND CONTRACTION OF THE METAL IN BASE AND CAP FLASHINGS

Solution 171

Copper base and cap flashings usually occur against fire walls, chimneys, gables, curbs, dormer windows, etc., and the building materials are either of brick, stone, terra cotta, iron or wood. The following methods are for providing for expansion and contraction when the flashings butt against various building materials. Thus, Fig. 573 shows the regulation base and cap flashings against a brick wall. The cap flashing *a b*, on a good job is usually cut 7½ in. wide or four strips from a 30 in. wide sheet, in 8 ft. lengths. In the process of forming, it is bent 4 and 3½ in. The 3½ in. side is built into the wall as the work progresses, as indicated

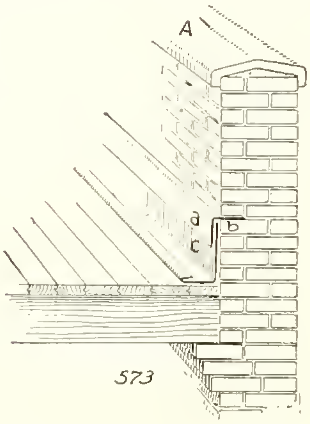


Fig. 573.—Base and Cap Flashing, Against a Brick Wall

by *b*, while the 4 in. apron *a* forms a cap over the base flashing *c*. This method allows for the expansion and contraction of the metal as well as for the settlement of the beams, wall, etc. The flashing is used in flat as well as in standing seam roofing and is of the same construction that is used upon roofs covered with slag, tile or pitch.

Occasionally there is trouble from leakage of the joints in the coping A thus making the walls damp on the inside. This is overcome by having the cap flashing extend through the wall, as indicated in

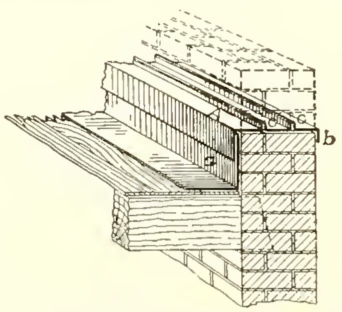


Fig. 574.—Copper Cap Flashing Covering Entire Wall

Fig. 574, where *a b* shows the cap flashing with upright ridges at *c c* to meet the width of the bricks, so as to form a good bond.

With parapet walls of stone or terra cotta, it is seldom that a mortar joint is in the proper position for the building in of the copper cap, the joint being either too high or too low. For this reason a raggle is cut in the stone work, as indicated by *X* in Fig. 575, or if the wall is of terra cotta this raggle is modeled in the terra cotta before the latter is baked. Then the cap A is formed as indicated in the section at *a* and is secured in the raggle by means of small lead plugs shown in diagram X. These lead plugs are cast in tapering form as shown, about 4 in. long and in thickness so that they will wedge the copper cap firmly in the wall. These plugs are placed about 12 in. apart and the spaces between

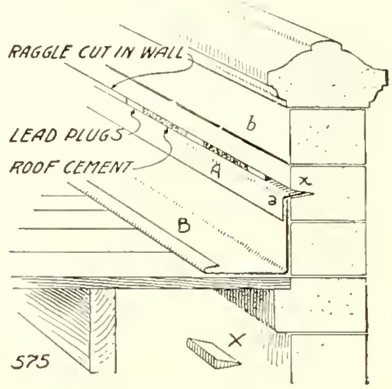


Fig. 575.—Securing Flashing in Stone or Terra Cotta Reglet

them are filled with roofers' cement to match the color of the wall. This roofing cement can be obtained to match any color. Under no circumstances should wooden plugs be used as is frequently done, for the wood will eventually rot away and a poor, insecure job is the result.

The base flashing *B* is then passed under the cap *A* in the usual manner. Sometimes on a coping wall of a mansard roof the distance between *a* and *b* is so short (say 6 in.), that the flashing may be put in in one piece, that is, without a cap. In this case the base flashing *B* would be secured direct to the raggle as before explained; and since the amount of metal exposed would be so small, there would be no considerable expansion or contraction.

On a large job, where a number of lead wedges are required, it is best to cast the wedges to the proper size. This is a much quicker method than pounding together sheet lead to the proper thickness, as is usually done, a procedure which does not give as good results as casting in the manner shown in Fig. 576. This figure shows an angle iron frame, over which a casting pan is hung at *A B*, made of 16-gauge black iron with heads rivetted in at *a, b* and *c*. By having the plugs cast in these pans, three plugs are made at one operation and they will be of the proper size for the raggle joint.

Fig. 577 shows how the base flashing is laid to allow for expansion and contraction under slate, tile or shingle siding. A lock *B*, is bent to the flashing *A* and fastened with the cleat *C* of the same

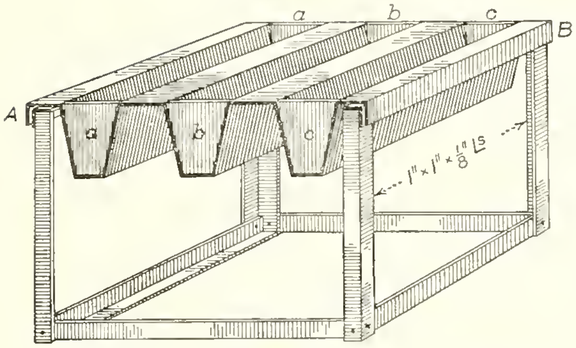


Fig. 576.—Molds for Casting Lead Plugs

material. There must be absolutely no nailing through the metal work.

When the construction is of angles and tees, and the siding is of corrugated copper, the flashing under this siding is prepared as shown in Fig. 578. In

indicated at *a*. This band iron is held in its proper position against the metal wall and the holes are marked on the wall, after which they are drilled and tapped to correspond with the thread of the round head machine screw in use. When all the holes have been tapped, the band iron, around which the copper cap has been bent, is screwed in position indicated by *A*. The base flashing is slipped under the cap, as shown. So that no leaks will occur between the copper cap and metal wall, soft roofers' cement is placed between the copper cap and wall before the screws *A* are drawn tight. Then when the cap flashing has been securely fastened, roofing cement is neatly set at an angle over the projecting ledge, as indicated by *o*. This makes a compactly finished piece of work. The base flashing is then slipped under the cap as shown.

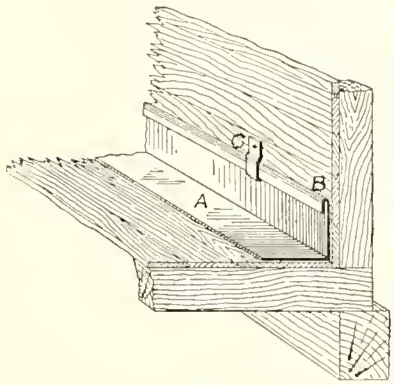


Fig. 577.—Allowing for Expansion and Contraction of Copper Flashing Under Slate, Tile or Shingles

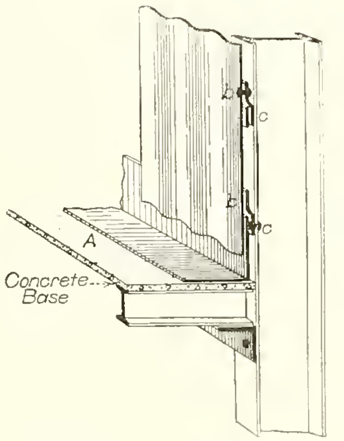


Fig. 578.—Securing Flashing Under Metal Siding

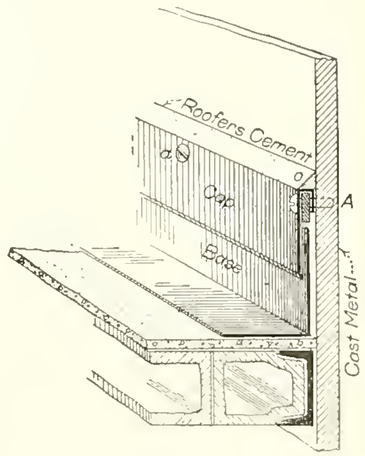


Fig. 579.—Secure Base and Cap Flashing to Metal Back

this construction, under no consideration, should the bolts pass through the metal flashing which should be left free to "move" as shown at *A*, as the corrugated side will hold it in position when the siding is secured to the iron laths *c c* by the cleats *b b*. In roofs of this class which are constructed of iron and concrete, the roof covering is usually of slag or gravel, or sometimes tile. The constructive features, however, are alike whether the roof be of slag, gravel, tile or copper.

When requirement demands a flashing, placed against a metal surface or wall, as shown in Fig. 579, an entirely different construction must be employed in securing the cap flashing and making a water tight joint. The upper part of the copper cap flashing is bent around a ¼ x 1 in. band iron, as shown in the illustration, and through this band at intervals of 8 or 9 in. holes of ¼ in. diameter are punched, through which the screws are to pass, as

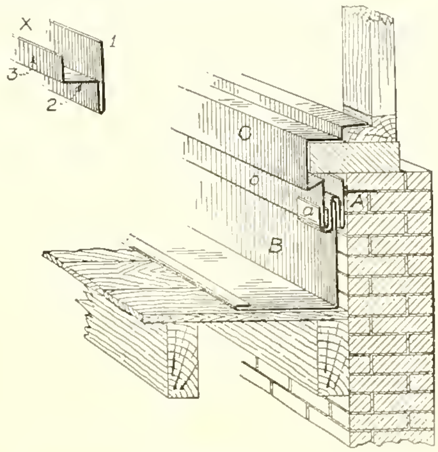


Fig. 580.—Securing Base Flashing and Sill Cap with Cleat

Where a projecting sheet metal sill is to serve for the cap flashing, as shown in Fig. 580 arrangement is made to secure the base as well as the cap flashings with copper cleats constructed to allow for the expansion and contraction of the two flashings. This is accomplished by the peculiar bent cleat shown by *a*, secured and bent as follows: The cleats are made about 2 in. wide, first bent as shown in diagram *X* by 1, 2 and 3. With the hight of the flashing known the cleats are nailed through flange 1, as indicated by *A*. The base flashing is placed in position, as indicated by *B* and 2 in diagram *X* turned down. This holds the base flashing *B* in position. The sill *C* is then set and the flange 3 in diagram *X* turned upward, as indicated by *a*, which holds the cap flange *o* of the sill in position. These cleats are usually placed about 12 in. apart.

METHODS EMPLOYED IN PROVIDING FOR EXPANSION AND CONTRACTION OF THE METAL IN LAYING FLAT-SEAM ROOFING

Solution 172

For flat-seam copper roofing good sheathing boards are an important requisite. They should be of even thickness, thoroughly seasoned; if not dry, they will shrink after being laid and will strain and break the seams in the roofing, causing constant buckling of the metal. Nor should the boards be light or springy, because the locked seams can be pounded down more smoothly when the boards are laid solid.

The size of the sheets to be used in copper roofing varies according to the specifications given. With the size of the roof and the size of sheets determined, the number of sheets required can be ordered direct from the copper mill, cut to the proper size, thus saving the labor of this work in the shop. It is best also to have the sheets tinned at the mill, with pure tin 1½ in. wide, all around the edges on both sides. The tinning may be done more cheaply and cleanly at the mill than in the shop by means of dipping or with the soldering copper. Whatever size sheets may be used the following explanations will apply to notching, edging and soldering.

A most important point often overlooked is the notching of the sheets. Fig. 581 shows how to determine the amount that should be notched off the corners of the sheet. Determination upon the size of the lock to be used, which should neither be upward of ½ in. nor less than ⅜ in. Set the dividers to the desired width of the edge and on a sheet of copper scribe a line around the entire area as indicated by the dotted lines. Where these lines meet at 1 at each corner, cut off at an angle of 45 degrees, slightly more inside the corner 1, as shown from *a* to *b*. This notching is sometimes done by hand, in the smaller shops, with a gauge made of sheet iron as a guide. It is preferable and less expensive to use a corner notching machine, as shown in Fig. 582. This machine is designed for notching several thicknesses of roofing sheets at one time. There is one fixed or stationary gauge and the other is adjustable to regulate the size of the corner notches.

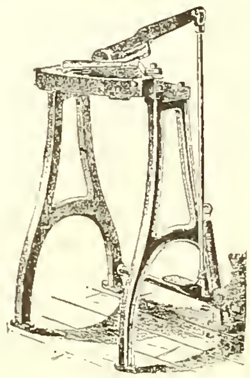
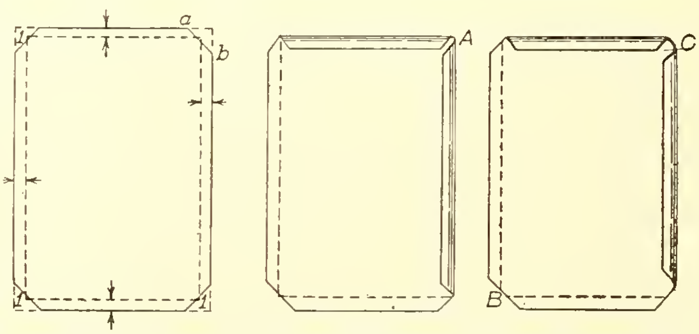


Fig. 582.—Corner Notching Machine

After the sheets are properly notched and edged, the fold at the corner will have the appearance of *A* in Fig. 583, but where the corner of the sheet has been cut off too much, as at *B* in Fig. 584, the sheet when edged will show a large opening as indicated by *C*, and when the sheets are laid as shown in Fig. 585, instead of the "butt" being covered, it would show an opening which is exaggerated by *A*; this makes a poor job and requires a quantity of solder to close up the opening.

On laying the sheets, cleats should be employed to take care of expansion or contraction. If the nail



Figs. 581, 583, 584.—Diagrams to Illustrate Proper and Improper Notching were driven directly through the sheet, the movement of the metal would be likely to cause a tear, but if the sheets are fastened by cleats as shown in

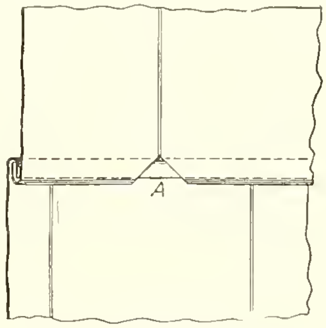


Fig. 585.—Opening at "Butts" on Improperly Notched Sheets

Fig. 586, the entire metal roof surface is free to move without breakage. The number of cleats shown in the cut is based on the use of a small sheet. Note that one cleat is placed near the "butt"

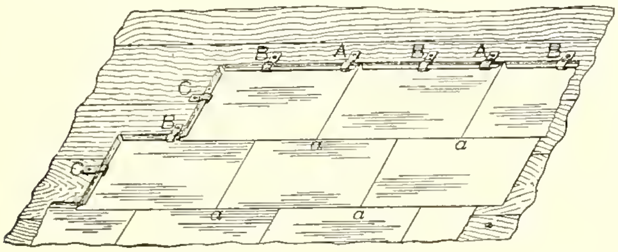


Fig. 586.—Spacing the Cleats

at *A,* and another midway between at *B,* while a cleat is placed in the center of the narrow side of the sheet at *C.*

It frequently occurs that the nail with which the cleat is fastened rises from the heat of the sun, and footsteps on the nail head will show an impression on the upper sheet, and wear through. This can be avoided by cutting the cleat ½ in. longer and turning this ½-in. flange over the nail head, as indicated

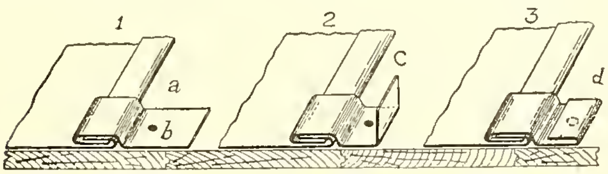


Fig. 587.—Three Operations in Securing Cleats

in the diagrams 1, 2 and 3 in Fig. 587. In the first diagram, the cleat is shown nailed at *a.* The surplus flange *b* is then turned up as indicated by *c* in 2, and is then flattened down as shown by *d* in 3.

When the roof has been laid the sheets are flattened to a smooth surface with a flat faced mallet, when with rosin as a flux, the seams are thoroughly sweated with half and half solder (50 new tin and 50 new lead) with 10-lb. soldering coppers. In soldering, it is desirable to solder the long seams first, then to slightly tap the "butts" *a* in Fig. 586 with the hammer, to smoothen same and then to solder the short seams. When the roof has been completely soldered including the upright seams of the flashings, the seams should be gone over carefully to prevent possible leaks and at the same time to scrape off the surplus rosin. Then the roof is carefully swept and flashings paint-skinned; and if the seams have been well sweated lasting results are assured.

METHODS EMPLOYED IN PROVIDING FOR EXPANSION AND CONTRACTION OF THE METAL IN LAYING STANDING SEAM ROOFING

Solution 173

The procedure on roof sheathing in the preceding solution applies also to standing seam roofing. In laying such roofing, of copper, the sheets can be bent up in 8 or 10-ft. lengths in the cornice brake, or of such length as the brake will permit. Usually sheets of 20 x 96 in. are employed, bent to the

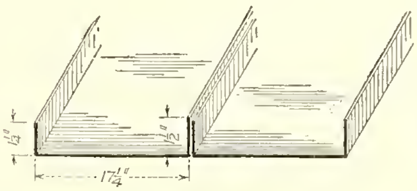


Fig. 588.—Vertical Heights of Standing Seam

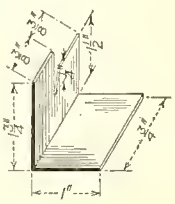


Fig. 589.—Cleat to Suit Lock in Fig. 588

dimensions indicated in Fig. 588, which gives a finished standing lock of 1 in. Occasionally instead of bending up 1¼ and 1½ in. on the sheet, only 1 and 1¼ in. are turned up, thus giving a ¾-in. finished seam.

The cross seams in standing lock roofing must have the edges tinned as in flat seam roofing; the edges are also cleated and soldered to make tight cross joints. The cleats used for standing lock roofing can be cut from scrap. For these 14-oz. copper is heavy enough. They are cut and formed as shown in Fig. 589, which gives full size measurements to work in connection with the seams shown in Fig. 588.

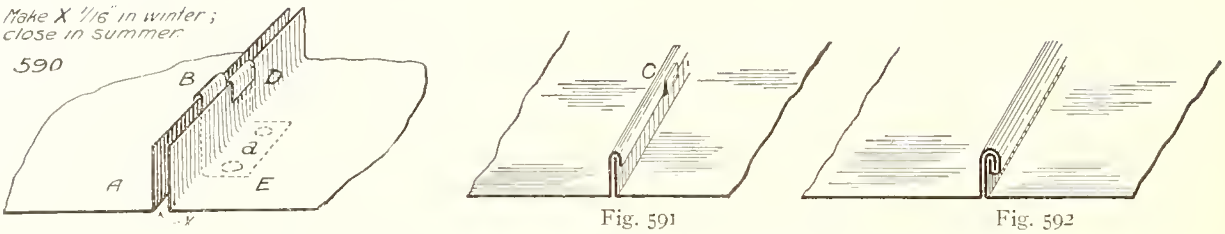


Fig. 591 Fig. 592

Fig. 590.—Three Operations of Double Seaming in Laying Standing Seam Copper Roofing

Copper standing seam should not be laid too snugly; a slight space should be allowed, as indicated by the arrow *X* in Fig. 590. This gives some slight play for expansion in connection with the use of the cleats. The cleats should be placed about 18 in. apart in a manner as follows: If the sheet *A* be laid first, the cleat *B* is set against *A* and nailed at *a*, and the upper ¼-in. edge is turned down as indicated by *B*. The sheet *E* is now laid against the cleat and the ¼-in. edge is turned down as shown at *D*. Thus the turned down edges *B* and *D* hold both sheets in position; this is the first operation. With the hand roofing double seamers and mallet, the quarter in. edge on sheet *A* is turned over as indicated in the second operation shown in Fig. 591, which shows part of the cleat exposed at *C*. Again with the hand double seamers and mallet the double seamed lock is completed as shown in Fig. 592, which covers the cleats entirely.

When the lower end of the sheet join to an

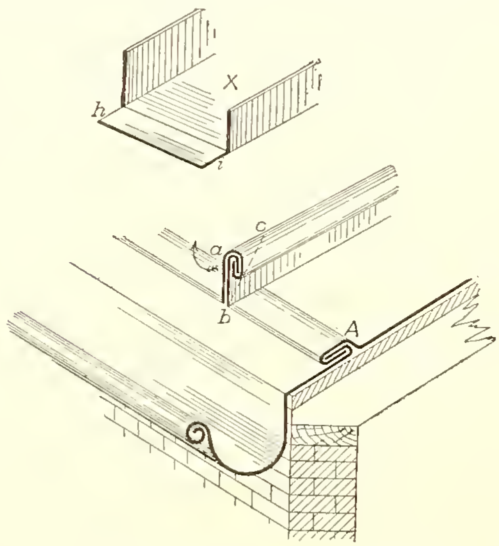


Fig. 593.—Locking the Strips to Eaves Gutter and Soldering the "Butts"

eave gutter it is locked, as shown in Fig. 593, the sheet having been previously prepared as indicated in diagram *X*, where an edge occurs at *h i*, for locking to the gutter. This lock is bent with the roofing tongs and is locked to the gutter as shown at *A*. Then, after the standing lock has been tightly closed, the butt is soldered water tight along *a b*. It is sometimes seen in practice that this butt is turned along *b c* at an angle of 45 degrees, in the direction of the arrow, or that the double seam will show on the outside, where it must be soldered up to the line of bend *b c*.

The method of joining the lock to the gutter also applies to connecting the standing lock roofing to the valley. Of course in the case of the valley the sheets must be cut to the proper bevel, with allowance for the lock made in a similar manner to that explained in connection with diagram *X*.

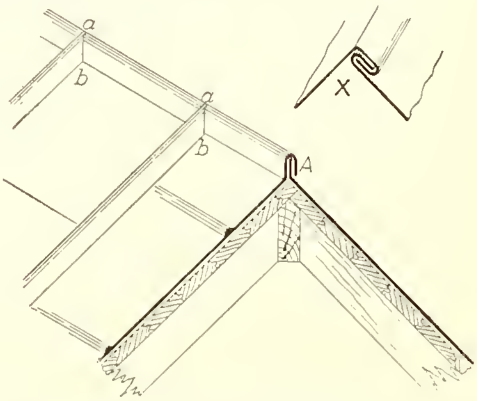


Fig. 594.—Completed Comb Ridge Which Can be Applied to Finish Against Hips

Fig. 594 shows how the roofing is finished at the ridge. In this case the finish is made with a comb ridge as indicated by *A*. This comb is prepared by means of a standing lock as shown, the doubled standing seam of the roofing proper being cut to miter against this comb ridge at *a b*, which must be carefully soldered. Preparatory to closing tightly, the standing lock *A*, red lead should be placed between the locks at *A* and then tightly malleted down. A rag dipped in turpentine is then used to wipe the red leaded seam clean, so that the copper will show clean.

Sometimes the standing lock as indicated at *A* is substituted by turning this same lock over, as shown in diagram *X*, where the top ridge is finished by double seaming. If this style of finish be utilized, the standing seams at *b a* are turned down flat a short distance and double seamed with the ridge finish as indicated in *X*, with the standing seams on both pitches of the roof breaking joints as shown

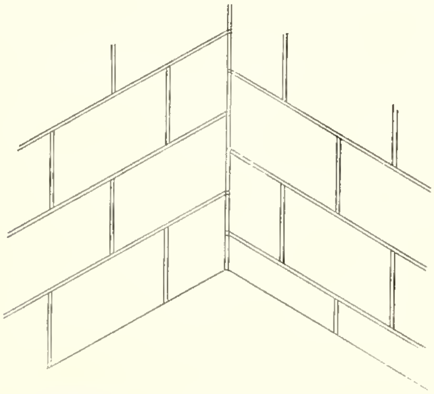
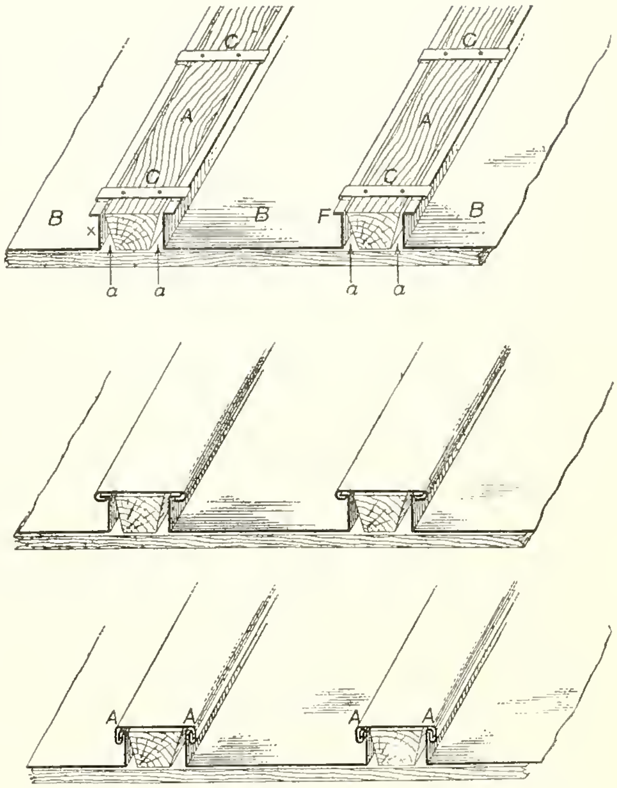


Fig. 595.—Breaking Joints when Double Seaming Ridge Lock

in Fig. 595. If the double seams meet it will be impossible to double seam the ridge because of the many thicknesses of metal.

The foregoing method of procedure applies also to finishing the hip ridge with the exception that the sheets are cut at a bevel to conform to the angle of the hip.



OPERATIONS IN CONNECTION WITH BATTENS
Fig. 596.—(Top) Spacing Battens and Cleating Copper Sheets
Fig. 597.—(Center) Capping the Battens. Fig. 598.—(Below). Double Seaming the Corners

LAYING ZINC OR COPPER ROOFING ON WOOD BATTENS

Solution 174

Battens are usually employed with zinc and copper roofing, and have a greater value in allowing for expansion of the sheets than can be obtained by any other method. This style consists of a series of battens nailed at proper intervals and covered with either sheet zinc or copper.

Wood battens must be carefully spaced with a gauge so that the proper width may be maintained as shown in Fig. 596 by A A. Note the formation of the batten; it is narrow on the roof line but wide at the top.

The metal sheets can be bent in the brake in 8 or 10-ft. lengths, as shown by B B B, with a flange turned outward as shown at F. The sheets are secured by cleats, C, which are spaced 10 in. apart, nailed to the batten and locked to the sheets. Note that the sheets B are bent up square, which gives ample space between the sheet and batten to allow for expansion, as indicated by the arrows *a, a, a, a.*

When the roof is not steep the cross seams are cleated, locked and soldered in batten roofing, the same as in flat seam roofing. If the roof is very steep, say one-half pitch, the cross seams need only be cleated and locked, with the lock about 3/4 in. wide. In turning up the sides of the sheet X care must be taken not to close the lock so that the lower and upper sheets can be hooked together. The closing of the lock can be avoided by placing a piece of leather or sheet lead in the lock. When the long strips have all been laid, the caps are slipped into position from the bottom, as indicated in Fig. 597, and then turned down and double seamed, as shown at the corners A in Fig. 598.

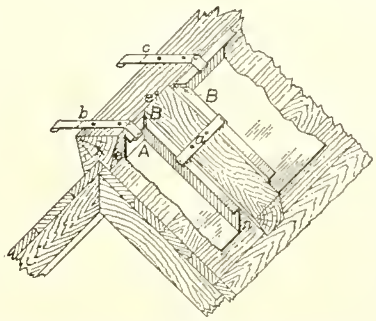


Fig. 599.—Cleating Sheets at Ridge or at Hip

Where the common battens meet the ridge batten X, as in Fig. 599, the wood battens are so cut that they run flush at *c*°. The metal sheets are then formed against the ridge batten, as indicated in the cut, and the upright corner is soldered at A, with the corners at B notched out as indicated. Cleats, about 10 in. apart, are used to fasten the sheets at *a*, *b* and *c*. This allows free movement of the sheet at the side *n* as well as at the top *c*.

The caps are then slipped over the common and

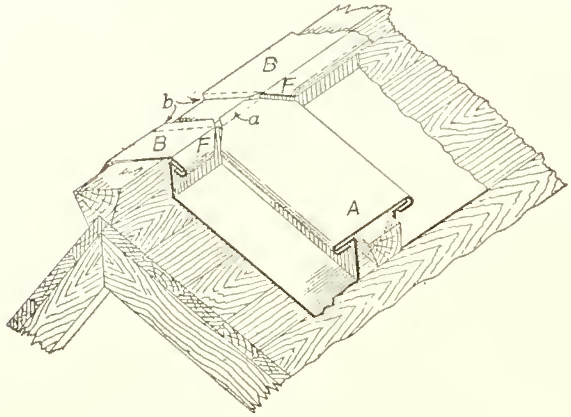


Fig. 600.—Slipping on the Caps

ridge battens as in Fig. 600 by A, B and B, with 1-in. lap at *a* and *b* for soldering purposes. The notches at F and F are greatly exaggerated. The caps are then turned down and double-seamed at the sides as

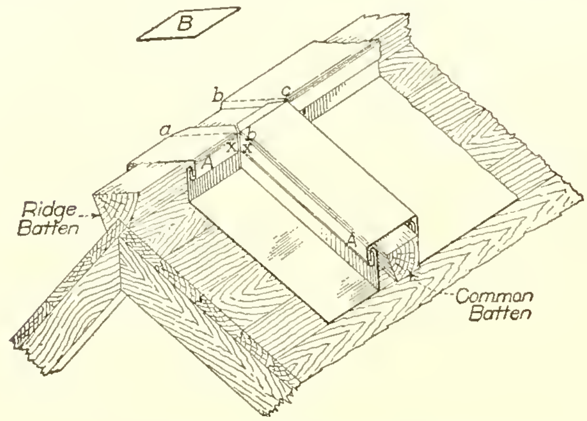


Fig. 601.—Double Seaming the Caps and Joining the Common and Ridge Batten Caps

shown by A in Fig. 601 with the upright corner at *x x* soldered to prevent leakage. Then over the laps *a*, *b* and *c* the piece B is soldered. This soldering of the cap corners and top B in no way interferes with the free movement of the sheets, which are free to expand and contract.

This method of finishing at the ridge also can be applied to the hip, with the exception that the common battens have to be cut at an angle against the hip batten.

The finish at the eave, whether connected to an eave strip or gutter, is shown in connection with Fig. 602. Care must be taken that the top of the gutter is at least 2 in. below the lower edge of the eave edge as indicated at A, and that the eave edge is not less than 1½ in. wide as shown. The wood battens should project over the back of the gutter a distance equal to the projection of the eave edge as shown in the reduced side view, and then cut at an angle shown from *c* to *f*, so that *f* will be in line with the back of the gutter. The batten will then look as shown by *a' a'*. Over the bottom end of each batten a flashing cap is set

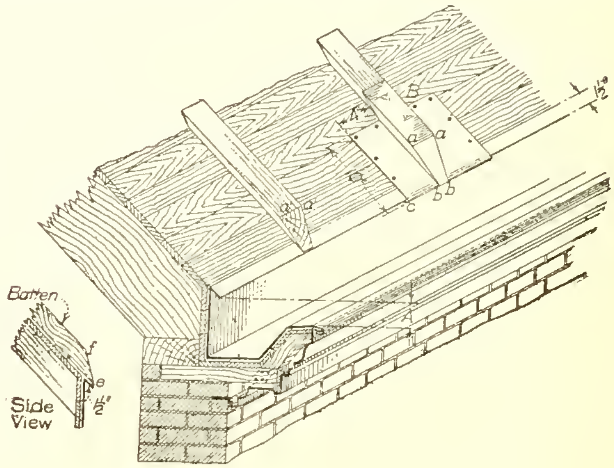


Fig. 602.—Applying Copper Flashing Cap at Eave

as shown at B. This must fit snug and tight and be made to the dimensions shown in Fig. 602.

A head is soldered at *a a b b* and the lower edge is locked to the ledge at *c*, and the cap nailed to the roof boards as shown. This flashing cap is to prevent any leaks from driving snow or rain, as no soldering must be done at the ends of the battens when the sheets are laid, as this would prevent the free movement of the sheets when expanding and contracting.

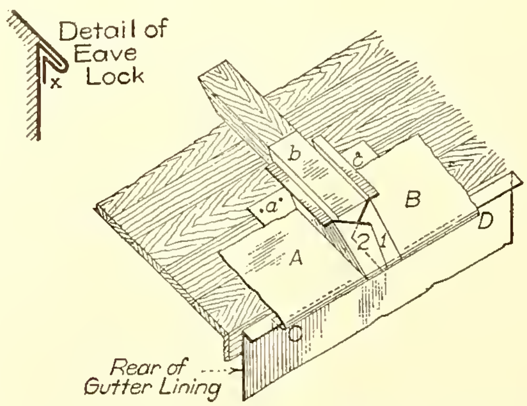


Fig. 603.—Laying Sheets Over Flashing Cap at Eave

After this flashing cap has been placed on all battens, either common or hip, the metal sheets are then laid as shown in Fig. 603, in which *a b c* shows the flashing cap and A and B the roofing sheets bent as before explained. These sheets are allowed to project below the battens sufficiently to allow the front ends to be turned over as indicated by the under lap 1 and the top lap 2. When making the lock along the eaves strip at C D, it should be formed as shown in the detail at *x*. This acts as a precautionary drip.

The cap is then slipped over the edges and double-

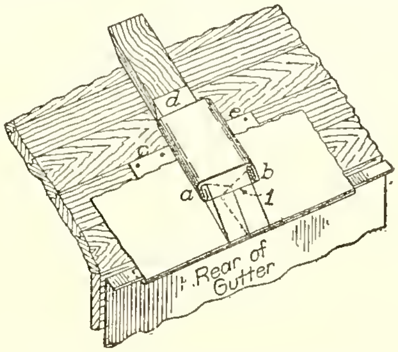


Fig. 604.—Completing the Locked Cap

seamed, as shown in Fig. 604, with the cap projecting sufficiently beyond *a* and *b* so that the lap 1 can be turned down over the side laps as indicated. No soldering must be done at the ends of the battens, as this would prevent the free movement of the sheets. No leak will occur at this point because the flashing cap *c d e* will prevent any leakage.

This method of finishing at the eaves is also used for finishing in the valleys. The sheet metal valley should turn up 14 in. on each side, with a 1-in. lock, thus using a 30-in. sheet. The battens should be cut on this line. The same shaped flashing cap should be used in the valley as at the eaves, and should hook in the lock of the valley, but should not be soldered.

The sheets should be locked to the lock of the

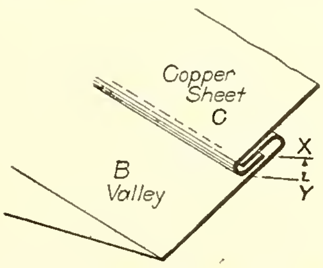


Fig. 605.—Locking Sheets to Valley

valley as shown in Fig. 605. They should have rounded edges, and the lock on the lower sheet or valley B must be larger than the lock on the roofing sheet C, so that in case of any water soaking under the lock and filling the lock on the roofing sheet C, it will overflow and return to the roof without getting on the inside. This lock is also likely to be filled with water in a driving wind storm, the rain striking the upper part of the lock on B and filling the lock of the sheet C with water as high as X Y, when it overflows without entering the inside. The valleys are cleated the same as in flat seam roofing.

LAYING A STANDING SEAM CIRCULAR METAL ROOF

Method of Laying Out the Work, Obtaining the Width and Length of Sheets and Cutting Them to Avoid Waste

Solution 175

When circular towers are to be covered with standing seam metal roofing the method is alike to that of standing seam roofing, but the laying out of sheets requires special attention. Fig. 606 shows a plan and elevation of a circular roof over the rear of nave and altar of a church. That part of the straight double pitched roof between X Y 1 16 is laid in the manner previously described, but the semi-circular roof between 1, 7, 16 in plan is the subject under consideration.

The semi-circular roof is divided into equal spaces of such dimensions that the metal sheets can be cut without waste. In copper or galvanized iron roofing of this kind sheets 8 or 10 ft. long are used. In tin roofing the sheets can be locked together any desired length. The spacings are indicated in the plan in Fig. 606, from 1 to 16.

The next step is to obtain the length of the rafter from B to the apex C in elevation and then deduct the distance equal to C A, as the finial will set over same, thus allowing it to overlap the roofing to the extent indicated by A. Tack a piece of building paper or roofing felt on the roof or floor in the building and lay off on the line *a b* in Fig. 607 the distance from B to A to C in elevation in Fig. 606 as shown from B to A to C in Fig. 607. At right angles to A B, through A and B draw lines as shown. Now take the length of one of the spaces in plan in Fig. 606 as 1-2 and set off one-half of same on either side of the line A B in Fig. 607 as shown by 1 and 2. From 1 and 2 draw lines to the apex C, cutting the line drawn through A as shown. Allow

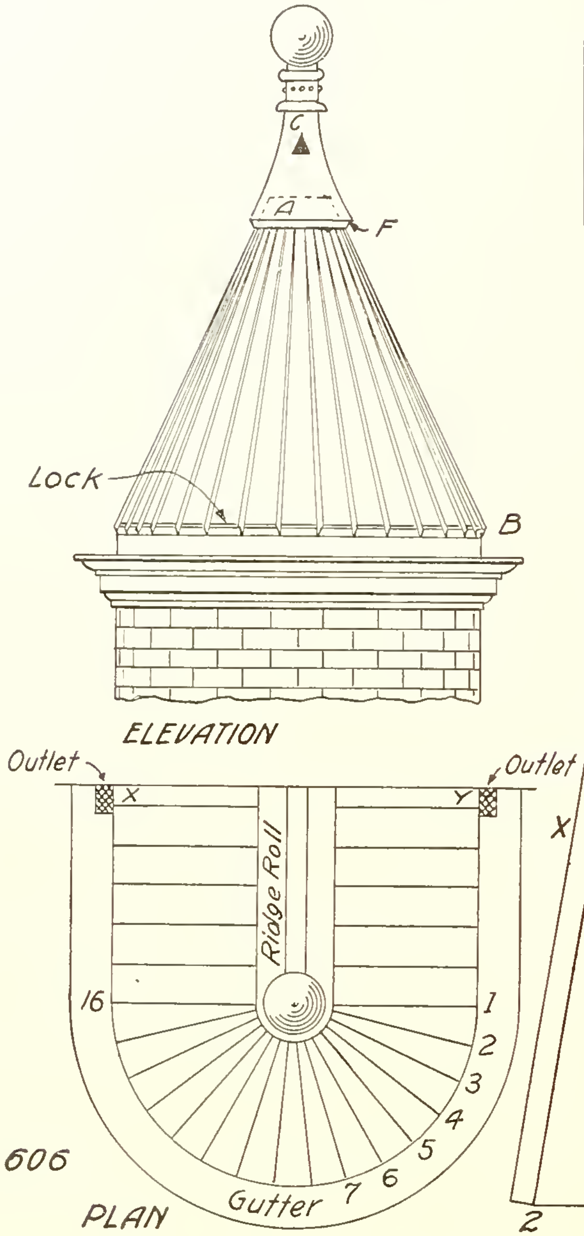


Fig. 606.—Plan and Elevation of a Circular Roof

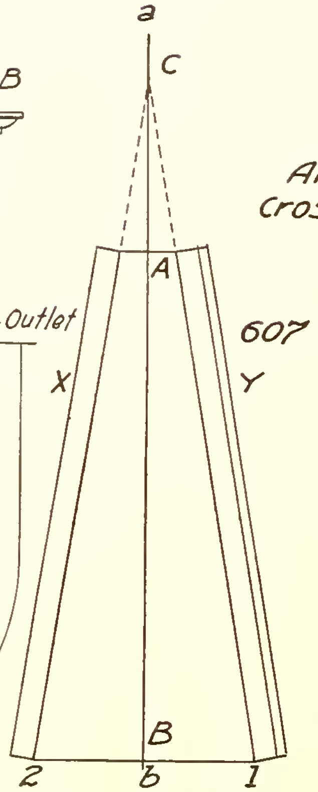


Fig. 607.—Getting Pattern for Individual Sheets

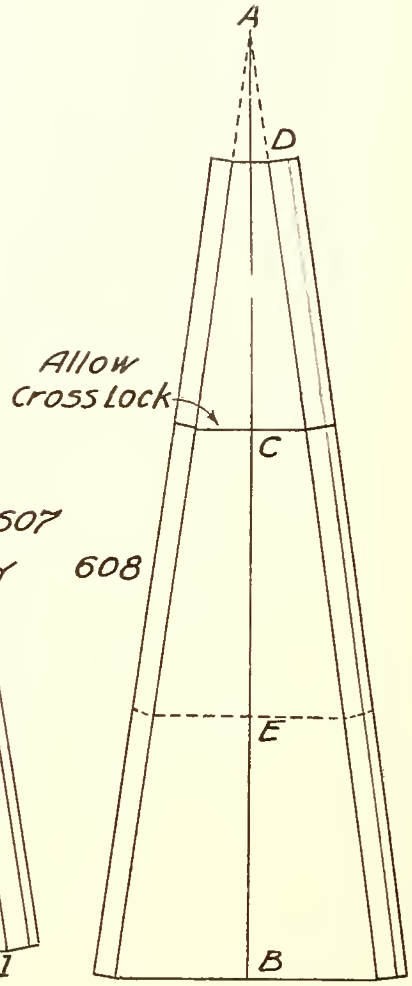


Fig. 608.—Getting Pattern for Individual Sheets when One or More Long Sheets Are Required

for the standing edges on both sides as indicated at X and Y. Then 1 2 A will be the pattern, of which 15 will be required as called for in plan in Fig. 606.

If desired the paper pattern, Fig. 607, can be sent to the shop to be cut and formed or the pieces can be cut at the building and roofing tongs used for bending up the standing edges.

Some may consider that as this pattern is laid out on the principle of developing a right cone, the bottom cut from 1 to 2 should be slightly curved. While this is true, the curvature is so small on a full sized roof that the straight line from 1 to 2 is entirely practical to use.

When the length of the rafter is such that two or more large sheets are required, the pattern is laid out as shown in Fig. 608. In this case we will assume that the distance on the center line A B from B to D is 14 ft., and that 8-ft. sheets or strips are employed. The distance from B to C is figured 7 ft. 11 in., which allows ½ in. lap at top and bottom for locking the sheets. So that the cross locks will not meet in double seaming the standing locks always break joints in the sheets; therefore on the next layer the distance of 7 ft. 11 in. will be measured from D to E. This will break joints alternately. For a roof of this run of rafter we would require eight sheets from B to C and eight from C to D; also seven sheets from D to E and seven sheets from E B breaking joints alternately. While the diagram shown is net, cross locks must be allowed to the paper patterns for the cross seams.

When the various tapering sheets are being cut the proper width of the sheet must be selected, from which there will be the least waste, as shown in

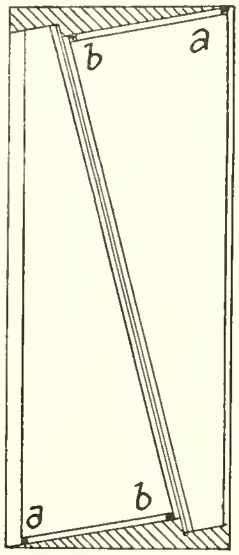


Fig. 609.—Showing Minimum Waste on Sheets when Proper Width is Selected

Fig. 609 where the only waste is indicated by the shaded portion. The heavy dashes at *a* and *b* in both sheets indicate notches at the lower end of the sheet, on which locks are turned to attach to the gutter lining. Where one or more sheets are to be locked together, edges are added to top and bottom.

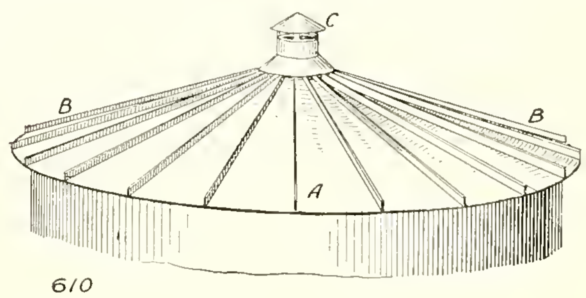
The sheets are cleated, locked and double seamed as already described.

Where the finial sets over the apex of the roof as shown in Fig. 606, mechanics sometimes flatten down the standing lock, which destroys the architectural effect of the standing seam. A better method is to notch out the lower flare of the finial at F wherever the standing seam occurs and then set this over the standing edges, which makes a first class finish.

STANDING SEAM CONICAL ROOF OVER LARGE GRAIN BIN

Solution 176

The perspective of Fig. 610 shows a roof laid out in 20 sections, alike to A, with standing seams indicated by B, B, C showing a plain ventilator at the apex. The ventilator at the top brings the roof to the formation of a frustum of a right cone, which is laid out as shown in Fig. 611, where the shortest method of development is given. First draw the center line A B, at right angles to which draw the line C D to equal the half diameter of the roof. Establish the hight of the roof at its apex, as shown by C E. Lay off the semi-width of the ventilator as shown at H. With E as a center, and E D as a radius, draw the arc D G. To provide for the division of the roof into twenty sections, the one-quarter plan B C D struck from C as center, is divided into five spaces as indicated from I to V, and one of the spaces as I is laid off into equal divisions, as shown by the heavy dots. With this distance D D° divided into five spaces, we start from G in the pattern and set off five corresponding spaces, as shown from G to F, and draw the radial lines F E and G E. Refer to where the ventilator intersects the roof line at H, and proceeding to use E as center and E H as radius, intersect the radial lines previously drawn from G and F, as shown. Many of these bins



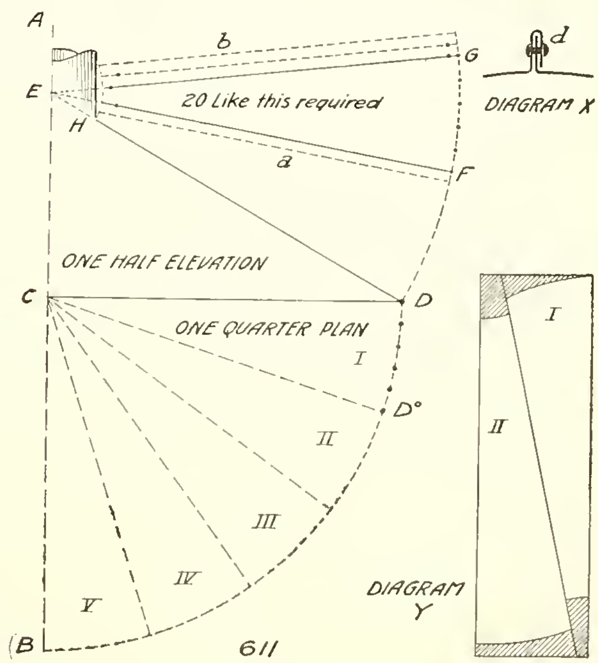


Fig. 610.—Perspective View of Conical Roof over Large Grain Bins

Fig. 611.—Obtaining the Pattern for Conical Roof over Bins

are of large size, and if we assume that the bin in question measures 6 ft. 6 in. diameter or a total of 78 in., it is not necessary to draw the quarter plan, since the circumference may be simply computed, as follows: 78 in. $\times$ 3.1416 = 245 in. 245 in. divided by 20, the number of roof sections sought, equals 12¼ in., the distance to be laid off along the line F G in the pattern. The standing seams are usually made as indicated in sketch X, with rivets at intervals, as at *d*, and we allow the single edge of 1 in. to the pattern at *a* and a double edge of 2 in. at *b*. The twenty sections are then bent on the brake, as shown at X, when they are locked together on the bin. Including the standing edge about 15¼ in. of material would be required along F G in the pattern; therefore, two sections may be obtained from a 20 in. wide sheet, on which the pattern is moved along as indicated in diagram Y the shaded portion represents the waste.

LAYING CORRUGATED GALVANIZED IRON OR COPPER ROOFING AND SIDING

With Methods of Obtaining Water-Tight Connections at Eave, Wall and Ridge

Solution 177

Galvanized iron or copper corrugated sheets, usually employed for roofing and siding, measure 2½ in. from center to center and have ⅝ in. depth. The full width of sheet with corrugations is 26 in. and

Fig. 612.—Corrugated Sheet Iron Roof Covering

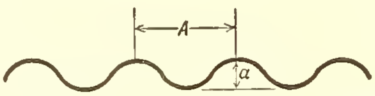


Fig. 613.—How the Corrugations are Measured

the covering width is 24 in., Fig. 612. The sheets may be obtained in from 5 to 12 ft. lengths, and gauges from Nos. 16 to 28 inclusive. The measurement of the corrugations is indicated by A and *a* in Fig. 613, A representing 2½ in. and *a* ⅝ in.

Fig. 614 indicates the lap recommended for roofing. The left edge *a* curves upward and the right edge downward, to the center of the corrugation. Thus in the use of the sheets of the standard width

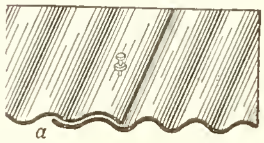


Fig. 614.—Lap Required for Roofing

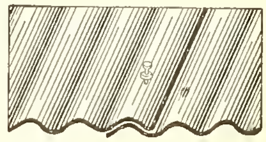


Fig. 615.—Lap Required for Siding

of 26 in., alternate sheets are inverted when applied to the roof. A satisfactory siding with one corrugation side lap is shown in Fig. 615. Referring to Figs. 614 and 615 the nail of galvanized iron is invariably driven through the highest point of the corrugation. The nails and lead washers employed

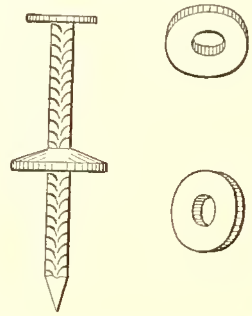
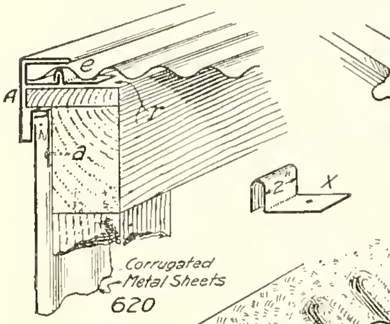


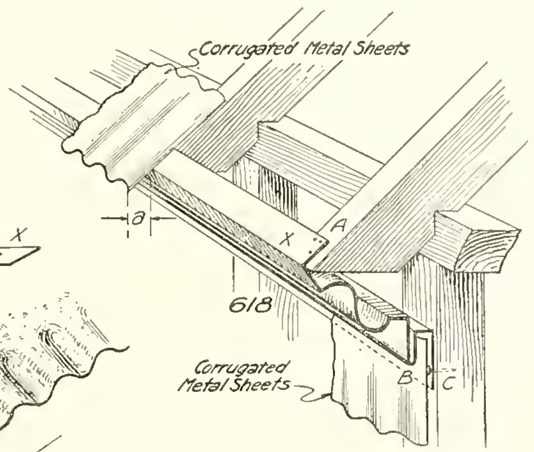
Fig. 616.—Lead Washers and Galvanized Nails used on Wood Framing

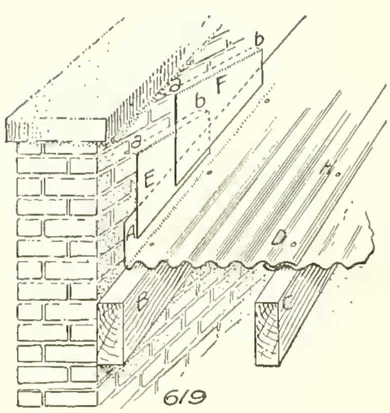
are shown in Fig. 616. The lead washers effect a water-tight joint, preventing leakage and rusting at the nail hole, thereby prolonging the life of the roof. The ends of the corrugated sheets, applied to roofs, should be lapped from three to six inches as required by the pitch of the roof, but for siding two inches is sufficient. For corrugated roofing, the quickest method of fastening the sheets to iron purlins or iron frame work is by means of clinch nails, in addition to lead washers. The nails are of No. 9 galvanized wire, in lengths of from 3 to 14

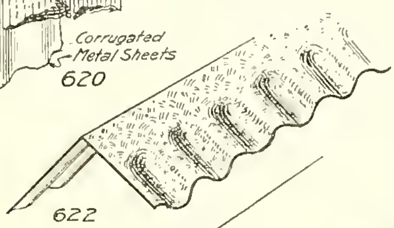
Fig. 617.—Clinch Nails for Fastening Corrugated Sheets to Iron Purlins or Iron Framework

inches, Fig. 617. Roofing or siding made from copper sheets requires to be secured with either brass or copper fastenings. In the procedure of applying metal corrugated roofing on wood sheathing or rafters, the roofer of experience begins by laying









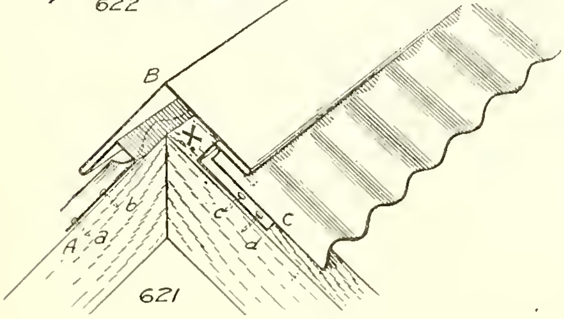


Fig. 618.—Finishing at the Eaves when the Framing is of Wood

Fig. 619.—Finishing at Gable Walls when Framing is of Wood

Fig. 620.—Finishing at Gable End when Framing is of Wood

Fig. 621.—Finishing at the Ridge

Fig. 622.—Corrugated V Ridge Capping

the roofing from the side opposite to that from which the wind blows; in other words, at the right of the building should the wind current come from the left, and vice versa. The purpose is to prevent the wind driving under the laps. If a finish at the eaves be desired, a molding may be formed, as indicated by A-B-C in Fig. 618; the upper flange is nailed on the rafters at X and allowance is made for a drip and pocket at B-C; the flange C is nailed to the uprights, as shown. The sheets should project over the eaves from two to three inches, as indicated at *a*. An eave gutter may also be hung over the flange X and connected to the ground by conductor pipes. In all cases care should be taken to have all corrugations on the length of the rafter run in straight lines. If roofing be of light gauge metal, as numbers 28 or 26, the roof should be close sheathed; for the heavier gauges, sheathing boards may be dispensed with and be substituted by purlins, whose distances from center to center equal the nailing distances of the sheets. The groove or pocket between B and C should be of accurate width to hold the corrugated sheet compactly. Where corrugated roofing abuts a brick wall, as in Fig. 619, sheets known as "corrugated side wall flashings" are employed, not less than 6 in. of which should be turned up against the wall as indicated at A. In this case the rafters B and C are spaced to conform to the width of the sheets used; the sheets are nailed 12 in. apart at D and H, with galvanized iron or zinc nails with lead washers. The flashing is then counter-flashed as indicated at E and F, allowance being made for a 1½ in. flange, *a-b*, to be securely fastened and paint-skinned into the joints of the brick work. When there are no brick walls present and the entire structure is of wood or iron framing, the finish at the gable end or elsewhere may be made as indicated in Fig. 620. Note that the formation of this gable end finish A, is to receive the corrugated sheet on the roof as well as at the sides. It is nailed at the side at *a* and has an upturned edge to meet the high point of the corrugation at *e*. The edge *e* is secured to the roof by means of cleats, shown in detail at X, nailed 12 in. apart. The roofing sheet slips in at *e*, and the siding should fit compactly into the side pocket at *i*. In the case of a roof having no sheathing, it is necessary to sheath its gable end sufficiently to receive the ledge cleats and form a solid foundation. If framing be of iron angles and tees, the flange of the gable finish A, may be extended to meet the second corrugation at *r*. The finish at the ridge can be made in three ways. The first method is illustrated by Fig. 621. The ridge is formed with a groove therein, as shown by A-B-C, and is nailed to the roof at *a-b-c* and *d*. The width of the groove at X is such that the corrugations will fit closely. Should there be exposure to leakage from driving storms, the groove may be filled with roofer's cement and the sheets pressed in. The second method of finishing at the ridge is by means of a corrugated V ridge capping, shown in Fig. 622. The corrugations of these cappings are pressed in and fit over the corrugated sheets; they are nailed, riveted or bolted thereto. Another shape of ridge covering is shown in Fig.

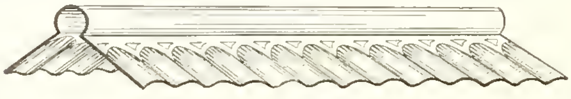


Fig. 623.—Corrugated Ridge Roll

623. This has pressed corrugation in addition to a ridge roll, as shown. In the use of this ridge roll it is desirable to fasten a ridge pole to the roof, as

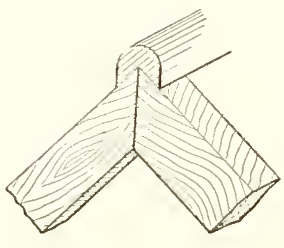


Fig. 624.—Wood Ridge Pole to Receive Metal Ridge Roll

shown in Fig. 624, to receive the metal roll and prevent injury to the metal during the erection and use of scaffolding.

A corrugated roof abutting a vertical wall or shaft is finished against the wall by means of a corru-

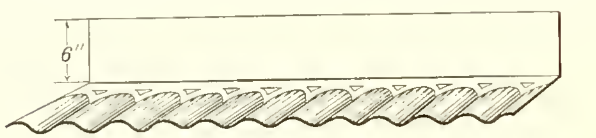


Fig. 625.—Corrugated Flashing for Wall Abutment

gated wall flashing, shown in Fig. 625. Such sheets are pressed in conformity with the standard requirements of corrugated material and have a flat upright metal surface which it is found in practice should measure not less than 6 in. It will be understood that these flashings are to be cap flashed to make a tight joint with the wall abutment.

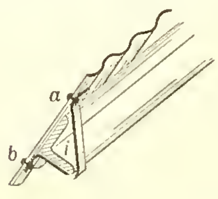


Fig. 626.—Using Strap Iron Cleat on Iron Framing

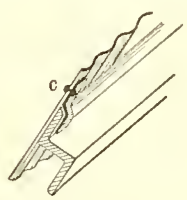


Fig. 627.—Using Band Iron Cleat on Iron Framing

When fastening the sheets to iron framing the side laps are riveted at intervals of from 12 to 15 in. or less; the end laps on every alternate corrugation. Four methods of fastening the corrugated sheets to the iron framing are illustrated in Figs. 626 to 629 inclusive. The first method, Fig. 626, is to pass a cleat of galvanized band iron, ¾ in. wide and 1/16 in. thick, around the purlin or beam and to rivet each end to the sheet at *a* and *b*; by contracting or pressing this band iron cleat towards the web of the beam or purlins at *i*, a compact and secure fastening is made which also allows for expansion and contraction of the sheet. Fig. 627 shows how galvanized band iron cleats are

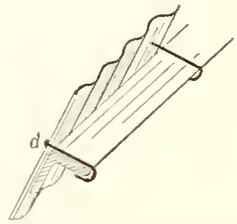


Fig. 628.—Using Clinch Nails Shown in Fig. 617 for Iron Framing

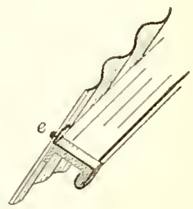


Fig. 629.—Using Strap Iron Cleats for Iron Framing

firmly riveted to the sheet, at *c*, and bind against the flange of the Z bar or angle iron. Fig. 628 shows a galvanized clinch nail, *d*, driven through the corrugated sheet and bent around the angle iron. Another fastening is shown in Fig. 629, where the cleat is riveted to the sheet at *e* and clamped to the flange of the channel iron. When nailing the corrugated siding to wood framing without sheathing boards, the studding should be framed to measure 24 in. from center to center, unless it is preferred to place them farther apart and nail the sheets to furring or batten strips, placed approximately two feet apart, or the distance from nailing centers of the sheet. The vertical seams of the siding are invariably nailed through the tops of the corrugations, as indicated in Fig. 630 by 1-2-3 and 4; the horizontal seams are nailed in the valleys of the corrugations, as indicated in the illustration by *a-b-c*, etc. In fastening the siding laps at the ends of the sheets, the nails or rivets should be placed about 2 in. above the upper edge of the lower sheets, thus providing latitude for movement should there be any settling. The use of heavy gauge corrugated sheets, dispensing with wood sheathing board, reduces fire risk, favoring minimum insurance cost. The siding should be set clear off the ground, em-

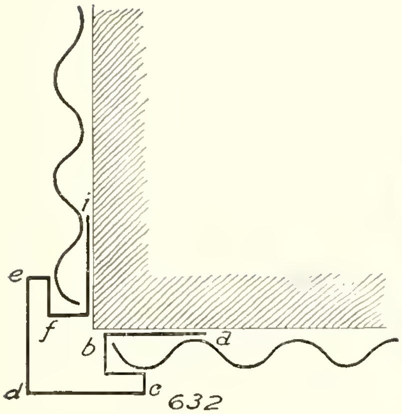


Fig. 632.—Metal Corner Stile to Receive Corrugated Siding

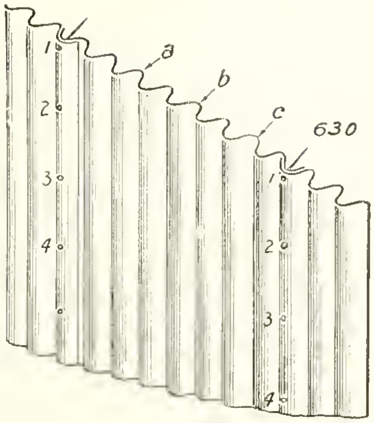


Fig. 630.—Lapping and Nailing Vertical Seams of Corrugated Siding

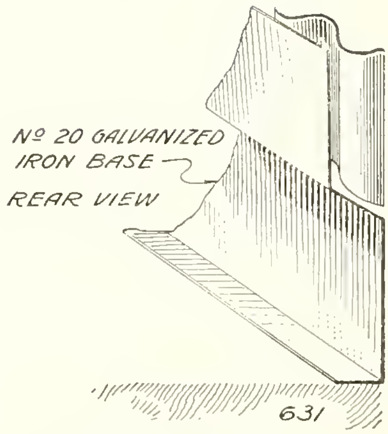


Fig. 631.—Sheet Metal Base to Receive Corrugated Siding

ploying a base of No. 20 or heavier galvanized iron, as shown in Fig. 631; the lower part should be covered with two coats of asphalt paint, thickly applied. Fig. 632 shows the method of employing a metal corner stile to receive corrugated siding. It is nailed or bolted to the framing, through the flanges *a* and *i*, the grooves *b* and *f* being of a size to admit and hold the corrugation compactly. The width of the stile *c-d* or *d-e* is determined by individual preference. On first class work, sheets and trimmings are usually painted on the two sides with red lead; they must be thoroughly dry before being applied.

COVERING DOMES WITH FLAT SEAM ROOFING: METHODS APPLICABLE TO ROOFS OF TIN, COPPER OR ZINC

Solution 178

Fig. 633 shows a front elevation of a dome roof which we will assume is to be covered with flat seam roofing. The gutter, indicated in the cornice, requires to be carefully lined with a view to locating the first lock about 2 in. above the cornice top, as shown at *a*; thus overflowing drainage will be intercepted and run over the front edge of the cornice, without reaching the lock, since no locks on the roof are to be soldered, excepting the extreme top of the dome below the finial, or those locks occurring as far down as is indicated by AA. Great care is required in laying out the various patterns for the several courses; the method illustrated by Fig. 634 applies to roofing of tin, sheet iron, zinc, and sheet copper. After the dome has been carefully wood sheathed, find the exact center of its top and drive a wire nail therein, to which fasten some spool wire. The spool wire is drawn over the roof of the dome and to the bottom of the first course, indicated by X-X in Fig. 634, a circle

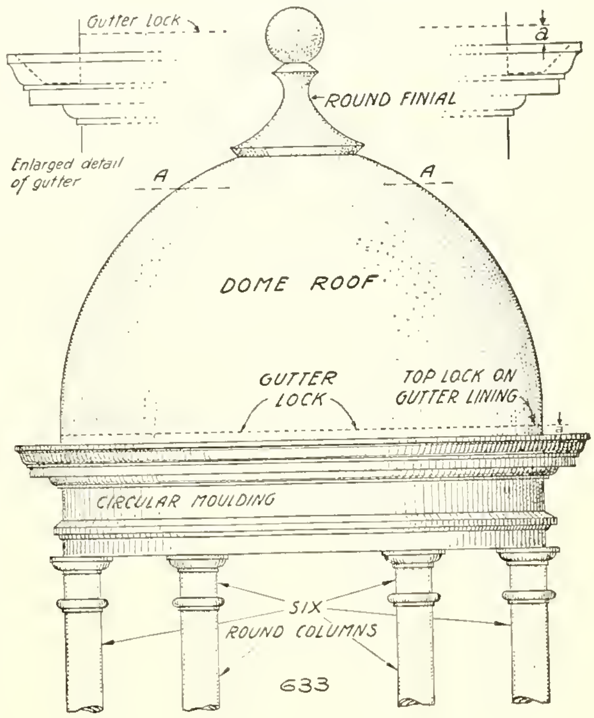


Fig. 633.—Front Elevation of Dome Roof

is drawn around the base of the dome, forming a guide line for giving the metal a straight and level start; this operation requires to be conducted with considerable care.

The base line, X-X, around the entire dome is divided into an equal number of parts, when careful consideration of the diameter of the dome is required in order that the spaces or parts are so separated as to readily conform to the curve of the dome; the sheets must not be of excess width, else they will buckle when the locks are closed; they must be made to lie smoothly and compactly against the dome, so that, when the work is completed the dome will present a true spherical surface. In this case, in which we have considered a dome of

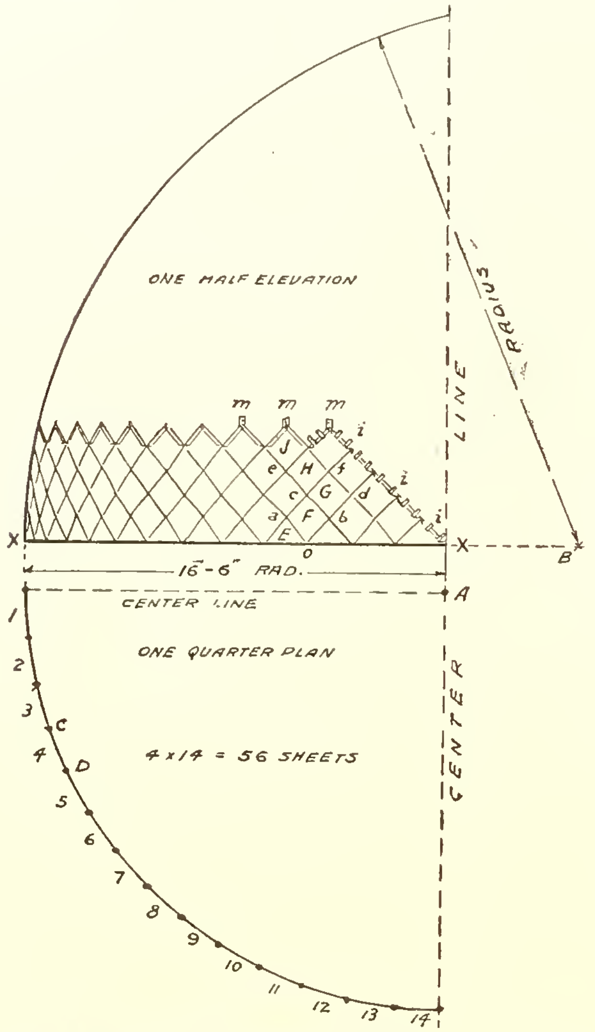


Fig. 634.—Obtaining Dimensions for Laying out Patterns of Sheets for Courses

33 ft. diameter, which is reduced to inches, as 12x33 or 396 in. We find the circumference of the base of the dome by multiplying 396 by 3.1416, the product being 1,244 in. We space this sum of distance into 56 parts or 14 parts to each quarter, as indicated in the one-quarter plan, making each space to slightly exceed 22.2 in. The reader should not overlook that the smaller the diameter of the dome, the smaller will be the required size of sheet. The 56 divisions in the first course form the basis for obtaining the pattern for each succeeding course. The sheets in the first course are triangular in shape, as shown in the one-half elevation, and they have the lock turned up and down, so that water will flow over the seam. Laying the sheets diagonally as shown disposes of vertical seams and permits water to pass without the likelihood of leakage. The pattern for the first course, marked E in ele-

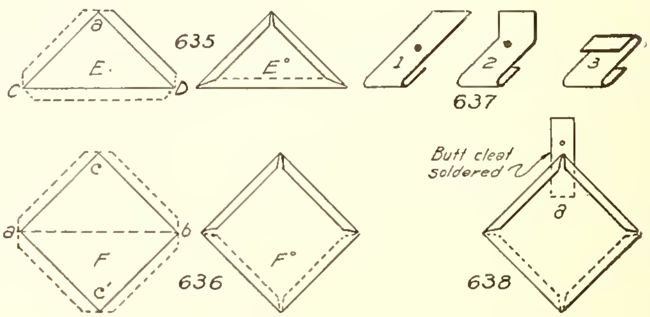


Fig. 635.—Pattern for First Course
Fig. 636.—Pattern for Second Course
Fig. 637.—Operations in Turning the Cleat
Fig. 638.—Soldered Cleat to Hold Down Butts of Sheet

vation, is laid out as shown in Fig. 635. Take the length of one of the divisions previously obtained from the circumference of the first course or C-D in the quarter plan in Fig. 634 and lay it off on any line, as C-D in Fig. 635. From C and D, draw lines at angles of 45 degrees, meeting at *a*. Connect lines C-*a* and *a*-D and allow half-inch locks on the three sides, as shown. E indicates the pattern for the sheets in the first course, of which 56 are required. When these are cut, turn the lower lock downward and the two diagonal locks upward as indicated in diagram E°. The first course, E, in Fig. 634 is then laid; the lock of the gutter lining is adjusted and each side lock secured with two cleats as indicated by *i-i*, etc., in the half elevation. When this first course has been laid, measurements may be taken for the second course, indicated by F. Take accurately the distance across from *a* to *b*, which must be the same between each sheet around the entire circumference, and place it on any line as *a-b* in diagram F, in Fig. 636. Proceed by taking accurately the equal distances from *o* to *a* or from *o* to *b* in Fig. 634; using *a* and *b* in diagram F, Fig. 636, as centers, describe arcs intersecting each other at *c* and *c'*; complete the outline *a-c-b-c'*. Allow half-inch locks on the four sides; turn two locks downward and two locks upward as indicated in diagram F°. In like manner there will also be 56 sheets required for course F, Fig. 634, fastened with cleats, as shown. Note how the edges are notched in E, Fig. 635, and in F, Fig. 636; it will be seen that the notching is vertical at the sides and horizontal at top and bottom. In the manner described each succeeding pattern or course is measured from the course previously laid. Thus the pattern for course G in Fig. 634 is found with the distance between the corners *c* and *d* and the lengths *b-c* and *b-d*, as radii. Course H is laid out by means of the distance *c-f* with the distances *c-c* and *c-f*, as radii. All sheets must be secured with cleats which are approximately 1 in. wide; the cleats are turned as shown in the three operations in Fig. 637; the first diagram indicates the nail inserted; the second shows the back of the cleat turned up and ready to close over the nail head which is shown in diagram 3. In cases of tendency on the part of the butts, at *a*, *c* and *f* in Fig. 634, to raise, a cleat is required to be soldered *under the sheet*, as indicated at *a*, in Fig. 638, and when the butt cleat is nailed to the roof the nail head requires to be covered, as was explained heretofore. When the dome has thus been completely covered, the seams are carefully malleted down; at the top of the dome, the seams are soldered where it is necessary. If no soldering be undertaken, white lead is placed between the locks, with a small tool brush; this is done before malleting down the locks and gives additional security. If the roof is of galvanized iron or tin, the white lead may remain, to be covered with the desired color of paint; but the seams of roofs of copper should be cleaned promptly by the usual means of rags saturated with turpentine.

Number of Sheets Required to Cover a Given Surface of Tin Roofing

	Flat Seam				Standing Seam								
					Single Lock				Double Lock				
	Edged ¼ In.		Edged ⅜ In.		¾-In. Seam		1-In. Seam		¾-In. Seam		1-In. Seam		
Given Surface	14 x 20	20 x 28	14 x 20	20 x 28	14 x 20	20 x 28	14 x 20	20 x 28	14 x 20	20 x 28	14 x 20	20 x 28	Given Surface
Sq. Ft.	S	S	S	S	S	S	S	S	S	S	S	S	Sq. Ft.
10	6	3	6	3	7	4	7	4	7	4	7	4	10
11	7	4	7	4	7	4	8	4	8	4	8	4	11
12	7	4	8	4	8	4	8	4	8	4	8	4	12
13	8	4	8	4	9	4	9	5	9	4	9	5	13
14	9	4	9	4	9	5	10	5	10	5	10	5	14
15	9	5	9	5	10	5	10	5	10	5	10	5	15
16	10	5	10	5	11	5	11	5	11	5	11	6	16
17	10	5	11	5	11	6	12	6	12	6	12	6	17
18	11	6	11	6	12	6	12	6	12	6	12	6	18
19	12	6	12	6	12	6	13	6	13	6	13	6	19
20	12	6	12	6	13	7	13	7	13	7	14	7	20
21	13	6	13	6	14	7	14	7	14	7	14	7	21
22	13	7	14	7	14	7	15	7	15	7	15	7	22
23	14	7	14	7	15	7	15	8	15	8	16	8	23
24	14	7	15	7	16	8	16	8	16	8	16	8	24
25	15	8	15	8	16	8	17	8	17	8	17	8	25
26	16	8	16	8	17	8	17	9	17	8	18	9	26
27	16	8	16	8	18	9	18	9	18	9	18	9	27
28	17	8	17	8	18	9	19	9	19	9	19	9	28
29	17	9	18	9	19	9	19	10	19	9	20	10	29
30	18	9	18	9	19	10	20	10	20	10	20	10	30
31	19	9	19	9	20	10	21	10	21	10	21	10	31
32	19	9	19	10	21	10	21	10	21	10	22	11	32
33	20	10	20	10	21	10	22	11	22	11	22	11	33
34	20	10	21	10	22	11	23	11	22	11	23	11	34
35	21	10	21	10	23	11	23	11	23	11	24	11	35
36	21	11	22	11	23	11	24	12	24	11	24	12	36
37	22	11	22	11	24	12	24	12	24	12	25	12	37
38	23	11	23	11	24	12	25	12	25	12	26	12	38
39	23	11	24	12	25	12	26	13	26	12	26	13	39
40	24	12	24	12	26	13	26	13	26	13	27	13	40
41	24	12	25	12	26	13	27	13	27	13	28	13	41
42	25	12	25	12	27	13	28	14	28	13	28	14	42
43	26	13	26	13	28	13	28	14	28	14	29	14	43
44	26	13	27	13	28	14	29	14	29	14	30	14	44
45	27	13	27	13	29	14	30	14	30	14	30	15	45
46	27	13	28	14	29	14	30	15	30	15	31	15	46
47	28	14	28	14	30	15	31	15	31	15	32	15	47
48	28	14	29	14	31	15	32	15	31	15	32	16	48
49	29	14	30	14	31	15	32	16	32	15	33	16	49
50	30	15	30	15	32	16	33	16	33	16	34	16	50
51	30	15	31	15	33	16	34	16	33	16	34	17	51
52	31	15	31	15	33	16	34	17	34	16	35	17	52
53	31	15	32	16	34	16	35	17	35	17	36	17	53
54	32	16	32	16	35	17	36	17	35	17	36	17	54
55	33	16	33	16	35	17	36	18	36	17	37	18	55
56	33	16	34	16	36	17	37	18	37	18	38	18	56
57	34	16	34	17	36	18	37	18	37	18	38	18	57
58	34	17	35	17	37	18	38	19	38	18	39	19	58
59	35	17	35	17	38	18	39	19	39	19	40	19	59
60	35	17	36	18	38	19	39	19	39	19	40	19	60
61	36	18	37	18	39	19	40	19	40	19	41	20	61
62	37	18	37	18	40	19	41	20	41	19	42	20	62
63	37	18	38	18	40	20	41	20	41	20	42	20	63
64	38	18	38	19	41	20	42	20	42	20	43	21	64
65	38	19	39	19	41	20	43	21	42	20	44	21	65
66	39	19	40	19	42	20	43	21	43	21	44	21	66
67	40	19	40	20	43	21	44	21	44	21	45	22	67
68	40	20	41	20	43	21	45	22	44	21	46	22	68
69	41	20	41	20	44	21	45	22	45	22	46	22	69
70	41	20	42	20	45	22	46	22	46	22	47	22	70
71	42	20	43	21	45	22	47	23	46	22	48	23	71
72	42	21	43	21	46	22	47	23	47	22	48	23	72
73	43	21	44	21	46	23	48	23	48	23	49	23	73
74	44	21	44	22	47	23	48	23	48	23	50	24	74
75	44	22	45	22	48	23	49	24	49	23	50	24	75
76	45	22	46	22	48	23	50	24	50	24	51	24	76
77	45	22	46	22	49	24	50	24	50	24	52	25	77
78	46	22	47	23	50	24	51	25	51	24	52	25	78
79	47	23	47	23	50	24	52	25	52	25	53	25	79
80	47	23	48	23	51	25	52	25	52	25	54	26	80
81	48	23	48	23	52	25	53	26	53	25	54	26	81
82	48	24	49	24	52	25	54	26	53	26	55	26	82
83	49	24	50	24	53	26	54	26	54	26	56	27	83
84	49	24	50	24	53	26	55	27	55	26	56	27	84
85	50	24	51	25	54	26	56	27	55	26	57	27	85
86	51	25	51	25	55	26	56	27	56	27	58	28	86
87	51	25	52	25	55	27	57	28	57	27	58	28	87
88	52	25	53	25	56	27	58	28	57	27	59	28	88
89	52	26	53	26	57	27	58	28	58	28	60	28	89
90	53	26	54	26	57	28	59	28	59	28	60	29	90
91	54	26	54	26	58	28	60	29	59	28	61	29	91
92	54	26	55	27	58	28	60	29	60	29	62	29	92
93	55	27	56	27	59	29	61	29	61	29	62	30	93
94	55	27	56	27	60	29	61	30	61	29	63	30	94
95	56	27	57	27	60	29	62	30	62	30	64	30	95
96	56	27	57	28	61	29	63	30	62	30	64	31	96
97	57	28	58	28	62	30	63	31	63	30	65	31	97
98	58	28	59	28	62	30	64	31	64	30	66	31	98
99	58	28	59	29	63	30	65	31	64	31	66	32	99

Number of Boxes and Sheets Required to Cover a Given Surface of Tin Roofing

Given Surface of Roof to be Covered	Flat Seam								Standing Seam				Given Surface of Roof to be Covered
	Edged ¼ In.				Edged ⅜ In.				Single Lock ¾-In. Seam				
	14 x 20		20 x 28		14 x 20		20 x 28		14 x 20		20 x 28		
Sq. Ft.	B.	S.	B.	S.	B.	S.	B.	S.	B.	S.	B.	S.	Sq. Ft.
100	0	59	0	29	0	60	0	29	0	64	0	31	100
200	1	5	0	57	1	7	0	57	1	15	0	61	200
300	1	63	0	85	1	66	0	86	1	78	0	91	300
400	2	10	1	1	2	14	1	2	2	29	1	9	400
500	2	68	1	29	2	73	1	30	2	92	1	39	500
600	3	14	1	57	3	20	1	59	3	43	1	70	600
700	3	73	1	85	3	79	1	87	3	106	1	100	700
800	4	19	2	1	4	27	2	3	4	57	2	18	800
900	4	77	2	29	4	86	2	32	5	8	2	48	900
1000	5	23	2	57	5	33	2	60	5	71	2	78	1000
1100	5	82	2	85	5	92	2	89	6	22	2	109	1100
1200	6	28	3	1	6	40	3	5	6	85	3	27	1200
1300	6	86	3	29	6	99	3	34	7	36	3	57	1300
1400	7	33	3	57	7	46	3	62	7	99	3	87	1400
1500	7	91	3	86	7	105	3	90	8	50	4	5	1500
1600	8	37	4	2	8	53	4	7	9	1	4	35	1600
1700	8	96	4	30	9	0	4	35	9	64	4	66	1700
1800	9	42	4	58	9	59	4	63	10	15	4	96	1800
1900	9	100	4	86	10	6	4	92	10	78	5	14	1900
2000	10	46	5	2	10	66	5	8	11	29	5	44	2000
2100	10	105	5	30	11	13	5	37	11	92	5	74	2100
2200	11	52	5	58	11	72	5	65	12	43	5	105	2200
2300	11	110	5	86	12	19	5	93	12	106	6	23	2300
2400	12	36	6	2	12	79	6	10	13	57	6	53	2400
2500	13	2	6	30	13	26	6	38	14	8	6	83	2500
2600	13	60	6	58	13	85	6	67	14	71	7	1	2600
2700	14	7	6	86	14	32	6	95	15	22	7	32	2700
2800	14	65	7	2	14	92	7	11	15	85	7	62	2800

Given Surface of Roof to be Covered	Flat Seam — Edged ¼ In. — 14 x 20		Flat Seam — Edged ¼ In. — 20 x 28		Flat Seam — Edged ⅜ In. — 14 x 20		Flat Seam — Edged ⅜ In. — 20 x 28		Standing Seam — Single Lock ¾-In. Seam — 14 x 20		Standing Seam — Single Lock ¾-In. Seam — 20 x 28		Given Surface of Roof to be Covered
Sq. Ft.	B.	S.	B.	S.	B.	S.	B.	S.	B.	S.	B.	S.	Sq. Ft.
2900	15	11	7	31	15	39	7	40	16	36	7	92	2900
3000	15	69	7	59	15	98	7	68	16	99	8	10	3000
3100	16	16	7	87	16	45	7	97	17	50	8	40	3100
3200	16	74	8	3	16	105	8	13	18	1	8	70	3200
3300	17	20	8	31	17	52	8	41	18	64	8	101	3300
3400	17	78	8	59	17	111	8	70	19	15	9	19	3400
3500	18	25	8	87	18	58	8	98	19	78	9	49	3500
3600	18	83	9	3	19	6	9	14	20	29	9	79	3600
3700	19	30	9	31	19	65	9	43	20	92	9	109	3700
3800	19	88	9	59	20	12	9	71	21	43	10	28	3800
3900	20	35	9	87	20	71	9	100	21	106	10	58	3900
4000	20	92	10	3	21	19	10	16	22	57	10	88	4000
4100	21	39	10	31	21	78	10	44	23	8	11	6	4100
4200	21	97	10	59	22	25	10	73	23	71	11	36	4200
4300	22	44	10	88	22	85	10	101	24	22	11	67	4300
4400	22	102	11	4	23	32	11	18	24	85	11	97	4400
4500	23	48	11	32	23	91	11	46	25	36	12	15	4500
4600	23	107	11	60	24	38	11	74	25	99	12	45	4600
4700	24	53	11	85	24	98	11	103	26	50	12	75	4700
4800	24	111	12	4	25	45	12	19	27	1	12	105	4800
4900	25	57	12	37	25	104	12	48	27	64	13	24	4900
5000	26	4	12	60	26	51	12	76	28	15	13	54	5000
6000	31	27	15	5	31	84	15	24	33	85	16	20	6000
7000	36	50	17	62	37	4	17	84	39	43	18	98	7000
8000	41	73	20	7	42	37	20	32	45	1	21	63	8000
9000	46	95	22	65	47	70	22	91	50	72	24	29	9000
10000	52	6	25	8	52	102	25	39	56	30	26	107	10000

Number of Boxes and Sheets Required to Cover a Given Surface of Tin Roofing

Standing Seam

Given Surface of Roof to be Covered	Single Lock — 1-In. Seam — 14 x 20		Single Lock — 1-In. Seam — 20 x 28		Double Lock — ¾-In. Seam — 14 x 20		Double Lock — ¾-In. Seam — 20 x 28		Double Lock — 1-In. Seam — 14 x 20		Double Lock — 1-In. Seam — 20 x 28		Given Surface of Roof to be Covered
Sp. Ft.	B.	S.	B.	S.	B.	S.	B.	S.	B.	S.	B.	S.	Sp. F.
100	0	65	0	32	0	65	0	31	0	67	0	32	100
200	1	18	0	63	1	18	0	62	1	21	0	63	200
300	1	83	0	94	1	82	0	92	1	88	0	95	300
400	2	36	1	13	2	35	1	11	2	42	1	14	400
500	2	101	1	44	2	99	1	41	2	109	1	46	500
600	2	54	1	75	3	52	1	72	3	63	1	77	600
700	4	6	1	106	4	5	1	102	4	18	1	108	700
800	4	71	2	25	4	69	2	21	4	84	2	28	800
900	5	24	2	56	5	22	2	51	5	39	2	59	900
1000	5	89	2	87	5	86	2	82	5	105	2	91	1000
1100	6	42	3	6	6	39	3	0	6	59	3	10	1100
1200	6	107	3	37	6	103	3	31	7	14	3	42	1200
1300	7	59	3	68	7	56	3	62	7	80	3	73	1300
1400	8	12	3	99	8	9	3	92	8	39	3	104	1400
1500	8	77	4	18	8	73	4	11	8	101	4	24	1500
1600	9	30	4	49	9	26	4	41	9	56	4	55	1600
1700	9	95	4	81	9	90	4	72	10	10	4	87	1700
1800	10	48	5	0	10	43	4	102	10	77	5	6	1800
1900	11	0	5	31	10	108	5	21	11	31	5	38	1900
2000	11	65	5	62	11	60	5	51	11	97	5	69	2000
2100	12	18	5	93	12	13	5	82	12	52	5	100	2100
2200	12	83	6	12	12	77	6	0	13	6	6	20	2200
2300	13	36	6	43	13	30	6	31	13	73	6	51	2300
2400	13	101	6	74	13	94	6	61	14	27	6	83	2400
2500	14	53	6	105	14	47	6	92	14	94	7	2	2500
2600	15	6	7	24	15	0	7	11	15	48	7	34	2600
2700	15	71	7	55	15	64	7	41	16	3	7	65	2700
2800	16	24	7	86	16	17	7	72	16	69	7	96	2800
2900	16	89	8	5	16	81	7	102	17	24	8	16	2900
3000	17	42	8	36	17	34	8	21	17	90	8	47	3000
3100	17	106	8	67	17	98	8	51	18	44	8	79	3100
3200	18	59	8	98	18	51	8	82	18	111	8	110	3200
3300	19	12	9	18	19	4	9	0	19	65	9	30	3300
3400	19	77	9	49	19	68	9	31	20	20	9	61	3400
3500	20	30	9	80	20	21	9	61	20	86	9	92	3500
3600	20	95	9	111	20	85	9	92	21	41	10	12	3600
3700	21	48	10	30	21	38	10	11	21	107	10	43	3700
3800	22	0	10	61	21	103	10	41	22	62	10	75	3800
3900	22	65	10	92	22	55	10	72	23	16	10	106	3900
4000	23	18	11	11	23	8	10	102	23	82	11	26	4000
4100	23	83	11	42	23	72	11	21	24	37	11	57	4100
4200	24	36	11	73	24	25	11	51	24	103	11	88	4200
4300	24	101	11	104	24	89	11	82	25	58	12	8	4300
4400	25	53	12	23	25	42	12	0	26	12	12	39	4400
4500	26	6	12	54	25	107	12	31	26	79	12	71	4500
4600	26	71	12	85	26	59	12	61	27	33	12	102	4600
4700	27	24	13	4	27	12	12	92	27	100	13	22	4700
4800	27	89	13	35	27	76	13	10	28	54	13	53	4800
4900	28	42	13	67	28	29	13	41	29	9	13	84	4900
5000	28	106	13	98	28	93	13	72	29	75	14	4	5000
6000	34	83	16	72	34	67	16	41	35	67	16	94	6000
7000	40	59	19	47	40	41	19	10	41	60	19	72	7000
8000	46	36	22	21	46	15	21	92	47	52	22	51	8000
9000	52	12	24	108	51	101	24	61	53	45	25	29	9000
10000	57	100	27	83	57	74	27	31	59	37	28	7	10000

Number of Sheets Required for Tin Rolls, and Gutter-Strips

Number of sheets required per linear foot for 20 and 28-inch widths

Feet	Widths 20	Widths 28	Feet	Widths 20	Widths 28	Feet	Widths 20	Widths 28	Feet	Widths 20	Widths 28
1	1	1	35	16	23	69	31	44	200	89	128
2	1	2	36	16	23	70	32	45	300	134	192
3	2	2	37	17	24	71	32	45	400	178	256
4	2	3	38	17	24	72	32	46	500	223	320
5	3	4	39	18	25	73	33	47	600	267	384
6	3	4	40	18	26	74	33	47	700	312	444
7	4	5	41	19	27	75	34	48	800	356	512
8	4	5	42	19	27	76	34	48	900	401	576
9	4	6	43	20	28	77	35	49	1,000	445	640
10	5	7	44	20	28	78	35	50	1,100	495	704
11	5	7	45	20	29	79	36	50	1,200	540	768
12	6	8	46	21	29	80	36	51	1,300	585	832
13	6	9	47	21	30	81	36	52	1,400	630	896
14	7	9	48	22	31	82	37	52	1,500	675	960
15	7	10	49	22	31	83	37	53	1,600	720	1,024
16	8	11	50	23	32	84	38	54	1,700	765	1,088
17	8	11	51	23	33	85	38	54	1,800	810	1,152
18	8	12	52	24	33	86	39	55	1,900	855	1,216
19	9	12	53	24	34	87	39	55	2,000	900	1,280
20	9	13	54	24	34	88	40	56	2,100	945	1,344
21	10	14	55	25	35	89	40	57	2,200	990	1,344
22	10	14	56	25	36	90	40	57	2,300	1,035	1,472
23	11	15	57	26	36	91	41	58	2,400	1,080	1,536
24	11	16	58	26	37	92	41	59	2,500	1,135	1,600
25	12	16	59	27	38	93	42	59	2,600	1,170	1,664
26	12	17	60	27	38	94	42	60	2,700	1,215	1,738
27	12	18	61	28	39	95	43	61	2,800	1,260	1,792
28	13	18	62	28	40	96	43	62	2,900	1,305	1,856
29	13	19	63	28	40	97	44	62	3,000	1,350	1,920
30	14	19	64	29	41	98	44	63	3,100	1,395	1,984
31	14	20	65	29	41	99	44	64	3,200	1,440	2,048
32	15	21	66	30	42	100	45	64	3,300	1,485	2,112
33	15	21	67	30	43	..	..	..	3,400	1,530	2,170
34	16	22	68	31	43	..	..	..	3,500	1,575	2,240

112 sheets in 28-in. roll cover 175 lin. ft.
112 sheets in 20-in. roll cover 248 lin. ft.
112 sheets in 14-in. roll cover 350 lin. ft.
112 sheets in 10-in. roll cover 496 lin. ft.

This table enables tin roofers to tell how many sheets to lock together to cover any desired length. For example: How many 20 x 28-inch sheets shall be locked together to "knock out" a gutter strip 72 feet long, 28 inches wide.

Now, if the strip is to be 28 inches wide it means that the sheets are to be edged on the 28-inch sides so that from turned edge to turned edge will be approximately 19 inches and it will then take 46 times this dimension to make 72 feet; so referring to first column locate 72 feet, read across to column under 28-inch width and find 46, meaning 46 sheets are required. Supposing the strip is to be 20 inches wide, which would mean that the edges are to be turned on the 20-inch sides, so that there will be about 27 inches from turned edge to turned edge and the 20-inch wide column directs that 32 sheets be locked together for 72 feet length.

Weight of Sheet Copper

Stubs' Gauge Nearest No.	Thickness in Decimal Parts of 1 Inch	Oz. Per Sq. Ft.	Sheets 14 x 48, Weight in Lbs.	Sheets 24 x 48, Weight in Lbs.	Sheets 30 x 60, Weight in Lbs.	Sheets 36 x 72, Weight in Lbs.	Sheets 48 x 72, Weight in Lbs.
35	.00537	4	1.16	2	3.12	4.50	6
33	.00806	6	1.75	3	4.68	6.75	9
31	.0107	8	2.03	4	6.25	9	12
29	.0134	10	2.91	5	7.81	11.25	15
27	.0161	12	3.50	6	9.37	13.50	18
26	.0188	14	4.08	7	10.93	15.75	21
24	.0215	16	4.66	8	12.50	18	24
23	.0242	18	5.25	9	14.06	20.25	27
22	.0269	20	5.83	10	15.62	22.50	30
21	.0322	24	7	12	18.75	27	36
19	.0430	32	9.33	16	25	36	48
18	.0538	40	11.66	20	31.25	45	60
16	.0645	48	14	24	37.50	54	72
15	.0754	56	16.33	28	43.75	63	84
14	.0860	64	18.66	32	50	72	96
13	.095	70	.....	35	55	79	105
12	.109	81	.....	40½	63	91	122
11	.120	89	.....	44½	70	100	134
10	.134	100	.....	50	78	112	150
9	.148	110	.....	55	86	124	165
8	.165	123	.....	61	96	138	184

Stubs' Gauge Nearest No.	Thickness in Decimal Parts of 1 Inch	Oz. Per Sq Ft.	Sheets 14 x 48, Weight in Lbs.	Sheets 24 x 48, Weight in Lbs.	Sheets 30 x 60, Weight in Lbs.	Sheets 36 x 72, Weight in Lbs.	Sheets 48 x 72, Weight in Lbs.
7	.180	134	.....	67	105	151	201
6	.203	151	.....	75½	118	170	227
5	.220	164	.....	82	128	184	246
4	.238	177	.....	88½	138	199	266
3	.259	193	.....	96	151	217	289
2	.284	211	.....	105½	165	238	317
1	.300	223	.....	111½	174	251	335
0	.340	253	.....	126½	198	285	380

Official table adopted by the Association of Copper Manufacturers of the United States.

Rolled copper has specific gravity of 8.93. One cubic foot weighs 558 125/1000 pounds. One square foot, of 1 inch thick, weighs 46 51/100 pounds.

Helps for Figuring Corrugated Sheets

Number of Corrugated Sheets in One Sq.			Number of Sq. Ft. in One Corrugated Sheet		
Length Sheet Feet	2, 2½ and 3 inch Corrugations (width 26 inches)	1¼ inch Corrugations (width 25 inches)	Length Sheet Feet	2, 2½ and 3 inch Corrugations (width 26 inches)	1¼ inch Corrugations (width 25 inches)
5	9.23	9.60	5	10.83	10.42
6	7.69	8.00	6	13.00	12.50
7	6.59	6.86	7	15.17	14.58
8	5.77	6.00	8	17.33	16.67
9	5.13	5.33	9	19.50	18.75
10	4.62	4.80	10	21.67	20.83
11	4.19	4.37	11	23.85	22.88
12	3.85	4.00	12	26.00	25.00

Full width of Corrugated Sheets is charged for. No allowance is made for laps in these tables.

Weights of Roofing Materials

Table showing approximate weights in a square foot of various materials used for roofing.

MATERIAL	Average Weight Pounds to a Square Foot
Asphalt on slabs	20
Corrugated Galvanized Metal Sheets, No. 20 unboarded	2¼
Copper, 16 oz. standing seam	1¼
Felt and asphalt, without sheathing	2
Glass, ⅛ inch thick	1¾
Hemlock sheathing, 1 inch thick	2
Lead, about ⅛ inch thick	6 to 8
Paper, tarred	6
Spruce sheathing, 1 inch thick	2½
Slate, 3/16 inch thick, double lap	6¾
Slate, ⅛ inch thick, 3-inch double lap	4½
Slate, on iron	10
Shingles, 6 x 18—one-third to weather	2
Skylight of glass, 3/16 to ½ inch, including frame	4 to 10
Slag roof, 4-ply	4
Terne plate, 1C., without sheathing	½
Terne plate, 1X., without sheathing	⅝
Tiles (plain) 10½ x 6¼—5¼ inches to weather	18
Tiles (Spanish) 14½ x 10½—7¼ inches to weather	8½
White pine sheathing, 1 inch thick	2½
Yellow pine sheathing, 1 inch thick	4
Zinc, sheet	8

Calculating Flat Seam Sheets

One table is calculated on a basis of ¼-inch edges on 14 x 20 and 20 x 28 sheets, consuming nearly 1 inch, covering a space 13¼ x 19¼ and 19¼ x 27¼ inches and exposing a surface a trifle more than 247 and 513 square inches respectively.

The other table is calculated on a basis of ⅜-inch edges on 14 x 20 nd 20 x 28 sheets, consuming 1⅛ inches, covering a space 12⅞ x 18⅞ and 18⅞ x 26⅞ inches and exposing a surface of 243 1/64 and 507 17/64 square inches respectively.

Calculating Standing Seam, Single Lock Sheets

The basis of calculation is for ⅜-inch single lock cross seams, consuming 1⅛ inches of tin and covering 228 17/32 square inches when edged 1 and 1¼ inches, giving a finished seam ¾-inch high, and covering 222 3/32 square inches when edged 1¼ and 1½ inches and giving a finished seam 1 inch high, with 14 x 20 tin. With 20 x 28 tin edged in the same way with a ¾-inch finished seam 477 1/32 square inches are covered, and with a 1-inch finished seam 463 19/32 square inches are covered.

Calculating Standing Seam, Double Lock Sheets

The basis of calculation is the quantity of tin consumed by double lock machines, which is 1 7/16 inches by measurement for cross seams and covering 222 63/64 square inches when edged 1 and 1¼ inches and giving a finished seam ¾ inch high, and covering 216 45/64 square inches when edged 1¼ and 1½ inches, giving a finished seam 1 inch high, with 14 x 20 tin. With 20 x 28 tin edged in the same way with a ¾-inch finished seam 471 31/64 square inches are covered, and with a 1-inch finished seam 458 13/64 square inches are covered.

How to Use the Tables

Refer to the number of squares nearest the required surface. See the quantity of tin opposite in the column for the nature of the roof to be put on, whether of ¼-inch or ⅜-inch Flat Seam or ¾-inch or 1-inch Standing Seam, Single Lock or Double Lock. Set down the amount. In the same manner determine the quantity of tin for the odd feet and add this to the former amount. The sheets are reduced to boxes by dividing by 112.

Example for Flat Seam Roof

How much 14 x 20 tin edged ¼-inch covering 13¼ x 19¼ will be required to cover a roof of 5,060 square feet Flat Seam?

First look for 5,000 square feet (=50 squares) and set down the quantity opposite, thus:

	26 boxes 4 sheets
Then for 60 square feet and set down..	35 sheets
Making a total of......................	26 boxes 39 sheets

Example for Single Lock Standing Seam Roof

How much 14 x 20 tin will be required to cover a roof of 3,984 square feet with cross seams and 1-inch single lock standing seams?

First look for 3,900 square feet (=39 squares) and set down the quantity opposite, thus:

	22 boxes 65 sheets
Then for 84 square feet and set down..	55 sheets
Making a total of....................	22 boxes 120 sheets

which is equal to 23 boxes and 8 sheets, as there are 112 sheets to a box.

Example for Double Lock Standing Seam Roof

How much 20 x 28 tin will be required to cover a roof of 3,452 square feet with double lock cross seams and ¾-inch standing seams?

First look for 3,400 square feet (=34 squares) and set down the quantity opposite, thus:

	9 boxes 31 sheets
Then look for 52 square feet and set down	16 sheets
Making a total of........................	9 boxes 47 sheets

PART XVI

PLAN READING

THE most valuable acquirement by the student for obtaining ready familiarity with the reading or interpretation of architects' plans is a knowledge of that department of mechanical drafting known as projection drawing. Those who are thus qualified may, with the aid of a set of specifications, read plans and compute the items and quantities of material for construction purposes, without any difficulty.

However, during the writer's contact with hundreds of mechanics and students, much inquiry on this subject has been raised and particular questions asked. This has served to bring to his attention the basis of requirement for a useful treatment. The aim is to place in the hands of the reader who is not versed in the art of plan reading a fund of practical information, providing the necessary aid and guidance in respect to the requirements of sheet metal workers.

The general term "set of plans" will be understood as having reference to plans, elevations, sectional and constructive views, etc. Plans are commonly presented on blue print paper. They communicate the architect's conceptions with the precision necessary for realizing them in actual construction, through the medium of other hands. They express his thought in the shortest and most direct manner, without the usual detail of verbal communication. Through them he indicates such information as is necessary to construct a given object, presenting the necessary data as to structure, detail, sizes and items. The method by which plans are prepared also assists sufficiently in visualizing the subjects to which they relate.

In taking up the treatment of this subject, we will consider first the various technical terms which have to do with plan reading and the preparation of plans.

Definitions

Plan View. A view of an object when viewed directly from the top.

Soffit Plan. The view of an object viewed from the bottom, or looking up.

Front Elevation. The view of an object when looked at from the front.

Rear Elevation. The view of an object as seen from the back or rear.

Side Elevation. The view of an object looked at from the side.

Horizontal Section. The section of an object taken on a horizontal plane.

Vertical Section. The section of an object taken on a vertical plane.

Constructive View. A view showing the methods of construction of an object to be made.

To read a plan effectively it is very necessary first, to study its several views, until one possesses a faithful conception or pictural impression of the object to be constructed. One must be able to visualize the completed work, since the "flat" drawing before him is largely a language of lines, or "short hand" instruction from the architect. In the various solutions presented herewith the foregoing definitions are illustrated and exemplified.

PLAN AND ELEVATIONS OF A BEVELED TUBE

Solution 179

In Fig. 639 is presented a perspective view of a beveled tube. The two sides are flat and parallel

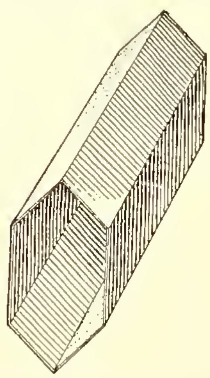


Fig. 639.—Perspective View of Beveled Tube

to each other and the angle at the top and bottom bevel toward the apex at 45 degrees.

Fig. 640 illustrates how the end and side elevations are drawn, as well as the plan. Here, as in general, it will be found that the ability to read the drawing is acquired in learning how to draw it. First, draw the shape of the object, as shown by A-B-C-D, placing it in its proper position, as shown. This becomes the end elevation of the object. From the various corners of the object, looking in the direction indicated by the arrow X, draw horizontal lines towards the left, as shown. Make the side elevation of the desired length, as G-H, and draw the vertical lines G-F and H-E; this completes the side elevation. Note that in the side elevation four lines are shown, since we look against the corners A-*a*-*b* and C, following in the direction of the arrow X. In drawing the plan of this object we look downward on it in the direction of the arrow A, and see only three lines, as indicated by the corners *a*-A and *a*′. The plan view, which is shown by K-L-M-O, is of length equal to the elevation F-E. It will be noted that projection lines are employed to obtain the lines in plan; these are drawn from the intersections on a°-b° to the line K-L, with a° as center.

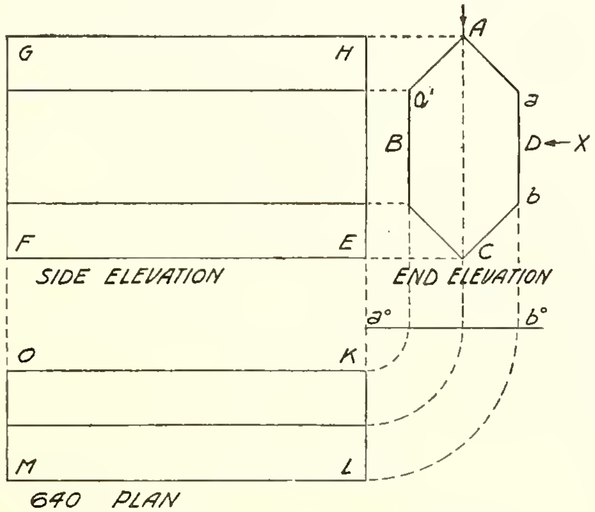


Fig. 640.—Plan and Elevations of Beveled Tube

This simple example, presents the principles of drawing in their proper relative positions, the various plans, elevations and other views to which fuller attention is devoted in exercises following.

PLAN AND ELEVATIONS OF A TEE JOINT

Solutions 180

Familiar to all sheet metal workers are the plans and elevations of a tee joint shown in Fig. 641.

It will be seen that the diameters of both vertical and horizontal pipes are equal, thus giving the points of tangency *a*′-*a*′ in the end elevation, while the corresponding points are indicated by *a* in the side elevation and by *a*″-*a*″ in plan. Projection lines are used to draw the plan where *b* is used as center and quadrants are drawn between *c*-*b* and *b*-*a*. The side elevation shows the outline of the tee,

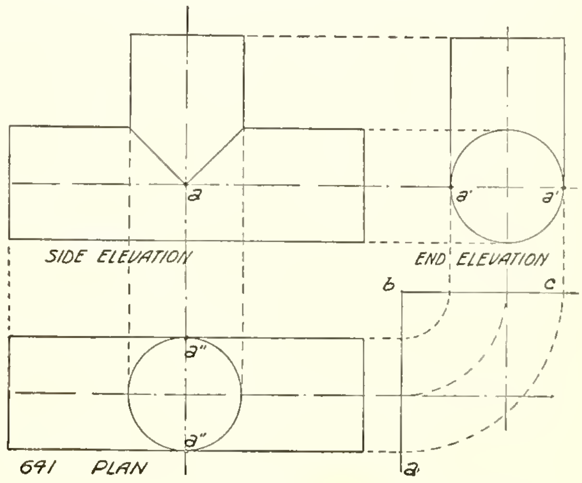


Fig. 641.—Plan and Elevations of a Tee Joint

with miter lines meeting at *a*. The end elevation shows the profile of the horizontal pipe, as well as the elevation of the vertical pipe. In the plan—that is, looking down on the object—is seen the profile of the vertical pipe and the plan view of the horizontal pipe.

ELEVATIONS AND SOFFIT PLAN OF A LEADER HEAD

Solution 181

The present example illustrated by Fig. 642 shows both a plan (as looked at from above) and a soffit plan (as looked at from beneath). The side elevation is drawn off the wall line, as indicated, and in line therewith is drawn the front elevation. Note that both in the front and side elevations there is a projecting panel, indicated by A and B, whose projection is shown by *a* and *b* respectively, on the opposite elevations. Thus, the projection of the panel A in the front elevation would be indicated by *a* in the side elevation, while the projection of the panel B in the side elevation would be shown by *b* in the front elevation.

The plan would be seen by looking downward on

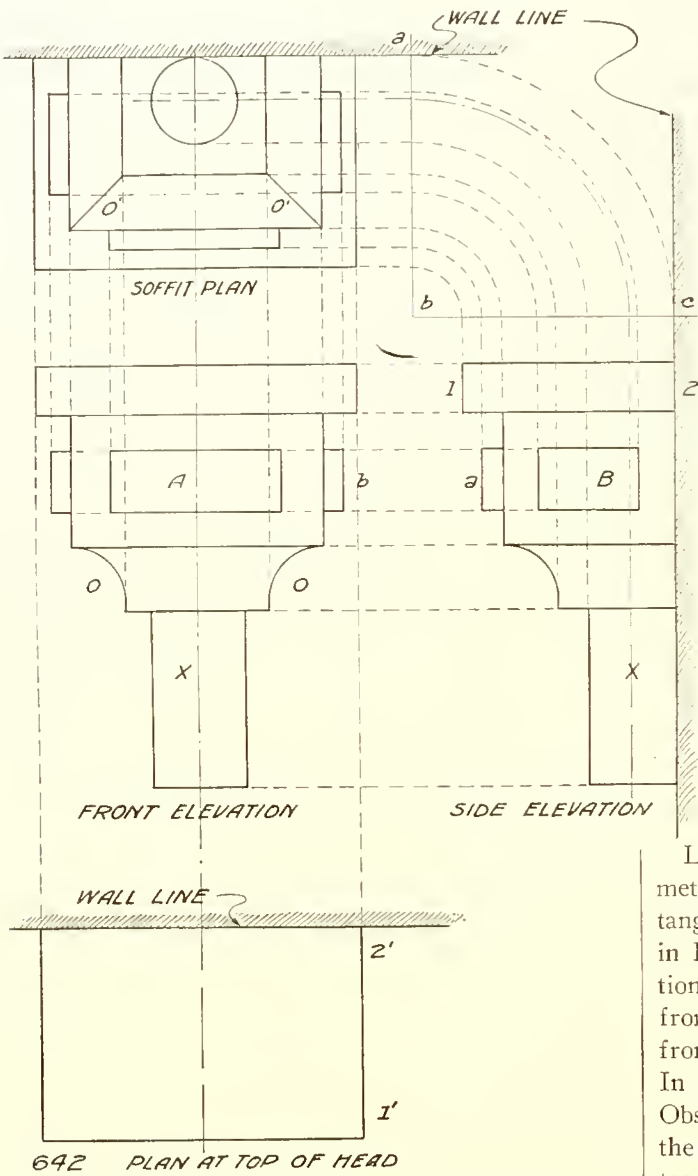


Fig. 642.—Plans and Elevations of Leader Head

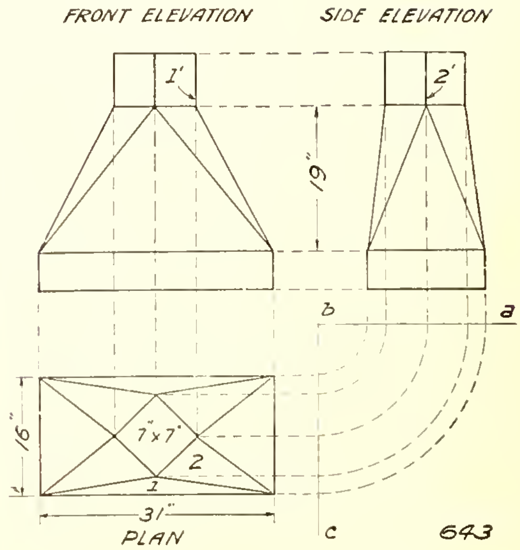


Fig. 643.—Plan and Elevations of Transition Piece

the top of the leader head, where the projection 1′-2′ is made to equal 1-2 in the side elevation. Looking at either front or side elevation fails to indicate whether the tube X is designed to be round or square. The soffit plan (seen by looking upward) shows the tube to be round. Here, by means of projection lines introduced between the angle *a-b-c*, is drawn the soffit plan, showing the projecting panels, already referred to. Note that the coves O and O in the front elevation show miter lines at O′ and O′ in the soffit plan.

This drawing may be carefully studied with much advantage, as it exemplifies the principles of projections, utilized in examples of a more complicated nature.

PLAN AND ELEVATIONS OF A TRANSITION PIECE

Solution 182

Let us assume that there is received at the sheet metal shop a blue print for a transition piece, rectangular to square, of the dimensions given in plan in Fig. 643, and of the hight shown in the elevation. In this case, the plan is first drawn and from it the front elevation is projected. Then, from both of these views the side elevation is drawn. In projecting this the right angle *a-b-c* is used. Observe that the base collar in both the front and the side elevation shows a flat surface, while the top collar in each elevation shows the corner lines 1 and 2 in plan, indicated respectively by 1′ and 2′ in either elevation. The lines drawn from the square collar at the top, to the base line, in the front and side elevations indicate slight bends, which are also shown in the plan.

PLAN AND ELEVATIONS OF AN IRREGULAR FITTING OR FRUSTUM OF A SCALENE CONE

Solution 183

Fig. 644 represents a plan and elevation of an irregular fitting, round to round, tangent at one side, as shown in the plan. If the two pipes are tangent at one side, the one view, found in the side elevation, shows a straight line at *d* and a taper at *c*, while the opposite view, shown in the front elevation, has equal tapers at *f* and *g*.

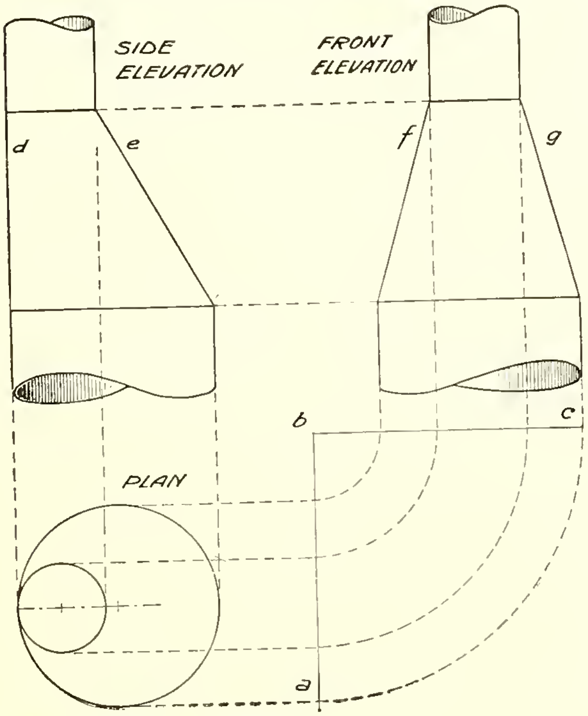


Fig. 644.—Plan and Elevations of an Irregular Fitting

The front elevation has been projected from the plan and side elevation, shown by the dotted lines.

PLAN, ELEVATION AND CONSTRUCTIVE VIEW OF A ROUND VENTILATOR

Solution 184

Fig. 645 shows the plan and elevation of a plain round ventilator. In this case, but one elevation is required, as the diameter is the same, from whichever direction the ventilator is viewed. 1-2-3 and 4 indicate by dotted lines the braces used to uphold the ventilator hood. Looking down on the ventilator, for a plan, presents only one circle, as indicated. The smaller and dotted circle in plan indicates the diameter of the body, shown by A in elevation. A dotted line, shown on a drawing, always indicates a hidden profile or some object below or behind the part we are viewing.

Constructive View

A section taken on the line *a-b* in plan will give a vertical constructive view, shown to the right of the elevation. This is the same in outline as the elevation, but comprehends the constructive features, as well as an inside elevation, behind the sectional lines, as shown by the horizontal lines drawn therein.

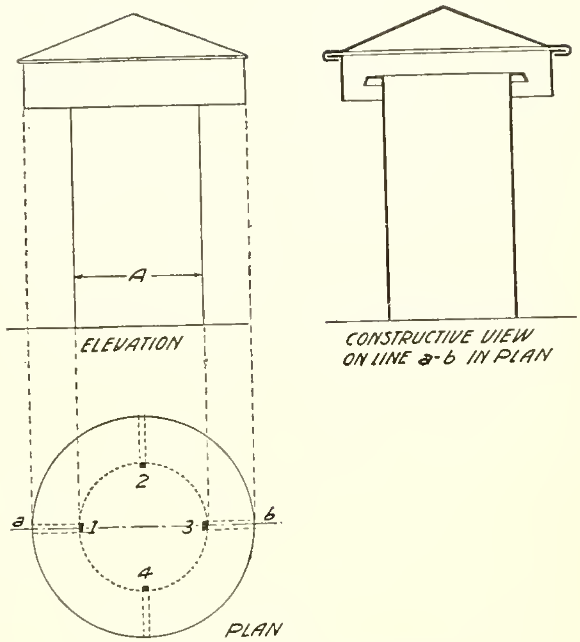


Fig. 645.—Plan, Elevation and Constructive View of a Round Ventilator

PLANS, ELEVATIONS AND CONSTRUCTIVE VIEWS OF A TOOL BOX

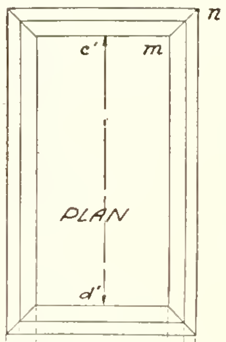
Solution 185

In Fig. 646 are presented eight views of a tool box, defining the various views, given under the heading Definitions, in this part.

The constructive view, A, is first drawn. This shows the formation of the upper frame of the body, which receives the beaded edge of the beveled cover. The bottom is double-seamed toward the bottom of the box, as shown. From the constructive view, A, the rear, side and front elevations are drawn, the outline profiles being made alike to those in A. In the front elevation a clasp is indicated by *a*, while *i-i* in the rear elevation show the hinges.

A plan view, looking downward on the box, is shown above the side elevation, the length *c'-d'* being made to equal *c-d* in the front elevation. Note that the corner miters, *m-n* in plan, show lines, indicating bevel or molded corners.

The soffit plan is shown below the side eleva-



in Fig. 647, to which reference will be made in the explanation of the eight views shown in Fig. 648.

The constructive view shown is first drawn. From this the other seven views are obtained. In the constructive view, note that the back of the base is bent, as shown from 4 to 1, and the front is bent, as shown from 6 to 2. In the front elevation note that the returns, 3-5-7 and 8-9-10, miter on the inside at *i* and *i*, in Fig. 647, and on the outside at *b* and *b*; while in the back, these same returns butt against the surface 1, in the constructive view, in Fig. 648, also shown at o and o in Fig. 647, and against the rear surface 4 in Fig. 648, at *a* and *a* in Fig. 647.

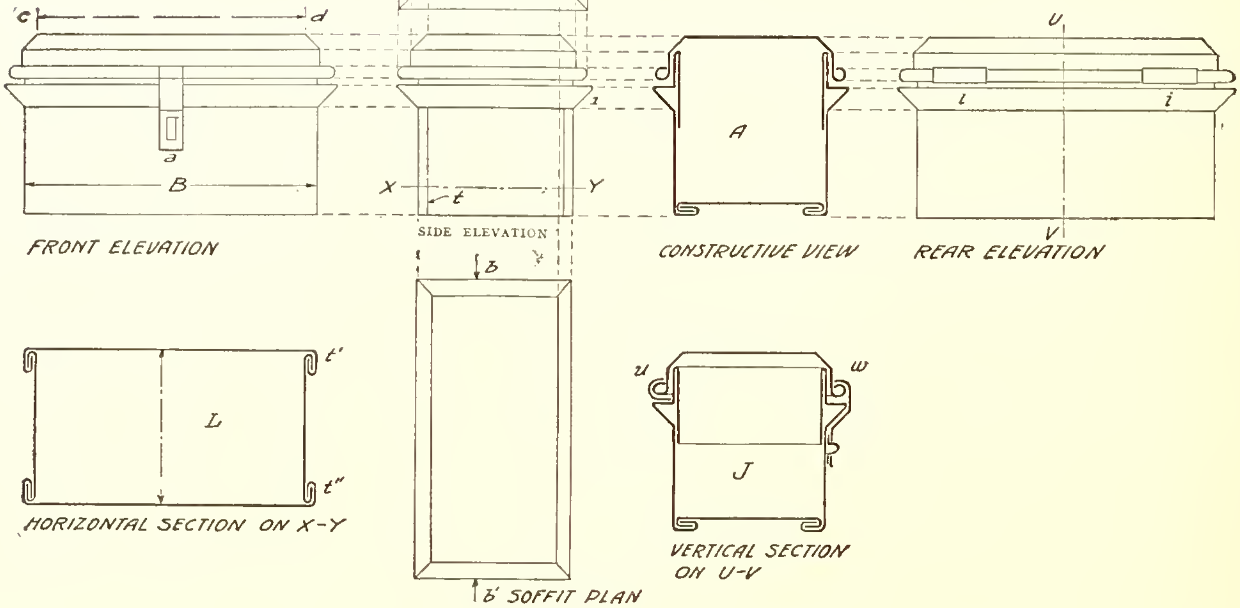


Fig. 646.—Various Views of a Tool Box

tion; this gives a view looking upward. The length of *b-b'* in the soffit plan is made to equal B in the front elevation. Take note that the corner, as *o-s* in the soffit plan, shows a line, indicating a beveled joint of the bevel 1 in the side elevation.

If a vertical section on the line U-V in rear elevation be desired, this would constitute a section alike to A, except that here a hinge is found at *u* in J and the clasp at *w*, in the vertical section on U-V.

A horizontal section on X-Y in the side elevation, shown at L, is made of length corresponding to B, in the front elevation. It shows the double seaming of the corner *t*, as indicated by *t'-t''* in the horizontal section.

The views here outlined are complete and should be studied carefully.

PLANS, ELEVATIONS AND CONSTRUCTIVE VIEWS OF AN IRREGULAR BASE

Solution 186

A perspective view of an irregular base is given

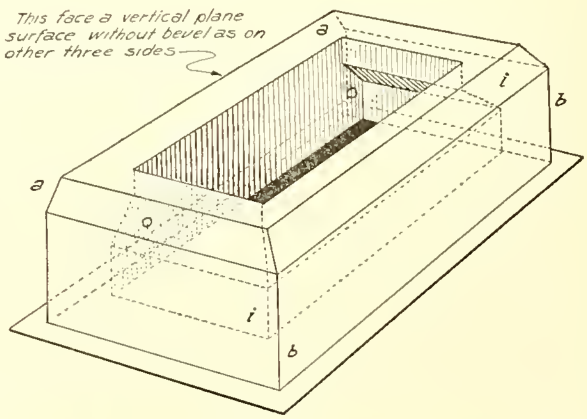


Fig. 647.—Perspective View of an Irregular Base

The front elevation in Fig. 648 indicates the

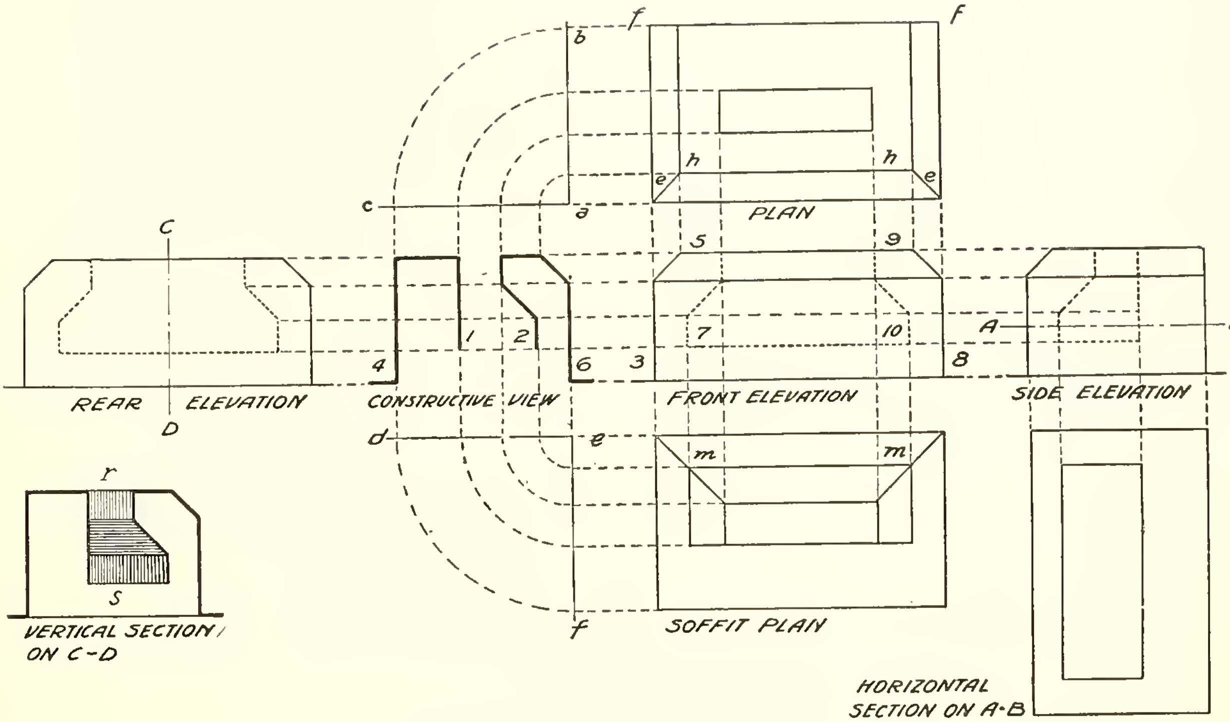


Fig. 648.—Various Views of an Irregular Base

length, correspondingly indicated in the rear elevation; the dotted lines in this figure represent the returns mentioned.

The side elevation at the right is of corresponding size and shape to the constructive view, but is reversed, and in the side elevation, the elevation lines are shown, while the dotted lines indicate the inside returns.

By means of projection lines, drawn from the constructive view on the planes, *c-a* and *a-b*, the plan view of the base is constructed, as shown above the front elevation. Observe that miter lines are shown at *e-e*, while *f* and *f* show the intersections with the flat back. As the surface, 5 and 9 in the front elevation, shows a flat surface, no miter line appears in plan for that part at *h-h*.

In like manner, by using the projection lines from the constructive view to the planes *d-e* and *e-f*, the soffit plan is drawn, or a view looking into the base, from the bottom. Note the position of the miter lines, *m* and *m*, in the soffit plan, making comparison with that in the plan.

If this base were cut on the line A-B in the side elevation, it would give the horizontal section, shown below the side elevation.

If the base were cut on the line C-D in the rear elevation, it would give a vertical section, shown below the rear elevation. Cutting through on the line C-D also brings to view those parts that are behind the plane C-D, these parts being shown in elevation between *r* and *s* in the vertical section. Thus this view is part elevation and part section. Careful consideration of the interesting study presented in this solution is suggested.

Plans and Elevations for Buildings

In Figs. 649 to 672 inclusive are illustrated the relations of all parts, namely, front, rear, left side and right side elevations, with plan, obtained by projection lines. Although in architects' drawings the projection lines do not appear, their use here will give the student a better understanding of the various views.

PLAN AND SECTIONAL VIEW OF A FLAT ROOF

Solution 187

Fig. 649 is a plan view of a flat roof, in which a hipped ridge skylight is shown, as well as a chimney, E, and a scuttle, S. The roof pitches in the direction of the arrows to the leader outlet, shown in the gutter. Behind the skylight and scuttle, at C, and in the corner of the chimney, at D, saddles or cant boards are placed; these are put on before

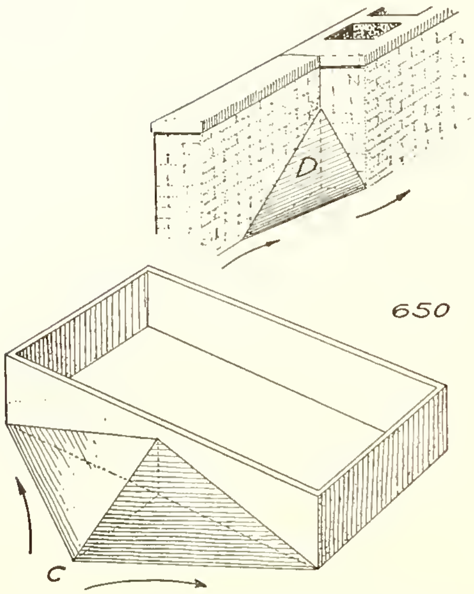


Fig. 650.—Showing Cant Strips or Saddles to Prevent Snow Pockets

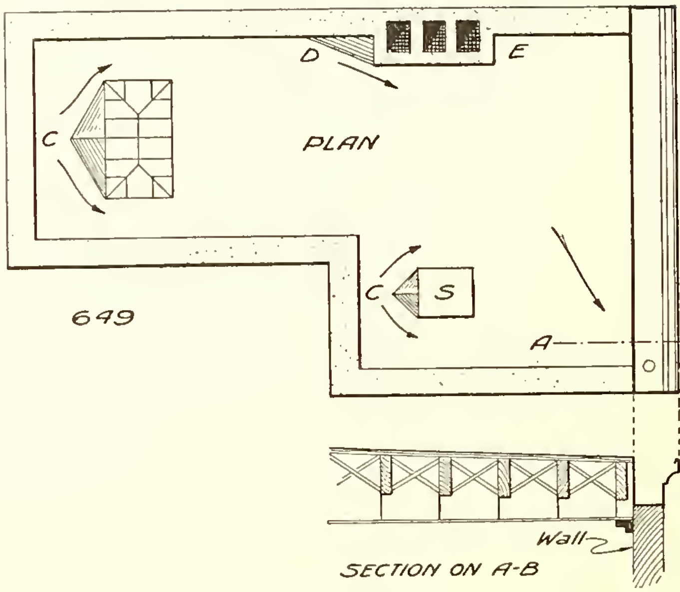


Fig. 649.—Plan and Sectional View of Flat Roof

the roof is covered with metal, to shed the water to the roof proper and also to prevent the occurrence of snow pockets. These saddles are formed, as shown in Fig. 650, where that illustrated by diagram C is the formation used behind the scuttle or skylight, and the saddle shown by diagram D is the formation used in the chimney corner. A section on A-B in Fig. 649 is given below the plan. This vertical section shows the profile of the gutter resting on the wall, also the pitch of the flat roof. A section, given on any line, as that of A-B, indicates that the portion in front of the line, A-B, has been removed and that we are therefore looking into the building from the line A-B, obtaining the view shown below the plan and in line with it.

PLAN AND ELEVATIONS OF BUILDING WITH GABLE ROOF

Solution 188

Fig. 651 presents the plan and elevations of a building with a gable roof. The end and side elevations and the plan are represented by means of projection lines. From *a* as a center the horizontal projections are carried to the plan, as shown, while the vertical projection lines are used in drawing the side elevation. Note that the side elevation shows but two lines in the roof, taken from 1 and 2 in the end elevation, while the plan shows three lines in the roof, taken from 1-2 and 3 in the end elevation, and projected by the quadrants struck from *a*.

PLAN AND ELEVATIONS OF BUILDING WITH HIPPED ROOF OF EQUAL PITCH

Solution 189

A building having a hipped roof of equal pitch is shown in Fig. 652. In this case, the plan of the roof is square, making the front and side elevations alike, as shown. Where a roof thus inclines on four sides, a line is always introduced in elevations, as at *b* and *c;* while, in Fig. 651, where the roof inclines on only two sides, a line is shown only as represented at *b*. In the plan, in Fig. 652, the diagonal lines indicate the lines of the hip.

PLAN AND ELEVATIONS OF BUILDING WITH HIPPED ROOF OF UNEQUAL PITCHES

Solution 190

Fig. 653 gives the plan and elevations of a hipped roof having unequal pitches. Here the plan is in the shape of a rectangle, but the apex of the roof is directly in the center in plan or, at the intersection of the two diagonal lines, at *b*. As the vertical hight, from 2 to 1, is alike in both elevations, unequal pitches therein result. Note that the projection lines from the plan and from side elevation give the end elevation.

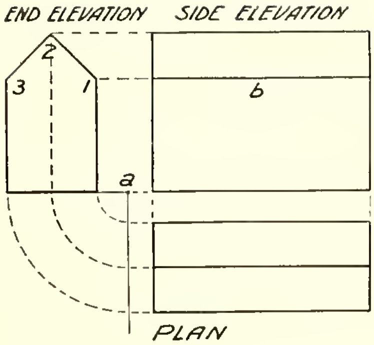


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Fig. 651.—Plan and Elevations of Gable Roofs

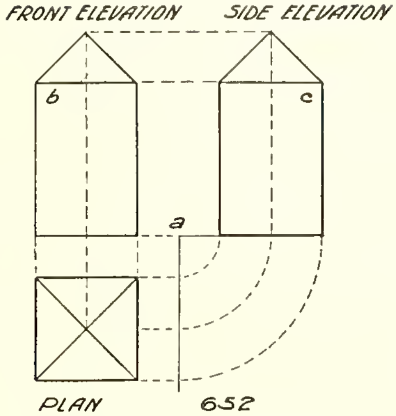

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Fig. 652.—Plan and Elevations of Hipped Roof of Equal Pitches

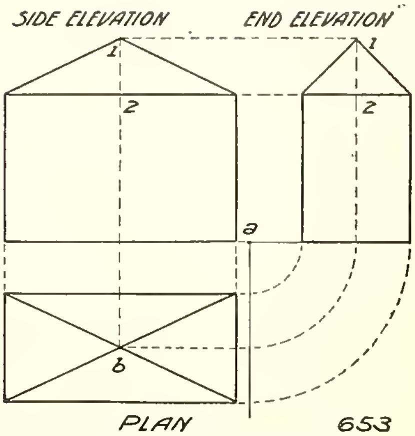

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Fig. 653.—Plan and Elevations of Hipped Roof of Unequal Pitches

PLAN AND ELEVATIONS OF BUILDING WITH HIPPED ROOF HAVING RIDGE AND HIPS

Solution 191

In Fig. 654 is shown a plan with side and end elevations of a building with a hipped roof having ridge and hips. As the pitch of the four sides of the roof are the same, the hip lines in plan present angles of 45 degrees, as shown. The end elevation is obtained from the side elevation and plan by means of projection lines. The ridge line is indicated by the letter R, in both the plan and side elevation.

PLAN AND ELEVATIONS OF BUILDING WITH FOUR GABLE ROOFS, HAVING EQUAL PITCHES

Solution 192

A roof having four equal gables is illustrated in Fig. 655. In this case, the plan of the building is square, so that the four gables are alike on the four sides; hence the elevation shown represents the elevation for all sides. Note the lines in plan. The diagonals, marked V, form the valley lines where the returns of any of the two gables meet, while the lines, marked R, show the ridge lines in plan, the same ridge lines being marked R° in elevation.

PLAN AND ELEVATIONS OF BUILDING WITH FOUR GABLE ROOFS HAVING UNEQUAL PITCHES

Solution 193

Fig. 656 shows a plan of a building of rectangular shape, on each side of which is placed a gable of the vertical hight, indicated by H between the two

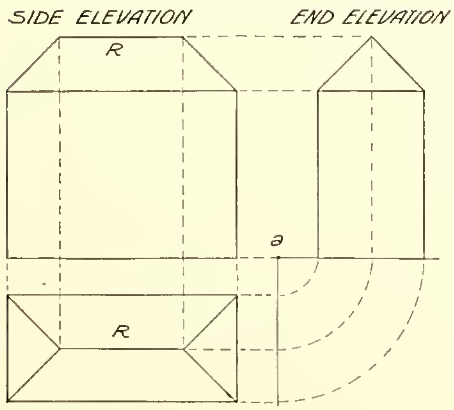

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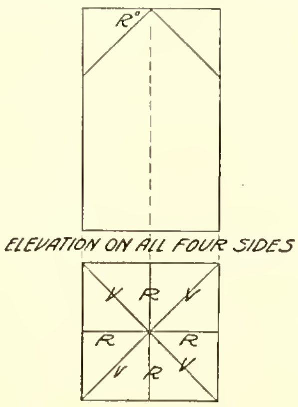
Fig. 654.—Plan and Elevations of Hipped Roof with Ridge



655 PLAN

Fig. 655.—Plan and Elevation of Four Intersecting Gable Roofs Having Equal Pitches

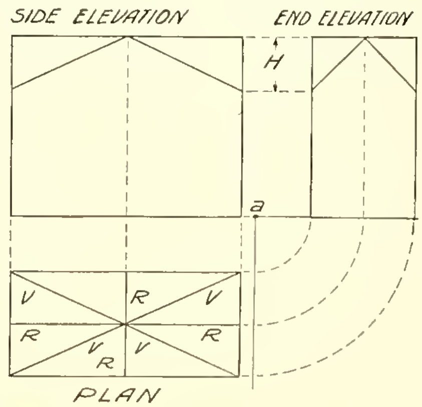


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Fig. 656.—Plan and Elevations of Four Intersecting Gable Roofs having Unequal Pitches

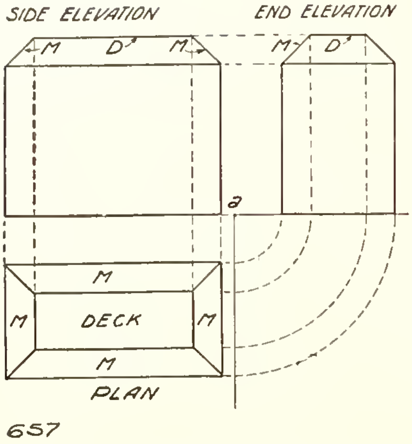


Fig. 657.—Plan and Elevations of Mansard and Deck Roofs

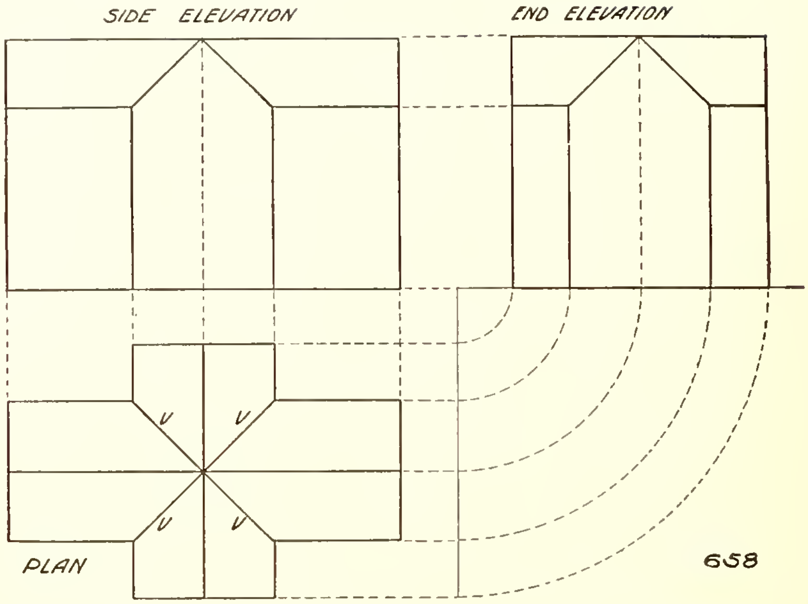


Fig. 658.—Plan and Elevations of Four Intersecting, Projecting Gable Roofs

elevations, thus making the pitch of the gables in side and in end elevations unequal, as indicated. In the plan view the ridge lines are indicated by the letter R and the valley lines forming the junction between the gables by the letter V. The end view is projected from the plan and side elevation, as shown.

PLAN AND ELEVATIONS OF BUILDING WITH MANSARD AND DECK ROOFS

Solution 194

Fig. 657 gives the plan and elevations of a building having deck and mansard roofs. The deck roof is the flat part at the top, indicated by the letter D in the elevations, and the mansard is the inclined roof, marked M, in both plan and elevations. Dormer windows are usually placed in the mansard part of the roof, forming valleys and cheeks with the mansard roof. The deck roof is usually pitched to shed the water into a leader not shown in these diagrams.

PLAN AND ELEVATIONS OF BUILDING WITH FOUR INTERSECTING PROJECTING GABLE ROOFS

Solution 195

Four intersecting, projecting gable roofs on a building, whose outline is shown in plan in Fig. 658, form the subject of this demonstration. Note that both ends and both sides are similar in plan, the two short wings intersecting the main building, thus forming the valleys, shown by V in plan. Observe the appearance of the side elevation and its relation to the plan view, as shown by the dotted lines. The end elevation is projected from the plan and side elevation, as shown by the projection lines. Two elevations only are necessary in this case, as the opposite sides are alike, as shown in plan.

PLAN AND ELEVATIONS OF BUILDING HAVING HIPPED AND GABLE ROOFS WITH WING ON ONE SIDE

Solution 196

In Fig. 659 are presented a plan, with front, rear, left side and right side elevations of a building with wing connected. As no two sides of the plan correspond, an elevation must be shown for each side. The plan view is marked front, rear, L-S (left side) and R-S (right side). Note that hipped roofs occur at A and B; C-C indicate the valleys and D the right side with a gable. Referring to the elevations, note that the left side of the front elevation shows the roof at an incline, while on the right side, at *a*, the vertical line indicates the gable *d*,

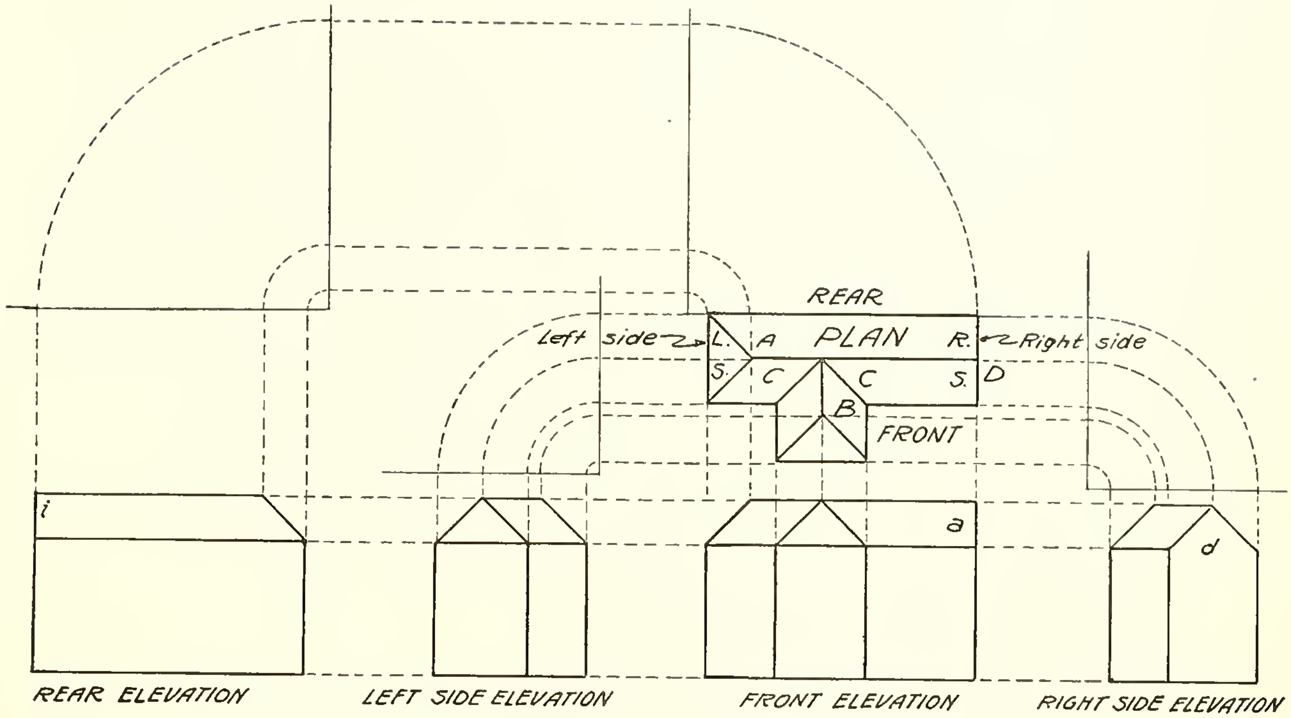


Fig. 659.—Projection Lines Showing the Relation of Plan and Elevations

which is seen in the right side elevation. The left side elevation is drawn by means of projection lines, as well as the rear elevation, where *i* indicates the gable line in that view, shown in the right side elevation by *d*. The relation between the plan and elevations should be carefully studied; the elevations should be turned back along the curved lines to their respective positions in plan.

PLAN AND ELEVATIONS OF BUILDING HAVING INTERSECTING HIPPED ROOFS WITH RIDGE OF WING LOWER THAN THAT OF MAIN ROOF

Solution 197

When a plan of a roof indicates an intersecting

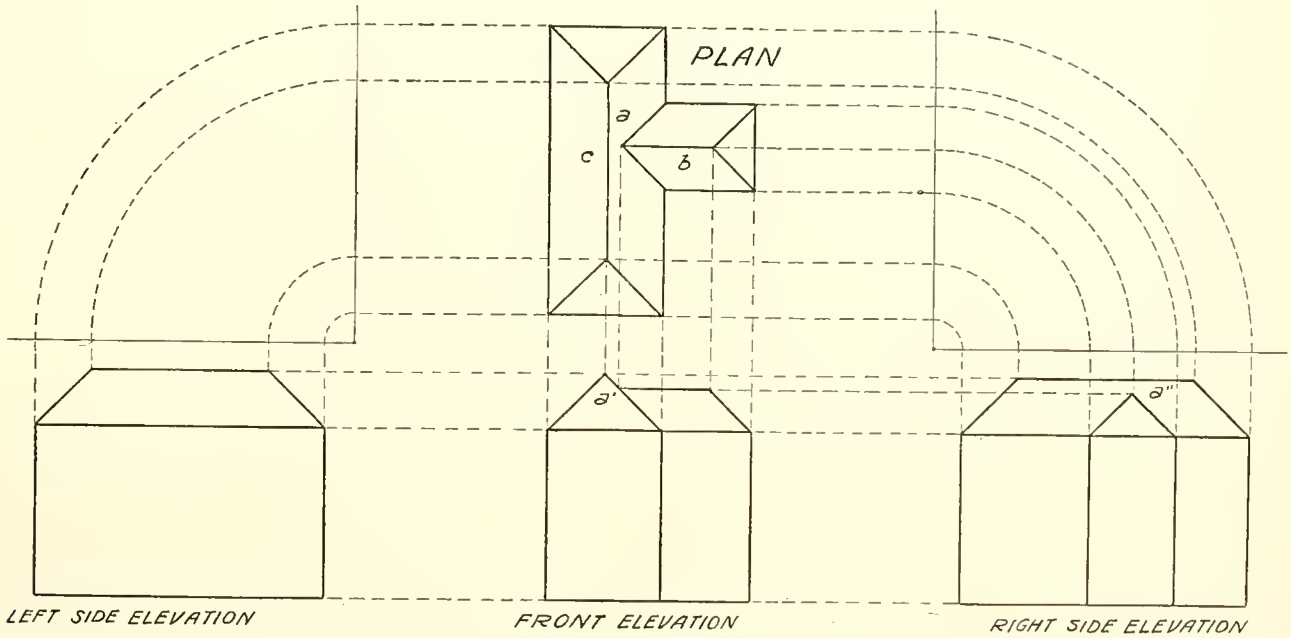


Fig. 660.—Plan and Elevations of Intersecting Hip Roofs

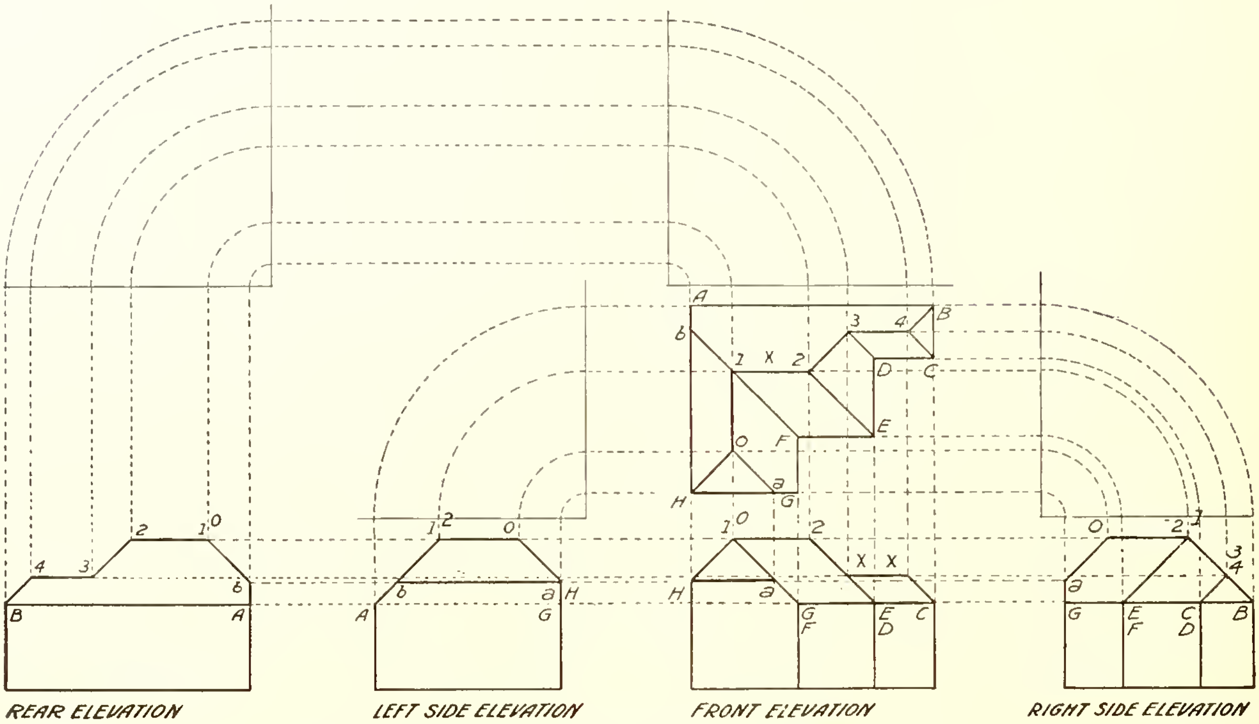


Fig. 661.—Relation of the Various Elevations in a Complex Roof Plan

roof, showing the intersecting lines in plan, as in Fig. 660 at *a*, we are to understand that the ridge at *b* is lower than the ridge at *c*. The intersection of the ridge line *b* in plan with the pitched roof at *a* is shown by means of projection lines by *a'* in the front elevation and by *a''* in the right side elevation. The rear elevation would present the same appearance as the front elevation, but in a reversed position. The left side elevation, having no intersecting wing, will show the view indicated.

PLAN AND ELEVATIONS OF BUILDING WITH COMPLEX ROOF INTERSECTIONS

Solution 198

An interesting exercise in plan reading which should be carefully examined, is presented in Fig. 661, where is shown, by means of projection lines, the relation of the various elevations to the plan. First, note the outline of the building, shown in plan by A-B-C-D-E-F-G-H. Observe the ridge lines O-1, 1-2 and 3-4; also the hip lines H-O-*a*, E-2-3, C-4-B and *b*-1; and the valley lines, D-3 and F-1. Follow the projection lines carefully and note the positions of the front, right side, left side and rear elevations, where each elevation is lettered and numbered to correspond with similar letters and numbers in plan. Note that where the hip lines, O-*a* and 1-*b* in plan, meet the face of the wall at *a* and *b*, partial gable lines appear in the front and left side elevations, shown by G-*a* and A-*b*, respectively.

ELEVATION AND SECTIONS OF A PANEL, SHOWING THE IMPORTANCE OF SECTION LINES

Solution 199

Section lines are used to indicate a section or profile of an object; they are usually introduced at an angle of 45 degrees and serve to show the inner side of the profile.

A in Fig. 662 illustrates the partial elevation of a panel, in which are to be placed raised letters, *a-b-c* representing the profile of the panel molding. As no section lines have been marked on the profile *a-b-c*, we are at a loss to determine which is the inside and which the outside of the panel. By placing the section lines, as in diagram B, a sunk panel would result, the letters being placed on the outer surface indicated by the arrow. By using the same profile, but placing the section lines, as in diagram C, a raised panel is the result, the letters being placed on the outer surface indicated by the

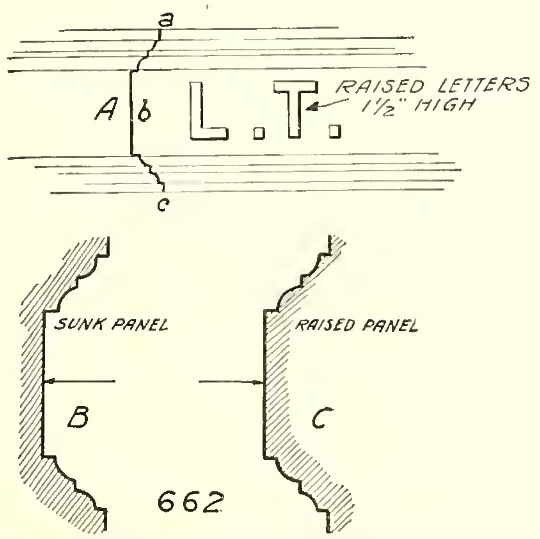


Fig. 662.—Elevation and Sections of a Panel, Showing the Importance of Sectional Lines

arrow. This will illustrate the importance of the section lines, the side having the section lines always indicating the INSIDE and the side having no section lines always representing the OUTSIDE.

ELEVATION AND SECTIONAL VIEW OF CORNICE

Solution 200

Fig. 663 exemplifies how the elevation and sectional view of a cornice are shown. Note the positions of the dentils *o* and *o*; also that the dotted lines, *a* and *b*, indicate the hidden bends or lines of the drip below the crown and foot moldings.

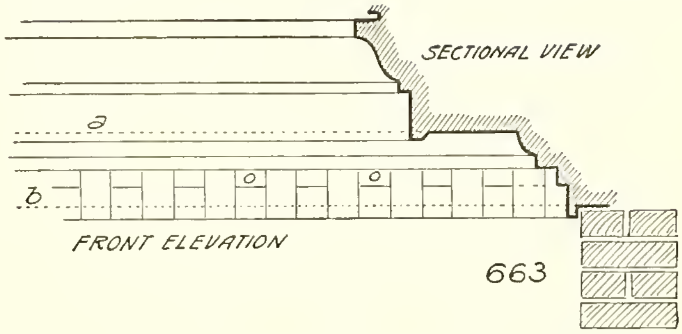


Fig. 663.—Elevation and Sectional View of Cornice

The following table gives the scales employed in drawing plans, elevations and sectional views, and their proportions to full size dimensions:

⅛	in. to the foot equals	1/96 full size.
¼	in. to the foot equals	1/48 full size.
½	in. to the foot equals	1/24 full size.
¾	in. to the foot equals	1/16 full size.
1	in. to the foot equals	1/12 full size.
1½	in. to the foot equals	1/8 full size.
2	in. to the foot equals	1/6 full size.
3	in. to the foot equals	1/4 full size.
4	in. to the foot equals	1/3 full size.
6	in. to the foot equals	1/2 full size.
12	in. to the foot equals	full size.

Whatever the scale be called that distance is divided into twelve equal parts, and each of these parts represents an inch. Thus, referring to Fig. 664, showing part of a one-inch scale rule, note that the first inch to O is divided into twelve equal spaces. Again, in Fig. 665 is shown a partial one-half inch scale, in which the first half inch is divided into twelve equal parts, each division representing one inch in the procedure of checking up a half-inch scale drawing.

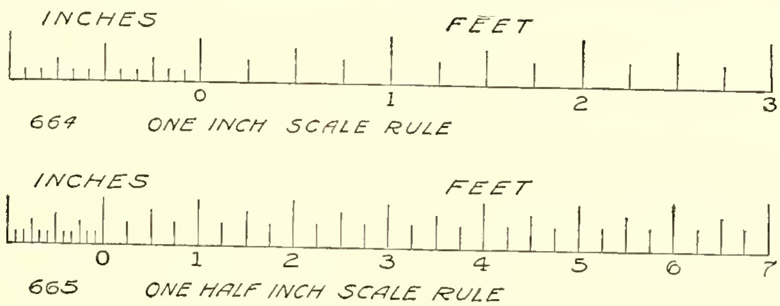


Fig. 664.—One Inch Scale Rule
Fig. 665.—One-half Inch Scale Rule

Scale Rules

Scale rules are employed in measuring drawings drawn to a scale. The usual architect's drawing is executed to the scale of one-quarter inch to the foot.

Using the Scale Rule

Fig. 666 illustrates a partial roof plan, drawn to a scale of one-quarter inch to the foot, showing a hipped and ridge skylight. Applying the one-quarter

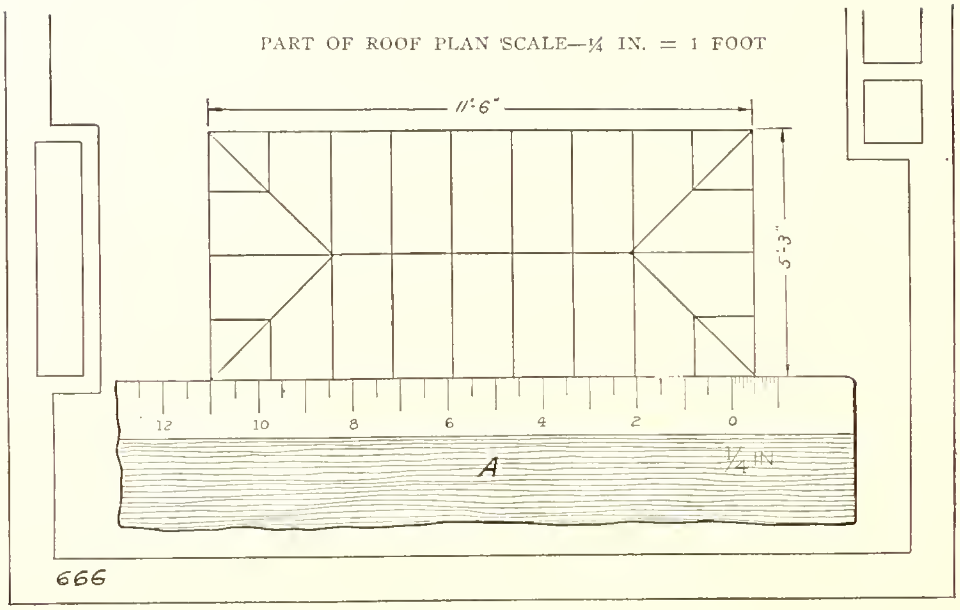


Fig. 666.—Method of Using Scale Rule

inch scale rule A, we find that the length of the skylight on its curb line measures 11 ft. 6 in. In like manner the rule is applied in obtaining the width, which will measure 5 ft. 3 in. In this manner the scale rule is applied in obtaining measurements from drawings made to any scale.

PLANS, ELEVATIONS AND SECTION OF ARCHITECTURAL WORK

Solution 201

Fig. 667 presents the front elevation of an example of architectural work; the four sides which are alike are drawn to a scale of one-half inch to the foot. At the left is shown a sectional view, on the line A-A in the elevation. Below the elevation, at the right, is shown the plan of the base and a sectional view on the line C-C in elevation, and, at the left, below the elevation, the ceiling plan and section on the line B-B in the elevation. Careful study of these views is urged.

READING PLANS OF FURNACE PIPING

Solution 202

Figs, 668, 669 and 670 present the plans of the basement, first and second floors of a residence. They afford an interesting study in reading plans of furnace piping and ventilation.

Fig. 668 is the basement plan showing the distribution of warm air, ventilating and smoke pipes.

Fig. 669 illustrates the first floor plan, showing four rooms and a pantry. The reception room, living room and dining room are warmed and ventilated, while the kitchen is ventilated only, not warmed.

On the second floor, Fig. 670, four bed rooms and two bath rooms are warmed and ventilated.

The living room and dining room on the first floor, Fig. 669, are ventilated by means of open fire places. The servant's bed room and the bath room on the second floor, Fig. 670, are ventilated by connecting the vent ducts with a 9x10 in. vent flue built against the kitchen smoke flue, from which it is heated. The ventilating ducts from all other rooms connect into a 13 in. x 19 in. vent flue, through which a 9 in. terra cotta smoke flue which serves the furnace, is carried. The ventilating flue, 13 x 13 in. in size, is carried up through the first story; it is enlarged to 13 in. x 19 in. before the ventilating ducts of the second floor are connected into it.

The kitchen ventilation is not included in the foregoing arrangement. At a point near the ceiling, Fig. 669, this room is equipped with a 10 in x 14 in. ventilating register connected into the 9 in x 10 in. vent. flue for carrying off steam and odors of cooking and excessive heat from the range, in summer or winter. The basement plan, Fig. 668, illustrates also the arrangement for supplying fresh cold air.

With this general specification of requirements outlined, we proceed to read the plans for the heat

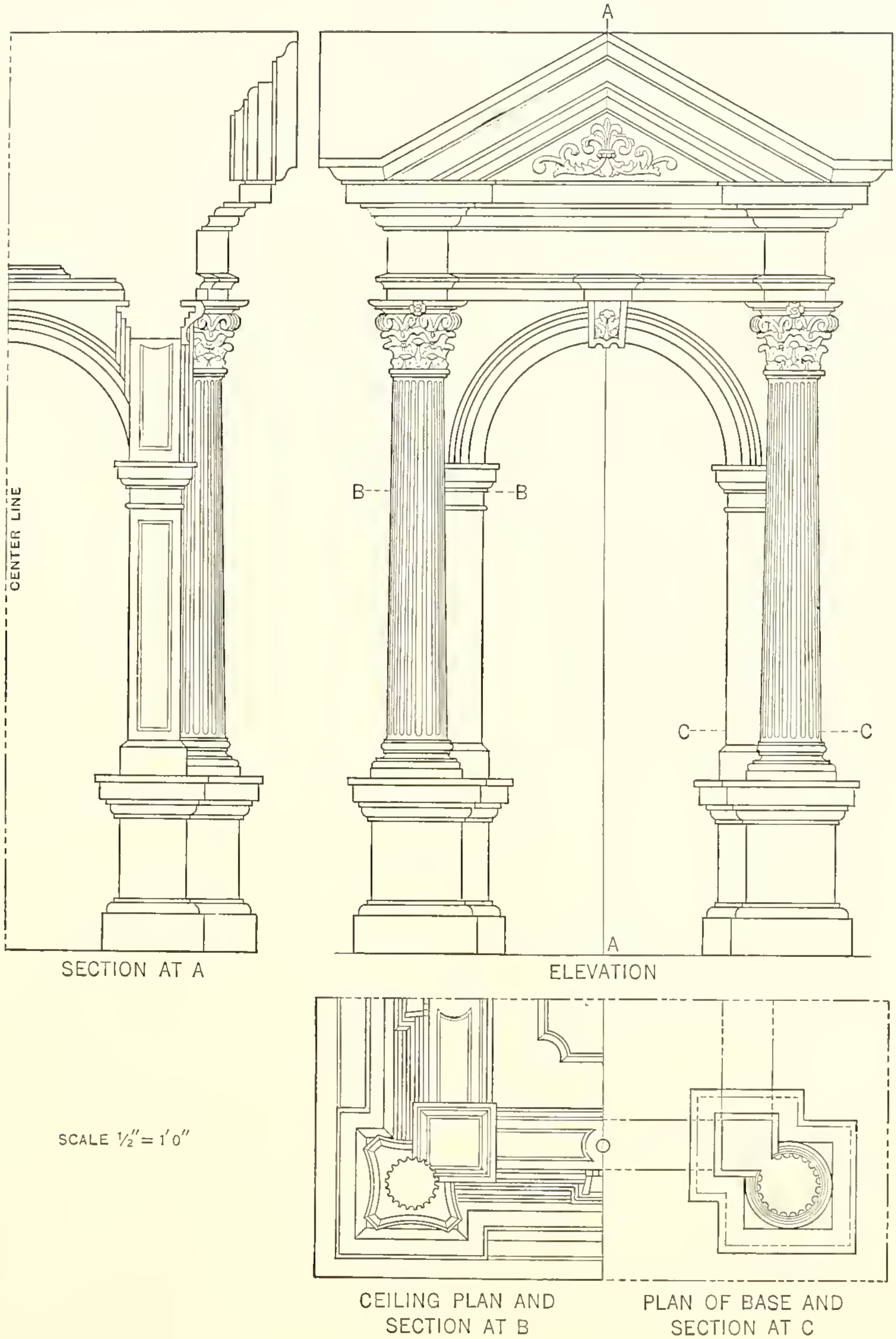


Fig. 667.—Plans, Elevation and Section of Architectural Work

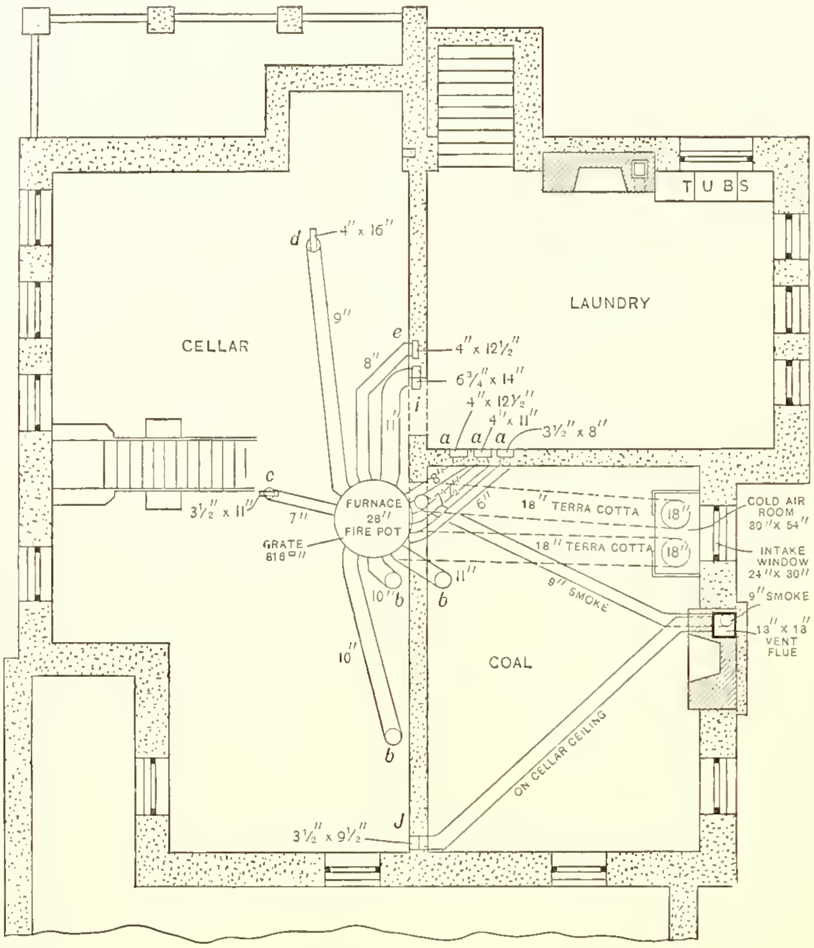


Fig. 668.—Basement Plan

and vent pipes. Starting with the basement plan in Fig. 668, let us follow the three warm air pipes, marked *a, a, a,* whose dimensions are 3½ in. x 8 in., 4 in. x 11 in. and 4 in. x 12½ in. respectively. They are connected to the furnace casing by 6 in., 7½ in. and 8 in. round pipes, respectively.

Following these flues to the first floor plan in Fig. 669, we locate their positions by corresponding letters, *a, a, a;* and, as we find no outlets marked, we refer to the next, or second floor plan, Fig. 670, where we find them to be shown by dotted lines at the corresponding letters, *a, a, a.* The dotted rectangles indicate that they do not rise over the second floor line but that elbows connect under the floor line between the floor beams and are carried under the floor between the beams to heat chamber No. 1 and the bath room. The one flue, marked *a'*, is carried under the floor, as shown by the dotted lines, and then rises within the partition, to heat a bed room in the attic or third floor, no plan of which is shown. It should be borne in mind that the presence of dotted lines in a plan signifies that the flue or other object is hidden; thus in the case just considered it is to be understood that the flue is under the floor.

Again referring to the basement plan in Fig. 668, let us follow the three warm air pipes marked *b, b* and *b*, which connect to the furnace casing by means of two pipes each of 10 in. diameter and one of 11 in. diameter. On examining the first floor plan, Fig. 669, we find that these three pipes connect to floor registers, also indicated by *b, b* and *b*, one in the living room and two in the reception room.

Again referring to the basement plan in Fig. 668, let us follow the uptake *c*, which connects to the furnace casing by a 7 in. round pipe. The rectangle over the circle at *c* indicates that a transition elbow will be required, forming a transition from the 7 in. round pipe to the 3½ in. x 11 in. riser. Referring to the corresponding position of this flue on the first floor plan, in Fig. 669, we find it in the stair partition marked *c*; as no outlet is indicated, we examine the second floor plan, in Fig. 670, and find it at *c*, where it is shown to be dotted, from the partition, indicating that it is carried under the floor, between the beams and up in the partition, as shown, to heat chamber No. 2.

d in the basement plan, in Fig. 668, again indicates that a transition elbow or boot is required to connect a 9 in. round pipe from the furnace to a 4 in. x 16 in. riser. Following this riser to the first floor plan, in Fig. 669, where it is shown at *d*, we find no outlet marked; this indicates that the riser continues to the second floor, where in the plan, Fig. 670, it is shown at *d*. The small arrows indicate that it will warm the bath room, as well as the servant's chamber, No. 3.

It may be well in this connection to call the reader's attention to the fact that in all plans of heating and ventilation work, arrows pointing OUTWARD FROM THE PARTITIONS into the rooms always indicate warm air pipes; while arrows pointing TOWARD THE PARTITIONS OR REGISTERS always indicate vent pipes.

The riser, marked *c* in the basement plan, Fig. 668, which connects with the furnace casing by an 8 in. round pipe, is 4 in. x 12½ in. in size and is shown by *c* in the first floor plan, Fig. 669; here no outlet is shown. This indicates that the riser continues to the next floor, shown by *c* in Fig. 670, where the arrow indicates its outlet through a 10 in. x 10 in. register face.

Again referring to the basement plan, Fig. 668, let us follow riser *i*, which connects to the furnace casing by an 11 in. round pipe. The outlet of this flue, as indicated by *i* in the first floor plan, Fig. 669, is to the dining room.

The position of the furnace smoke pipe is clearly indicated in the basement plan, in Fig. 668, where it connects to the tile flue.

Reading the Plans of Ventilating Flues

As already mentioned, the kitchen is ventilated by direct connection at the ceiling line to the tile flue at A, in Fig. 669. The dining room and living room are ventilated through open fireplaces. On the second floor plan, Fig. 670, the servant's chamber, No. 3, is ventilated at the ceiling line through direct connection to the tile flue at B. The ventilation of the servant's bath room is indicated by the vent flue D, which is carried up to the attic floor (not shown), thence to the left on the unfinished attic floor to connect with the tile flue, B, which is carried upward. Chamber No. 4 is ventilated by means of the open fire place. The main bath room is ventilated by the metal flue, E (shown dotted), carried under the floor to connect with the tile vent flue, F. Chamber No. 1 is ventilated by direct

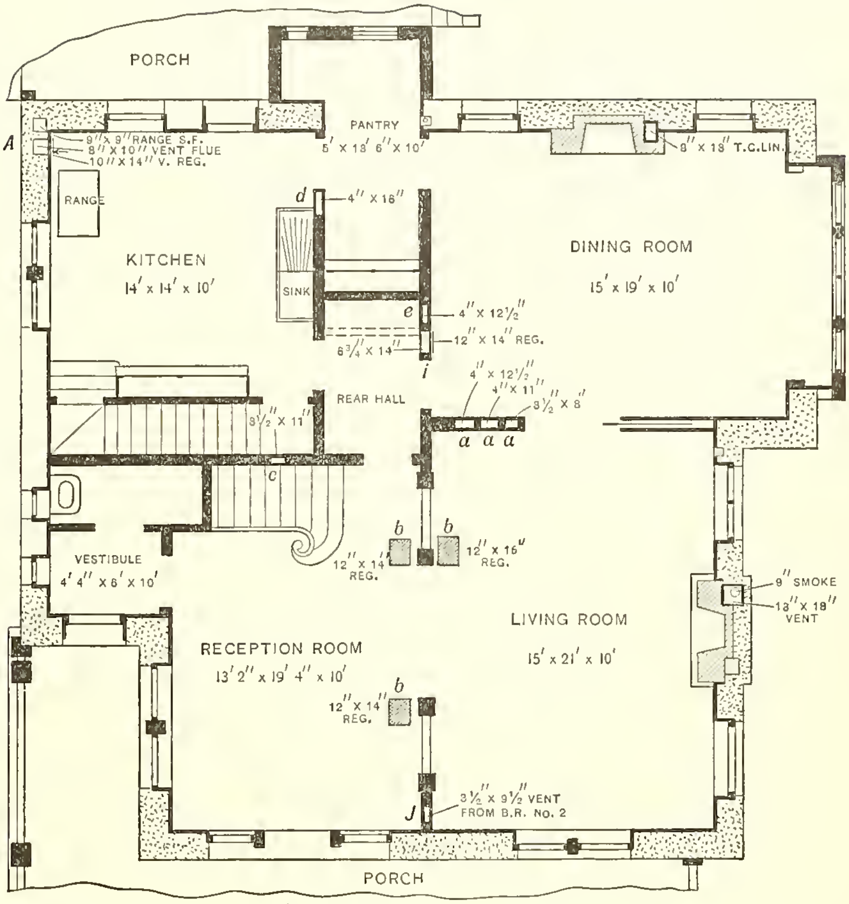


Fig. 669.—First Floor Plan

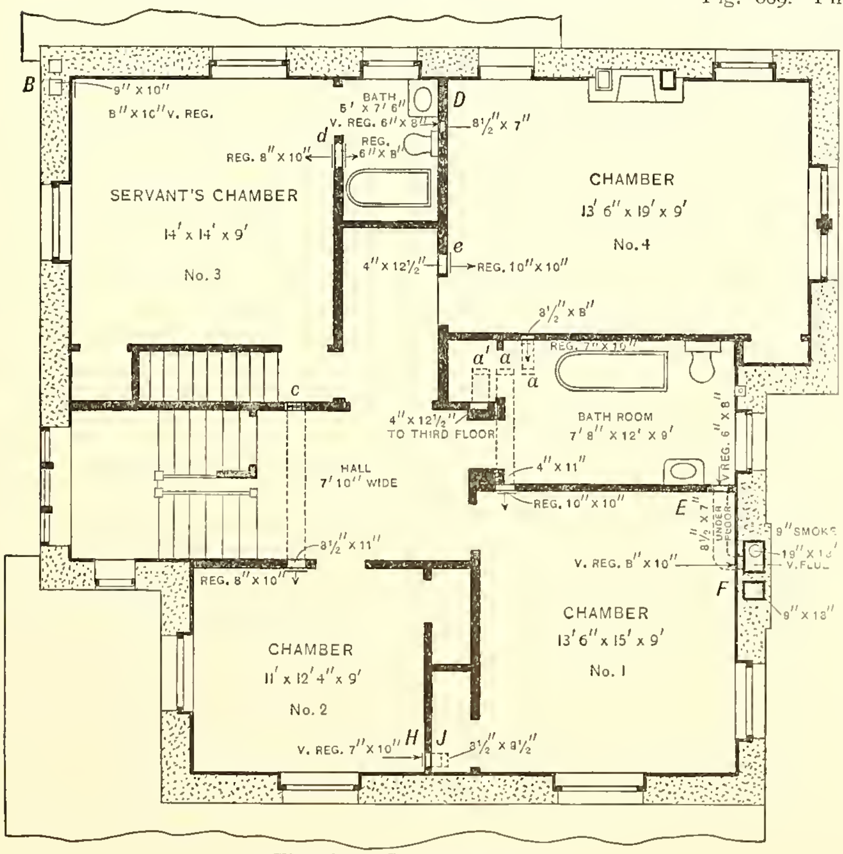


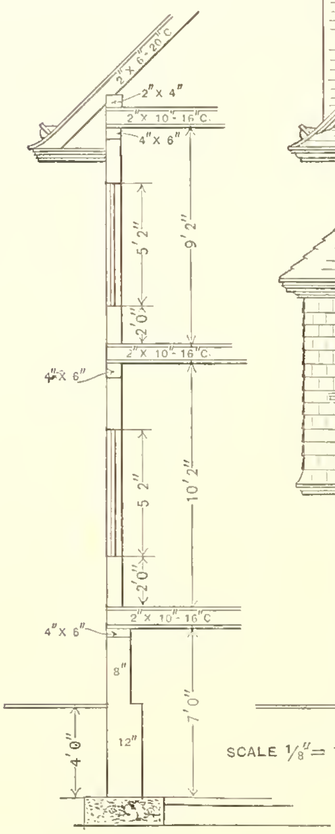
Fig. 670.—Second Floor Plan

connection to the tile flue at F. Chamber No. 2 is ventilated through the vent register H. This flue is carried under the floor, as shown dotted at J, so as to come in line with the first floor partition, shown at J in Fig. 669; it continues down to the cellar or basement ceiling line, where it is indicated by J in the basement plan, in Fig. 668, from which it is carried along the ceiling to connect to the 13 in. x 13 in. tile vent flue, as shown. The foregoing methods of delineation apply universally to plans of heating and ventilating pipes.

Because of the limitation necessarily imposed by the size of page, the plans, elevations and sectional view presented here have been reduced to one-eighth inch to the foot.

This full set of plans for a private residence consists of four plan views and four elevations, including a sectional view, and comprehends Figs. 671 to 678, inclusive.

Fig. 671 shows the front elevation facing west. To the left of this elevation is presented a sectional view giving the hights of the cellar, first and



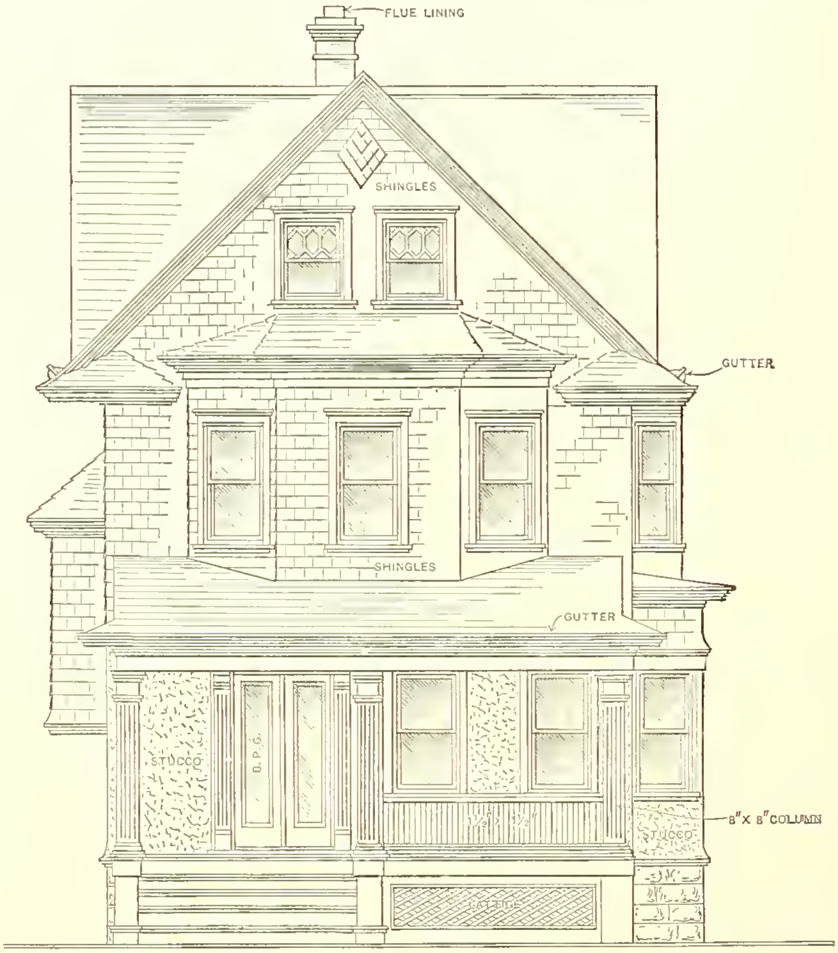


Fig. 671.—Front Elevation, Facing West

second stories. Note that the concrete footing is 12 in. thick, upon which concrete blocks 12 in. thick are placed up to the grade line. Above the grade line the blocks are 8 in. thick, as indicated. The hight of the basement is 7 ft. in the clear as indicated, that of the first floor 10 ft. 2 in., and that of the second floor 9 ft. 2 in. The beams are marked 2x10—16, these figures indicating that they are 2 in. thick, 10 in. high and 16 in. on the centers. The roof rafters are 2 in. x 6 in., placed 20 in. on

READING A COMPLETE SET OF ARCHITECT'S PLANS DRAWN TO A SCALE

Solution 203

As already stated, architect's plans are usually drawn to a scale of one-quarter inch to the foot.

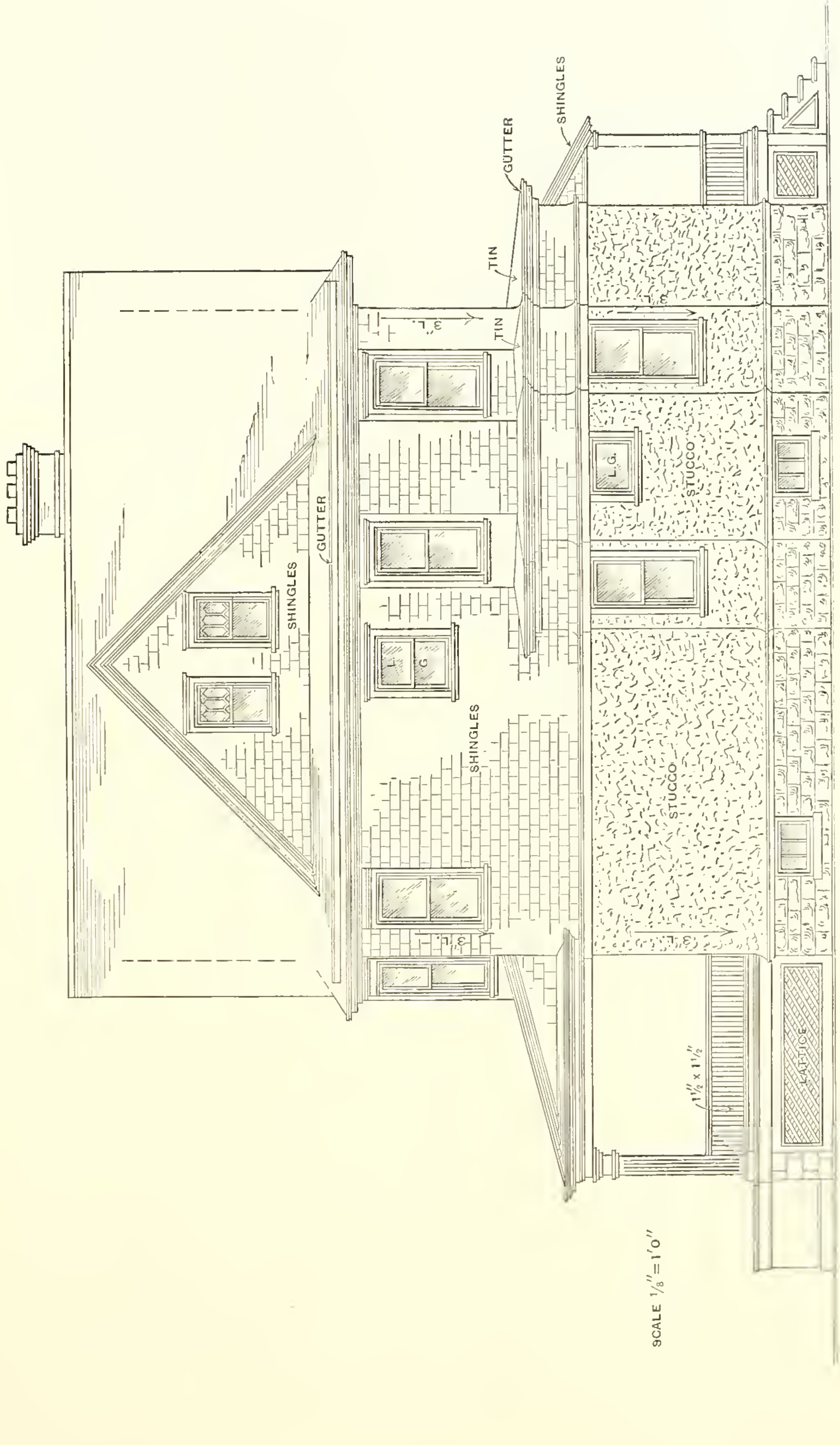


Fig. 672.—Side Elevation, Facing South

centers. The windows are 5 ft. 2 in. high, placed 2 ft. above the floor line. As shown in the front elevation, the first story is of stucco and the second and attic stories are covered with shingles. The main roof has a roof gutter lined with tin, while the porch roof and extension in rear have box formed gutters, also lined with tin. The letters B. P. G. in the front elevation front doors indicate beveled plate glass. The figures 1½ x 1½ below the porch rail indicate the size of the balusters.

The side elevation facing south is presented in Fig. 672, which shows the gutters and tin roof over extension. The arrow lines, marked 3″ L indicate the position of the 3 in. leaders or rain water conductors. The mark L. G. in the windows indicates leaded glass. In reading plans it is always well to place the various elevations over the proper side in plans; this shows at once the various relations of similar parts.

Fig. 673 gives the rear elevation facing east. This view shows the side of the dormer window, found in the side elevation facing north in Fig. 674. The position of the main gutters and leaders are here shown. The cross lines under the porch, also shown in both front and side elevations, indicate the lattice work.

Note that in the door leading to the basement in Fig. 674, a sash is placed in the upper panel.

The foundation plan, shown in Fig. 675, gives a mass of information for the mason, the framer, the plumber, the roofer and the steam fitter. First, the contractor should check up the various dimensions on the plan, to find if they tally. Note the location of the windows and door, A, and of the stairs leading from the grade line to the basement floor, which is of cement. The location of the concrete footing for the metal columns, also the 6 in. x 8 in. spruce girder, is also shown. B indicates the steam boiler and C the laundry stove. The wash trays and maid's toilet are also indicated, as well as the lines of waste,

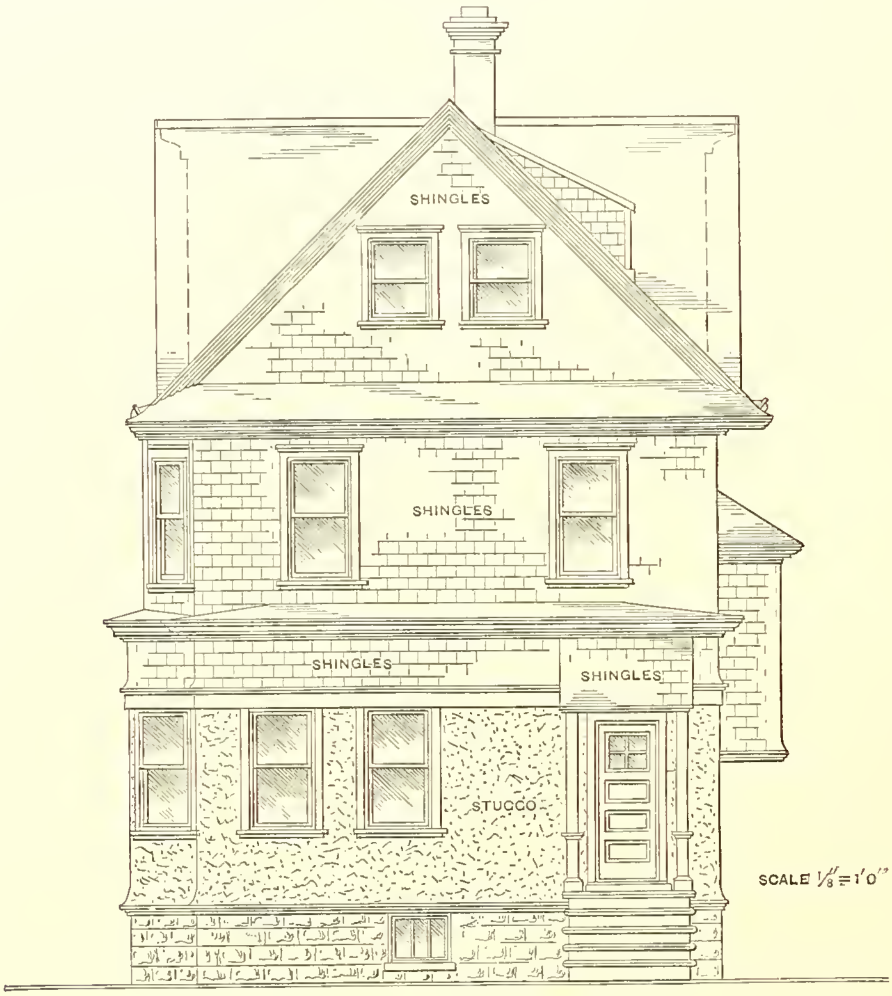


Fig. 673.—Rear Elevation, Facing East

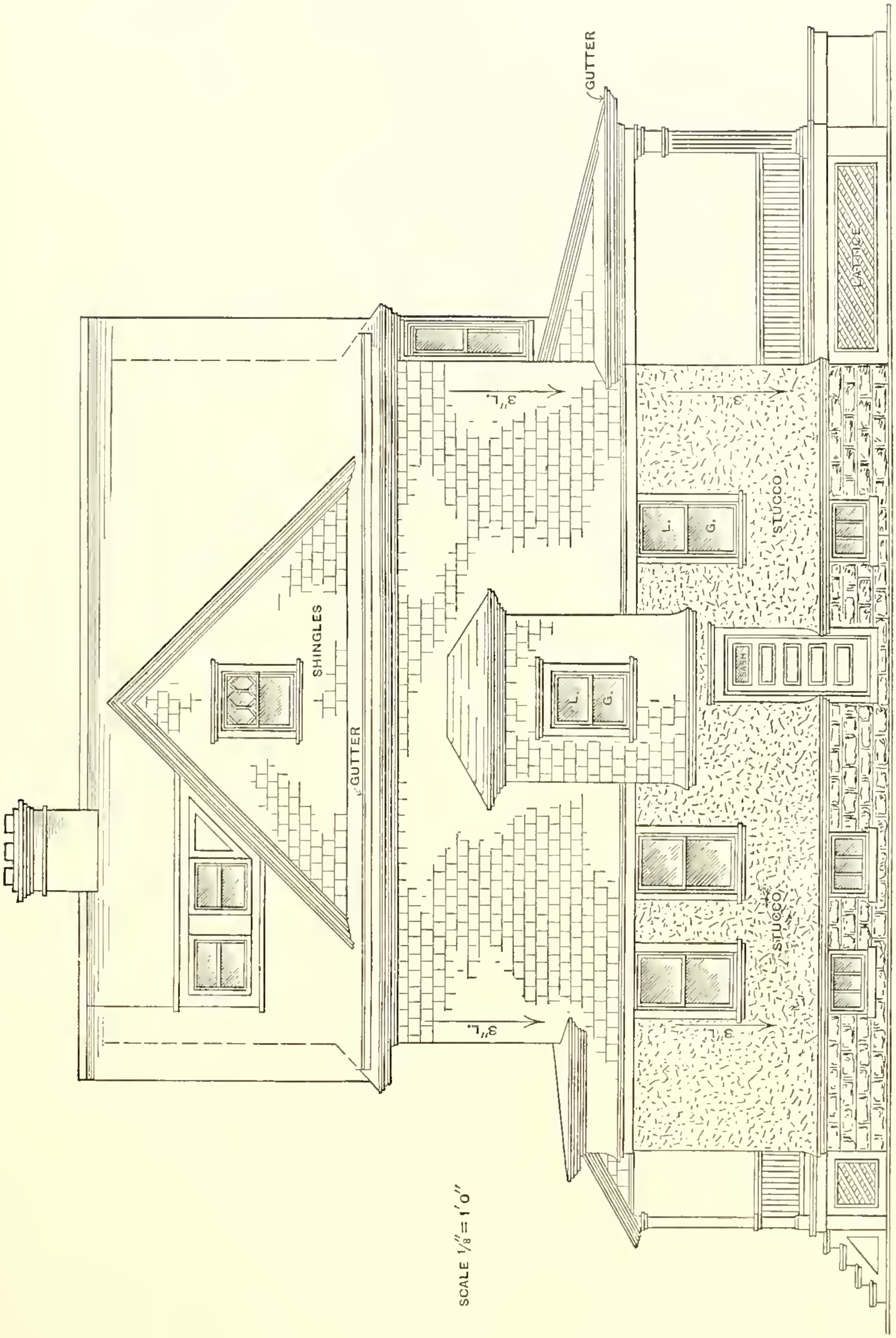


Fig. 674.—Side Elevation, Facing North

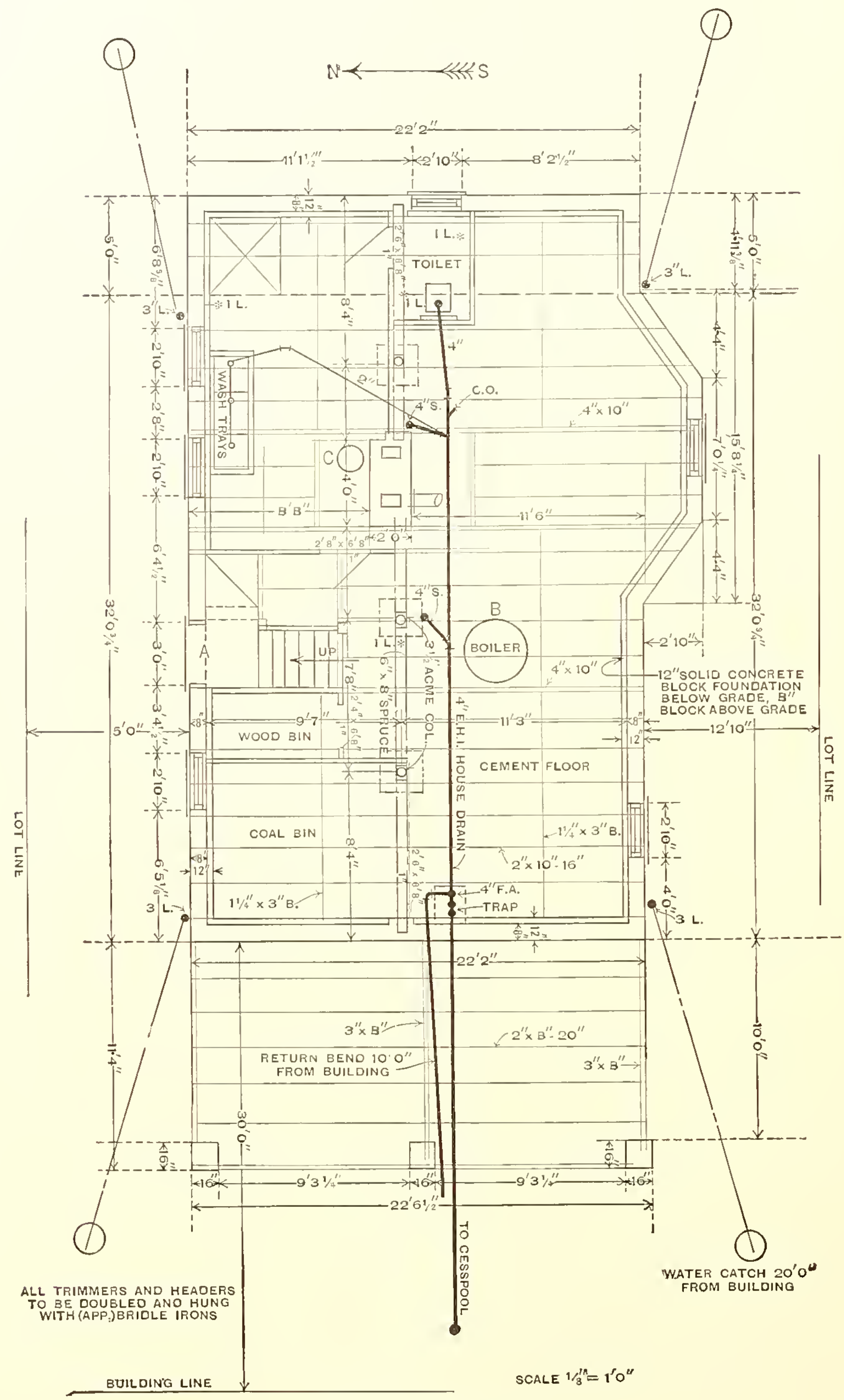


Fig. 675.—Foundation Plan

soil and house drains. The heavy line shown in the center of the plan, marked 4″ E. H. I. house drain, indicated that the house drain will be of extra heavy iron pipe of 4 in. diameter. The 4 in. fresh air traps and the return fresh air bend are also shown. In this case a cesspool can be installed; and the four down spouts, marked 3″ L; are connected to a water catch 20 ft. from the building, to prevent the near approach of water to the cellar. Cast iron pipes are also connected to the house drain, so that when sewers are laid in the street, the down spouts are connected to them. The size of the doors to the coal bin, wood bin, laundry and maid's toilet are indicated. The faint lines shown, with the various sizes thereon, indicate the first floor and porch floor beams. Those for the porch are 2 in. x 8 in., 20 in. on centers; and those for the first floor are 2 in. x 10 in., 16 in. on centers, with 1¼ in. x 3 in. cross braces. Girders are placed at intervals in both first and porch floors, as indicated. The brick chimney is also shown, with two flues; one for the steam boiler and the other for the kitchen range. Three gas and electric lights are shown in the basement plan; they are marked 1 L, indicating one electric and gas light for the toilet, the same for the laundry and the same at the foot of the stairs, on the column. C. O. indicates clean outs for the house drain and 4″ S. and 2″ S. indicate cast iron drains connecting to the house drain.

The first story plan, shown in Fig. 676, should also be checked up before any measurements are laid out. Note the cement walk around the north side, front and rear, with dimension widths marked. The veranda or porch has four steps and one electric light in the ceiling. As an illustration of the method of indicating the size and thickness of doors, note the front doors, which are marked $\frac{4'\text{—}4'' \text{ x } 7'\text{—}6''}{2''}$. This conveys the meaning that the front doors are 4 ft. 4 in. wide and 7 ft. 6 in high by 2 in. thick. In this way all doors are indicated.

The double oblique lines in the front doors indicate that they are double doors. Otherwise indicated, the doors are single and the direction in which they open, is shown. A double oblique line such as is shown between kitchen and dining room, indicates a swinging door. The doors indicated between the parlor and dining room are of the rolling type. An "opening" as marked between the reception hall and parlor, indicates that no door is to be installed. Note that the vestibule floor is tiled and that the dotted lines in both reception hall and dining room indicate paneled beamed ceilings. In both of these rooms plate shelf and wainscot strips are indicated. The full size dimensions of all window frames are shown. Along the stairs in the reception hall a seat is placed, with hinged covers, forming a moth-proof box. One electric ceiling light is indicated in the reception hall by the double cross. The stairs, with newel posts, leading to the second floor, are also indicated. In the kitchen the range, boiler and sink with drain board are indicated, as also provisions for ice box drain in the rear entry. Two lights are indicated in the kitchen, one in the ceiling and the other alongside the range. The location of the 2 in. waste pipe from kitchen sink is shown, as also the 4 in. soil pipe from the upper bath room. In the dining room, a mantel is shown, as also a four-light gas and electric dome. The parlor has a console mirror and a three-light gas and electric fixture. The faint lines show the size and location of the floor beams.

The second floor plan is given in Fig. 677. Here we find the roof plan of the veranda, showing a tin-lined box gutter, the arrows indicating the flow or pitch toward the 3 in. leader marked 3″ L. This roof is covered with shingles and the faint lines on it indicate the rafters, which are 2 in. x 6 in., placed 20 in. on centers. The location, swing and door dimensions are all shown. The faint lines in the plan show the size of the floor beams. The three bed rooms have each a two-light gas and electric fixture, the bath room two single lights, one on either side of a mirror, and there is a single electric light in the hall, all as indicated. The bath room is tiled. The 4 in. cast iron soil pipe, the 2 in. cast iron waste pipe and the 2 in. cast iron vent are all shown. The roof over the rear extension is covered with tin; it has two hips as indicated, the water pitching north and south to the outlets marked 3″ L. The projecting cornice of the bay window on the south side is also covered with tin; the water is carried off by means of a box gutter, pitching toward the outlet 3″ L on the east end. This tin roof over the bay is more clearly shown in Fig. 672, giving the side elevation facing south. The roof plan over the rear porch shown in the second floor plan, in Fig. 677, is covered with shingles, as shown.

It is well to remark here that in case of doubt as to the correct reading of plans, the proper elevation should be placed to face the proper side in plan, as this will bring the various views into their right relation.

The last plan view is that given in Fig. 678, which shows the plan of the roof and attic. The dimen-

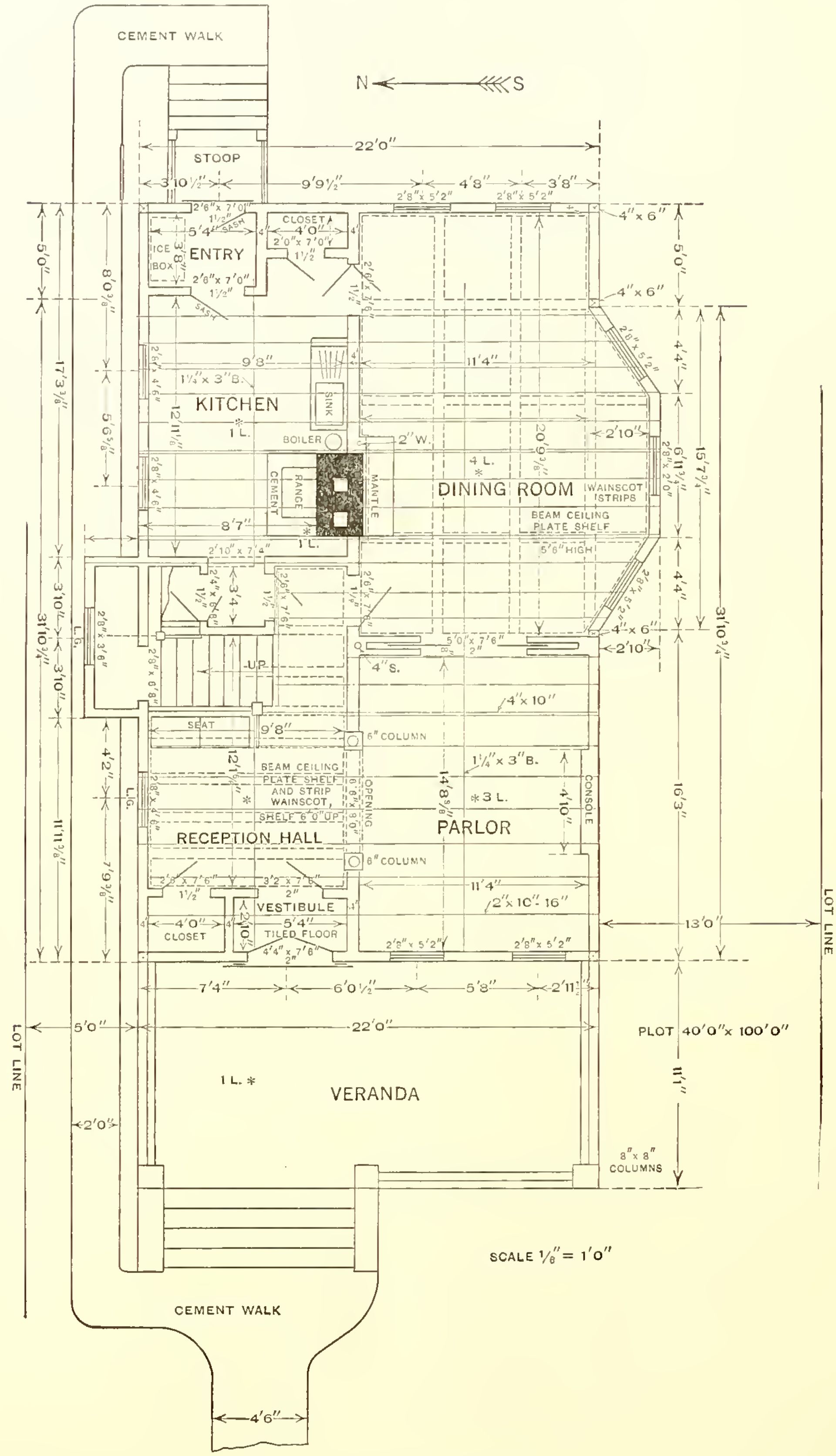
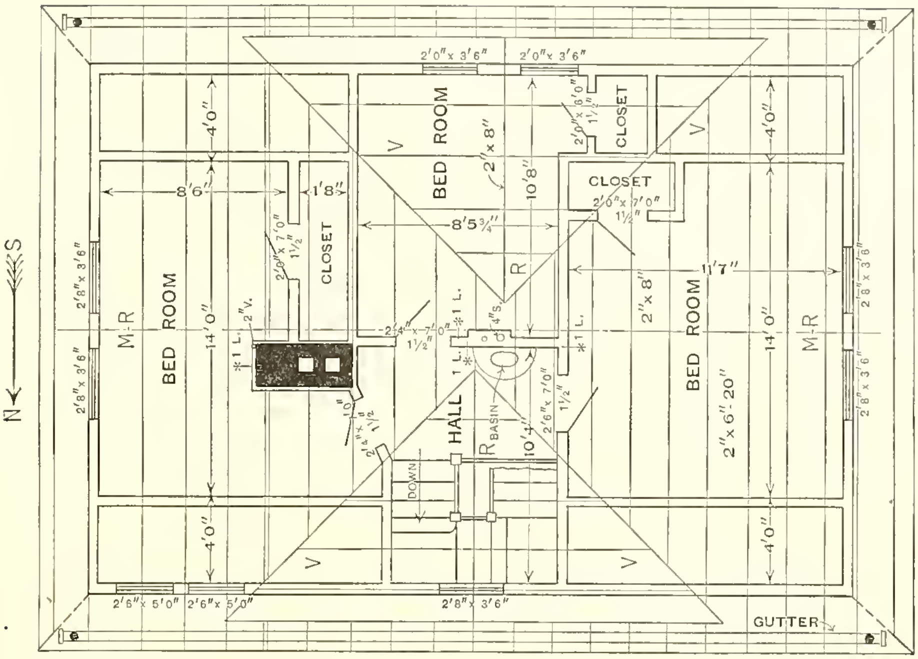
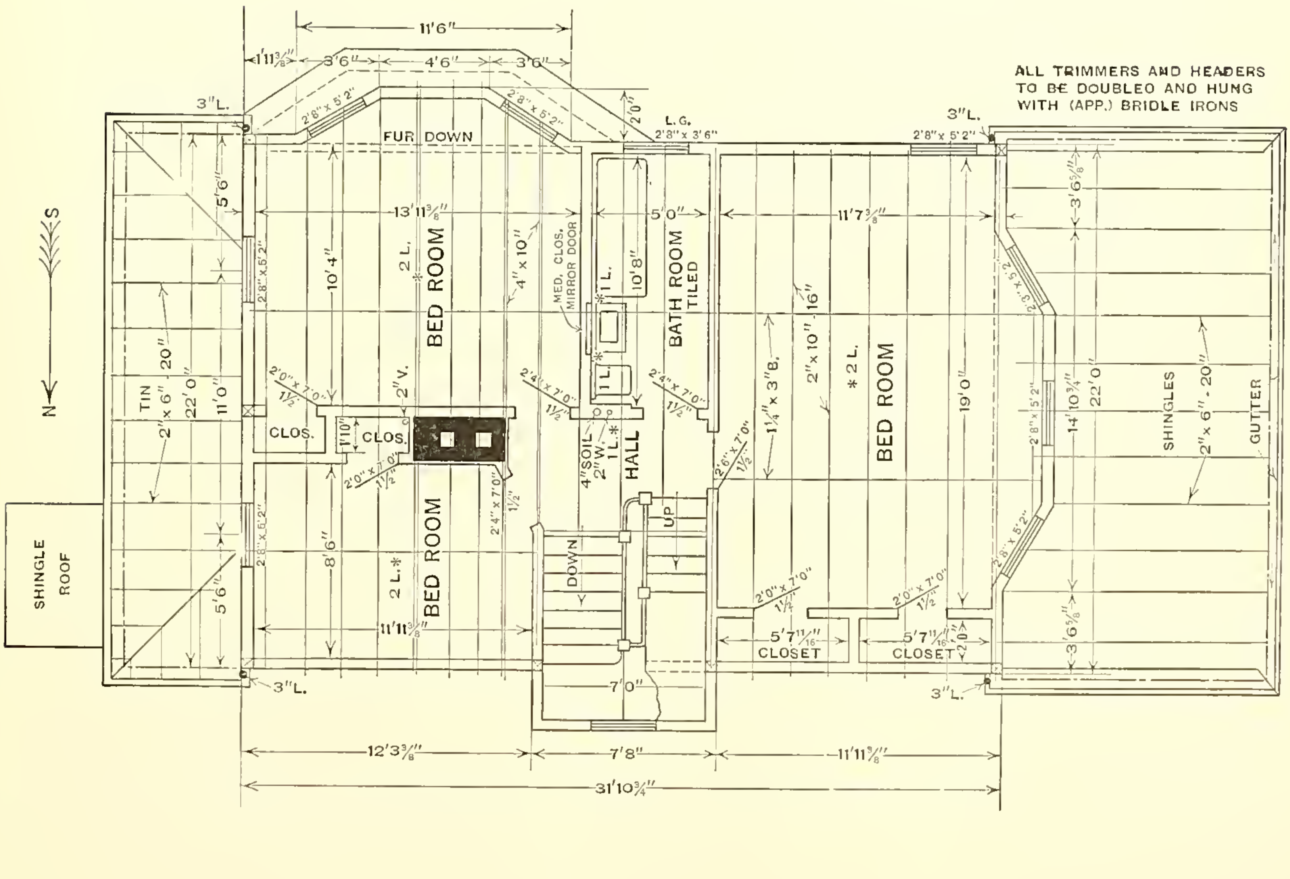


Fig. 676.—First Floor Plan



SCALE 1/8" = 1'0"

Fig. 678.—Roof and Attic Plan



SCALE 1/8"=1'0"

Fig. 677.—Second Floor Plan

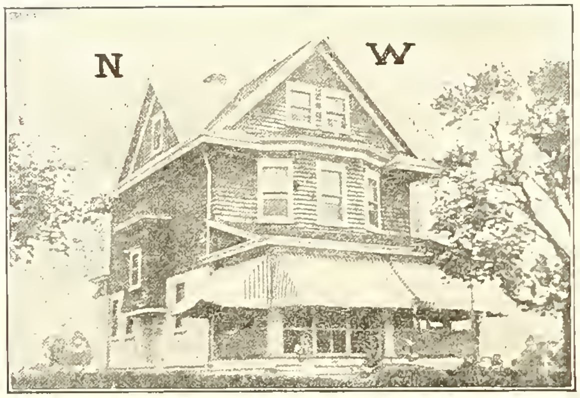


Fig. 679.—Facing Northwest

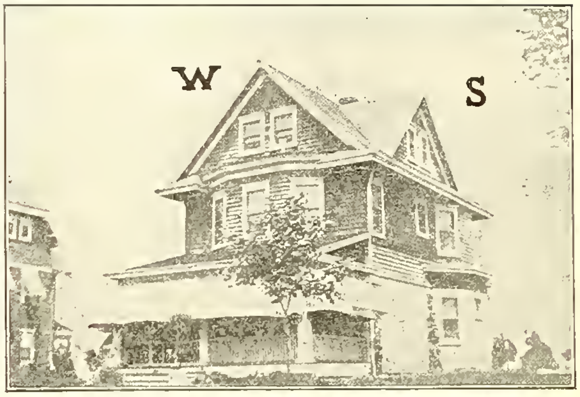


Fig. 680.—Facing Southwest

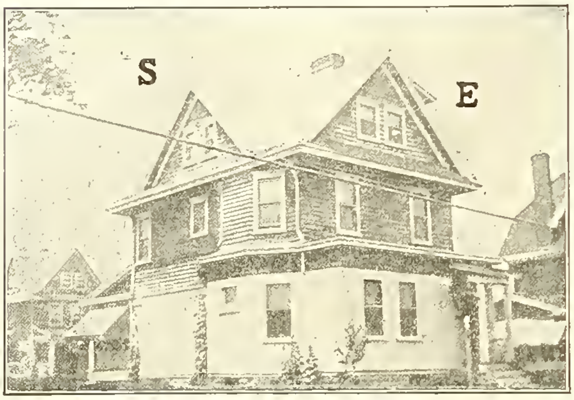


Fig. 681.—Facing Southeast

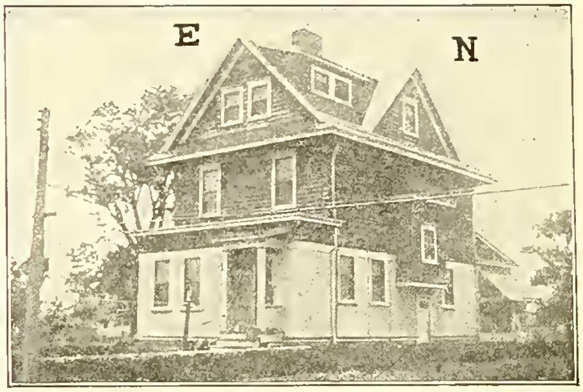


Fig. 682.—Facing Northeast

Figs. 679 to 682.—Photographic Views of a Residence at Four Angles

sions on this plan should also be checked to avoid error in laying out the work or in estimating on the job. The heavy lines, marked R, are the ridge lines of the two gables on the north and south sides, seen in the elevations. The line marked M-R indicates the main ridge of the gables facing east and west, seen in the elevations. The valley lines are indicated by the letter V. The tin-lined gutters on the north and south sides are indicated and are seen to pitch toward the leader outlets. The faint lines indicate the rafter lines, serving to show that 2 in. x 6 in. rafters, placed on 20 in. centers, are required. The ridge beams are of a size of 2 in. x 8 in., as shown. In the plan of the attic which is also shown, note the sizes of all window frames and doors. A wash basin is placed in the hall connected to the 4 in. soil pipe, as shown. A 2 in. vent pipe is also indicated. Note that the stair rail stops against the front bed-room wall. In the three bed rooms and hall, four single electric wall lights are indicated by 1 L. The reader should compare carefully the various elevations with the plans, until he can readily comprehend all the views.

Figs. 679 to 682, inclusive, are photographs of the house under consideration, giving the views facing northwest, southwest, southeast and northeast, respectively. These photographs will be of considerable assistance when compared with elevations and plans of the structure facing in like direction, giving the actual positions of gutters, leaders, ridging and valleys.

PART XVII

ESTIMATING ITEMS AND QUANTITIES OF SHEET METAL IN THE CONSTRUCTION OF BUILDINGS

THE mechanic who has mastered the science of sheet metal pattern drafting is possessed of the practical means of a livelihood in a successful calling and he who combines with his knowledge of that important department of sheet metal work an understanding of the methods of taking off items and quantities from architects' scaled plans is still more substantially equipped for successful occupation in the sheet metal trade.

The aim of the present part is to furnish guidance to the mechanic applicable at all times for taking from plans, the items to be comprehended in sheet metal worker's contract, as cornices, skylights, roofing, gutters, spouting, furnace piping, etc., without reference, however, to price schedules of material and labor which, subject as they are to varying circumstances and ever changing market conditions are necessarily omitted from consideration here.

The exercise on estimating the material for covering a hipped roof is of special value as showing how to find the true lengths of the hips, ridges and valleys which is equivalent to finding the true lengths, by means of triangulation. The method usually employed is to take off the quantities from a set of plans in the order of their occurrence in the specifications, which latter are the medium by which the architect indicates requirements, gauge of material to be employed, manner of construction, etc. The first example given consideration is that of a copper coping as follows:

FINDING QUANTITIES IN COPPER COPING OVER WALL ON PITCHED ROOF

Solution 204

Fig. 683 presents a finished view of a molded coping, to be installed above the gable walls over a pitched roof. These copings are constructed of copper, a light and durable substitute for stone which does not leak at the joints, as stone copings usually do. The following is a typical specification for this class of work.

Specifications

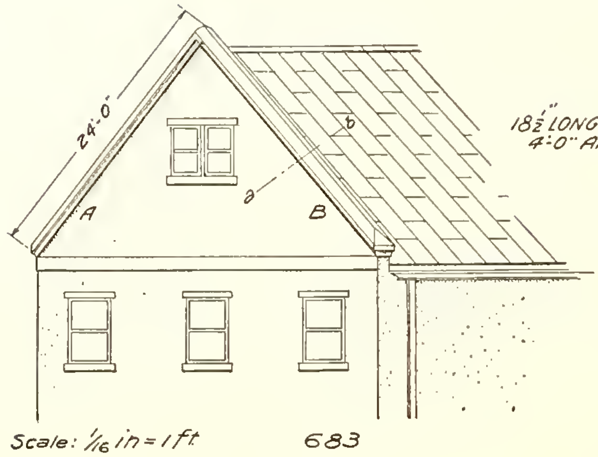
"Copings over gable walls to be made of 20-oz. cold rolled copper; all seams to be riveted with 1 lb. copper rivets and thoroughly sweated with solder on the inside; all outside seams to remain clean and smooth; all miters to be re-enforced, according to directions hereinafter.

"The coping is to be secured to wooden frame work prepared by the carpenter; all work is to be well secured by means of round head brass screws; the bottom of the coping is to have sufficient drip to protect the wall and the top is to be secured by means of a standing locked seam. All work is to be executed in a first-class, workmanlike manner."

Computing the Quantities

After reading the specification, it should be compared with the notes on the drawing and the drawings should be thoroughly studied, so that the estimator may understand precisely what is wanted. Pencil, note book, scale rule, a pair of four-inch dividers and some tracing paper, will serve requirements.

The view given in Fig. 683 is drawn to a scale of 1/16 in. to the foot. The extreme length of the coping scales 24 feet for side A and the same measurement for side B. When a drawing is made to so small a scale, an enlarged scale detail is usually furnished. From this the accurate girth of material can be taken. This enlarged scale detail also shows the character and requirements of construction and erection. In Fig. 684 is given a two-inch scale detail of the wall, the rough framing and method of fastening. Note that iron bolts are built in the wall at intervals of four feet; to these the solid wooden brackets 18½ in. long are secured, and over these brackets are placed sheathing boards on which



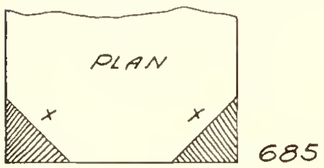


Fig. 683.—View of Coping over Gable Wall
Fig. 685.—Re-enforced Corners

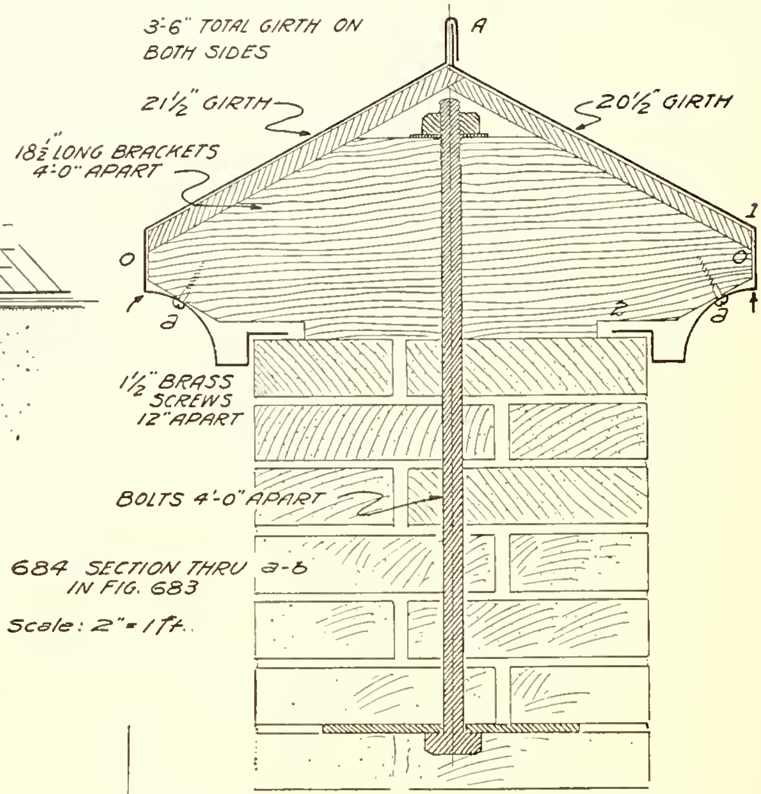


Fig. 684.—Obtaining Girth of Mold, and Method of Construction

the copper coping is set. Allowance is made at the bottom of the brackets to receive the flange of the drip, and the two washes of the coping are seamed at A. Brass screws, 1½ in. long, are placed as indicated at *a*; these hold the cove and drip tightly in position.

As the section is drawn to a two-inch scale, set the dividers apart 1/12 of two inches, which represents one inch on the two-inch scale; starting from A take the girth on the right side to the end of the drip flange, obtaining measurement of 20½ in. Since there is a lock on the opposite side of the coping, the left side will measure 21½ in. giving a total girth of 42 in., or 3 ft. 6 in.

As there is 48 ft. of coping in all, as shown in Fig. 683, and as the girth of the coping is 3 ft. 6 in., 48 ft. x 3.5 ft. = 168 sq. ft. of copper required. The 20-oz. cold rolled copper specified, indicating 20 oz. to the square foot = 20 x 168 = 3360 oz. Since there are 16 oz. to the lb., we have 3360 ÷ 16 = 210 lbs. of cold rolled copper required.

As there will be three seams on each side of the copper coping 1 in. wide or 6 seams in all, we have 6 x 1 in = 6 in. or .5 ft.; .5 ft. x 3.5 (the girth) = 1.75 sq. ft. The width of the lower head of the gable measures 1 ft. 6 in. and the girth of the head from 1 to 2 scales 9 in. Therefore .75 ft. x 1.5 ft. = 1.125 x 2 = 2.25 sq. ft. Add 1.75 sq. ft. (for seams) + 2.25 sq. ft. (for heads) = 4 sq. ft. x 20 oz. = 80 oz. 80 oz. ÷ 16 = 5 lbs. The main coping requires 210 lbs. plus 5; that is, 215 lbs. of 20-oz. cold rolled copper is required. As the brass screws can be placed 12 in. apart, $\frac{48}{1}$ = 48 brass screws required for each side. 48 x 2 = 96, which is the quantity all told of brass screws 1½ in. long, that is necessary.

All the material needed for the work may be summed up as follows:

215 lbs. of 20-oz. cold rolled copper.

96 brass screws—1½ in. long.

120 one-lb. copper rivets (rivets 2 in. apart on six seams).

5 lbs. solder (approximate).

To these must be added time, labor, overhead expenses, etc., all of which vary in different parts of the country.

Fig. 685 shows how the mitered corners of the lower heads are re-enforced by soldering gusset pieces, shown shaded by X, in the corners of the mold, marked by the arrow O and O in Fig. 684. This strengthens the corners and prevents the miters from bursting in the procedure of erecting the work.

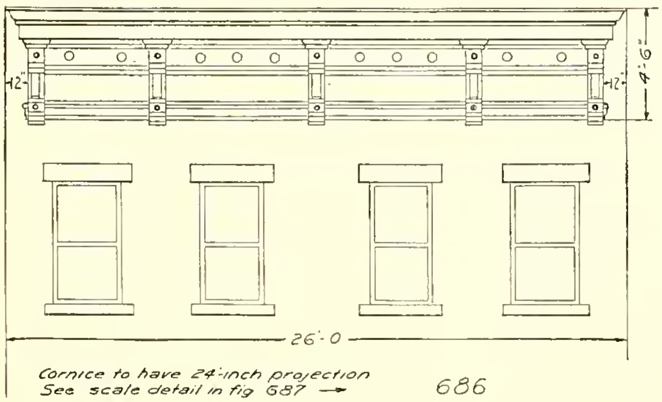
COMPUTING QUANTITIES IN A CORNICE

Solution 205

An elevation of a main cornice on the roof of a building is shown in Fig. 686; it is drawn to a scale of 1/8 inch to the ft. The full length of the cornice is to be 26 ft., its hight 4 ft. 6 in., and its projection 24 in. Of course, it is impossible to get the true girth from so small a drawing, and a scale detail, from which the quantities are determined, is furnished by the architect.

Specifications

"The main cornice is to be constructed from No. 24 galvanized iron, braced at intervals of four feet with band iron lookouts or braces, having thickness 1/4 in x 1 1/4 in. The braces are to be bolted to the cornice. The seams of the cornice are to be riveted with 2-lb. tinned rivets and all well sweated with



Scale 1/8" = 1 Foot

Fig. 686.—Elevation of Main Cornice with Bracket

solder. Before erection of the cornice it is required to be painted with one coat of red lead in raw linseed oil on both sides. This work to be executed in a first-class manner, erected plumb and true."

Taking Off the Quantities

Fig. 687 presents a one-half inch scale detail of the cornice shown in elevation in Fig. 686. A full section of the main cornice is shown in Fig. 687, as well as the outline of the band iron brace (shown dotted). The dashes indicate the position of the bolts. The side view and face of the bracket is also shown.

To determine the quantity of sheet metal required for the construction of the cornice is a very simple matter. Set the dividers apart one inch on the one-half inch scale, that is, 1/12 of one-half inch. Starting at *i* in the section take the full girth of the main cornice down to the end of the drip flange at *m*; it will be found to measure 90 in. or 7 ft. 6 in. As the extreme length of the crown mold in Fig. 686 is 26 ft. and that of the bed mold, panel course and foot mold 2 ft. less, we will, in computing the number of sq. ft., assume to have the full 26 ft. which will provide sufficient material for the two crown mold returns. The full girth of the cornice being 90 in. or, 7 ft. 6 in., we have 7.5 ft. x 26 ft. = 195 sq. ft. Again, setting the dividers apart one inch on the scale, take the girth from *o* to *r* in the section of bracket in Fig. 687, and it will be found to have a girth of 66 in. or 5 ft. 6 in. As the face of the bracket is 9 in. or .75 ft., we have .75 ft. x 5.5 ft. = 4.125 sq. ft. As there are five brackets, 5 x 4.125 sq. ft. = 20.625 sq. ft. in bracket faces.

The quantity of material for the bracket sides is obtained as follows:

Extend the upper line of the bracket cap, as

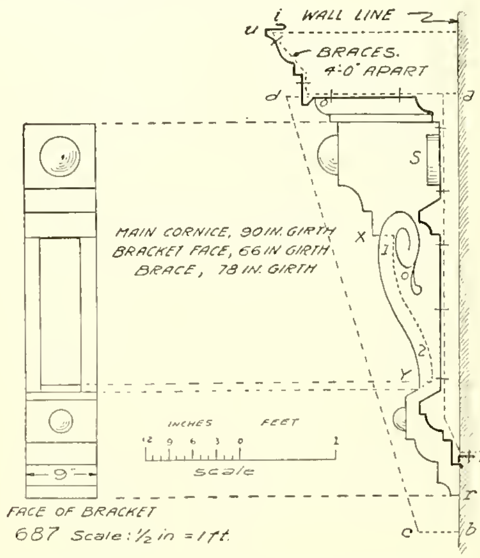


Fig. 687.—Scale Detail of Cornice Shown in Fig. 686

a-d; then draw the diagonal, *d c*, to meet the horizontal line below *r* as *c* b. The line *d c* is averaged to a sufficient distance beyond the profile of the bracket, to allow the sink strips 1-2 to be cut from the waste in X Y. The distance from *a* to *b* scales 4 ft. 6 in.; the distance from *a* to *d* scales 1 ft. 9 in., and the distance from *b* to *c* scales 3 in. Then 1 ft. 9 in. plus 3 in. equals 2 ft. 2 ft. x 4 ft. 6 in. equals 9 sq. ft., for two sides. As there are five brackets in all, we have 5 x 9 sq. ft. = 45 sq. ft., required for bracket sides.

Ten flat discs shown in the bed molding in Fig.

686 are each of 6 in. diameter, as shown by S in the scale detail in Fig. 687; thus 6 in. x 6 in. = 36 in. x 10 = 360 sq. in. for discs. The discs are to be stripped 2 in. wide; therefore 3 x 6 in. = 18 in., the approximate girth; 18 x 2 = 36 sq. in.; 36 sq. in. x 10 = 360 sq. in. for strips. 360 sq. in. (discs) + 360 sq. in. (strips) = 720 sq. in. 720 sq. in. ÷ 144 = 5 sq. ft.

There will be five 5-in. half zinc balls required, also five 3-in. half zinc balls for brackets. Again set the dividers one inch apart, according to the one-half inch scale rule, and step off the girth of the braces from *u* to *v*; this will measure 78 in. or 6 ft. 6 in. As the braces are to be spaced 4 ft. apart, seven braces will be required; 7 x 6.5 ft. = 45 ft. 6 in. of ¼ in x 1¼ in. band iron. Computing the dashes in the one-half inch scale drawing, which represent the bolts, we have 10 bolts to each brace; 7 x 10 = 70—¼ in. x ¾ in stove bolts that are required.

In addition, there must be added approximately 100—2 lb. tinned rivets; about 9 lbs. of solder; acid, coal, etc. Time and labor for construction and erection, expenses, cartage, overhead, etc., must be added; all these will vary in different sections of the country.

The entire quantity of galvanized sheet iron required may now be summed up as follows:

Main Cornice	195 sq. ft.
Bracket Faces	21 " "
Bracket Sides	45 " "
Discs	5 " "
Total	266 " "

As No. 24 gauge iron is to be used and as No. 24 galvanized sheet iron weighs 16 oz. to the sq. ft., 266 lbs. will be required.

Finding Quantities in Skylight Work

The general rule in estimating skylight work is to measure the size of the roof frame, obtaining the number of square feet and to multiply the result by the price per square foot. Many shops adopt a graded schedule of prices per square foot for skylights of different size in either the flat, double-pitched or hipped skylights, glazed with either rough, ribbed or wired glass and made in either galvanized iron or copper, of different gauges. It is our aim to explain how the quantities of metal and glass are computed, omitting the price, per square foot, which may be made according to prevailing conditions.

Specifications

The example under consideration is a flat skylight, with the pitch in the roof frame. It is to be constructed of 16-oz. cold rolled copper, with condensation gutters in both the rafters and curb, all condensation or leakage drained to the outside. The skylight is to be glazed with ¼ in. rough wired glass, well bedded in white lead putty. The rules and regulations of the National Board of Fire Underwriters are to be complied with in the construction and installation of the skylight. These rules and regulations are as follows:

"All skylights, plane or inclined not over 45 degrees to be glazed with either standard wired glass not less than ¼ in. thick or ½ in. thick glass, protected with approved wire screen. Glass panes to be not over 20 in. wide and not to exceed 720 sq. in. in area." In other words these rules require that if the area to be glazed over is greater than 18 x 40 in., that is, 720 sq. in., two lights of glass must be employed.

COMPUTING QUANTITIES IN A FLAT SKYLIGHT

Solution 206

In Fig. 688 is shown a plan and section of a flat skylight, whose frame measure is 6 ft. x 10 ft. 10 in., and in which the length has been spaced in eight

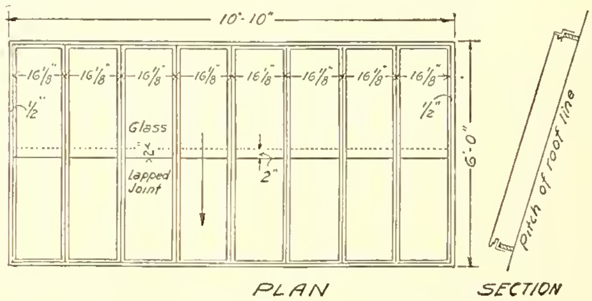


Fig. 688.—Plan and Section of a Flat Skylight

lights, each 16⅛ in. wide, as follows: Total length 10 ft. 10 in. or 130 in., less ½ in., for the shoulder on each side of the curb shown by X in Fig. 690, leaves 129 in., Fig. 688. $\frac{129 \text{ in.}}{8}$ = 16⅛ in. space.

As each light of glass would therefore contain more than 720 sq. in., the glass will be laid in two panes, with a two-inch over lap, as shown.

In Fig. 689 is shown a full size section of the rafter and its cap. The rafter requires a girth of 5¼ in. and its cap a girth of 1½ in., making a total of 6¾ in. There are seven rafters in the skylight in Fig. 688 and the length of each bar with riveting

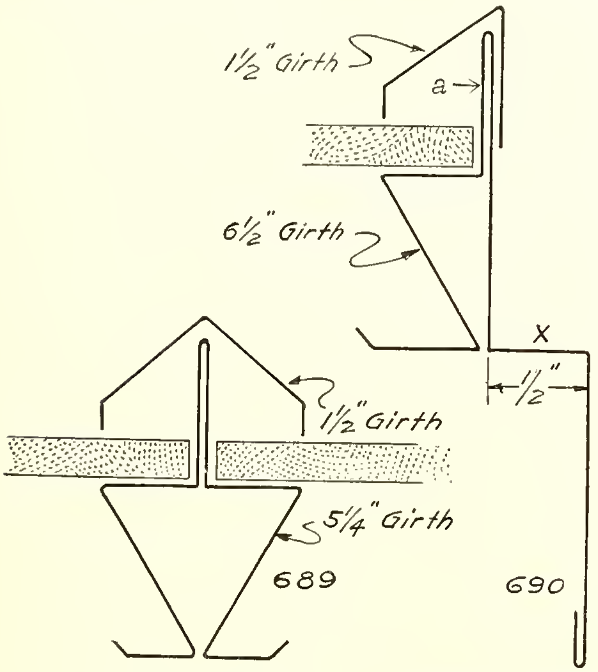


Fig. 689. — Obtaining Girth of Common Bar and Cap

Fig. 690.—Obtaining Girth of Curb

laps included can be figured as 6 ft. or 72 in. Thus 72 in. x 6.75 in. = 486 sq. in. for each bar, and 7 x 486 sq. in. = 3,402 sq. in.

Fig. 690 presents the full size section of the curb frame. The curb itself requires a 6½ in. girth and the cap a 1½ in. girth, making a total of 8 in. At the lower end of the skylight, the copper is turned downward at the arrow point *a*. The skylight under consideration in Fig. 688 measures 6 ft. by 10 ft. 10 in. Allowing for laps we may call it 6 ft. x 11 ft. Then 6 ft. + 11 ft. + 6 ft. + 11 ft. = 34 ft. or 408 in. Then we have 8 x 408 in. = 3,264 sq. in. in curb. We then have 3,402 sq. in. for skylight bars and caps and 3,264 sq. in for skylight curb and caps making a total of 6,666 sq. in. Since 144 sq. in. equals one sq. ft., $\frac{6{,}666}{144}$ = 46¼ sq. ft. Since our material is 16-oz. cold rolled copper, weighing 16 oz. or 1 lb., to the sq. ft., 46¼ lbs. of copper will be required. To this must be added approximately 1 lb. of copper for clips to fasten caps, about 50 1-lb. copper rivets, 1½ lb. of solder and about 15 1¼-in. round head brass wood screws to secure skylight curb to frame.

The quantity of glass and putty is computed as follows:

All glass is made in even numbers, unless ordered direct from the mill. In other words, if we require glass 16¼ in. wide, it will be cut from panes 18 in. wide, and 1¾ inches of glass, which would have to be paid for, would be waste. It is, therefore, important, that the width of the lights be so spaced that there will be no waste that is not absolutely necessary. In this case the lights will be 16⅛ in. wide, as indicated in Fig. 688, allowing ⅛ in. for expansion and contraction, they may be ordered in 16-in. widths, thus avoiding waste. The length of the rafter, 72 in., less 1 in. for curb shoulders, plus 2 in. for overlap, makes 73 in. of glass required for each light. 16 in. x 73 in. = 1,168 sq. in. x 8 lights = 9,344 sq. in. $\frac{9{,}344 \text{ sq. in.}}{144}$ = 65 sq. ft. of ¼-in. wired glass.

An approximately accurate rule for finding the amount of putty, is to allow 1 lb. for good imbedding for every 2 ft. of bar on both sides. Thus, we have in the skylight in Fig. 688 two runs of 11 ft.; 2 runs of 6 ft., and 7 double runs of 6 ft. Therefore 22 ft. + 12 ft. + 84 ft. = 118 ft. of single imbedding. $\frac{118}{4}$ = 29½ lbs. of white lead putty required.

To the quantities of materials here computed must be added the cost of labor, expenses, etc. With the cost of the skylight thus obtained, divide that cost by 65, the number of square feet in the skylight in this estimate, and obtain the cost or price per square foot. These prices may, with advantage, be kept for future reference; in this way a graded schedule for the various sizes is available.

Computing Double Pitched Skylights

In computing double pitched skylights the method used in calculating flat skylights is followed, simply allowing twice the sum of a flat skylight and substituting, in its center, a ridge bar in the place of two curbs, and adding the area of the two triangular sections in the ends.

COMPUTING QUANTITIES IN A HIPPED SKYLIGHT

Solution 207

The specifications used in connection with the preceding exercise in figuring a flat skylight may be employed also in the present case of a hipped skylight. Finding the quantities in a hipped skylight will prove somewhat more difficult, for the reason that the lengths of the various bars must be computed.

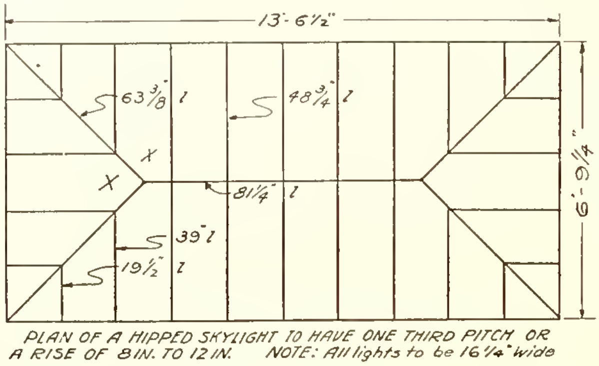


Fig. 691.—Obtaining True Lengths of Skylight Bars

Fig. 691 gives the plan of a hipped skylight, which will have a one-third pitch or a rise of 8 in. to a 12-in. run. In this example the size of the frame is made to be 6 ft. 9¼ in. by 13 ft. 6½ in.; the frame is to contain a ridge bar, without a ventilator.

The full size section of the skylight curb is shown in Fig. 692; it requires a girth of 6½ in. The amount of material in the curb is figured as follows: Referring to Fig. 691, the length of the curb is 13 ft. 6½ in. and the width is 6 ft. 9¼ in. Adding these dimensions, we obtain 20 ft. 3¾ in. Multiply this sum by 2 and we get the total length of 40 ft. 7½ in. We add to this result 4½ in. for seams and miter laps, making a total of 41 ft., or 492 in. As the girth of the curb, Fig. 692, is 6½ in., we have 6.5 in. x 492 in. = 3,198 sq. in. Divide 3,198 sq. in. by 144 and get 22¼ sq. ft.

The full size section of the ridge bar with its cap, shown in Fig. 693, has a total girth of 8½ in. The length of the ridge bar is found by deducting the width of the curb, in Fig. 691, from the length. Thus 13 ft. 6½ in. — 6 ft. 9¼ in. leaves 6 ft. 9¼ in. or 81¼ in. Add ¾ in. for lap, making 82 in.

$$82 \text{ in.} \times 8.5 \text{ in.} = 697 \text{ sq. in. and } \frac{697}{144} = 5 \text{ sq. ft.}$$

Before the quantities in the common, jack and hip bars can be ascertained, the lengths of the various bars must first be found. As a rule, the regulation pitch for hipped skylights is one-third or 8 in. rise to a 12 in. base and the factors used for finding the true lengths of the common and jack bars for one-third pitch is 1.2, and for the hip bar, 1.56. The method of obtaining these factors has already

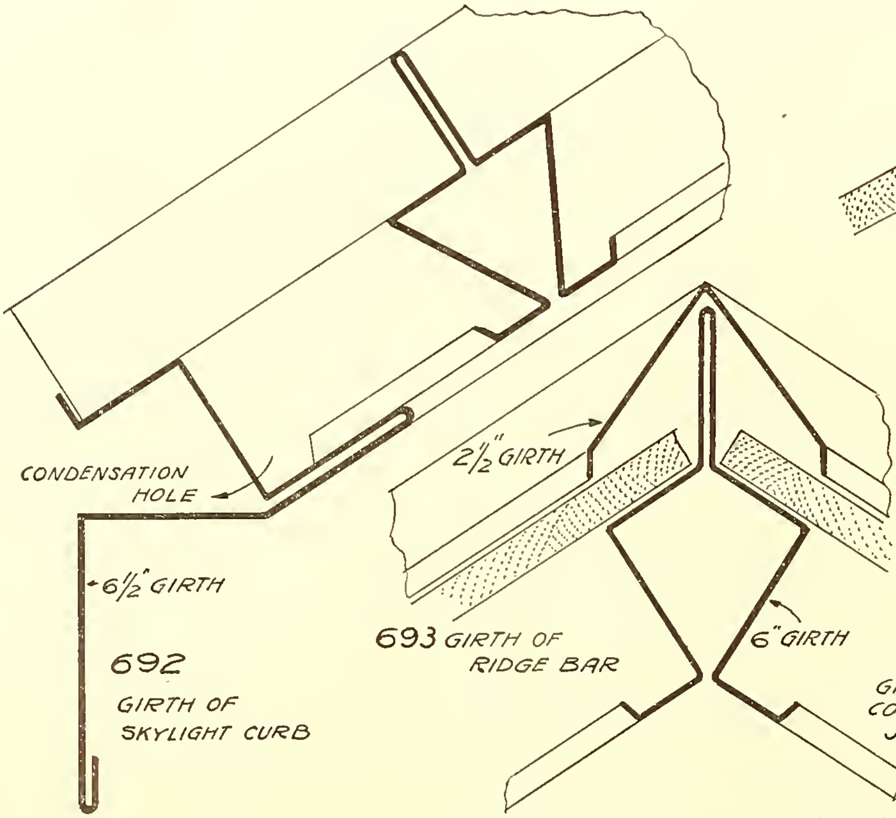


Fig. 692.—Obtaining Girth of Skylight Curb
Fig. 693.—Obtaining Girth of Ridge Bar

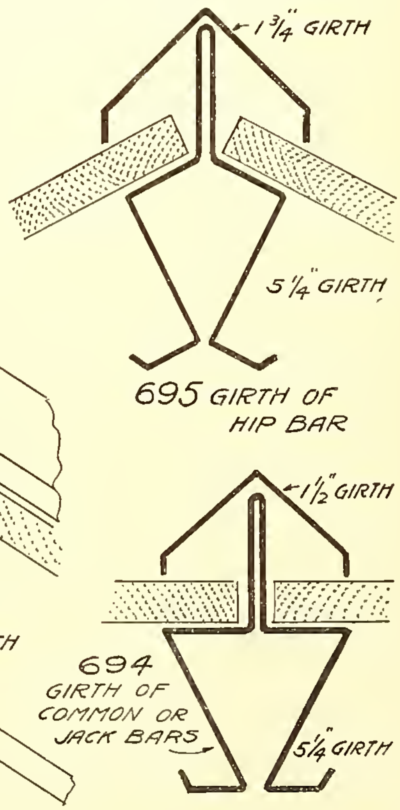


Fig. 694.—Obtaining Girth of Common and Jack Bars
Fig. 695.—Obtaining Girth of Hip Bar

been taken up in Solution 155, relative to hipped skylight work. Should the pitch be other than one-third, Solution 156 may be referred to for the method of finding the factors.

The true length of the common bar is computed by the following method in consulting which refer also to Fig. 691. Always take the measurement of one-half of the narrow side of the frame and divide it by 2, thus, $\frac{81.25 \text{ in.}}{2} = 40.625$ in. 40.625 in. x 1.2 = 48.75 in., the length of the common bars. Using the same number, 40.625 in., multiply it by the hip bar factor, 1.56, and obtain 63.375 in. or 63⅜ in., the length of the hip bar.

As the distance between all lights is 16.25 in., multiply this length by 1.2, to find the true length of the first jack bar. Thus 16.25 in. x 1.2 = 19.5 in.

As the second jack bar, in Fig. 691, being equally spaced at 16.25 in., we double the length of the first jack 19½ in., which will give the true length of 39 in., all as shown in plan. If it be desired, the second jack bar may be computed by doubling the sum of the spaces as, 2 x 16¼ in = 32½ in. then multiplying this result by 1.2, obtaining, as before, 39 in.

Fig. 694 presents the full size section of the common and jack bars, whose girth, including the cap, measures 6¾ in. The true length of the common bar being 48¾ in., as indicated in Fig. 691, we have 48.75 in. x 6.75 in. = 329 sq. in., in each bar. Therefore the ten bars are computed thus: 10 x 329 sq. in. = 3,290 sq. in. This figure divided by 144, gives 23 sq. ft.

The amount of material in the jack bars is obtained thus: The length of bar, 19.5 in. x 6.75 in. = 131.625 sq. in., x 8 bars = 1,053 sq. in. In like manner the long jack bar is figured. 39 in. x 6.75 in. = 263.25 sq. in. x 8 bars = 2,106 sq. in. 2,106 sq. in. + 1.053 sq. in. = $\frac{3{,}159 \text{ sq. in.}}{144} = 22$ sq. ft. The length of hip bar is 63.375 in. x 7 in. girth, for the bar and cap, shown in Fig. 695, giving 443.625 sq. in. x 4 bars = 1774.5 sq. in. $\frac{1774.5 \text{ sq. in.}}{144} = 12\frac{1}{2}$ sq. ft.

The total quantity, in square feet, if copper is used in the hipped skylight, Fig. 691, can now be added, as follows:

Curb	22.25 sq. ft.
Ridge	5. " "
10 Common bars	23. " "
16 Jack bars	22. " "
4 Hip bars	12.5 " "
Total	84.75 " "

Thus the total of copper required, at 16 oz. per square foot, is 84¾ lbs.

To this quantity must be added approximately 2 lbs. of copper clips for securing caps; about 150 copper rivets to rivet bars to ridge and curb; about 2 lbs. of solder; and about 18 1¼ in. brass wood screws to secure skylight curb to frame.

The glass and putty are figured as explained in connection with the flat skylight. The width of each of the panes of glass in Fig. 691 is 16¼ in., for which 16 in. panes are to be installed. The required quantity of wired glass may be computed accurately as follows: The width of panes is 16 in. The length of the common bars is 48¾ in. and that of the jack bars 19½ in. and 39 in., as indicated on the plan. Deduct for expansion ¼ in. from the length of the common bar, and consider the two irregular lights marked X and X as full panes; then will 14 rectangular lights, each 48½ in. x 16 in., be required. 16 in. x 48.5 in. = 776 sq. in. 776 in. x 14 in. = 10,864 sq. in. Eight irregular lights 16 in. wide, 39 in. on one side and 19.5 in. on the other side, will be required. The rule to follow, in finding this area, is to take one-half the sum of the sides and multiply it by the width, thus: $\frac{39 \times 19.5}{2} = \frac{58.5}{2} = 29.25$; 29.25 x 16 = 468; 468 x 8 = 3,744 sq. in. The eight triangular lights have an area of $\frac{19.5 \times 16}{2} = 156$; 156 x 8 = 1,248 sq. in.

The quantity of glass may now be summed up, as follows:

14 Rectangular lights	=	10,864 sq. in.
8 Irregular lights	=	3,744 " "
8 Triangular lights	=	1,248 " "
		15,856 " "

$\frac{15{,}856}{144} = 110$ sq. ft. (of ¼ in. thick wired glass).

Figuring four linear ft. of putty to the pound, we have 40 ft. for curb, 14 ft. for ridge bar, 80 ft. for common bars, 40 ft. for hip bars, 80 ft. for jack bars; total, 254 ft. $\frac{254}{4}$ = 64 lbs. of white lead putty.

In this way are obtained quantities for hipped skylights; to these must be added expense of time and labor, which differ in various districts. It is advisable to preserve all estimating blanks as they supply valuable information, which can be utilized when skylights of similar size are figured; from them a schedule can also be made.

Skylights to contain stationary or movable louvres and glazed-side sashes or ridge ventilators, involve also the foregoing methods for finding quantities.

FINDING TRUE LENGTHS OF HIPS, VALLEYS AND RIDGES ON GABLE AND HIPPED ROOF

Solution 208

In Fig. 696 is given a perspective view of a gable and hipped roof, showing clearly the hips, valleys

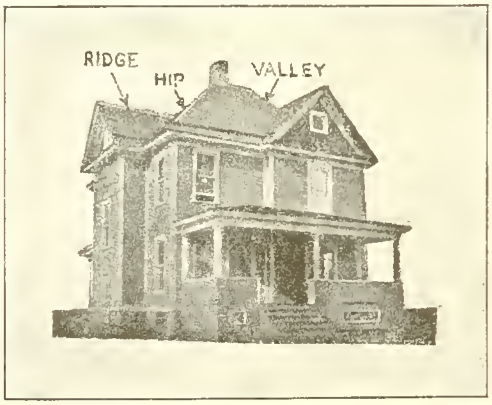


Fig. 696.—View of Dwelling

and ridges. We will take up the method of finding true lengths direct from the architect's plans. Referring to Fig. 697 a roof plan and the four elevations are shown, comprising the various views of the building, shown in Fig. 696. Fig. 697 comprehends the roof plan showing the hips, ridges and valleys. In their proper positions are shown the front, rear, left side and right side views, although in practice the front elevation and roof plan serve requirements in finding the various true lengths, as shall be made clear.

Finding True Lengths of Hips

The vertical hight A in the front view, represents the hight of the hip; place this at right angles to one of the hip lines in plan, as *a o*, as shown by *o b*. A line drawn from *a* to *b* gives the true length of the hip, of which there are three, indicated by 1, 2 and 3. Another hip is indicated by 5, the true length of which is found by taking the vertical hight, marked C in the front view, and placing it at right angles to *e r* in plan, as shown from *r* to *f*. *e f* gives the true length of the hip, shown by *e r* in plan.

Finding True Lengths of Valleys

The lines, marked 3°, 4 and 6 in plan, represent valleys. As 3° and 4 are alike the true length of both will be the same. It is obtained by taking the vertical hight, B in the front view, and placing it at right angles to *d t* in plan, as shown from *t* to *c*. A line drawn from *c* to *d* shows the true length of the valley, two of which will be required. The true length of the valley, marked 6, is obtained in like manner. Take the vertical hight, D in the front view, and set it off at right angles to *i r* in plan, as indicated from *r* to *h*. A line drawn from *h* to *i* is the desired true length.

True Ridge Lengths

The true ridge lengths are found to be shown on the plan where they are indicated by the distances *u t*, *o e* and *r s*. The foregoing procedure is employed in finding the true length of any valley or hip. As the plan is drawn to correspond with the illustration in Fig. 696, comparison of the several views in Fig. 697 with Fig. 696 will make the various operations clear.

Estimating Sheet Metal Quantities in Building Construction

In the three examples to follow, the procedure for estimating sheet metal quantities from architect's scale drawings will be outlined.

Fig. 698 is a photograph of a house taken as a subject for treatment. Architects' plans are, as already mentioned, usually drawn to a scale of one-quarter inch to the foot and from these the quantities must be measured with a scale rule. The drawings here presented are reproductions of architect's plans and should be carefully followed in the course of the discussion.

Specifications

A flat seam tin roof is to be laid over the porch, also on the steep part of the roofs at the foot

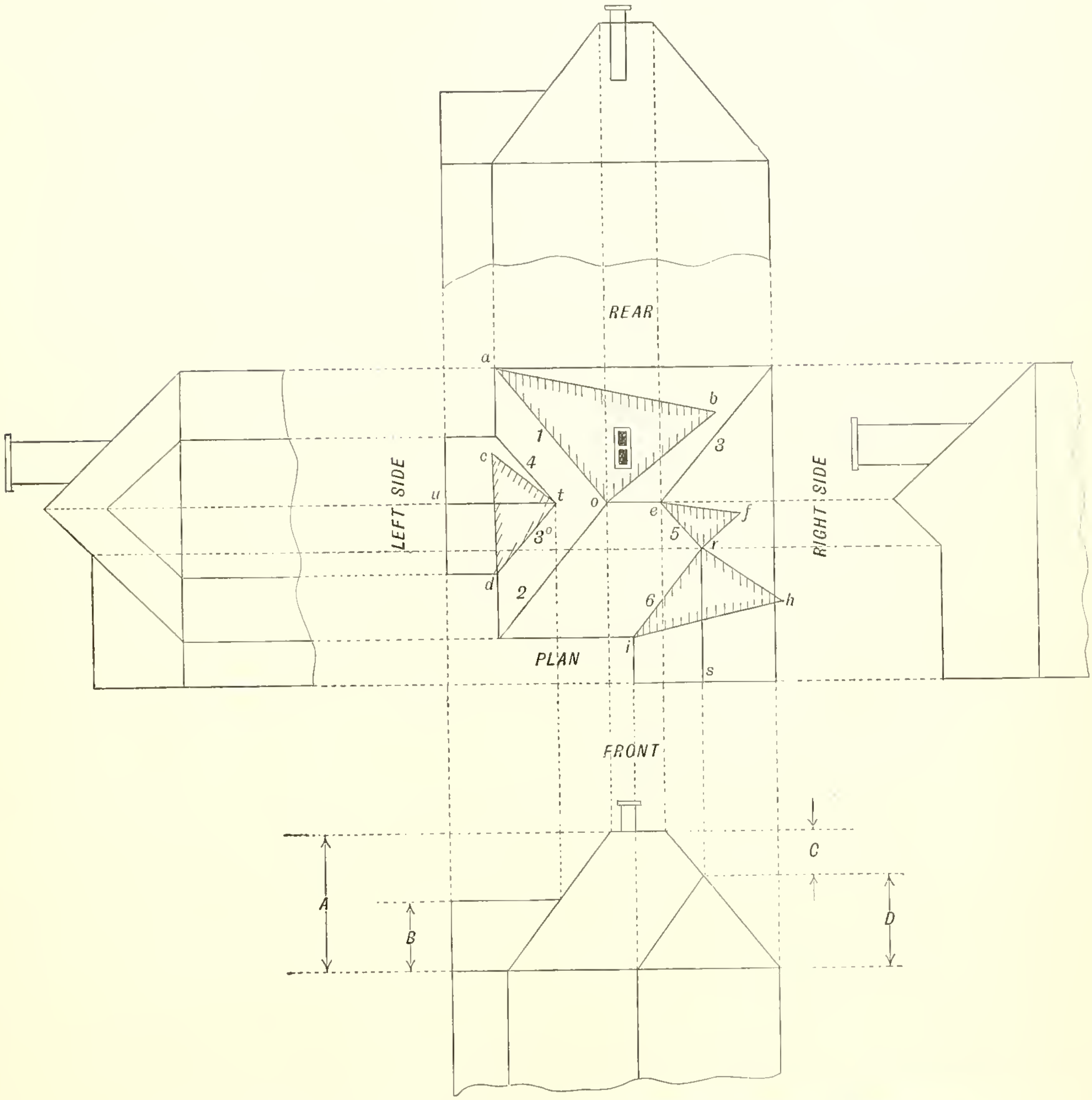


Fig. 697.—Finding the True Lengths of Hips, Valleys and Ridges on a Gable and Hipped Roof

of the gables over main roof, shown in the front and right side elevations. The steep roofs over the main building to be covered with standing seam tin roofing. The tin roof over the porch to be fitted with a box-lined tin gutter, the pitched roof over the main building to have a galvanized iron eave gutter. All leaders to be of galvanized iron and have shoes at the base, or be connected to the pipes leading to the sewer or cesspool. All galvanized iron work to be of No. 24 gauge; all tin work to be of 40 lb. coating, laid with cleats; all cleats and other tin and galvanized iron work to be nailed with

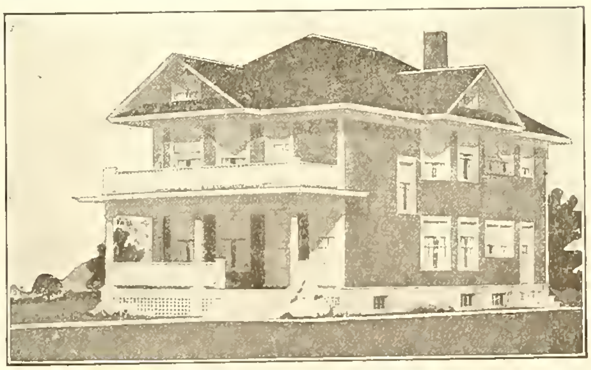


Fig. 698.—View of Dwelling

tinned roofing nails. All tin work to flash up under all siding not less than 6 in.; flashings around brick chimney to turn up not less than 12 in. Wood columns supporting balustrade on porch roof to be flashed not less than 6 in. high and tin from the gutter lining turned down over the top member of the wooden cornice not less than one inch, and nailed along this edge with tinned roofing nails. Under all tin roofing put one-ply rosin sized paper, paint all tin roofing one coat on the underside before laying and two coats on the top. All galvanized iron work to be painted one coat before erection and a second coat after erection. All paint to be of metallic brown, ground in linseed oil. Gutter hangers, straps and leader fasteners to be galvanized.

ESTIMATING QUANTITIES OF FLAT SEAM ROOFING

Solution 209

We will first consider the flat seam tin roofing on the porch roof, the front elevation of which is shown in Fig. 699, and of which a plan view is found in Fig. 700. The length of the roof to the inner edges of the box gutter is 27 ft., as is indicated, and its width from the inner edge of the gutter to the building line is 9 ft. No deduction need be made for the bay window B, since extra materials are used at the returns at D and C, as well as for flashing up around the balustrade columns, *a*, *b* and *c*. As the flashing under the siding is to turn up 6 in., add this amount to the 9 ft. width, obtaining 9 ft. 6 in. Thus we have 9.5 ft. x 27 ft. = 256.5 sq. ft. The same quantity of one-ply rosin sized paper will be required.

Referring to Fig. 701, which shows the detail of the porch roof gutter, note that the girth of the gutter lining scales 1 ft. 3 in. and that the total lengths of the gutters required, as found in Fig. 700, will be 2.5 ft. + 12 ft. + 28 ft. + 12 ft. + 2.5 ft. = 57 ft. Thus we have 57 ft. × 1.25 ft. = 71.25 sq. ft. of gutter lining.

As flat seam roofing is required at the foot of the gables, shown in Fig. 699 and Fig. 702, measure this quantity as follows: Referring to the extreme right of the front elevation in Fig. 699, the pitch of the lower wash of the gable scales 2 ft. 6 in., which plus 6 in. allowance for turning up under the siding, makes a total of 3 ft. girth. Find the average distance of this wash, that is, bisect the distance between the eaves line and top intersection with the siding; it scales 15 ft., as shown to the extreme edges of the gable molds, which allows for the flashings to turn up at the ends of the wash under the molds. Thus 3 ft. × 15 ft. = 45 sq. ft. for the front gable wash. As there is a corresponding gable of like dimensions on the right side elevation, Fig. 702, we have 2 × 45 sq. ft. = 90 sq. ft., calling, of course, also for 90 sq. ft. of rosin sized paper.

The total of flat seam tin roofing required will be as follows:

Porch Roof,	256.50	sq. ft.
Porch Gutter,	71.25	" "
Two Gable Washes,	90.	" "
Total,	417.75	" "

or 418 sq. ft. of tin roofing, with the same amount of one-ply rosin sized paper, the tin to receive one coat of paint on the under side and two coats on the upper side.

Assuming that the roof is to be laid with 14 in. x 20 in. sheets edged 3/8 in., each sheet will have an exposed surface of 12 7/8 in. × 18 7/8 in., or 243 1/64 sq. in. 418 sq. ft. contain 60,192 sq. in., each sheet containing 243 1/64 sq. in., therefore 60,192 ÷ 243 1/64 results in 248 sheets of tin of 14 × 20 in. size, the quantity required. Refer to Tables on page 335.

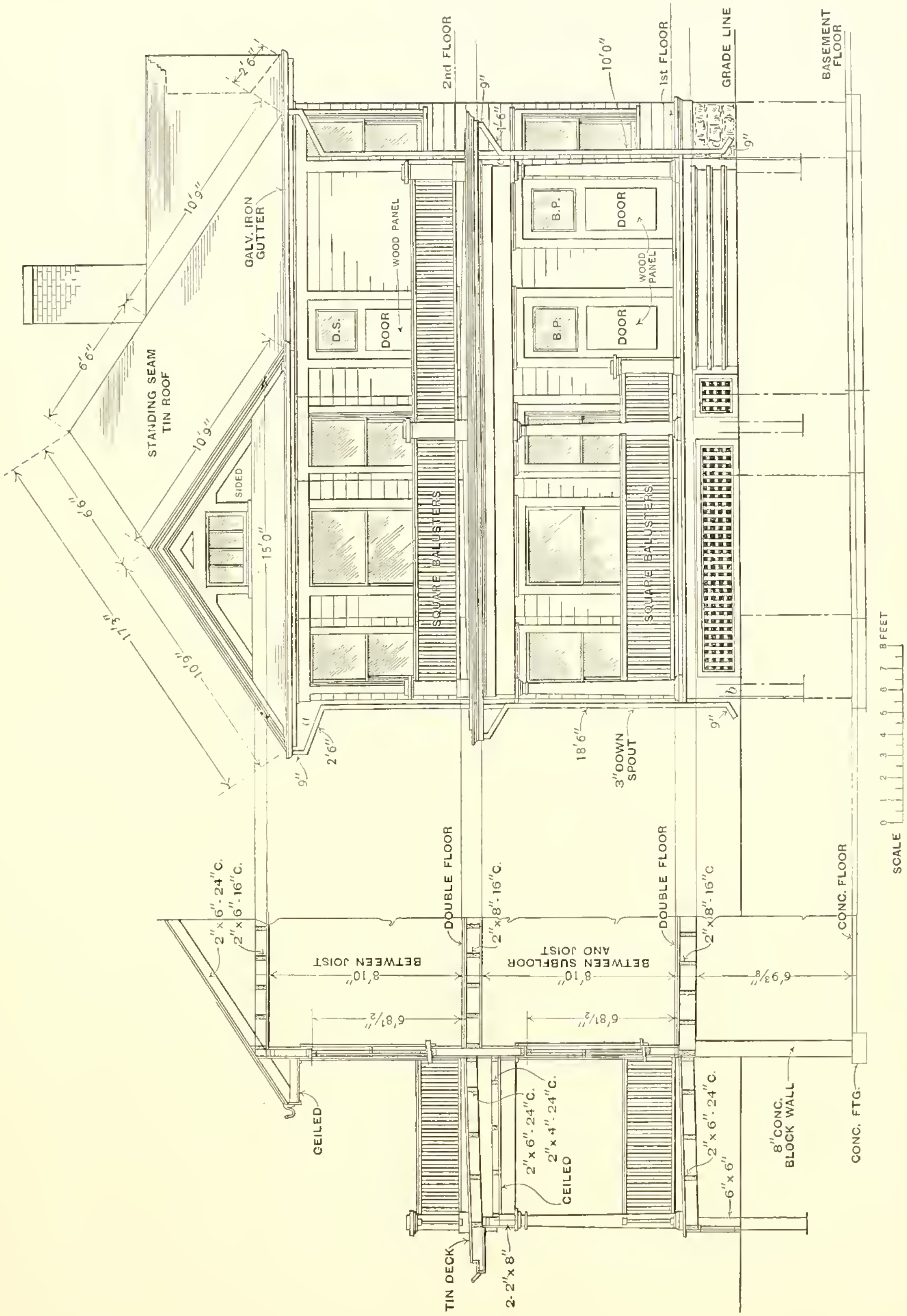
ESTIMATING QUANTITIES OF STANDING SEAM ROOFING

Solution 210

To obtain the quantities of standing seam for the steep roofs, refer to Fig. 699, the front elevation of the pitched roof, Fig. 702 the right side elevation, Fig. 703 the rear elevation and Fig. 704 the left side elevation. Fig. 705 is the roof plan, showing the hips, valleys and ridges of the main roof.

In estimating the quantities for this pitched roof, it is necessary to consult only the four elevations. In fact, an experienced estimator might dispense with the roof plan and obtain all quantities from these elevations. For the benefit of the less experienced, the roof plan is presented, to make clear the procedure of computing all surfaces.

In estimating irregular surfaces of pitched or hipped roofs, the various parts of the roof are divided into irregular geometrical figures; this procedure permits the area of the surfaces to be ascertained easily. Note that the roof plan is divided into various geometrical figures, marked A, A^1, A^2, indicating that the three surfaces with similar let-



Front Elevation

Fig. 699.—Typical Section

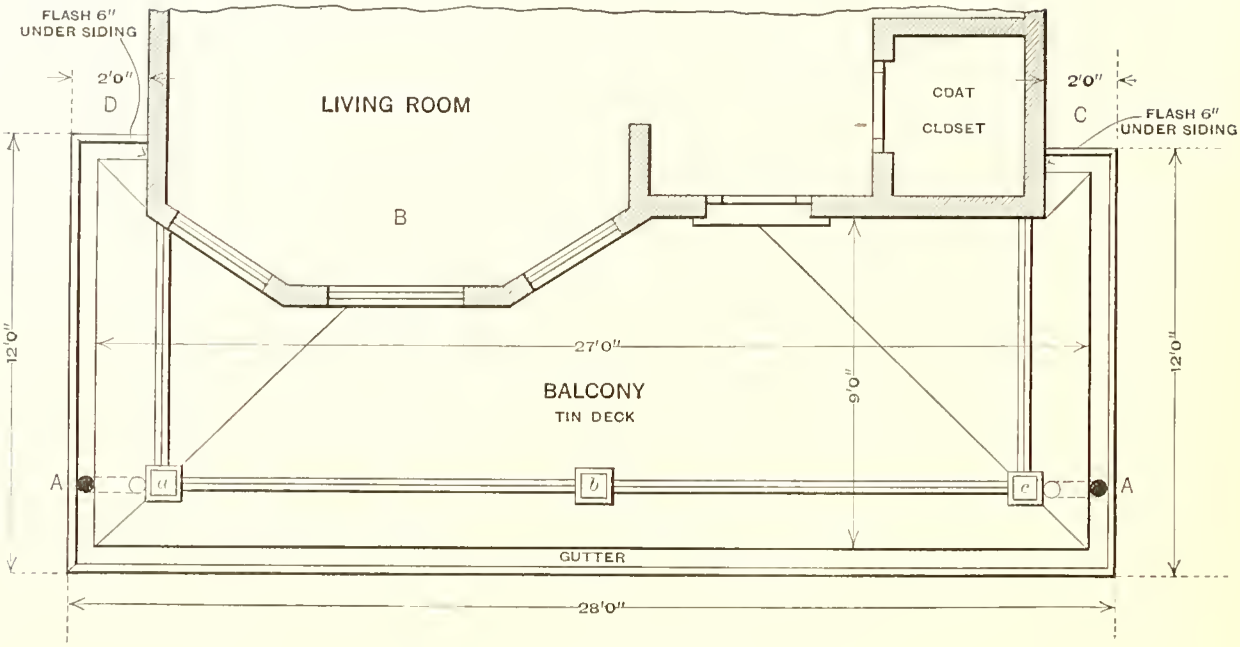


Fig. 700.—Part of Second Story Plan

ters have like dimensions. We have also B and B¹, C and C¹, D and D¹, E, F, G, H, and J.

The first quantity measured will be that for the surface marked A. Bisect the distance between the ridge line *a* and the eave line *b* and obtain *c*, through which draw a line parallel to the ridge line *a f*, thus obtaining *d c*, which scales 7 ft. The length of the rafter of this surface A is indicated in the front elevation in Fig. 699 by the scaled measurement of 10 ft. 9 in. Thus, 10.75 ft. $\times$ 7 ft $=$ 75.25 sq. ft. As the roof surfaces A, A¹ and A² in Fig. 705 have like dimensions, 3 $\times$ 75.25 sq. ft. $=$ 225.75 sq. ft., the total area of the three surfaces.

To obtain the area of the surface of B, draw a line from the intersection of the valley and ridge at *f* parallel to the eave line, as indicated by *f g*. As *f g* is of length equal to that of the eave line, that is, 10 ft. 6 in., and as *f g* B forms a triangle, we compute one-half of *f g* as 5 ft. 3 in., or the distance from *h* to *i*. The length of the rafter from the line *f g* to the apex B is indicated in the right side elevation in Fig. 702 shown by the scaled dimension of 6 ft. 6 in. Thus, 6.5 ft. $\times$ 5.25 ft. $=$ 34.125 sq. ft. As the roof surface *t j* B¹, in the roof plan in Fig. 705 is of corresponding dimensions to the surface B, 2 $\times$ 34.125 sq. ft. $=$ 68.25 sq. ft., the total area of the two surfaces.

The horizontal distance of the surface C is 10 ft. 6 in. both at the eave line and along *f g*. The length of the rafter through C is indicated in Fig. 702 by

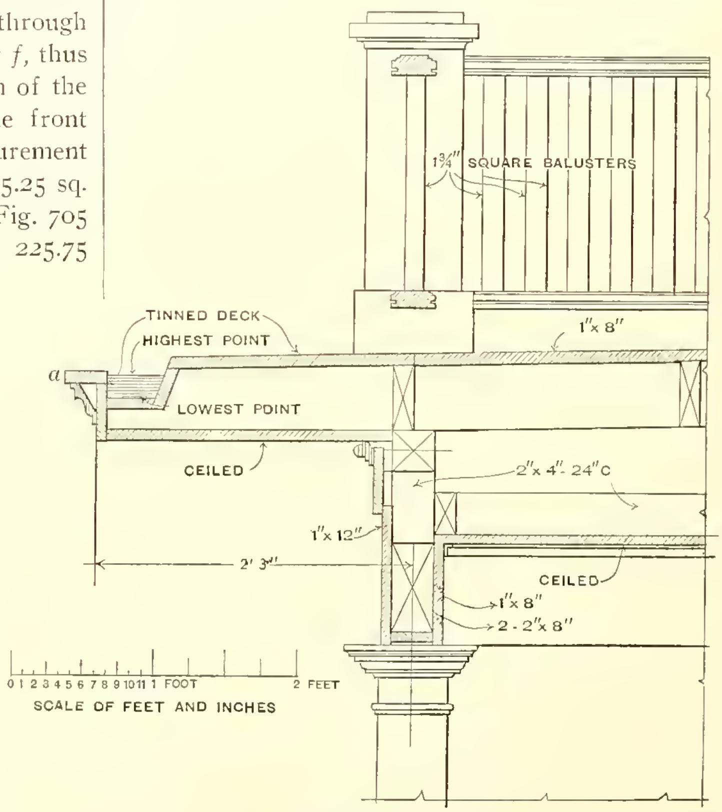


Fig. 701.—Detail of Porch Roof Gutter

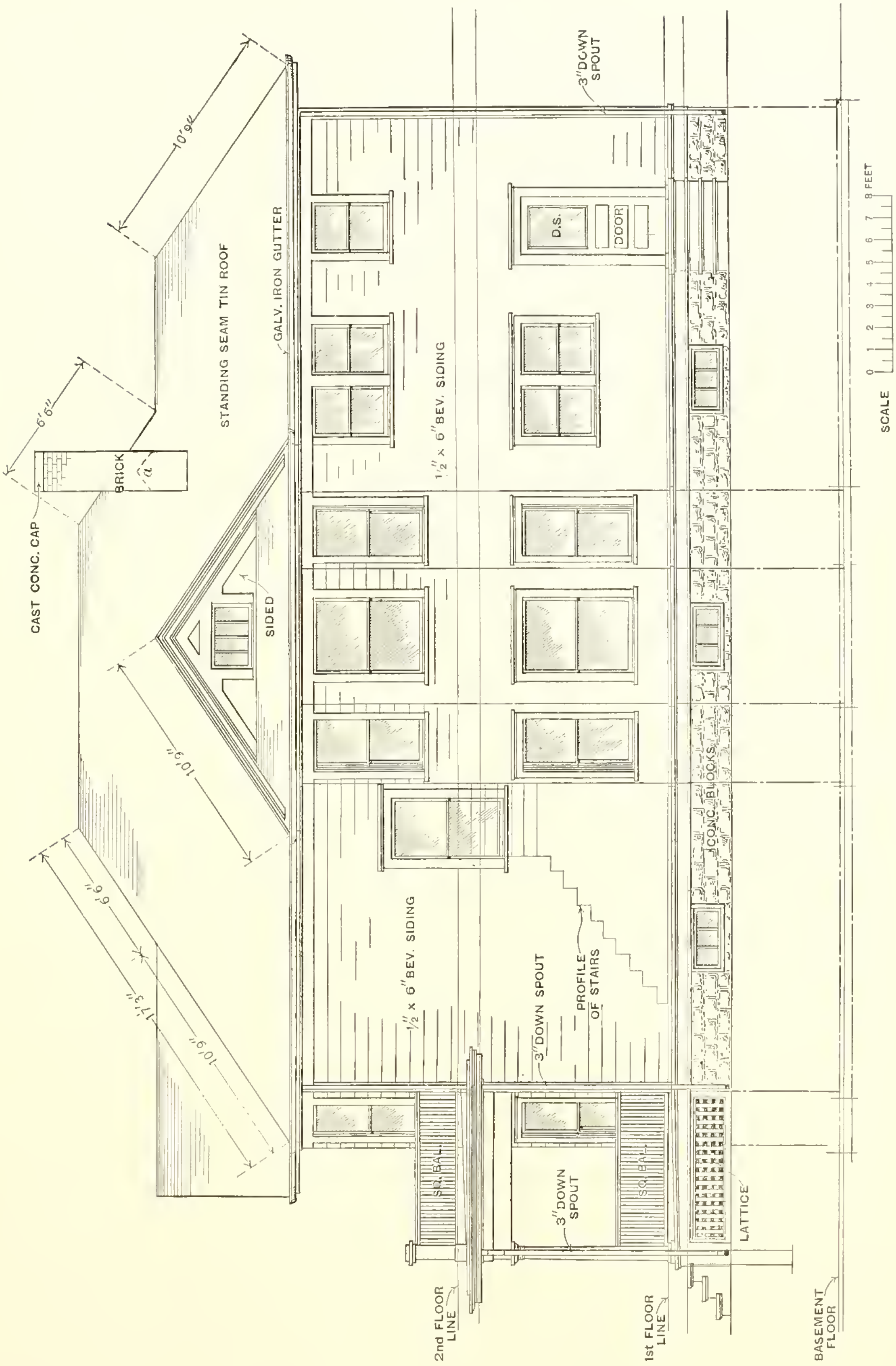


Fig. 702.—Right Side Elevation

the scaled dimension of 10 ft. 9 in. 10.75 ft. × 10.5 ft. = 112.875 sq. ft. As the roof surface C^1 in Fig. 705 is of dimensions corresponding to C, we have, 2 × 112.875 sq. ft. = 225.750 sq. ft., the total area of the two surfaces. If the reader finds difficulty in following the roof plan and elevations, a helpful practice is to place the plan in the center of the table and lay the various elevations around it, to correspond to the "front," "right side," "rear" and "left side."

scales 6 ft. 6 in. Thus, 6.5 ft. × 19 ft. = 123.5 sq. ft. As the surface *f t* B^1 B in Fig. 705 is of like dimensions to D, then 2 × 123.5 sq. ft. = 247 sq. ft., the total area of these two surfaces.

The area of the surface E is next to be obtained. The length *g n* is equal to the length of the eave line at the bottom, that is, 13 ft. 9 in. The length of the rafter between the line *g n* and the eave line is indicated in the front elevation in Fig. 699, which scales 10 ft. 9 in., as shown. Thus, 10.75 ft. ×

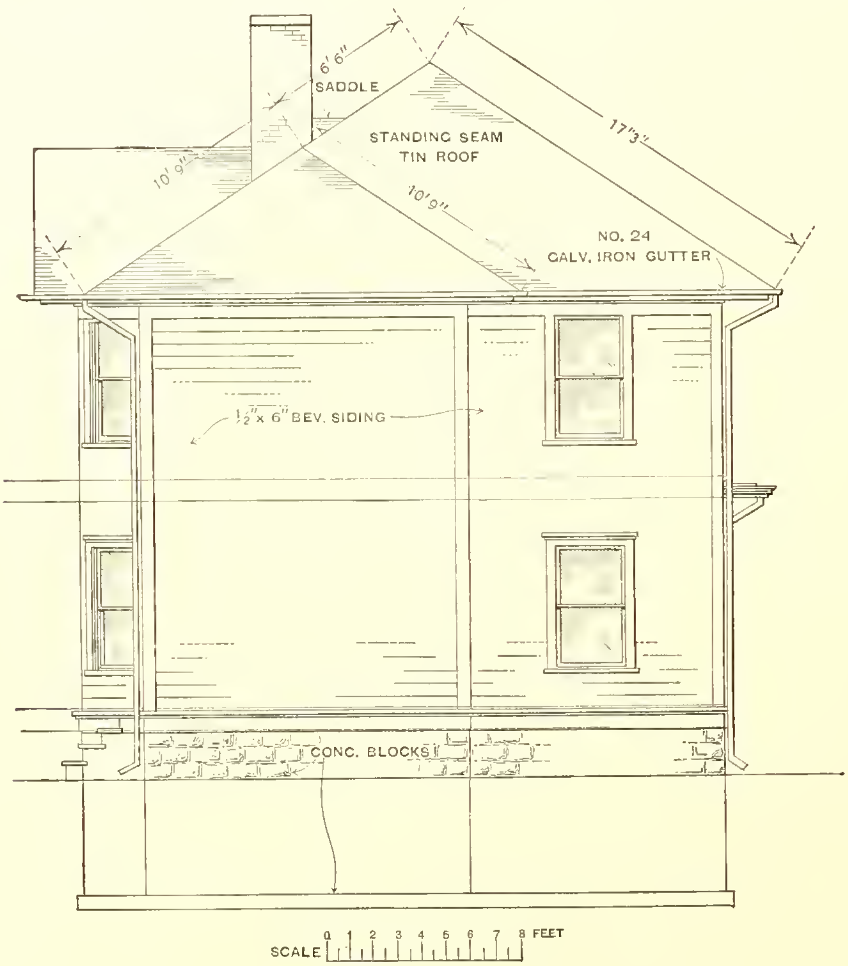


Fig. 703.—Rear Elevation

To obtain the area of the surface of D in roof plan in Fig. 705, extend the ridge line *o j* intersecting the two valley intersections at *n* and meeting the intersection at the hip line at *g*. At right angles to the ridge line B B^1 draw the line *k l*, meeting the line *j g* at *l*. Bisect *k l*, thus obtaining *x*. Through *x* draw a line, parallel to *j g*, meeting the hip lines at *i* and *m*, which scales 19 ft. The length of the rafter on *k l* is found in either the front elevation in Fig. 699 or the rear elevation in Fig. 703, which

13.75 ft. = 147.8125 sq. ft. of surface for outline E.

The length of *o n* of the surface F in the roof plan in Fig. 705 is equal to the lower eave line, or 17 ft. 9 in. The length of the rafter between the eave line and the line *o n* is indicated in the rear elevation in Fig. 703 by the scaled dimension of 10 ft. 9 in. Thus, 10.75 ft. × 17.75 ft. = 190.8125 sq. ft., the total area.

The area of the surface G in Fig. 705 is computed as follows: The length of the extreme front edge of the gutter scales 19 ft., and as the gutter is to be 5 in. wide, deduct 2 × 5 in., or 10 in., from 19 ft., obtaining 18 ft. 2 in. The roof surface G is of triangular shape, and the distance through *r s*, the center of the triangle, will be one-half of 18 ft. 2 in., or 9 ft. 1 in. The length of the rafter from the eave line to the apex at *o* is shown in the right side elevation in Fig. 702 and scales 10 ft. 9 in., as shown. Thus 9 ft. × 10.75 ft. = 96.75 sq. ft., the total area of G.

The roof surface H in Fig. 705, next to be considered. Its ridge line *o j* is of the same length as the eave line, that is, 7 ft. The length of the rafter of the surface H is indicated in the rear elevation in Fig. 703 and scales 10 ft. 9 in. Thus 7 ft. × 10.75 ft. = 75.25 sq. ft. of surface.

The last surface to be computed is shown by J in the roof plan in Fig. 705. In this case extend the ridge line *a f* until it meets the intersection *t* at the hip. At right angles to *t a* draw the line *a′ b′*; bisect this line and obtain the point *u*, through which draw a line parallel to the eave line, cutting the gable line at *v* and the hip line at *w*. This distance *v w* scales 40 ft. 6 in. The run of the rafter between the eave line and the line *t f* is indicated in the front elevation in Fig. 699 and scales 10 ft. 9 in. Thus 10.75 ft. × 40.5 ft. = 435.375 sq. ft. of surface.

This completes the task of finding the areas of all the surfaces of the main roof. No allowance has been made for the brick chimney in Fig. 705, as the quantity of tin roofing cut out at the chimney will be used in the flashings and saddle, as shown.

The total amount of standing seam roofing may then be summed up, as follows, referring to the roof plan in Fig. 705:

Areas of	A, A¹ and A²	= 225.75	sq. ft.
" "	B and B¹	= 68.25	" "
" "	C and C¹	= 225.75	" "
" "	D and D¹	= 247.	" "
Area "	E	= 147.8125	" "
" "	F	= 190.8125	" "
" "	G	= 96.75	" "
" "	H	= 75.25	" "
" "	J	= 435.375	" "
Total		1712.75	sq. ft.

Assuming that the cross seams are single locked, with edges ⅜ in. wide consuming 1⅛ in. of tin,

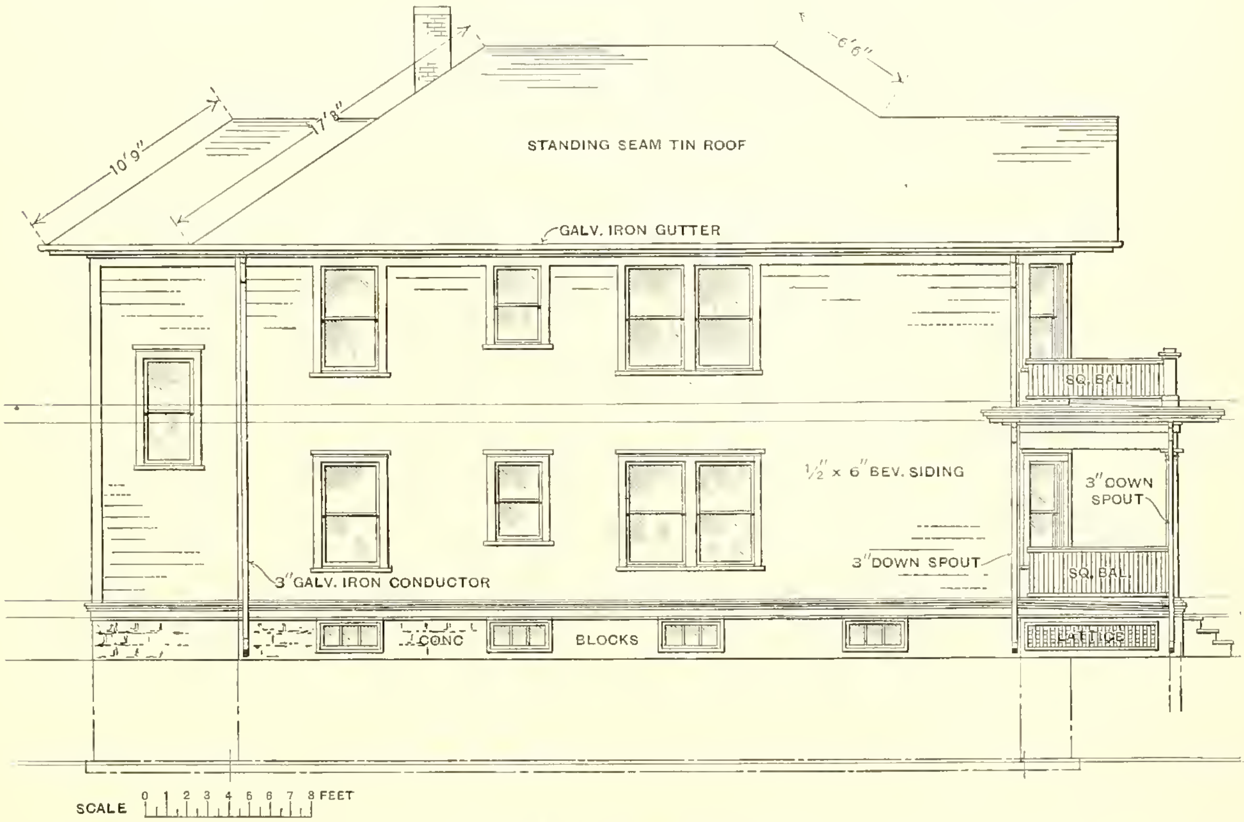


Fig. 704.—Left Side Elevation

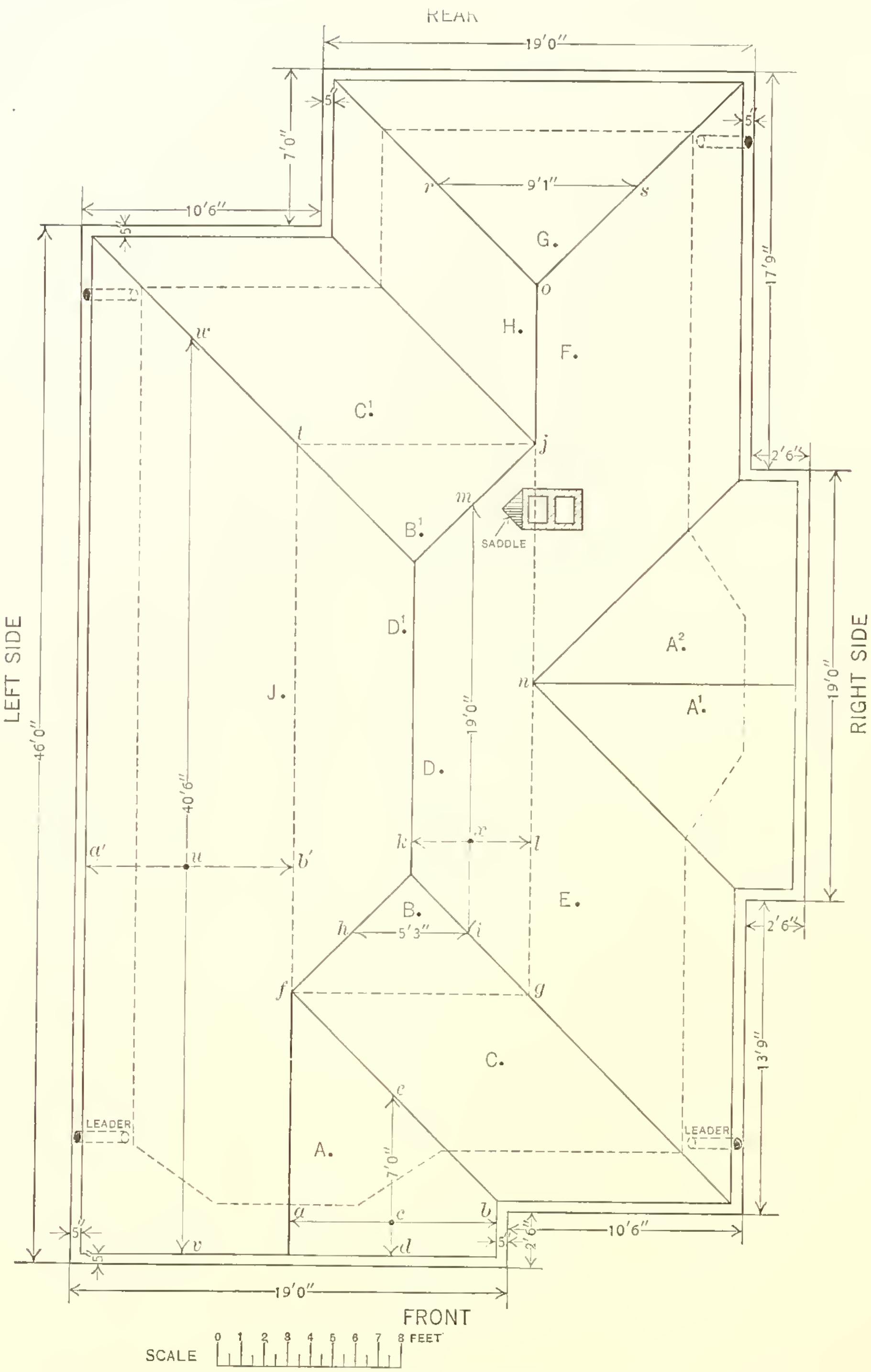


Fig. 705.—Roof Plan Showing Dimensions

each sheet of 14 in. × 20 in. tin will cover 212 3/32 sq. in., if edged 1¼ in. and 1½ in., giving a finished standing locked seam of 1 in.

The number of sheets of tin required for the main roof may now be ascertained, as follows: 1713 sq. ft. reduced to square inches will be 1713 × 144, or 246,672 sq. in. As each sheet covers 212 sq. in., we have 246,672 ÷ 212 = 1164 sheets of 14 in. × 20 in. tin; or 10 boxes and 44 sheets. There will also be required 1713 sq. ft. of one-ply rosin sized paper, as well as solder, cleats, nails, rosin, charcoal, etc. All tin roofing must be painted one coat underneath before laying, and two coats on top after laying.

COMPUTING QUANTITIES IN GUTTERS AND LEADERS

Solution 211

The girth of No. 24 galvanized iron gutters required at the eave of the pitched roofs is found by referring to the detail shown in Fig. 706, where the girth of the gutter less the roof flange X measures 12 in. The girth of any mold or gutter can be found by means of a small strip of cardboard or a small pair of dividers set apart one inch of the scale in use, and then stepping off divisions, counting them as the stepping proceeds; in this case we have 12 steps or inches. The gutter flange has not been added, for the reason that the tin roofing was measured down to the eave line. The number of linear feet of gutter required is found to be as scaled and indicated in Fig. 705, which presents the plan of the gutters and the leaders. Beginning at the front, we have 19 ft. + 2.5 ft. + 10.5 ft. + 13.75 ft. + 2.5 ft. + 19 ft. + 2.5 ft. + 17.75 ft. + 19 ft. + 7 ft. + 10.5 ft. + 46 ft. = 170 ft. of gutter. Since the gutter less the roof flange has a 12 in. girth, 170 sq. ft. of No. 24 galvanized iron will be required. The square foot of No. 24 galvanized iron weighs one pound; therefore the total of 170 square feet is 170 lbs. In the detail in Fig. 706, a note is made that the gutter hangers and straps are to be placed 24 in. apart. We have 170 ft. of gutter, thus 170 ÷ 2 = 85, the number of hangers and of straps, all of galvanized malleable iron, that will be required.

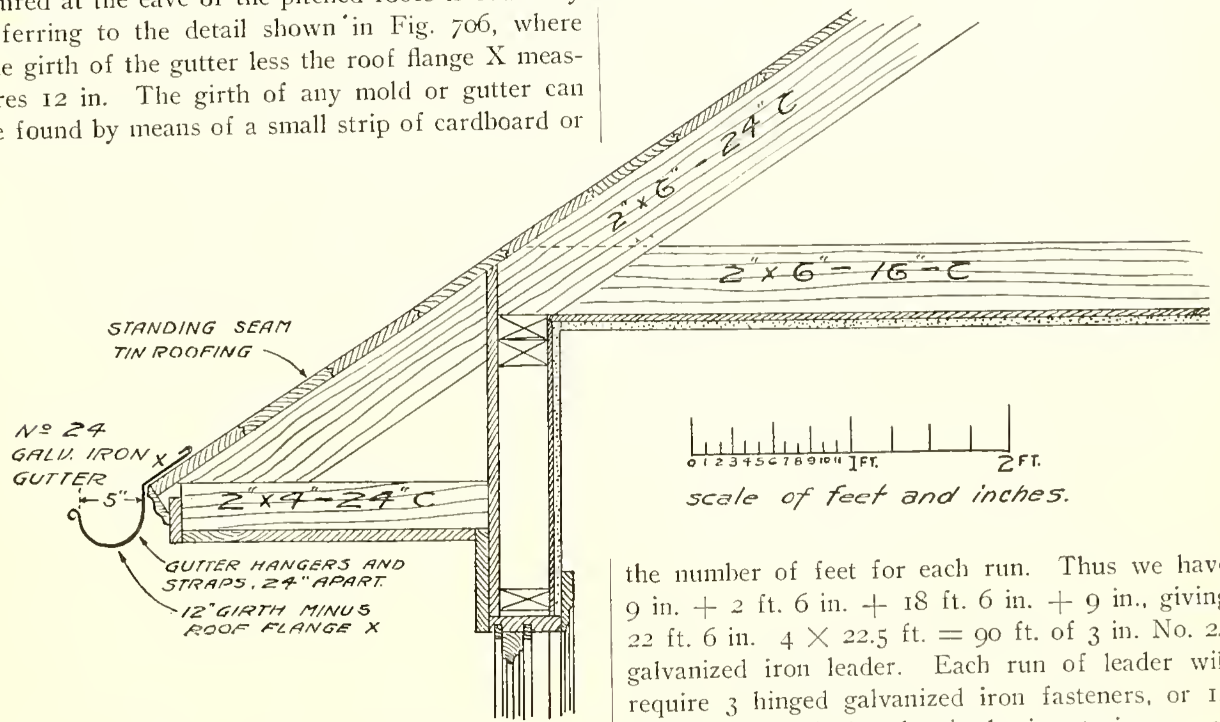


Fig. 706.—Detail of Main Roof Gutter

Referring to the roof plan in Fig. 705, it will be seen that four leaders will be required; as they are all of equal length, the length of one can be multiplied by 4 to obtain the quantity total. The scaled measurements shown in Fig. 699, on the left, give the number of feet for each run. Thus we have 9 in. + 2 ft. 6 in. + 18 ft. 6 in. + 9 in., giving 22 ft. 6 in. 4 × 22.5 ft. = 90 ft. of 3 in. No. 24 galvanized iron leader. Each run of leader will require 3 hinged galvanized iron fasteners, or 12 in all. Four 3-inch galvanized wire strainers over all outlets, as well as four leader tubes, will be required. Galvanized iron leaders are required for the porch roof, as shown in the scaled front elevation in Fig. 699; their full-size dimensions are marked at the right, as follows: 9 in. + 1 ft. 6 in. + 10 ft. + 9 in. = 13 ft. of 3-inch No. 24 galvanized iron leader. As there are two runs of leader from the porch roof, as indicated by A and A in Fig. 700, then 2 × 13 ft. = 26 ft. of leader required for that area. Each run of leader will require two 3-inch hinged galvanized iron leader hooks, or four hooks in all for the porch roofs, with two 3-inch galvanized wire baskets or strainers over leader outlets. Two galvanized iron leader tubes will also be needed.

This completes the total quantities of materials used, except that, as above mentioned, 6 lbs. of half-and-half solder should be figured for each square (10 ft. × 10 ft.) of flat seam roofing. To this estimate of materials must be added the costs for cartage and labor, allowance for profit and overhead expenses, all to be figured, of course, according to the rates and conditions prevailing in the part of the country where the work is executed.

ESTIMATING FURNACE HEATING MATERIALS

Solution 212

In this final example is outlined the method of figuring the quantity of materials utilized for furnace heating. The structure accommodates two families. The method for calculating the exposures, the sizes of the furnaces, diameters of basement leaders, sizes of rectangular risers, register boxes, etc., are omitted, these sizes usually being indicated on the plans.

The plans presented herewith are reproduced from architect's drawings; they are the floor plans of the building shown in Fig. 698

Specifications

Each floor or family will have six rooms and a bath, heated by a separate furnace, as shown in the basement plan in Fig. 708. On this basement plan the locations of the furnaces are indicated, as are the runs and sizes of leader pipes and risers, also the sizes of the cold air pipes, which re-circulate the cold air from the rooms above. On the first and second story plans, shown in Fig. 709 and 710, respectively, are given the dimensions of the various registers and cold air faces. In this house the return system is employed, provision being made for galvanized iron ducts and pipes, which take the cold air off the floors and leads it down to the furnace and up again into the rooms above, air leakage from the doors and windows being depended on for change of air. The furnaces, Fig. 708, are to be equipped with double galvanized iron casings of No. 22 galvanized iron, with pitched bonnets and an inverted cone top. The leaders, elbows, collars, boots, etc., are to be of No. 24 galvanized iron, covered with asbestos air cell covering, to prevent loss of heat. The risers are to be made of IX. bright charcoal tin, also covered with asbestos air cell covering. Register boxes are to be of the same material as the pipe with which they connect, and of proper size, as indicated on the various plans, shown in Figs. 708, 709 and 710. All registers are to be of the sizes indicated on the plans, to be finished in white enamel, those connecting with the heat pipes to be equipped with movable valves and those connecting with the cold air returns to have open faces. Dampers are to be placed in all smoke, heat and cold air pipes and each pipe be distinctly marked, showing to which room it is connected, as shown in Fig. 707.

Fig. 707.—Label to Each Furnace Pipe, as Called for in Specifications

Assuming that the sizes shown on the plans have been correctly calculated, the various quantities can be scaled from the architect's drawings, as follows:

Computing the Quantities

Referring to Fig. 708, take off the various items, beginning with the furnaces, one furnace being supplied to heat each floor. The plan indicates that the furnaces are to have a 40 in. double casing. The furnace for the first floor, which is shown in the vertical section in Fig. 711, will require two cold air shoes, with round collars, size 12 in. and 18 in., respectively, for inside air connections from the hall and dining room, as shown in Fig. 709. The bonnet of the first story furnace, shown in Fig. 711, will also require four collars, one 8 in. and three 12 in., for hot air connections. Four feet of 8-in. No. 22 galvanized iron smoke pipe will be required, as scaled from the sectional view, and two four-pieced 45 degree elbows of 8 in. diameter, with one 8-in. malleable iron damper.

The furnace heating the second floor, shown in plan in Fig. 708, will require three cold air shoes with round collars of 12 in. diameter for inside cold air connections from the hall, living and dining rooms, shown in the second story plan in Fig. 710. For hot air connections five collars will be required in the bonnet of the second story furnace, shown in the basement plan in Fig. 708, four of 12 in. diameter and one of 8 in. diameter. Fourteen feet of 8-in. smoke pipe will be required, with two four-pieced 45 degree adjustable elbows, of 8 in. diameter, including one 8-in. malleable iron damper.

The total quantities of material required for the two furnaces, with their connections to the brick chimneys, may be summed up as follows:

Two furnaces with 40 in. double casings of No. 22 galvanized iron.

One cold air shoe with 18-in. round collar of No. 24 galvanized iron.

Four cold air shoes with 12-in. round collar of No. 24 galvanized iron.

Seven collars in bonnets of 12 in. diameter, 6 in. long, of No. 24 galvanized iron.

Two collars in bonnets of 8 in. diameter, 6 in. long, of No. 24 galvanized iron.

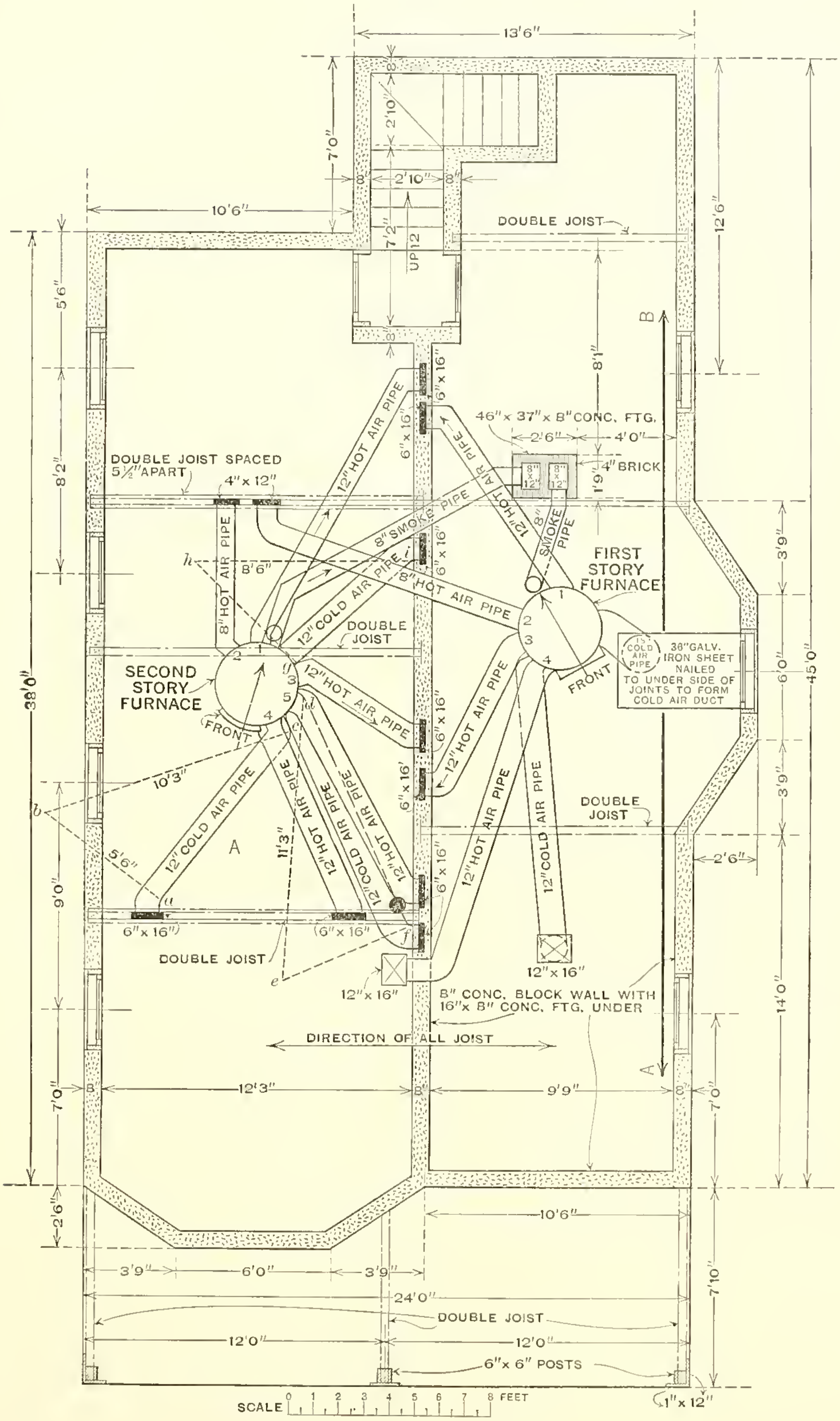


Fig. 708.—Basement Plan

Eighteen feet of 8-in. smoke pipe of No. 22 galvanized iron.

Four four-pieced 45 degree adjustable elbows of 8 in. diameter of No. 22 galvanized iron.

Two 8-in. malleable iron dampers.

The next item for consideration is the quantities required of cold air pipes and fittings. Two cold air returns run from the first story, as is indicated in Fig. 709. Again referring to the section in Fig. 711, we scale the various cold air pipes, as follows:

Six feet of 18-in. round pipe of No. 24 galvanized iron.

Ten feet of 12-in. round pipe of No. 24 galvanized iron.

Two 12-in. four-pieced 45 degree elbows of No. 24 galvanized iron.

One cold air face box 12¼ in. × 16¼ in. × 12 in. deep, No. 24 galvanized iron.

One cold air face box 16¼ in. × 30¼ in. × 12 in. deep, No. 24 galvanized iron.

One cold air duct under dining room (see Fig. 708) 36 in. × 60 in. × 12 in. deep, No. 24 galvanized iron, with one 12-in. round collar, 6 in. long.

Lining 4 beams (see *e*, *f*, *g* and *h* in Fig. 711) 2 in. × 8 in. × 60 in. deep, of No. 24 galvanized iron.

One cold air face 12 in. × 16 in. with border, white enameled. See Fig. 709.

One cold air face 16 in. × 30 in. with border, white enameled. See Fig. 709.

One 12-in. malleable iron damper.

One 18-in. malleable iron damper.

Starting with the second story plan in Fig. 710, we find that cold air faces are placed in the living room, hall and dining room, and beginning here with our scale rule we obtain the following quantities.

Three cold air faces with borders, 12 in. × 16 in., white enameled.

Three cold air face boxes, 12¼ in. × 16¼ in., of IX bright tin.

Three 90-degree elbows, with circular heels, to connect with 6 in. × 16 in. risers, of IX bright tin.

Six ft. 6 in. of 6 in × 16 in. horizontal pipe, of IX bright tin, under floor of dining room and hall.

The hight of the first floor being 9 ft., from ceiling line to floor line (see Fig. 711), the three risers of cold air pipes will measure 3 × 9 ft. or 27 ft. of 6 in. × 16 in. IX bright tin pipe.

Where these three cold air returns connect with the 12 in. round pipe in basement, Fig. 708, 3 transition boots will be required, to be placed between the beams of the basement ceiling, forming a transition from a 6 in. × 16 in. rectangle to a 12-in. round pipe of No. 24 galvanized iron, the transitions to be 12 in. high. The true lengths of the 12-in. diameter cold air returns, from the transition at the ceiling line to the bottom of the cold air furnace boot, is obtained as follows:

The hight of the basement ceiling in Fig. 711 is 7 ft.; from this deduct the hight of the cold air shoe and elbow of the cold air return, as well as the hight of the elbow below the transition piece at the ceiling line; this leaves 5 ft. 6 in. net. Place this hight in Fig. 708, at right angles to the cold air pipe A, from *a* to *b*, when the distance of the slant line drawn from *b* to *c* will scale 10 ft. 3 in., the true length of the slant.

Proceed likewise with the other two cold air pipes, where the true length of *d* to *e* and *h* to *i* will scale 11 ft. 3 in. and 8 ft. 6 in. respectively. The three lengths will make a total of 30 ft. of 12-inch round cold air pipe of No. 24 galvanized iron. For each run of pipe two elbows will be required, or a total of 6 three-pieced 45 degree adjustable 12-inch round elbows of No. 24 galvanized iron.

Three 12-inch malleable iron dampers complete the items for the cold air pipes from the second story.

In scaling the lengths of the hot air pipes in basement, they can be measured direct from this plan, as the pitch is so slight as to make but little variation from the horizontal. We will take up all hot air pipes and fittings leading to the first story, starting from the collars in the furnace bonnet.

Two 45 degree three-pieced adjustable elbows 8-inch round No. 24 galvanized iron.

Seven 45 degree three-pieced adjustable elbows 12-inch round No. 24 galvanized iron.

Twenty-six ft. 6 in. of 12-inch round hot air pipe of No. 24 galvanized iron.

Eleven ft. of 8-inch round hot air pipe of No. 24 galvanized iron.

Two transition boots from 6 in. × 16 in. risers to 12-inch round pipe, 12 in. high of No. 24 galvanized iron.

One transition boot from 4 in. × 12 in. riser to 8-inch round pipe, 12 in. high of No. 24 galvanized iron.

As the bottom of the registers set 12 inches above the first floor line, Fig. 711, and as there are two 6 in. × 16 in. risers to the first floor and one 4 in. × 12 in. riser, we will require 2 ft. of 6 in. × 16 in. riser made of IX bright tin. One ft. of 4 in. × 12 in. riser made of IX bright tin.

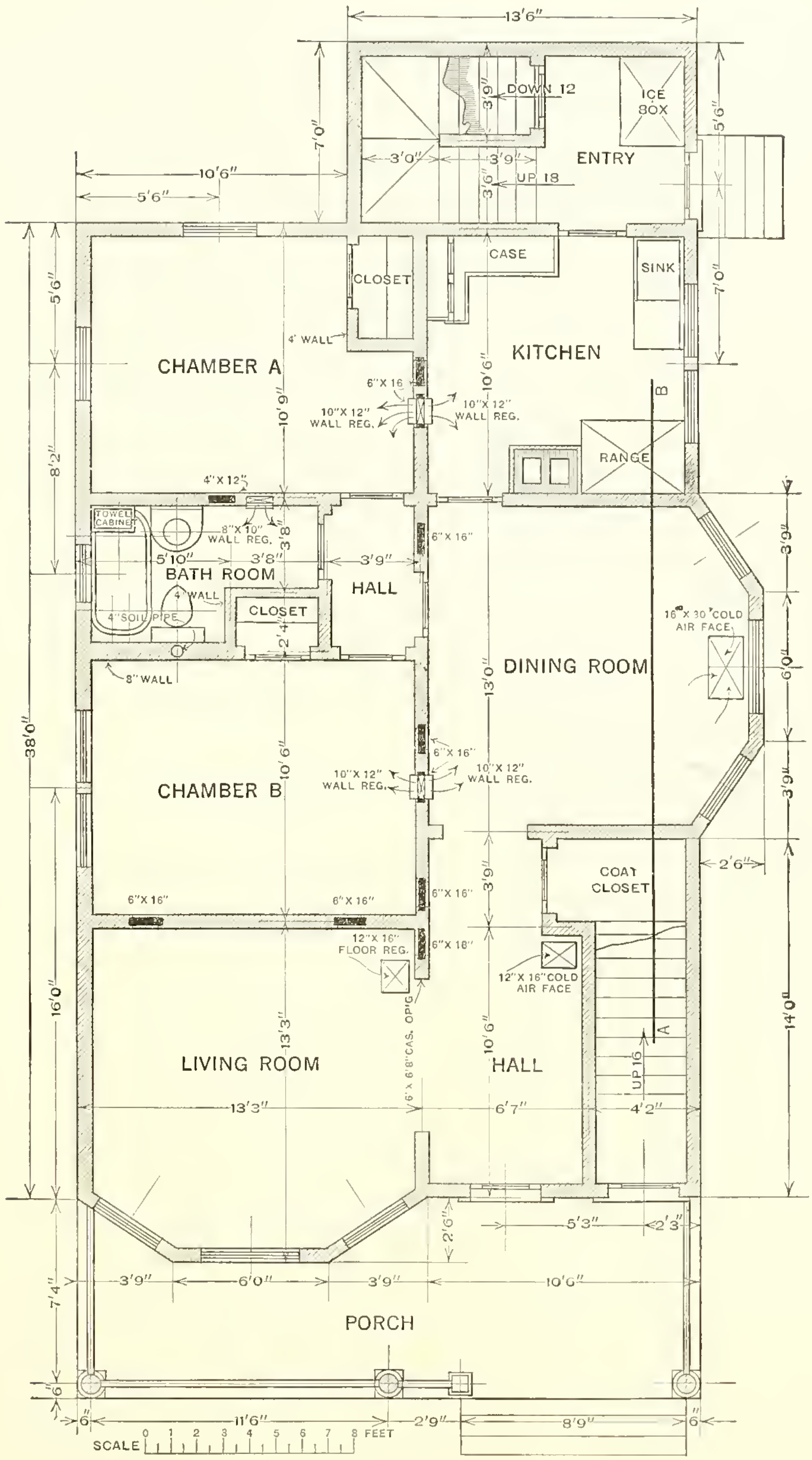


Fig. 709.—First Story Plan

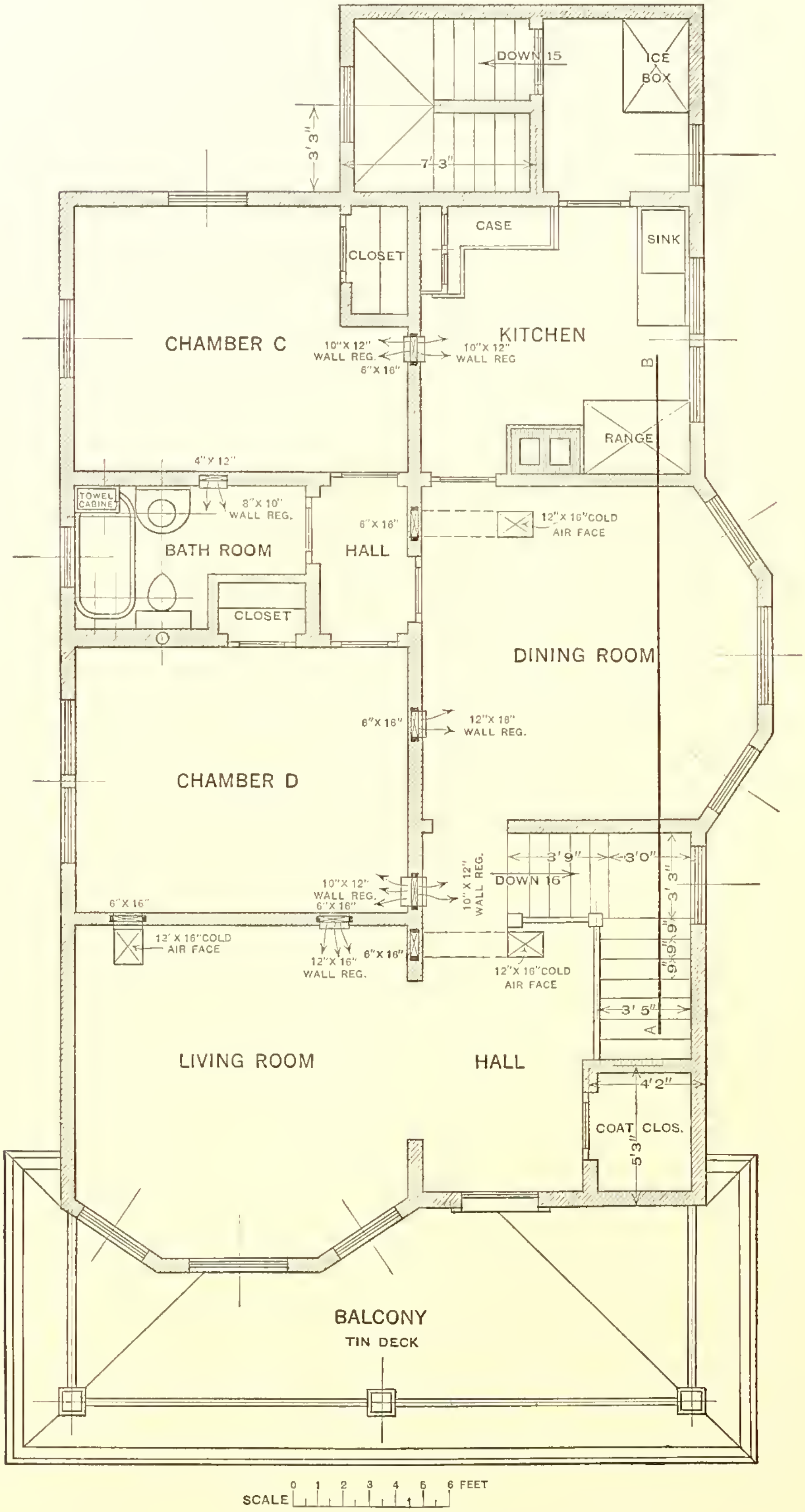


Fig. 710.—Second Story Plan

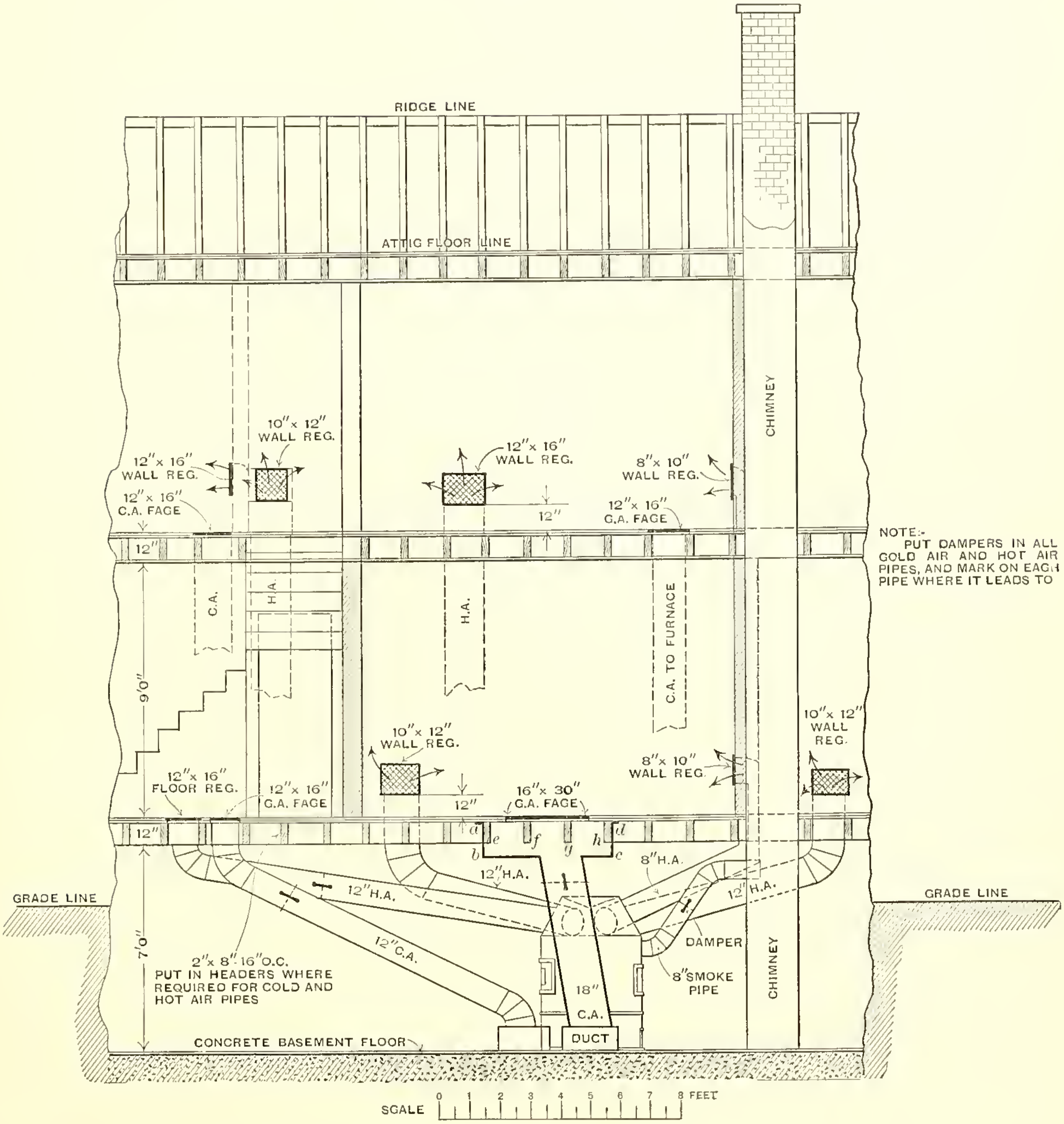


Fig. 711.—Vertical Section on the Lines A-B on all Plans, Shown in Figs. 708, 709 and 710

Referring to Fig. 709 we find requirement for:

One floor register box 12¼ in. × 16¼ in., with 12 in. round collar, the box to be 12 in. deep of IX bright tin.

One single top register box 8¼ in. × 10¼ in., for connection to 4 in. × 12 in. riser of IX bright tin.

Two double top register boxes 10¼ in. × 12¼ in., for connection to 6 in. × 16 in. riser, made of IX bright tin.

One floor register, with border and valves, 12 in. × 16 in., white enameled.

One wall register, with valves 8 in. × 10 in., white enameled.

Four wall registers, with valves 10 in. × 12 in., white enameled.

One 8-in. and three 12-in. dampers for hot air pipes from first story furnace in basement in Fig. 708. To get the greatest benefit from this explanation, the reader should follow each item given and check it off carefully on the accompanying plans.

The final items to be measured are for heating pipes to the second story. Here again the hot air pipes shown in the basement plan in Fig. 708 are scaled as if they lay horizontally, no account being taken of the slight pitch which these hot air pipes should have.

Again starting from the collars in the bonnet of the second-story furnace, shown in Fig. 708, we will require the following materials:

Two 45 degree three-pieced adjustable elbows, 8 in. round No. 24 galvanized iron.

Eight 45 degree three-pieced adjustable elbows, 12 in. round No. 24 galvanized iron.

On scaling the five runs of hot air pipes or leaders we have 5 ft. 6 in. of 8-in. round hot air pipe made of No. 24 galvanized iron.

Thirty-four ft. 9 in. of 12-in. round hot air pipe made of No. 24 galvanized iron.

One transition boot from 8-in. round pipe to 4 in. × 12 in. rectangular pipe, 12 in. high of No. 24 galvanized iron.

Four transition boots from 12-in. round pipe to 6 in. × 16 in. rectangular pipe, 12 in. high of No. 24 galvanized iron.

All of these transition boots run nearly flush with the first story and, referring to Fig. 711, it is found that the hight of the first story from floor to ceiling line is 9 ft.; from the ceiling line to the base of the register on the second floor is 2 ft., thus making a total of 11 ft. for each second-story riser.

The total quantities of risers for the second story may now be summed up as follows:

Referring to the basement plan, in Fig. 708, we find one 4 in. × 12 in. riser to the second story and four 6 in. × 16 in. risers. We will require, therefore, 11 ft. of 4 in. × 12 in. riser of IX bright tin and 44 ft. of 6 in. × 16 in. risers of IX bright tin.

Referring to Fig. 710, the second story plan, we find we will require one single top register box 8¼ in. × 10¼ in., for connection to 4 in. × 12 in. riser of IX bright tin.

Two single top register boxes, 12¼ in. × 16¼ in., for connection to 6 in. × 16 in. risers of IX bright tin.

Two double top register boxes 10¼ in. × 12¼ in., for connection to 6 in. × 16 in. risers of IX bright tin.

One wall register, with valves, 8 in. × 10 in., white enameled.

Two wall registers, with valves, 12 in. × 16 in. white enameled.

Four wall registers, with valves 10 in. × 12 in., white enameled.

One 8 in. and four 12 in. malleable iron dampers for hot air pipes leading to second story.

With the quantities determined, net prices must be made, to include, of course, the cost of the materials, expenses of cartage, labor, loss of time, allowance for profit and overhead expenses, all of which necessarily vary with localities and prevailing conditions.

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