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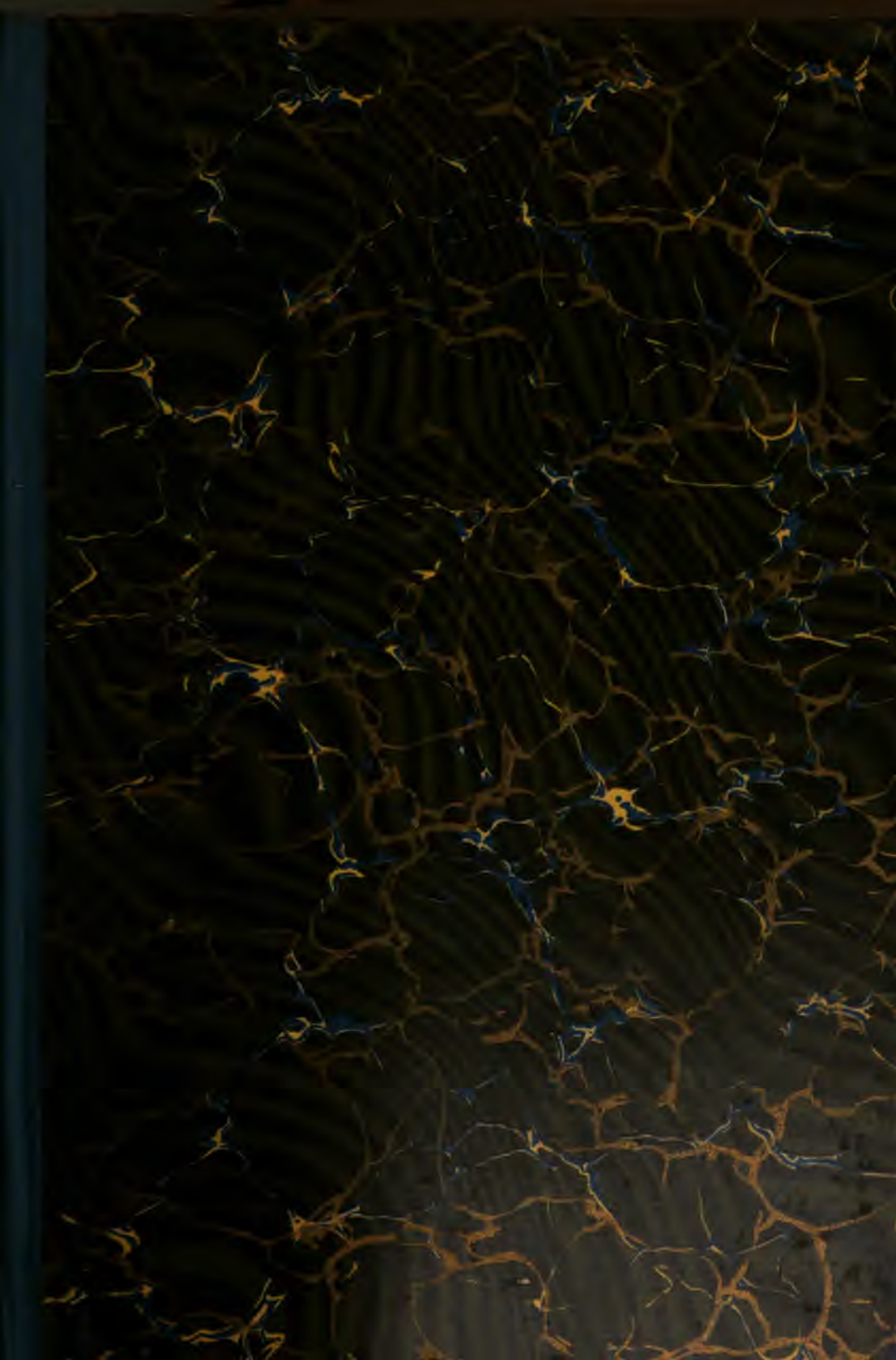
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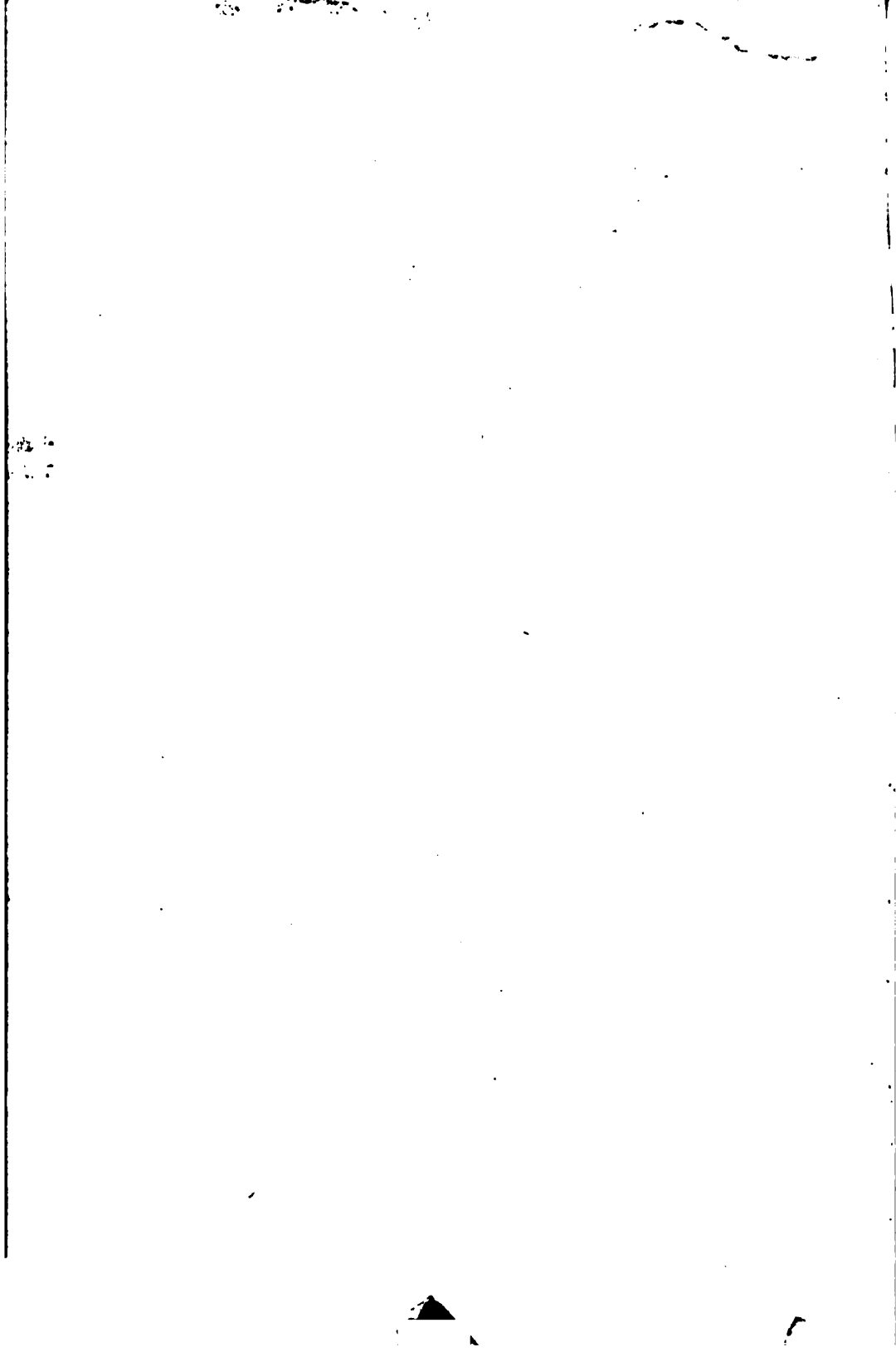
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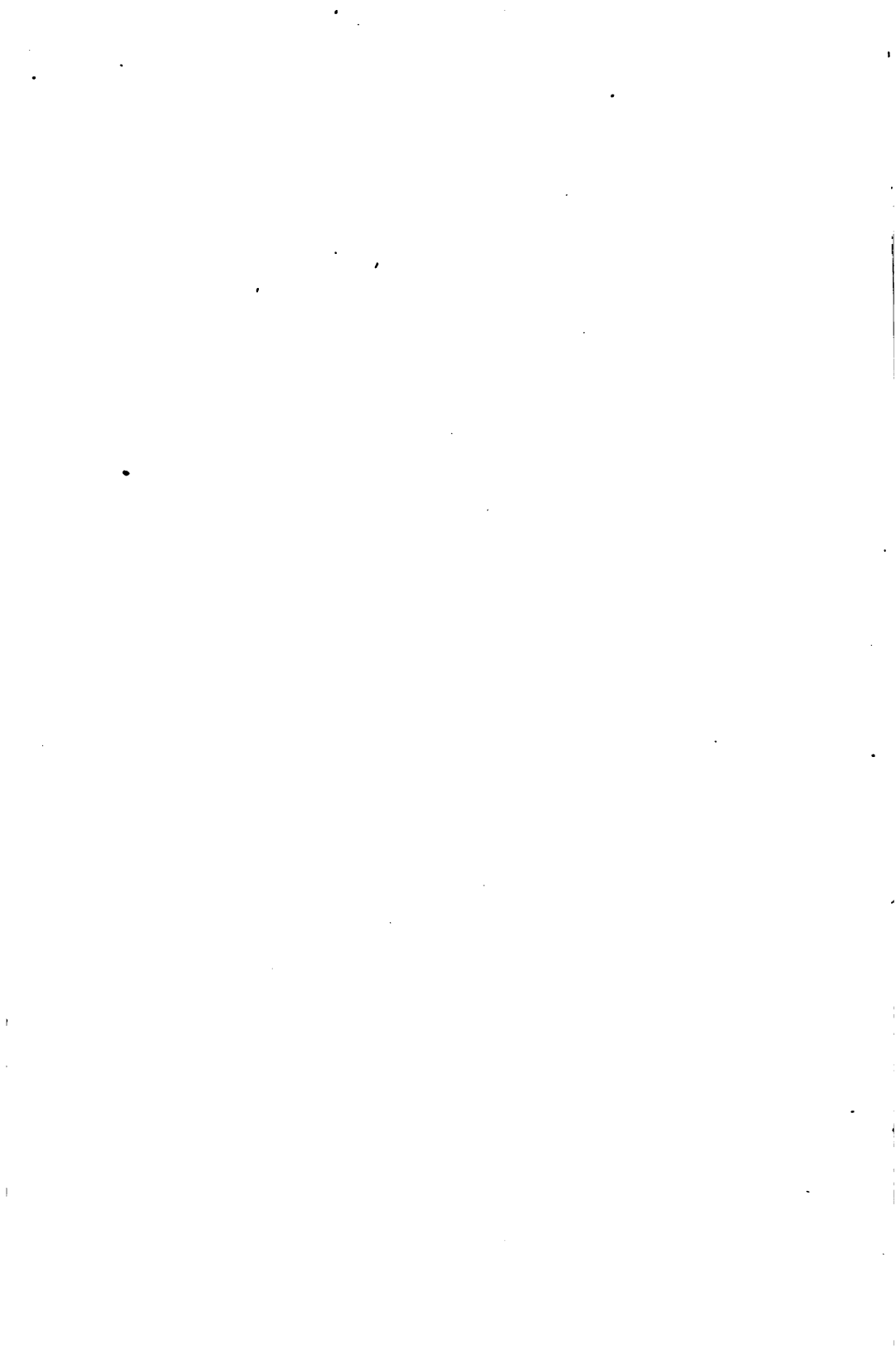


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PREFACE

The International Library of Technology is the outgrowth of a large and increasing demand that has arisen for the Reference Libraries of the International Correspondence Schools on the part of those who are not students of the Schools. As the volumes composing this Library are all printed from the same plates used in printing the Reference Libraries above mentioned, a few words are necessary regarding the scope and purpose of the instruction imparted to the students of—and the class of students taught by—these Schools, in order to afford a clear understanding of their salient and unique features.

The only requirement for admission to any of the courses offered by the International Correspondence Schools is that the applicant shall be able to read the English language and to write it sufficiently well to make his written answers to the questions asked him intelligible. Each course is complete in itself, and no textbooks are required other than those prepared by the Schools for the particular course selected. The students themselves are from every class, trade, and profession and from every country; they are, almost without exception, busily engaged in some vocation, and can spare but little time for study, and that usually outside of their regular working hours. The information desired is such as can be immediately applied in practice, so that the student may be enabled to exchange his present vocation for a more congenial one or to rise to a higher level in the one he now pursues. Furthermore, he

wishes to obtain a good working knowledge of the subjects treated in the shortest time and in the most direct manner possible.

In meeting these requirements, we have produced a set of books that in many respects, and particularly in the general plan followed, are absolutely unique. In the majority of subjects treated the knowledge of mathematics required is limited to the simplest principles of arithmetic and mensuration, and in no case is any greater knowledge of mathematics needed than the simplest elementary principles of algebra, geometry, and trigonometry, with a thorough, practical acquaintance with the use of the logarithmic table. To effect this result, derivations of rules and formulas are omitted, but thorough and complete instructions are given regarding how, when, and under what circumstances any particular rule, formula, or process should be applied; and whenever possible one or more examples, such as would be likely to arise in actual practice—together with their solutions—are given to illustrate and explain its application.

In preparing these textbooks, it has been our constant endeavor to view the matter from the student's standpoint, and to try and anticipate everything that would cause him trouble. The utmost pains have been taken to avoid and correct any and all ambiguous expressions—both those due to faulty rhetoric and those due to insufficiency of statement or explanation. As the best way to make a statement, explanation, or description clear is to give a picture or a diagram in connection with it, illustrations have been used almost without limit. The illustrations have in all cases been adapted to the requirements of the text, and projections and sections or outline, partially shaded, or full-shaded perspectives have been used, according to which will best produce the desired results. Half-tones have been used rather sparingly, except in those cases where the general effect is desired rather than the actual details.

It is obvious that books prepared along the lines mentioned must not only be clear and concise beyond anything

heretofore attempted, but they must also possess unequaled value for reference purposes. They not only give the maximum of information in a minimum space, but this information is so ingeniously arranged and correlated, and the indexes are so full and complete, that it can at once be made available to the reader. The numerous examples and explanatory remarks, together with the absence of long demonstrations and abstruse mathematical calculations, are of great assistance in helping one to select the proper formula, method, or process and in teaching him how and when it should be used.

This volume contains papers on the subjects of stair building, ornamental ironwork, roofing, sheet-metal work, building superintendence, and contracts and permits, and will be of service to the building contractor in making his estimates and in superintending his work; also, to the clerk of the works, or building superintendent. The stair builder, ornamental ironworker, house smith, roofer, cornice maker, etc., will find herein the details of work made and erected by other craftsmen, so that he can make proper allowance in fitting the same to his own. All the papers in this volume are treated from a thoroughly practical standpoint, and embody the conditions that are likely to arise in each trade in actual building operations.

The method of numbering the pages, cuts, articles, etc. is such that each subject or part, when the subject is divided into two or more parts, is complete in itself; hence, in order to make the index intelligible, it was necessary to give each subject or part a number. This number is placed at the top of each page, on the headline, opposite the page number; and to distinguish it from the page number it is preceded by the printer's section mark (§). Consequently, a reference such as § 37, page 26, will be readily found by looking along the inside edges of the headlines until § 37 is found, and then through § 37 until page 26 is found.

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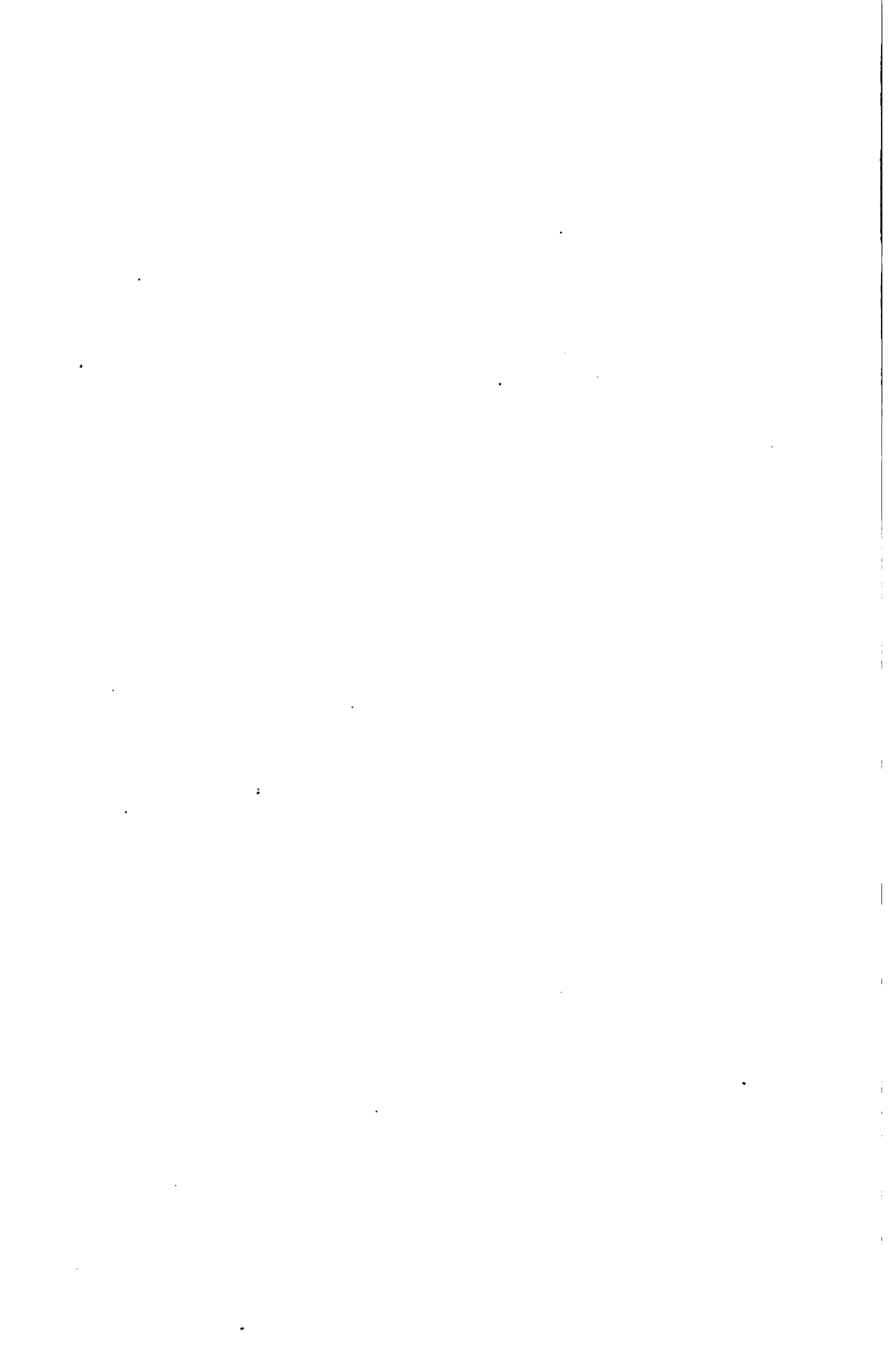
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STAIR BUILDING.

INTRODUCTION.

1. Stair building grew out of the necessity of securing an easy and safe passage from one level, or floor, to another. Such a passage might therefore be regarded in its inception as an inclined plane which connects two horizontal planes and provided with a series of equal risers, or steps, formed for the purpose of giving a sufficient footing to facilitate travel.

The construction of wooden stairways is considered the highest branch of joinery; more care and knowledge are required in their planning, more ingenuity in setting them out, and more skilful workmanship in their execution, than in any other work about a building.

The architect, in studying the plan and treatment of a stairway, should consider its adaptability for the building in which it is to be placed, its proposed situation, the weight likely to come upon it, the width to accommodate probable travel, and, especially, the ease of travel. It is not enough, as is sometimes done, to roughly calculate the treads and risers and sketch on the winders, leaving the stair builder to make the best he can of the conditions.

The first and most important consideration in designing stairways is their disposition for obtaining the utmost facility of access to the various stories to which they communicate. Care should be taken to secure proper headroom while ascending and descending, and the treads and risers should be arranged so as to secure easy travel. The proper width

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of the stairway has also much to do with its appearance; in a private house, it should never be less than 2 feet 8 inches wide, and in public buildings never less than 4 feet 6 inches. The staircase wherein the stairway is enclosed should be given special attention, and the correct length and width should be carefully considered. It is not conducive to sound construction to be obliged to cut out trimmer beams; neither is it good practice to have to piece out a few inches when the staircase has been framed too large.

The importance of proper arrangement of stairways is evident, when it is considered that they are seen by every one, their convenience and beauty being readily appreciated, and their faults and defects instantly detected.

STAIRWAY CONSTRUCTION.

MATERIALS USED.

2. The materials most commonly used in the construction of stairways are stone, iron, and wood; the selection of material should be based on the location and the use to be made of the stairway. If placed outside of a building, stone, owing to its natural capability of resisting atmospheric influences, should be used; while, if placed inside a building designed to be fireproof, iron is generally selected, as it possesses great resistance to heat. Both iron and stone are preferable to wood when used in public buildings, where the amount of travel requires extra strength; wood, however, is the material most commonly used, especially in private buildings, where no heavy travel is to be expected.

TERMS USED IN STAIR BUILDING.

3. In stair building, a **riser** and **tread** together are termed a step, the *riser* being the upright portion which supports the *tread*, or horizontal part, upon which the foot is placed. The **nosing** is the projection of the tread beyond the face of the riser.

The term **run** is applied to the aggregate width of the treads.

Where the risers are parallel to each other on plan, thus forming straight steps, the steps are called **flers**; but where the risers radiate on plan, the steps are called **winders**.

The term **flight** designates a succession of steps between one starting point and the one next above it. The spaces wider than steps, which constitute resting places between the flights, or which are the terminations of the stairways, are termed **landings**, or platforms. If the landing is square and occupies half the width of the stairway, it is called a **quarter-space** landing; but when it takes in the full width of the stairway, it is called a **half-space** landing. The space required for landings is sometimes filled in by winders; this is especially the case in geometrical stairways and those in which the run is limited. Usually, the required rise and run in the given space decide the nature of the landing, whether it is to be quarter or half space, or filled in with winders. Where the run is unlimited, a half-space landing should be adopted; but where the run does not allow this kind of landing, a quarter space is preferable to winders, as the latter should never be put in a stairway when they can be avoided.

When the lower step of a flight has its outer end in the form of a horizontal spiral, it is termed a **curtall** step. When the outer end of the lower step is rounded to a semi-circle, it is a **bull-nose** step. Where steps have an outward curve, they are called *swelled* steps; this form is generally used when the front stringer is curved out at the starting of the stairway.

If, in ascending a stairway, the hand rail is on the right-hand side, the stairway is called a **right-hand** stairway. If the hand rail is on the left-hand side, the stairway is called a **left-hand** stairway.

The above are some of the more common terms used in stair building; others will be explained as occasion arises for their use.

GENERAL CLASSIFICATION.

4. Stairways are known as dog leg, open newel, and geometrical. A **dog-leg** stairway has no well hole, and the face stringer of the upper flight is vertically over that of the lower one. A **well hole** is the vertical clear space between flights when the stringers are not located in the same vertical plane. The objection to dog-leg stairways is that the hand rail is not continuous, but strikes the soffit of the upper flight.

Where newels are placed at the angles of the well hole, the stairway is termed an **open-newel** stairway; but when the stringer is continued unobstructed by newels in a curve around the winders, the stringer is said to be **wreathed**, and the stairway is designated as **geometrical**.

5. The above classification relates more especially to the general design than to the structural details, many of which

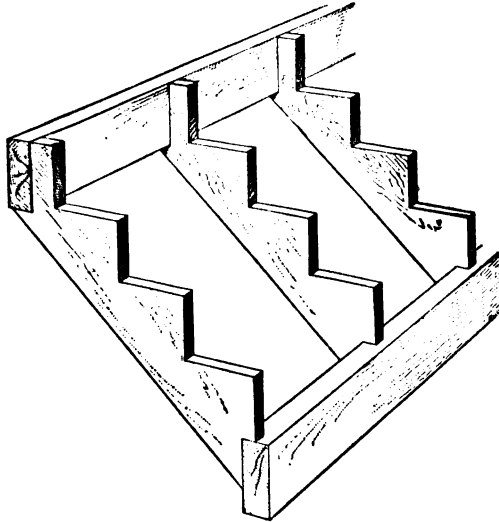


FIG. 1.

are common to each. When classified with relation to the methods of construction, there are two systems: the first consists in the use of rough timbers, or *carriages*, cut to the

angle of intersection between the treads and risers, as shown in Fig. 1; the other, which is the more generally used, has the treads and risers tongued, or *housed*, from $\frac{1}{4}$ to $\frac{3}{8}$ inch, into the grooved stringers. In the first case, the treads and risers are nailed on the carriages, and, where they intersect with the wall, a board of the same thickness as the baseboard connecting with the stairway is *scribed*, or cut, to the required outline so as to fit closely the angles of treads and risers; this runs the full length of the stairway, forming what is termed the **wall stringer**. In favor of this method of construction are its simplicity and strength. Against its adoption may be adduced the great difficulty of satisfactorily scribing the wall stringers, and even when this is successfully done, the stairway is likely, in time, through shrinkage and jarring, to show imperfections.

The **carriages**, also called **horses** and **springing trees**, for the second form of construction of stairways, are not cut

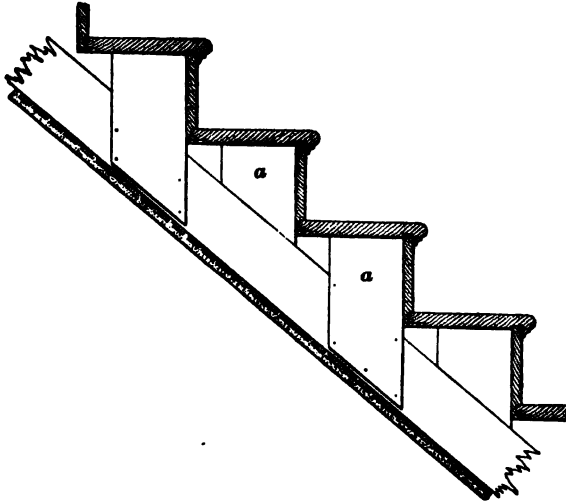


FIG. 2.

to the angle of treads and risers, as is the case in the first method, but are simply straight scantlings of sufficient

strength to support the stairway and its probable load, rough brackets being nailed on the sides of these scantlings and fitted tightly under each tread, as shown at *a*, Fig. 2. In some cases, where the treads and risers are enclosed in stringers, the wall stringer only is housed to receive the treads and risers, the front, or outer, stringer being cut square to receive the tread, and mitered to receive the riser. When thus prepared the front stringer is termed a **cut-and-mitered**, or **open**, stringer, the wall stringer being termed a **housed** stringer. Occasionally both wall and front stringer are housed, in which case the front stringer is said to be a **close** stringer. Geometrical stairways are seldom thus constructed, the method being mostly confined to dog-leg and open-newel stairways.

In geometrical stairways, the front stringer is cut and mitered so as to meet the conditions arising from the wreathed portion of the stringer and rail, which are assumed to be parallel to each other in the same vertical plane. The rail in this case is supported by the balusters and starting newel, instead of by newels, and the cut-and-mitered stringer affords a substantial footing to the balusters, which are dovetailed, glued, and nailed to the ends of treads; the nosing and molding of the treads being returned their full width on the face of the stringer. Stairs thus constructed are said to have *nosed* and *mitered* moldings, and when brackets are placed along the front stringer below the nosing, the stairway is known as a **bracketed** stairway.

DETAILS OF CONSTRUCTION.

RISERS AND TREADS.

6. Height of Risers.—In setting out a stairway, the first consideration should be to ascertain the exact height between the floors, the height to be measured from the top of the floor below to the top of the floor above. For this

purpose, a rule or rod is sometimes used, termed a **story rod**, on which the whole number of risers is to be marked. Care should be used in determining the risers, with the view of constructing a stairway having steps of convenient height. Experience teaches that between 6 inches and 7 inches rise is the limit of easy stepping; therefore, the total height of the story rod should be divided by either one of these numbers, which will give the number of risers required. Having in this manner ascertained the number needed, divide it into the height of the story rod; the quotient will be the exact height of each riser.

7. Proportioning Treads and Risers.—The next step is to ascertain the width of the treads, not forgetting the rules of proportion between treads and risers, and always remembering that the number of treads in each flight is one less than the number of risers; this is owing to the landing not being counted as a tread.

There are several rules for determining the proportion which should exist between tread and riser for regular stairways, and upon which depends not only the appearance of the stairway, but the ease with which it may be traveled.

Three rules will be given, of which the first is the simplest, and is generally preferred.

Rule I.—*Let the product of the tread and riser equal the number 66.*

For example, assume that the riser is six inches high, then the width of the tread will be $66 \div 6 = 11$ inches. In the same way, the width of tread may be assumed, and the height of the riser found.

Rule II.—*To any given height of riser in inches, add a number that will make the sum equal 12; double the number added, and the result will be the width of the tread in inches.*

For example, assume that the height of a riser is 7 inches; then $7 + 5 = 12$, and $5 \times 2 = 10$, the width of the tread in inches.

Rule III.—Draw a right triangle, as shown in Fig. 3, with a base of 24 inches and altitude of 11 inches. Mark the width of tread from *a* on line *a b*, as *a c*; at *c* erect a perpendicular, cutting the hypotenuse at *e*. Then *c e* indicates the riser.

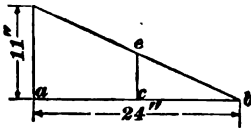


FIG. 3.

HEADROOM.

8. In trimming joists of staircases, the two cross-beams which are called *headers* should be so placed as to allow sufficient headroom to meet all probable requirements of a stairway. The header (which determines the headroom) should be placed so as to secure 7 feet of headroom from the tread vertically beneath it. A careful drawing of the elevation of the stairway will accurately determine this point.

In cases where a number of winders are placed at the bottom of a stairway, and the risers thereby stand one above the other at the center from which they radiate, a considerable rise is produced at the commencement of the run, the amount depending on the number of winders. In such a case, the header is placed at the extreme end of the staircase, and thereby ceases to be a factor in the headroom. This applies especially to *boxed stairways*, which are enclosed between partitions.

Care should be taken to make the staircase of the correct width, which should be at least 5 inches wider than the stairway; that is, the distance across the cylinder from the center of the rail of the flight to the fascia of the floor landing should be at least 5 inches, to permit the rail of the flight to pass clear of the nosing on the landing.

STRINGERS.

9. **Laying Out.**—A straight stringer is laid out by means of a *pitch board*, shown at (*a*) in Fig. 4. This board should be made of thin wood, with the grain parallel to the hypotenuse, so that the effects of shrinkage will be the least

possible. The base is cut to equal the tread, and the perpendicular to equal the riser. At (b) is shown the stringer, as marked out for the steps; the dotted line *ab* is drawn at a sufficient distance from the edge, so that the lower edges of the riser and tread will intersect on the line of the under side of the stringer, as shown at *d*. On the line *ab*, step off, with dividers, distances equal to the slope length of the pitch board. The latter may then be applied as shown, and its outline marked on the stringer edges. Templets, as

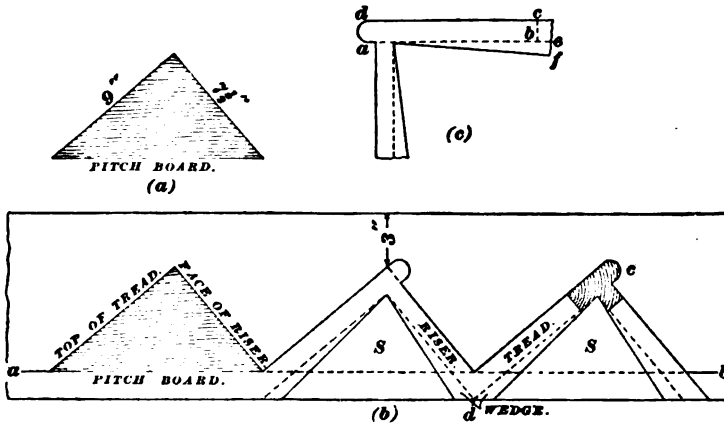


FIG. 4.

shown at (c), should be made for the treads, risers, and wedges, care being taken that the pitches are alike, so that the same shaped wedges can be used. The lines *adcb* show the section of the tread, and *aeef* shows the shape of the wedge. The tread and riser templets, when applied to the stringer, should have their outer edges coincide with the lines made from the pitch board, giving the outline shown at *S*.

To form the housing, holes are bored in the stringers adjacent to the nosing of the tread, as at *c*, and that portion is removed by means of a chisel. The lines of the templets may then be cut to the depth of the groove by a saw, and the material removed with a router plane.

Such a stringer is shown in Fig. 5, with the exception

that the under edge is kept somewhat lower than the point *d* in Fig. 4, and is preferable to the latter method in that the wedges are well supported at their outer ends. If the staircase will allow the insertion of the assembled parts, the

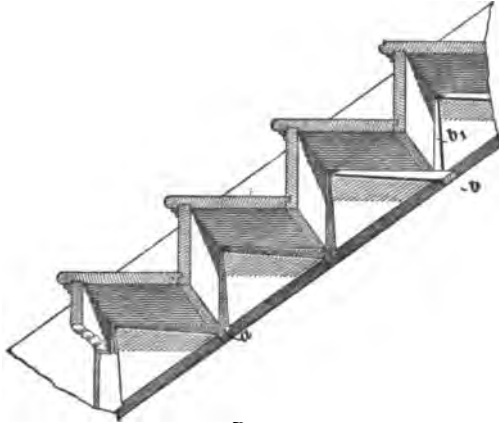


FIG. 5.

treads and risers are attached to the stringers, wedged, and glued into the housing, and the whole taken bodily to its place in the building. The wedges are shown in place at *a* and *b*, Fig. 5.

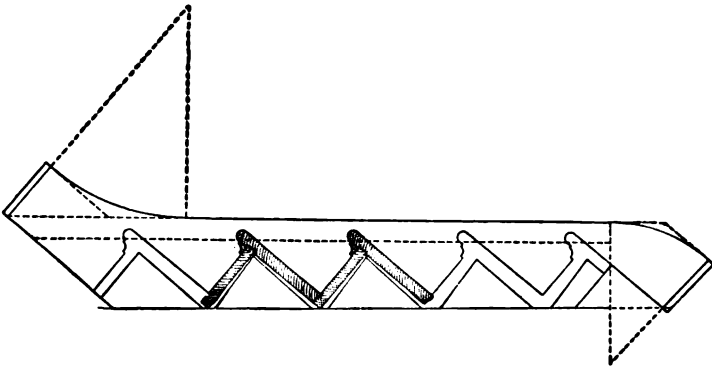


FIG. 6.

The wall stringer, as shown in Fig. 6, and also the front stringer, if a close one, are each grooved as already explained,

•••••

the depth depending upon the thickness of the stringer. Two or more carriage timbers are used in the width of the stairway, the number, depth, and thickness depending on the width of the stairway and the load to be carried.

The front stringer, as shown in Fig. 7, is well nailed to the front carriage timber *a*, while the other timbers are rough

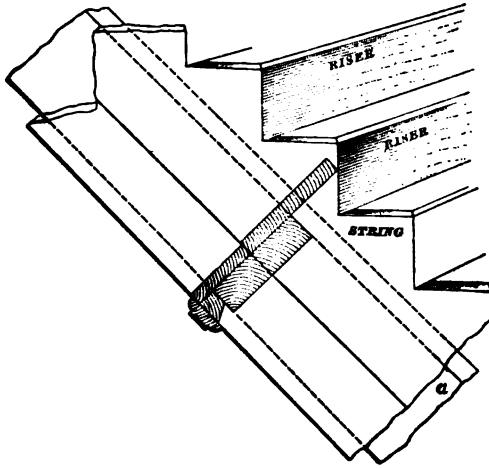


FIG. 7.

bracketed under each step alternately on the sides, and nailed as shown at *a*, Fig. 2. A furring strip is nailed to the wall in line with the lower edge of the carriage timbers, to receive the lath.

The prepared mortised wall stringer is nailed to the wall to square properly with the previously set carriage timber and front stringer.

10. Scribing Wall Stringers.—When the treads and risers are supported by rough cut carriages, it becomes necessary to cut a wall stringer that will fit around the steps and make a finish with the wall. In Fig. 8 is shown a method of *scribing* a wall stringer. The stringer is represented as being laid with one edge on the line of the nosings,

and the instrument to be used is shown in position. The hard-wood or iron bar *bh* has a hook on the lower end projecting sufficiently to enable the bar to clear the nosing when the point *b* is touching the face of the riser. The bar *bh* is placed against the guide *m* and loosely bound to it by the

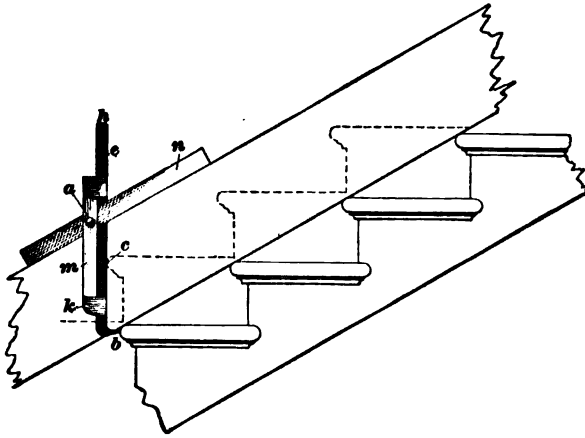


FIG. 8.

metal straps *e* and *k*. The strip *n* is fastened to *m* by a bolt *a*, which can be tightened so as to preserve the bevel. A small nick is made in the sliding bar *bh* at *c*, so that *bc* is the height of a riser. When the point *b* is on the end of the nosing, the nick *c* gives the position of the corresponding point on the wall stringer. Other points may be found in a similar manner, and the outline to which the wall stringer is to be cut can then be drawn.

CONSTRUCTION OF STEPS.

11. A portion of the upper edge of the riser may be tongued into a groove in the under side of the tread, as shown at *a* in (a), Fig. 9, instead of letting the whole thickness of the riser into the tread, as shown at *b* in (b). The lower edge of the riser may also be tongued into a groove in the upper

surface of the tread beneath it, as shown at *b* in (a), in which case the tread would have to be nailed up into the riser as at *c*; this method, however, does not give as good results as that shown at *a* in (b).

The finished treads and risers are glued, and clamped together with handscrews until the glue has set. From two to four well fitted blocks are then glued and nailed to the internal angle of the tread and riser, as shown at *b* in (b). In Fig. 9 (b) are also shown the dovetails for inserting the balusters.

12. Bull-Nose Steps.—A form of step

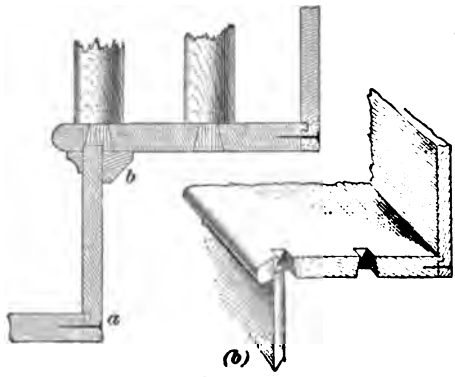
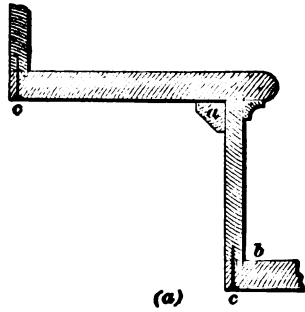


FIG. 9.

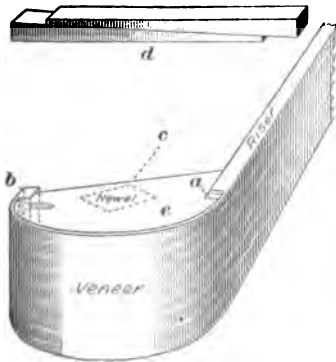


FIG. 10.

much used is represented in Fig. 10. The solid block *e* is sawed into shape, and the riser is sawed out as shown, leaving a veneer for the face of the block. The end *b* is firmly fastened to the solid block with screws. At *a*, a square hole is left the full depth of the riser, into which wedges are driven from each end, as suggested at *d*. The back of the veneer is covered with glue, and, as the wedges are driven home, it is clamped

firmly against the face of the block. The newel is generally set on top of this step, as indicated by the dotted lines. The second riser may be placed in line with the middle of the newel, as indicated at *c*, or in any other position desired.

13. Curved Risers.—Where risers are curved, they should be made of solid wood, or of curved strips of seasoned wood glued solidly together. It is often difficult to get seasoned wood in pieces large enough to make a solid curved riser. In such cases it is desirable to bend pieces of 1-inch board by kerfing. Fig. 11 illustrates the method of finding

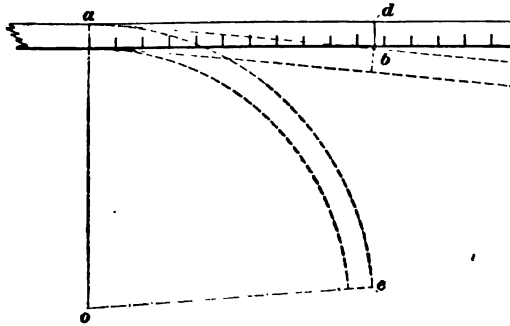


FIG. 11.

the distance between kerfs for a curve of given radius. The method is as follows: Cut one kerf, as at *a*; then, marking the distance *ad* equal to the radius *ao* of the curve to which the piece is to be bent, bend the board to position *ab* until the saw kerf is closed, as shown. Measure the distance between *d* and *b*. This length *db* is therefore the distance between kerfs, which, if continued, will shape the board to the curve *ae*. All the kerfs must be made with the same saw and to the same depth.

14. Platforms.—Where the stairways of a building are of considerable length, and are straight in plan, it is best to break the flight by a platform. Such a platform may be projected from the side wall, as shown in Fig. 12. In a

brick wall, the lookouts *a, a* should be set in at least 8 inches with slip keys tightly wedged between the bricks and the top of the timbers. In frame walls the lookouts are nailed

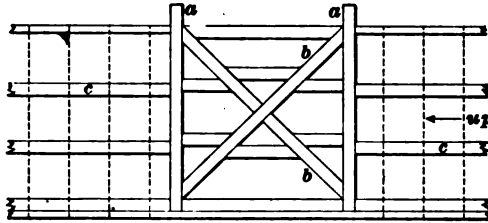


FIG. 12.

to the studs. The braces *b, b* should be well fitted and spiked to the lookouts; these braces serve to keep the platform square, and should be made of thoroughly seasoned

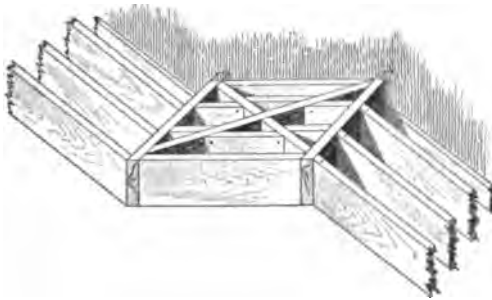


FIG. 13.

wood. A flight terminating in a platform should not contain more than 12 steps. A perspective sketch of the platform is shown in Fig. 13.

CYLINDERS.

15. In a geometrical stairway, the hand rail travels, unobstructed by newels, from the first step to the last, sometimes over six or more flights; it then becomes necessary to wreath the stringer and rail around the well hole. The

well hole thus treated is said to contain a **cylinder**. The cylinder is the curved space around which the hand rail and stringer are wreathed. In a circular stairway, the cylinder assumed has a complete circle for its plan, and the stringer and rail are made to wind around it, following a curve termed a *helix*—a curve of the same nature as the winding thread of an ordinary screw. The finished treatment of the stringer and balustrade is continued around the cylinder, and where the stairway terminates in a landing, the same treatment is continued along the trimmer beam. The finishing piece on the face of landing beam corresponding to the stringer of the flight is called the *facia*. Thus it will be seen that the stringer of the flights, the cylinder of the well hole, and the facia of the trimmer beam are but parts of one continued stringer known by different terms.

Cylinders are built up as shown in Fig. 14. The construction shown at (a) is used for small cylinders, while for larger ones, the methods shown at (b) and (c) are used. The joints, as *st* and *vs*, are glued and strengthened by screws or wooden dowel-pins. For extra fine work the face of the cylinder is veneered, so that the joints of the staves in the semicircle from *a* to *b*, in (c), are covered. The veneer is bent over a skeleton cylinder whose diameter is equal to the diameter of the well cylinder, and then backed with properly fitted staves, as *c* and *d*, well glued, and screwed or doweled at the joints, if necessary.

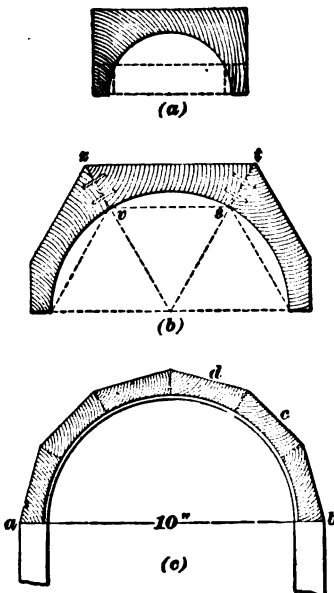


FIG. 14.

common methods are shown in Fig. 15. In the first method

(a), a dovetailed groove is cut in the stringer into which the end stave fits. Wedges *W*, glued in, hold the stave in place.

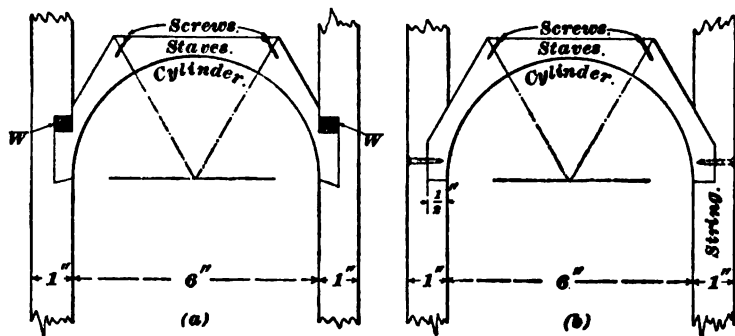


FIG. 15.

In the second method (b), the end staves are merely set into the stringers and screwed fast from the outside.

MISCELLANEOUS DETAILS.

16. Moldings.—All base and stringer moldings should be worked out of solid wood. Work that is to be bent is generally stronger when laminated, as shown in Fig. 16; but for moldings this method cannot always be used, since the joints will show, no matter how well the work is done. This is particularly true of hard woods. If the work is to be painted, however, this method is not objectionable.

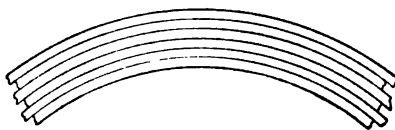


FIG. 16.

17. Erection.—If the stairway is put up against the brown-mortared wall, the finished parts must be well covered with building paper, and rough boards placed over the paper on the treads, to remain until the interior woodwork is completed. The covering must be fixed in such a manner as to permit enough of it to be easily removed to allow the hand rail and balusters to be put up.

When the steps are set in place, they should be carefully inspected to ascertain if any of them are cut short and pieced, if any of the wedges are improperly glued, or the nailing of treads and risers omitted. When a person ascends or descends the stairway, it should make no creaking noise, as even a slight creaking is sure to grow louder in time and be a lasting reminder of defective work. Creaking is generally due to defective gluing, nailing, wedging, or to the use of unseasoned stuff in either the rough carriages or the finished material.

BALUSTRADES.

18. **Newel posts, or newels,** are used to support the hand rail, and are either made of solid materials and turned, or built up, box-like, in which case they are called *boxed newels*. They vary in design, form, and size, some—especially the one placed at the bottom of the stairway, called the *starting* newel—often being elaborately decorated with panels and carvings.

The newel is also variously fixed in its relation to the steps adjoining. In ordinary cases it is placed on the floor, and when so placed its center should be in line with the center of the first riser. Where space is limited at the bottom of a stairway, the newel may be placed on top of the first step, and even on top of the second or third step; but in each case, it is desirable to place it so as to have the center of the riser in line with the newel center, and the steps outside rounded, and returned into the stringer; the end of the latter being inserted in a prepared mortise in the center of the newel.

The *angle* newels on the landings are generally smaller in size and have less decoration than the starting newels. The same rule applies to their relation to the risers; viz., that the center of the riser should be in line with the center of the newel. Working from centers in stair-building construction is almost a maxim. The center of the rail is to be in the center of the newel; so, also, is the center of the stringer; and the center of the baluster is to be in the center

of both stringer and rail; and, as before mentioned, the center of the riser adjoining the newel is to be placed at the center of the latter.

19. Balusters are small columns, generally turned, set vertically on the ends of treads or on the stringer, forming an ornamental guard, and supporting the hand rail. When the front stringer is closed, or housed, the balusters are fixed to the stringer, instead of to the treads, a grooved molding, called a *cap*, being prepared to receive them; the lower ends of the balusters in this case are cut to the pitch of the stairway, and the top is either cut to the same pitch as the rail, or mortised into it. This applies to balusters having square ends. Frequently they are made square or round at the bottom, and turned to a spindle shape at the top, being then termed *pin balusters*. Balusters with square bases are preferable to those with round bases, as the square base gives bearing surface and resistance to movement almost double that of a round base. Holes are bored about an inch deep into the under side of the rail to receive the balusters, and the lower ends are either cut to the pitch of the stairway or dovetailed to the ends of the treads, depending on whether the stringer is housed or cut and mitered.

In ordinary stairways, two balusters are used to each tread, but in the better class of stairways, the number is increased, adding thereby to the beauty and strength of the balustrade, and general appearance of the stairway. With two balusters on a tread, they are placed half the width of a tread apart between centers, the short one standing close to the nosing and the long baluster being placed midway between the adjacent nosing balusters, so that it is exactly one-half the rise of the steps longer than the short one on the same tread. The usual height of pin balusters is either 2 feet 4 inches or 2 feet 8 inches, of which 1 inch is allowed at each end for insertion into rail and tread.

In extra fine stairways the space between the balusters is filled in with brackets of various designs, or the space is paneled; in either case the number of balusters is reduced

to one for each tread, ordinarily placed over the face of each riser, thus leaving the full width of the tread (less the thickness of one baluster) for the decorative brackets or panels.

20. Hand Rails.—The development of hand rails, which involves complex geometrical problems, is not within the province of the architect or builder, though a few remarks regarding their construction are pertinent. The rail—except where placed over winders, whether at the bottom of the stairway or around the cylinder in the well hole—should be set parallel to line of nosings. The pitch over the winders will be more inclined than it will be over the straight rail, and as the amount of the inclination determines the height of the rail, it follows that additional inclination over the winders requires more height for the wreath; but this addition in height should never be such as to cause an unsightly crippled appearance where the curve of the wreath intersects with the straight rail. In stair construction each baluster should be vertical, and solidly glued and nailed to the hand rail, so that when tested, there should be no noise, which would indicate the presence of loose balusters through imperfect fitting, poor gluing, or carelessness in nailing.

Where the straight rail enters the newel without a ramp, it allows the newel to be made from 4 to 6 inches shorter than would otherwise be possible, the reduced height being often a matter of some consideration. Where such is not the case, the hand rail may be bent upwards (in which case it is said to be ramped), so as to enter the newel in a plane perpendicular to it, and the angle of intersection between the raised level portion and the inclined plane of the straight rail is gracefully eased. This last method is the one most commonly adopted, owing mainly to its superior ornamental characteristic.

21. Ramps and Easements.—In an open-newel stairway the rails usually meet the newels one above the other. To bring them to the same level, the rail must be ramped, and sometimes they are ramped and *kneed*—the latter being a concave easement with its upper end forming an angular knee.

When the knee is convex, the combined curve is then called a *swan neck* or sometimes a *goose neck*. The lower ends of rails abutting against the newels may be either straight or curved. When curved, the rail is said to be *eased*, and the curved portion of the rail is called the *easement*, and this arrangement requires the newel to be somewhat longer.

22. Stiffening Hand Rails.—Continued hand rails are sometimes provided with an iron brace extending across the cylinder from the fascia to the bottom of the rail. Instead of

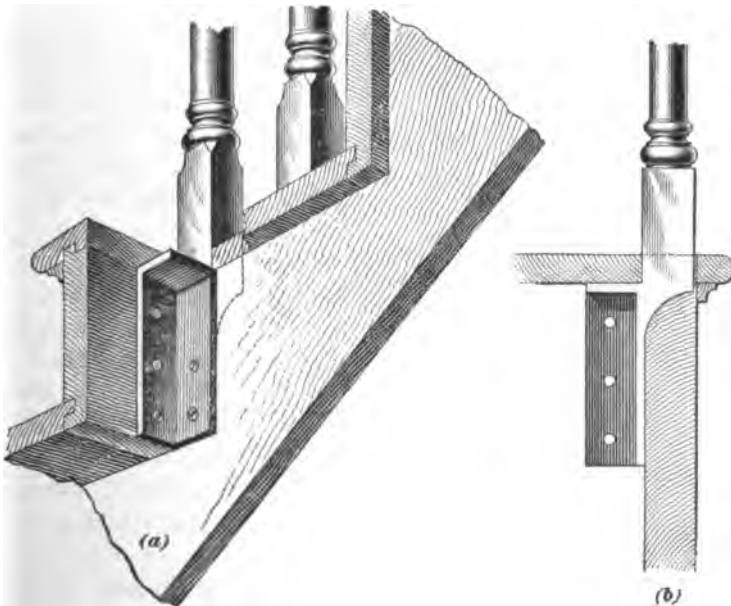


FIG. 17.

this brace, an iron baluster is often placed at each end of the wreath. Fig. 17 (a) is a perspective sketch of the base of such a baluster, which is formed into a flanged connection and attached to riser and stringer by screws. At (b) is shown a side elevation of the base, and its relative position with reference to the face stringer.

STAIRWAY DESIGN AND CONSTRUCTION.

ORDINARY FORMS.

23. Step Ladders.—One of the simplest forms of stairways in use is a step ladder,

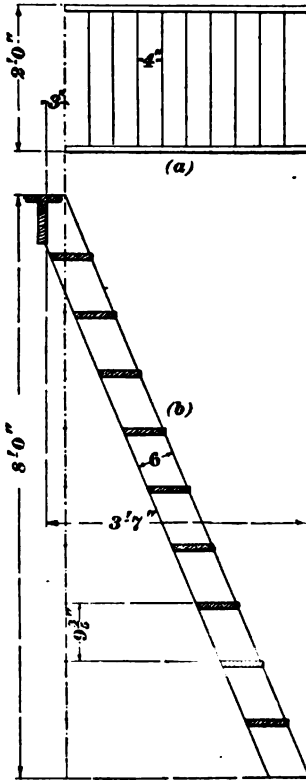


FIG. 13.

ways in use is a step ladder, fixed or movable, such as is sometimes built from an attic floor to the roof, as is shown in Fig. 18, where (a) is a plan, and (b) an elevation. The top step should always have an increased width, and the sides of the ladder should be at least 6 inches wide by $1\frac{1}{2}$ inches thick. The steps are *gained* into the sides not less than $\frac{3}{8}$ inch and securely nailed or screwed thereto. This ladder rises 8 feet, or 96 inches, which, divided by 10, the number of steps, gives $9\frac{1}{2}$ inches for each riser. The horizontal distance from the face of the landing beam to the bottom of the ladder equals 3 feet 7 inches. This distance, less 3 inches for additional width of top step, leaves 3 feet 4 inches, or 40 inches, which, divided by 10, the number of treads, gives 4 inches as the width of each tread from

its nosing to a vertical line dropped from the nosing above.

24. Plank Stairway.—In (a) and (b), Fig. 19, are shown the plan and elevation of a strong stairway, such as may be required for a shop or factory; a and b are newels, 6 inches

square, to which $3'' \times 1\frac{1}{2}''$ hand rails *c* and *d* are fastened and

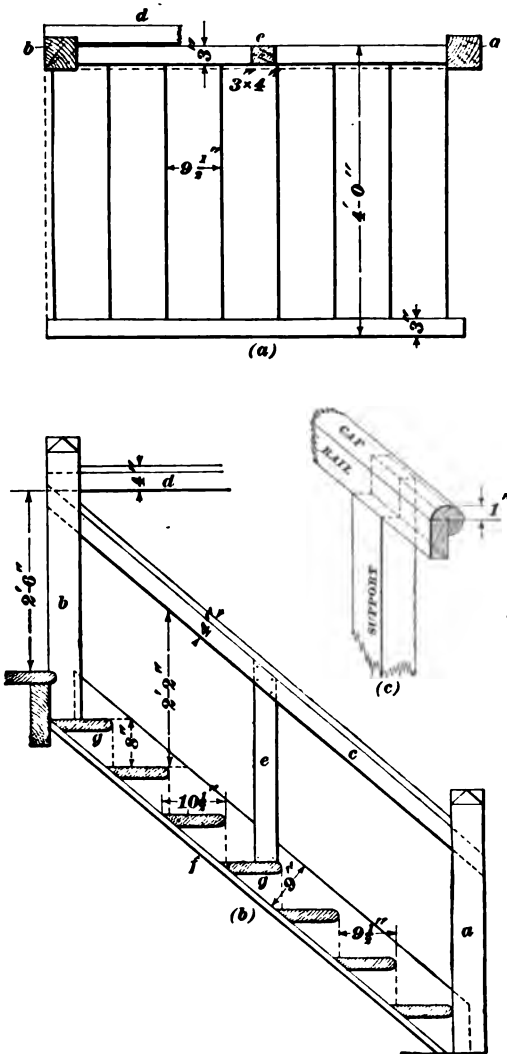


FIG. 19.

braced with one or more uprights *e*. At (c) is shown a section of the hand rail. Hard-wood treads *g*, 2 inches thick,

are mortised 1 inch into 3-inch timber stringers, tightly fitted into the mortises and well spiked, but not wedged. The soffit may be ceiled with matched lining, as at *f*.

GEOMETRICAL STAIRWAY.

25. **Straight Stairway.**—In Fig. 20 are shown the plan (a) and elevation (b) of a straight stairway with a 6-inch

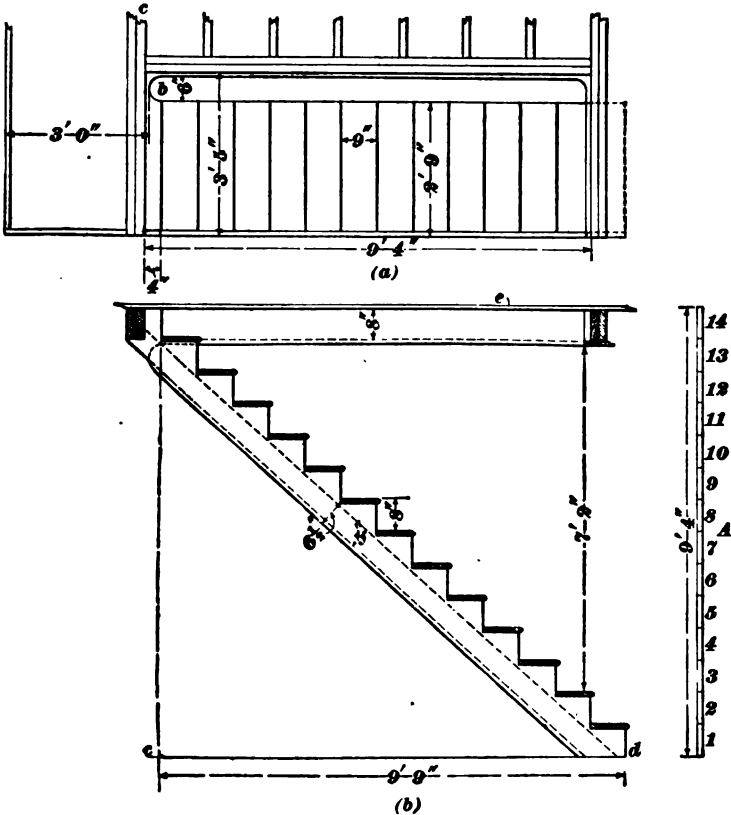


FIG. 20.

cylinder. The first requirement in planning this stairway is to fix the number and height of risers. The story rod *A* indicates the height of the story to be 9 feet 4 inches, or 112

inches, which, divided by 14, the number of risers, gives 8 inches as the height of each riser. The total run cd is 10 feet 1 inch, less 4 inches for the depth of the cylinder, which leaves 9 feet 9 inches to be divided into 13 treads, giving 9 inches as the width of each tread. As the floor at the landing makes one of the steps, there is one tread less than there are risers. The width of the stairway, shown in (*a*) as 2 feet 9 inches, is measured from the face of the plaster to the face of the front stringer, while the width of the well includes the width of stairs, the diameter of the cylinder (in this case 6 inches), plus 1 inch for the thickness of the fascia, and 1 inch for lath and plaster—altogether 3 feet 5 inches; and if the outside wall be constructed of brick, 1 inch more for thickness of furring will be required. At the landing of a straight flight, there must be at least as much room between the cylinder and the partition as the width of the stairway, preferably as much more as possible. In this case 3 feet is the width used in the platform, the 3 inches extra being allowed for convenience in moving furniture, etc.

The headroom of the stairway shown in Fig. 20 is 7 feet 2 inches from the top of the second step to the ceiling, and the point where this headroom can be secured governs the length of the well hole—as figured on the plan, 9 feet 4 inches. It is not necessary to make a drawing of the elevation in order to find the length of the well hole for the required headroom, as this can be calculated from the plan, by counting 12 risers down. If each riser is 8 inches, the 12 risers make 96 inches. From 96 inches subtract 10 inches, the depth of the floor, giving 7 feet 2 inches as the headroom. The 12 treads, of 9 inches each, make 9 feet, to which must be added 3 inches for the depth of the cylinder, and 1 inch for its thickness, making the total length of well hole 9 feet 4 inches.

The hand rail for such a stairway as this would be from 3 to $3\frac{1}{2}$ inches wide, and the balusters from $1\frac{1}{2}$ to 2 inches, square or turned.

26. Platform Stairways.—The plan (*a*) and the elevation (*b*) of a half-turn platform stairway, with a continued

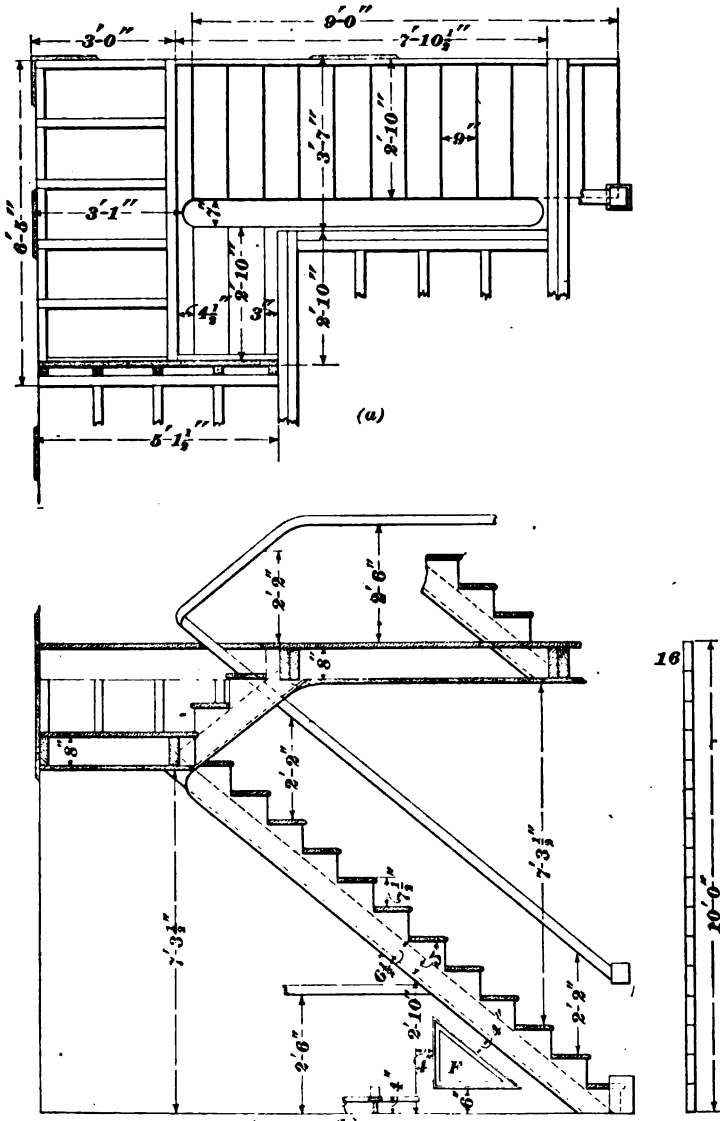


FIG. 21.

hand rail around a 7-inch cylinder, is shown in Fig. 21. This kind of a stairway is easy of ascent, breaking the flight, as it does, with a roomy platform, and allowing space for a window to light the stairway and hall from above the platform, while below it affords room for a doorway to the outside. With the last mentioned purpose in view, the soffit of the platform must not be less than 7 feet in height. The plan indicates also the timber framing of the well and the platform. A jib panel *F* is shown at the start of the stairway in the elevation (*b*), the object of which is to close and neatly finish the angular space formed by the intersection of the stringer and the floor. The height of the jib panel is such as to receive the hand rail of the basement stairway. Where it is desired, the latter stairway may be enclosed by a paneled or lath-and-plaster partition extending up to the stringer of the upper flight.

The hand rail on the flight is 2 feet 2 inches in height from the center of the short baluster at the top of the step to the bottom of the rail; along the hallway the bottom of the rail is 2 feet 6 inches from the floor. These heights are based upon the commercial custom of turning ordinary pin balusters in lengths of 2 feet 4 inches and 2 feet 8 inches, 1 inch being allowed for entering the hand rail and 1 inch for the dovetail entering the tread, thus leaving the exposed part the length mentioned.

This kind of platform stairway can be altered in various ways, without changing the number of risers. For instance, a step can be taken from the upper flight, and added to the lower flight, increasing the run 9 inches and raising the platform one riser, making it 7 feet 11 inches. Then the well hole for the same headroom must be 9 inches longer, and the beam at the landing of the short flight must be brought forward the same distance. On the other hand, a step may be added to the short flight, making 4 risers in the short, and leaving 12 risers in the long flight. The well hole can now be shortened 9 inches, and have the same headroom as before; but it will be necessary to move the landing beam of the short flight back 9 inches, to accommodate the

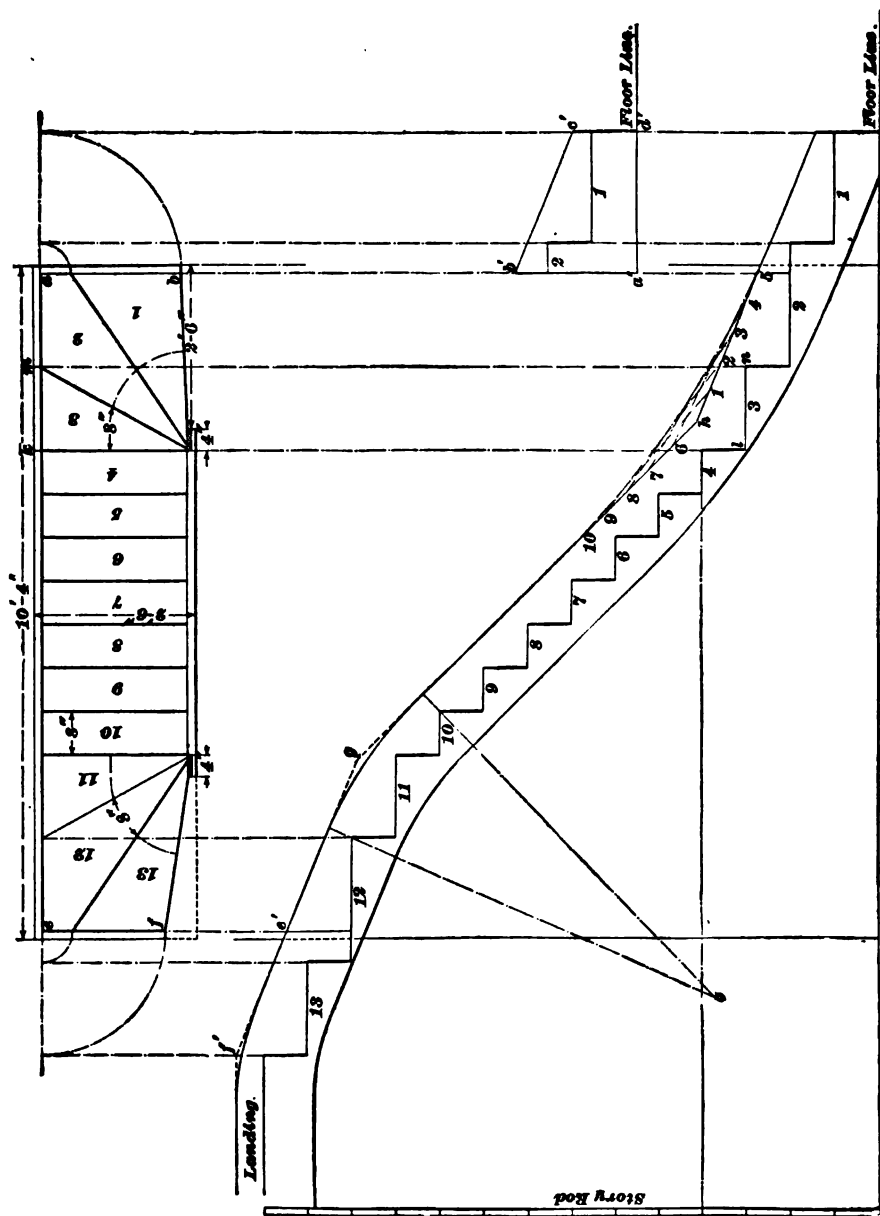


FIG. 22.

additional step. The platform, however, is one riser lower, making it 6 feet 8 inches; but if the total depth of the platform can be made 6 inches, thus reducing its depth 4 inches, the height to the soffit of the platform will be 7 feet.

27. Winding Treads.—In Fig. 22 is shown an enclosed stairway, illustrating the method of laying out the wall stringer, easement curves, etc. The widths of the winding treads at the wall are projected down from the plan by lines *kl*, *mn*, etc. Then the wall stringer *ab*, at right angles to the main wall stringer *ae*, is revolved as shown, parallel to the main wall stringer and laid out in a similar manner; *a'b'c'd'* shows the stringer *ab* in elevation. The stringer *ef* is treated in a similar manner. The story rod is shown at the left, and the steps are projected from it and from the plan, as shown at step 4. Where the treads are wide, as in steps 1, 2, and 3, the line of the nosings makes an angle with the horizontal different from that made by the line of the nosings in the body of the stairway. This is because the uprights, or risers, remain the same, while the horizontals, or treads, vary in width.

28. Easement Curves.—At the angles, easement curves are necessary, or, at least, advisable. At *h* is shown a method of drawing an easement curve. From the vertex *h* lay off equal distances in both directions, as 1, 2, 3, 4, etc. Draw lines from 5 to 6, 4 to 7, etc. Through the points of intersection of these lines, draw a curved line by means of a spline. If the angle is sharp, as at *g*, perpendiculars may be drawn at equal distances from *g* until they intersect, as at *o*; the curve can then be drawn with a compass.

29. Items of Detail.—Both wall and front stringers are to be mortised, or housed; for the steps, the treads and risers are to be glued together, wedged and back nailed, as before explained, in order to secure good, solid work. The front stringer has a vertical strip 4 inches wide spliced and glued to it so as to receive the winders. The well must be framed wide enough to include, beside the figured width of the stairway, the thickness of the enclosing lining.

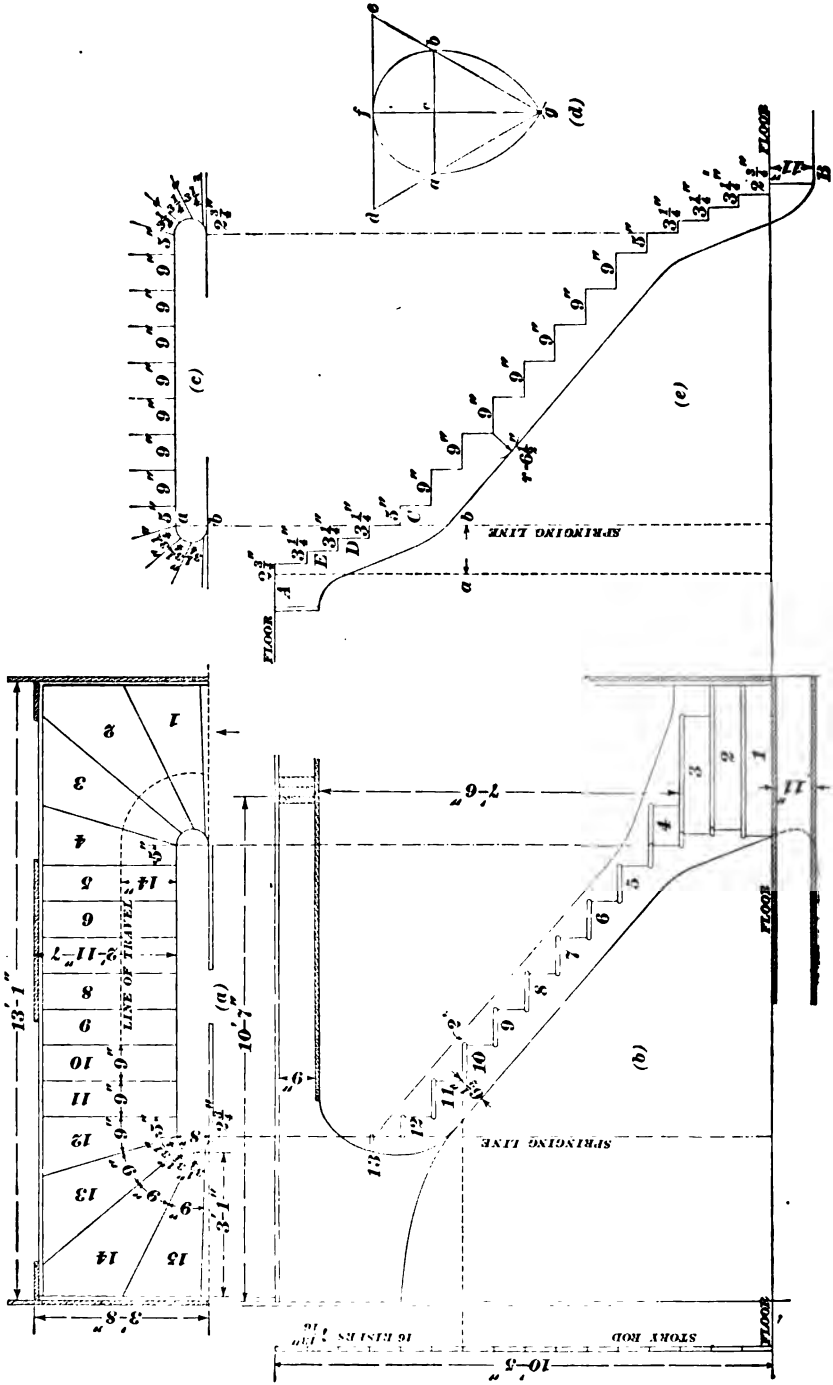


FIG. 28.

30. Double Winders.—In Fig. 23 is shown a stairway winding one-quarter turn at the top and bottom, with an 8-inch cylinder, for a continued hand rail. In planning winding stairways, it is important to make the treads as nearly as possible of the same width on the line of travel. This line should be about 14 inches from the face of the stringer, as shown on the plan (*a*). The width between finished walls for this stairway should be at least 6 feet 4 inches, as follows:

Width of stairway from finished wall.....	2 feet 10 inches.
Diameter of cylinder	8 inches.
Hall passage.....	2 feet 10 inches.
	6 feet 4 inches.

The distance from the finished wall to the cylinder is made 3 feet 1 inch, so as to allow room for moving furniture. Where the stairway is continuous, the first and last risers of each flight should be placed 2 inches beyond the landing facia line, in order to make a proper finish with the facia.

In commencing the drawing, the starting and landing risers are marked on the plan, and the line of travel divided equally, as before mentioned. Then the space along the cylinder is divided; and lastly, the risers along the straight stringer are drawn in position. Lines are drawn through the points found along the line of travel and passing through the points located along the front stringer, thus completing the plan of the stairway. The elevation (*b*) of the stairway is drawn by projecting the lines of the risers down from the plan, and by drawing the lines of the treads horizontally from the story rod, as shown at tread 10. For the development of the wall stringer, follow the method given in Fig. 22. The headroom, as shown, is 7 feet 6 inches from the top of the third step to the ceiling.

31. Width of Winders.—The winding treads must be made of uniform width around the cylinder, so as to obtain a uniform curve in the rail. It will be observed that there

is a 5-inch width introduced between the straight flight and the cylinder, which provides for a better easement, or ramp, from the pitch of the straight rail into the steeper pitch of the wreath rail; besides, if the winders were all contained in the cylinder, it would make a sudden and abrupt change of inclination in the stairway, causing travelers to stumble and fall.

32. Development of Stringers.—At (c) and (e) in Fig. 23 are shown the methods of developing the front stringer when each end curves around a cylinder. The plan (c) of the front stringer is the same as in (a). The distance ab in (e) is equal to the "layout" of the semicircular cylinder, found as in (d), where de is the *outstretched*, or developed, length of the curve afb . The length of de may be determined as follows: Make ab equal to the diameter of the cylinder; from c , with a radius equal to one-half of ab , describe an arc afb ; from a and b as centers, with a radius equal to ab , describe arcs intersecting in g . From g , through the points a and b , draw lines gd and ge ; through f draw a line tangent to the arc and parallel to ab ; the points where this line intersects with the lines drawn through g , will define the length of de , or the developed length of the arc afb . ACB in (e) is the front stringer, any outstretched step, as C , being obtained by projecting the line of the riser vertically from the plan, and the tread horizontally from the story rod. As the steps D, E , etc., in the cylinder, have their width marked on the plan as $3\frac{1}{4}$ inches, that width is therefore transferred to the development. The stringer in this case is $6\frac{1}{2}$ inches, measured from the angle between the treads and risers. This width is marked out with a compass from each angle, and a pleasing curve is drawn tangent to the arcs, as shown. When a cylinder is of this diameter, or smaller, at the bottom of the flight, the curve of the hand rail presents a better appearance, and it is more convenient when the rail over the regular treads is continued on its pitch into the wreath, without ramping the straight rail. In this case there would

be an easement introduced between the straight rail and the wreath piece.

33. Arrangement of Winders.—In Fig. 24 are shown the plans of two different stairways brought together for comparison, each having one-quarter turn with an 8-inch cylinder and a continued hand rail. It will be seen that by the arrangement shown in (b) a platform is obtained, thus making the flight a much more desirable one. In plan (a)

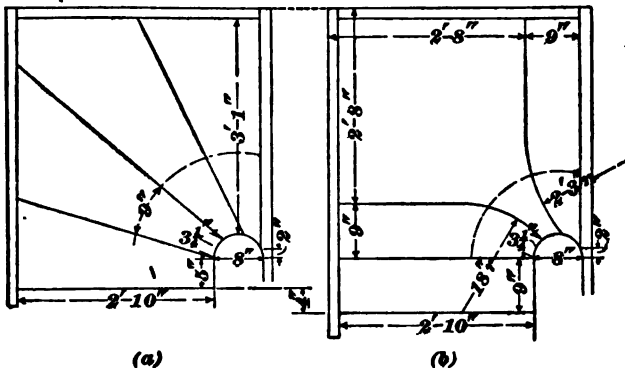


FIG. 24.

there are 4 winders, differing but little from the plan shown in Fig. 23; while in (b) there are 3 winders with slightly curved ends. The 5 risers so changed in their arrangement in (b) take 4 inches more run than the plan with 4 winders as shown. The placing of the carriage timbers in such stairways is a matter requiring care, as the strength and stability of the stairway largely depend thereon.

34. Carriage Timbers.—In Fig. 25 is shown the plan of the top winders of a stairway similar to that in Fig. 23, *a*, *b*, and *c* being the principal timbers in position. The timber *a* is set in place after the stringers are put up, nailed to the floorbeam at *d*, and fastened to the wall at *e*. A piece of furring strip held in the direction *ed*, together with a straightedge tried along the line of the risers, will indicate the best position for this timber.

The bottom of the flight, as shown in Fig. 26 (a), may be timbered by securely placing a level piece $f k$ extending from the front stringer into the wall, and then the two timbers $g h$ and $l m$ at a steeper pitch than the main timbers n and o . To do this may require the insertion across the well hole of the floorbeam $j i$; this is shown by the elevation at (b), where $l m$ and $g h$ of the plan are seen at, and lettered, $g' h'$, and n and o at n' . Or, instead of timbering in this manner, omit the level piece $k f$ and place a diagonal timber

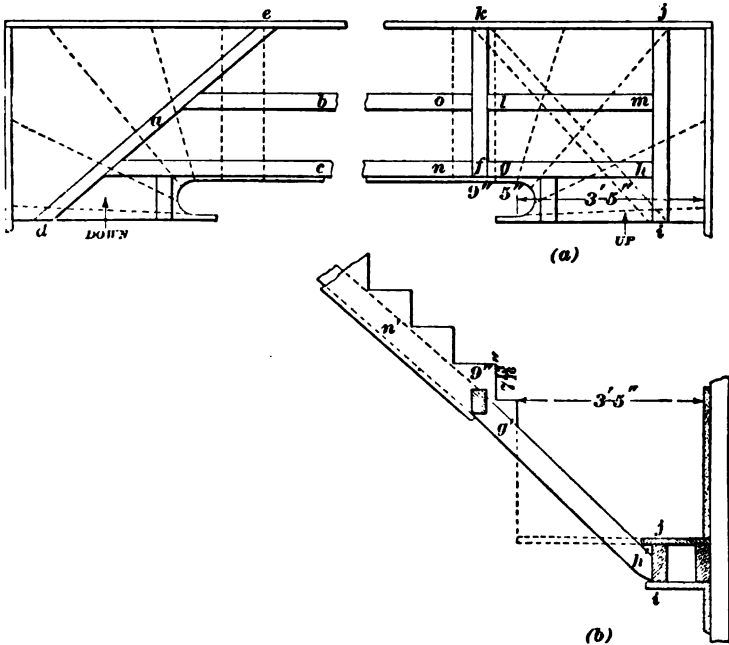


FIG. 25.

FIG. 26.

$i k$, as at the top, and continue the principal timbers n and o to meet it. The remaining timbers are filled in as required for furring, which must be done so as to allow the lath to be nailed on in the direction of the risers. In order to obtain a smooth, curved surface on the soffit—which will be more or less warped—care must be taken to align the blocking by means of a guide lath. In lathing so placed, care must be

taken that space has been allowed at all points for the rivet of the plaster which, under stairways, is subjected, at times, to heavy jarring that is likely to loosen the plaster unless it is well keyed or riveted.

NEWEL STAIRWAYS.

35. In Fig. 27 is shown a plan of a quarter-platform open-stringer stairway with 4-inch square newels framed in the angles, the handrails making straight connections with

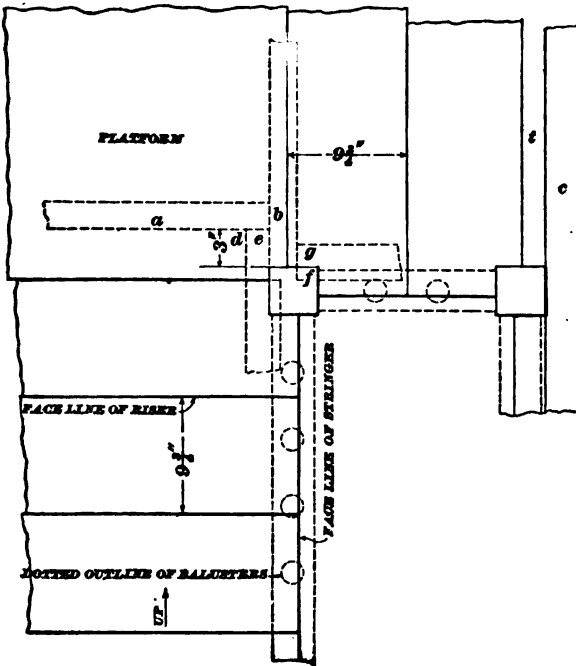


FIG. 27.

the newels, as shown in Fig. 28. The position of the platform beams *a* and *b* and of floorbeam *c* at the landing must be such that a good bearing is secured for the carriage timbers at *d*, *e* and *f*, *g*. The platform beam *b* must be brought forward to give a support of about $\frac{3}{4}$ inch for the newel. The elevation, shown in Fig. 28, is projected from the plan,

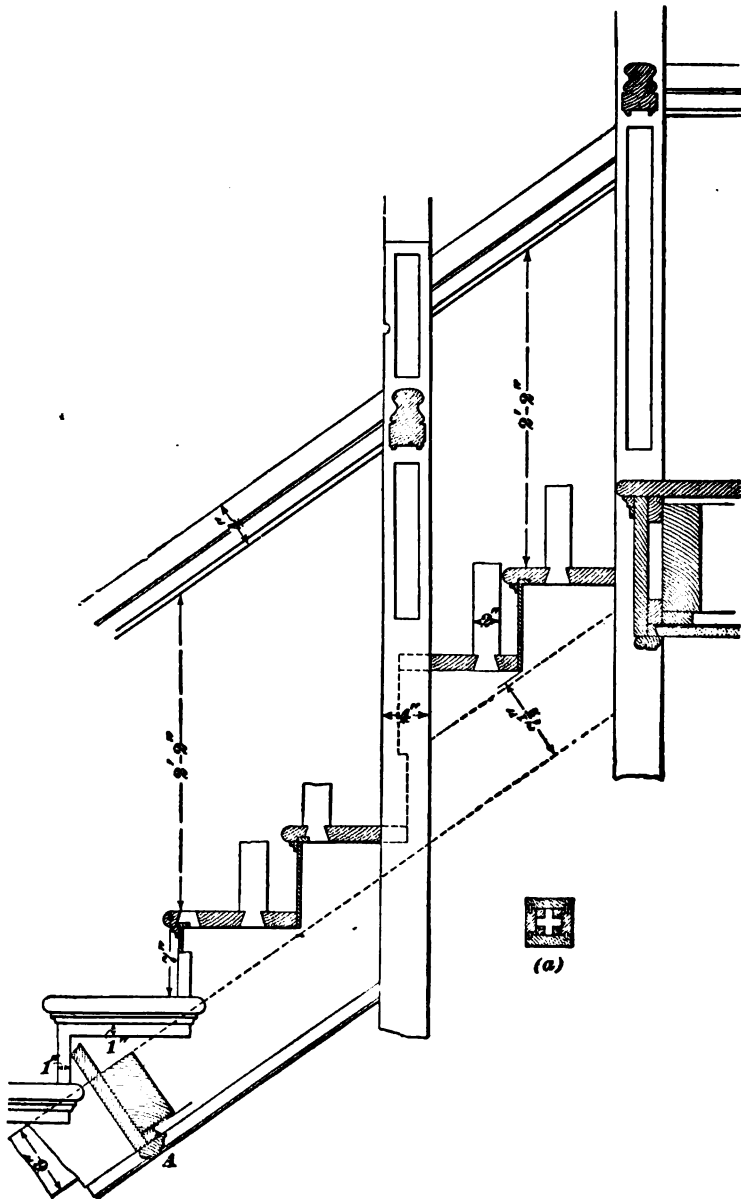


FIG. 28.

and shows the relative position of the newels, hand rails, balusters, and step trim; the latter is composed of $1'' \times \frac{1}{4}''$ fillets, nosing, and scotia. The newels are built up as shown at (a) in Fig. 28, slip-tongues being inserted into grooves in the sides, and the whole being properly glued and blocked. The blocks are glued first to the two narrow sides of the newel and when dry are planed square with the edge of these pieces. The whole is then heated in the hot box, and blocks, edges, and slip-tongues are glued and brought together with handscrews.

36. Open Stringers.—In Fig. 29 are shown an elevation and section of an open stringer, where fillets are used. At (a) is a portion of the stringer showing the step trim with fillets *a, a*; the lower portion of the stringer is relieved to

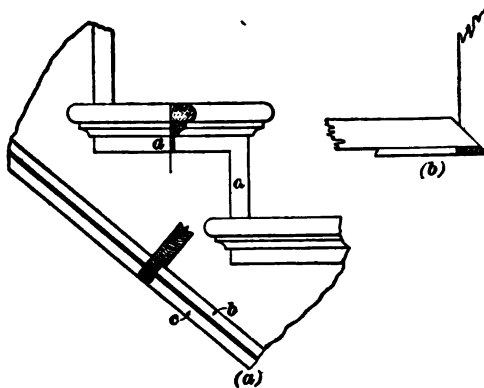


FIG. 29.

form a fascia *b*, and the edge is formed into a quirk bead, against which the plaster would finish. This method, although often used, does not give as good a bond for the plaster as does the soffit mold shown at *A* in Fig. 28, in which the edge of the stringer is kept square. At (b), Fig. 29, is represented a section of the fillet, mitering with the riser, which shows that the face stringer requires to be kept back the thickness of the fillet, in order that the latter may miter properly with the riser.

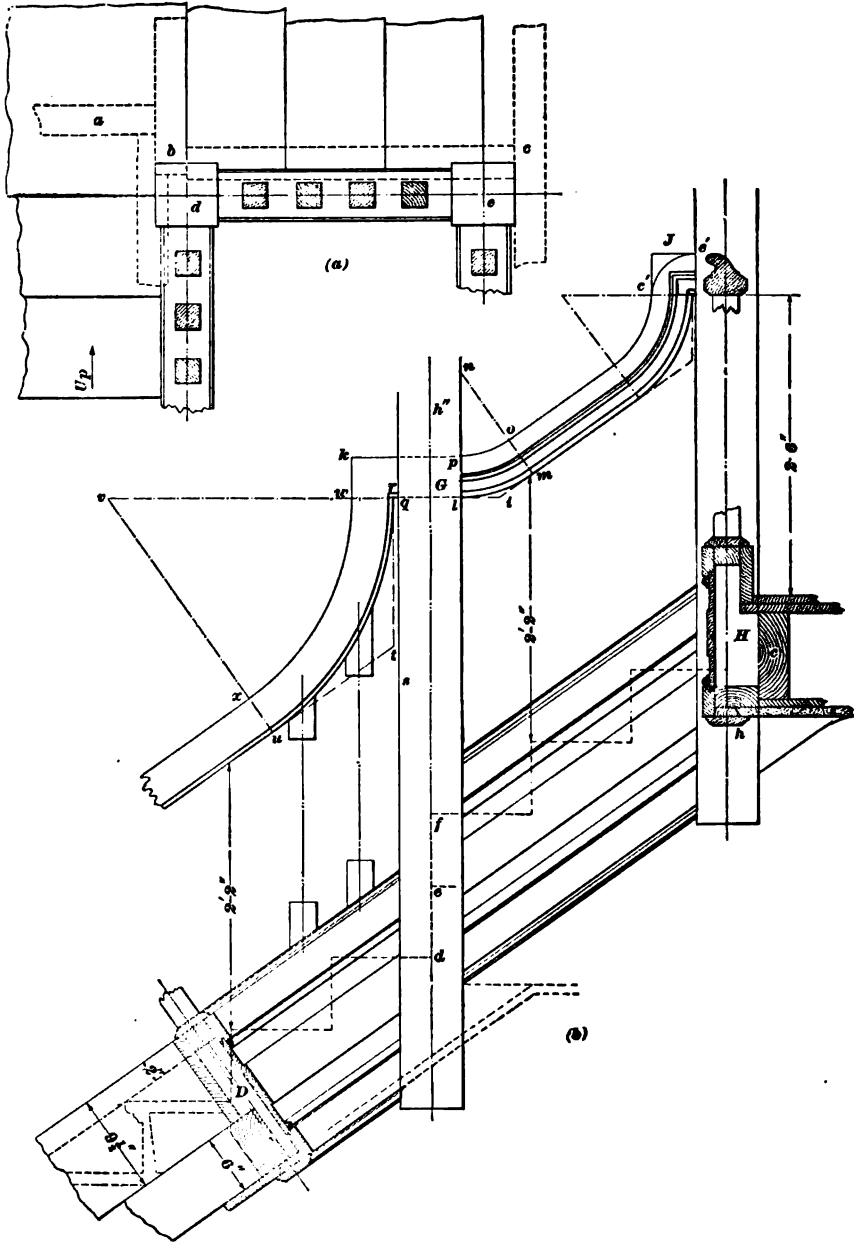


FIG. 30.

37. Close Stringers.—In Fig. 30 are shown a plan (*a*) and an elevation (*b*) of a quarter-platform stairway with 4 risers in the flight adjacent to the landing, close paneled and molded stringers, 6-inch square newels, 2½-inch turned and square base balusters, and a 4" × 4½" double molded hand rail, with ramp and knee, or *goose neck*, connection with newels. In the plan, *a* and *b* are the principal floor-beams of the platform, and *c* is the top landing floor-beam. In drawing the elevation, the first step is to locate the treads and risers as shown by dotted lines. The balusters may be placed at any distance apart that is desirable on close stringers, as their relation to the treads is not noticed. On the plan is shown their relation with reference to the newels, from which measurements should be taken.

Observe, in the elevation of the lower newel, that there are two risers at right angles to each other at the center of the newel, one riser being from the top step of the lower flight to the platform, and one riser from the platform to the first step of the short flight, as shown at *d e f*. In this elevation the portion *d h e' h'* is the elevation, or side view, of the short flight, from *d* to *e* on the plan (*a*). A cross-section of the close stringer, showing the panel, timbers, blocking, etc., is shown at *D*, and from this the connections with the newels are lined in as indicated. The section *H* along the floor level is the same as at *D*, but if this should prove at any time to be too high above the floor, the panels may be reduced in width. Panel work of this character may have stiles at newel connections, and muntins at suitable intervals in the long flights and landing facias.

38. Half Newels.—In neweled stairways, the rails should always finish against a half newel at the wall connection, and the lower ends of the half newels may be shown below the soffit. Where half newels are placed on the walls opposite the platform newels, ornamental flat-arch spandrels may be framed between each newel and half newel, thus finishing the soffit of the platform

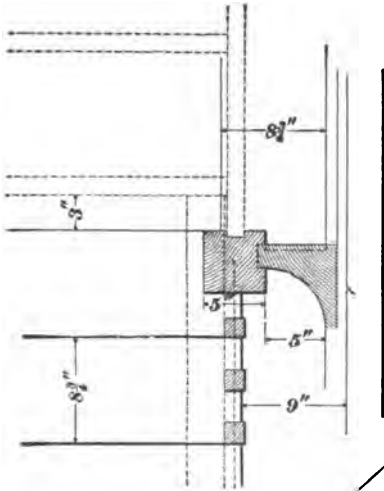


FIG. 81.

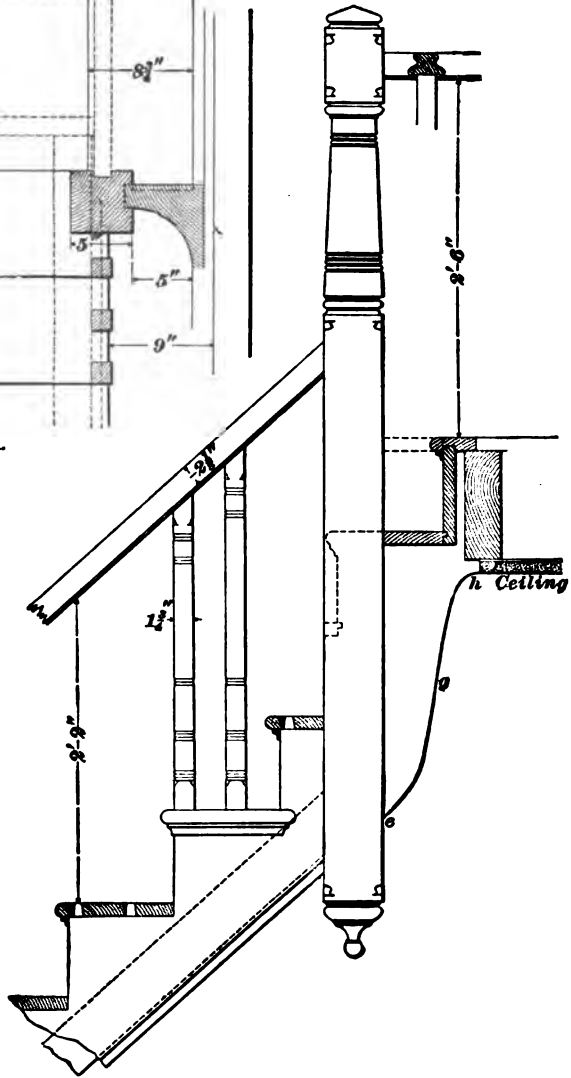


FIG. 82.

39. Newel Posts and Rails.—The length of newel posts is governed by the depth of the stringer, including the soffit molding. Fixing the height of the easement at G , Fig. 30, and the height of the level hand rail at J , the height of the hand rail up the flight is figured, and the rail is made parallel to the line of the stringer. There is nothing important in the position of G , except that it fixes the level of the knee at k .

To produce a good easement, draw the horizontal line li at the required height of the easement and continue the bottom line of the inclined rail until it intersects this horizontal line. Lay off im equal to il and draw mn perpendicular to im . Let mo equal the thickness of the hand rail; from n as a center, describe the easement lines op and ml . For the ramp and knee, make qr from $\frac{1}{2}$ to $1\frac{1}{2}$ inches; perpendicular to qs , draw rv , which is a continuation of il . Draw rt parallel to the newel, and continue the bottom line of rail until it intersects rt ; make tu equal to rt ; from u draw uv at right angles to tu ; make rw equal to the thickness of the rail, and draw wk parallel to qs . With v , the intersection of rv and uv , as a center, describe the arcs ru and wx . The ramp and knee at the upper landing are defined in the same way. The rail may be curved, as indicated by the arc $c'e'$, forming a *goose neck*.

40. Special Arrangement of Newels.—In Figs. 31 and 32 are shown the plan and elevation of a quarter-platform stairway having a quarter-cylinder connection to the landing, thus avoiding the use of a second newel.

41. In Fig. 33 are shown the plan (a), elevation (b), and development (c) of a straight stairway, with a single newel set diagonally at the landing, the stringer facia and hand rail being curved to enter two adjacent faces of the newel. In the plan, $abcd$ is the position of the carriage timber; A and B indicate the position of the floorbeams. Half balusters are set against the sides of the newel to which the hand rails are connected. In the elevation, $a'b'd'c'$ show the depth and position of the carriage timbers, and A is the landing

floorbeam. In the development (c) lay off from the face of the riser, $s'e'$ equal to the corresponding distance on the plan, designated at os ; then lay off $e'h'$ equal to the arc sh on plan; through h' and c' erect perpendiculars for the sides of the newel; through e' draw $e'j$ parallel to the face of the newel; lay off $s''t'$ equal to st in the plan; parallel to $s''j$ draw $t'i$; from the point where this line intersects the

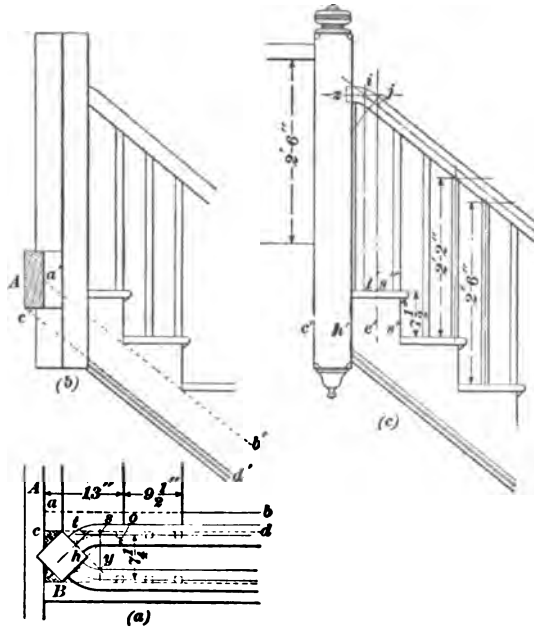


FIG. 88.

center line of the inclined rail draw is parallel to the tread, then jis is the center line of the rail. This fixes the height of the flight rail at the newel; the level rail is 2 ft. 6 in. above the floor. The easement curve at the top of the rail is entirely independent of the horizontal curve on the plan, and may be determined by laying off equal tangents on each side of i and erecting perpendiculars to the respective tangents. The point of intersection of these perpendiculars is the center for the easement curve sj .

The horizontal curve on plan is determined by laying off ts equal to th and drawing perpendiculars sy and hy . Then y is the center for the curves of the rail and stringer.

42. Swelled Steps and Curved Stringers.—For a pleasing effect the start of a stairway is often widened by curving the front stringer, and increasing the width of several treads by curving the risers. Fig. 34 shows a plan of such a stairway and a development of the stringer and rail.

To find the height at which the rail enters the newel, draw the bottom line of the rail through the points where the centers of the short balusters would occur, as at dd' ; set off from dd' the thickness of the rail, 2 inches, and draw the center line of the rail ef . The tangents ck and ca are equal, and k is where the rail joins the newel. Make gf equal to mk ; draw co vertically; through o , draw hj at right angles to co . If the rail is brought to a level on oj , its height will be 10 inches above the bottom step pq . In this development the rail is below its real position a distance the height of a short baluster, or 2 feet 2 inches. This distance, added to 10 inches, gives 3 feet as the distance from the first step pq to the center of the rail at hj . If the rail is without an easement to the newel, as at f , its height will be 2 feet 5 $\frac{3}{4}$ inches.

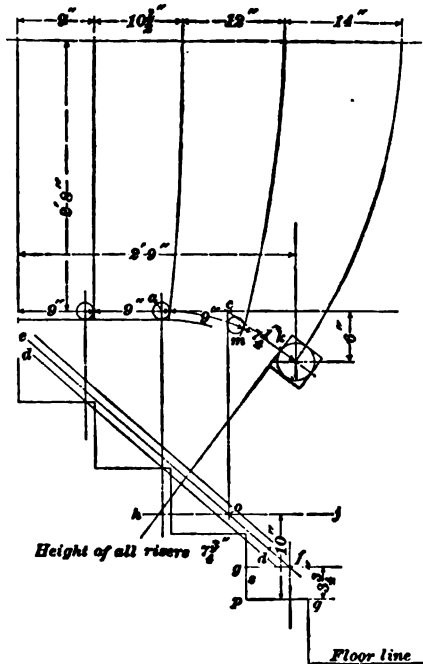


FIG. 34.

In Fig. 35 is shown a stairway starting at the newel with a curved stringer and swelled steps; the newel in this arrangement is to stand on the first step, the riser extending

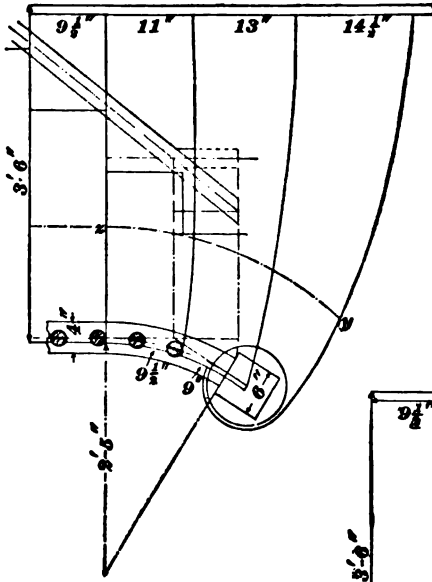


FIG. 35.

method explained for Fig. 34.

In Fig. 36 is shown a plan wherein the stringer is curved as in the previous examples, but, with the exception of the starting one, the risers are made straight.

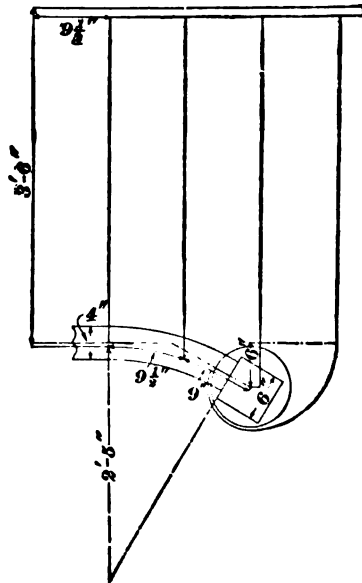


FIG. 36.

43. Curtail Step.—In Fig. 37 is shown a method of describing the curves of a *curtail step*. Begin by drawing a circle of a size greater than that required to enclose the required scroll. Let *abcd* be such a

circle; divide it into 16 equal parts, and let the diameter of the eye of the scroll be equal to ef , in this case 7 inches. The diameter of the eye should always be somewhat greater than the width of the hand rail, which in this case is 6 inches. At right angles to bd , and tangent to the eye, draw $e'i$; from i draw ij , perpendicular to hg ; and so proceed, drawing lines at right angles to the successive radial lines; and continue this process to m , or to any point desired. From the points of intersection m, n , etc., on the radial lines, with

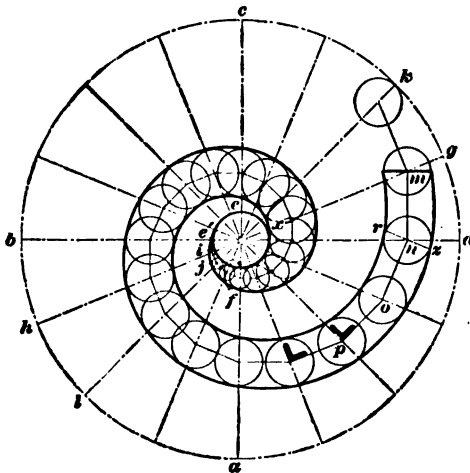


FIG. 37.

a radius equal to 3 inches, or one-half the width of the rail, describe circles as shown until one is tangent to the eye, as at x . From here each successive circle is smaller so as to be tangent to the eye. Tangent to these circles, draw in an outline of the curve of the hand rail.

In Fig. 38 is shown a plan (a) of the curtail step with curved steps receding from same. This plan may be drawn from the dimensions shown, taking as much of the scroll delineated in Fig. 37 as is required to fulfil the conditions. At sr , in Fig. 38, is shown the junction of the scroll with the straight rail. Where the scroll has been developed in a diagram, as shown

in Fig. 37, the whole or any part of it may be transferred to the plan of the stairway, as was done in Fig. 38. In order to fix the height of the wreathed portion of the scroll, draw an elevation of the risers and treads as at (b). Draw the

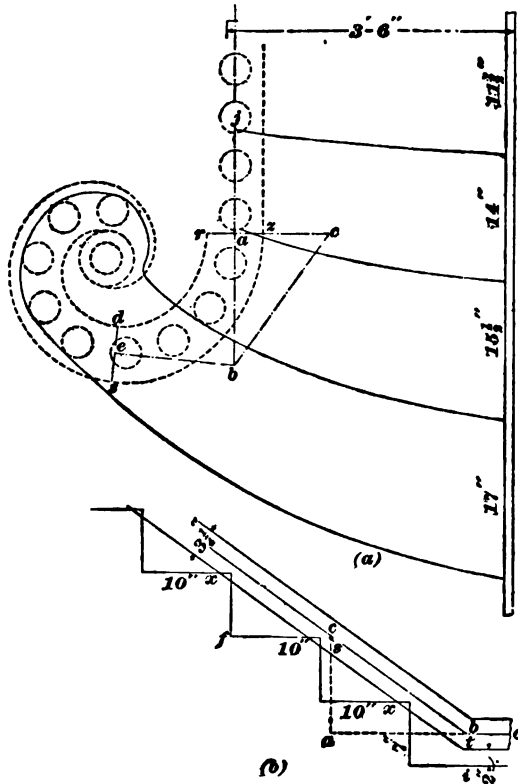


FIG. 38.

bottom line of the rail xx through the points on the treads where the center lines of the short balusters intersect; draw the center line cb of the rail; make fs equal to ja in (a). Parallel to the riser lines, draw ca through s ; make ti equal to, say, 2 inches, thereby fixing the height of the eye and the level portion of the scroll. Make tb equal to one-half the depth of the rail; draw ba parallel to the tread line.

Then, as the bottom line of the scrolled rail is 2 inches above the first step *i*, and the length of a short baluster is 2 feet 2 inches, the height from *i* to *t* will be 2 feet 4 inches, when in position. It is desirable to keep the scrolled rail as low as that shown, so that its varying and pleasing curvature will be seen to the best advantage. In the plan (a), *ab* is the center line of the rail prolonged, and *acb* is taken from lines similarly lettered in (b). From *b*, draw *be* tangent to the center line of the rail at *e*. The joint *sd* is made at right angles to *eb*. From *sd* to *sr* is the wreathed portion of the rail, since it both curves and rises. The remaining portion of the scroll, from *sd* to the eye, is horizontal, as shown by *bo* in the elevation (b), and in this part of the scroll, three or four of

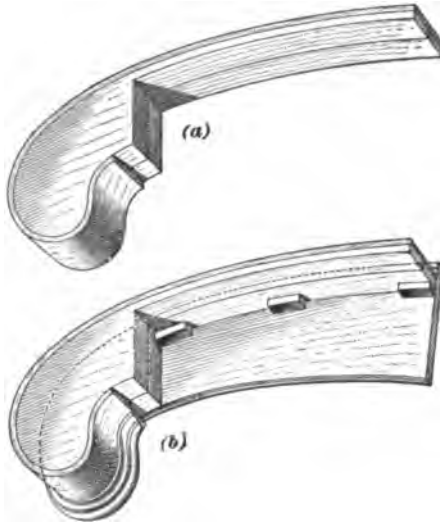


FIG. 39.

the balusters should be bolted to the step at their bases, and to the scrolled rail at their tops. The construction of the veneered riser and scroll block is shown in Fig. 39 (a), and the complete scroll step is shown in (b).

SPECIAL FORMS OF STAIRWAYS.

44. Quarter Platform.—In Fig. 40 is shown a plan of a quarter-platform stairway with a quarter cylinder for a continued hand rail. Any radius of cylinder considered desirable may be used, but if the risers *ob* and *o'b'* be put at a distance equal to one-half the width of a tread from the

point *a*, the intersection of the center lines of the rail, the wreath piece will conform to the common pitch of the flights. If the front stringer is a close one, and the risers are placed as shown, the effect will be more agreeable than it would be if the risers were placed either nearer to, or farther from, the point *a*. This arrangement of the risers will allow a graceful curve in the development of the front stringer and the hand rail, while if placed in any other position, the result would be an unsightly crippled rail and stringer.

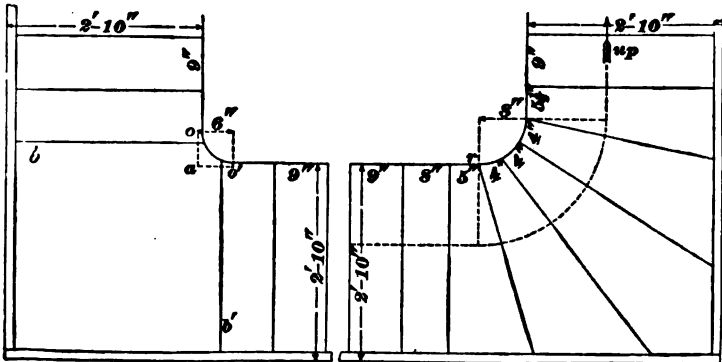


FIG. 40.

FIG. 41.

45. Quarter-Turn Winding.—The plan of a quarter-turn winding stairway, with a quarter cylinder for a continued hand rail, and with regular treads above and below, is shown in Fig. 41. It will be noticed that the treads adjoining the cylinder in both flights are reduced. The benefit derived from the reduction will appear in the curve of the rail and stringer, as it modifies the angle of intersection between the pitch of one straight rail and that over the winders, the stringer, of course, being affected in the same manner.

46. Platform and Curved Risers.—In Fig. 42 is shown a plan of a stairway which includes two platforms with a tread and two curved risers in the 10-inch cylinder between the platforms, making a half turn. The wreathed rail

over this plan has a pleasing shape, and no ramp is required in the straight rail either above or below the wreath.

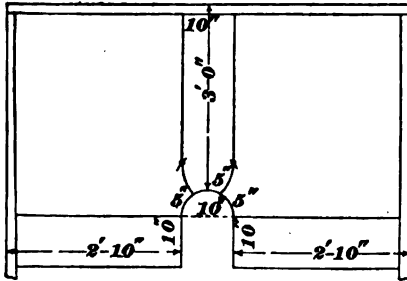


FIG. 42.

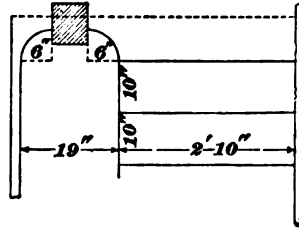


FIG. 43.

47. Newel Between Quarter Cylinders.—Fig. 43 is a plan of a stairway with a newel post set between quarter cylinders on the landing of a flight; the hand rail in this case would be bolted to the newel.

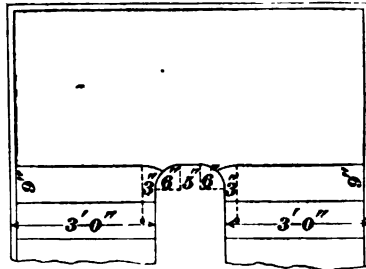


FIG. 44.

48. Half-Turn Platform.—In Fig. 44 is shown a half-turn platform stairway. The face of the top riser of lower flight and of the bottom riser of upper flight have a slight curve adjacent to the flattened cylinder. By this method the whole depth of the cylinder is saved in the width of landing—an advantage where space is limited.

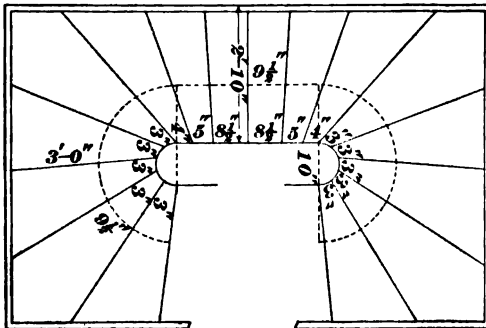


FIG. 45.

49. Winding Stairway.— Fig. 45 is a plan of a winding stairway with 17 risers, and 10-inch cylinders for a continued hand rail. This

arrangement is suitable where space is limited and where the entrance to the staircase is on the side.

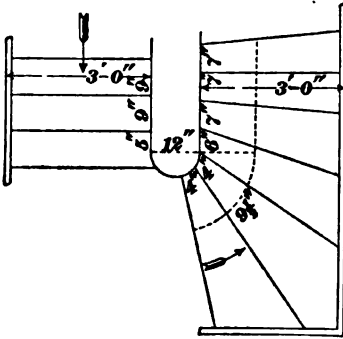


FIG. 46.

50. Arrangement for Intermediate Floor.—Fig. 46 is a plan for the starting and landing of two flights connected by a 12-inch cylinder; such an arrangement is used where the short flight ascends to an intermediate floor on the platform level.

51. Quarter Platform With Tangent Between Quarter Cylinders.—Fig. 47 is a plan of a quarter-platform stairway for a continued hand rail. The cylinder opening of 18 inches is formed by two quarter circles, each of 5 inches radius, and an 8-inch piece of straight stringer between. By this method a platform is secured, and angular winders are dispensed with; the length of the staircase is also reduced.

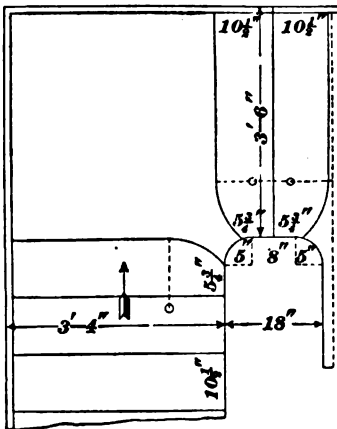


FIG. 47.

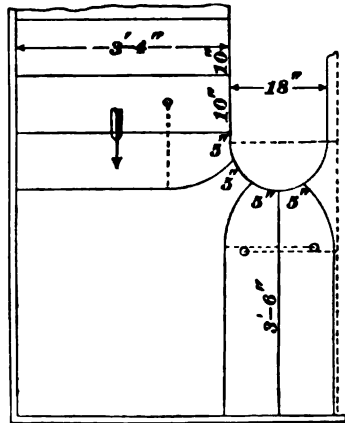


FIG. 48.

52. Quarter Platform With Semicircular Cylinder. Fig. 48 differs from the preceding plan only in the form of its

cylinder, which is semicircular in plan, and, while requiring a little more run, furnishes a more pleasing rail and cylinder.

53. Double Platforms.—Fig. 49 is a plan of a platform stairway making a half turn, one riser at the center of the cylinder dividing the space into two platforms. Where the run will permit, it is always advisable to dispense with this central riser, thus adding breadth to the platform, and avoiding the danger of stumbling at the step placed where it is not expected.

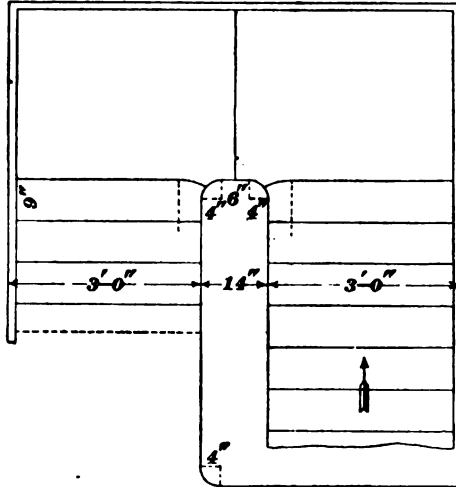


FIG. 49.

54. Quarter Platform With Step.—Fig. 50 is a plan of a quarter-platform stairway with a 15-inch cylinder having a regular step at its center.

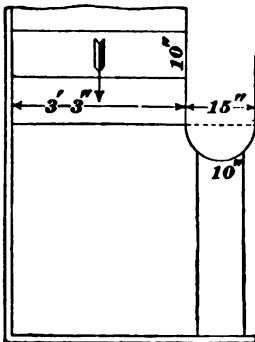


FIG. 50.

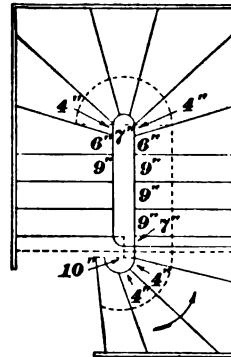


FIG. 51.

55. Three-Quarter Turn.—Fig. 51 is a plan of a winding stairway making a three-quarter turn, the entrance being at one end of the staircase.

56. Starting or Landing Winders.—Fig. 52 is a plan of a stairway which has winders either at the starting or at the landing. The curving of the risers is resorted to for the purpose of making them occupy less room from *l* to *m*. Curving the risers in this manner also improves the appearance of the stairway, by reducing its angularity.

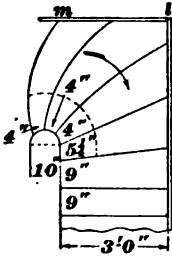


FIG. 52.

57. Quarter Platform With Newels.—

Fig. 53 is a plan of a quarter-platform stairway with small newels framed to the stringers in the angles; the hand rail may join the newels either straight, or with easements and with ramp and knee, or with a goose neck. The curved risers are introduced to save the space in the run of the flights.

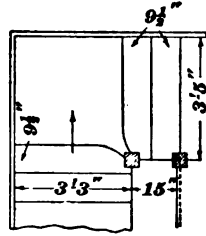


FIG. 53.

58. Platform Stairway With Two Return Flights. Fig. 54 is a plan of a platform stairway with two return,

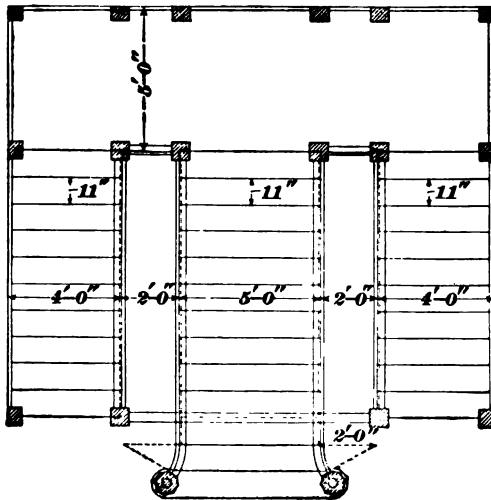


FIG. 54.

or *wing*, flights, suitable for a public building. The flights and platform may be wainscoted, and, by the introduction of half newels set against the wall opposite the regular newels, a good structural effect is obtained. The regular and wall newels may be carried up as columns and pilasters, further improving the treatment. Flat, ornamental arches may be introduced between the newels and half newels where they extend below the soffit of the platform, to break up and panel the soffit spaces. For a public stairway of this character, in either wood or iron, a better effect is produced by omitting the plaster and showing the framework.

59. Circular Stairway.—A plan of a circular stairway is shown in Fig. 55; all the risers except the three curved ones at the start radiate from the center *b*, and are equally spaced at the front and wall stringers. The front stringer along the first two steps is curved out, to increase the width of the stairway at the start, thus giving it a more pleasing appearance. A curtail step and hand rail at the starting of such a stairway are very appropriate and attractive. The dotted lines indicate the position of the carriage timbers. A similar method may be followed for elliptic stairways.

Instead of a cylindrical front stringer, as in this plan, a circular newel post of sufficient length is sometimes used as a central support, the treads and risers being framed into the central newel and into the wall stringer. The newel post may be cased with $\frac{7}{8}$ -inch boards of the same width as the treads at the point of connection, affording support and enclosure like mortises, to the steps; the grooves for the risers

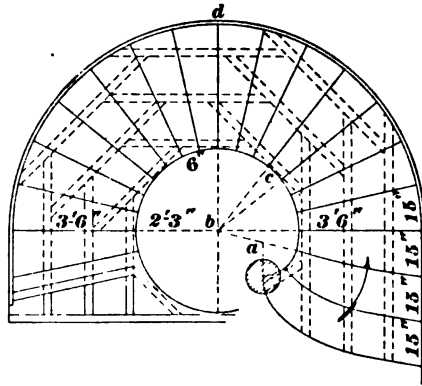


FIG. 55.

may also be cut out from the edge of the boards, thereby rigidly securing them. This casing, or staving, would not be set in place until the steps were all nailed in position.

60. Elliptic Stairway.—In Fig. 56 is shown a plan of an elliptic stairway. The usual method of providing a uniform width for the treads along the wall stringer, and also along the front stringer, causes some of the risers to stand

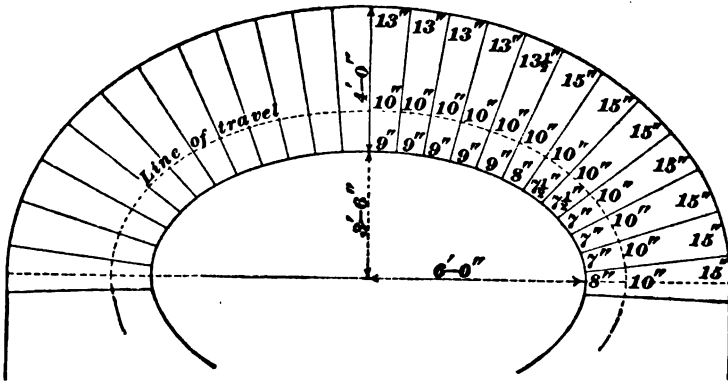


FIG. 56.

at such an angle with the line of travel as to diminish the width of treads at those points. It has the advantage, however, of giving the hand rail a uniform pitch from end to end. In the plan shown, the treads are divided equally on the line of travel, and the risers are drawn as nearly as possible normal to the front stringer.

WAINSCOTING.

61. The paneled wall lining for halls and stairways is made of various heights, the arrangement and treatment of the panels being varied to meet the ideas of the designer. In Fig. 57 is shown a portion of wainscoting as it passes from the hall up the flight. A vertical section of the framework, panels and moldings as usually made, is shown at *D*, in which *a* is the baseboard; *b*, the bottom rail; *c*, the panels;

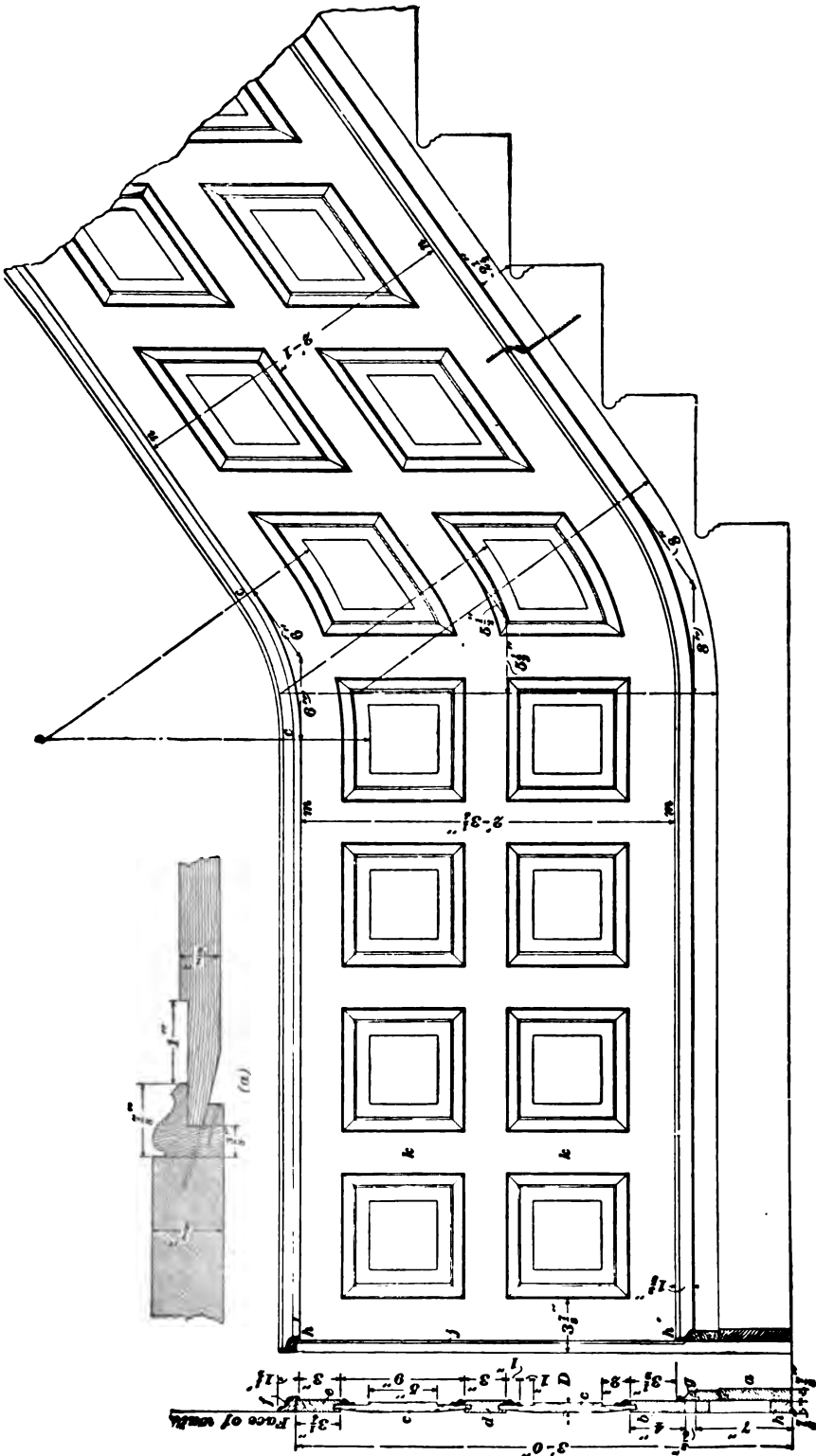


FIG. 57.

d, the middle rail; *e*, the top rail; *f*, the cap molding; *g*, the base molding; and *h*, the furring strip. In the elevation, *h' h'* is a stile with a groove *j* to receive the return wainscoting; at *k*, *k* are muntins. The stile *h' h'* extends the whole height, and the three rails are framed into it. The panels are square on the level portion, but up the flight they become lower, as the width of the wainscot *n n* is less than the width *m m*. The curves at the junction of the pitch and level lines are described from three different centers, as shown. The curves cannot be described from a common center, as the two portions are not of the same width. By producing the tangents of the level and inclined portions of the top, bottom, and central rails, and deciding on the length of the curves, radial lines may be drawn from the points, as at *c*, *c*, thus locating the center, from which simple curves may be drawn. At (*a*) is shown a method of fastening the panels whereby no nails show on the face of the molding.

The panels are polished separately, and put in place after the frame and moldings are finished. The framework should be well seasoned, and the walls should be perfectly dry before the wainscoting is set in position.

ORNAMENTAL IRONWORK.

INTRODUCTION.

1. Iron is used in building construction to serve two purposes, one structural and the other ornamental; but becomes an element of architectural consideration only when both purposes are combined. Unfortunately, the facility with which iron may be cast or wrought into any desired form, renders the execution of the whole facade of a building as simple as though it were constructed of wood, and imbues the ironwork designer with a tendency to ignore the characteristics of the material with which he is working, and to execute columns, capitals, and friezes in cast iron, with fidelity to original examples which were carved in stone, and whose designs are ill suited to iron.

However, the incombustible character of this material, and the fact that its use materially shortens the time and decreases the expense of erecting a building, render it certain that iron as a building material is as important at the dawn of the twentieth century, as was stone before the Christian era; and instead of condemning it as an "unarchitectural material," as some are inclined to do, it is our duty to study its character and possibilities in design, and to develop a system or scheme of design which will be consistent with the conditions imposed by the material and its structural use.

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To do this it will be necessary for the student to understand the method of manufacture, and difficulties attendant upon the execution of any design in ironwork, so that in preparing a design he may keep it free from impossible demands. For instance, if the design is for a piece of cast-iron work, the designer must provide a means of molding the form properly, and of getting the fluid metal into the mold without injuring any of the finer details. If the design is for a piece of wrought-iron work, such as a grille or a railing, provision must be made for enough space to permit riveting, hand welding, etc.

Thus it will be seen that a careful consideration of the methods used in general shop practice, will be the best way for the ironwork designer to advance in the comprehension of his work. This section will, therefore, treat of the details of shop and field work in connection with the manufacture of iron for architectural purposes; and, therefore, the illustrations of working drawings used herein to elucidate the text are reproductions of drawings which have actually been used in the preparation of ironwork for some of the most important buildings.

The first part of the paper will consider cast-iron work, while the manufacture of wrought iron and the combination of cast and wrought iron will follow consecutively.

CAST-IRON WORK.

METHOD OF MANUFACTURE.

DEFINITIONS OF TERMS.

2. **Cast iron** is the term given to that quality of iron which exists when the melted metal is poured into a suitable receptacle, or *mold*, and allowed to cool and solidify. Cast iron is hard, brittle, and somewhat crystalline in its composition—that is, it shows on its fractured surfaces an appearance resembling an aggregation of small crystals,

instead of a fibrous fracture like wrought iron. It is used, architecturally, for columns and newel posts, and, under certain conditions, for lintels or beams; but, owing to its lack of elasticity, it is not well adapted to conditions of transverse strain. It is also formed into slabs for the purpose of stair treads, pavements, etc., and some forms of ornament are cast and attached to purely structural details.

3. Molds are the receptacles into which the molten metal is poured to give it some definite form consistent with the purpose the cast iron is to serve in the building. The molds are made by impressing in sand a cavity or a number of cavities which correspond, in shape and relation of parts, with the contour of the object to be cast. The process of so impressing the sand is called *molding*, and is effected by means of a wood or plaster model of the object, called a *pattern*, which is so embedded in the sand that it will leave its impress when withdrawn.

4. Patterns are generally made of wood, though sometimes of plaster, and occasionally partly of each. Where there are to be a great many castings of one kind, the pattern is sometimes made of bronze or iron, in order to stand the wear, but even in such cases the bronze or iron pattern would be cast in a mold originally impressed with a wood or plaster model. Whether a pattern shall be of wood or plaster depends entirely on the character of the work. Plain straight work, such as molded panels, stair strings, columns, etc., is generally made of wood; but ornamented moldings, decorated panels, complicated capitals, etc. are first modeled in clay or wax, from which a cast is taken in plaster.

All patterns must have an allowance made for **shrinkage**—that is, the contraction and consequent decrease in size which every casting undergoes in the process of cooling. In ordinary work this amounts to about $\frac{1}{8}$ inch per foot in every direction, so that the patternmaker in working from full-size drawings must use a *shrinkage rule* to lay out his work. The shrinkage rule is usually a little over 2 feet in length and

the divisions on it corresponding to 1 foot are in reality 1 foot and $\frac{1}{8}$ inch, and the subdivisions are proportionately excessive. Consequently, the pattern for a cast-iron bar 1 foot long, 3 inches wide, and $1\frac{1}{2}$ inches thick, would measure 1 ft. $0\frac{1}{8}$ in. long, $3\frac{1}{8}$ inches wide, and $1\frac{3}{8}$ inches thick.

In order that they may be freely withdrawn from the mold, patterns are worked with a **draft**, or taper. For example, if the object to be cast is a solid bar 1 ft. 3 in. long and 3 inches square in section, as at (a), Fig. 1, it

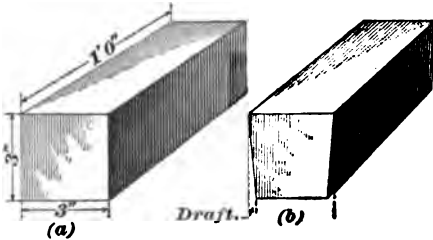


FIG. 1.

would be found in lifting the pattern from the mold that the sand had a tendency to cling to the sides and thus destroy the mold. But if the sides of the pattern are slightly beveled, as at (b), this

tendency is overcome, and the sides of the mold are left clean and sharp; therefore, in all cases where it is possible, all surfaces that occupy a vertical position in the mold should have an allowance for *draft*. The exact amount of this allowance cannot be given, as in some cases it is desirable that there should be as little as possible, while in others it may be quite considerable without in any way impairing either the purpose or the appearance of the part.

5. Casting is the operation of pouring the molten iron through the inlets—or *gates*, as they are called—into the sand mold from which the pattern has been withdrawn. All the above described details culminate in the casting. The making of the pattern, with its allowances for shrinkage and draft, the preparation of the mold with its inlets and gates, and all the details attendant thereon, are for the sole purpose of securing a perfect casting, and all conditions and contingencies must be considered before the metal is poured.

6. Suppose, for example, a newel post, such as is shown in Fig. 2 (d), is to be cast with ornamental panels on each of the

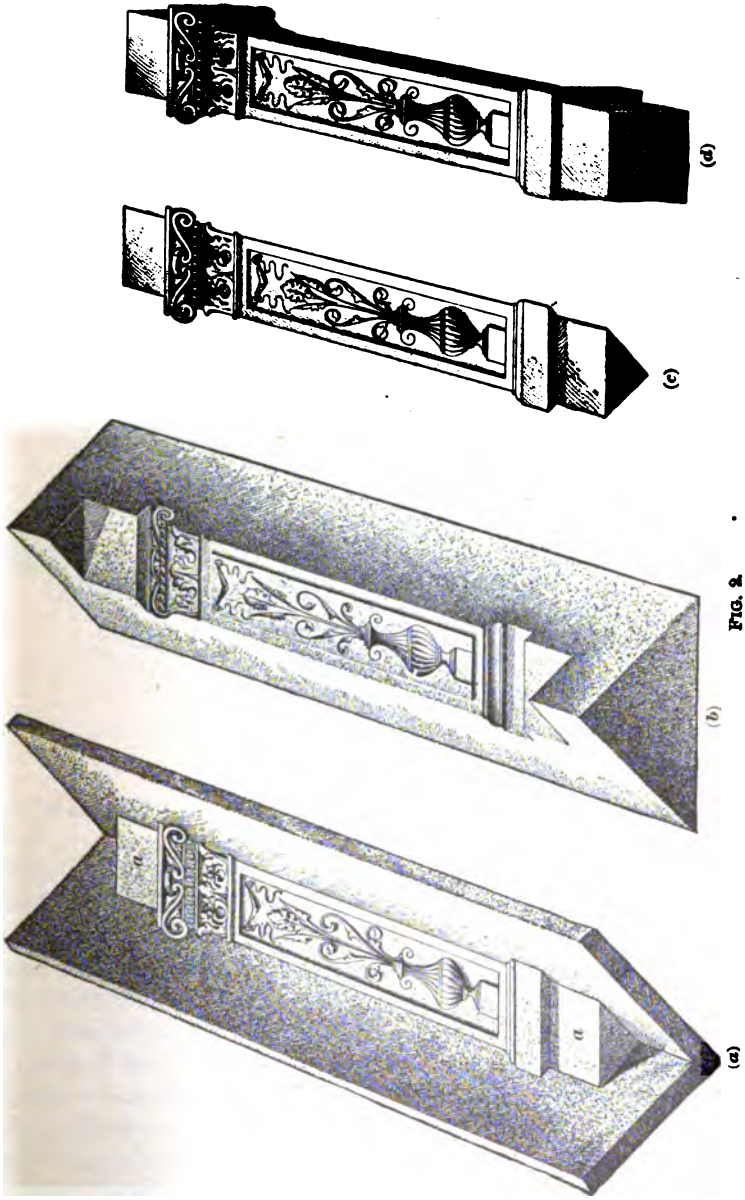


FIG. 2.

four sides. The first step is to prepare the model; and, as all sides are alike, one complete side is therefore modeled in clay, from which plaster casts are taken and combined to form the complete pattern shown in Fig. 2 (*d*). The simplest method of making this pattern is in halves, with the joint at the corners. One-half of the pattern is then laid on a board, as shown at *a*, Fig. 3; and one-half of the mold-



FIG. 3.

ing box *c* is laid over the board *b*, as shown. The sand is then rammed tightly all around and over the pattern, and the mold turned upside down. The board *b* is now removed, and the other half of the pattern is laid in place. The upper part of the molding box is then placed over the lower part, and filled with sand around the upper half of the pattern, as before. The top part of the mold is now lifted off and the pattern withdrawn, leaving one-half of the mold, as shown at (*b*), Fig. 4; but, as the casting is to be hollow, a *core* will be necessary to form the cavity. This core consists of a block or bar of sand, the size and shape of the hollow portion, or inside of the casting, as shown at *d*, Fig. 4. The core is supported at each end in recesses *g* formed for the

purpose by projections on the pattern called *core prints*. When the core *d* is in place, the recess *f* shows the thickness the metal will be when the newel is cast.

The core is made of sand mixed with oil and flour, or some similar composition, and is molded in a box especially made for it; it is then baked hard in an oven before it is ready for use. The core being adjusted, the molding box is closed.

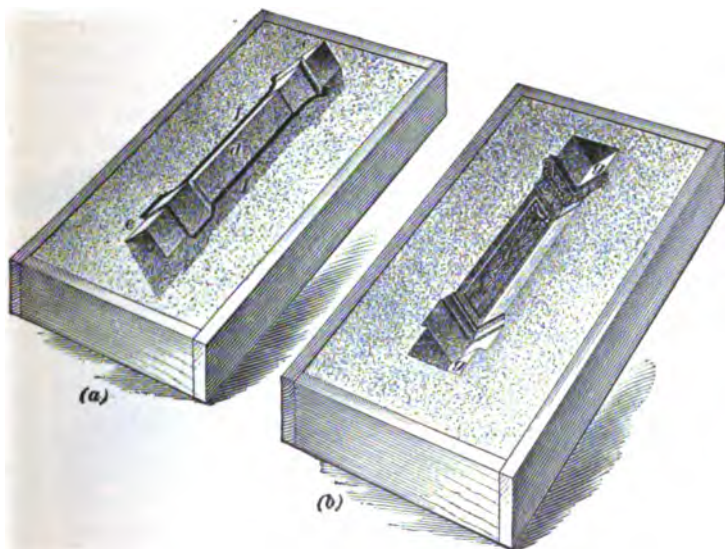
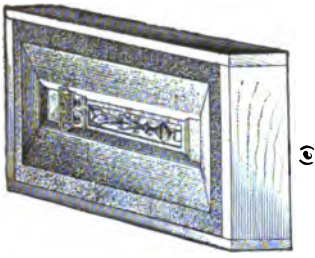


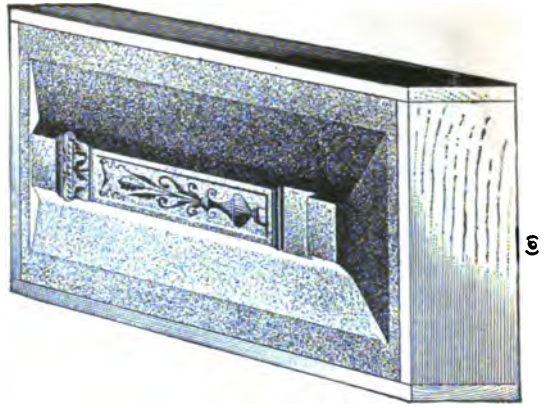
FIG. 4.

and the two halves are clamped firmly together. When filling the top part of the molding box with sand, a passage is formed reaching down to the part to be occupied by the cast metal; small holes are also left for the gases to escape which might otherwise destroy the mold by explosion when the molten metal is poured through.

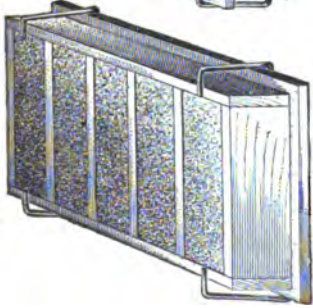
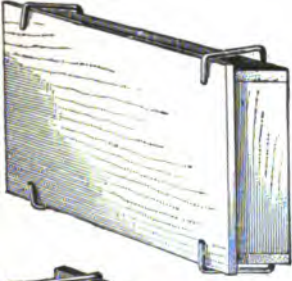
This method of molding is the simplest, and is perfectly suitable for any plain casting, but in a more elaborate piece of work, the ornament of which is *undercut*, as it is termed, a different method must be resorted to, or the undercut portions, when withdrawn from the mold, will tear out a part of the sand with them. There are several devices for overcoming



(c)

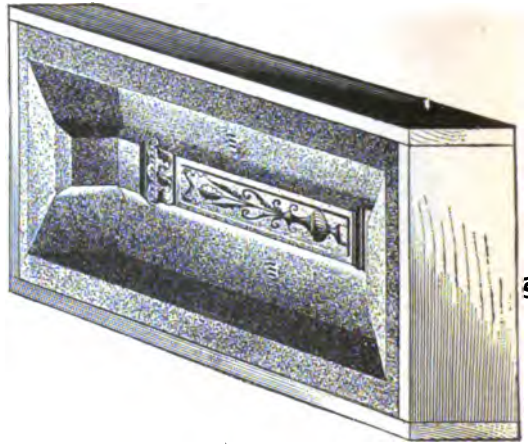


(c)

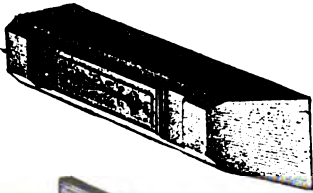


(e)

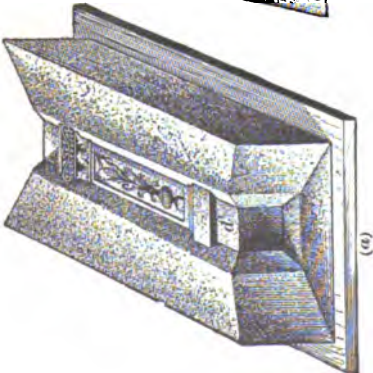
FIG. 5



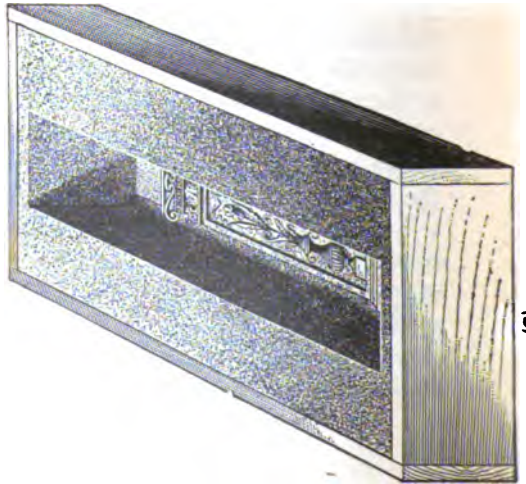
(b) FIG. 6



(b)



(a)



(a)

this difficulty, such as making these parts loose or detachable on the pattern, so that after withdrawing the main part of the pattern, these pieces are left in the mold and can be picked out separately. A better method is to prepare a pattern of plaster somewhat as follows:

7. In the angle formed between two wood or plaster slabs, set as shown in Fig. 2 (*a*), the pattern is molded in clay, leaving a projection at each end, as shown at *a*, to form the core print.

When the clay model is complete, it is coated with shellac varnish, and the sides of the slabs are oiled. A plaster cast is then taken of the clay model, as shown in Fig. 2 (*b*). This mold, when it is dry, is itself oiled, and from it are made four additional plaster casts, as shown in Fig. 2 (*c*). The purpose for modeling the original pattern in the angle between two slabs is now apparent, for in molding the four final casts the plaster is simply poured on top of the mold, Fig. 2 (*b*), and roughly heaped up to form a ridge; then, by drawing a straightedge against each side of the mold in turn, the resulting casts are properly mitered, and may be secured together with shellac, forming a complete model, as shown in Fig. 2 (*d*). The undercut portions are so arranged that no seams, loose parts, or cores are necessary, and the danger of displacement is overcome by treating the pattern as follows: The pattern is laid on a board and leveled up, as shown at *d*, Fig. 5 (*a*). The ornament at several points may rest on the board, but the body will be clear. It is then bedded up with clay, sloping the clay from the line of the lower edge of the pattern gradually down to the level of the board; then the pattern is oiled to keep the wet plaster from sticking, and a plaster cast is made of both sides, sloping the plaster upwards to the top edge, and beveling the sides and ends as shown, the object of which will be seen hereafter.

In Fig. 5 (*a*) the pattern is shown resting on a board, with the two plaster casts of the sides completed and lying against it. These casts or molds, when detached, appear as shown in Fig. 5 (*b*).

In the same manner, a plaster mold is made from each of these blocks. As these molds will be used in the foundry repeatedly, they should have a rough wooden frame to protect them from fracture, as shown in Fig. 6 (*a*).

Two blocks, such as shown in Fig. 5 (*b*), are attached firmly with shellac to each side of the original pattern, thus bringing it back to the form shown in Fig. 5 (*a*). The pattern thus treated is ready to be put in the sand.

The pattern *d*, Fig. 5 (*a*), is now laid on the molding board, and one-half of the molding box placed over it, and rammed full of sand, as shown in Fig. 5 (*c*). It is then turned over in the position shown in Fig. 5 (*d*), and the temporary clamps and the molding board are removed. The face of the pattern when brushed off will then appear, as shown in Fig. 5 (*e*). The upper part of the box is then put in place and rammed up with sand, and then the box is opened and the pattern removed. The mold is left one-half in the lower box, as shown in Fig. 6 (*b*), and one-half in the upper box, as shown in Fig. 6 (*c*). The plaster mold, Fig. 6 (*a*), is filled with sand, and also the corresponding mold for the other side, thus making two blocks which correspond in shape and size with the recesses *m*, *m* left in the mold, Fig. 6 (*b*), into which they are carefully slipped. The core is put in place and the molding box closed. The mold is now ready for the metal, it being understood that gates and outlets have been provided.

8. In the process of casting, it is not good practice to have heavy members cast adjacent to much lighter ones, because, as the lighter parts cool so quickly, compared with the heavy portions, the result would be disastrous, on account of the unequal shrinkage of the metal. The thin members do all their shrinking in a very short time, and in so doing are likely to crack away from the thicker parts, which would have retained the heat longer and consequently have shrunk to a lesser degree. This is not to be taken to mean that every casting must be one dead level of thickness all through, but where there are variations of this sort adjoining, thick

and thin sections should be graded gradually together, avoiding as much as possible any very abrupt transition from one to the other.

A casting designed without regard to this matter may be molded successfully, and, in some cases, the unequal shrinkage of the parts avoided by opening the box as soon as the iron has had time to solidify, and exposing the thick portions to the atmosphere, while the thinner parts remain covered with the sand, that they may retain the heat for a longer period, thereby somewhat equalizing matters. The fact remains even then that there would be a certain amount of latent strain left, likely to be sufficient to cause a subsequent fracture when the casting is subjected to a sudden jar or impact.

Having thus far described the use of iron as a medium for decoration, and the processes generally used for cast-iron patternmaking, molding, and casting, the different structures and parts generally made of iron will now be considered.

STRUCTURAL DETAILS.

9. **Screws and Bolts.**—In Fig. 7 at (a) is shown what is termed a *square-head* bolt. These are used for all common connections, such as the joining of two flanges or other

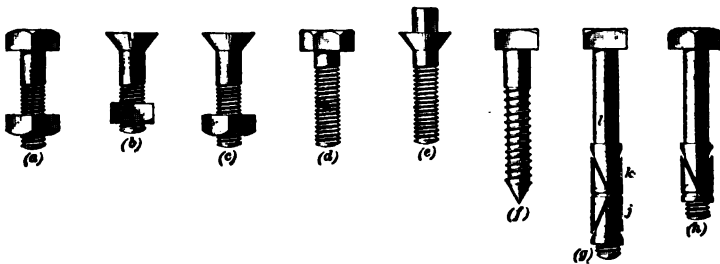


FIG. 7.

surfaces which are not exposed to view. At (b) is shown a *screw-head* bolt, which is used for work where a countersunk head is necessary in order to obtain a smooth surface, the

slot in the head being filled with putty after the work is in place.

At (c) is shown a *countersunk-head* bolt used for the same purpose as a screw head, and also for securing wooden stair treads to wrought-iron strings, so as to permit the head to finish flush with the tread. A *button-head* bolt with a square shoulder is also used for the same purpose, the shoulder aiding in the tightening of the nut. The countersunk bolt is also used in joining flat surfaces where a smooth finish is required. At (d) is shown a *tap bolt*. This is used for all connections where it would be impossible to get a nut on the end. The hole into which this bolt is to be screwed has a thread cut in it, or is *tapped*, as the technical phrase would express it.

At (e) is shown a countersunk tap bolt which is used where very heavy work is to be joined, and requires a smooth-finished surface. After the bolt has been tightened up by the aid of a wrench, the square head is cut off.

Lagscrews, shown at (f), are used to secure iron to stonework or woodwork; a plug of soft metal or wood is driven in a hole drilled in the stonework and into this the screw is inserted.

At (g) is shown a double-expansion bolt, which is used for fastening work to smooth surfaces, as brick or stone walls. This bolt consists of four pieces and a nut. The bolt is inserted in a hole drilled in the wall for it, and over it is slipped the expansion piece *j*; the expansion piece *k* is then put in place, and finally the expansion socket *l*. The nut is then turned down against the article to be secured, and the expansion socket *l* is forced down, while the bolt draws up, and the prongs on *j* and *k* expand, taking hold in the stonework and binding in the strongest manner possible. The single-expansion bolt (*h*) acts in the same way, and is used for the same purpose. The chief advantage of these bolts is that they may be taken out without damage to the surrounding stonework.

Expansion bolts are also made with screw heads, for use where the surface will be exposed to view.

10. Mullions.—A window such as shown in Fig. 8 is sometimes so wide that it requires a mullion, and the design of this mullion must be consistent with the rest of the building, no matter what its construction may be. There are three ways of constructing the mullion: (1) with an upright **I** beam, and cast-iron facing, as shown in plan at (a);

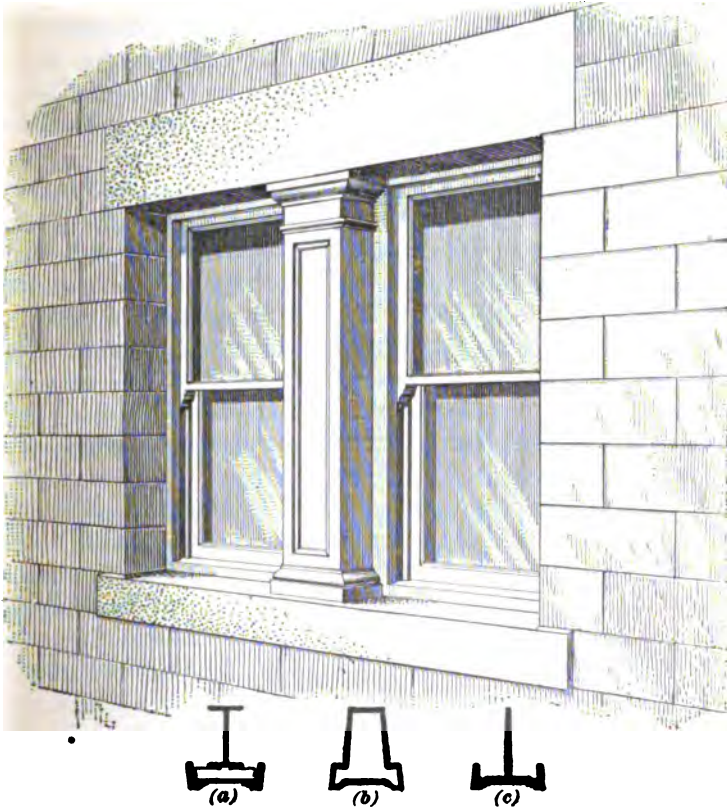


FIG. 8.

(2) with a cast-iron box on which the ornament is cast, as at (b); and (3) a modification of the two preceding, which consists of a **T**-shaped casting with the ornament on the face, as at (c). The advantage of the first method is that the ornament may be applied without regard to the structural

support, while in the other two, sufficient allowance must be made in the thickness of the metal to proportion the support to the load.

In the first example (*a*), the cast-iron facing is screwed or bolted to the **I** beam. The decoration may be a simple panel as shown, or a highly ornamented arabesque, according to the requirements of the design, for so long as the sides are plain, the casting of the mullion presents no particular difficulty, being but a plain panel, the pattern for which would be of wood about $\frac{1}{2}$ inch thick with the sides slightly beveled or drafted to allow it to be drawn freely from the mold.

The length of the mullion is 8 feet; therefore, the pattern should be 8 ft. 1 in. in length, to allow for shrinkage.

If the design of the mullion be ornamental, the pattern may be entirely of plaster, or the body of wood and the ornament modeled in clay. If there are to be a number of these mullions in the facade, only one model is made; and, by covering this with plaster of Paris, a mold is obtained from which any number of wax duplicates can be cast of the original, which are then mounted on the body of the pattern for the mullion.

In the second case (*b*), the pattern should be made in a similar manner to (*a*), but, in addition, a core box is necessary, in which the sand core is made to be placed in the mold so that the desired thickness of metal is obtained. The sides of this mullion are checked or rebated to receive the window frames, while in (*a*) and (*c*) the frame passes back of the reveal or side.

The third case (*c*) should only be used where the superimposed load is small; its chief advantage lies in the fact that it does away with the use of the **I** beam without requiring a core for the casting, saving thereby both in the cost of manufacture and in the setting.

11. Window Frames.—The section of the window soffit shown at Fig. 9 shows a cast-iron frame, the outer edge of which takes the place of the weather stop, and is

ornamented with an egg-and-dart molding. The section of the iron jamb and head shown at *a* are for either a stationary window set directly in the iron frame or a French sash window, the hinges of which are secured to the iron frame with countersunk tap screws; or, when a wooden hanging stile is introduced, as shown at *b*, a pivoted sash may be used. The decoration of the weather stop and the inside of the frame should conform to the general design of the building.

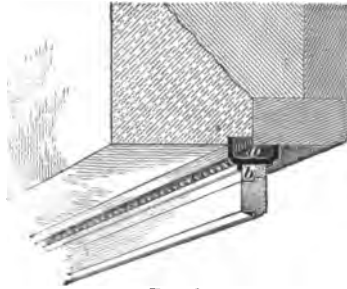


FIG. 9.

The pattern for the body of the frame would be modeled in wood, and the decorated parts done in clay, cast in plaster, and applied to the body of the pattern. The outer and inner faces of the frame should have considerable draft, as shown, so that the casting may be easily withdrawn from the mold. If the requirements of the case demand a transom bar in the frame, its construction should be somewhat as shown at *e*, Fig. 10. A lug is cast on each side of the frame, and the transom bar is secured to these lugs with countersunk screws. The position of the sash is shown at *f*, and the transom may be hung directly from the iron frame at the top, or pivoted, as described in Fig. 9.

12. It frequently happens that the window-frame casting includes the outside casing and molded reveal, as in Fig. 10, which shows a richly ornate soffit. In this case the reveal of the soffit *a*, or the jamb at the side of the opening, is first set, then the frame *b* is put in place, and last the casing, or architrave, *c*, the head of which is checked into the stone. The only difference in the modeling and casting of these pieces is that the architrave *c* has the rosette ornament, while the reveal *b* has a repeating ornament modeled and cast separately. By this procedure, only one model is required for the rosette, and one for the repeating ornament;

and castings from these are taken until the required quantity is obtained. Thus, in case of a failure in casting the ornament, the entire casting of the soffit or architrave is not

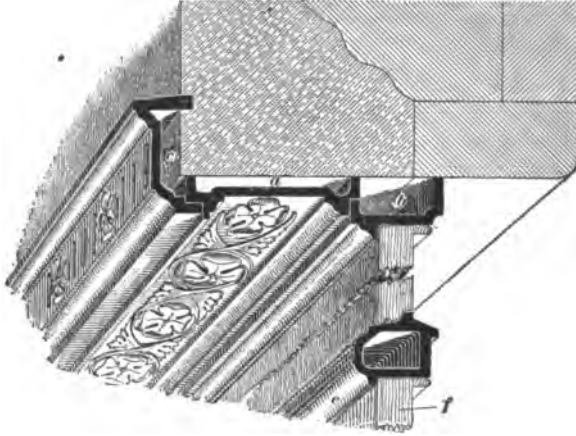


FIG. 10.

made worthless, as it would be if the ornament was cast with the main detail in one piece and a portion of the ornament proved defective.

13. Door frames may be most elaborate, or plain and simple. As a rule, when cast iron is used for a door frame,

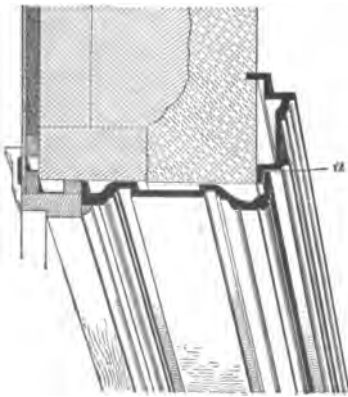


FIG. 11.

it is more properly a jamb and architrave, though in some cases the door frame proper is of iron, the same as a window frame, and the hinge butts are secured directly to it, unless a regular wooden door frame has been provided. The design shown in the illustration, Fig. 11, is the soffit of a simple molded jamb and architrave, the wooden door frame fitted against it. Both

the jamb and the architrave are secured to the stonework with expansion bolts, and the joints bolted together with countersunk screw bolts. In designing a door frame, the two chief points to bear in mind are the "draft" and the proper location of the joint between the two pieces. All joints of this character should be specially designed, and so placed that they may form the meeting line between two moldings, as shown at *a*, so that they may be practically invisible. In very large work, and in buildings that are entirely of iron construction, it is better to set up a series of jamb pieces 2 feet apart, of 2" x 2" angle iron to bolt the door jambs to, the inside ends of which have knees, to which the door frame proper is bolted. The architrave should also have an angle-iron frame set up against the stonework and secured with expansion bolts, and the architrave should be secured to this with countersunk screw bolts.

CAST-IRON STAIRS.

STRAIGHT-RUN STAIRS.

14. Stairways in public buildings should be of iron, and by reason of the prominence of their location it is usually necessary that their design should be in accordance with their surroundings. A number of stairways are herein shown, not to give a variety of examples, but to illustrate the different conditions that are likely to arise in building. Any of these designs may be stripped of its ornament and be used in the plainest of structures, or the ornament may be increased and the design made suitable for a most elaborate interior. The stairs shown in Fig. 12 are suitable for such use as a basement stairway, or in a place where two floors are leased or used by one occupant, and a communication between them is necessary independent of the public halls and stairs.

15. In laying out the drawings for this flight of stairs, locate the center line of the newel *d* one inch from the face of the beam *e*, and the face of the last riser at the center of

the newel, and from this riser measure off 15 times 10 inches, or 150 inches (there being 15 treads), which will be 12 ft. 6 in., and there locate the position of the face of the first

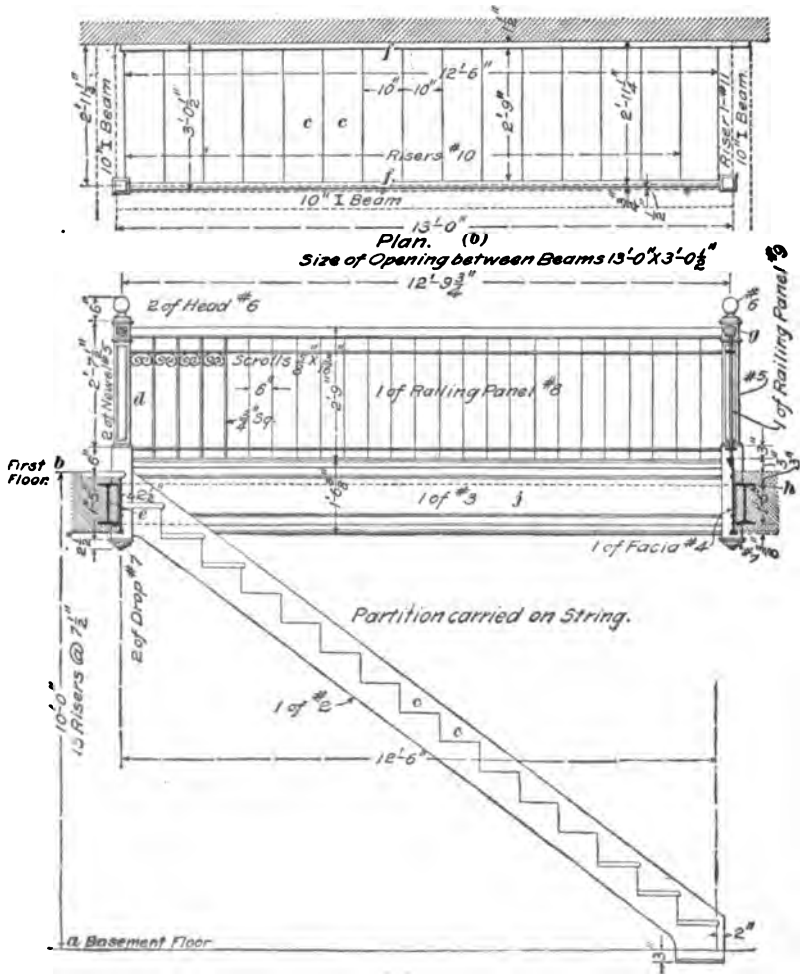


FIG. 12.

riser. The framed opening of the well through which the stair is raised is more than the length of the stair, so that

the headroom does not necessarily have to be considered. The width of the opening is 3 feet, and the strings *f* must not be more than that distance apart over all. The rise, the tread, and the position of the newel, the first and the last riser, and the width of the opening being fixed, a plan, as at (*b*), should be laid out, then the section (*a*), which shows the inside face of the string which finishes against the newel. The outer string should be similarly laid out. The next point to consider is the finish of the well; this, as shown in the section (*a*), has a molded fascia *j*, a light hand rail of wood, and a balustrade of wrought iron composed of $\frac{3}{4}$ -inch square balusters with a top and a bottom rail, and two additional rails forming a frieze and dado through which the balusters pass, making a very stiff rail. The moldings on the fascia *j* are so placed that they come inside the face of the wall string, as shown at *f*, against which they abut. The newel *g* and the end rail are set $1\frac{1}{4}$ inches from the flange of the beam *h*. These points fixed, the general layout is complete and the next procedure is to make the several parts in detail.

16. The first piece to detail is the string *f*, the sectional shape of which is shown at *i*, Fig. 13 (*c*). The lug *k* is cast on the string, and supports the ends of the treads. The heads of the strings are cast with the base or lower part of the newel on them, and are shown in plan at *d*, Fig. 13 (*b*), and in section and elevation at (*a*). The plan (*b*) shows a lug *l* cast on the back of the newel which holds the string in place, and is secured to the flange of the beam with a hexagonal-headed bolt; the lug *m* is cast on the inside of the newel to receive the last riser. The stair strings are stiffened and anchored to the walls by the plate and brace device shown at *u* in Fig. 13 (*c*), and are set sufficiently far from the wall to receive the plaster or other finish at top and bottom. At *o* and *p*, Fig. 13 (*a*), a small allowance is made for any variation that might arise, thus enabling the erectors to raise or lower the stairs a fraction of an inch in case of necessity.

The angle newel is secured to the beam in the same manner as the newel *d*, and is cast with two lugs, so as to receive both the end and the side facias. These facias are cast with ribs *r* [see Fig. 13 (c)], along the back 2 feet apart, in order

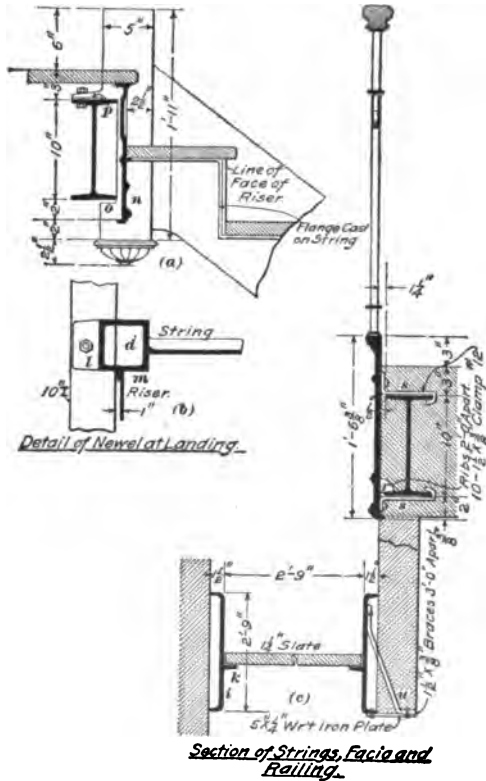


FIG. 13.

to stiffen and support them. The facias are held in place by wrought-iron anchors *s* to which they are bolted with hexagonal-headed bolts, which enable the erector to use a wrench in this close place.

17. The newels are cast with the upper part of each separate. A wrought-iron rod runs through the base and the shaft of the newel, the lower end passing through a

plate in the base, and the upper end through a plate in the head of the shaft; the newel is thus held firmly together when the nut is screwed on. The caps of the newels are cast with a shoulder and secured to the newel with countersunk screws. The lower rail of the balustrade is secured to the fascia with countersunk screws, and the upper rail in the same manner to the newel.

In Fig. 14 is shown one of the risers, which, except the top one, are all alike. The flange *v* in the section is cast on the lower edge, and receives the marble or slate tread, and the nosing *w* is extended at the back to give a bearing for the tread. At

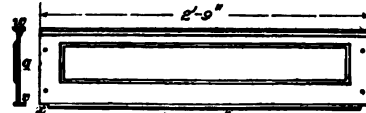


FIG. 14.

x is a check, in which the lug of the string fits. The upper riser of the flight differs from all the others, as it must be wide enough to form a fascia and finish under the stairs, as shown at *n* in Fig. 13 (*a*), and at the same time provide a stop for the plaster of the ceiling. The method of casting is not described, as it is perfectly plain work.

PLATFORM STAIRS.

18. The stairs shown in Fig. 15 is one of a series of flights that might be used from the basement to the top floor of a building wherein the stairs just described would be suitable in the basement. This flight represents the run between the third and fourth floors of a building as being typical of the whole stair system which is enclosed on three sides by a brick wall. In many respects the general construction is the same as in the previous example. The course to be pursued in laying out the stairs is the same as described for the previous case. The principal data to fix are (1) the size of the well; (2) the height of the story; (3) the number of risers and treads, with their height and width; and (4) the width of the stairs. The drawing is then laid out precisely as in the previous case, except that the

parts in this example are numbered in the order they will be required, as is usually done with working drawings, in order to facilitate the process of erection. These numbers are

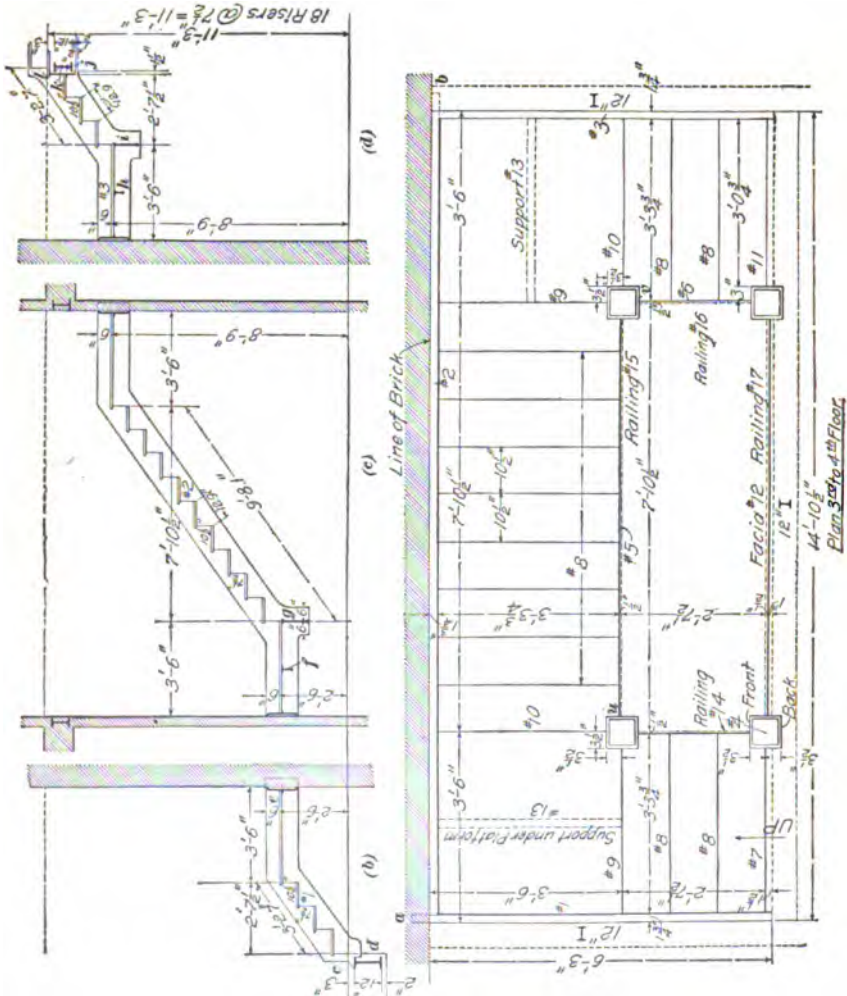


FIG. 15.

marked on the plans, when laying out the stairs; and the workman, by referring to the plan, finds, for instance, that # 1 indicates the wall string which must be first put in place.

He consequently looks for $\#1$, and refers to each piece by its number instead of its name.

19. The holes indicated by the letters a and b on the plan (a), Fig. 15, are 4 inches deep for the reception of the ends of wall strings, and contain either an iron or a stone templet for the strings to bear upon. The wall string marked $\#1$ in the elevation (b) has a lug cast on the lower end c , through which it is bolted to the top of the beam d ; at its upper end a lug e , which is shown in detail in Fig. 16 (a), is cast to receive the end of the string $\#2$ which supports the platform and the stairs on the wall side of the second run. String $\#2$ has two lugs f and g cast on the lower end; f to receive the light beam which carries the platform, and g to receive the end of the face string marked $\#4$ on the plan. The upper end of string $\#2$ has a lug, the same as that on $\#1$ at c , cast on it to receive the wall string $\#3$. String $\#3$ also has on the lower part two lugs h and i ; h to take a light beam to support the platform, and i to receive the face string $\#5$. On the upper part of $\#3$ is cast a flange j , through which it is bolted to the beam k ; there is also a small extension or easement l cast on this string to receive the case of the finish in the hallways. Provision for allowance or variation has been made at the floor ends of the strings $\#1$ and $\#3$, as indicated.

20. The face string $\#4$, as shown at (a), Fig. 16, is cast with the first two newel bases attached to it, the lower one of which has a lug cast on the back, as shown at m in Fig. 16 (c), which is a detail of the development of the base, through which it is bolted to the beam. This detail shows the base of the start newel developed flat so as to show all four sides. The back a is checked out at n , so that it may fit over the flange of the beam. The inside face of the newel d , against which the first riser must fit, has a lug o . The riser p , which also extends to form the fascia p' , is bolted with countersunk screw bolts to the lug o . The front face of the newel c shows the section of the face string $\#4$ at q , and the

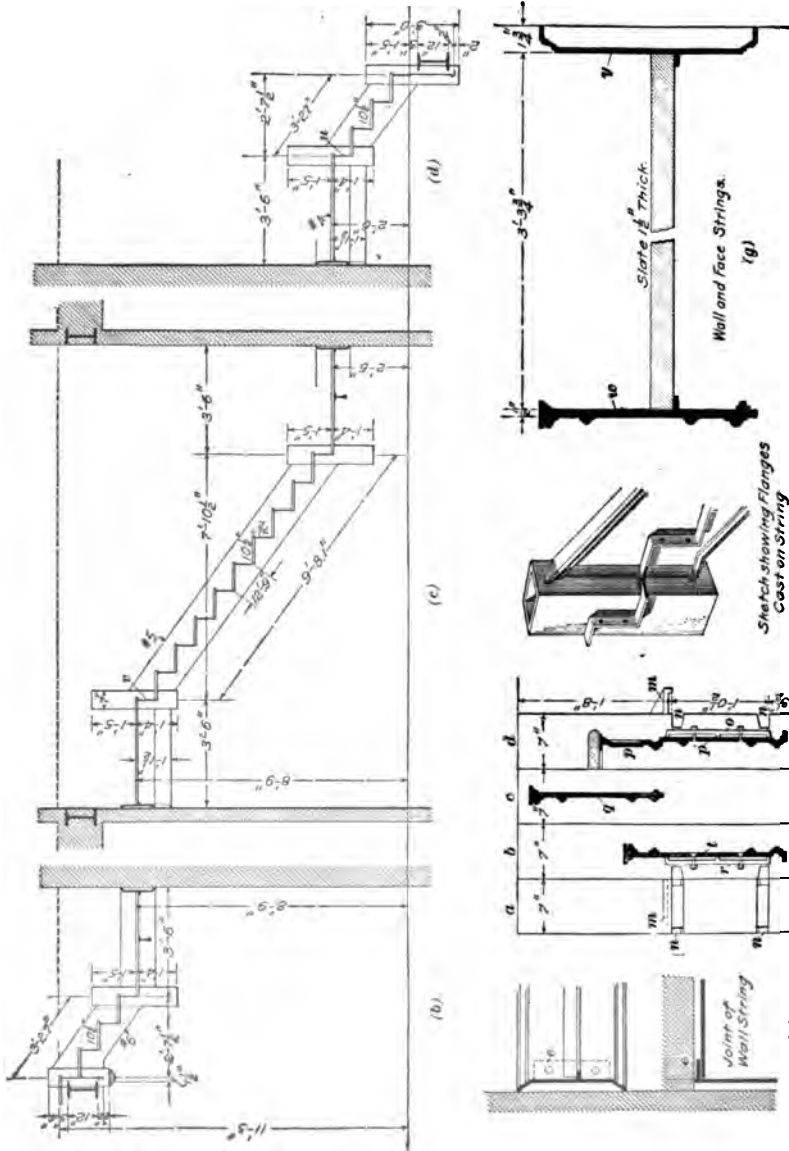


FIG. 15.

outside of the newel *b* has a lug *r* to which the well facia *t* is bolted. The second newel base on string *+4* has a lug shown at *u*, Fig. 15 (*a*), cast on the outside to receive the end of the face string *+5*. The end of string *+4* is bolted to the lug *g* on wall string *+2* (see Fig. 15). The face string *+5* has the third newel base cast with it, and extends through to the wall string *+3*, to which it is bolted. The lower end is bolted to the lug *u* on the second newel base. On the third newel is cast a lug *v*, to which face string *+6* is bolted at its lower end. Face string *+6* has the base of the fourth newel cast on it, and the lugs are practically the same as those shown in the detail.

The next pieces which demand attention are the risers. It will be noticed, by referring to the plan (*a*), Fig. 15, that there are five different kinds of risers, and that each is indicated by a number commencing at seven and ending with eleven; these risers are the same as in the first example, and have been described, except those marked *+9*, which have a lug cast on the back at the center to carry the outer end of the light beam *+13*, which aids in the support of the platforms. The facia *+12*, a section of which is shown at *t* in Fig. 16 (*e*), has ribs cast 2 feet apart along the back to stiffen and support it, while clamps, which are bolted to the facia with countersunk screw bolts, are hooked over the beam. A detail, Fig. 16 (*f*), shows a perspective view of the string and base of the newel, with the flanges to receive the treads and risers.

In the detail shown in Fig. 16 (*g*), *w* and *y* are sections of the face and wall strings, showing the moldings of each, the position of the slate treads, and the flanges supporting them. The railings include *+14*, *+15*, *+16*, and *+17*, shown in Fig. 15, and are the same as those described in Fig. 12. It often happens that it is necessary to introduce winding treads in

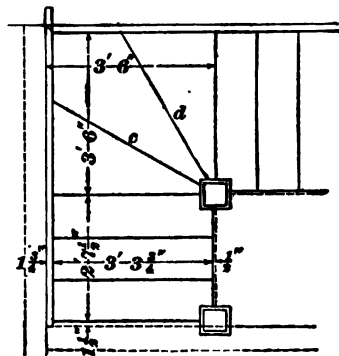


FIG. 17.

the angles, instead of straight platforms. For example, had the distance between the partitions in Fig. 15 been but 11 ft. 4½ in. instead of 14 ft. 10½ in., the treads might still have been kept 10½ inches in width by planning the corners as shown in Fig. 17. In this case the strings would take a curve which would be determined by the intersection of the treads and risers with the wall string; the elevation of these

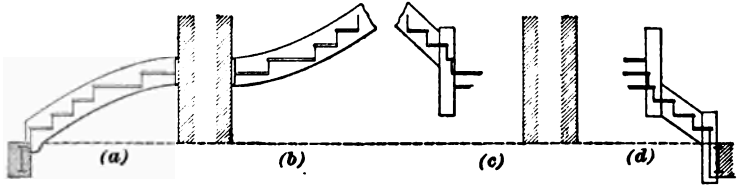


FIG. 18.

curves is shown in the section at (a) and (b), Fig. 18. The only other detail affected by the difference of conditions would be the increased length of the newels brought about by the winder risers *c* and *d* of Fig. 17, having their start at the newel, thereby lengthening it by their height, as shown in the section at (c) and (d), Fig. 18.

SEMICIRCULAR STAIRS.

21. In Fig. 19 is shown at (a) the plan of a semicircular stairway; while in Fig. 20 is shown the front elevation at (a), the development of the string at (b), and a detail of the rail on the upper landing at (c). The first three treads *a*, *b*, and *c* of the plan, Fig. 19, are 11 inches wide, and the remaining ones are so spaced as to be wider than this, if measured on a line midway between the strings. The diameter of the well hole is 14 ft. 6 in.; and, deducting twice the distance from the wall to the center of the treads, it will be found that the diameter of a circle drawn through the center of the flight is 9 ft. 11 in., or 119 inches, which, multiplied by 3.1416, will give for the circumference 373.85 inches. Dividing this by 2 and deducting from the result 1 inch (the distance from the top riser to the beam *d*) gives

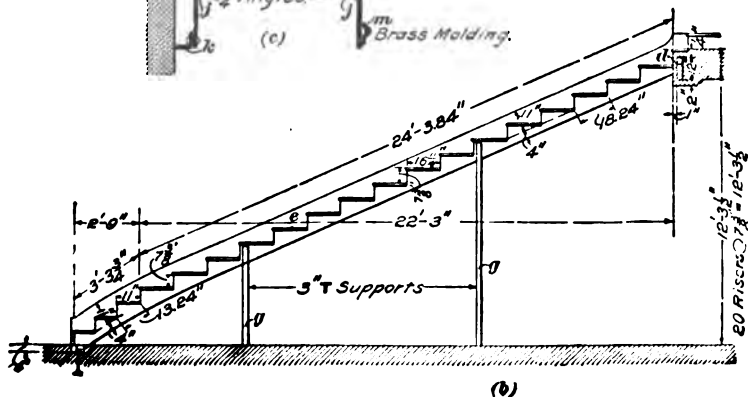
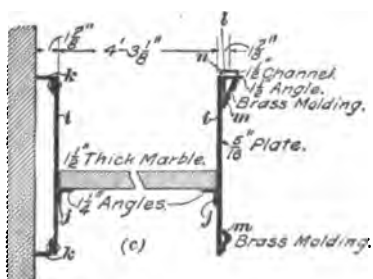
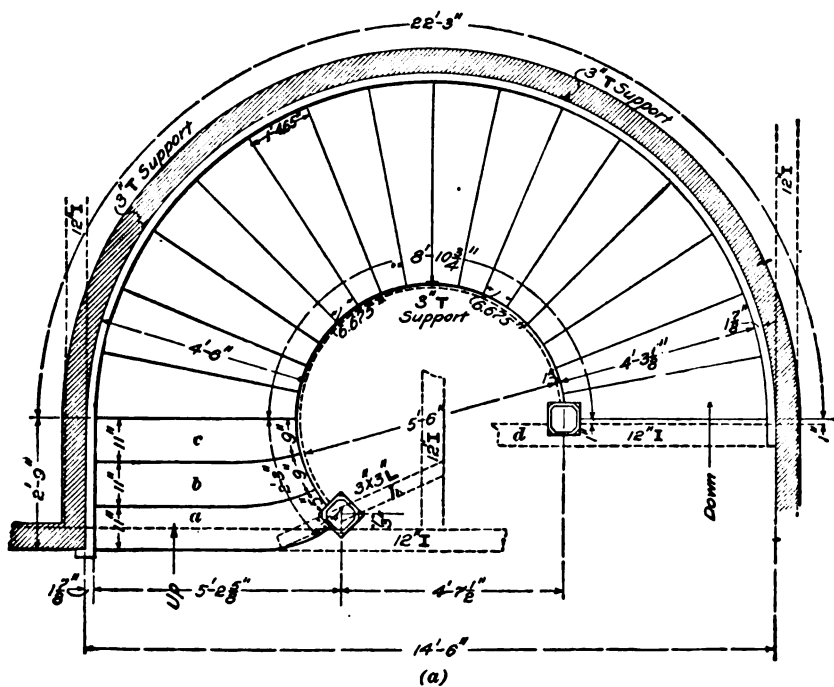


FIG. 19.

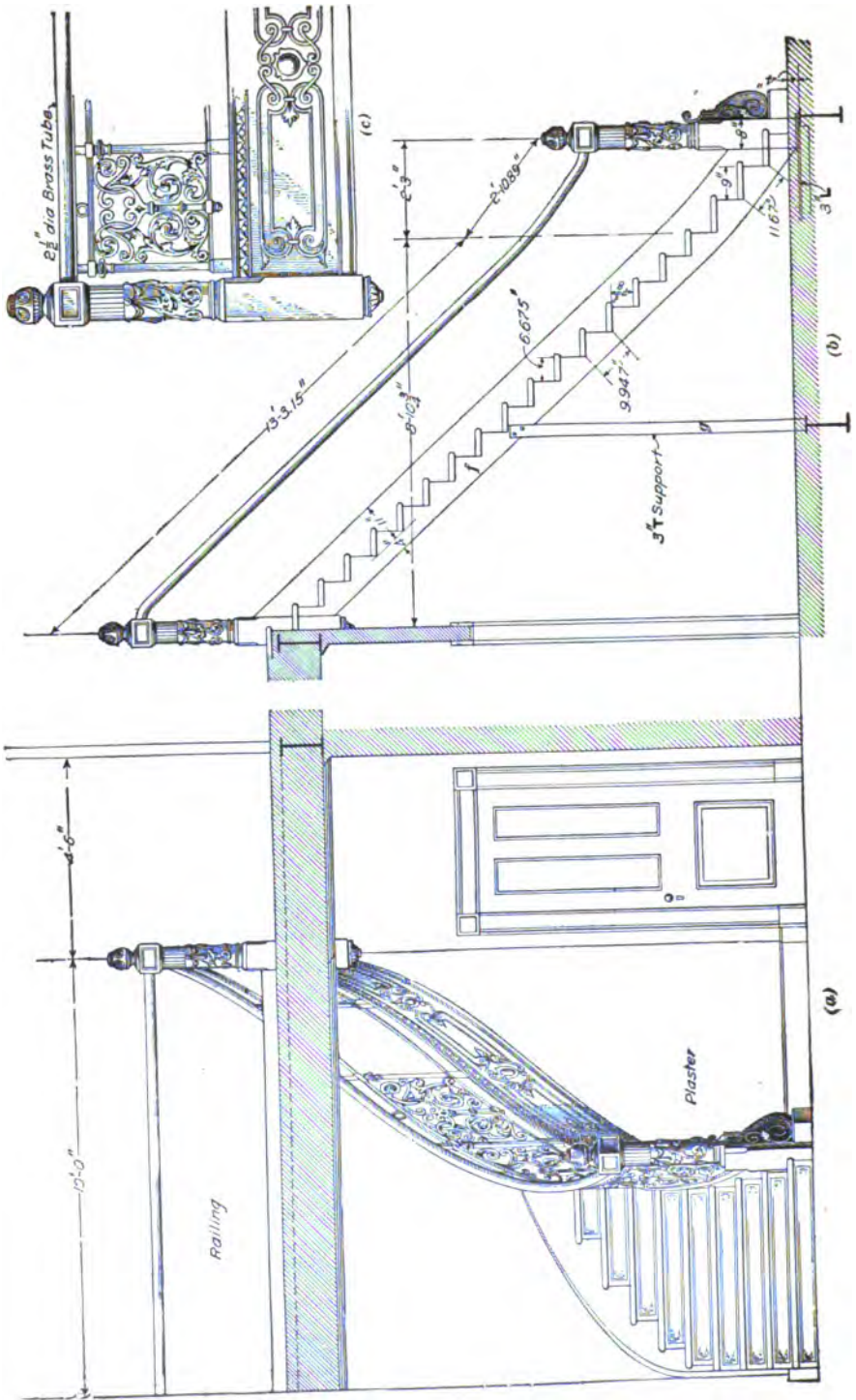


FIG. 20.

the length of the center line required as 185.92 inches. This divided by the number of treads determines the width of each tread on that line to be $11\frac{5}{8}$ inches. The lengths of the strings around the outer and inner circumferences are taken on the inside faces, and determined in the same manner. In a stair of this character it is not possible to make sections through any particular part in such a way as to be of any service, but the development of each string is given instead.

22. To lay out a plan of such a flight of stairs as this, begin with the wall string and lay off from the foot of the flight the first three treads 11 inches wide, and the other sixteen will be 1 ft. $4\frac{1}{4}$ in., the latter dimension being found in the same manner as the width on the center line, and used in the development of the string, as shown at (*b*). A line drawn through the lower intersections of the treads and risers will form a basis from which to determine the width of the wall string, and to lay off the top and bottom lines of this string, as shown in Fig. 19 (*b*). The proportion of the treads to the risers in the short straight part of the string is 11 to $7\frac{3}{8}$, while that of the curved portion is $16\frac{1}{8}$ to $7\frac{3}{8}$, thus causing the string to take a different angle; the juncture of these two parts should be eased off, instead of showing the sharp angle, which would be out of harmony with a circular stair. This applies only to the wall string, as, in the development of the face string shown at *f* in Fig. 20 (*b*), we have a surface that is circular throughout its entire length. These circular strings are usually made of wrought-iron or steel plate, capable of being bent to the required curve, and this bending is done by hammering on a curved block if the material is light, or by mechanical pressure in case of heavy work.

23. With the exception of the straight part at the bottom of the wall string, both strings are helical in shape; that is, they take the form of a ribbon spirally wound around a cylinder and rising at a certain ratio.

To get this helical shape, the strings are first laid out flat, as shown in the developments, Figs. 19 (*b*) and 20 (*b*), with

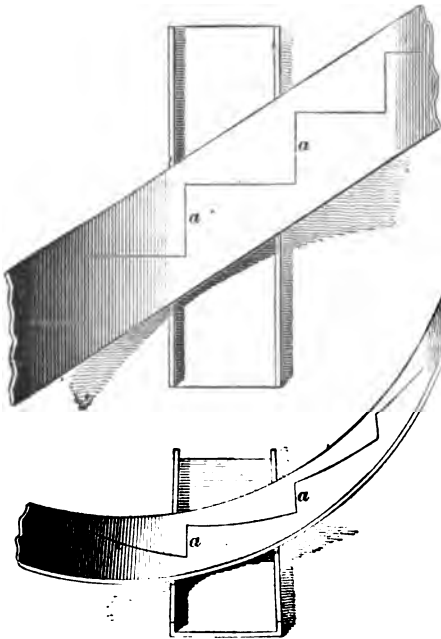


FIG. 21.

the lines of the treads and risers drawn on them; they are then laid across a block with the lines of the *risers* *a*, Fig. 21, parallel to the sides of the block, and, while in this position, are hammered or subjected to pressure every few inches. A wooden templet with one edge curved to the radius to which the string is to be bent is used to test the string and determine when it has been pressed to the proper curve. This templet is placed against the iron at short intervals, and

held in a direction parallel to the lines of the *treads*. This bending may also be accomplished by passing the string through a set of rollers in an angular direction, provided the rollers are long enough; this method, however, is seldom used, in consequence of the great length of roller required.

24. In making the pattern for the railing, it is advisable to first prepare a wooden drum of the same diameter as the stair well, on which the steps are laid out; and from them the top line of the string is obtained, which is also the bottom line of the railing. The top and any intermediate lines of the railing are then found by measuring perpendicularly from any point on the string line or from the center of each tread; and the whole railing may be either

modeled directly to the proper curve or made straight and bent to the curve afterwards. The well holes of all stairs are framed before the stairs are built, and in straight stairs there is little more required in the shape of structural support; in curved stairs, however, it is often necessary to introduce special supports, as has been done in this case by the upright T irons *g* shown in Figs. 19 (*b*) and 20 (*b*). The circular partition under the string in this case is of terracotta blocks, and is therefore incapable of affording sufficient support to the wall string. The strings should rest on the top of the floorbeams below, and be bolted to the webs of the floorbeams above wherever such is possible; but, as this cannot always be managed, bearings, such as shown at *h* in Fig. 19 (*a*), should be provided under the starting newel, and laid diagonally between the nearest beams.

25. The face string being of wrought iron, it must be bolted to the newel faces, and, in view of this, flanges are cast on the newel bases for this purpose. The constructive details for these stairs in the connections are the same as in Fig. 15 with the exception of the strings.

These strings are shown at *i* in Fig. 19 (*c*); the treads are supported on wrought-iron flanges *j* bolted to the string. The top and bottom flanges *k* of the wall string and the top flange *l* of the face string are of angle irons riveted to the string. The upper and lower edges of the face string are finished with brass moldings *m*, and the rail is first secured to the channel iron *n*, which in turn is bolted to the string.

CIRCULAR STAIRS.

26. A type of circular stairway, similar to that described on drawing plate entitled, *Winding Stairs*, in the section on *Architectural Drawing*, is shown in Fig. 22. This stair is suitable in some such position as an engine room, from a sidewalk to a subcellar, or from an attic to a dome or tower, or in any position where space is limited. The construction is of the simplest character, and consists of a central core or

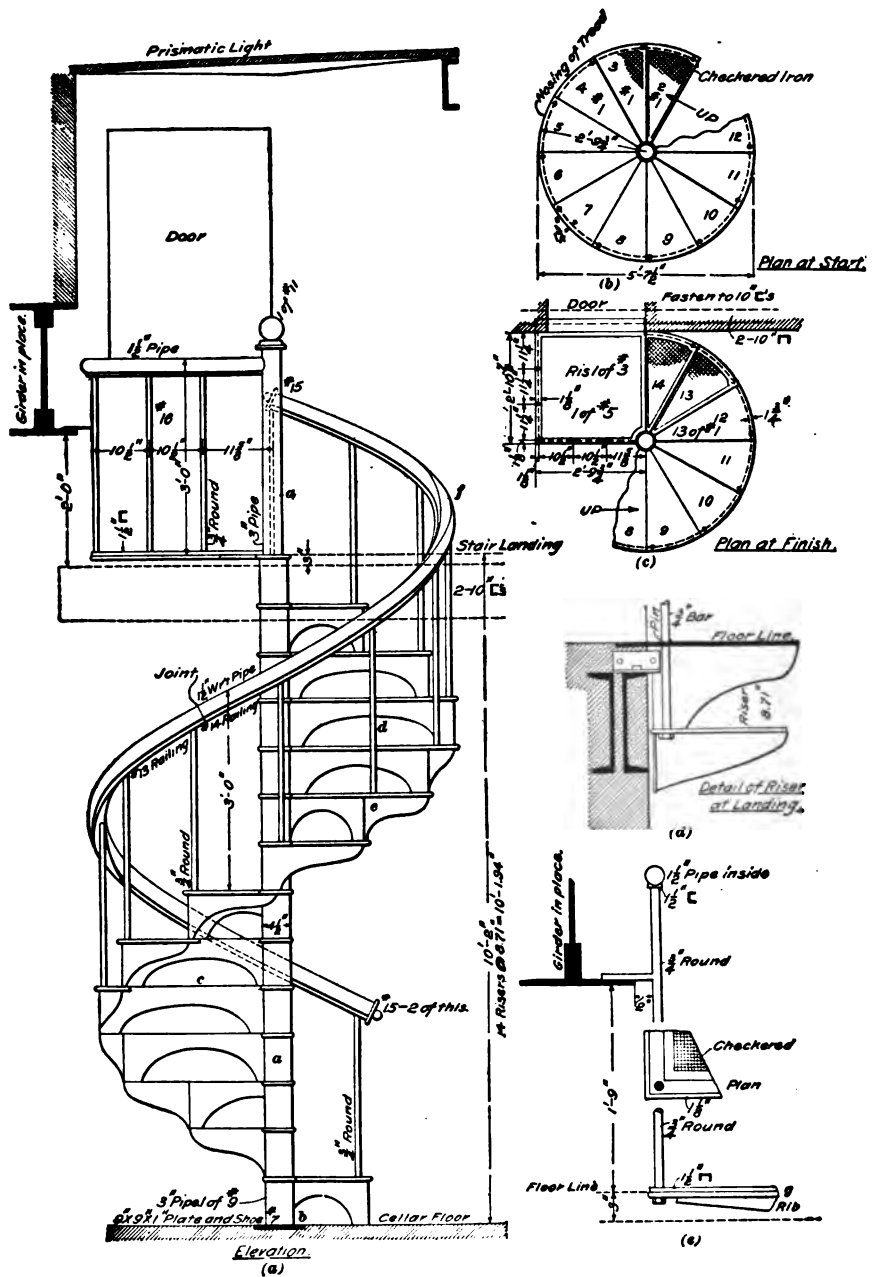


FIG. 22.

wrought-iron pipe *a* resting on a plate *b* at the bottom. The treads and risers *c* are of cast iron in one piece, with a collar to fit over the pipe *a*, so that in erecting the stair the risers and treads are slipped on as shown at Fig. 23. In order to keep them in place, the upright bars of the railing *d*, Fig. 22, are continued down through each tread near the front edge to a lug, or projection, *e* on the back of the tread immediately underneath, and secured with a nut. The top riser acts as a brace to hold the pipe in place, and is fastened to the beam with a wrought-iron strap of any suitable shape. There are no strings to be bent in this stair, but the hand rail *f* must be bent to the proper curve. This rail is composed of a small channel iron

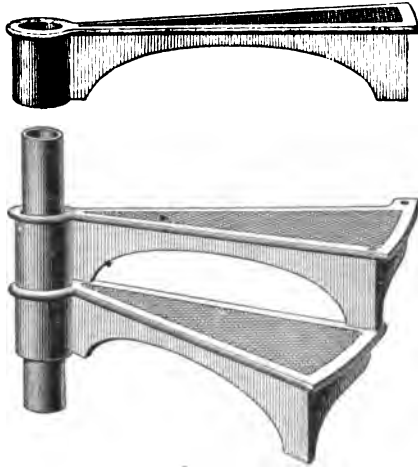


FIG. 23.

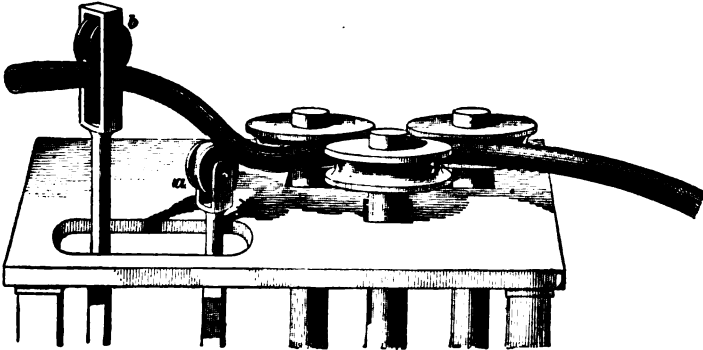


FIG. 24.

with a $1\frac{1}{4}$ -inch wrought-iron pipe on top. To bend any bar or pipe, the most satisfactory results are obtained by the use of rollers, preferably run by power, as shown in Fig. 24. one

of these rollers being capable of adjustment, so that the pipe or bar may be bent to any required radius. In this way, not only is it possible to give the hand rail the necessary curve, but, as the amount of rise per foot is known, it can be given this upward direction at the same time by setting the gauges, or guides, *a* and *b* to the proper angle. It is presumed the stair is erected before the hand rail is bent; and to determine if the rail has been bent to the proper curve, it is laid over the top of the steps, and corrected, if need be, by hand. It might, however, be required that the hand rail should be bent and set quite independently, and assuming that the rail were a flat bar, $1\frac{1}{2}$ in. \times $\frac{3}{8}$ in., it would be accomplished as follows: An end view of a tread and riser would be laid out in outline, the sizes being taken at the center line of the railing, as shown in Fig. 25 at *b*. A part plan of the stair,

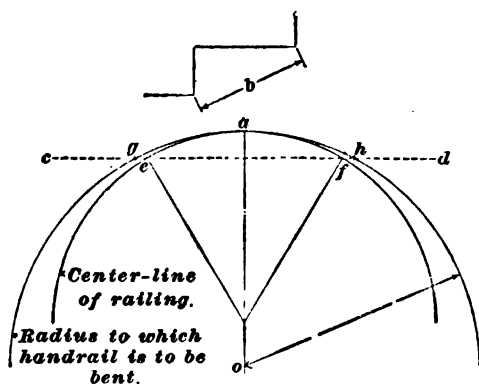


FIG. 25.

showing two treads, would then be drawn, as *ea* and *af*, with a dotted line *cd*, through the points *e* and *f* where the tread lines intersect the outline of the stair plan. Then, from *a* as a center, and with a radius equal to *b* (the true length of the rail over each step), arcs would be struck on the curve, the intersections of which, *g* and *h*, with the line *cd* would give points in the true curve of the rail. A circle described through the points *g*, *a*, *h* would give the curve to which the hand rail should be bent. The bar is then bent to this new radius and twisted evenly along the whole length of the stairs, in the manner and with the tools shown in Fig. 26. It will be found that the whole bar has now the form of a helix, and is of the required radius. Before being twisted, the positions

of the balusters should be marked on the bar, and the holes for them bored or punched, as the case may be.

At (b) and (c), Fig. 22, are two plans, one showing the start at the cellar-floor level, and the other the finish of the stairs

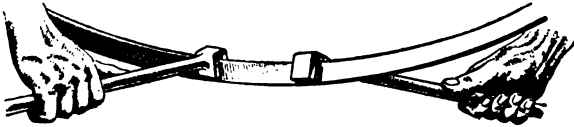


FIG. 22.

at the platform. The detail of the connection at the platform, and the method of securing the baluster through the



FIG. 27.

tread, and details showing the corner of the platform and the pipe forming the rail, are shown at (d) and (e). The platform is strengthened by the ribs *g* cast on the under side.

FRIEZES AND BALUSTRADES.

27. In Fig. 27 is shown a cast-iron frieze. The ornament is bold, and has considerable relief, but, being entirely on the surface, and not undercut, it does not present any special difficulty in molding, and the model may be withdrawn from the sand without injuring the ornament. The modeling of this frieze should be in clay, and then cast in



FIG. 28.

plaster, and the working mold cast from this last in the same material.

28. Figs. 28 and 29 are examples of stair balustrades or panels. Figs. 30 and 31 are examples suitable for exterior or exposed positions. The newel *a* in Fig. 28 is modeled,

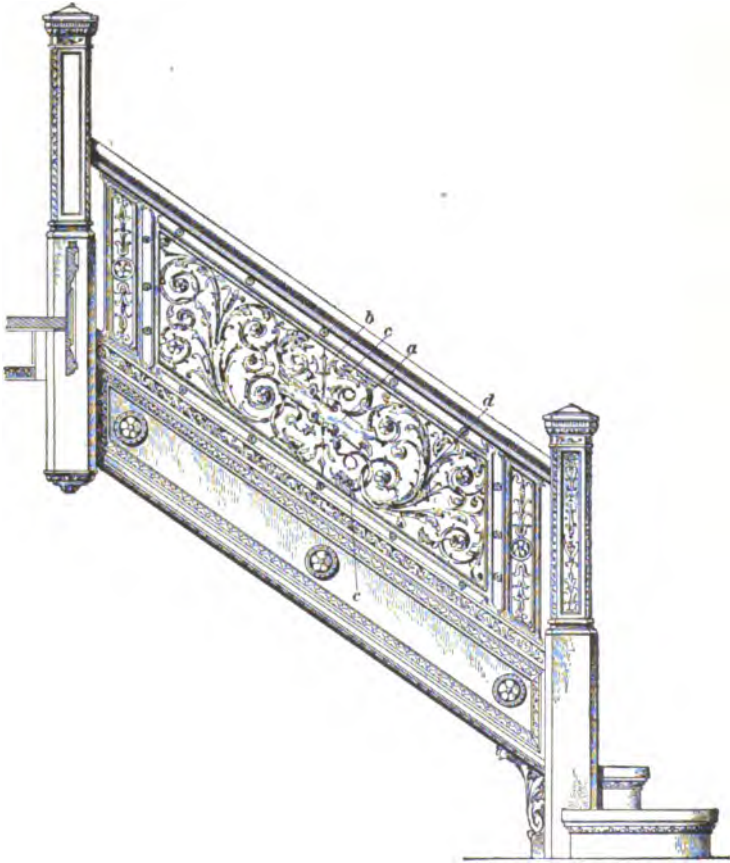


FIG. 29.

molded, cored, and cast in the same manner as the one before described. The balusters *b* are modeled in wood and cast *solid*. They are secured by countersunk tap bolts at the

bottom and top to an iron strap or rail *c* and *d* $\frac{1}{4}$ inch thick, and of width equal to the baluster base, or to a channel iron.

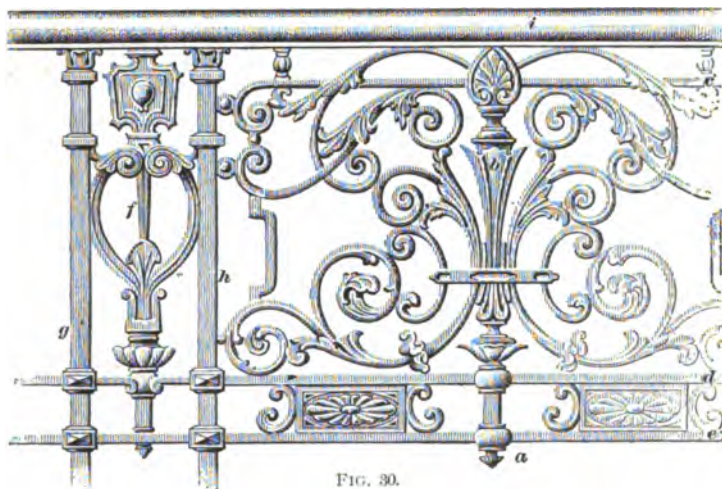


FIG. 30.

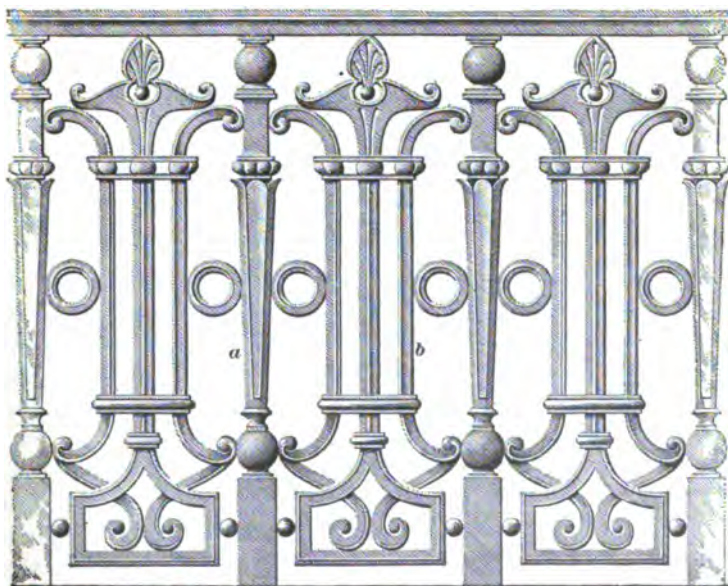


FIG. 31.

The characteristic features of the design shown in Fig. 29 are the cartouche *a* at the center of the panel, the trident *b* which pierces it, the dolphins *c* which act as supporters, and the scrolls *d* which complete a very rich and artistic panel. This design for a stair rail is especially good, as it fills the void between the string and rail, affording perfect protection, while at the same time the design is not overloaded with ornament, and is very well constructed.

The features of the railing shown at Fig. 30 are the long and short panels forming its divisions. The large panels *a* are strengthened and braced vertically at the middle, with a post *b* running from the top rail to the lower rail, and horizontally with the rails *c*, *d*, and *e*. The short panel *f* is let in between the posts *g* and *h*, combining them. The hand rail *i* is made of a brass or bronze pipe.

The rail at Fig. 31 is composed of a series of balusters *a* and panels *b* let in between them. The panel is well secured at four points on each side. The hand rail is formed of iron with a molded cap piece screwed on.

WROUGHT-IRON WORK.

METHODS OF MANUFACTURE.

CHARACTERISTICS.

29. Wrought iron differs from cast iron principally in the characteristics that it is soft, malleable, and fibrous, while the latter is hard, brittle, and crystalline, as explained in Art. 2. This difference in character is due to the method of manufacture, as both kinds of material come originally from the same ore. Wrought iron is purer than cast iron, as the carbon, phosphorus, and sulphur are eliminated as far as possible, as well as other ingredients which abound in cast iron. It is the carbon which gives cast iron its hardness, and the phosphorus which makes it brittle, while the elimination of the sulphur renders wrought iron malleable

and capable of being forged. While it is practically impossible to entirely eliminate these ingredients in the manufacture of wrought iron, they may be so reduced as to be harmless. The presence of too much phosphorus will render the iron what is termed **cold short**, that is, brittle, or liable to split or break when hammered or bent cold. Sulphur, however, does not so much affect the cold working of the iron, but if present in excess it tends to make it **hot short**, or brittle at a red heat, and unweldable at any temperature.

The value of these characteristics will be better appreciated when the methods of working are described.

TOOLS AND IMPLEMENTS.

30. In some structural work, cast iron is used extensively on account of its cheapness; but for certain classes of work, cast iron is not suitable, and wrought iron is employed almost exclusively; as, for instance, the grille-work of elevator enclosures, light railings, lamp brackets, and work of a like character.

Ornamental wrought-iron work may be divided into two general classes; namely, that which requires to be fashioned while hot, and lighter work which is manufactured from cold materials. In each case the original material is in the same form—long bars of varying widths and thicknesses, which are worked with vise and pliers, or forged with hammer and anvil into any desired shape. The dominating feature of some designs is frequently the repetition of similar scrolls or rings; and when there are a number of these, it is necessary that they should be produced rapidly and exactly alike. In making any small scroll of light iron, the first and most important step is the forming of the small quirk, or curl, at the center, and the method and machine for doing this is shown in Figs. 32 and 33. The tool employed is of a very simple character, and consists of a fixed cam *a*, over which the clamp, or die, *b* fits closely and is pivoted at the other end; the spring *c* keeps the die clear of the cam, and the lever *d* forces it into place. In Fig. 32 the lever is

thrown back to allow the clamp to be pressed open by the spring *c*. The bar, the end of which is to be bent, is introduced between the cam *a* and the clamp *b*. The lever is

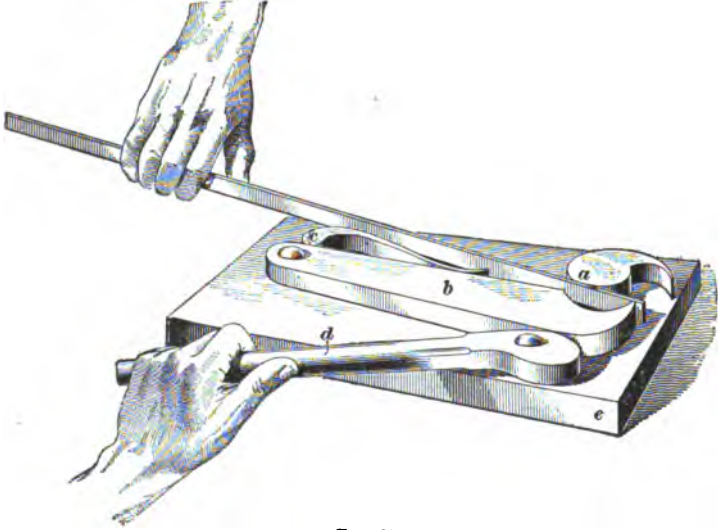


FIG. 32.

then pulled forward, and the die is forced against the cam, and the beginning of the scroll is formed. The bar is then

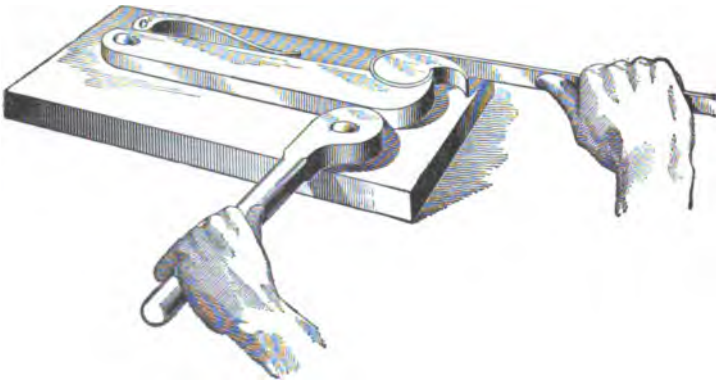


FIG. 33.

brought around to the position shown in Fig. 33, and the first convolution of the spiral thus completed.

31. The bar is now placed in the machine shown in Fig. 34, and the remainder of the scroll is formed. This machine consists of a shaft *a*, on which a screw thread is cut, and over which is coiled a steel spring *b*. On one end of the shaft is a crank or handle, and on the other end is the disk *e*

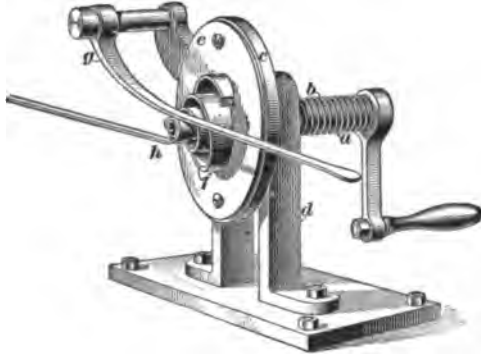


FIG. 34.

carrying the coil or volute *f*, which forms the die or pattern for the rest of the scroll. This plate and volute are detachable, so that different sizes of scrolls may be formed on the same machine.

The bar, having had the first convolution of the scroll formed as already described, is now placed in the machine, as shown at *h*. The lever *g* is pressed against it to hold it in close contact with the volute *f*, and the disk is revolved until the scroll has assumed the proper number of convolutions. As the shaft turns, the screw thread causes the disk to advance, and the bar *h* is coiled evenly in one plane, instead of conically, as might appear from the spiral on the disk. When the shaft has reached the point where the proper number of revolutions has been attained, a catch releases the nut from the screw thread, and the spring *b* throws the shaft and disk back to their original positions, and releases the completed scroll, which is now cut off the bar, and another one prepared in the same manner. With such appliances one man can make from 300 to 600 scrolls a day, according to their size and weight; but where only a few

are required it is usual to make them almost entirely by hand, for which tools similar to those shown in Fig. 35 are

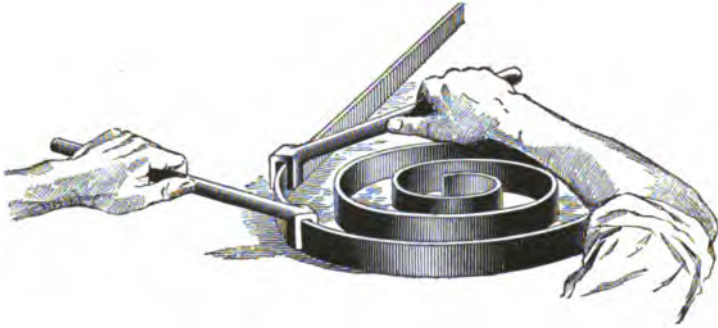


FIG. 35.

used, the operation being so simple that description is not necessary.

32. As it is more economical to have special machines for the manufacture of scrolls in quantities, the same applies to the twisting of flat bars, and for this purpose the appliance shown in Fig. 36 is used. This apparatus consists of a

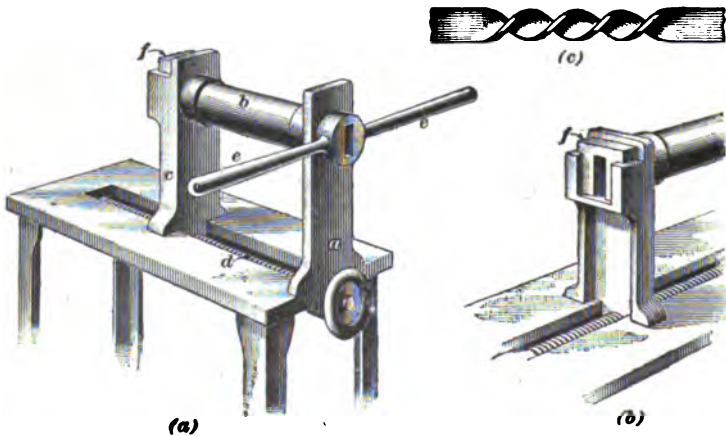


FIG. 36.

fixed upright *a*, with a socket to receive the pipe *b*, the other end of which rests in the movable upright *c*. The latter is arranged to travel along the bedplate by means of a threaded

shaft d , so that the length of the pipe b may be changed to suit the length of the twist required to be produced. The bar to be twisted is passed through the pipe and the slot in the lever e until in proper position, and the slotted piece f is dropped into the pocket, as shown at (b) . If the length of the pipe is such that the distance between the lever and the slotted piece is of the desired length for the twist, then the bar being held at these two points and prevented from revolving independently, the lever is wound around as many times as is necessary to produce the required twist. The greater the number of turns, the closer will be the twist. The piece f is made loose and dropped into place, so that it may be easily lifted out when the twist is complete, and the finished bar drawn out without twisting it through the slot, as would be necessary if the slots were permanently fixed in each end. The pipe b merely acts as a guide to prevent the bar from bending in a lateral direction when the twist is of considerable length.

33. This machine is for making a regular twist, as shown at (c) , but another form of twist in common use, especially

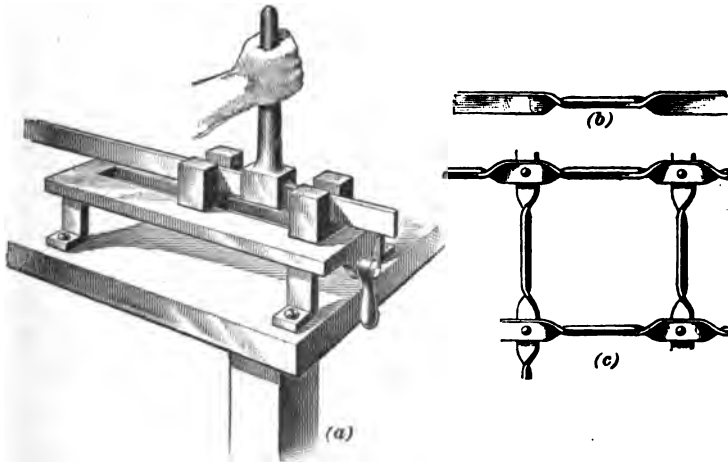


FIG. 37.

in light grille-work, is made by giving the bar a series of half turns, as shown in Fig. 37. The bar is dropped into

two slots, as shown, one of which can be adjusted by means of a long screw underneath the bedplate, so that the length of the part to be twisted may be regulated. It is then grasped between these slots by the loose clutch, and given a half turn, producing the result shown at (b). If the bar is to form a part of a square mesh grille, as shown at (c), there will be a number of these twists to each piece, and the distance from center to center must be marked out before the twisting is commenced. If the quantity required should be great, it might be advantageous to make a set of fixed pockets set to the proper centers, so that six or more turns could be made without lifting the bar. The foregoing are a few of the tools used in the manufacture of light grille-work; where, however, this class of work is produced to any great extent, there is a constant demand for new tools to meet the requirements of special conditions, but these tools cannot be bought and must be made. It would be impossible to provide for the manifold variations that are likely to occur; but, apart from these special tools, those that are here illustrated are always in demand, and supplement the general machines, such as drills, punches, lathes, etc.

34. Grilles.—Having described the tools used in working wrought-iron bars into forms from grilles, a few examples of the simpler forms of grilles are shown at Figs. 38 to

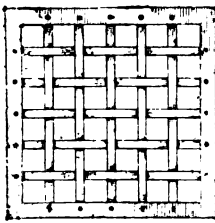


FIG. 38.

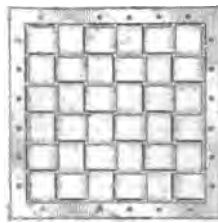


FIG. 39.

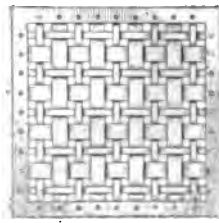


FIG. 40.

41. These are plain basket patterns, and can be made in any size iron and set to any mesh. The frame is of angle iron, the ends of the meshwork being riveted to it. The

meshwork grilles, being of an interlaced pattern, form a strong and economical screen to manufacture. If the surface to be screened by this basketwork is considerable, it is desirable to run a line of rivets at intervals through the mesh;

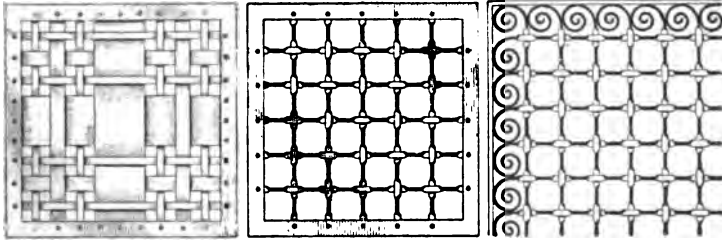


FIG. 41.

FIG. 42.

FIG. 43.

otherwise, the metal strips that form the mesh are likely to slip out of place and become distorted. If a more ornamental grille is wanted, the simplest variation is secured by twisting the bars as shown in Fig. 42, the result being that

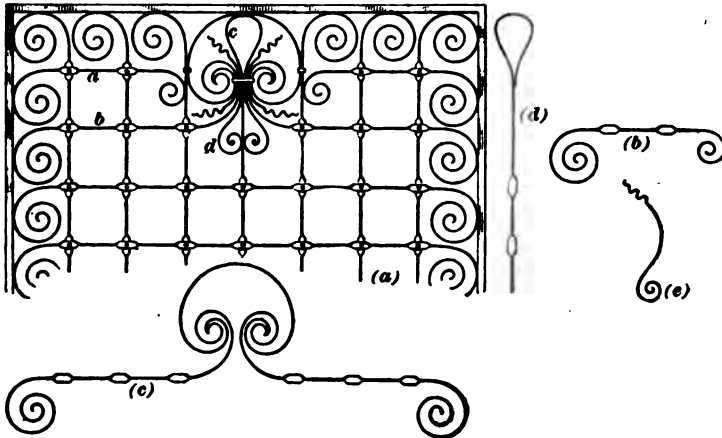


FIG. 44.

a mesh is produced with the edges towards the eye and a series of flat crosses at the intersections. If a border to the grille is desired, the scroll ornament shown in Fig. 43 is suitable and inexpensive. A glance at the illustration will

show how this is made, by turning the ends of each strip or bar. In this case an angle-iron frame could not very well be used, because part of the scroll would be hidden by the flange of the angle. The frame may be a flat bar, though a small channel would be preferable, as the ends of the rivets that fasten the scrolls could be hidden in the hollow of the channel.

35. A great variety of grille designs have the square meshwork shown in Fig. 42 as a basis, with additional ornament introduced at top and bottom, as shown in Fig. 44, or with a border and center ornament, as in Fig. 45. It will be seen that the ornament is formed to a great extent by

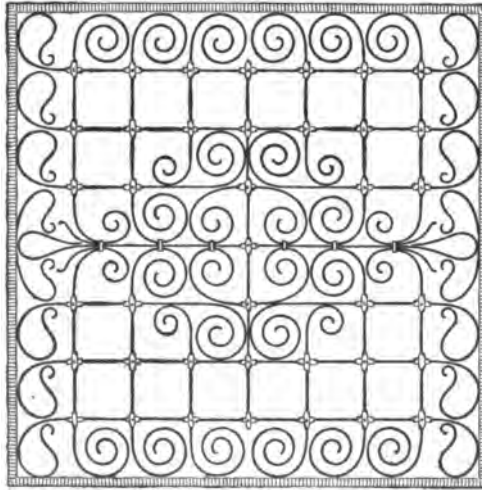


FIG. 43.

turning the ends of the bars forming the square meshwork into scrolls, and adding other scrolls as may be desired. This can readily be seen by examining the designs shown, but to make it perfectly clear, some of the component parts of Fig. 44 are shown separately. The small top scroll *a* is shown separately at (*b*); the large central scroll *b* is shown at (*c*); the central division and loop *c* is shown at (*d*); and the small scroll and ribbon *d* is shown at (*e*). These are all made of single pieces

of iron. The pattern shown in Fig. 46 is designed to produce a diaper effect, as is also Fig. 47, the latter being a

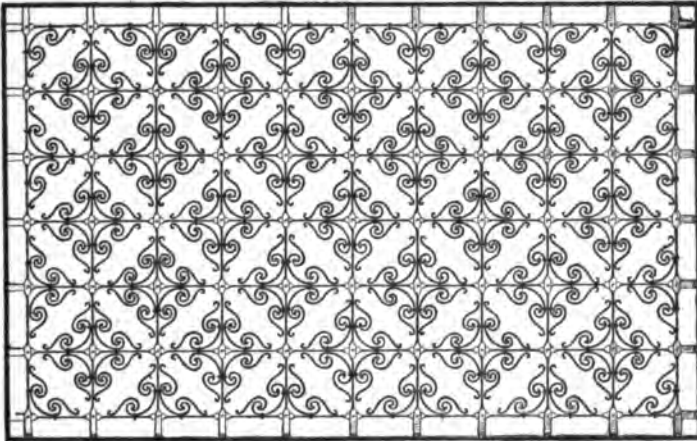


FIG. 46.

more open pattern. These designs are all for grilles of light strips not over $\frac{1}{8}$ inch thick by $\frac{5}{16}$ inch wide, though at times

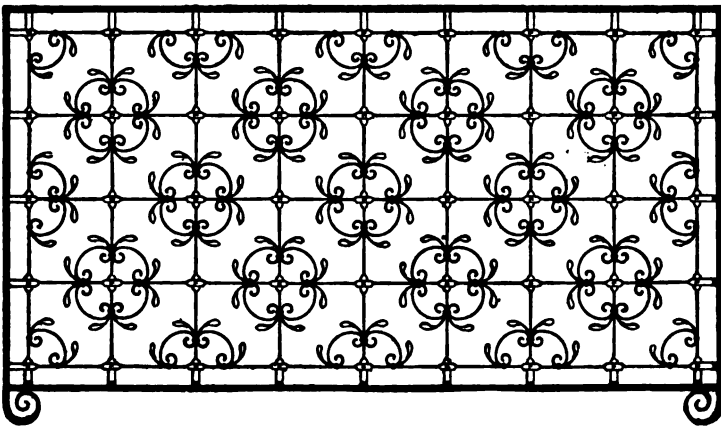


FIG. 47.

heavier material may be employed. Figs. 48 and 49 are radiating designs suitable for arched window or door

openings, but in other respects are precisely the same as the above described. At Figs. 50 and 51 the square mesh is



FIG. 48.

abandoned, and the metal is made rather heavier, so that the long straight bars may be strong enough to resist the tend-

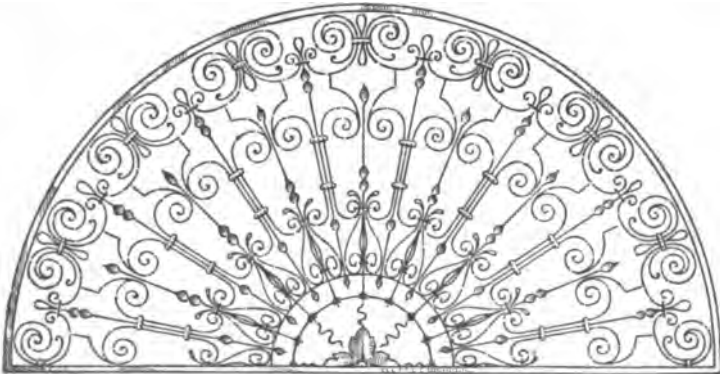


FIG. 49.

ency to bend. There is no set rule for determining the size of iron of which a design should be composed, as this is

governed by considerations of artistic fitness for the position for which it has been designed. If the iron is too thick to be

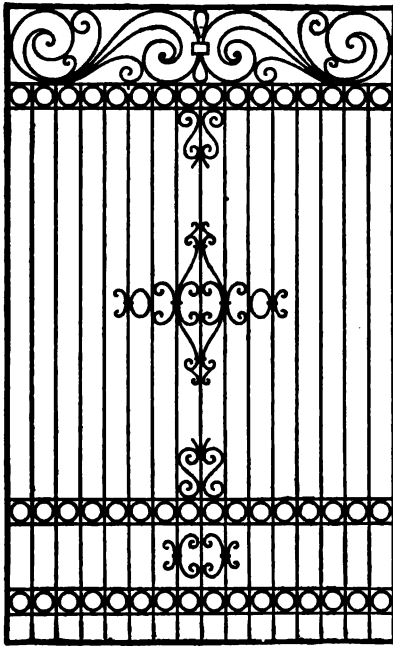


FIG. 50.

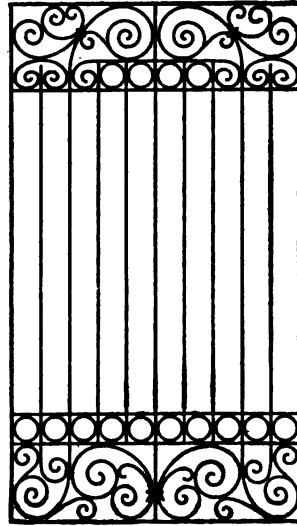


FIG. 51.

readily twisted at the intersection, it may be half checked,

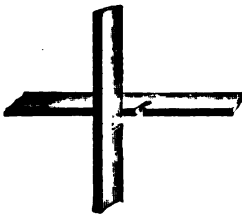


FIG. 52.

as shown in Fig. 52; or, if one piece is wider than the other, the wide piece may be punched out to permit the narrower one to pass through it, as shown in Fig. 53.



FIG. 53.

OFFICE GRILLES.

36. The metal counter rails in banking houses, offices, etc., so far as the grille-work is concerned, are in no way different from the grilles heretofore described; but the

arrangement of the supports, and the height and division of the rail, must all be proportioned to suit the special conditions of each case. Figs. 54 and 55 are examples of grilles made of cast and wrought iron. In Fig. 54 the rail and the posts are of cast iron, but the frame of the grille and the wicket gate and frame are of wrought iron. The grille is a simple basket pattern of ribbon iron twisted at the intersections and

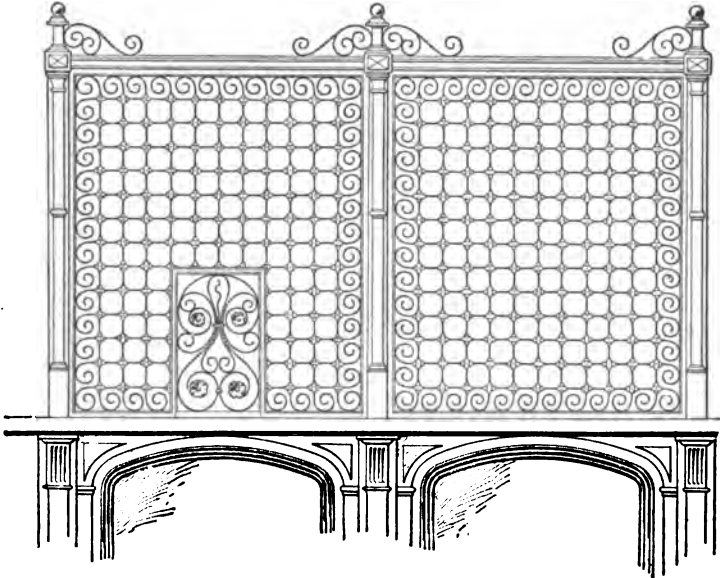


FIG. 54.

wrought into scrolls at the outside to form a border. The main scrolls of the wicket are finished with cast-iron rosettes. The rail has a cresting produced by extending the post with a finial ornament, and placing a scroll each side of it.

The design shown in Fig. 55 is more elaborate. The posts and rails are of cast iron, as in the former case, as well as the frame surrounding the wicket gate; but the entire screen is backed up with plate glass. The posts have a fluted band above the base, and just above this is a band or circlet to carry out the line of the baluster rail of the screen. The entire grille of each panel is set in one frame, which is

divided into two parts, the lower part forming a balustrade design, and the upper part a diaper; the loop scrolls of the diaper are ornamented with a pendant of leaves, as shown. The frame is separated from the rail, counter, and sides, by button washers, as shown. The plate-glass panels back of the screen are set in an angle-iron frame fitted with hinges, and swinging inwards so that they may be opened to clean

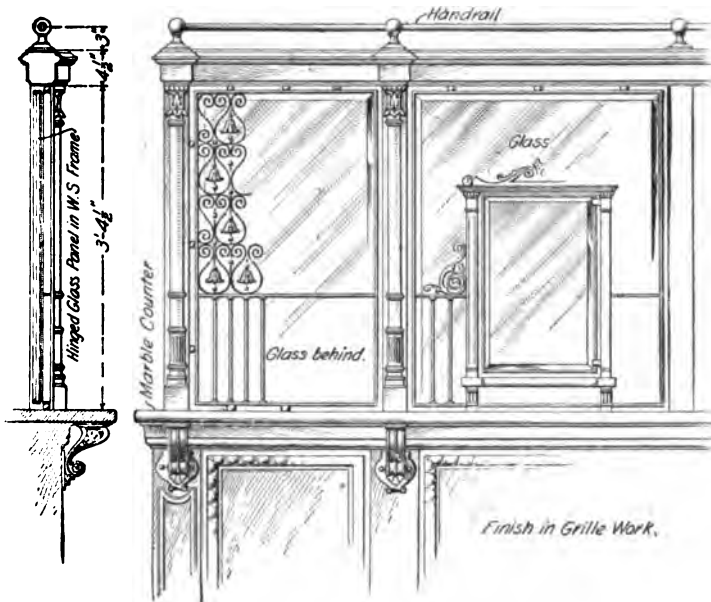
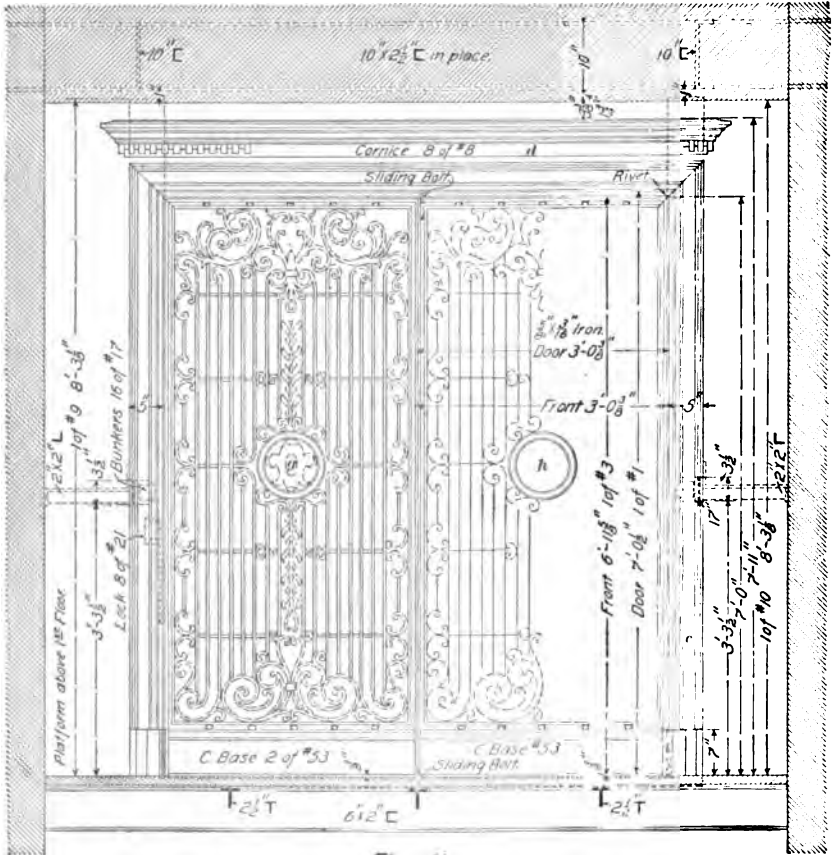
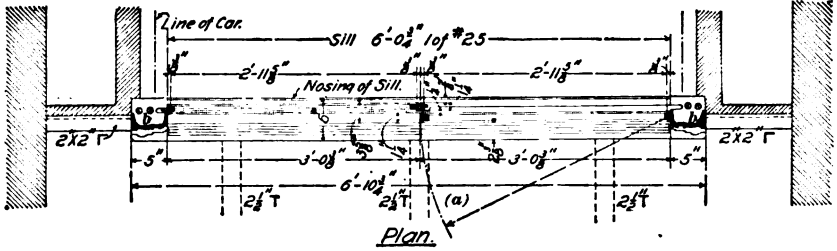


FIG. 55.

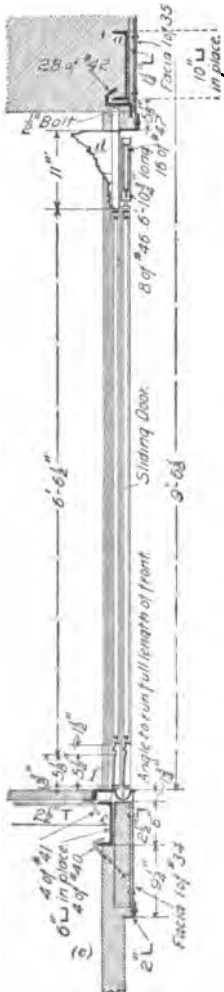
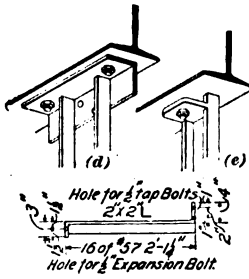
the glass. The wicket frame is designed with architraves and lintel, as would be any door or window. The change shelf under the wicket is of polished metal supported on two console brackets. The head of the opening is ornamented with a cast-iron scroll and leaf, but the scroll at the junction of the frame and the baluster rail is of wrought iron, and is placed there to give rigidity to that point.

The moldings of the rail at the top of the screen are broken out over the posts to emphasize the divisions of the screen. Over each of these points is a finial ornament, which also serves as a standard through which the brass upper rail



(b)

FIG. 56.



Section.
FIG. 56.

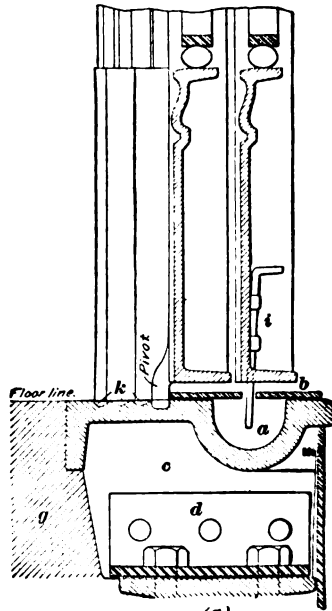
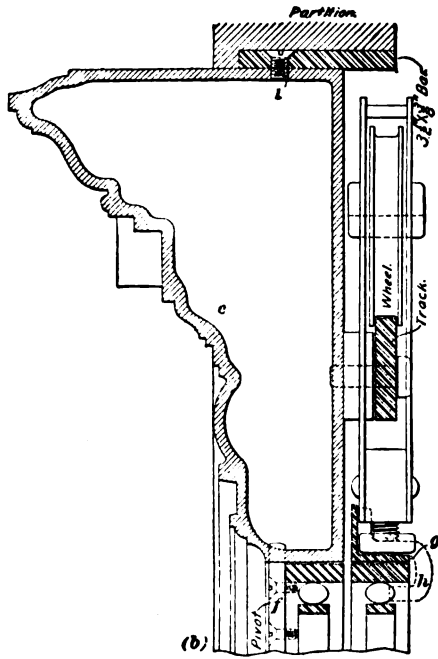


FIG. 57.

passes. These examples represent the usual forms and outline of this class of work, but the details of the design will vary with each individual case.

ELEVATOR ENCLOSURES.

37. All the preceding examples of grille-work are suitable for use in elevator enclosures or any similar screen work, and their application to such work will now be considered. In Fig. 56 is shown an example of grille-work front for an elevator shaft. The shaft is formed by the main wall of the building in the rear, and fireproof partitions on the sides, the front only being of grille-work. An angle iron or a channel is usually set across the front of the well at each floor, as shown at *a*, Fig. 56 (*c*), the top of which is generally 4 inches below the level of the finished floor of the story above, although the location of these beams, being a matter that is determined in connection with the general structural framework of the building, varies materially in different structures. The enclosure work must, of course, be made to suit the positions of these beams on which it is supported, and the important point is their relation to the finished floor level. In fact, the principal measurements necessary to lay out the work are the width between the partitions, the distance from the finished floor to the top of the beams, the depth of the beams, and the height from floor to floor (which will generally be the same as from beam to beam). Having these points determined, the position of the cast-iron jambs shown at *b* in the plan (*a*) should be fixed. In this example the whole opening is surrounded with a cast-iron architrave *c* consisting of the jambs shown at *b* in the plan, over which is set the cornice *d*, standing independent and distinct from the partition. The jambs rest on top of the steel channel shown at *e* in the section (*c*), and are bolted to it at the bottom; while the top is run up and bolted to the bottom of the channel *a*, as the partition itself affords no support. The upper portion of the jamb is checked back from the point where the architrave is mitered, to the bottom of the beam

490

above, in order to permit the cornice to pass in front of it, and to permit it to be enclosed in the partition. The top connections may be made by riveting to the head of the jamb a short piece of angle iron, to project each side of the jamb, as shown at (*d*); or, the top of the jamb may be cast with a flange or lug about $\frac{1}{2}$ inch down from the top, as shown at (*e*). The half-inch clearance permits the jamb to be shortened a trifle if necessary, when fitted to its position.

The jambs being set perfectly plumb, the sill *f* is then put down, and, as will be seen in the section (*c*), the edge next to the floor is turned down about $1\frac{1}{2}$ inches, to form a flat surface for the woodwork to finish against. The angular grooves shown at *k* in the large detail of the sill, Fig. 57 (*a*), give a better foothold than if the surface were smooth; the deep groove *a* in the same detail is for the bottom guide of the sliding door to travel in, and is made ample in width, and closed in on each side with a strip of wrought iron *b*, to permit of adjustment in case the cast sill is not set true. The wrought-iron plates are also advantageous, inasmuch as they serve better to keep the door in its proper place and reduce the friction surface to the narrow edges of the strips only. As the side of the sill next the shaft is not deep enough to reach to the beam, upright ribs *c* are cast about 3 feet apart along the under side; and on one side of each of these ribs is riveted a piece of angle iron *d*, which is bolted to the beam. The cornice is a hollow casting, as shown at (*b*). It is open at the ends where the extensions of the side jambs pass behind it, and it is mitered at the corners where it joins and is bolted to the jambs and architrave with countersunk screw bolts. The cornice is secured to a bar with screw bolts, as shown at *l*, and the bar in turn is bolted at each end to the jamb.

38. In Fig. 58 is shown a plan and horizontal section of the front of the enclosure. The strap brackets *a* are of 2"×2" angle iron, and are so placed as to brace the opening laterally. They are bolted to the structural column with expansion bolts, and to the architrave with countersunk screw

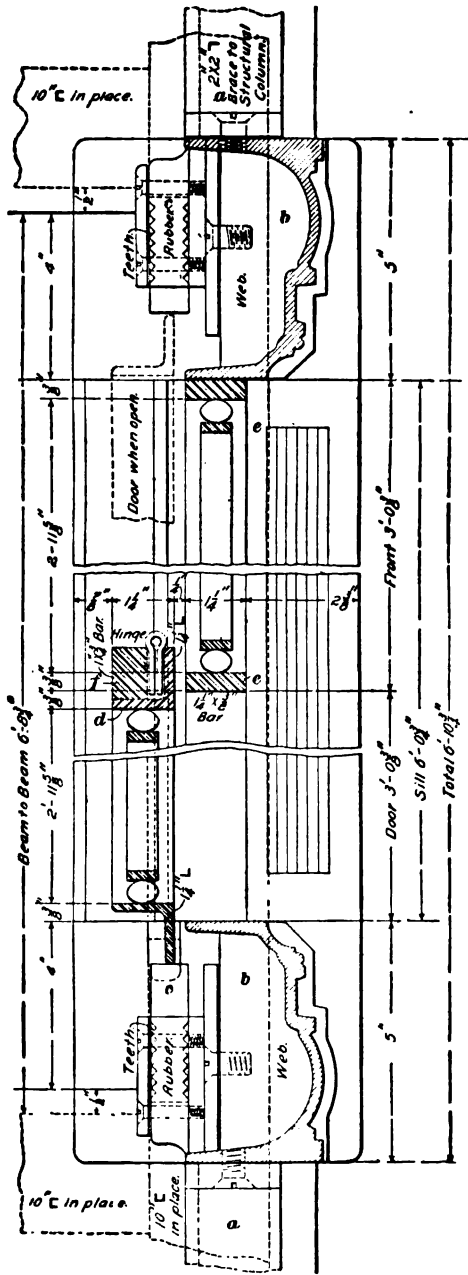


FIG. 58.

bolts. The webs *b* of the architrave are sufficiently thick to provide the tap or screw bolts securing the door stop a firm and sufficient hold. These stops are fitted with a rubber cushion *c*, which takes up the recoil and noise of the door when operated.

By referring to the elevation (*b*), Fig. 56, it will be observed that the grille-work is divided into two large panels, one being the door *g*, and the other a pivoted panel *h*. The frame of the door is composed of angle irons, as shown at *d*, Fig. 58, and the frame of the pivoted panel of flat bars, as shown at *e*. The pivots are secured to these bars with screw

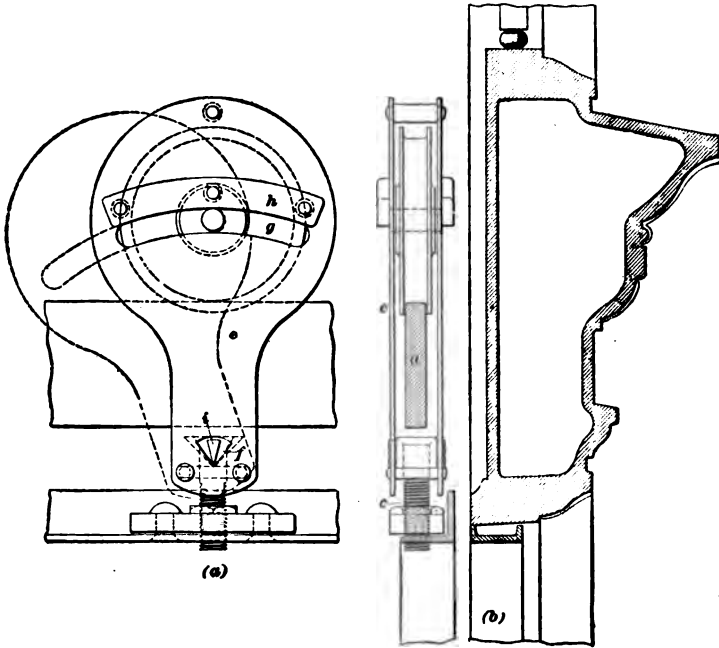


FIG. 58.

bolts, as shown at *f* in Fig. 57. On the sliding door is a bar shown at *f*, Fig. 58, to which the door is hinged. The bottom of this bar carries a guide, fitting in the groove of the track, and at the top secured to the angle iron *g*, Fig. 57, which is a slight extension of the door frame. The door is held in

place by the guide bolt *i*, and the panel by sliding bolts. The reason for this arrangement is to facilitate and make possible the entrance to the elevator of large pieces of furniture; in such a case, the whole front may be swung open by first drawing the sliding bolts in the pivoted panel, then drawing the guide bolts and pushing back the sliding door to its full extent. Both sections are then swung open, the bar and the angle iron remaining attached to the hinges. When used under ordinary conditions, the sliding door is held in place and firmly attached to the hanger by the clips shown dotted at *k*.

39. The hanger consists primarily of a pair of wheels running on a track, from which the door is suspended. These wheels are both alike and are set about 12 inches from each end of the door, the position varying somewhat in different doors. Fig. 59 shows the principal features of this hanger, which is patented. The track *a* shown in the section (*b*), on which the wheels run, is fixed to the back of the transom at each end by cast-iron supporters *b*, shown in detail in Fig. 60, which should be set perfectly level. The track, with the

wheels on it, is then put in position, and the bolts *b'* are loosely screwed through the slotted holes in the end. If it is found necessary to further adjust the track, the screws *c* are for that purpose, so that it can be easily set level; then the bolts *b'* are to be screwed up tight. On the arrangement of the

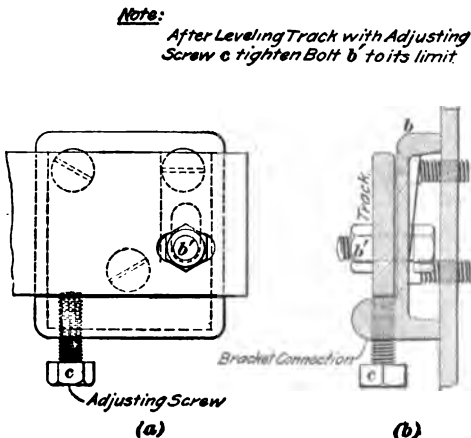


FIG. 60.

sides which enclose the wheels depends the easy gliding

motion. These sides *e*, Fig. 59, are punched out of solid steel. At the lower end there is a V-shaped hole *f* and across the center is a slot *g* reinforced by a steel strap *h* in which the axle of the wheel travels and revolves. The slot is an arc of a circle whose center is the lower angle of the V-shaped hole, and the door is suspended from the knife-edge bearings *i* resting in this V. When the door is at rest the wheel is in the position shown by the full lines, and as it is pushed along the sheaves gradually swing over to the position shown by the dotted lines, the center of the wheel always remaining over the point of suspension. This prevents any rubbing motion at any point, as the axle of the wheel is not bound in any way, but simply rolls in the slot, and it is evident that the friction at the point from which the door hangs is practically nothing. If it is found necessary to raise or lower the door itself, this may be done, after everything is in position, by turning the suspending bolts *c*, which are squared at the neck to afford a hold for a key or wrench.

40. The construction of the enclosure, as well as the design shown in Fig. 61, differs considerably from that of the preceding example. With the exception of three details, it is entirely of wrought iron, these exceptions being the sill, the transom, and the molding at the top of the lower panels. By referring to the plan (*a*) of the small scale detail, Fig. 62, also the section (*d*), the surroundings governing the design may readily be seen. The main support of the screen is a round bar or column, shown at *a*, Fig. 61, which consists of a wrought-iron pipe $2\frac{1}{2}$ inches in diameter fitted with a cap and base. The top is secured to the soffit of the brick arch over the partition with an expansion bolt, and also to the cast-iron sill at the floor level. The grille screen is separated from this column by a small post *b*, which forms the sides of the grille frame and is finished with base and finial. It is secured to the main column *b* by collar straps *c* on the lower part, and by the transom extension *d* at the top. The jambs of the door opening are formed of half rounds to correspond to the post *b* and to strengthen the center of the

screen. The space between the post and the partition is fitted with a small bar *f* to fill the space between the column *a* and the side walls. The sill shown in detail at (*f*), Fig. 62,

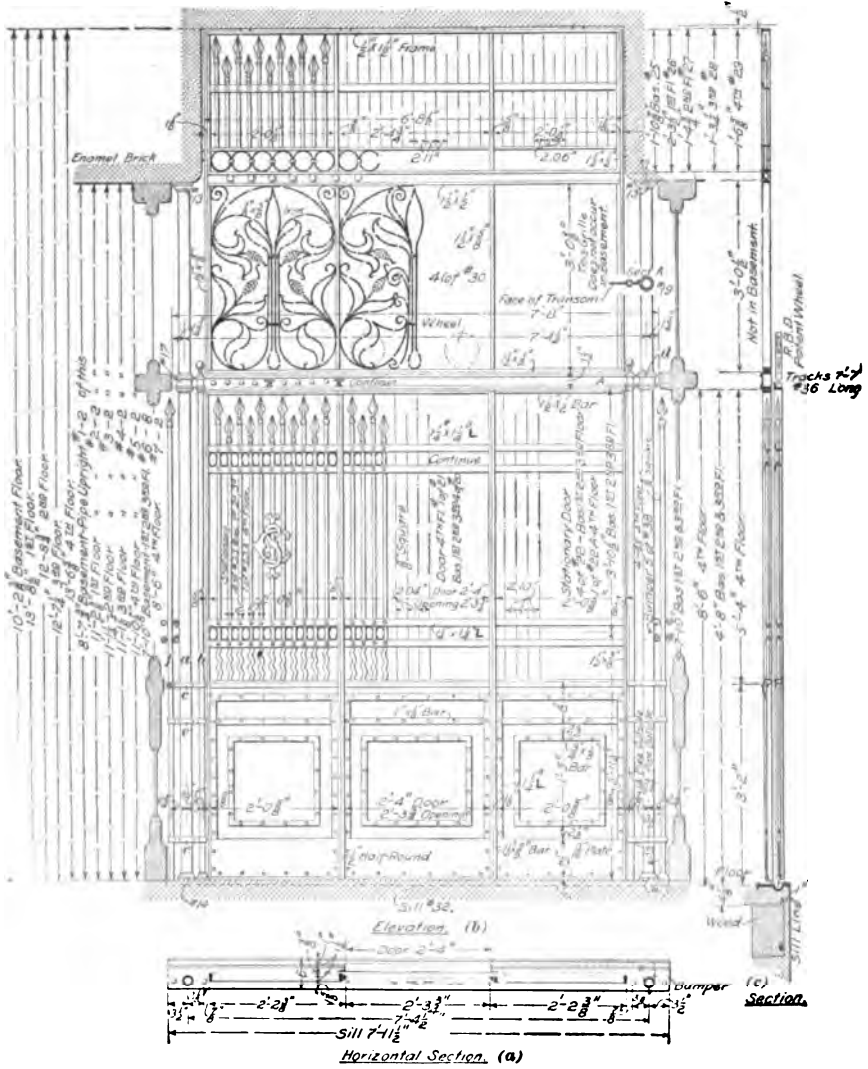
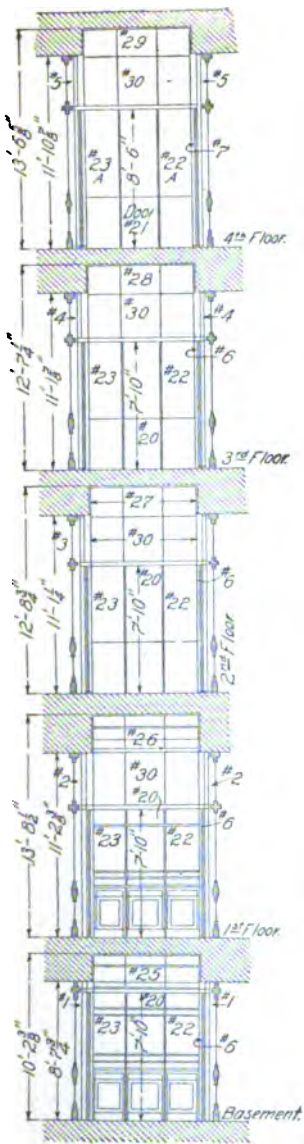
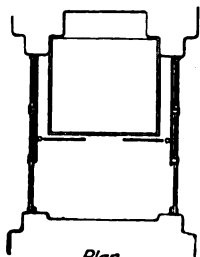


FIG. 61.

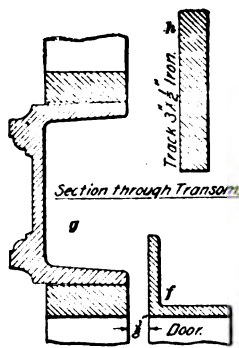


Elevation. (b)

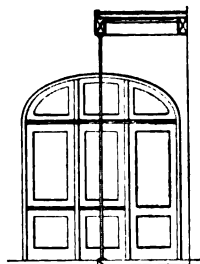


Plan

(a)

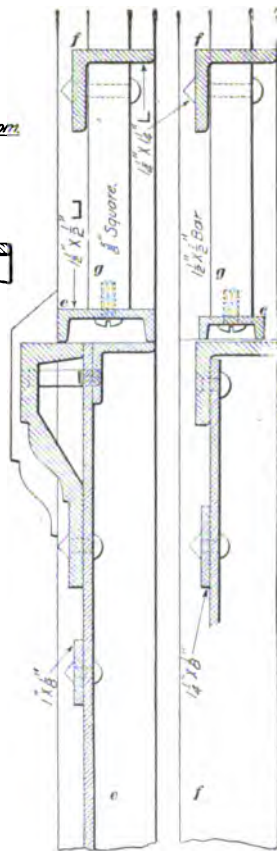


(e)

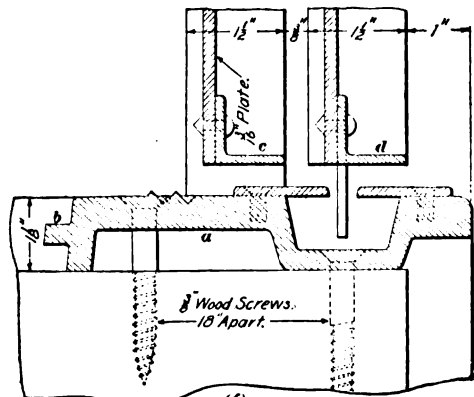


Section

(d)



(e)



(f)

FIG. 62

has a tongue *b* cast on it to receive the finished floor, which is grooved to fit over this tongue and thereby make a snug and unyielding joint. The stationary panels of the screen each side of the door have a dado panel in plate iron, and grille-work above; the same treatment being used in the door.

41. A section of the screen at *c*, Fig. 61, shows the sliding door on the inside of the shaft and the hanger above. Fig. 62 shows, at (*f*), a section through the cast-iron sill and the method of screwing it to the wooden-floor construction. At *d* is a section of the bottom of the sliding door, while at *e* is the fixed panel. The sections of the upper moldings on the dado panel of the door and screen are shown in Fig. 62 (*e*); and at *g* is seen the elevation of the lower part of the bars of the grille, and the screw which secures each of them to the channel iron forming the surrounding and protecting frame. In Fig. 62 (*c*) a section of the transom bar is shown at *g*, a section of the top of the door at *f*, and the track on which it slides at *h*.

42. The general construction of all elevator enclosures is pretty much the same as the examples given in the preceding figures, and further details are unnecessary. In the enclosure screen shown in Fig. 63, the architrave is of cast iron, the general outlines and form of which are designed to correspond with the adjoining trim. This architrave is decorated on the jamb side with a spool-and-spindle fillet mold, and on the outer edge with an egg-and-dart echinus molding. The dado panel is of sheet iron surrounded with a tooth molding, and the center decorated with a wreath of myrtle leaves, berries, and ribbon in wrought or cast iron. The grille of the door is much closer than the transom grille, thus giving a heavier and close effect in the proper place. Both these grilles are formed of $\frac{1}{16}$ " \times $\frac{3}{8}$ " strap iron set with the edge to the front, the very open portions being relieved by twisting the bars so as to produce a spiral, showing the full width of the bar to the front.

43. In Fig. 64 the whole screen is formed of wrought iron, except the transom bar. This design presents several

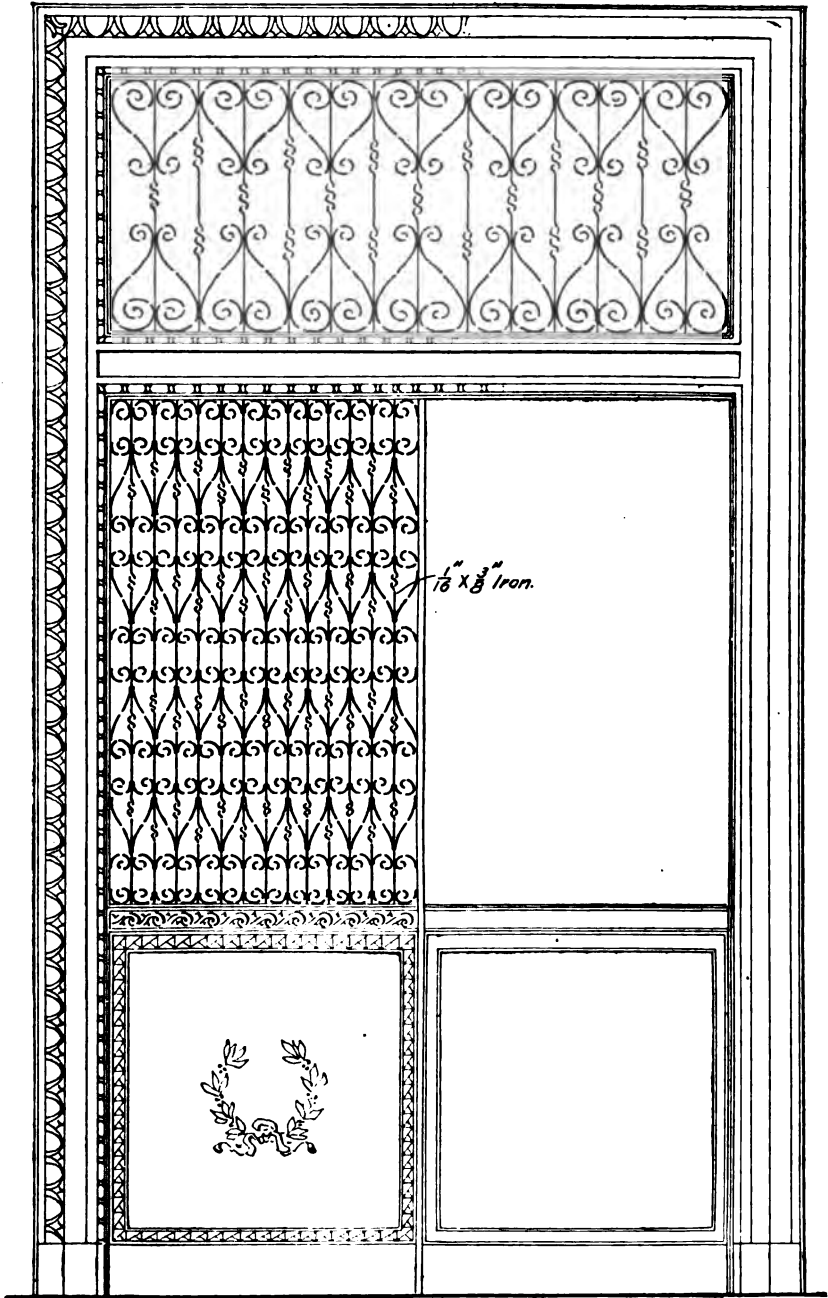


FIG. 68.

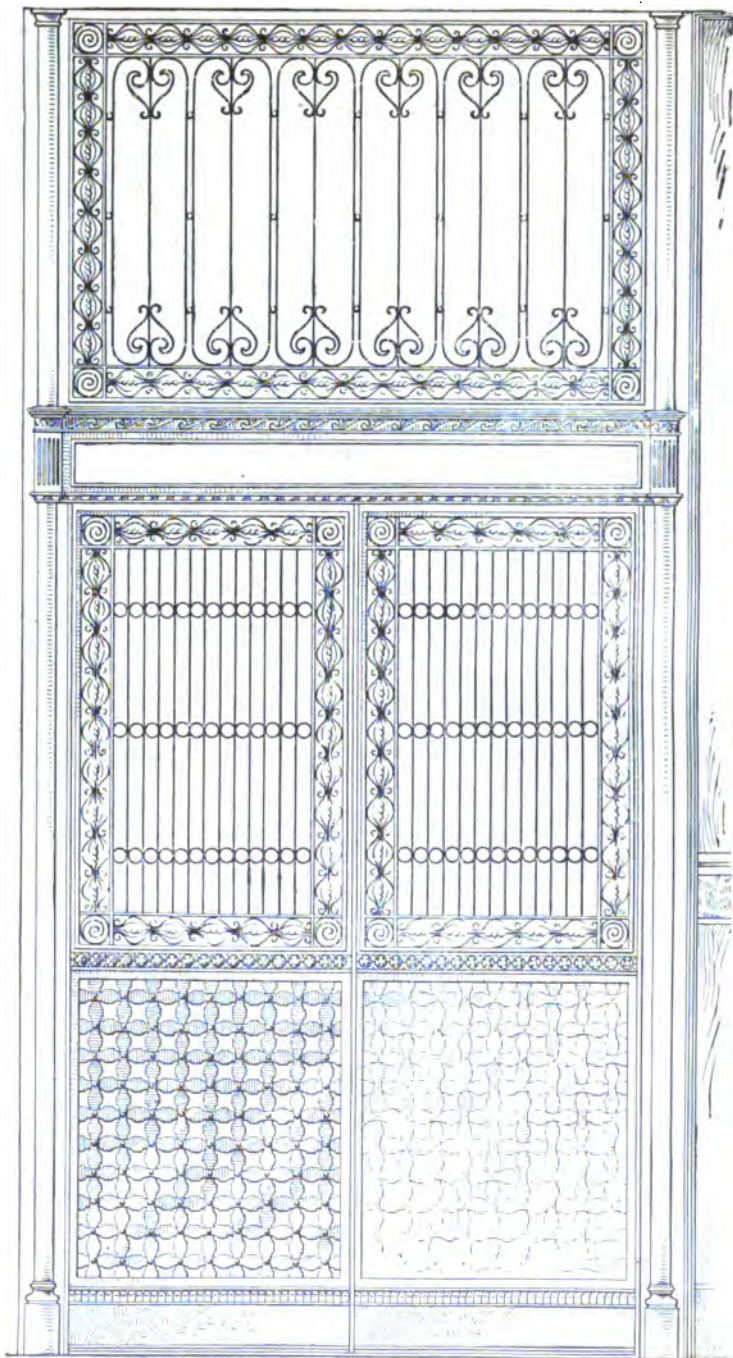


FIG. 64.

most agreeable and pleasing features; it is well balanced, and the transition, which should always be studied in design, from the heavy effect in the dado to the light area in the transom, is here well defined. The dado is especially good, as it combines protection, good design, and cheapness. The pattern, which is a diaper, is made of the usual basket strap work with the edges cut to-the-form shown. The rail is not too heavy, and shows a molding with a rosette-and-leaf decoration. The filling of the panel is of a series of bars well braced and bound together with three rows of rings. The transom bar—the only piece of cast iron—is finished at the ends with fluted and molded collar bands, through which the columns supporting the screen pass. The transom grille border is a repetition of the door grille, and the center is composed of six very open panels, separated by small button washers, thus completing the screen.

COMBINED ELEVATOR AND STAIR SHAFTS.

44. In fireproof buildings it is a common practice to combine the elevators and stairs in one shaft. In such cases the elevator usually occupies the center of the shaft, and the stairway is constructed around it. Such a combination is shown in plan in Fig. 65, where the arrangement of stairs and elevator shaft on the first floor is shown at (*a*), and on the upper floors at (*b*). An elevator shaft 6 ft. \times 6 ft. $9\frac{1}{2}$ in. is thus provided, around three sides of which rises a stairway 3 ft. $2\frac{1}{2}$ in. in the clear. So far as the details of the stairs are concerned, they are precisely the same in principle as those described in Arts. **18**, **19**, and **20**; the wall strings are first set in place, then the face strings (which in this case are the *well* strings), and finally the risers and treads. The well strings, however, have to be considered with the elevator shaft, as they form a part of that structure; and the details of the grille-work screen around the elevator shaft must include a treatment that will take the place of a balustrade on that side of the stairs.

The elevations of the wall strings, the outside strings, and

the sides and back of the enclosure, also the front elevation of the enclosure, are shown at (a), (b), (c), and (d), in Fig. 66.

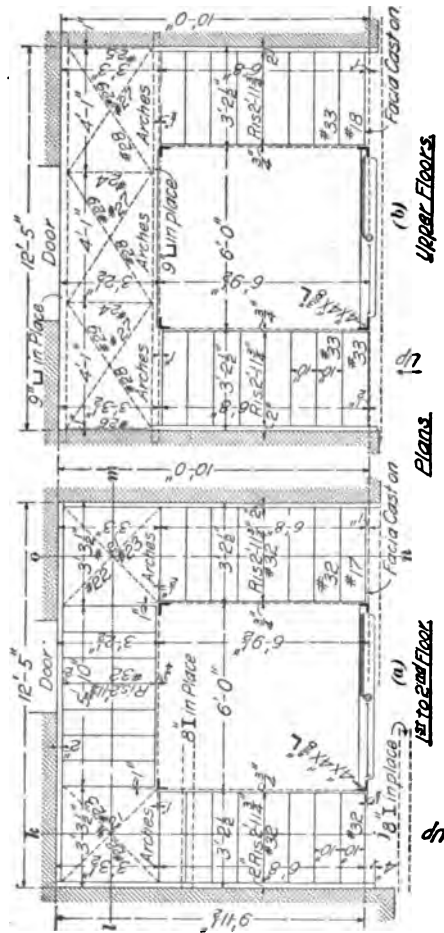


FIG. 65.

The grille-work on the first story is of brass, and on the stories above of iron.

45. As in the previous examples of stair work, the first procedure is to fix the number of risers and the width of the stairs. The height, as shown at (a), is 14 ft. 8 1/4 in. between

the first and second stories; and to determine the number of risers, the size of the well hole, as well as the approximate space that the elevator will occupy, must be considered, though the latter may be modified to work out the stairs.

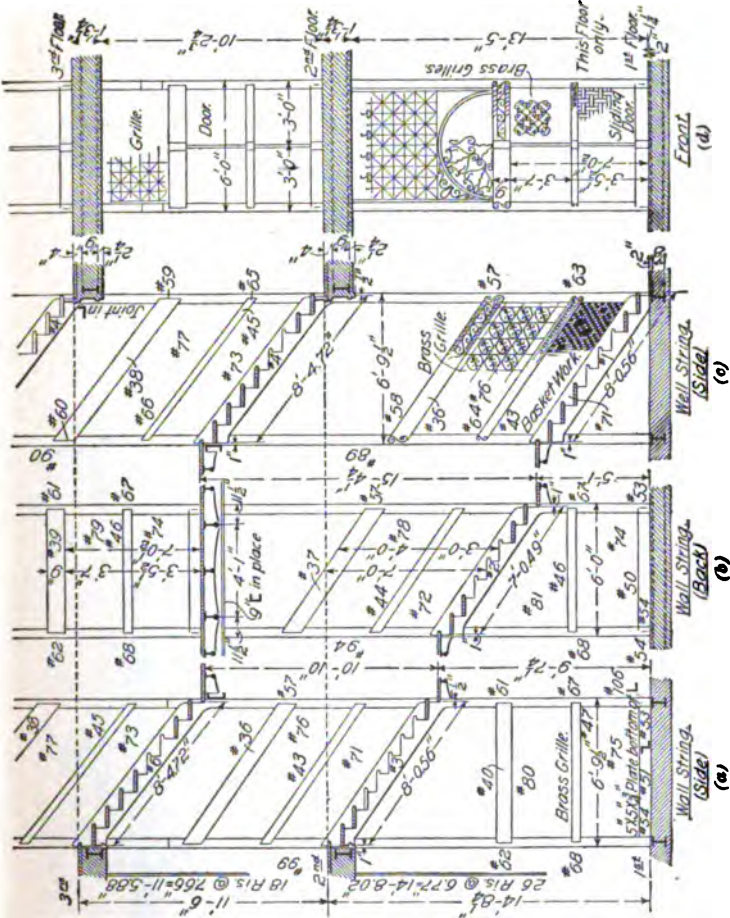


FIG. 66.

It will be seen that 26 risers at 6.77 inches high, counting from the top to top of the treads, gives 9 risers each side of the well and 8 at the back. This will permit the treads to be 10 inches wide on the sides and back, all finishing nearly symmetrically at the corners. The face of the first riser, as

shown in Fig. 65 (a), is $\frac{1}{2}$ inch from the corner of the angle-iron frame of the well, and the ninth riser is 1 inch from the corner of the corresponding angle at the back of the shaft.

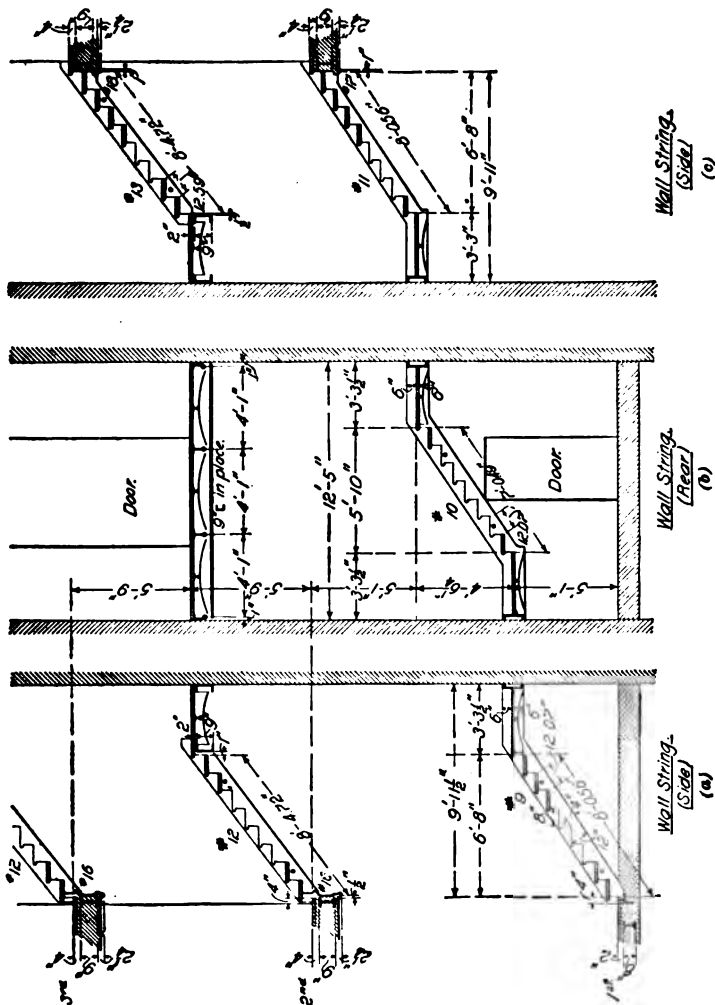
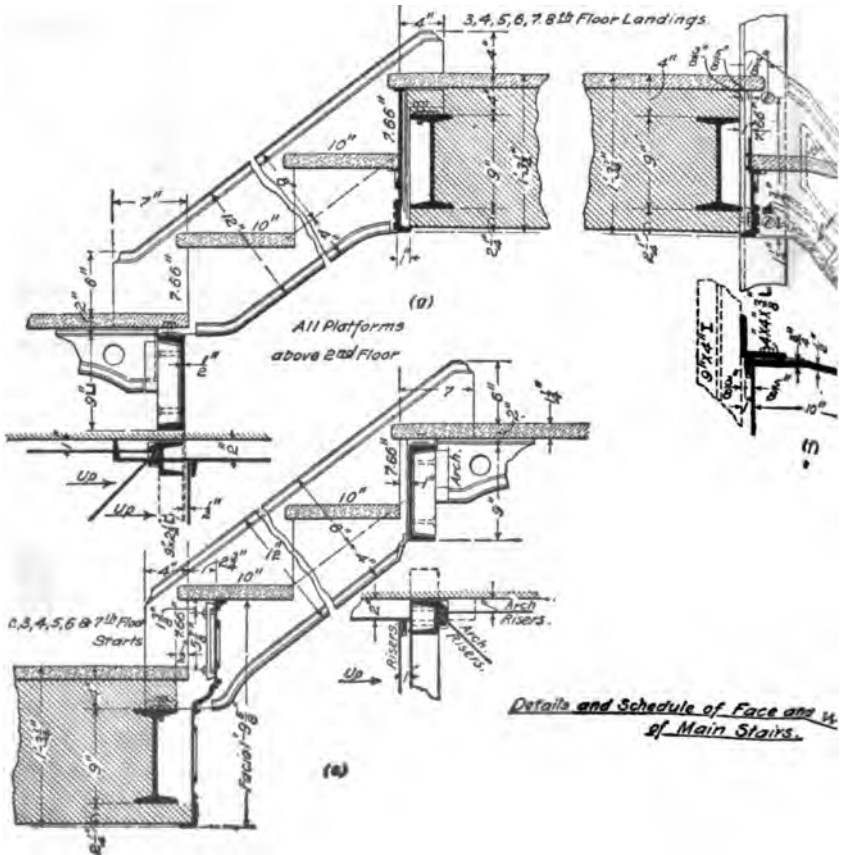
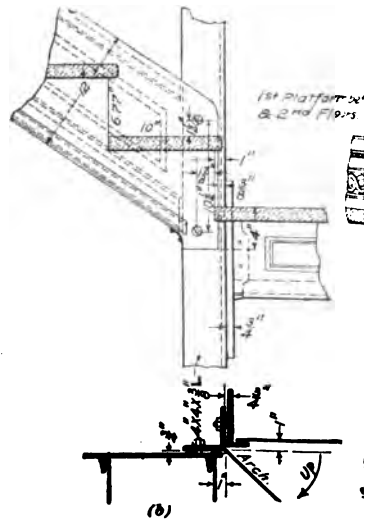
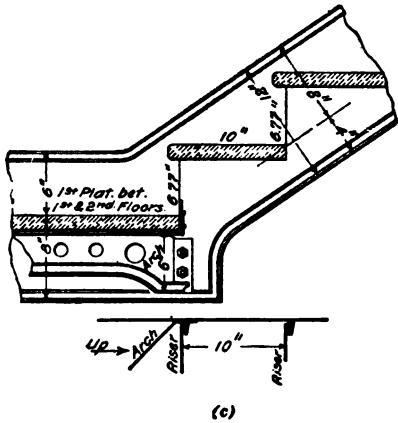


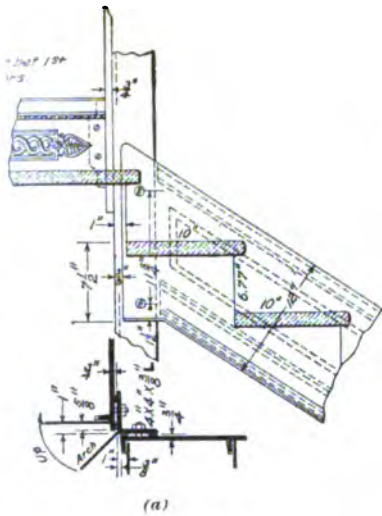
FIG. 67.

The upper part of the opposite side is similar, and the run at the back has the tenth and seventeenth risers, each 1 inch back of the angle iron, thus in each case allowing sufficient

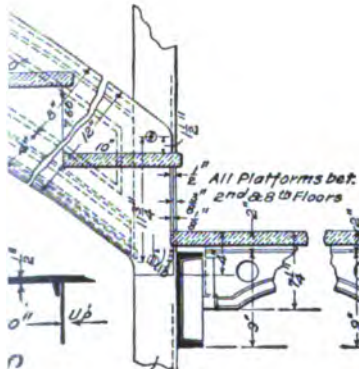




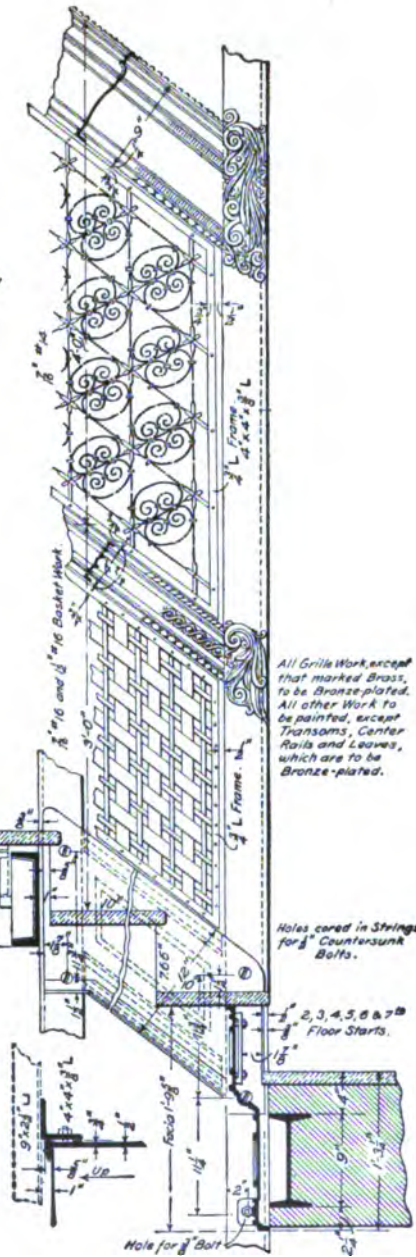
Details and Schedule of Face and W. of Main Stairs.



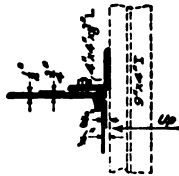
(a)



Wall Strings.



(d)





room for the finished tread to stop inside the edge of the angle. In planning any stair that is broken by intermediate platforms, the starting riser of each section should, if possible, be kept the same distance from a fixed point; in this example these points are represented by the angles at the corners of the well. Circumstances may arise, as in the present case, when this arrangement is not possible, and then the space is divided equally, in place of having the cleventh riser $\frac{1}{2}$ inch back, and the seventeenth $1\frac{1}{2}$ inches; this also allows the platform to be the same breadth.

The upper stories being less in height than the first story, fewer risers are required; and by making them 7.66 inches high, the plan of the stair on each side of the well remains the same as the first story, while at the back the platform extends across the full width of the well. In fact, the stairs in every case should be planned as a whole, and not simply flight by flight.

46. The plans being determined, the wall and outside, or well, strings, and the sides and back of the enclosure should be laid out on the section lines *jk*, *lm*, and *no*, shown in Fig. 65 (*a*), the developments of which are shown at (*a*), (*b*), (*c*), and (*d*), Fig. 66, and (*a*), (*b*), and (*c*), Fig. 67. The elevation of the front is also shown at (*d*), Fig. 66. In most stairs, the platforms are of slate or marble, and must be supported at the center or diagonally by either cast or wrought iron ribs or arches, as indicated by the dotted lines shown on the plans, Fig. 65. The development and details of the parts of the enclosures and stairs are shown in Fig. 68. (*a*) shows the head of the outside string in plan and section at the first platform, between the first and second stories; (*b*), the foot of the outside string in plan and section at the first platform, between the first and second stories; (*c*), the wall string in plan and section at the first platform between the first and second stories, and an elevation of the arch rib supporting the platform and the springing block to which the rib is bolted. At (*d*) is shown the plan and section of the head and foot of the outside string, with the enclosure of

basketwork and grille as they exist in the upper stories, and (e) shows the plan and section of the *wall* string of the same run. At (f) is shown a plan and section of the head and

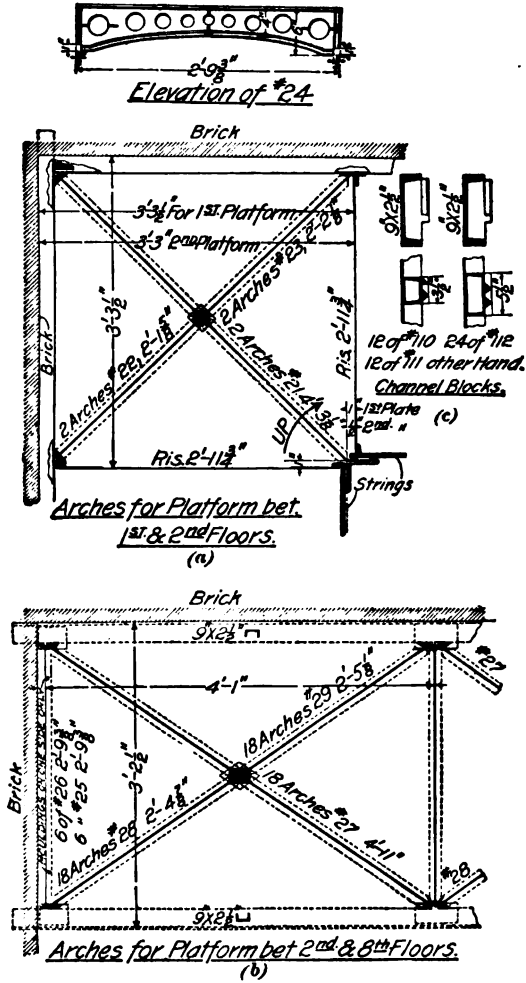


FIG. 69.

foot of the outside string on all the platforms and landings of the upper stories. At (g) is shown the wall string and

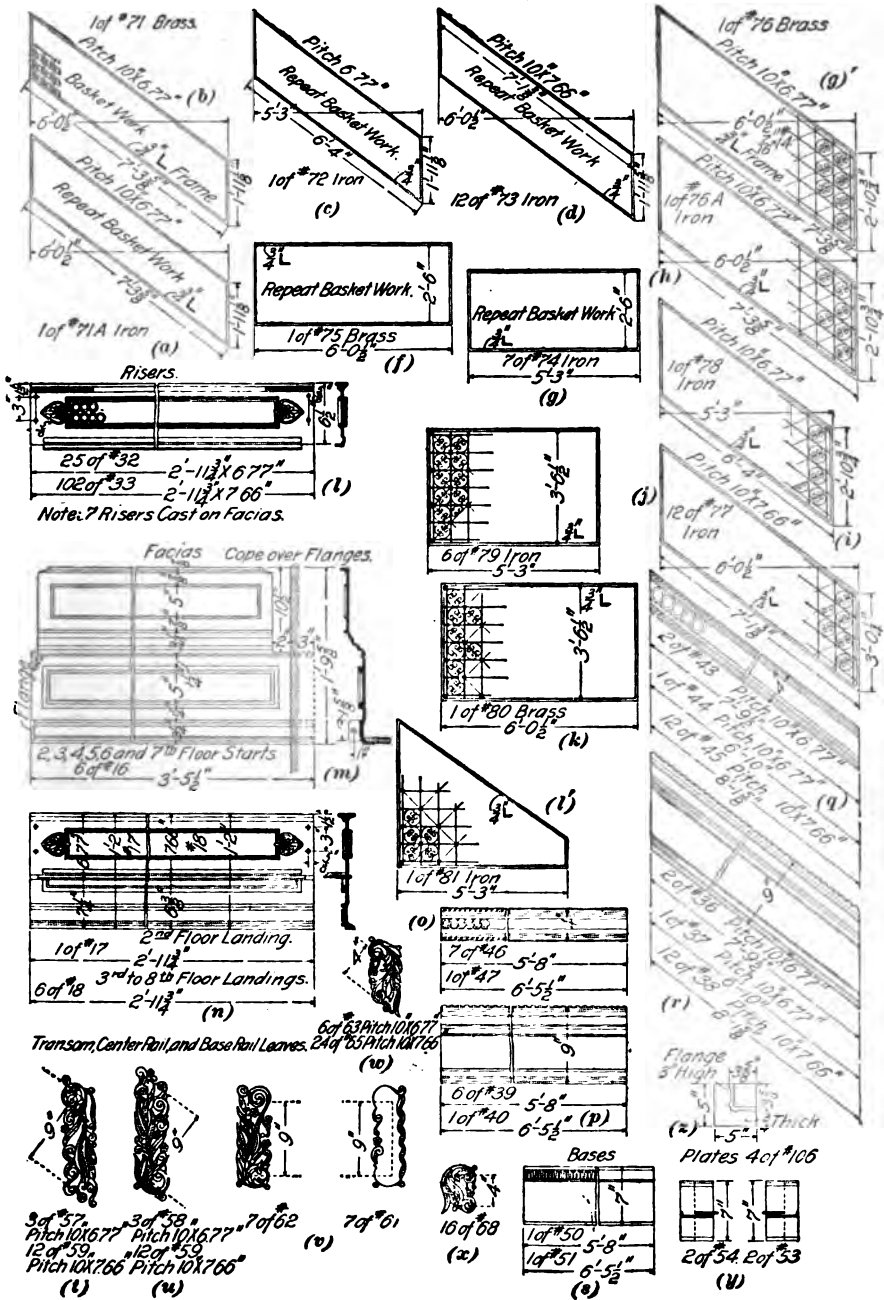
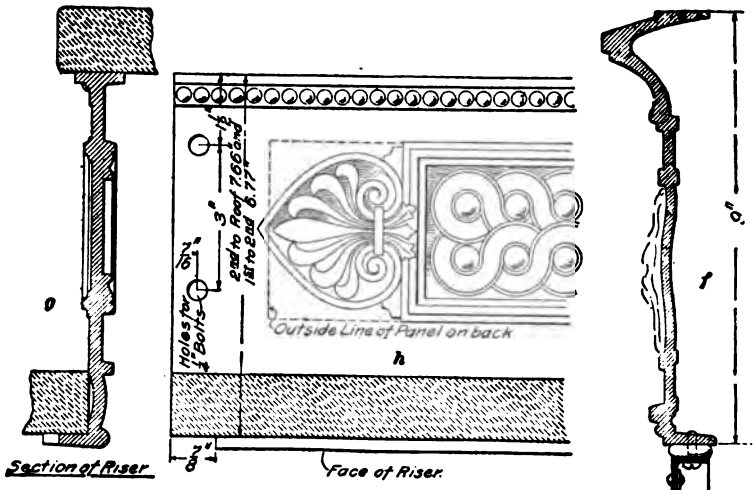
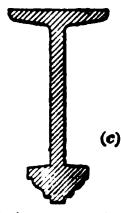


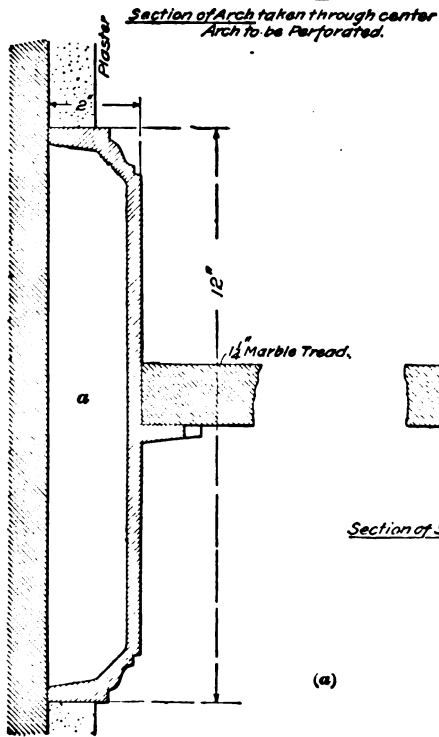
FIG. 70.



(b)



(c)



(a)

FIG. 71.

the platforms and landings of the same run. In Fig. 69 is shown the elevation and section of the rib arches that support the platforms. The ends are checked out $\frac{3}{4}$ in. \times 1 in. where they rest on the springing blocks as shown. Fig. 69 shows at (a) the plan of these platform arches for the first story, and at (b) for the upper stories, while the springing blocks that support these ribs are shown at (c). They are cast channel shape, with the web, or socket, and the lug on the face.

47. The risers shown in Fig. 70 (l) are for all starters on each floor, and for all intermediate risers. The facias shown in Fig. 70 (m) are at the start of the upper stories, and form a finish from the first tread to the plaster of the ceiling below. The seven risers cast on the facias are shown at (n), and are for the upper landings, and form a finish from the last tread to the under side of the plaster. The top rails, center rails, and bases are shown at (o), (p), (q), (r), and (s); the base (s) finishes the enclosure on the first floor only. The center rails (o) and (p) extend throughout all floors, as do the top rails (q) and (r). The leaves forming the finish, and covering the joints of the transom, center rail, and base rail, are shown at (t). The finish at the base of the angle irons at the first floor is shown at (y) and (z), the latter being the plate which is bolted to the I beams to form the foundation of the enclosure, the four angles at the corner being bolted to these plates. The basket grille which forms the dado of the enclosure is shown at (a), (b), (c), (d), (f), and (g), and the grille-work at (g'), (h), (i), (j), (k), and (l').

48. Fig. 71 (a) shows the strings, enclosure, arch, and riser in detail. The wall string is shown at a, and the well string at b; the frame of the basket grille composed of small angle irons is shown at c, and the center rail at d; the grille frame composed of small angles at e, and the top rail at f. A section of the riser and an elevation of the front of the same are shown at g and h in Fig. 71 (b), and the arch rib at (c).

ELEVATOR CARS.

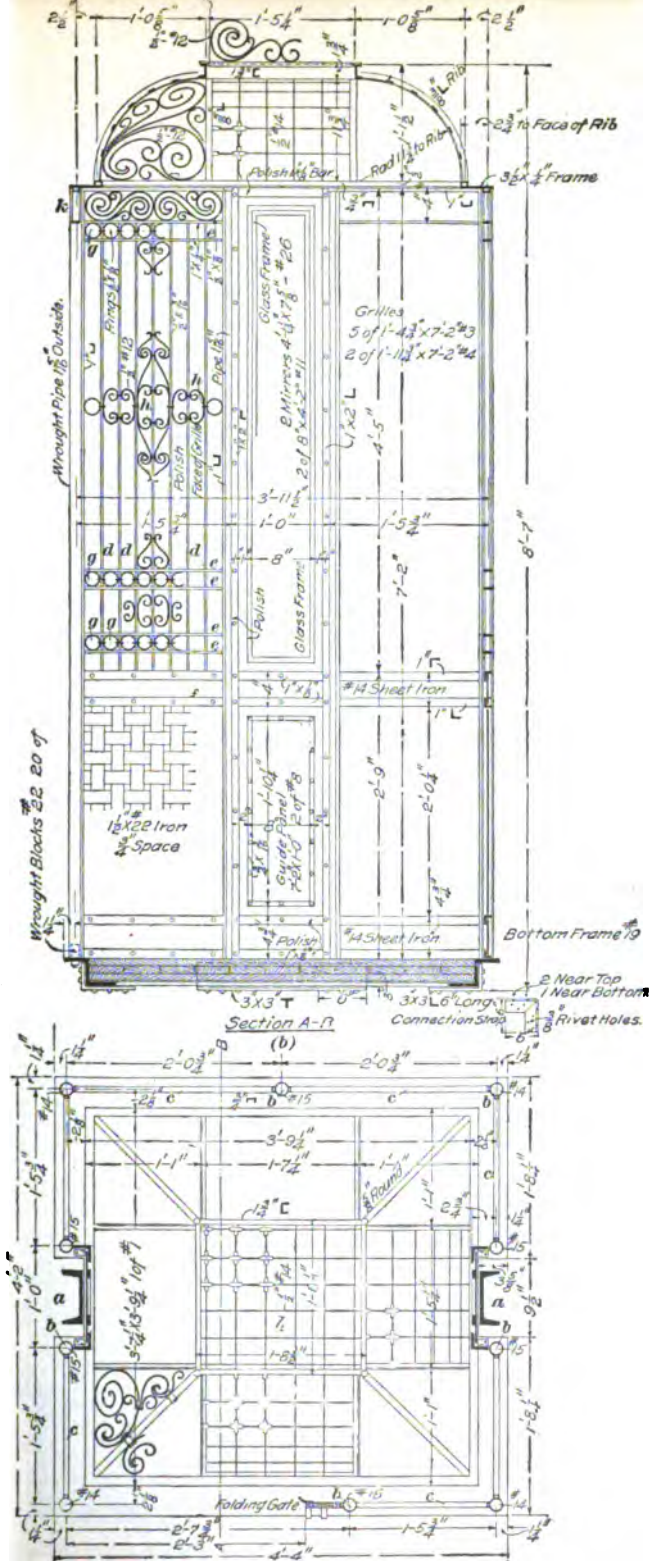
49. Elevator cars are usually constructed of angle-iron or pipe framework, and filled in with woven-basket and twisted-iron grille-work and scrollwork. The design of the grille-work is usually similar to, if not identical with, the design of the grille of the enclosure, though sometimes certain conditions require a stronger and less elaborate design in one place than in the other.

In Fig. 72 is shown a plan at (*a*), and a section or interior elevation at (*b*), of an elevator car, the design of which is simple and inexpensive, while the construction is substantial and serviceable.

The plan (*a*) shows two recesses at *a*, in which are located the guides, thus permitting the car to extend the full width of the shaft. The frame of the car is composed mostly of wrought-iron pipe, as shown at *b* in the plan, between the vertical members of which small channels *c* are secured to receive the basketwork and grilles. On the inside of the car the guides are covered with sheet-iron dado panels, extending 2 ft. 9 in. above the floor and with a beveled plate-glass mirror from here to the top of the car. The rest of the side walls of the car, with the exception of the door, is composed entirely of grille-work.

50. The dado consists of a simple basketwork of $1\frac{1}{2}$ -inch iron straps, spaced $\frac{3}{4}$ inch apart and secured by riveting the end of each strap to the leg of a 1-inch angle iron, as shown at *f*. The space between the dado and the grille-work consists of a sheet-iron panel secured in place by riveting it to the vertical legs of two 1-inch angle irons, which are framed in between the vertical supports.

The grilles forming the upper part of the elevator are composed of $\frac{1}{2}$ " \times $\frac{3}{16}$ " bars *d*, which are held vertically in place by means of 1" \times $\frac{1}{4}$ " horizontal rails *e*, through which the vertical members extend. By arranging the rails in pairs, and keeping their distance apart equal to the spaces between the vertical members, a series of squares is formed, in which rings are inserted, as shown at *g*, thus bracing the joint and



(a)
FIG. 72

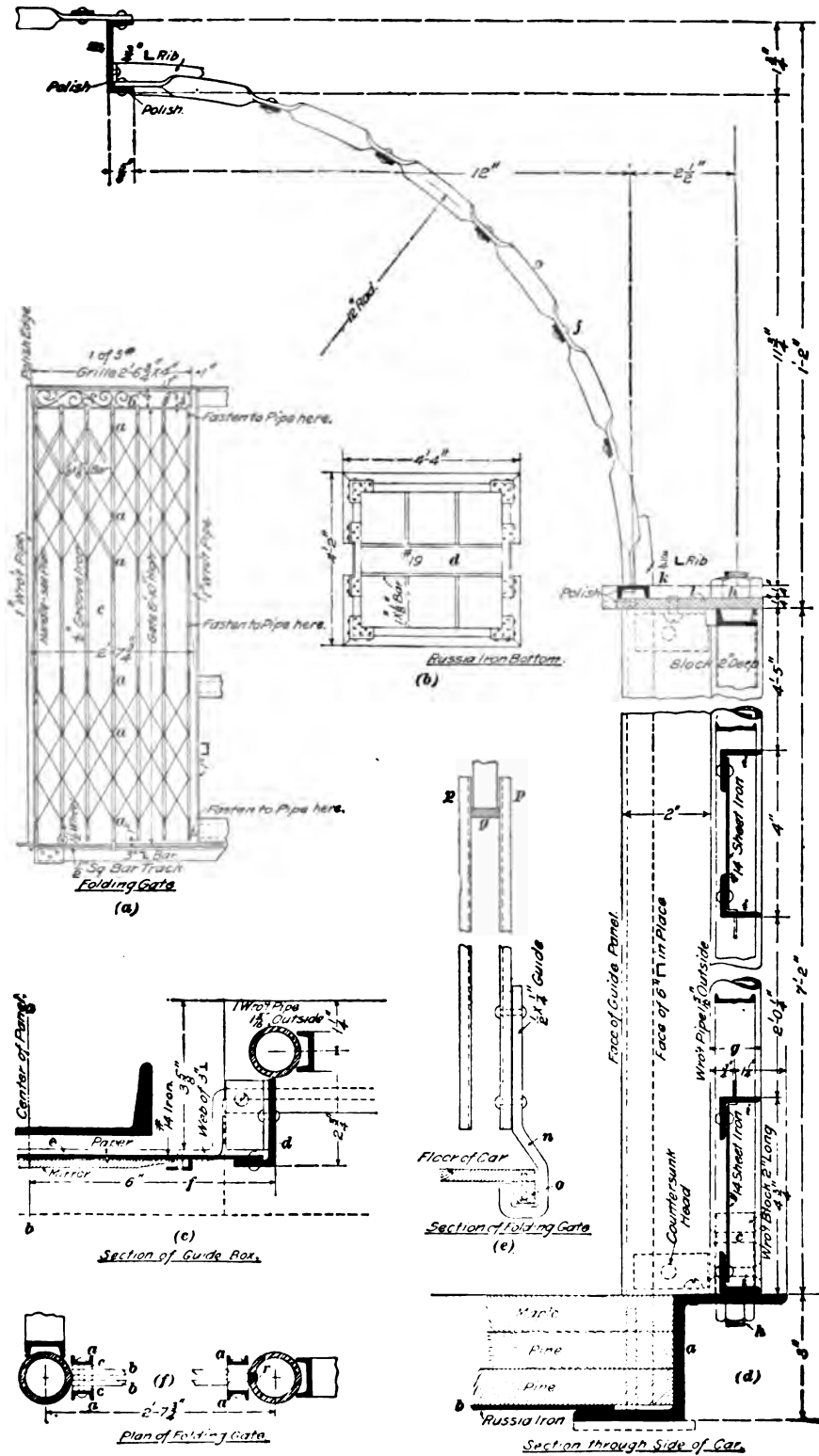


FIG. 73.

rendering the entire grille stiff and secure. Across the middle of the grille, a series of scroll ornaments relieves the plainness of the panel, while at the same time it gives lateral stiffness to the vertical bars. At the top of the wall panels a scroll design forms a frieze at the ceiling line, and serves to combine the character of the side walls with that of the domed roof. The grilles of the roof are composed of simple twisted strap iron, such as was described in Art. 33, on the sides, and of a more elaborate scrollwork in the angles.

51. In Fig. 73 (*a*) is shown a section through the side of the car, illustrating on a larger scale the details of its construction. The rectangular floor frame is composed of 3-inch **Z** bars, as shown at *a*, and three thicknesses of wood flooring, lined with a Russia-iron shield *b*, rest on the lower flange of the **Z** bar, while the walls of the car are secured to its upper flange. The corner and intermediate supports *g*, composed of $1\frac{5}{16}$ -inch wrought-iron pipe, are secured to the upper flange of the **Z** bar *a* at the floor level, and to a $\frac{1}{4}$ -inch wrought-iron plate *l* at the top. This is accomplished by plugging the ends of the pipes with wrought-iron blocks and riveting the blocks in place through the pipe, as shown dotted at *c*. The ends of the plugging blocks are then cut with a screw thread and the nuts *h* turned up on them, after their insertion through the flange and plate. Two 1-inch angle irons *i* form the upper and lower members of the frame for the base and middle rail, as shown, and a 1-inch channel, extending full length of the sides and across the top of each panel, secures the grilles and scrolls in their places. A smaller channel *k* rests on top of the plate *l* and receives the lower ends of the vertical members of the roof grille *o*. At *m* another channel set vertically receives the upper ends of the vertical members of the roof grille, and also the ends of the straps forming the center ceiling panel shown at *l* in Fig. 72. The straps of the dome and ceiling grilles are $\frac{1}{4} \times \frac{3}{16}$ iron twisted as shown, and riveted where they cross at *j*, as described in Art. 33.

52. In Fig. 73 (c) is shown a section through the panel and guide at the side of the car, the line *a b* being the center line through the guides. The angle irons *d* are secured to

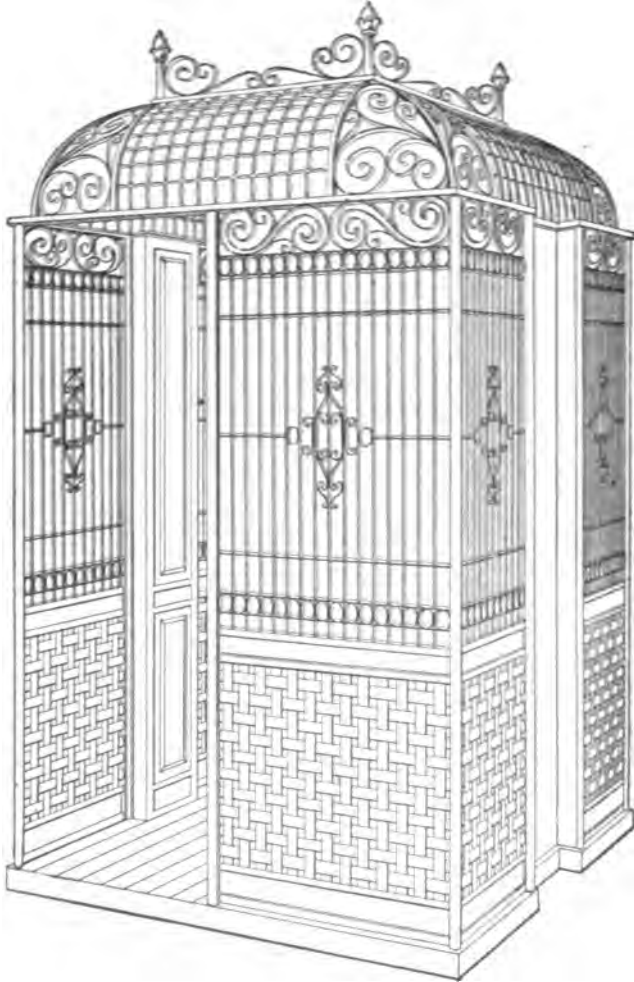


FIG. 74.

the flange of the **Z** bar at the bottom and to the $\frac{1}{4}$ -inch plate at the top by means of small angle-iron knees, and a plate of sheet iron *e* riveted to the short legs of the angles forms the

back of the chase or guide recess. On the inside of the car the mirror is secured against this plate by means of $\frac{5}{8}$ " \times $\frac{1}{4}$ " angle irons screwed to the chase back with countersunk screw bolts.

53. An elevation of the sliding or folding gate, protecting the entrance to the car, is shown in Fig. 73 (*a*), while Fig. 73 (*e*) shows a large scale detail of the bottom of the sliding post of the gate *n* and the guide *o* in which it slides. The vertical members of the gate are each composed of a pair of $\frac{1}{2}$ -inch channels, as shown at *a* in Fig. 73 (*f*), which is an enlarged plan. Between these channels the diagonal lattice bars *b* are secured as shown, with washers *c* between them to prevent their rubbing together as the gate is opened and shut. The rivets securing this latticework to the channels are not driven tight, but are left sufficiently free to play up and down in the slotted openings shown in the elevation, Fig. 73 (*a*), at *a*. Thus, the gate, which effectively bars the 2 ft. $7\frac{3}{4}$ in. opening in the car, occupies, when open to its fullest extent, only the width of the seven vertical channels, or $3\frac{1}{2}$ inches. On the exterior channel a $\frac{1}{2}$ " \times $\frac{1}{4}$ " guide is riveted, as shown at *n* in Fig. 73 (*e*), and on the under side of the Z-bar flange a track *o* is secured for the guide to travel in. At the top of the gate the $\frac{1}{2}$ -inch channels are carried up each side of the frieze grille of the car, as shown at *b* in Fig. 73 (*a*), and also in Fig. 73 (*e*), where the lower bar of the frieze grille is shown at *g* and the side bars or channels at *p*. The general appearance of the car when completed and all of its parts assembled, is shown in Fig. 74.

54. In Fig. 75 is shown a reproduction of a shop drawing of one of these cars, which was to be one of several all constructed alike, and accounts for the excess of material stated on the drawing for the different parts. This car is designed for a similar disposition of tracks and guides as the last example, but the design is more elaborate. The bottom of the car shown at *a* in the interior elevation (*a*) is of wood; the upright framing is of square tubes, as shown in

the plan at *b*, inside of which an iron rod *c* passes through the floor and the cornice *d*, and secures these parts as shown. The framework is bound together horizontally by rods at the rail and base, as shown in the elevation at *e*, and by the cornice at the top. Similar rods are placed in the corners behind the projecting panels on each side, thus binding the whole car together. The top of the car is of sheet iron, and, being dome-shaped, is self-supporting. The sides of the car are of cast iron *below* the rail, and cast and wrought iron above, with a mirror on each side. The small section of front shown in the plan at *s* is made to swing inwards, to allow the use of the full width of the car in taking on merchandise. The outside of the car below the rail is covered with sheet iron. The dado of the side shown at *g* in the elevation (*a*) is cast in one piece, including the base, panel, frieze, and cap. The base and cap are plain molded; the outside molding of the panel is decorated with a link leaf and the inner with a spool-and-reed ornament. The casting is secured at the top and bottom by bolts through the angle irons *h*, which are framed in between, and bolted to, each pair of corner posts. At the sides the panels are held by small lugs cast on them to receive dowel-pins, as shown at *i*. The top and bottom of the outside frames for the grilles shown at *j* are made of bar iron $1\frac{1}{4}$ in. \times $1\frac{1}{4}$ in., and the sides *k* of $\frac{3}{4}$ " \times $\frac{1}{4}$ " iron. The inside frame dividing the cast-iron border and the grille is of $\frac{5}{8}$ in. \times $\frac{3}{8}$ in., as shown; the bars of the grille are $\frac{5}{8}$ in. \times $\frac{1}{8}$ in., and the scrolls are all $\frac{1}{8}$ inch thick. The cast-iron border of the grille is a laurel-leaf design with a rosette in each corner and in the center of the top and bottom sections. The scrolls are secured to the frame by rivets, but to the bars they are held by straps. The cast-iron guide box, shown at *l* in the plan, is strengthened at the corners and finished on the inside with a pilaster, the upper part or shaft of which is fluted and finished with a cap, while the pedestal is paneled and filled with a guilloche ornament. The cornice is of cast-iron, molded and ornamented with a dentil course, as shown on the interior elevation, while on

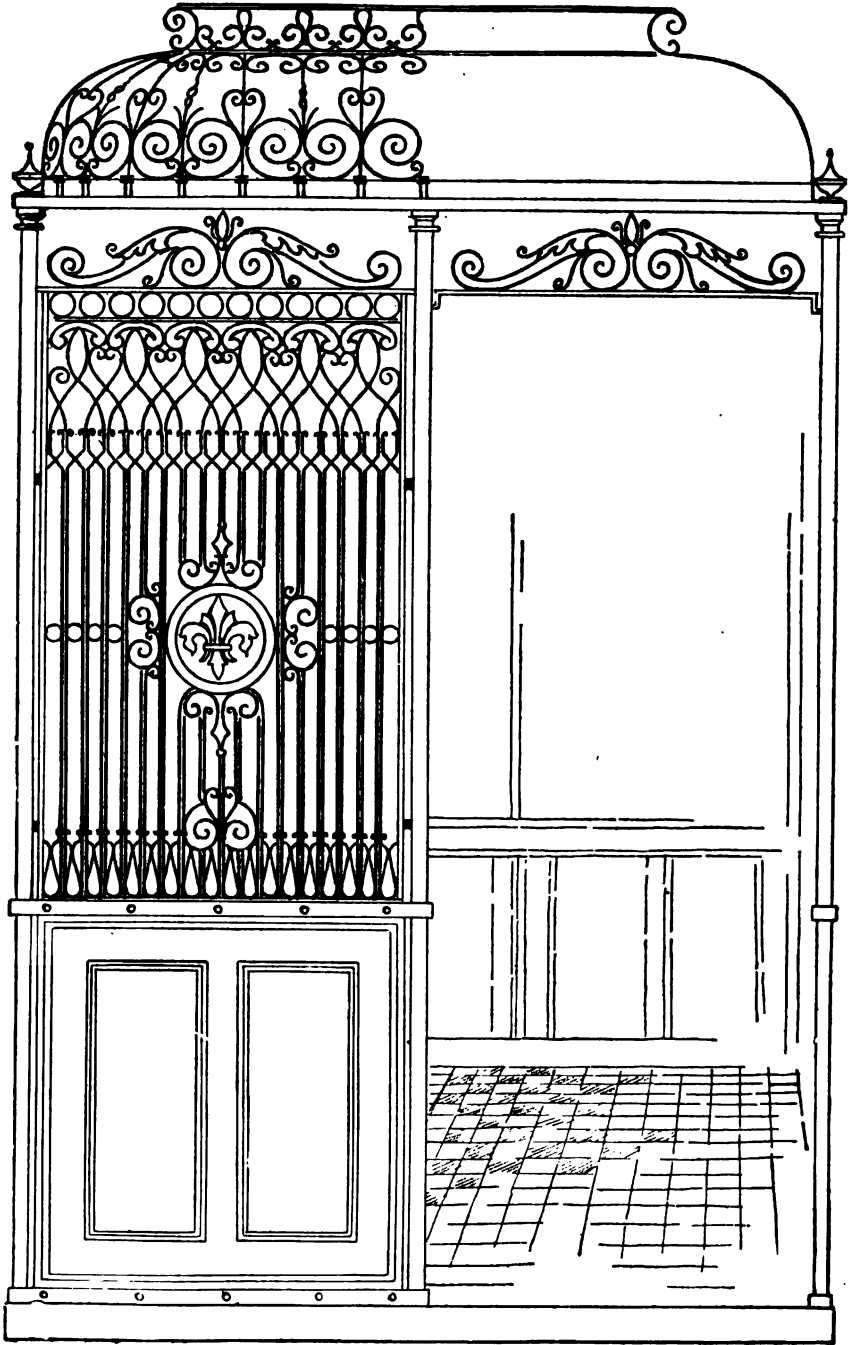


FIG. 78.

the back it is finished with small moldings top and bottom, which return as indicated by the dotted lines *n*. The dome plates are mitered at the angles and paneled on the inside face. The miters are covered by bronze spool-and-reed moldings, and the panel molding is decorated with a leaf link. The dome plates are secured to the vertical leg of an angle *o*, which is riveted to the top of the cornice of the car; and the cast-iron cornice of the *dome* is supported by these dome plates. The soffit of this dome cornice is decorated with a guilloche and flower rosette, as shown at *p* in the plan; while its fascia and corona are supported on modillion brackets, as shown at *q*. The dome grille *r* is designed suggestive of the usual treatment of a ceiling, being first divided in panels, which are afterwards filled with a circle, and the circle with a quarterfoil of scrolls. This grille is set in an angle-iron frame, which is bolted to the cornice. The swinging door shown in the plan at *s* is seen in elevation at (*d*). The pivots *s* are riveted to the frame of the grille, the top one being inserted in the cornice and the bottom one in the pivot plate *t*. The top and bottom of the post *u* are fitted with spring bolts, which are withdrawn when the section is to be opened. By a careful inspection of the details of the preceding examples, the construction of elevator cars should now be fully comprehended; and, as such work does not differ materially, the student should be able to design the construction details of any car required.

55. In Fig. 76 is shown a design for an elevator car entirely of wrought iron. The grille differs from the previous examples, as it has no border, but is divided into a dado, field, and frieze. The dado is composed of an interlaced leaf; the field has a cartouche with a fleur de lis in the center, and the frieze with an interwoven pattern ending in scrolls. The panels which take the place of the cornice are filled with scrolls, and decorated with leaves having a flower or bud at the center. The grille of the dome is in motive similar to the honeysuckle-link decoration used in classic architecture. The car illustrated at Fig. 77 is wrought

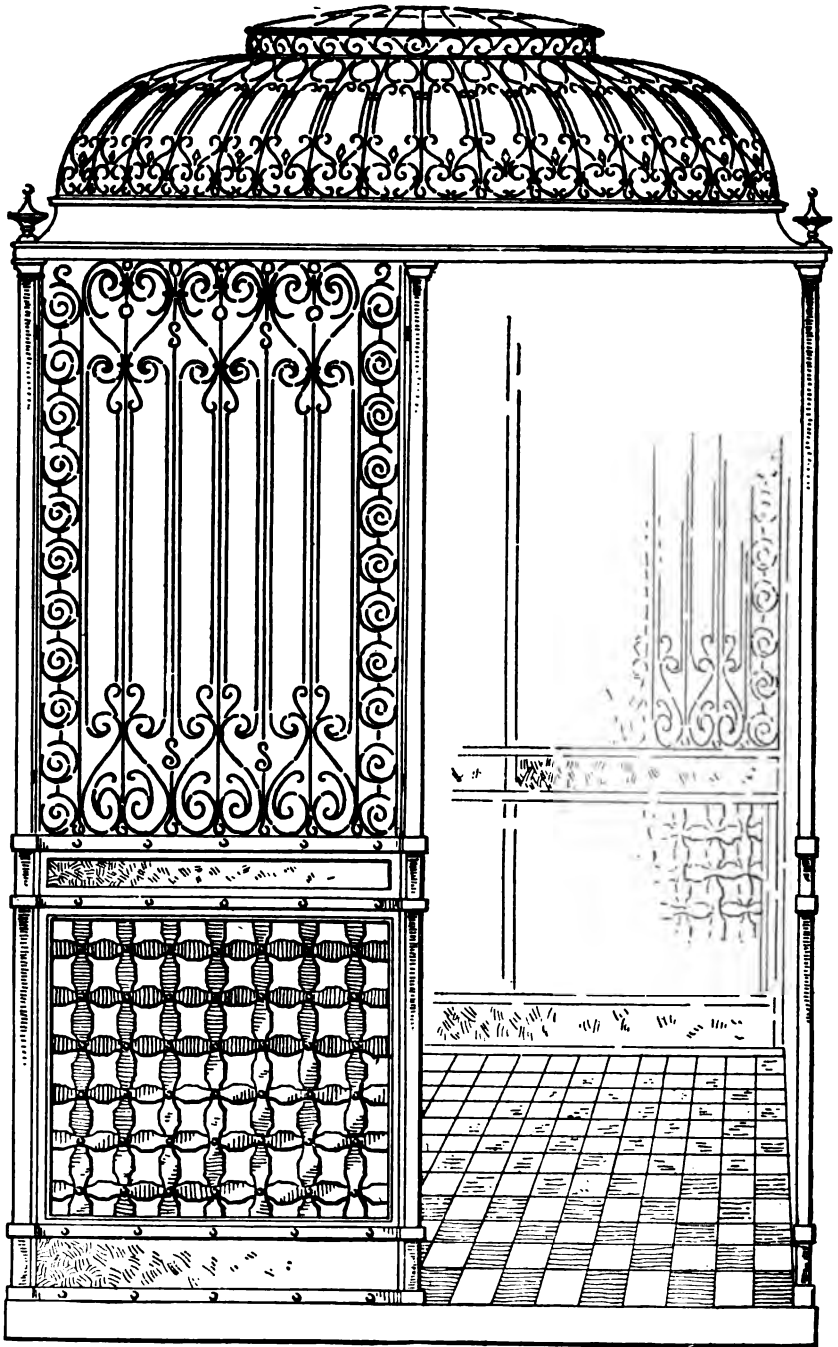


Table 77.

iron; the dado is a diaper of basketwork. The grille by the arrangement of the scrolls does away with a border top and bottom, but, as it is divided into three panels having the bars gathered reed fashion, it is necessary that a border be provided to close the space at the sides. The rods forming the reeds are separated by button washers and riveted together. The dome of this car is circular in plan, divided into a series of radiating panels finished at the bottom with a link-scroll design and at the top with rings. The crown of the dome has the scrolls so arranged that they form a natural continuation of the panels.

LEAVES AND FOLIATED WORK.

56. All the work considered up to the present time has been purely structural. Such ornament as has been necessary in elevator fronts or office partitions has been of a conventional character, and is confined to strap-iron grilles. Now, however, we come to the consideration of another kind of ornamental ironwork—the execution of leaves and flowers in sheet and bar iron, by means of forging and working the metal. No machinery is required for this work but man's own ingenuity and skill; however, artistic intelligence and dexterity of hand in the use of simple tools are indispensable in the production of satisfactory results.

In this branch of wrought-iron work, the designer must be intimately acquainted with his material; he must know how much working his metal will stand under certain conditions, and how much working his design will require to bring it into shape. He must know at what point and under what conditions forging will be necessary, how much of the work can be formed cold, and what details will have to be executed with the metal at a red or a white heat. Wrought-iron leaves are usually executed in sheet metal and hammered into shape; flowers sometimes require both sheet and bar metal; while designs of foliated grille-work require sheet, bar, and strap iron in varying quantities, according to the character of the work.

57. In Fig. 78 is shown a finished leaf as it would appear when placed in the position it was to permanently occupy. To reproduce this leaf in iron, it will first be necessary to make a developed drawing of it—that is, a drawing of the leaf as it would appear if flattened out to the original shape of the metal when first cut out, before



FIG. 78.

working in any manner. It is hardly possible to lay it out exactly—and, in fact, such accuracy is not required, as, the general dimensions being correct, the other parts may be worked into shape in subsequent operations. In Fig. 79 is shown the general appearance of the developed drawing. This drawing should now be carefully traced on the sheet metal and cut out. The crude iron leaf is then placed upon a block of soft metal, such as lead, and cold hammered into the general shape required. As constant hammering is likely to make the metal brittle and hard, it is sometimes necessary to anneal the iron in the forge several times before the leaf is finished. Special forms of hammers are used to shape the work, two of which are shown in Fig. 80.



FIG. 79.

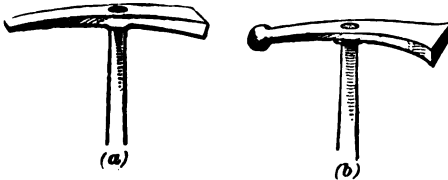


FIG. 80.

The one at (a) is flat on both faces, and is used in the general shaping of the leaf, while the one at (b) with its spherical head is used to produce the curves of the lobes and indentations, and to bring the leaf to its finished form. The flared face opposite the spherical head is brought into service when sharp indentations or veins are to be expressed, though other tools and punches are used in connection with the work for this purpose.

58. In designing leafwork for a grille, a gate, or a railing, consideration must always be given to the appropriateness of its position in accordance with the utility of the device and the architectural style of the building. For instance, in the elevator cars and enclosures heretofore discussed, we have given little or no consideration to wrought-iron leafwork, because an elevator is essentially a utilitarian device, and such ornamental features as we express in its design should be a part and detail of the necessities of its construction. The grilled sides of the elevator are rendered ornamental simply by twisting the iron straps and bars of the frame filling into geometrical forms; but where a grille is inserted in a transom light, or over a gateway, simply as a finish and ornament to the opening, the design may be elaborated with leafwork, as the purpose of the grille is not utilitarian but ornamental. Again, the heavy gates of a carriage entranceway require some leaf decoration to harmonize with the design of their surroundings, but they must at the same time preserve their identity as a purely utilitarian detail. The leaves and tendrils must not be delicately modeled in thin metal, but must be boldly hammered from sheet iron of from $\frac{3}{8}$ to $\frac{5}{8}$ inch in thickness. There must be no feeling of frailty in such a detail, and the ornament must be as strong and serviceable as the main structural details of the gate.

59. In Fig. 81 is shown the design of a panel suitable for a light railing, or a protecting grille over a glass screen. The lines of the design are too delicate to permit of its use in a position where it would receive hard usage, and its details may therefore be of very light materials. The main framework, it will be observed, is composed of substantial bar iron, while the filling and leafwork is of very light gauge. The treatment of the panel shown in Fig. 82 is the reverse of this. Heavy framework filled in with substantially proportioned scrolls and bars forms the general scheme of the design, while the leafwork is applied to the parts where the scrolls unite, and thereby render the points of

forging more pleasing to the eye. The leafwork in this design plays no part in the structural strength, but renders the structural necessities artistic, by combining and uniting them under an artistic form.

These two examples, Figs. 81 and 82, are intended to show the two principal conditions to be met in leafwork design. Fig. 81 shows a framework full of ornament, possessing little strength and mainly intended for appearance. Fig. 82 shows a strong frame and rigid grille-work, certain



FIG. 81.

details of which are *emphasized* with leaf design. In Fig. 82, strength is the main consideration, and the ornament clothes the utilitarian details in artistic forms.

60. In Fig. 83 is shown a piece of wrought-iron work which exceeds, in elaboration of design, anything heretofore considered. It is a design for one panel of a railing, and is intended to be supported at each end by a heavy stone pier or post. The top rail *a* and the bottom rail *b*

extend from one of these posts to the other in an unbroken line, while the inner rail *c* is broken by the lines of the main scrolls, and is worked into a fret design in the corners.

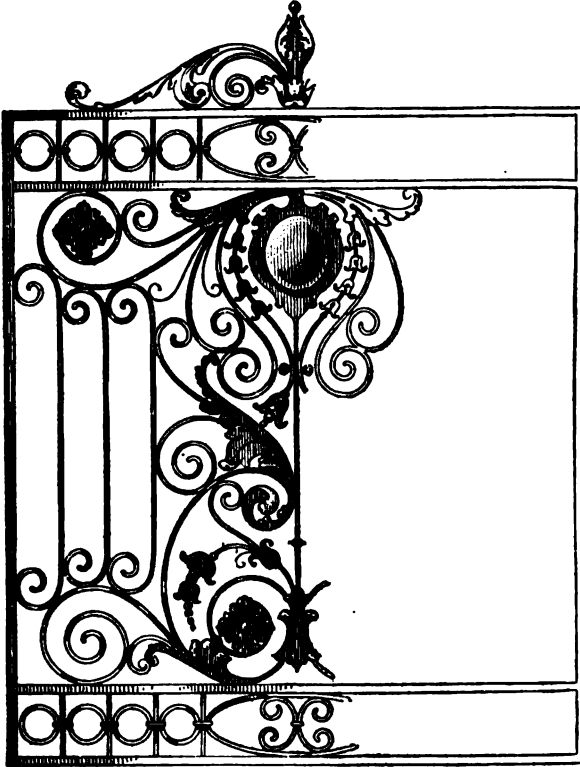


FIG. 82.

As the filling of this panel is nearly all leafwork, it follows that the leaves should be wrought in a heavy gauge of iron. The delicacy of the design will in no way be impaired by such treatment, as the parts must possess an appearance of strength sufficient to fulfil their several functions.

The main lines of the ornament in this design are composed of heavy iron bars, to which the leafwork is secured by forging. The double lines of the large scrolls forming the scheme of design at each end are filled in with a fret

ornament of light iron. The iron of the main scroll being wider than that of the fret, the latter is protected from injury, but is raised from its support on button washers, in order that it may be more readily seen. The same may be said of the guilloche ornament on the left side of the center scroll, but the stem-and-bud ornament on the right side of the centerpiece is bent in place independent of the surrounding bars.



FIG. 86.

The leafwork is forged to the structural details as shown, and therefore seems to form a natural part of them, though the style of leaf is of an exaggerated system of design which is not highly artistic from a strictly architectural standpoint. The example serves to illustrate, however, the extremes to which wrought-iron-work designs may be carried, and the tasks which a skilful workman may be called upon to carry out. Fig. 84 shows another design which, though less ornate in its leafwork, is equally complex in the arrangement and management of its scrolls. The main scroll lines break and change their direction suddenly, thereby leaving some points improperly secured, and necessitating other scrolls to secure them in place. The centerpiece is executed entirely in sheet metal,

the drooping leaves being secured to the surface of the vase with rivets. The main leaf of the scroll on the right-hand end of the rail is somewhat similar to the one shown in

Fig. 78, though larger. In this position it forms an ornate



FIG. 84.

finish to the panel, and at the same time serves as a floral calyx out of which the lower lines of the scroll appear to naturally grow.

FORGED WORK.

61. In the succeeding pages, descriptions of the illustrations given cannot be more than general, as the chief object is to give examples which are standards of artistic and ornamental design. Instruction of the student in smith-work has not been attempted, nor has it been deemed advisable to try to cover the complete field of useful and ornamental objects made in wrought iron, but to discuss only a small number of the ones more commonly seen and used in house building. That a knowledge of the tools and the methods employed in working iron may be made known to the student, and that the designs shown may thereby be better understood, the following short description is given: The few primary tools consist of a forge, an anvil, a pair of tongs, an ordinary blacksmith's hammer, a fuller, a set of punches (say, three sizes each of square and round), three swage hammers, a set hammer, a flatter, and a riveting hammer. The fuller and the swage hammers are usually called *top* swages, as a duplicate of the hammer face, which fits in a hole in the top of the anvil, is called a *bottom* fuller or swage. The making of grilles and scrolls by bending and

riveting is described under another head. Any two or more parts joined while hot are called *welded*, and all objects worked from a single piece are called *forged*. Whether welded or forged, the iron must first be brought to a white heat, and work commenced with the metal at this color, and continued until the iron assumes a deep cherry red, although, of course, this will somewhat depend on the grade of iron used. When the object to be welded or wrought is placed on the anvil, the blows at first should be light, and gradually increased in force as the metal cools, or the forging is likely to be knocked needlessly out of shape. To convert a section of a flat bar into a round one, the bar is brought to the proper heat in the forge fire and then laid across a bottom fuller set in the anvil, where, with a pair of tongs, it is held edge up, with the fuller hammer on the upper side. In this position it is indented until the approximate size of the round is made. The bar will now look as though it had a nick cut out of it on each side, the space between being the guide for the round part. The bar is now again heated, and a bottom swage put in the hole in the top of the anvil, and the bar is placed on the anvil and worked to a rough round. It is then once more heated, and this time placed in the bottom swage, the smith holding the top swage in place, while the helper strikes the top of it repeatedly as the bar is drawn between the swages, producing an even smooth finish. In the case of a fence railing or window guard, where the bars or pickets are to pass through the horizontal rails, and it is desired that the rails shall be of a uniform thickness where bars pass through, it is necessary that the rail shall be what is termed *upset*, that is, heated and driven together endwise to produce a bulge at the desired portion; or a small piece may be welded on at the point where each bar is to pass through; the rail is then heated, and the required hole is made with a square or round punch. After reheating, the rail is passed over the anvil, evening up the thickness where necessary, and is then finished with the flatter, to remove all the marks of the other tools. If two bars are to be joined at right angles, they are placed one over the other at a white heat

and welded together with a common smith's hammer, after which the slight bulging at the juncture is worked out. In especially fine work, a small piece is cut from each bar at the point of welding, though this is seldom necessary in ordinary practice. Surface cuts, indentations, etc., for the production of diaper designs or patterns on plain surfaces, should be made at a low heat with fullers set in the bench, or anvil, as the case may require, a guide or spacer being so placed as to keep the work uniform and true. The finials of posts and knobs on fence bars are first roughly forged out by hand, and then placed in a die under a trip hammer; or, where this is not at hand, the die is struck with sledges. When small work is welded, the tool marks are removed by the set hammer, which is simply a small flatter.

62. In making festoons of leaves or flowers, or of both, a stem should first be made of the required length, and the pieces for the leaves cut from thin bar or strap iron, on which the individual stems of the flowers are welded. The shape of the leaf or flower is then worked out on a soft metal block, as described for leafwork. When all the leaves and flowers are made, the main stem and a single leaf or flower are heated in the forge and welded together, this process being repeated with each leaf and flower until all are in place; they are then finished up and put in exact position or alinement after the metal is cold. When an object is to be forged out of a single piece of material, it is heated in the forge and worked under the hammer to the required shape or form; this is the most expensive part of wrought-iron work.

GATES AND FENCES.

63. Most of the examples heretofore given have been of light work that could be made without heating the iron, but in Fig. 85 is shown a piece of a more substantial character. The main bars are $1\frac{1}{2}$ inches square, the cross bars are 3 in. \times $1\frac{1}{2}$ in., wide enough for the uprights to pass through, and the scrollwork is of $\frac{1}{4}$ " \times 1" material. When

a bar is to be punched out, as in the horizontal members in this case, there should be ample metal left on each side

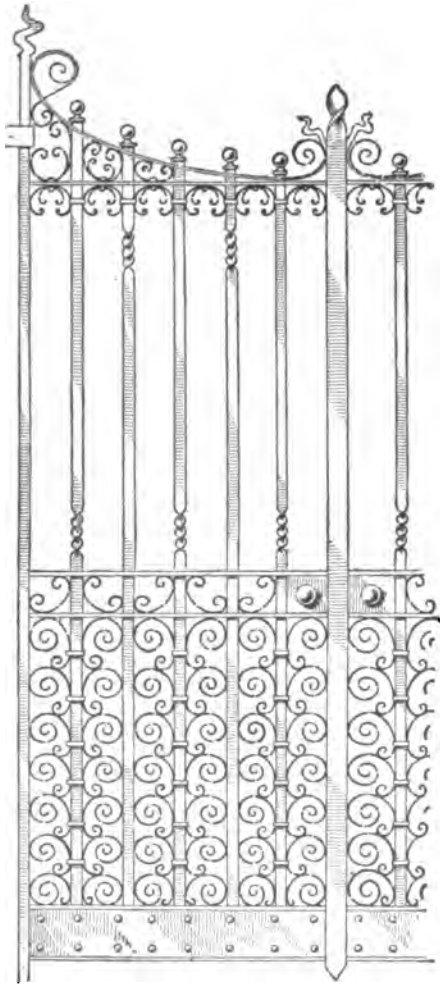


FIG. 85.

of the hole punched to prevent the sides from spreading under the pressure of the punch and leaving the bar somewhat protruded at these points. The scrolls are alike in the lower part of the gate, and are secured to the upright bars by a narrow strap on one side and a countersunk screw on the other. The hinge or hanger should be arranged at the top and made as shown in Fig. 86. The frame of the gate, which is a square bar, is rounded where the hinge clasps it, as shown at (a). The jagged part of the hinge is embedded in the stone piers or wall to which the gate is to be hung, and fixed in place with molten lead; or, where circumstances will permit it, the bar is passed entirely

through the wall and secured on the other side with a large washer and nut. The gate is held by the clasp, which is secured with two bolts passing through the hinge bar, as shown at (b).

In exceptionally high-grade work, the inside of the hinge is lined with a brass collar, as shown in Fig. 87, which prevents the two surfaces from rusting when they are in contact. Nearly all gates, and especially heavy gates, are pivoted at the bottom; and the pivot is usually formed at the lower part, or *heel*, of the gate itself, and fits in a

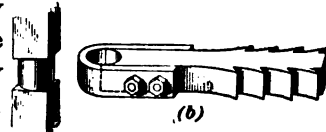


FIG. 86.

socket under the gate. The objection to this method is that the socket is likely to fill with dirt, and the gate become difficult to move. A better way is to make the socket part of the gate, and

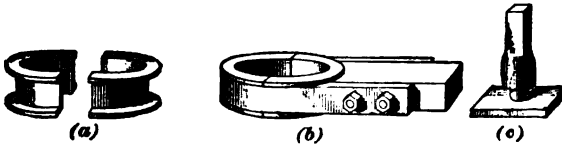


FIG. 87.

have the pivot separate, as shown in Fig. 87 (c). An oil hole may then be bored through the socket in an oblique direction to the pivot, which may then be oiled; and, as the socket is in the gate, the dust and dirt cannot get in and clog it up.

64. The railing shown in Fig. 88 is a good example of forged work, and illustrates the application of leafwork without detracting from the lines of the fence. The main uprights and the horizontal rails are clearly defined, and, as they should be, much heavier than the bars and scrolls filling the panels formed by them. The fence is divided into large panels or sections, one a double gateway. The first two upright bars at each end of the panels are carried up, forming posts, and an increase in the size of these bars would be an improvement and further emphasize the post effect. The top of the post is finished with a finial ornament, and the gate as well as the side panels are finished with a cresting. The cresting of the gates is arranged to group them as one panel, and the main scrolls are decorated

with leafwork. The top and bottom of both the gates and panels are well braced with an open rail having a scroll let in between. The scrolls filling the top and bottom of the panels are finished with a leaf-and-bud ornament, and the bars are braced by three rows of rings secured with straps and screws. The posts from which the gates are hung are

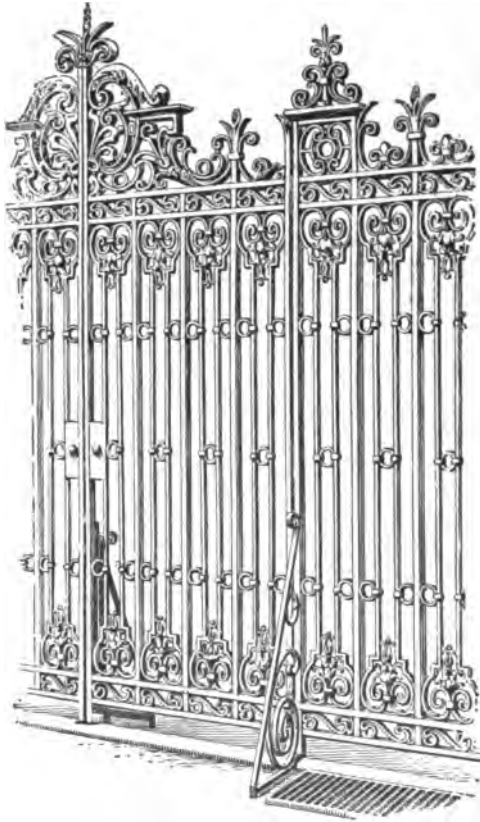


FIG. 88.

braced with triangular foot braces, and these as well as the posts themselves are led into the stonework, while the post next the column is secured with expansion bolts. The gate shown at Fig. 89 is a vigorous, well balanced design, decidedly German in character, and including in the design

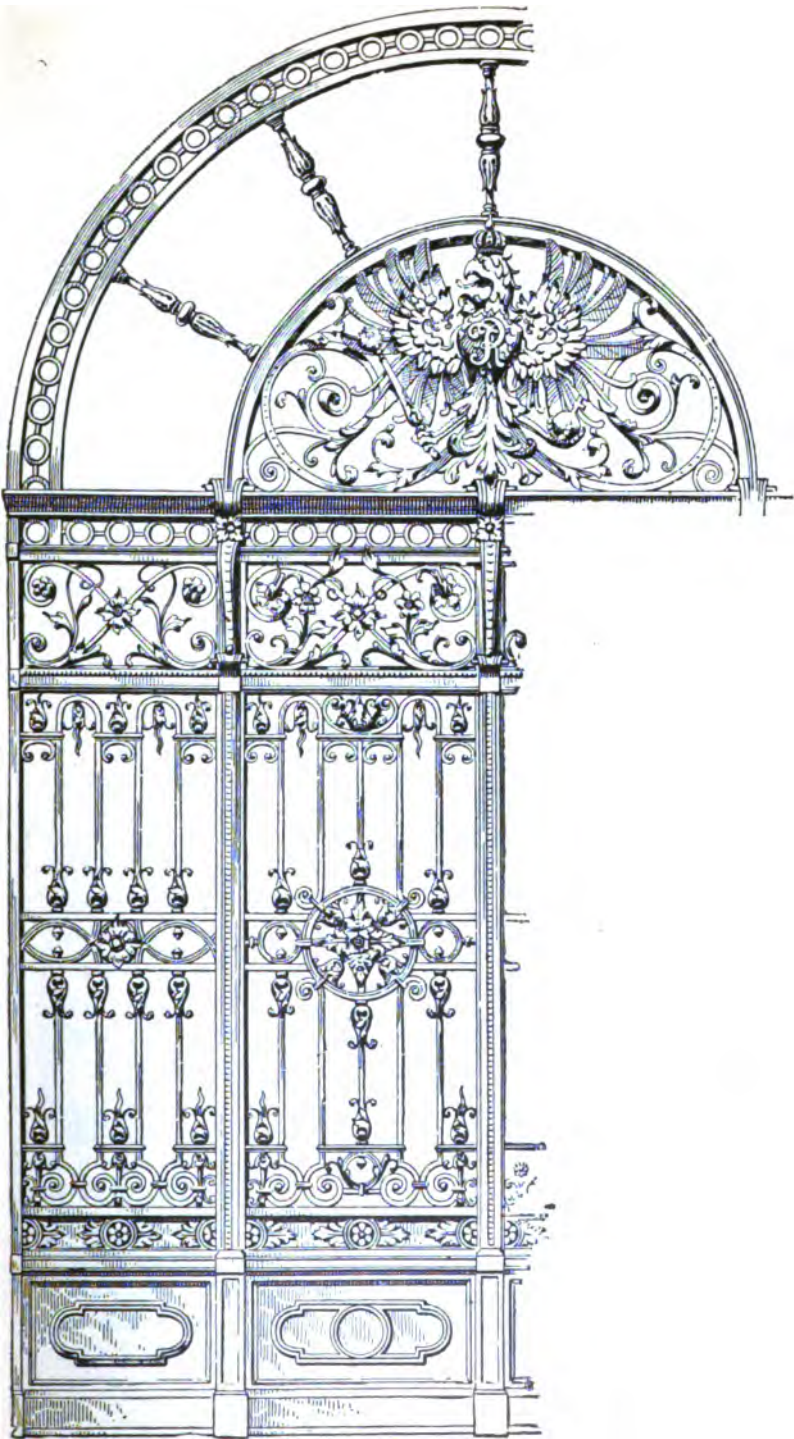


FIG. 80.

of its transom the German national emblem. The side panels of the screen, as well as the outside of the transom, are open and less elaborate than the central panels, the contrast between them heightening the effect by separating the rich carving which existed on the stone architrave from the elaborate iron grille of the center. The transom bar is in four panels, each of which is filled between the border frame and lower rail with grille-work composed of crossed scrolls and decorated with leaves and rosettes. The continuation of the principal vertical lines from the screen to the transom bar is accomplished by a console bracket, the top of which clasps the transom-bar rail. A point in this design which might be improved is the manner in which the inner frame

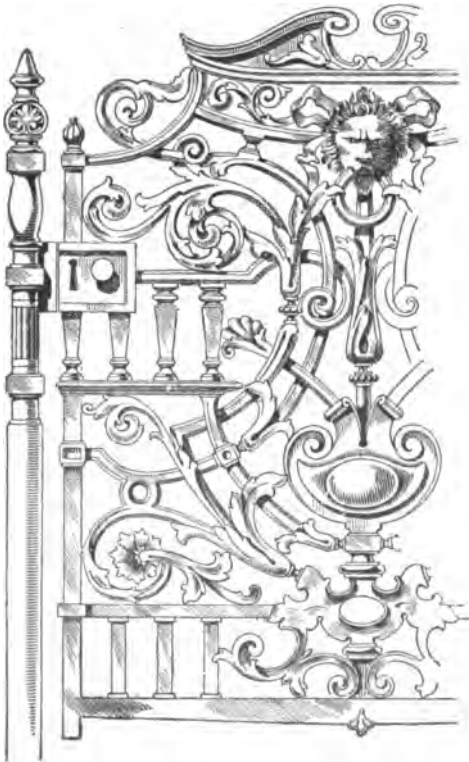


FIG. 90

of the semicircular transom border is carried down past the top of the transom bar to the border frame, thus giving the idea that the transom frame is supported there; the omission of this piece of frame would considerably heighten the border effect and remove this weak appearance.

65. At Fig. 90 is an example of a small garden gate in cast iron, and with the exception of the central shield and the ornament at the top, all the

members are kept approximately the same general thickness, to avoid any danger of cracking during the cooling

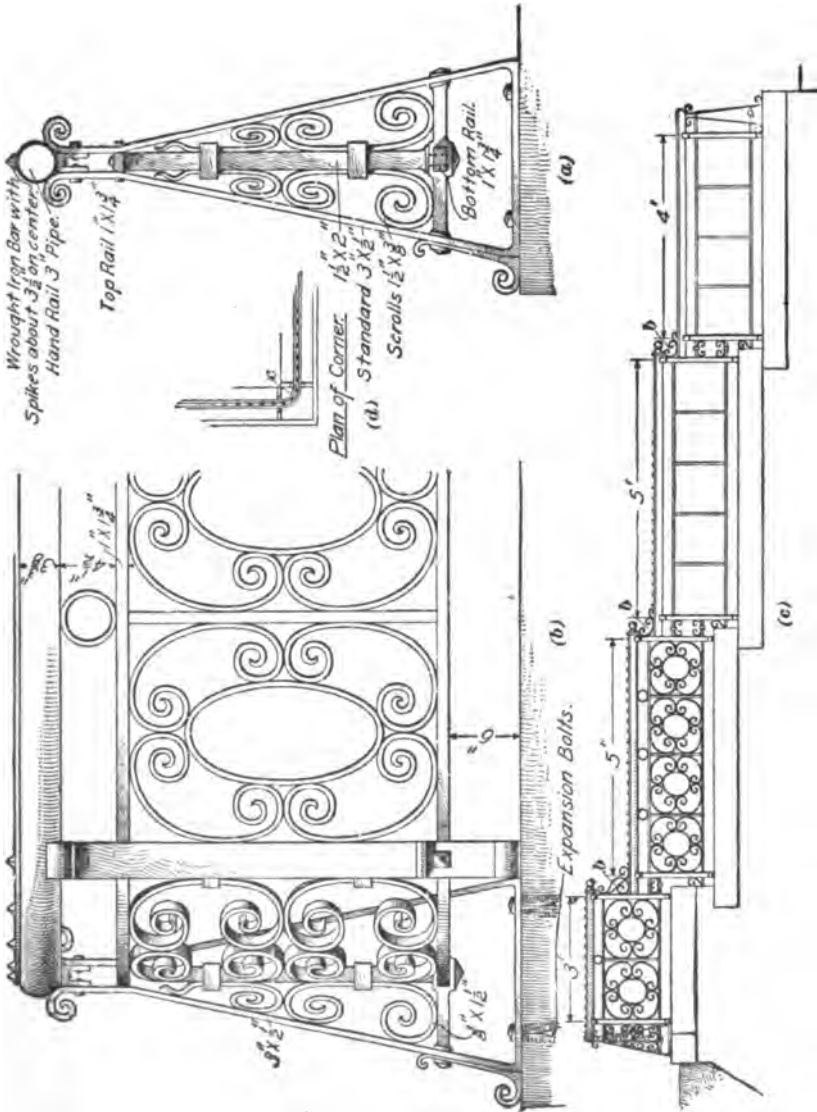
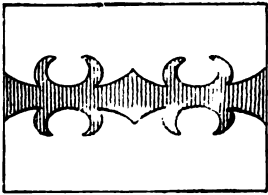


FIG. 91.

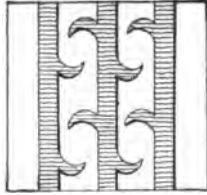
stage. The parts that appear heavier on the face are thinned out to preserve the balance of metal. Cast iron for small work of this kind is inferior to wrought, as the effect of contrasting heavy and delicate features is somewhat wanting, owing to the limitations of the material. The railing shown at Fig. 91 is a very massive one, and still the proper thought has been given to the different members. The posts or supports are made triangular in shape, as shown at (*a*), and would almost retain their position without the aid of the expansion bolts by which they are secured to the coping, as shown at (*b*). This railing tops a stepped coping, as shown at (*c*), and is joined by easy and graceful scrolls at the point of step *b*. The corners are arranged as at *c* in the plan (*d*), and the grille bent to the radius formed by the intersection of the supports at their bases. The hand rail is a wrought-iron pipe finished at the ends with a knob ornament, and the top has a bar studded with spikes to prevent lounging upon it.

WINDOW GUARDS.

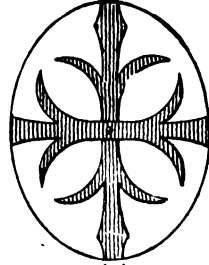
66. A window guard should be primarily a protective device, and secondarily an ornament or decoration. As a rule, especially in private-residence work, the design of these very necessary appendages is not given a proper amount of attention, but they are certainly as deserving of mature consideration as any other ironwork of the structure. They may be made to form the divisions of the window opening in place of the bars of the sash, and to produce the desired effect of window subdivision, at the same time leaving the glass in any required size. It is not necessary that a window guard shall be flat, nor set out of sight when looking towards the window from the street, but may be a roomy addition to the window sill, where in summer flowers may be placed to blossom in the sun and protected from high winds or careless hands. Small openings for ventilation or light may be rendered pleasing by simple and effective guards, such as those



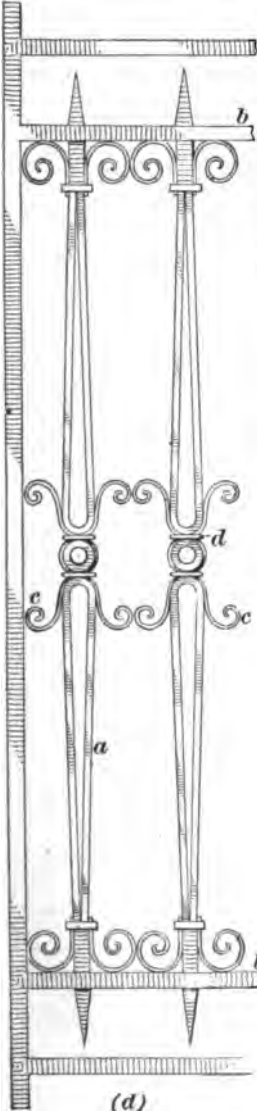
(a)



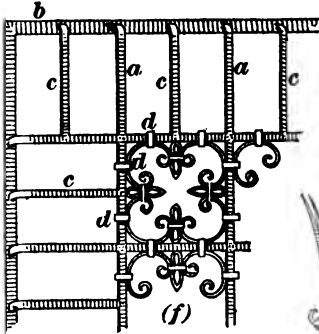
(b)



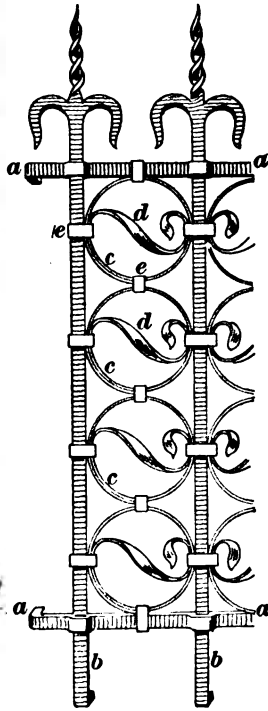
(c)



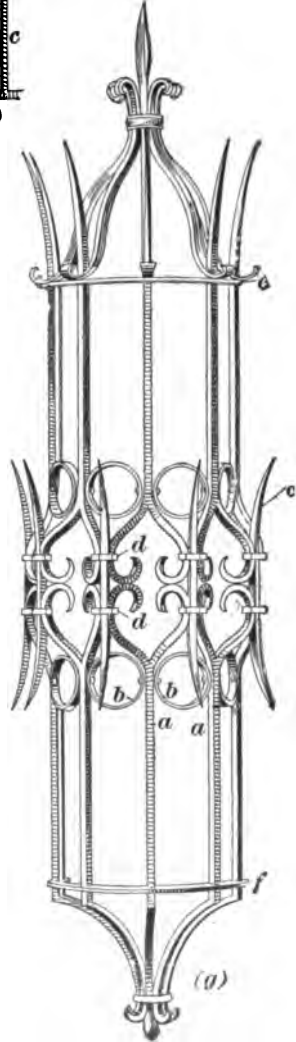
(d)



(f)



(e)



(g)

FIG. 92.

shown in (*a*), (*b*), and (*c*) in Fig. 92, cut out of single pieces of iron. The guard shown in Fig. 92 (*d*) is a clever piece of forging, and illustrates what simple and yet refined design may be executed in this class of work. The upper and lower parts of the bars *a* are made by bending the iron into long open loops as shown, the ends being carried through the rails *b*, a ring forged between the two interior ends, and the scrolls *c* forged to the bars and ring; the clip, or clasp, *d* encircles both ring and scroll, and binds them together. The design shown in Fig. 92 (*e*) is very old in style, and is made to set over the jambs of the opening, the rails *a* and bars *b* being provided with return ends which are let into the stonework about 6 inches from the edge of the window. The rings *c* forming the grille in this design are carried about a quarter-turn past the full circle, and the iron is twisted and flattened out in the center to form a leaf scroll *d*, which, with the rings and bars, is held in place by the flat clips *e*. The bars are drawn out and cut in three prongs at the top to form a cresting, the center one being twisted, and the other two bent down to give ample protection to the top of the opening. The design shown in Fig. 92 (*f*) is constructed for use either on the wooden window frame or on the face of the wall surrounding the window. The bars *a* forming the large square mesh are welded together, and extend beyond the mesh a distance equal to its width, and are then bent back 4 inches and welded to the frame *b*; intermediate pieces *c* are set between them, and a border is thus formed. The angles of the mesh are filled with scrolls as shown, which are held in place with flat clips *d*.

67. The guard shown in Fig. 92 (*g*) is an example of how effectively iron may be employed in decorating an otherwise plain opening, and transforming it into one of the attractive features of a house front. This guard is intended to cover a small window opening, which would almost escape observation without it, and certainly add nothing to the design of the building, though necessary for lighting the interior. The guard in Fig. 92 (*g*) is made up entirely of

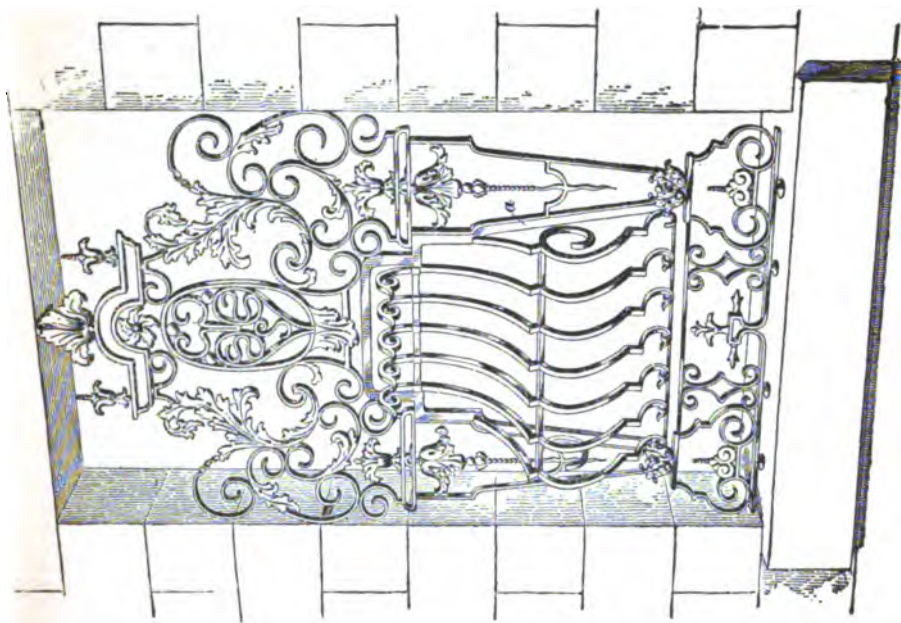


FIG. 94.

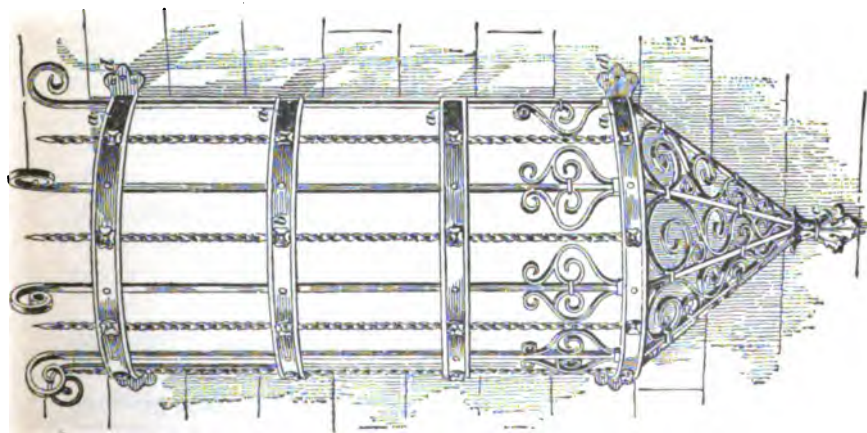


FIG. 93.

different sizes of bar iron. The principal features are the manner in which the bars *a* are divided just above the circles *b* which are riveted to them, the divided portions being wrought into scrolls, which are welded to the spikes *c*, and are further bound by the strap clips *d*. The tops of the bars are finished with spike points, passing through a band *e* and through the bars forming the top, and are welded together. The guard is attached to the opening by the ends of the bands *e* and *f* bent to form lugs which are leaded into holes cut for them in the stone jambs. In the guard shown in Fig. 93, the horizontal bands *a* not only greatly increase the protection, but by the ornamental studs or rosettes on their faces add much to the decorative effect. These studs *b* are riveted on over each twisted bar. The edges of the bands are turned over, forming a border or flange, strengthening and giving them a finish. The twisted bars terminate at the lower band, and the plain bars are carried down, all meeting in a point where they are welded together and covered at the junction with a leaf ornament *c*. The twisted bars are pointed at the top, and the plain ones finished with a scroll. The entire lower portion of the guard is filled with a scroll grille, and a dado of scrolls is filled in between the bars above the lower band. The guard is secured to the stone with expansion bolts let into the stonework back of the ornamental bolt plates *d*.

68. The design shown in Fig. 94 has many points in its favor from both a structural and an ornamental standpoint. It is constructed almost entirely of forged bar iron, with just sufficient leafwork to relieve the monotony of single lines. The design is so open that the interference with light, ventilation, or outlook is inconsiderable; but at the same time it is strong, secure, and amply adapted to its prime purpose as a *guard*.

The presence of the leafwork in the upper part gives it an appearance of lightness and delicacy, but observation will show that behind these leaves heavy wrought bars give the strength which the purpose of the device requires.

LAMPS AND BRACKETS.

69. For exterior and interior lamp posts and brackets, wrought scroll-and-leaf work lends itself most readily. There is no detail of house furnishings wherein wrought iron can be put to such effective use in decoration as in electric and gas fixtures. The necessary presence of the wire conduit or gas pipe forms the purely utilitarian element of the design, and is so easily disposed that the designer may devote nearly all of his energies to the perfection of the ornamental details and the grouping in the composition. It may be well also to remind the student that another consideration than the ironwork itself materially affects this style of design, and that is the forms of electric lamps and globes, with which the fixtures are to be furnished. Electric lamps may be obtained in all sizes and styles, from the large 300-candlepower strictly for commercial use to the small single and half candlepower globes used for decorative purposes. The latter are frequently mounted on the end of white-glass tubes blown in representation of wax candles, a number of which are grouped in one candelabrum or bracket, diffusing the soft unobtrusive glow of old-fashioned candle light, without the offensive grease, smoke, or smell. Again, these same diminutive lamps are enclosed in china globes representative of various flowers, such as the rose, lily, morning glory, etc., and the bracket which supports them is correspondingly designed to suggest the details of the foliated bush or vine.

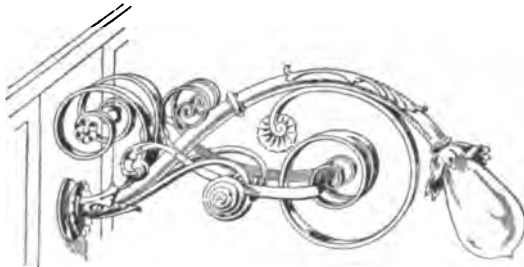


FIG. 95.

70. The lamp in most common use is the 16-candlepower size, and Fig. 95 shows the simple arrangement of one

of these globes at the end of a wrought-iron wall bracket. The design is extremely simple; the tube containing the wires extends in a curve from the wall to the lamp. Iron scrolls appear to emerge from the small foliated wall plate with the tube, and help support it on the outside, while the lamp is so set that its light will not cast a shadow of any part of the ornament of the fixture.

Fig. 96 shows a similar design, somewhat more ornate, though precisely the same in principle. The tube or conduit forms, as it protrudes from the leafwork, the main stem of a floral device, from which scrolls branch out at each side, and at the termination of which is the blossom consisting of a 16-candlepower lamp, surrounded by a calyx of wrought-iron leaves.



FIG. 96.

The essential points of difference between Figs. 95 and 96 lie in the fact that the former consists almost entirely of strap-iron scrolls, while the latter is primarily a foliated design the scrolls of which exist as a part of the floral composition, and are not, as in Fig. 95, the main scheme of the design. The long wall plate in Fig. 96 renders this bracket much stiffer than the former one, particularly as the scroll on the curve of the conduit tends to tie the wall plate and bracket in two places. The scrolls in Fig. 95 might serve a similar purpose, but not without impairing the effect of a single tube springing abruptly from the wall surface.

71. In Fig. 97 we have a combination bracket designed for both gas and electric light. Here the wall plate is much heavier, and though the general scheme of design is

similar to the example shown in Fig. 96, the leaf and ornamental work is heavier, as is required by the presence of more electric lamps and a gas globe. The main tube or conduit contains both the electric wires and the gas pipe, and as it terminates in a spray of four lamps and one gas jet, it must appear sufficiently strong and well proportioned to carry these details



FIG. 97.

successfully—hence the extra leafwork to give its body bulk and weight, together with the scrolls which appear to support it from above. Behind these is the wall plate which apparently carries the weight of all, and is therefore made bold and substantial in proportion to the work it has to do.

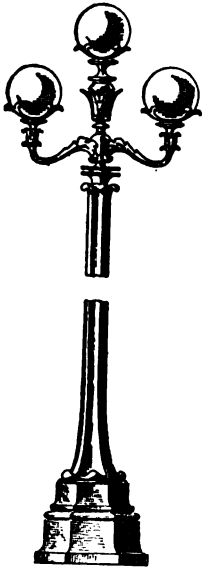


FIG. 98.

72. When gas and electric fixtures are designed for exterior situations, they are usually in the form of posts, though sometimes a wall bracket is desirable, and occasionally a pendant from an archway. Fig. 98 shows a form of lamp post, the design of which is suggestive of a giant candelabrum. The base and shaft of cast iron are octagonal in plan, and support the three spherical globes containing the electric lamps. The arms supporting the globes are simply designed with just a suggestion of foliated work in the details. The globe

may be of opalescent or ground glass, in order to diffuse the light from the electric lamps within, of which there

may be three or more to each globe, according to the illuminating requirements. This style of lamp post is frequently used as a

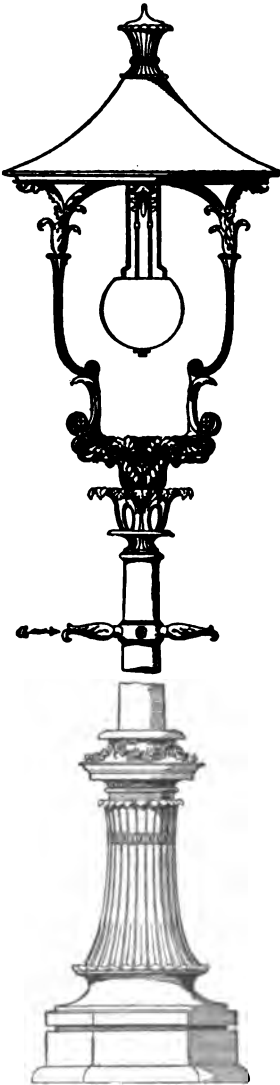


FIG. 99.

luminant for the porch of a private residence, hotel, or club, but for street lighting where the arc light is used, a different form of post is required, owing both to the difference in the form of the lamp, and to the care attendant upon its maintenance. Fig. 99 shows the style of support suitable for the latter case. It is executed in cast iron, as was the design shown in the previous example, but owing to the difference of its purpose the entire character of the design has necessarily been altered.

In the first place, the post shown in Fig. 99 is much heavier and bulkier than the one in Fig. 98; as, being likely to receive somewhat rough usage from passing vehicles or careless draymen, it must not be so slender as to be easily broken. The upper portion is designed as a loop or wicket, in which the arc light hangs under a protective roof or hood. Thus we see that its exposed position requires the street lamp to be heavy and strong, and that the character of the light it carries determines the form of its top, while the maintenance of the arc light requires the two projecting rungs *a* against

which the keeper may rest his ladder or upon which he may stand when he adjusts new carbons or cleans the globe and copperwork.



FIG. 100.

73. In Fig. 100 is shown a form of post for a gas lamp. The main shaft or post is of cast iron, on which the fretwork and scrollwork of wrought iron is secured with counter-sunk screws. The lantern at the top consists of glass plates mounted in a wrought-iron frame which is covered with a dome-shaped hood. This lantern encloses the gas jet or jets and protects the flame from the wind. The scrollwork of this design is so delicate that it is hardly suited for a much exposed position such as a street light, but for courtyards and lawns or for park walks it is admirable, combining delicacy and refinement of design with simplicity and economy of construction.

The lamp shown in Fig. 101 is an elaborate design in cast and wrought iron, suitable as a porch light or as one of a series of lights arranged in a courtyard. The main body is of



FIG. 101.

cast iron, decorated and relieved with wrought-iron leaf-work, secured to the cast-iron standard with countersunk screws. The design is suggestive of an antique, standard, and torch; only, where the flame of the torch would have existed in ancient art, the globe and electric lamp are present here. The globe in this case would be of opal or ground glass, for reasons similar to those stated in connection with Fig. 98.

74. Bracket and gate lanterns of various forms are used on the entrance posts flanking a gate, or suspended over the



FIG. 102.

gate by means of a scroll-work arch. Fig. 102 shows a bracket lamp, the body of which is sheet iron and glass. The pyramidal sheet-iron roof—or *canopy*, as it is sometimes called—is pierced by eight small ventilators and finished on top with a foliated finial. The scrollwork connecting the lantern to the wall is composed entirely of strap work, and is secured to the masonry by means of expansion bolts. Strength and simplicity are the fundamental principles to be looked out for in this class of work.

The gateway lanterns shown in Figs. 103 and 104 are made of a combination of cast, wrought, and sheet iron. The de-

sign shown in Fig. 103 is intended to be placed between the

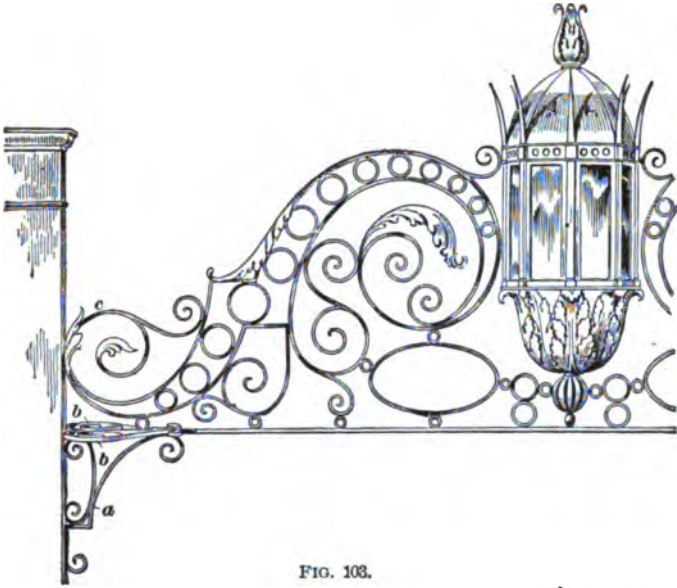


FIG. 103.

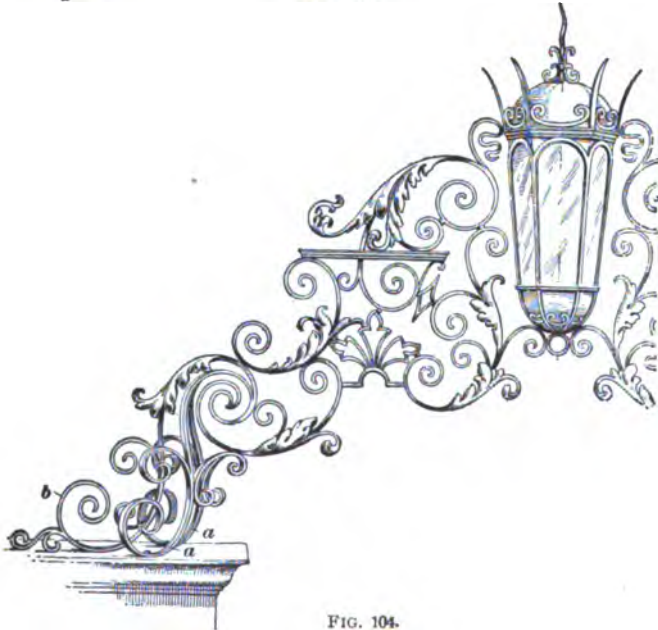


FIG. 104.

gate posts, and is provided with the bracket scrolls *a* to distribute and support the weight, with the scrolls *b* to brace the grille laterally, and with the scroll *c* to prevent any tendency towards a rotary movement. The iron arch in Fig. 104 is designed to rest on the top of the gate posts, and the scrolls *a* are so arranged at the foot of the arch that they prevent any lateral movement or tendency to revolve, the weight being better distributed and also a firmer hold being obtained, by extending the large scroll *b*.

IRON STRUCTURES.

75. It is sometimes desirable to erect small structures entirely of cast and wrought iron. Of these the most common are the small domes or cupolas crowning the roofs of certain classes of buildings, bay windows, oriole windows, and show windows for residences and stores, and occasionally small detached buildings used as offices for the sale of tickets at the entrance of places of amusement, or as an adjunct to some branch of a general service system, as is the example hereafter shown. In any case, the structure is necessarily of an ornamental character, and must accord in design with surrounding conditions.

An example of a detached iron structure is shown in Fig. 105. The entire edifice being constructed of cast and wrought iron framework carrying a copper roof and heavy plate-glass window lights. The purpose of the building is that of a *cab office* in connection with the service of a hotel, club, or theater. The plan is octagonal, as shown in Fig. 106, each angle of the octagon being marked by a hollow cast-iron upright, molded to form the architraves of the window and door openings, and at the same time to contain the T-iron supports *d* of the roof and superstructure. These supports extend to the ground in each case, and stand upon an iron plate, or shoe, as shown at *g* in the elevation, Fig. 105 (*a*), and between them is framed an angle iron, to receive the ends of the floorbeams, as shown at *l* in the

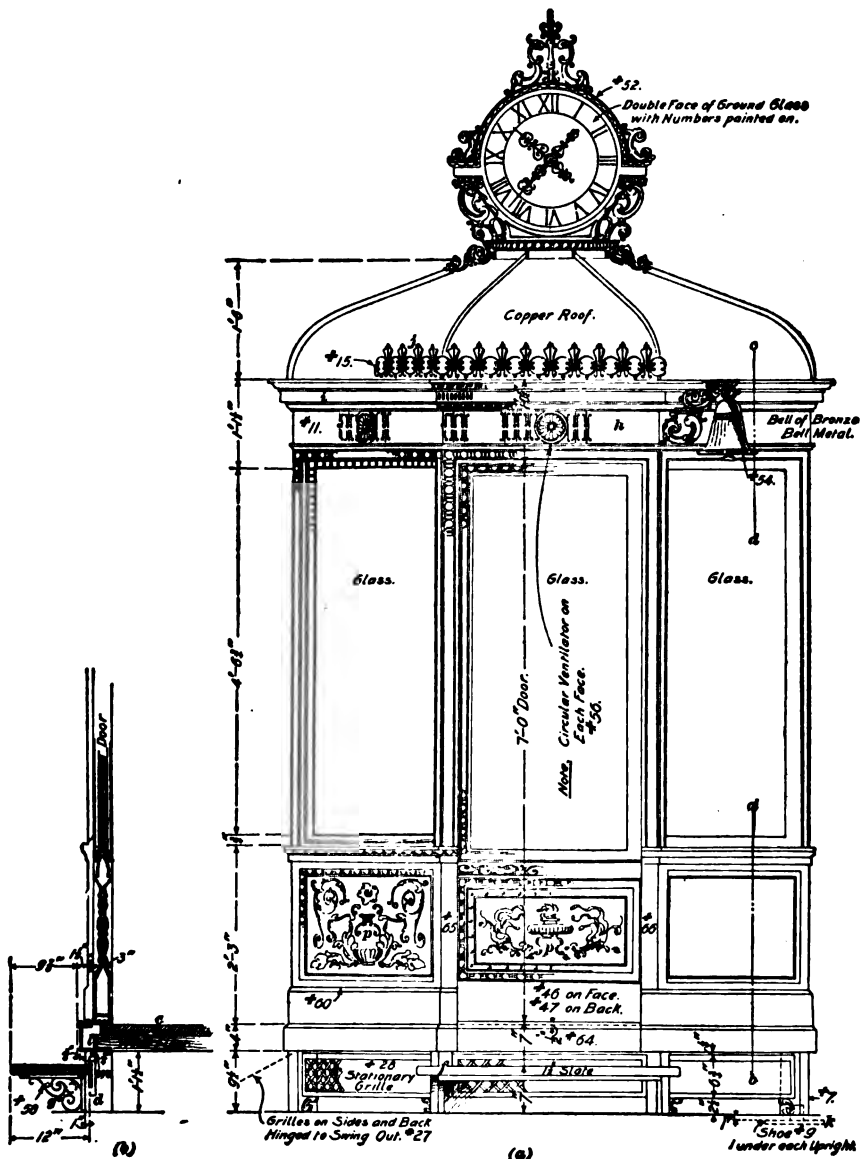


FIG. 105.

section, Fig. 105 (b). The space from this angle to the ground is filled with a cast-iron grille, as shown in the elevation at *c*;

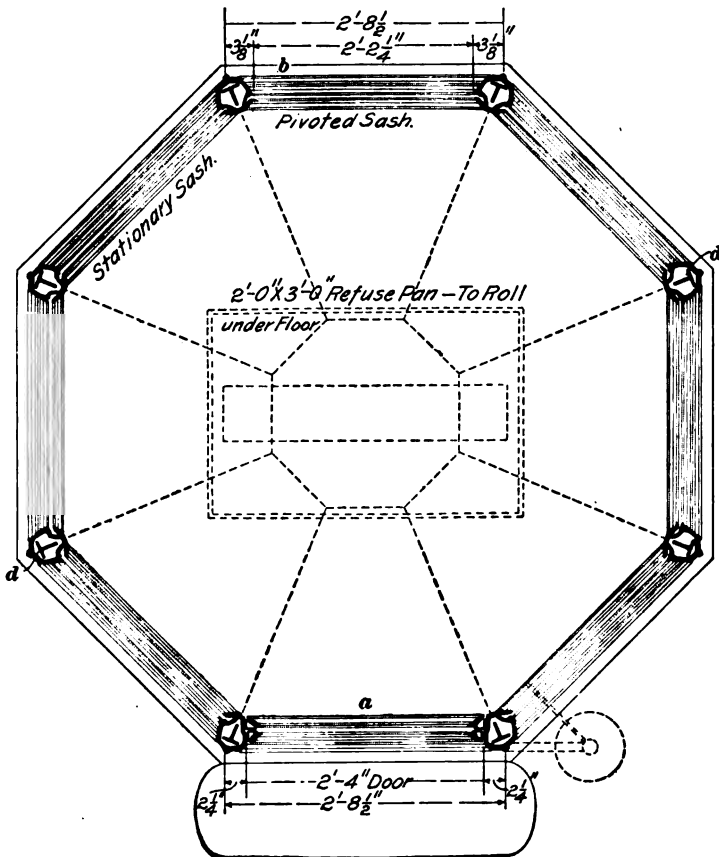


FIG. 106.

while from the floor to the window level a cast-iron plate encloses each side of the octagon with an ornamental panel *p*.

The construction of this paneled dado can be better understood from Fig. 107, which is a section taken on the line *ab* of Fig. 105 (a). The angle iron framed between the vertical T's, as shown at *l* in Fig. 105 (b), is here seen in section

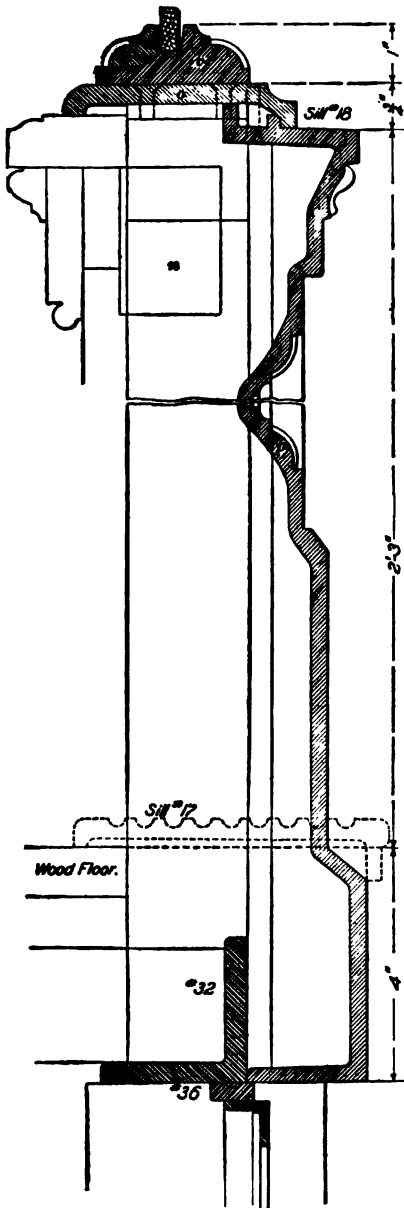


FIG. 107.

as piece #32, and outside of it is the cast-iron facing of the structure, consisting of a water-table 4 inches in height, and the plinth, panel, and window sill extending 2 ft. 3 in. more. The sill cap *o* is secured at each end to angle-iron knees or brackets previously riveted or bolted to the vertical T supports. These sill caps extend over the top of the panel pieces and hold the latter in place by clamping over a rib piece cast on the top of the main panel. On this sill piece *o* rests the sash as shown at *v*, and on the inside of the office is secured the wood trim which forms the finish under the sill.

76. In Fig. 108 is shown a section through the cornice on the line *cd* of Fig. 105 (*a*). This cast-iron cornice is fastened at each end to the T-iron uprights with screw bolts, and thereby braces and secures these uprights at top. The inside cornice *r* is secured

in place by means of the wrought-iron strap *s* bolted to the main cornice, and to which the inside cornice is fastened

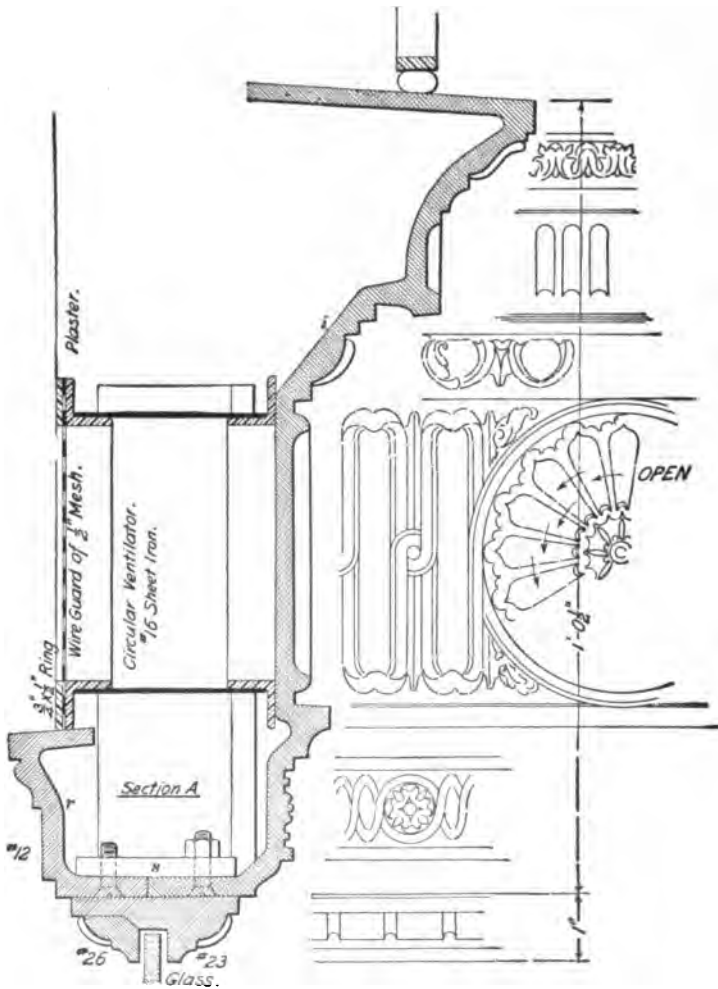


FIG. 108.

with screw bolts. Observe that these screw bolts do not pass through the sash head, but simply secure the two pieces of cast-iron cornice to the strap or bar *s*.

In Fig. 109 (*b*) is shown a section through the lower

part of the cornice where the sash is intended to be immovable.

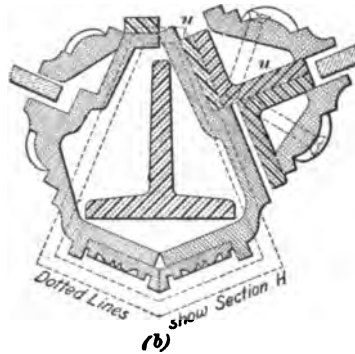
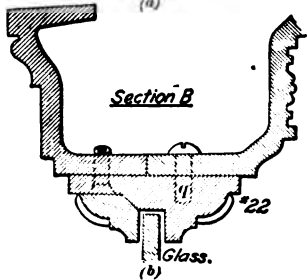
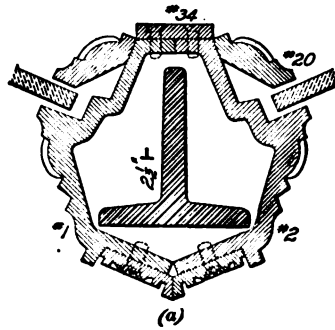
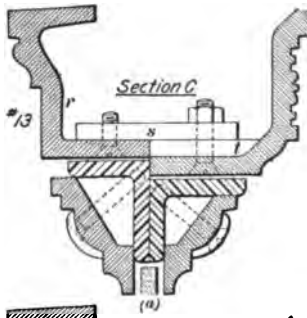


FIG. 100.

The inside or lining strap is omitted in this case, and the outside cornice secures the top of the sash with a round-headed screw bolt, while the inside cornice is secured to the sash head by a countersunk screw bolt, the sash head serving the same purpose here as did the strap piece *s* in Fig. 108. At the door opening, the lower fillet of the inside cornice is omitted, thus permitting the outside cornice to fall below it and form a *stop*, for the top of the door, as shown in Fig. 109 (a). An inside strap or bar



FIG. 110.

s is then used to screw these cornices to, for the preservation of their alinement, while the ribs *t* cast on the exterior cornice maintain it in its proper position as a door stop.

77. The door frame is formed of two angle irons, whose legs are unequal, as shown in Fig. 109 (*a*). This inequality permits the inside angle to extend beyond the exterior one, and strike (when the door is closed) against the door stop formed in the architrave or jamb casting.

Fig. 110 shows three sections through the architraves and supporting T irons of the main frame. At (*a*) is shown a section through the architraves of the fixed sashes, where the glass of the windows is held in place by a molding and recessions in the casting. At (*b*) the section shown is through the architrave at one side of the door, where provision is made in the casting for the door stop against which the longer-legged angle iron of the door frame shall strike, and at (*c*) is shown a section through the architrave at the side of a pivoted window sash. The glass is here shown secured in the cast-iron sash frame similar to that in Fig. 108, except that in this case a rebate is cast in the frame and jamb against which the sash may strike when closed, and thus be prevented from revolving past the architrave.

78. The roof is framed with light angle irons bent to the form shown in the elevation, Fig. 105, and covered with copper on the outside; while the inside or ceiling is plastered on wire lath. The cresting around the eaves is of simple strap iron, a detail of which is shown in Fig. 111. The clock face is framed in a cast-iron ring with ornamental scrolls as shown, the details being similar to other cast-iron ornament of this character heretofore described.

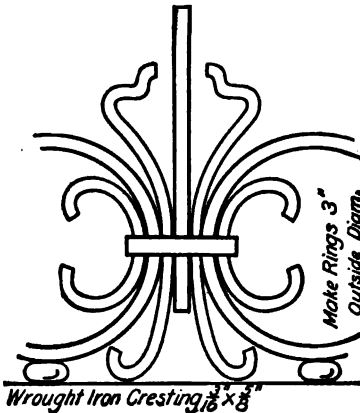


FIG. 111.

ROOFING.

HISTORICAL INTRODUCTION.

1. The origin of house roofing is to be found in the endeavor and determination of man to provide for his physical wants and comforts.

Man, in a primitive and uncultivated state, commenced by rudely imitating birds and beasts in his attempts at shelter seeking and self-protection, constructing or appropriating caves, or building arbors of twigs and branches. The hunter had recourse to the cave, the nomad to the tent and bower, while the agriculturist built himself huts of dried turf. The skins of beasts preceded the tent and the tent developed the bell roof



FIG. 1.

of the Chinese and Tartars. See Fig. 1.

2. Tents.—The skin tent was much used by the Arabs, and was generally made of goat's skin, dyed black, spread over two or more poles about 8 or 9 feet long.

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The Australians, the tribes of the Polynesian Archipelago, the Caribs, and the nomad tribes of North and South America were tent dwellers.

3. Huts.—After the tent, came the hut of wood or stone.



FIG. 2.

The construction of the stone huts, or beehives, so called from their shape (see Fig. 2), was a combination of both

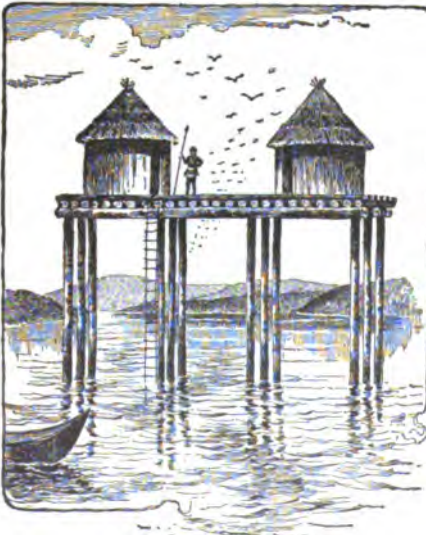


FIG. 3.

house and roof, and may still be found in England, Scotland, Wales, and Ireland. It is supposed that this period was followed by the cliff and the lake dwellers. The former hewed out caves in the cliffs to form a covering to protect them both from the weather and from the attacks of enemies.

The lake dwellers seem to have been imbued with similar purposes, for they cut down trees, which they drove

into the bottom of lakes, and upon these built huts with

thatched roofs (see Fig. 3). The lake dwellers' huts were very picturesque and mostly found in Italy, Sweden, Switzerland, and Ireland. In Mexico, in South America, and in African regions, there are yet numerous colonies of lake dwellers.

The most noted cliff dwellers' works are in Morocco, in the Old World, and in Arizona and New Mexico, in the New World.

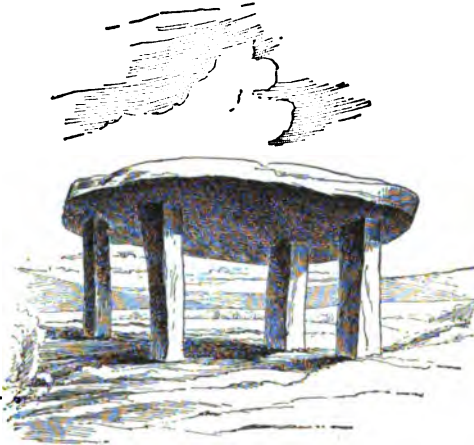


FIG. 4.

4. Stone and Earth Roofs.—The next form of covering was probably that of large stones or monoliths, over which flat stones were placed (see Fig. 4). In connection with stone roofs we note also the device of corbeling out each course on the two opposite sides, until they meet at the top. See Fig. 5.

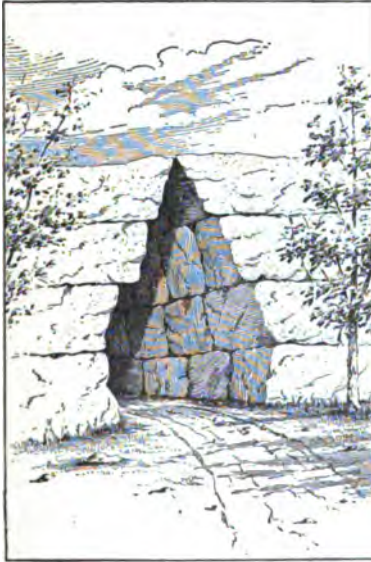


FIG. 5.

The first real roof covering, after the thatch and bough roofs of the nomads, was erected by the Assyrians. These were built of squared timber placed close together and the upper surface covered with thick layers of earth (see Fig. 6). These roofs are said to have

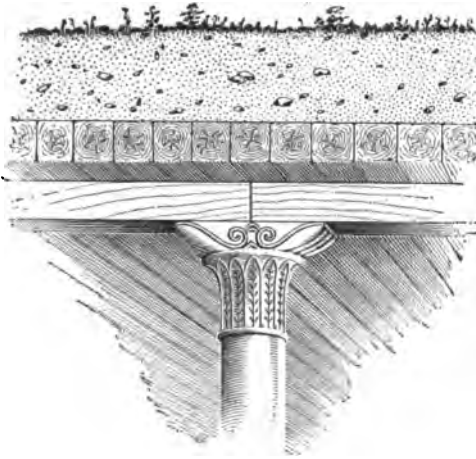


FIG. 6.

been beautified in many cases by varied vegetation, such as flowers, etc.

The earlier Egyptians and successive peoples constructed their roofs of flat slabs of stone, supported on stone lintels or beams resting on columns (see Fig. 7), and these, in turn, were suc-

ceeded by tiles on boards or vaulted stone roofs.

5. Tile Roofs.—The history of tiles as a roof covering is too extended to completely review; tiles, however, deserve

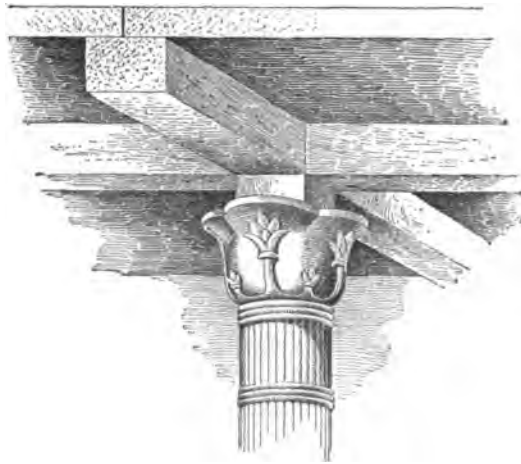


FIG. 7.

special mention, because they are the most desirable and the most serviceable materials used for roofing.

The earliest mention of tiles occurs perhaps in the Book

of Kings, in the description of Solomon's Temple. They have been used in China from a period of such remote antiquity as 2,000 years B. C. Whether the manufacture of roofing tiles was carried from China to India and Persia, and thence to Egypt, Phœnicia, and Assyria, or whether it was a native and spontaneous product of these peoples, who were the first to develop the artistic resources of the human intellect, is a disputed question. It was from these countries, undoubtedly, that the art found its way through Greece into Europe, where it was soon carried to great perfection. Tiles were used by the Grecians, Romans, Venetians, and most nations of southern Europe. The history of tiles, during the intervening time, from the Romans to the Mussulmans, Saracens, and Moors, is not known, but its revival is due to the last named. From 732 to 1492, Spain was famous for its potteries, as were also India and Asia Minor. The tiles most used were flat tiles turned up at the edges, with a row of inverted semicylindrical ones over the joints.

In the Middle Ages, tiles were the principal covering, though stone slabs were much used and laid in the same manner as shingles, supported on barrel-vaulted roofs.

6. In the following outline, the types of roofing tiles are illustrated in a general way, and mention is made of those by whom they were originally used.

Tiles are supposed to have been first brought to America by the German settlers in Pennsylvania, and were of the flat variety. The pan tile was brought by the Dutch, who settled on the Delaware River, New Jersey; and the Spanish tile, by the old Jesuits to California.

For the *normal* (Asiatic), see Fig. 8. Those marked (*a*) were used in the Orient, Ancient Greece, and Italy; those marked (*b*), in China and India; those marked (*c*), in the Orient, in Asia, and the Mediterranean countries, south of latitude 44°; those marked (*d*), in Greece and Italy, ancient and modern. For the *pan* (Belgic), see Fig. 9. Those marked (*e*) were used in England and Scandinavia; those marked

(*h*), in Belgium, Holland, Scandinavia, Japan, and Java; those marked (*g*), in various modern countries. The *flat*

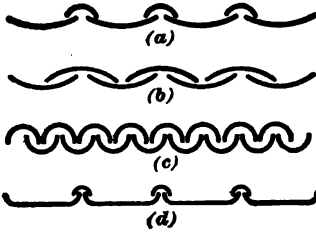


FIG. 8.

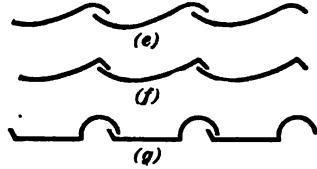


FIG. 9.

(Germanic) were used in Germany, Austria, Hungary, Poland, Switzerland, France, and England.

7. Metal Roofs.—Metal roofs may rightly be termed modern roofs. Lead was the first of these to be introduced; copper, zinc, and galvanized iron followed. Lead and copper were used in medieval times for covering roofs, but it was not until about 1760 that they came to be used as a general covering for large buildings.

Wood shingles and slate were known at an early period, and were used in the form of slabs having considerable weight. Edward II gave an order, in 1314 A. D., to replace the shingle roofs of certain government buildings with slate, thus showing that, even at that time, both were extensively used, though it is commonly supposed that wooden shingles are of a very much later date.

Tin, the most extensively used roof covering in the United States, was originally a North German product, and was made there as early as 1600; it next was made in Bohemia, 1620; at Pontypool, England, in 1670; and at Mausvaux, France, in 1714; but not until recently, in the United States. England produces at the present time 90 per cent. of all that is manufactured.

8. In the following pages, the different styles, methods, and materials used for roofing, as well as the application of each to the particular form or style of roof to which it is best adapted, will be discussed in the order of their importance and historical development.

GENERAL TERMS AND DEFINITIONS.**VARIETIES OF ROOFS.**

9. The names of different roofs are determined: (1) by their *style*; (2) by their *outline*; and (3) by their *angle of inclination*, or *pitch*.

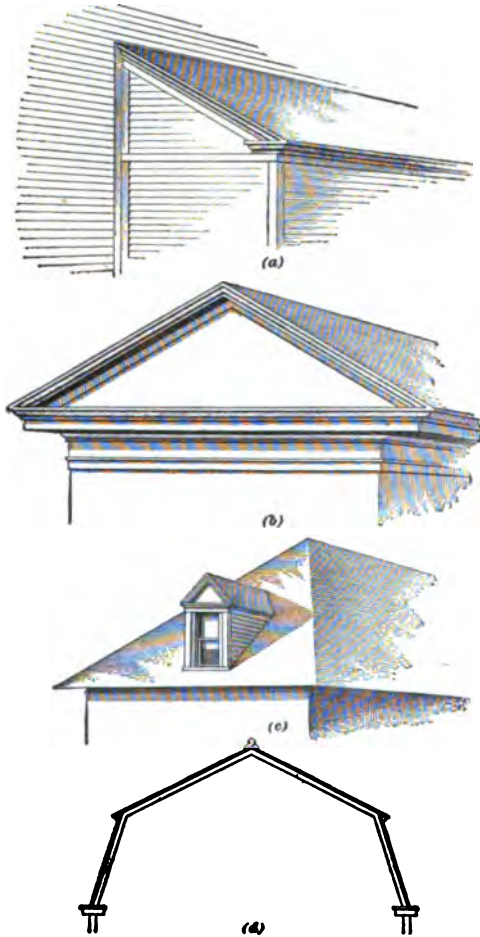


FIG. 10.

In Fig. 10, at (a), is shown a *pent*, *shed*, or *lean-to* roof; at

(*b*), a *gable* roof; at (*c*), a *hip* roof; and at (*d*), a *curb*, or *gambrel* roof.

In Fig. 11, at (*a*), is shown a *Mansard* roof with deck, or flat, top; at (*b*), an *ogee* roof; at (*c*), a *semicircular*, or *barrel*, roof; and at (*d*), a *hip-and-valley* roof.

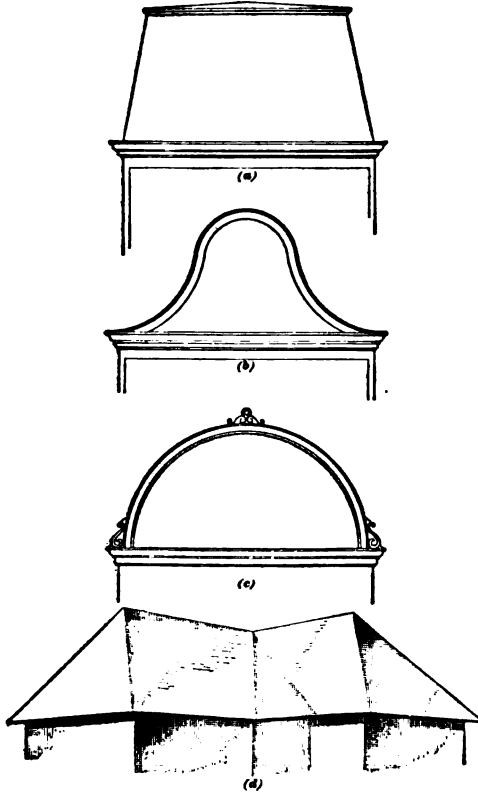


FIG. 11.

In Fig. 12, at (*a*), is shown a *dormer-window*, with cheeks, or flanks; at (*b*), an *eyebrow* window; at (*c*), a *squint* with cheeks, or flanks; and at (*d*), a *louvre ventilator*.

The pitches are regulated by a recognized standard of the style to which they belong. Thus, at (*a*), Fig. 13, is seen the pitch, generally found in Grecian design; i. e., inclined from

12° to 16°; at (b), the inclination is from 23° to 24°, which was the rule in Roman design; at (c), is shown the Gothic, or equilateral, pitch; and at (d), the Elizabethan, or knife-edge, pitch.

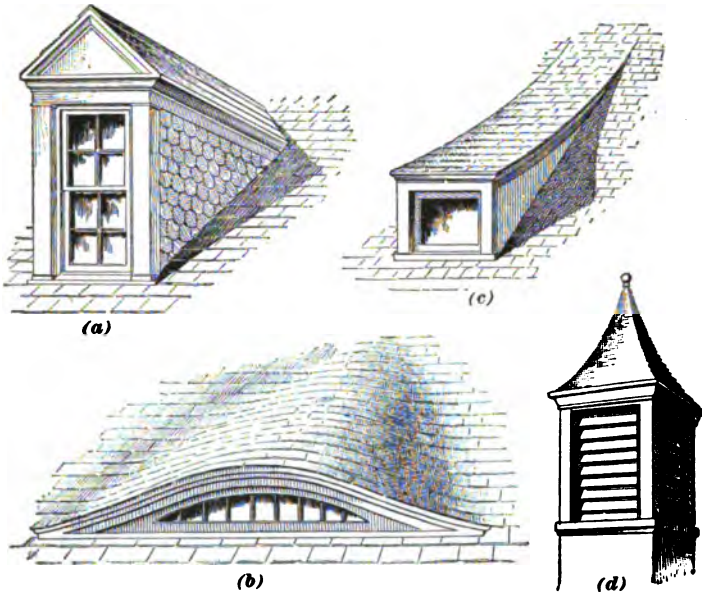


FIG. 12.

10. A dome, properly speaking, is a spherical form of roof; the term, however, is now applied to various forms having a circular base; thus, in Fig. 14, at (a), is a *surmounted dome*; at (b), a *semicircular dome*; at (c), an *ellipsoidal dome*; at (d), a *segmental dome*; and at (e), a *bell dome*. There are many other varieties, known as Turkish, Saracenic, Russian, etc.

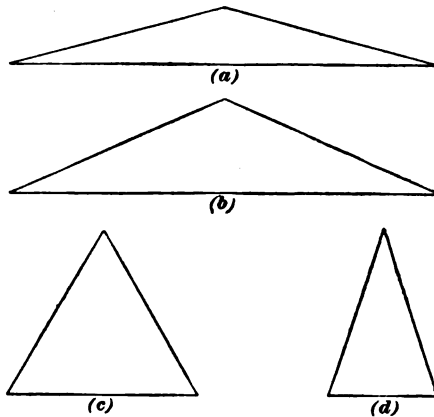


FIG. 13.

PARTS OF A ROOF.

11. The following terms are applied to express the different elements or details which exist in nearly all roofs:

Span is the distance between the supports.

Rise is the vertical distance between the ends of a slope.

Run is the horizontal distance between the ends of a slope.

Pitch is the slope of the rafters as determined by both the rise and run.

The **eaves** are the lower part of the roof projecting over the walls.

A **gable** is that portion of a wall extending above the eaves; it is generally built to the shape of the roof abutting or covering it.

Hips are the salient angles formed by the intersection of the roof slopes.

Valleys are the re-entrant angles formed by the intersections of the slopes. A **close valley** is that in which the material used in covering the roof is mitered and flashed at each course, no metal being exposed. **Open valleys** are formed by sheets of metal laid with a portion of their sides under the material used in covering the roof, and with the center part, or valley gutter, left exposed for a width of 4 or 5 inches on each slope.

The **ridge** is the line formed by the meeting of the slopes of the roof at its summit, or apex.

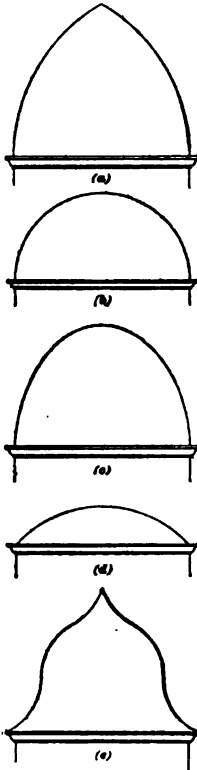


FIG. 14.

Saddles are small inverted V-shaped pieces of roof, placed at the backs of chimneys or other portions of a building, protruding through and above the roof. They serve the double purpose of shedding the water and preventing snow and ice from accumulating.

A **cant** is an angular-shaped piece of roof, used on flat-pitched roofs with parapet walls and placed at the lower end of the roof, commencing at a point at the leader head, and gradually

running out on the roof, until, at the opposite end, it is 4 or 5 feet wide and extends up on the wall about a foot. It is also used back of bulkheads, etc. for the same purposes as the saddle.

A **curb**, or **combing**, is a support for a skylight, or scuttle, and surrounds the opening cut in the roof.

A **bulkhead** is formed by a partition built around the openings cut into the roof for elevators, stairways, dumb waiters, and air-shafts. It is also occasionally applied to the vertical or sloped backing in the rear of the main cornice.

A **tilting strip**, or **fillet**, is a triangular strip of wood used to raise the flashing, shingles, slate, tile, etc. at the eaves, gable ends, around chimneys, skylights, bulkheads, and ventilators, or against parapet and gablewalks, to prevent the accumulation of dust, water, or snow.

DESIGN AND CONSTRUCTION OF ROOFS.

GENERAL CONSIDERATIONS.

12. In planning a roof, the first thought must be given to the pitch, which depends upon the climate, against which it is to act as a protection; the second consideration is the devices of construction to aid the free flow of water from the whole external surface when covered; and the third is the determination of the materials best suited to both the pitch and climate.

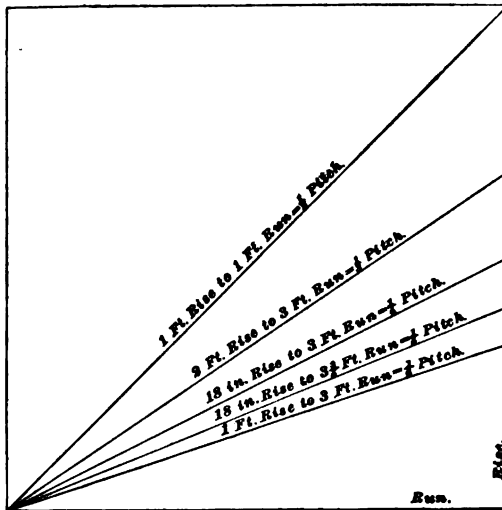


FIG. 15.

13. Fig. 15 is a diagram of comparative pitches, from $\frac{1}{4}$ to $\frac{1}{2}$ pitch, and the following table gives a list of roof materials and the least pitch permissible with each:

TABLE 1.

Material.	Pitch. Inches to the Foot.
Asphalt and composition	$\frac{1}{4}$
Tin	$\frac{3}{8}$
Zinc	$\frac{3}{8}$
Corrugated iron	$\frac{1}{4}$
Sheet iron	$\frac{1}{4}$
Copper	$\frac{1}{4}$
Lead	$\frac{3}{8}$
Thatch	6
Shingles	4
Slate	4
Tiles, terra cotta or copper	4

14. Although there are no invariable rules governing pitches, it has been the custom to construct slopes suitable to different localities, and to use the materials which are best adapted to meet the climatic changes.

In hot countries, the lack of rain makes it unnecessary to give the roof more pitch than enough to shed the water; but the roof must be well constructed and tight, for when the rain falls in hot regions it does so in great volume.

Rapid evaporation is a great help in preserving the roof, for the moment the rain ceases the roof is dried, and the conditions tending towards corrosion or decay of the materials are soon removed.

In cold climates, where the air holds the moisture, and the rain and snow are driven by high winds, the pitch must be steep, to prevent the loosening of the shingles, slate, or tile by the wind, and to cause snow and moisture to be quickly shed from the roof.

In temperate climates, the pitch may be varied as the locality approaches either the warm or the cold zones.

In very wet, damp, or cold situations, the roof is given a pitch of from 40° to 60°; in dry climates, where the roof is quickly cleaned of water, a moderate pitch of from 20° to 30°; and in hot climates, only sufficient to shed the water.

This must, of course, be varied with the material used. Thus, shingles, slate, or tiles could not be used in a hot climate, unless the pitch were sufficient to keep the water from driving under them, or overflowing their edges during a rainfall. Neither could lead be used on a steep-pitched roof, as it would crawl off by expansion.

15. The roof should be carefully prepared for the covering; and all pockets, where ice, snow, or water can accumulate, must be studiously avoided in the construction.

On steep roofs, the backs of chimneys, or other vertical walls cutting the roof plane, must be fitted with a saddle or cant board.

All angles made by corners or flashings against walls should be avoided, and a tilt fillet or cant board must be used, to allow the flashing to take an easy bend. In slate, shingle, and tile roofs, this observance will assist the passage of water and snow and prevent its accumulation. On metal roofs, the sand, dust, or other refuse blown thereon will not so readily lodge. Where such accumulations do lodge on the roof, they keep it damp, rotting and corroding the most vulnerable parts.

16. The boarding should run one way, so that the shrinkage may be uniform and not pull and tear the joints of the roofing material. With metal roofs, it is best to have the boards laid from the eaves to the ridge, as this, in case the boards warp, brings the ridges thus raised in the roof in line with the current or pitches. This is not always practicable, but in any case it is possible to lay the boards diagonally. The nails driven from the surface of the roof must be countersunk at least $\frac{1}{4}$ of an inch below

the top of the boards, to prevent corrosion and wear of the covering.

17. Double gables, or dormers, in which the roofs form an \wedge should not be erected, it being impossible to keep them clear of snow in winter; for the same reason decks should not be used, unless unavoidable.

THATCHING.

18. Thatching on a house is an admirable covering for securing warmth in winter and coolness in summer, but, being subject to injury from birds and a great risk from fire, is very seldom used. A good thatch roof has been known, when well put on and composed of sound straw, to last from 10 to 14 years; while in respect to its being the most picturesque form of covering for cottages, arbors, and like buildings, there can be no room for question.

19. The roof is prepared to receive the thatching by nailing to the rafters, lath, or light purlins, at 8-inch centers (see *a*, Fig. 16), on which the straw is laid. Like slating or shingling, the thatching is commenced at the eaves by laying on bundles, about 3 or 4 inches in thickness, and securing them to the laths, using a thatcher's needle and rope yarn. The yarn is tied around the purlins as at *a*, Fig. 17, or hung

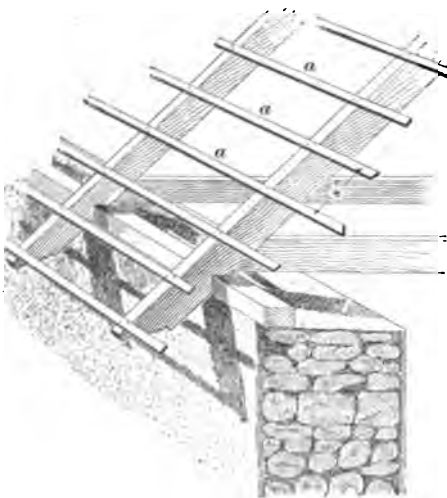


FIG. 16.

with thatching hooks, which are tied to the head of each bundle and hooked over the purlins. Starting at the end

wall, or at the gables, full-width bundles are laid until a row reaches the ridge, the thickness of the completed row being from 12 to 15 inches.

After two or three rows have been put on, they are interlaced with *withes*, or *reeds* (see *b*, Fig. 17), the ends of the withes being bound together and nailed to the purlins; the withes may also be tied to the purlins with the yarn.

The rods *c* are run through the thatch when 8 or 10 feet have been laid; they are spaced about 2 feet apart, and are secured by looping a withe over the rods and nailing the ends to the rafter.

Where the thatch comes against the gable wall, the joint must be well filled with lime mortar. After allowing this to thoroughly settle, it is pointed with cement mortar, carried well up against the wall. Similar pointing should be used about chimneys or other openings, or a canvas flashing may be nailed to the walls with a wood strip at the top, the flap being turned out on the thatch and the whole thoroughly tarred.

The ridge may be formed of thin bundles of straw, laid with the middle on the ridge and afterwards withed down to the roof [see (*a*), Fig. 18]; or

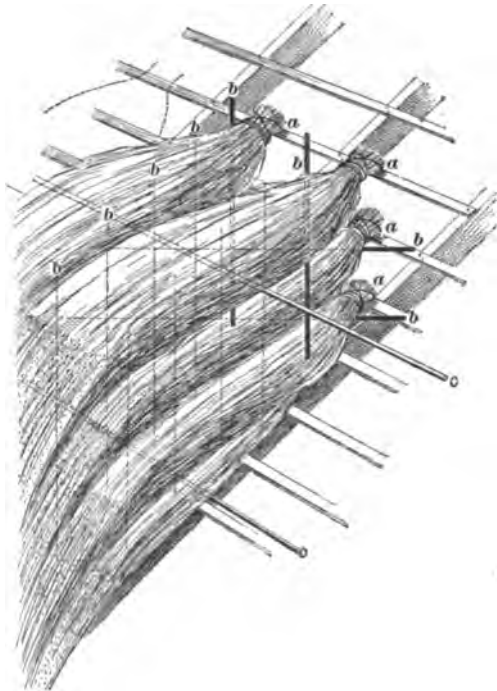


FIG. 17.

the straw ends of the upper layer may be turned up and withed together and surmounted by a terra-cotta ridge cresting set in cement, as shown at (b), Fig. 18.

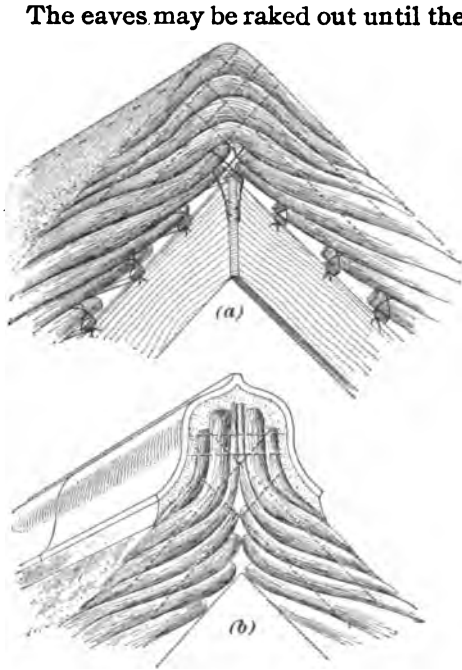


FIG. 18.

The eaves may be raked out until the edge is very fine, thus forming a round, easy shed for the water [see (a), Fig. 19], or cut off on the under side, as shown at (b), Fig. 19. As each course is laid, the lap ends should be raked out, to maintain as even and continuous a surface in the finish as possible.

20. The thatcher requires the following tools: a common stable fork, to toss the straw together before it is made into bundles; a

thatcher's fork, to carry straw up to the roof; a thatcher's rake, to comb down the straw straight and smooth; a knife, to point the withes; a half glove of leather, to protect the hand when drawing or pushing in the smaller withes; a long, flat needle; a pair of leather gaiters, to come above the knees, used when kneeling on the rafters.

The materials required are: good straw of any kind, or straw reeds, wheat straw being the best; also rope, nails, withes, and rods.

To complete a square of roof, the materials necessary are: two-thirds of a load of straw, laid on about 12 to 14 inches thick; a bundle of oak laths, $1\frac{1}{2}$ inches wide and from $\frac{1}{2}$ to $\frac{3}{4}$

inches thick, nailed to the rafters, as in Fig. 17; 75 withes;

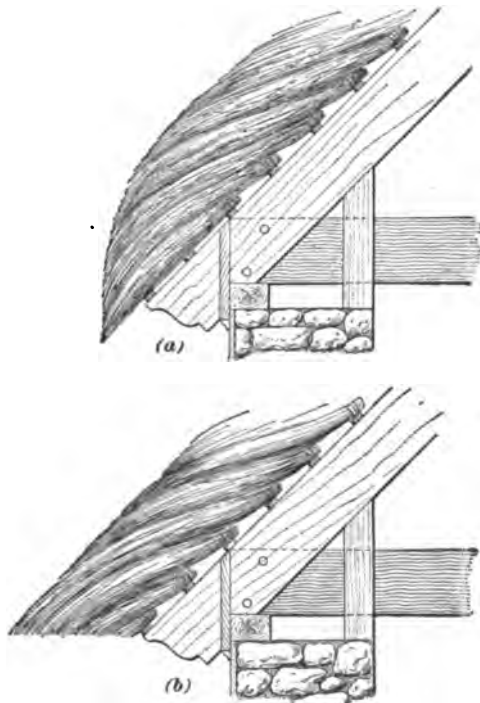


FIG. 19.

1½ pounds of rope yarn, or, in its place, Manila rope; 35 rods; and 250 nails.

ASPHALT ROOFING.

21. **Asphalt**, or solid bitumen, is found in several countries. Asphalt, combined with calcareous earth, that is, earth containing lime, forms a compact, semielastic solid, not liable to injury from the strongest influences of frost or thaw, impervious to water, and unaffected by acids.

22. There are three methods of laying asphalt:

The *first* and most durable method consists in laying felt entirely free from saturation with asphalt, then applying a coat of asphalt in solution, and finishing with a covering of gravel.

The *second* method consists in laying sheets of felt saturated with asphalt, finishing with sand.

The *third* is similar to the first, except that the finishing is done with a coating of Portland cement.

23. The application is very much like that in use in other composition roofing, except that the first and third methods call for copper or lead flashings. Two thicknesses of the composite roofing felt is stretched from the eaves to the ridge, the Manila side of the felt being placed downwards,

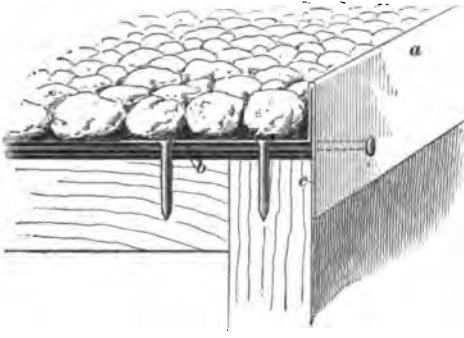


FIG. 20.

the felt being secured with nails about $2\frac{1}{4}$ feet apart. The entire surface should then receive a coating of natural asphalt cement.

Another thickness of the felt should be laid in the cement, securing it at the upper edge by nails 4 feet apart, lapping each successive sheet about 1 inch over that preceding it. Over the entire surface of the felt thus laid, there should be spread an even and continuous coating of the cement, and this coating should immediately be covered with an adequate body of well screened gravel.

24. The *flash-
ing* for this roof should preferably be of copper, as

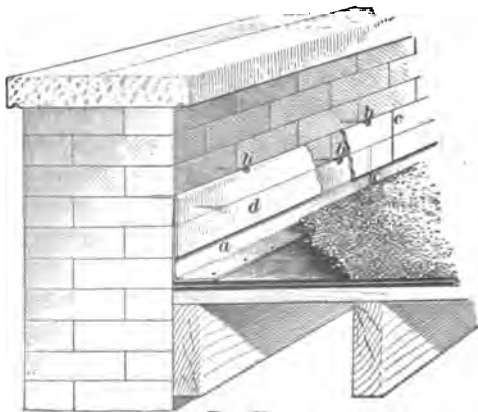


FIG. 21.

should also the eaves stops and nails. Flashings of zinc, galvanized iron, or tin may, however, be used as fairly satisfactory substitutes for copper.

The *eaves stops* (see *a*, Fig. 20) should extend 2 inches on the roof as shown at *b*; they are laid over the felt and should extend downwards over the eaves *c* not less than $\frac{1}{2}$ inch below the upper surface of the roof boards.

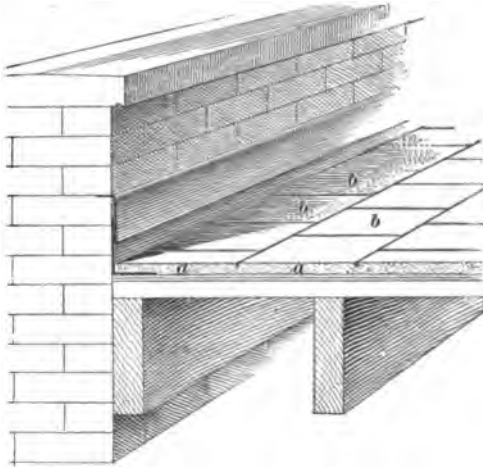


FIG. 20.

The *wall flashings* *a*, Fig. 21, extend at least 2 inches over the felt on the roof. They should be well nailed, and should be covered with ce-

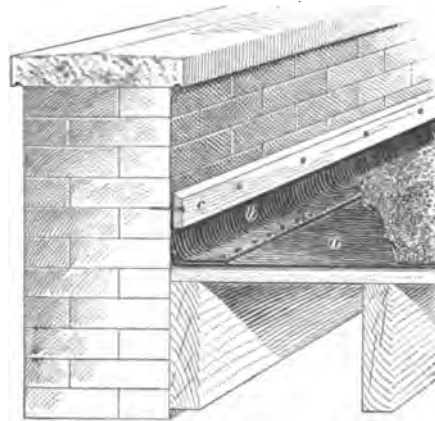


FIG. 21.

ment when the gravel is applied; they should project upwards against the wall at least 5 inches and be secured with flashing hooks, and should have the vertical joints *c* well locked and soldered.

The flashing should be covered with a *counterflashing* *d*, Fig. 21, which reaches within 2 inches of the roof, and is turned in to the wall at least 1 inch and secured by wall hooks

or plugging. The joint should be pointed with elastic cement.

This roofing may be covered with a layer of hydraulic

cement, as shown at *a*, Fig. 22, $1\frac{1}{2}$ inches thick, divided into small sections *b, b* suggestive of stone or tile.

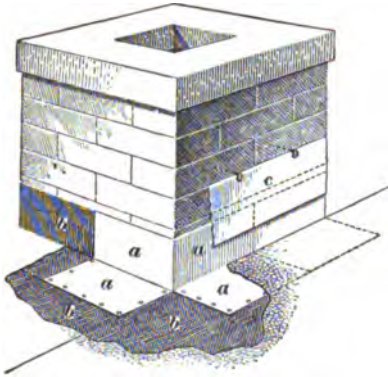


FIG. 24.

In the second method (see Fig. 23), the flashings are of the same material as the roof. In this method the felt *a* is laid close in to the angles against the walls, and is extended 2 inches upwards. Over this, in the angles, is laid a strip *b* 8 inches wide, with half its width against the walls and half on the roof. The upper edge is fastened with a wooden strip *c*, nailed to the walls and pointed with cement; the felt is pressed in to the angles of the wall and cemented to the roof with liquid coating. In securing the laps of the prepared felt, the nails should be spaced about 1 inch apart.

The outside angles of walls and chimneys should be flashed, as shown in Fig. 24.

A strip of felt *a* 8 inches wide is folded and cut as shown. It is bent around the angle, and is nailed and cemented, with the liquid coating, over the underroofing *b*, after which it is counterflashed as shown at *c*.

The inside angles of walls are flashed, as shown in Fig. 25, the strip of felt *a* being of the same dimensions and similar to that used for outside angles; the process of applying is the same.

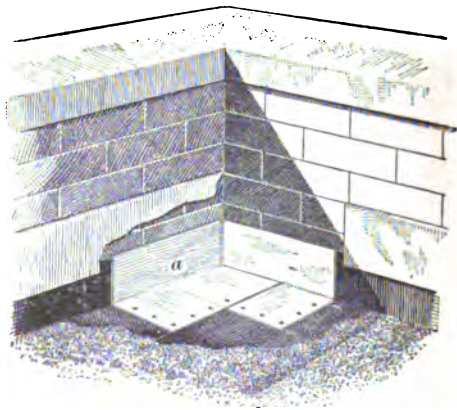


FIG. 25.

The **ridge** is capped with a 16-inch strip of felt, lapping on the roof each side of the ridge, well cemented and securely nailed at the edges and joints. The best temperature to apply this roofing in is one of 35° F. When it is colder than this, the material should be kept in a warm room before using, and taken out only as required.

The quantity of material required to lay and cover a square of this roofing is: 1 roll of 2 or 3 ply natural asphalt roofing; 2 gallons of liquid coating; 1 pound of nails; and 1 pound of tin caps.

ASBESTOS ROOFING.

25. **Asbestos** is a white, gray, or green-gray fibrous variety of amphibole, usually one containing but little aluminum, tremolite, or actinolite; also, improperly, a fibrous serpentine or chrydolite. The fibers are sometimes very long, easily separable, and flax like, sometimes compact and capable of a high polish. It is very soft when reduced to powder. It is incombustible, and from white, green, and gray, turns red and black. Asbestos is mined in Canada, Vermont, Virginia, South Carolina, and Staten Island, N. Y.

26. Before the application of asbestos, the roof surface should be cleaned of all refuse. Care should also be taken that the joints of the boards are planed to a level surface and then thoroughly swept.

Unroll the roofing as shown in Fig. 26, taking care that the material passes over and not under the roll. Cut enough off the roll to cover the length required. Commencing at the eaves, lay the sheets in succession parallel

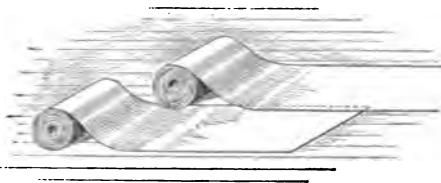


FIG. 26.

to the eaves. The lap for steep roofs should be 1½ inches, and for flat roofs, 2 or more inches. Where short lengths are used, see that the vertical joints do not come in line with each other;

and on steep roofs, where the roofing is vertical, or from ridge to eaves, place a continuous strip next to the short lengths. All edges and laps are cemented before being nailed down, the nails being spaced 1 inch apart. When

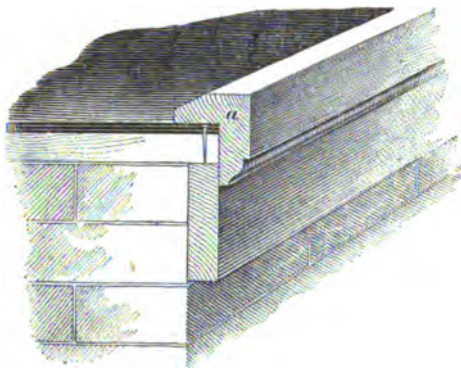


FIG. 27.

the roofing has been nailed, cement a second time, thoroughly covering the joints and laps, concealing all nail heads and filling up the edges as much as possible. Next apply a coating to the entire surface of the roof, and when thoroughly dry, apply a second coating, finishing, while fresh, with an even covering of fine ground asbestos powder.

Where there are no gable walls, the roofing is thoroughly cemented at the edge of the roof, with a coating mixed and thickened with hydraulic cement. It should, also, be nailed down close and tight and then covered with a wooden cap molding *a*, as shown in Fig. 27.

27. Where there are parapet walls, chimneys, bulkheads, etc., the roofing should run to the angle only. See Fig. 28. When the roofing has been nailed in place, the angle formed by the roof and walls should be thoroughly cemented. While this coating of cement *b* is wet, apply a separate flashing *c*, as shown; this flashing to be 8 inches wide, 4 inches on the roof and 4 inches up against the walls, nailed and also cemented.

Where a metal counterflashing is used, secure the upper edge of the flashing *c*, just mentioned, with a wooden strip *d*, well nailed to the walls, finishing the top with a good coating of cement *e*. By using a wide strip of wood, and keeping the top of it flush with a joint *f* in the brickwork,

the mortar can be raked out and the coating of cement made to enter the joint, thus rendering it more secure and water-tight.

Apply tin, copper, or zinc, where used for counterflashings, in the same manner as in other roofs. In fitting around the corners of chimneys, etc., take a piece of roofing 8 inches square, and from the middle point of either side, cut it half across; bend this on the angles as required and cement well. This pattern will suit an outside or an inside angle. See Figs. 24 and 25. Where the roofing connects with tin, or other metal portion of the build-

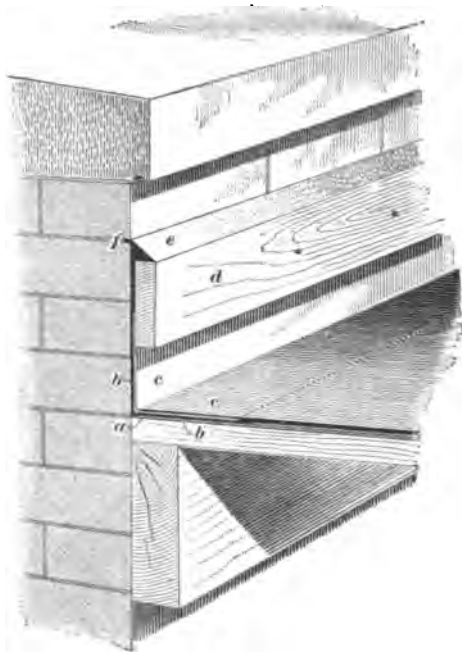


FIG. 28.

ing projecting through the roof, the edges should be carefully secured by nailing and cementing.

28. At the leader outlets (see Fig. 29), turn the leader sleeve over the gutter; cut a piece of roofing felt *a* with a hole in it the size of the outlet; place this over the sleeve's edge; then cement and nail in place. If the gutters are to be lined with the roofing felt, use a separate strip *b* in the trough, and put it in place before applying the material *c* on the roof proper. Nail and cement all the edges and laps, and give an extra coat of cement. Avoid forming sharp angles in the roofing felt, and take care not to injure the material while applying it to the roof.

29. See that all laps are made with the current, or pitch, of the roof. Large roofs should have a pitch of not less than 1 inch to the foot. This roofing should not be applied

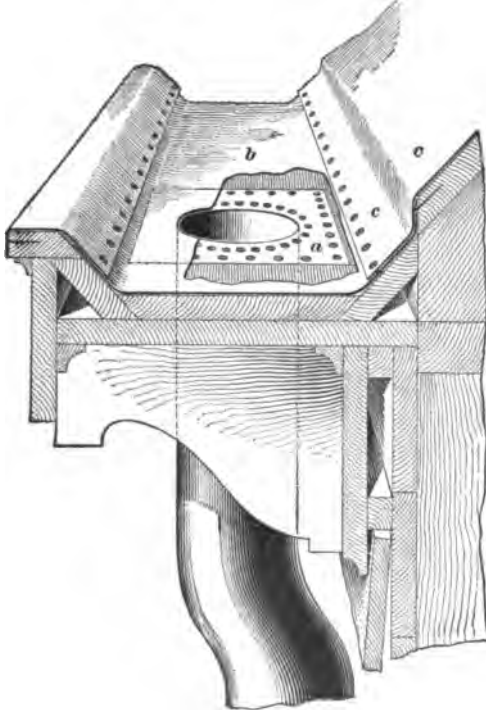


FIG. 20.

when the temperature is below 40°. With this method, it requires to cover a square: $\frac{1}{2}$ roll of roofing material, $1\frac{1}{2}$ gallons of coating, and $1\frac{1}{2}$ pounds of nails.

SHINGLE ROOFING.

WOOD SHINGLES.

30. Shingles are made by sawing or splitting chestnut, hemlock, cedar, white pine, or cypress.

Chestnut shingles are likely to curl in dry weather, and

when damp they swell and bulge; this continued movement gradually draws the nails and cracks the shingle.

Hemlock shingles are more serviceable than is generally supposed, and in dry localities last a long time; but in a moist atmosphere they rot quickly.

Red-cedar shingles last very well, and are on this account largely used. Because of the general straightness of the grain, red-cedar shingles are not roughened so much under the sun as other kinds, and, therefore, give a better weather surface.

White-pine shingles are commonly used, because, while offering most advantages under general requirements, they last longer than any but cypress or white-cedar, and do not curl and split so readily as the foregoing kinds. Their chief disadvantage is in the sawing, as the fiber roughens quite freely.

Cypress and *white-cedar* shingles are the least used, and, at the same time, the best that can be had. The wood saws fully as well as the red cedar, and will not curl or split, except under excessively severe conditions; as regards enduring qualities, these shingles are far superior to any other shingles known.

31. Sizes and Terms.—The ordinary lengths of shingles are from 16 to 18 inches, or 24 to 27 inches, and the widths, from 3 to 7 or 10 inches. A bundle contains about 250 shingles. Thick shingles measure about $\frac{9}{16}$ inch, and thin ones about $\frac{3}{8}$ inch at the butt. Shingles are wedge shaped and $\frac{1}{8}$ inch thick at the upper end.

Dimension shingles are always cut to a uniform size or width, and are preferable in laying patterns; they are 4, 5, or 6 inches in width, and are usually dressed.

The term *No. 1* signifies that the entire shingle is of a clear, sound, serviceable wood, free from all knots, sap, etc.

Shaved shingles are split and shaved with the draw knife.

Clear butts indicate that the shingles contained in the bundle have a clear butt, or enough clear surface for the exposure to the weather.

Fancy butts, or *pattern butts*, are shingles having the butts, or ends, sawed to a geometric or other form, such as saw tooth, round, hexagonal, etc. These shingles are usually dressed.

Shingle lath, on which the shingles are laid, usually runs from $1\frac{1}{4} \times 2$ inches to $1\frac{1}{4} \times 3$ inches.

Valley, *hip*, and *ridge boards* are of either 1 inch or $1\frac{1}{4}$ inches in thickness, as required.

LAYING SHINGLES.

32. The methods of laying shingles generally in use are: (1), on shingle lath; (2), on boarding without paper or felt; and (3), on matched boarding and lath with felt.

The *first* method is, no doubt, the best, though generally used only on cheap buildings. In more expensive houses, the requirements usually call for a matched-board roof, which prevents the free passage of air, and causes the shingles to rot.

33. To lay shingles according to the first method, commence at the eaves and lay from one to three hemlock boards 10 inches wide. The advantage of using more than one board is, that, if it becomes necessary to walk on the eaves of the roof to make repairs, the shingles will not be so readily broken. In the valleys formed by the main roof and dormers, where not very long, one board, however, on each side is sufficient. These boards also act as a stop to the wind, and, to a great extent, prevent the rain from being blown over the flashing. The same remark applies to hips and ridges.

The starting course of the shingles should be doubled at the eaves, and the ends should overlap the gutter about $1\frac{1}{2}$ inches.

Each shingle is secured with 2 fourpenny nails, at a distance of about 2 inches above the upper line of the exposure. The amount of exposure or gauge is measured back from the butt ends of the shingles, and a mark is struck with a chalk line, to which mark the butts of the next course of shingles are laid. The heads of the nails are in this manner protected by the laps, and the shingles are further secured

by the nails of each succeeding course passing through the heads of the previous course. If the gutter is built on the surface of the roof, as shown in Fig. 32, the butts of the shingles must be placed well up above the overflow line.

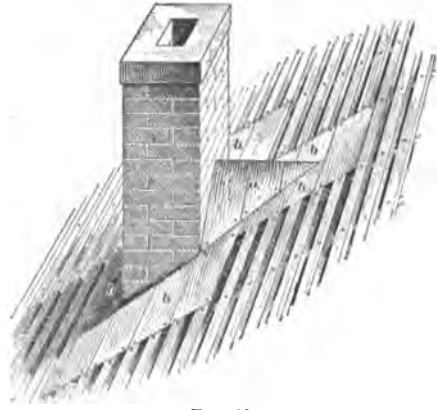


FIG. 32.

34. Around all chimneys, ventilators, skylights, etc., board the roof to the first rafter on each side; and at the back of all chimneys, build in a saddle, as shown

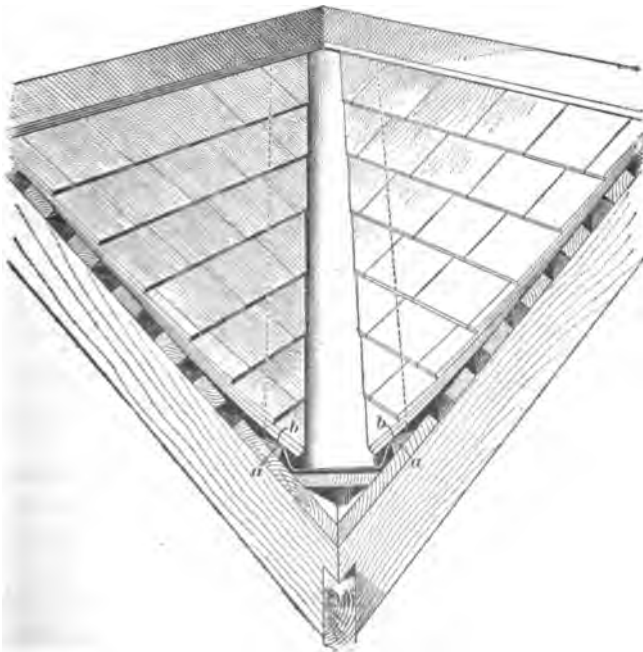


FIG. 33.

at *a*, Fig. 30, and nail the boards *b* at each side and at the front.

Along the valleys should be placed tilting fillets *a*, Fig. 31, over which the flashing is formed. Similar tilting fillets should be placed along the upper edge of the gutter just above the overflow.

Gutter linings may with advantage extend several inches up under the shingles. See *b*, Fig. 32. The valley lining also extends under the shingles 3 or 4 inches, as shown at *b*, Fig. 31;

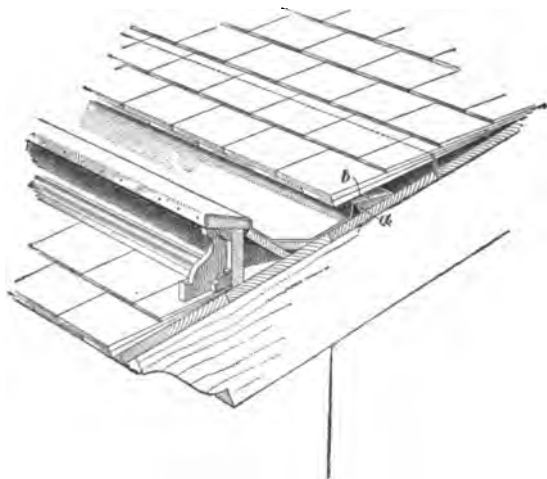


FIG. 32.

likewise, the chimney flashing extends 3 or 4 inches at the back and sides of the chimney, and 5 or 6 inches at the front.

35. Valleys.—In finishing against open valleys, care should be taken to cut the shingles parallel to the line of the tilting fillet, or the result will be a wavy line.

In constructing *close* valleys, the shingles are interwoven with metal sheets (see Fig. 33), and are mitered in the angle. The shape of these sheet flashings will vary with the pitch of the roof, if it is desired to make the lower edges of the sheets parallel with the butts; but this is not necessary, as square sheets will serve the same purpose, provided they are properly lapped.

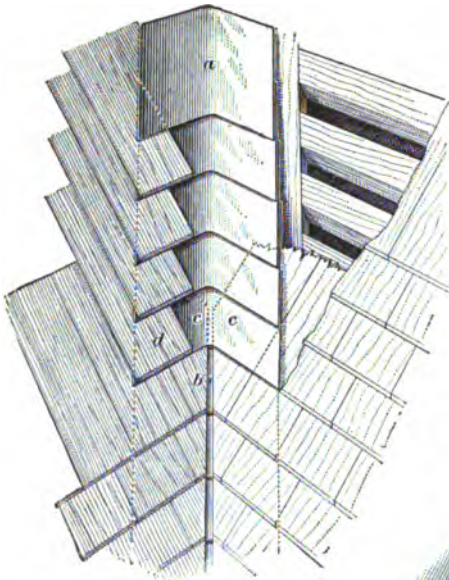


FIG. 33.

shown at *d*, covers the metal entirely, and each ascending flashing will be covered in like manner. This gives a tight valley and is used more on account of appearance than durability; for the snow and rain keep the shingles damp, consequently causing them to rot before the rest of the roof.

36. This method, applied to the hips of roofs, is shown in Fig. 34, *a* being the flashing laid in with

The general manner of constructing this valley is as follows: A row of shingles should be laid each side of the valley, a clear space of $\frac{1}{2}$ inch being kept between the miter edges as shown at *b*, to allow for expansion. The gauge should then be measured, and the flashing set, as shown at *c*, to the line so obtained; the next course of shingles, as

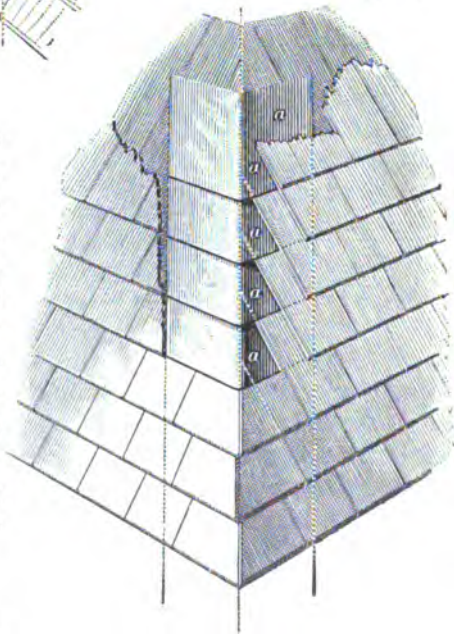
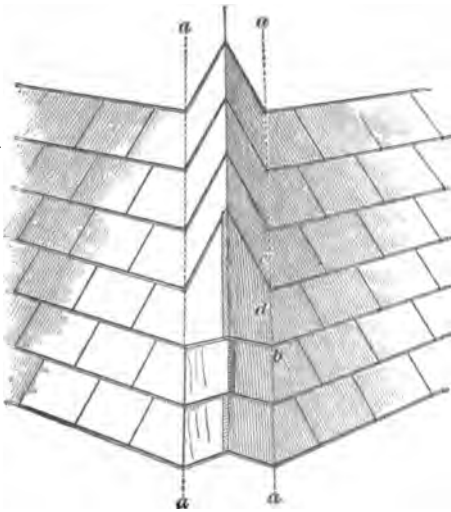


FIG. 34.

the shingles. While not prolonging the life of the shingles, this no doubt makes the most weather-proof hip except a metal roll. The roll, however, never looks well, and on that account should be avoided.

37. The method known as the **Boston hip** is very effective and neat, and under ordinary conditions, especially on a very steep roof, is sufficiently weather-tight for all purposes.

Shingles of a uniform width of, say, 5 inches, should be selected. A chalk line is snapped on either side of the hip, about $4\frac{1}{2}$ inches from its center and parallel to it. See *a*, Fig. 35.



The slope shingles should be carried up to this line, stepping back to allow the hips to be laid last. Lay a shingle on the roof with its edge at, and parallel to, the hip line, and the lower corner of its butt just touching the butt of the shingle below it, as shown at *b*. Across it, and at right angles to the eaves, draw a line for the vertical side cut, as at *c*. Slightly

taper the side *d* to heighten the effect of a hip roll, and to allow the next hip shingle above to slightly project over and cover the end of the vertical side cut. Fit the hip shingle to the side of the slope shingle, and nail in place. On the other side, lay the edge of the shingle flush with the upper and outside edge of the first shingle, obtaining the side and butt cuts in the same manner as before; the third shingle is laid on the same side as the second; the fourth shingle is laid on the same side as the first, with the hip edge flush with the outside edge of the third, and the fifth on the same

side as the fourth; continue thus, laying two alternately, until the hip is completed.

One of the chief advantages of this method is, that the grain of the wood runs with the hip, and the tendency to curl is taken away from the line of the hip to the side of the shingle.

The appearance of the roof may be improved, and the drip over the gables may be stopped, by putting a tilting fillet up the rake, running the shingles up on it as at *a*, Fig. 36, and cutting the ends of the shingles at an angle of 45° to the side joint, as shown at *b*.

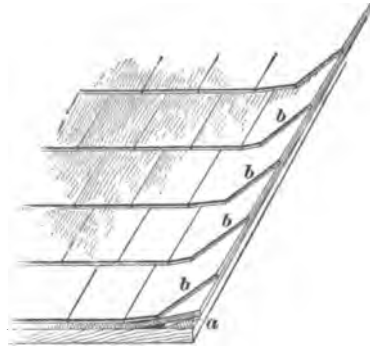


FIG. 36.

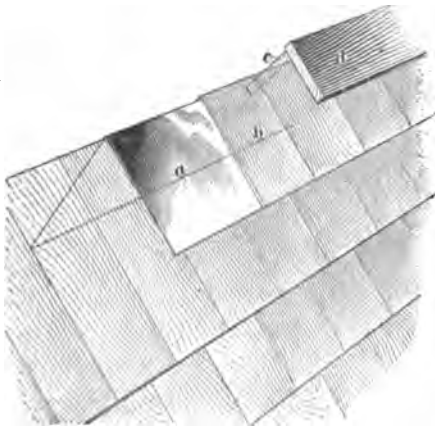


FIG. 37.

38. There are three methods of finishing the ridge of the roof. The *first* consists of laying over the last row of shingles but one, a metal flashing, as at *a*, Fig. 37, which extends on each side of the ridge to the depth of the last row, after which the last row of shingles may be laid and the ridge capped with a ridge saddle of white pine $1\frac{1}{2}$ inches thick. The first side *c* is put on flush with the ridge and opposite side of the roof, and the finished piece is put on with a lap of about $\frac{1}{2}$ or $\frac{3}{4}$ inch, as shown at *d*.

The *second* method [see (*a*) Fig. 38] consists of the two ridge pieces *a, a*, one being the thickness of the board wider

than the other, laid over two pieces just the thickness of the

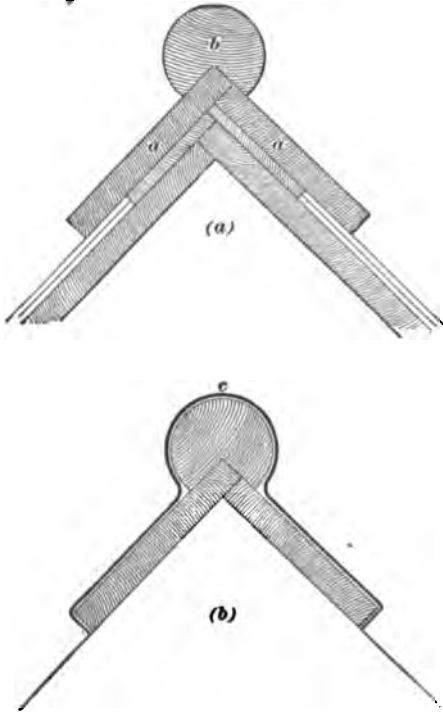


FIG. 38.

shingles, which are first nailed to the roof-boards, and against which the shingles abut. The top of the ridge piece is capped with a wooden roll *b*, Fig. 38. No metal flashing is required, as the roll effectually covers the joint.

The *third* method [see (*b*), Fig. 38] is similar to the second, except that the wood roll is covered with a galvanized-iron or copper roll and wings pushed over it. Galvanized nails are driven into the roll, near the wings, to keep it in place; lead is also used for the same purpose.

39. The *second* method of laying shingles is that of laying them on boards, which cover the entire surface of the roof. The boards should not be set close together, as they would then prevent the passage of air, stop ventilation, and cause the shingles to rot. This process of rotting arises from the warm air of the rooms below condensing when it comes in contact with the roof, making it wet, or resulting in what is called "sweating." It is also caused by capillary attraction acting through the butt ends of the shingles.

40. The *third* method of laying shingles (see Fig. 39) is on matched boarding *a* covered with roofing felt *b*; the lath *c* is then nailed on, the same as in the first method, and the shingles are laid on the lath.

This method makes a very good roof, when the spaces between the ends of the lath are left open at the gables for ventilation; but when closed, as is usually the case, makes the poorest roof of all, as the closed air space only increases the condensation and hastens the destruction of the roof.

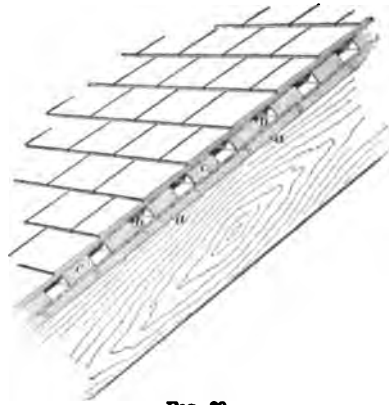


FIG. 38.

41. In laying shingles on a roof, the best results are obtained, and their endurance, which is the chief point, is vastly increased by setting the shingles from $\frac{3}{8}$ to $\frac{1}{2}$ inch apart. This allows the water to drain off rapidly, dries the roof quickly, and also allows for expansion and prevents buckling. Where narrow shingles are used, the joints should not be less than $\frac{1}{8}$ inch; while for shingles over 5 inches in width, from $\frac{1}{4}$ to $\frac{1}{2}$ inch joints should be allowed.

42. For covering conical roofs, the shingles should be selected in three or four widths, the largest butts being 5 inches at the gutter, and the smallest, 2 inches at the top. (See *a, b, c, d*, Fig. 40.)

To keep the shingles true to the radial lines, and the butts in line with the horizontal curves or courses running around the tower, a nail is driven into the center of the apex post *e*, to which a cord is attached. The starting course is laid horizontal with the eaves, the next gauge is laid off, and a shingle *g* is tacked in place. The cord is held to a joint of the first course under the tacked shingle, and a line is drawn through the center of the shingle *g* vertically; the cord is then moved to the outside corner of the butt, first on one side *h*, and then on the other side *i*: the side or taper lines *hj* and *ik* being drawn will be radial to the center of the apex, as shown by the plan *l*. The shingle, cut to the

lines marked, will form a templet for the first course. The shingles with 5-inch butts should be laid first, then the 4-inch, and so on until each lot is used, making a new templet as often as the joints begin to come too close.

This mode of application should be continued until the

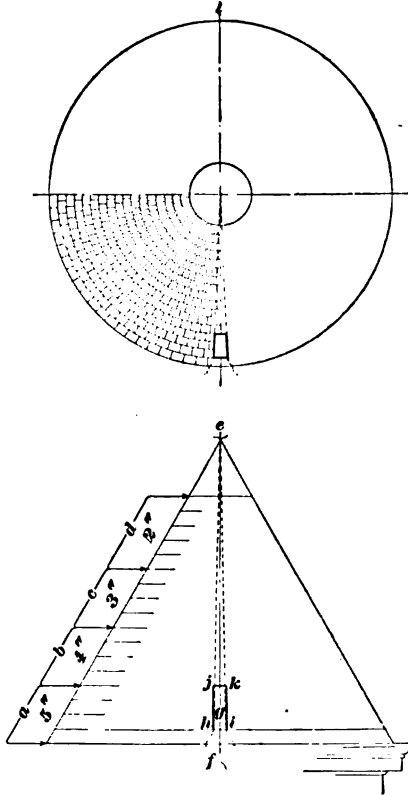


FIG. 40.

base of the finial is reached, when the apex should be flashed with tin if a wooden cap is to be used. If, however, a sheet-metal finial is required, the flashing may be omitted.

43. The gauge, or exposure to the weather, of a shingle is obtained by subtracting the lap from the length and dividing the difference by 3. Thus, for a shingle 18 inches long, and

with a 3-inch lap, the exposed length will be 18 inches—3 inches = 15 inches, which divided by 3, will give 5 inches.

The number of inches exposed to the weather multiplied by the average width of a shingle gives the area of the exposure; dividing 14,400 (the number of square inches in 100 square feet) by the area of the exposure gives the number of shingles required to cover 100 square feet of roof. The average width of a shingle is, for example, 4 inches, and if exposed to the weather 4 inches, the area of exposure is 16 square inches; now 14,400 square inches divided by 16 gives 900, the number of shingles required per square.

44. The following table is arranged for shingles from 16 to 27 inches in length, and based on a given exposure to the weather:

TABLE 2.

Exposure to the Weather. Inches.	Number of Square Feet of Roof Covered by 1,000 Shingles.		Number of Shingles Required for 100 Square Feet of Roof.	
	4 Inches Wide.	6 Inches Wide.	4 Inches Wide.	6 Inches Wide.
4	111	167	900	600
5	139	208	720	480
6	167	250	600	400
7	194	291	514	343
8	222	333	450	300

TIN ROOFING.

TIN AND TIN PLATE.

45. Tin, when pure, is a metal of whiteness and brilliancy next to silver. It is highly malleable, but inferior in ductility and tenacity to all metals, except lead. Little affected by the atmosphere, at ordinary temperature, it is extensively used in manufacturing tin plate. Tin is not

a widely distributed metal; on the contrary it is extremely scarce and very rarely found in the natural or pure state.

Of tin ore there are two kinds, *tin stone* and *tin pyrites*. It is found principally in Cornwall, England; Bohemia and Saxony in Continental Europe; in the Malayan Peninsula; Australia; and more recently, in the United States of America.

46. **Tin plate** is sheet iron or steel coated with tin. The plates of sheet iron are first well cleaned by washing, then dipped in melted tin, and afterwards in a solution of diluted sulphuric acid, this last process being known as *pickling*. The sheets are then scoured with fine sand and water and afterwards dried. To obtain the proper softness, they are next annealed, sorted, and passed between rollers which impart to them an even thickness. This rolling hardens the plates, after which they are again annealed, sorted, pickled, and trimmed.

The sheets, by this process, go through six different baths: (1) the tinman's pot, containing grease; (2) the tin pot, containing melted tin; (3) the washing pot, containing melted tin, covered with grease in one compartment; (4) the plates are then brushed to remove excessive tin, then dipped in the other compartment containing the purest of tin; (5) the cold pot, containing tallow heated to a low temperature; (6) the list pot, containing tin, in which the edges of the plates are dipped.

Crystalline tin is produced by the application of a mixture of diluted nitromuriatic acid, for a few seconds, to heated tin plate, then washing the plate with water and drying.

47. The tests for tin plate are for ductility, strength, and color. To possess these attributes, the iron must be of the best quality, and the process of tinning must be conducted with skill.

Good tin plate is determined by the following conditions: The sheet should bear cutting into strips of a width equal to ten times the thickness of the plate, both across the fiber and

in line therewith, without splitting. These strips must, while hot, stand the strain of being bent on a mold, the circumference of which is equal to four times the width of the strip. The plates when cool must bear bending on a heading machine to such an extent as to form a cylinder whose maximum diameter shall be equal to sixty times the thickness of the plate. If there be any suggestion of lead in the tin, apply to the latter a few drops of pure acetic acid, and a whitish coating will appear. Add to this a few drops of potassium chromate solution. If it turns yellow, the tin has lead in it; the more lead the deeper the yellow.

48. Manufacturing Terms.—The term *tin plate* has been defined. *Terne plate* is a plate of sheet iron coated with tin and lead, and is inferior in quality to tin plate. Plates in the market are known as *charcoal* and *coke* plates. These terms, derived from the process of making the iron, are used to designate the grade of plates, when marking the boxes containing the goods.

Brands are the different marks or devices used by makers. Reliable manufacturers always endeavor to maintain a uniform grade of merit in the different brands they turn out.

Gauge denotes the thickness of the plates, and is known by such signs and marks as **IC**, **IX**, etc. **IC** represents a plate in gauge about No. 29, and weighing about 10 ounces to the square foot. **IX** corresponds to No. 27 gauge, and weighs nearly 12 ounces to the square foot.

Sizes of the plates are marked on the boxes. The common sizes are: 10 in. × 14 in., 14 in. × 20 in., 20 in. × 28 in., etc.

Waster is an imperfect plate.

MATERIALS USED IN METAL ROOFING.

49. Solder is an alloy of two or more metals. When melted, it adheres strongly to the clean surfaces of the other metals less fusible. Solders are hard or soft, according to their relative fusibility. The following table gives the compositions and fusing points of different varieties:

TABLE 3.
COMPOSITIONS AND FUSING POINTS OF SOLDER.

Kind.	Hard.			Soft.			Fusing Point.
	Zinc.	Copper.	Silver.	Tin.	Lead.	Bismuth.	
Spelter, hardest	1						700°
Spelter, hard	2	3					550°
Spelter, soft	1	1					
Spelter, fine	2	2	$\frac{1}{4}$				
Silver, hard		1	4				
Silver, medium		1	3				
Silver, soft		1	2				
Plumbers', coarse				1	3		480°
Plumbers', ordinary				1	2		441°
Plumbers', fine				2	3		400°
Tinners'				1	1		370°
For tin pipe				3	2		330°
For tin pipe				4	4	1	

50. When solder becomes impure from use, it may be restored by heating it to 800°, and adding some sulphur, the mixture being well stirred. The sulphur, combining with the oxides and wastes of the metals, comes to the surface, where it can be skimmed off. By cooling to 400°, and putting in a little tallow to remove the sulphur, and adding tin, the proper quality may be restored.

Too much lead in solder produces a cellular joint and prevents its sweating properly.

Solder may be tested by melting, when, if a great many bright spots appear floating on top, it must be considered too soft or fine, while if the spots are totally absent, it contains too much lead. Tin spots about $\frac{3}{8}$ of an inch in diameter indicate good solder.

51. Fluxes are used to aid in the fusion of solder, and to clean the surfaces of metals to be joined. Those commonly used, and the metals to which they are applied, are as follows:

Flux.	Metals to be Joined.
Rosin	Lead, tin, or tinned metals; used with blowpipe.
Tallow	Copper and iron; used with blowpipe or bit.
Sal ammoniac	Dirty zinc; used with copper bit.
Muriatic acid or Hydrochloric acid...	Clean zinc, copper, tin, or tinned metals; used with bit or blowpipe.
Chloride of zinc	Lead and tin tubes; used with copper bit or blowpipe.
Borax	Iron, steel, copper; used with blowpipe.

52. The melting points of the metals used in roofing are given in the following table:

TABLE 4.

Metal	Melting Temperature.
Tin.....	446°
Copper	2,100°
Zinc	680°
Lead	626°
Wrought iron	2,732°

The fusing point varies greatly, according to the purity of the metal, while the fusing points of alloys vary with their composition.

53. Wall Hooks and Roofing Nails.—*Wall or flashing hooks*, as shown at (a), Fig. 41, or b, Fig. 42, hold the flashing in place where it lies against the wall, or they are driven

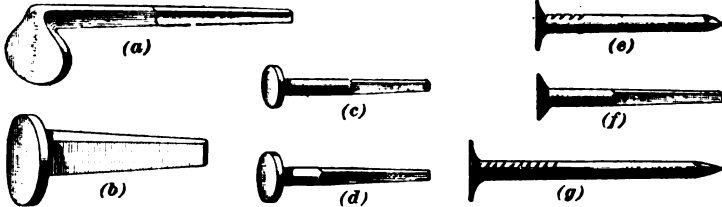


FIG. 41.

over the apron flashing to prevent it from pulling out; they are usually placed at about 16-inch centers.

Wall nails, as shown at (b), Fig. 41, are used for the same purpose, but are not so good, as only the shoulder, or under side of the head, bears against the flashing.

These wall hooks and nails should be of galvanized iron or of composition metal to prevent the corrosion of the metals they hold in place.

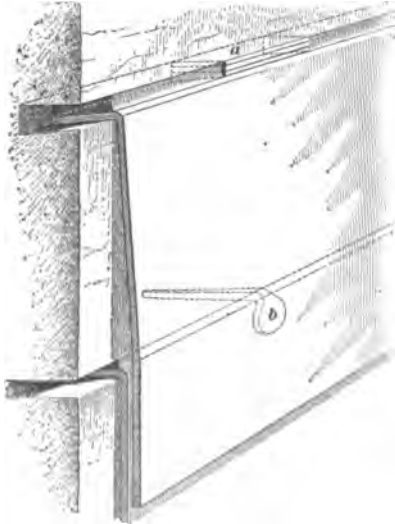


FIG. 42.

Tile, shingles, and slate are nailed to the roof with both *cut* and *wire* nails. For shingles or small slate, a cut nail (c) or (d), or a wire nail (e), Fig. 41, of a length equal to the thickness of the roof-boards should be used. These nails should be galvanized or tinned. The clean-cut steel nail, with countersunk head shown at (f), is generally used for slate.

The copper wire nail (g) is used for tiling, and the size is regulated by the kind of tile used and the thickness of the boarding. The thickness of the tile, plus the board thickness, gives the length. Cut

and wire steel nails, galvanized or tinned, are also used for tiles.

For composition roofing, the clout nail (*c*) and (*d*), Fig. 41, should be used, with or without a tin collar. Composite nails are preferable for all kinds of roofs where nails are used. The best are made of 7 parts copper and 4 parts zinc. By their use the dangers of corrosion and galvanic action are avoided or reduced to a minimum.

Where flashings are placed in a raglet in stonework, they are held by wood or lead plugs or bats; lead is preferred, as it permits more driving. These bats (see *a*, Fig. 42) are made up of pieces of lead $1\frac{1}{4}$ inches long by $\frac{3}{4}$ inch wide, until a thickness suitable to the joint is formed. They are placed at 12-inch centers, and are driven in and calked in place.

LAYING TIN ROOFS.

54. The methods for laying tin roofs vary. The *flat* seam, secured with either nails or cleats, is used on flat-pitched roofs; the *standing* seam is used on steep-pitched roofs, and occasionally on flat parts of such roofs, known as *decks*.

Of the first two methods of laying a tin roof, the one in which the seam is secured with cleats is to be preferred, the objection to the other being that the nails make holes in the tin, and as the tin expands or contracts, the holes become larger and the nails work loose.

55. Boarding for the roof should be matched and of even thickness, so that the surface shall be smooth and free from all rough spots or ridges; if possible, the boards should run lengthwise with the current or pitch, that is, the direction in which the water will flow when the roof is completed.

56. *Felt paper* under tin is of much advantage, and should be used. It prolongs the life of the tin; excludes any injurious vapors, gases, or fumes, which might reach the

tin from the rooms below; protects the tin from any injurious substances in the roof boards; and prevents "sweating."

57. The preparation of the sheets for laying, which should be carried out at the tinner's, consists of edging, that is, turning the edges of the sheets to form the seam. The upper and right-hand edges are turned up; the lower and left-hand edges are turned down.

In laying a tin roof, a start should be made at the lower left-hand corner of the roof, the course of which should lock

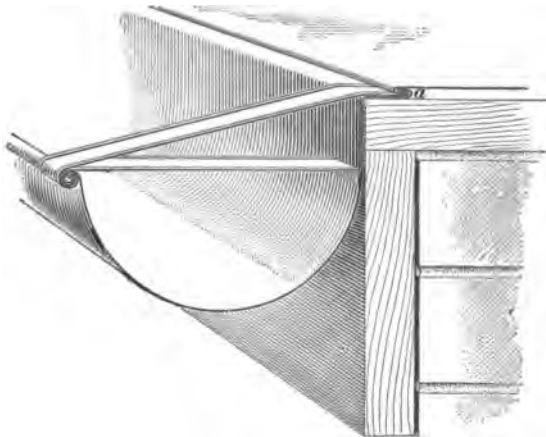


FIG. 43.

into the gutter seam *a*, as shown in Fig. 43, or into an eaves flashing. If the gutter is supported by straps, these should also be locked into the same seam.

In Fig. 44 is shown the flat seam roof secured with nails, which are put in as each sheet is laid. These nails should not be spaced further apart than 6 or 7 inches, and should be so placed that the nails of the last sheet will not come over those of the preceding ones.

In a 10" × 14" sheet there will be three nails, as shown at *a*, Fig. 44; while, by reason of the lock seams, the sheet will be further secured by the adjoining sheets and the nails in them. A sheet 14 in. × 20 in. will have five nails, and

one 20 in. \times 28 in., six nails. In exposed locations the number of nails should be increased, so that a firm and rigid surface can be obtained.

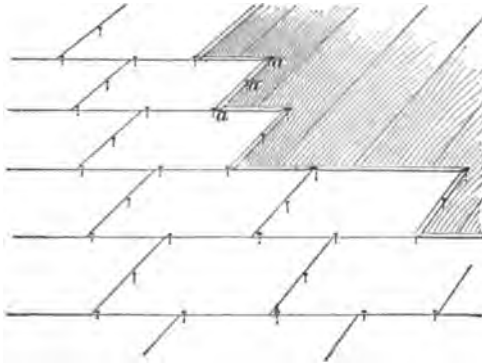


FIG. 44.

As shown at *a*, Fig. 45, the nails are covered by the overlapping edges of the next sheet, and also by the course above. After the tin has been nailed to the roof, the next process is to mallet down the seams; the quality of the roof to a great extent depending on the skill with which this operation is performed. Care should be taken not to break the seams, and to lay them evenly. The horizontal seams make the straight lines, while the other seams break joint, as shown in Fig. 44.

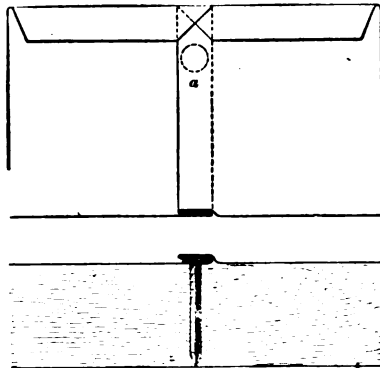


FIG. 45.

58. Flashings for skylight curbs, bulkheads, etc. are shown in Fig. 46; those for fire and gable walls, with apron or counterflashings, are indicated in Fig. 47.

The curb flashing (see *a*, Fig. 46) is nailed on top of the

curb *c* at *b*, is turned down against it to the roof, then carried over the fillet *d* out on the roof and seamed and locked to the roof tin at the joint *e*.

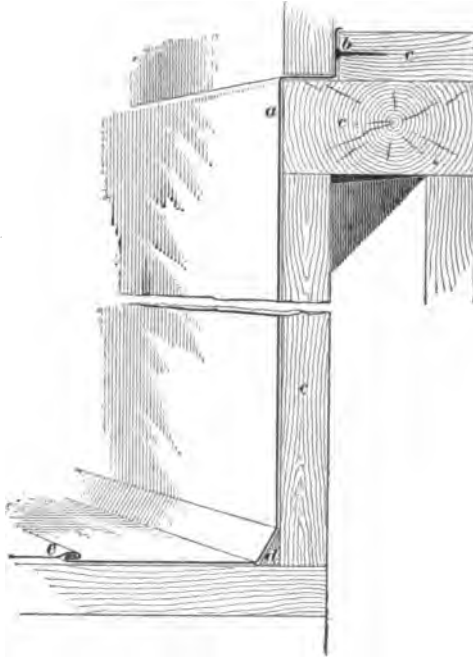


FIG. 46.

The wall flashing is placed in a raked-out joint *a*, Fig. 47, is secured with flashing hooks, turned down and over the fillet *b* to meet the roof tin *c*, and the two are seamed together. The apron flashing *d* is placed in the joint *e* and nailed with flashing hooks; it laps over the wall flashing about 4 inches. The joints *a* and *e* should be pointed with mastic or elastic cement.

59. The next process is soldering the seams. For joining tin, the solder should be composed of one-half tin and one-half lead. This solder is known and branded as *half-and-half*. After the seams have been resined, the solder is

applied by a flat-bottomed copper of sufficient size to melt the solder and keep it flowing. A small copper should not be used, because it does not hold heat well and produces, in consequence, an uneven seam without soaking the solder back into the crevices. Resin should be used as a flux for soldering tin; acid must not be used, for while it does as well for soldering as resin, it is likely to be driven into the seams and attack the metal.

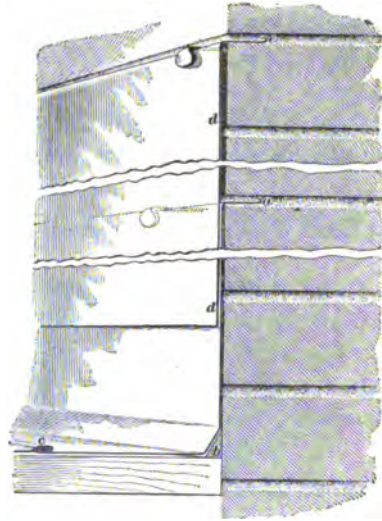


FIG. 47.

60. Fig. 48 illustrates the method of laying the tin with cleats. There are two nail holes made through the sheets, and the manner of fastening the cleat to the roof is such as

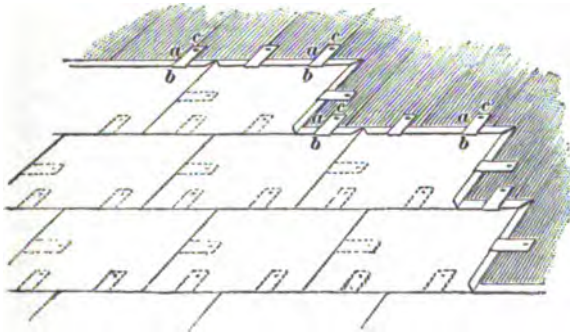


FIG. 48.

to permit all necessary contraction and expansion, without injury to the roofing material.

The cleat *a* consists of a simple strip of tin, from 2 to 3 inches in length, and from 1 to $1\frac{1}{2}$ inches in width. One end *b* is bent to the same shape as the corresponding edge

of the plate locking into it. The overlapping edge of the upper sheet covers the cleat. The nail is driven near the opposite end of the cleat, as shown at *c*, but so far removed as to have no effect on the expansion and contraction of the sheets. In consequence, no strain is produced on the seams. The strips, it may be noticed, are nailed to the board direct, and the next sheets cover them.

61. A **standing seam** is shown in Fig. 49. The sheets

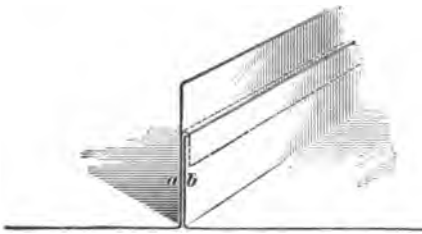


FIG. 49.

are bent up at the edges, which is done at the shop, the left-hand edge *a* about $1\frac{3}{8}$ inches, and the right-hand edge *b* about 1 inch. Between the sheets a cleat *a* (see Fig. 50) is nailed before the next sheet on the

right is placed. The cleat is 2 inches wide and its height is equal to the height of the left-hand standing edge of the sheet of roofing. Cleats should be spaced near together for steep roofs; for decks the spacing is usually the same as in flat roofs, or about 16 inches apart. There should be at least one cleat to each sheet of tin. The horizontal seams, as shown at *b*, are always flat like the flat-seam roof.

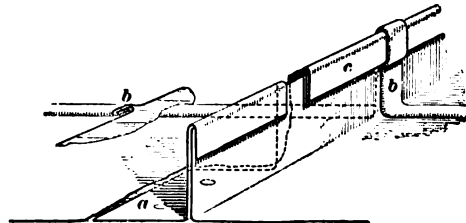


FIG. 50.

These seams may be either single lock, as at (*a*), or double

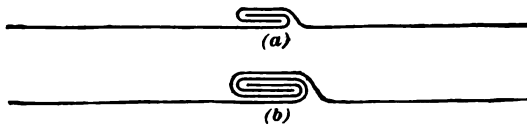


FIG. 51.

lock, as at (*b*) in Fig. 51. After the metal covering has been put on, the part of the left-hand sheet projecting above the right (see Fig. 49) in the vertical seams, is turned over and down with a seamer, as at *c*, Fig. 50.

62. *Nails* for tin roofs of all styles should have a length slightly less than the sum of the thicknesses of the roof boards, the felt and the tin, in order that they may not protrude below the lower surface of the sheathing.

The nails commonly used are similar to slaters' nails. They are thick, some having a slight bulge in the center, and are strong enough to drive through the thickest tin. Neither iron nor tin-coated, but zinc or galvanized nails should be used. The zinc produces a rough surface, tending to prevent the nails from drawing out.

63. For the sake of economy, sheets of 14 in. \times 20 in. or 20 in. \times 28 in. are generally used for roofing purposes.

Measurements in roofing are based on the square of 100 superficial feet; hips, valleys, and flashings are measured by the lineal foot, as are also gutters, down spouts, leaders, or conductors.

One sheet of tin 14 in. \times 20 in. covers $235\frac{3}{8}$ square inches, or 1 foot $7\frac{1}{2}$ inches, of standing-seam roof. A box of 112 sheets covers 182 feet 14 inches of roof, allowing 1 inch and $1\frac{1}{4}$ inches for the two side seams, and $\frac{1}{4}$ and $\frac{1}{2}$ inch for top and bottom seams, respectively. In these calculations, no allowance is made for waste of any kind. One sheet of 14 in. \times 20 in. covers 255 square inches, or 1 foot $9\frac{1}{4}$ inches of flat-lock roofing, and a box of 112 sheets, allowing $\frac{3}{8}$ inch all round for joints, covers 198 feet 3 inches.

64. The following table gives the size, grade, etc. of tin plate in general use:

TABLE 5.

Size. Inches.	Grade.	Sheets in Box.	Lb. in Box.	Gauge.
14×20	IC	112	113	29
14×20	IX	112	143	27
14×20	IXX	112	162	26
14×20	IXXX	112	182	25
14×20	IXXXX	112	202	24
20×28	IC	112	224	29
20×28	IX	112	280	27
20×28	IXX	112	322	26

TERNE PLATE.

14×20	IC	112	112	29
14×20	IX	112	140	27
20×28	IC	112	224	29
20×28	IX	112	280	27

65. The following table shows the length and diameter of leader pipes made from stock sizes of tin, and the length of pipe that may be made from 1 box of tin:

TABLE 6.

SHEETS.				BOXES.	
Diameter of Pipe in Inches.	Number of Sheets.	Size of Sheets in Inches.	Length of Pipe in Feet and Inches.	Number Sheets in Box.	Length of Pipe in Feet.
$6\frac{1}{8}$	1	14×20	1' $11\frac{1}{2}$ "	112	126
$4\frac{1}{2}$	1	14×20	1' $7\frac{1}{2}$ "	112	181
4	2	14×20	3' 3"	112	182
$3\frac{1}{8}$	1	14×20	2' 3"	112	252
$2\frac{1}{8}$	1	14×20	3' $4\frac{1}{2}$ "	112	378

If, for example, the leader pipe is to be 4 inches in diameter, and the circumference $12\frac{1}{2}$ inches, it is plain that only one length can be had out of the 14 in. \times 20 in. Allowing $\frac{1}{4}$ -inch lap for each joint at top and bottom, and using two sheets for a length of pipe, we have $20 \text{ in.} \times 2 - 1 \text{ in.} = 39$ inches, or 3 feet 3 inches; and $39 \text{ in.} \times 56$, half the number of sheets in a box, gives 182 feet, the length of leader sections that may be constructed from 1 box.

66. The following table gives length of semicircular eaves gutters that may be made from 1 box of tin:

TABLE 7.
SEMICIRCULAR EAVES GUTTERS.

SHEETS.				BOXES.	
Girth. Inches.	Number of Sheets.	Size of Sheets. Inches.	Length of Gutter in Feet and Inches.	Number Sheets in Box.	Length of Gutter. Feet.
19	1	14 \times 20	1' $11\frac{1}{2}$ "	112	126
13	1	14 \times 20	1' $7\frac{1}{2}$ "	112	182

SHEET-METAL SHINGLES.

67. Metal shingles take the place of tile, wooden shingles, slate, and other roof coverings. On a pitch of over 30° they make a light and effective roof. They are made of tin, zinc, galvanized iron, copper, bronze, and composition metal, and are manufactured in a variety of shapes and designs. They usually come in single pieces, each forming one shingle, but many makers also furnish a sheet with four shingles stamped on it. Metal shingles are, as a rule, named from their form of outline, and are designated as *Gothic, diamond, hexagonal, etc.*

68. **Laying Metal Shingles.**—Generally these shingles

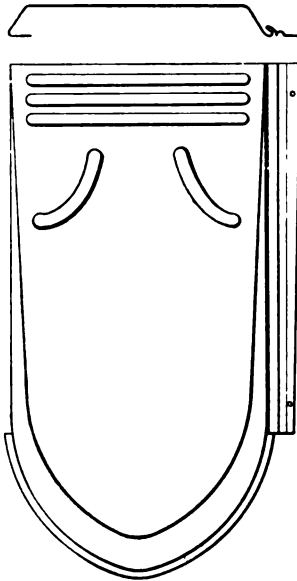


FIG. 52.

are laid from the eaves up to the ridge. There is, however, a method of laying the shingles from the ridge downwards. In laying shingles of the Gothic pattern (one of which is shown in Fig. 52), the gutter and eaves flashing should be set as shown at *a*, Fig. 53, the flashings being carried up about 6 or 8 inches on the roof boards. A start should be made at the lower left-hand corner, care being taken that the start is made straight with the eaves. The shingle point should be set back 2 or more inches, and nailed through the flange *b*. As each row is laid, the gable end flashings *c* should be attached as shown.

The ridge is finished as shown at *a*, Fig. 54, and is put in

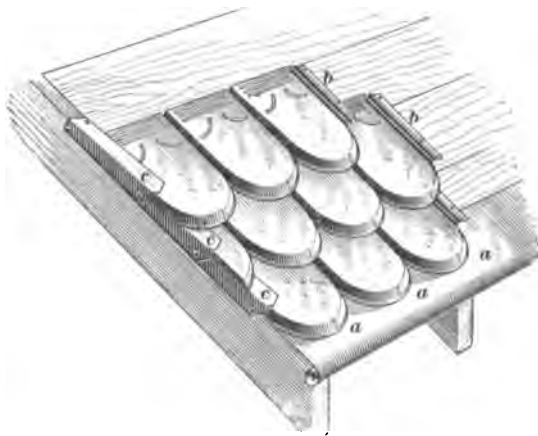


FIG. 53.

place before the last tier of shingles is laid. In the case of

a whole shingle not working and fitting into the grooves *b* of the ridge, it should be cut to the proper length.

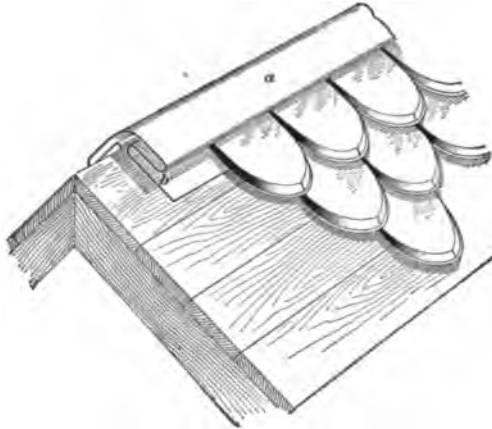


FIG. 54.

69. Flashings.—*Hips* are finished as shown at *a*, Fig. 55. The edges of the shingles should be cut to the proper angle and fitted into the groove *b* of the hip flashing.

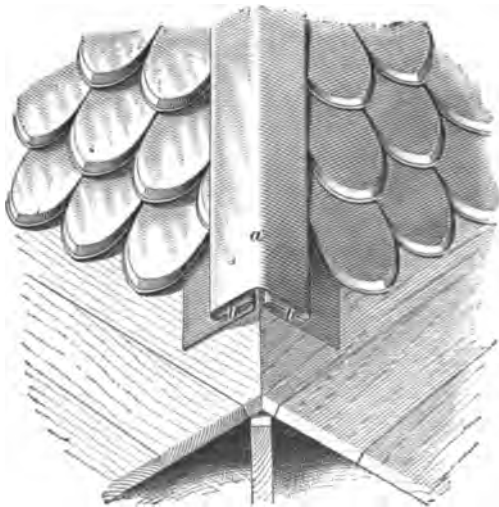


FIG. 55.

Valley flashings, as at *a*, Fig. 56, should be made with a lock or fillet *b* at the edges of the gutter portion.

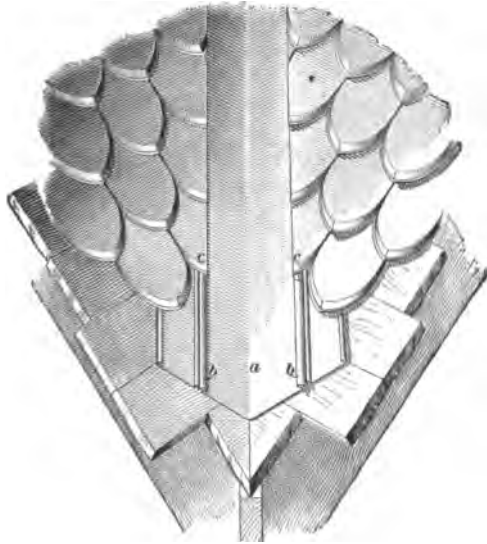


FIG. 56.

The edges of the shingles should be trimmed to the proper angle and turned over with a pair of hand tongs. The edges of the shingles should be made to clasp the edges of the valley fillet.

The chimneys and wall junctions are flashed as indicated in Fig. 57. The brick joints, as at *a*, are raked out, and a flashing of tin, of the shape shown at *b*, is formed with a groove into which the shingles are pushed. The flashing, having been inserted into the joint *a*, is secured to the wall with flashing hooks *d, d*, and the joint is carefully repointed with elastic cement.

Dormers and skylights may be flashed as shown in Fig. 58. The flashing *a* is turned up against the sheathing boards *b* and under the clapboards *c*, or other vertical side covering; the edges of the shingles are then carried up and fitted into the grooves.

The gable cap and flashing used with square-tailed

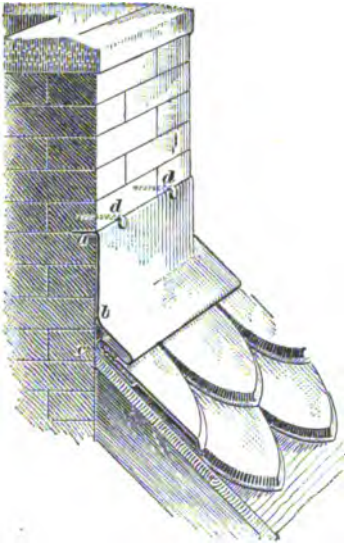


FIG. 57.

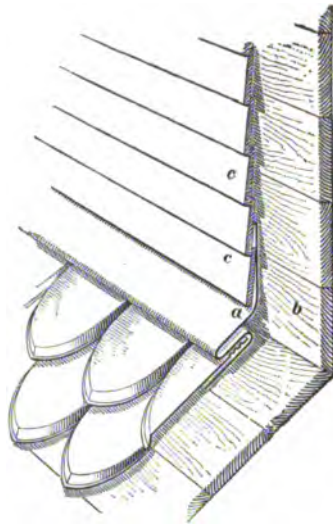


FIG. 58.

shingles are indicated in Fig. 59. The molding *a* caps the start of all the rows of shingles and laps over the barge board *b* to which it is nailed.

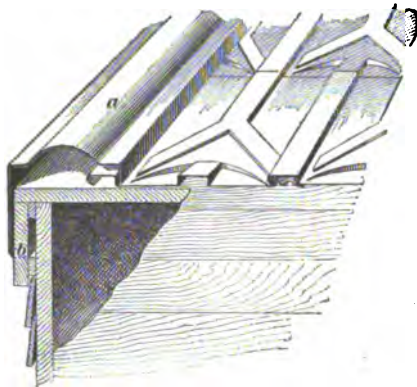


FIG. 59.

70. Diamond-shaped shingles, as shown in the views (*a*), (*b*), and (*c*), Fig. 60, are laid in the same general manner

as the Gothic, with the exception that the start may be made from either the right or left hand, as the case may require. The fillet *a* on the two upper flanges becomes a water-tight

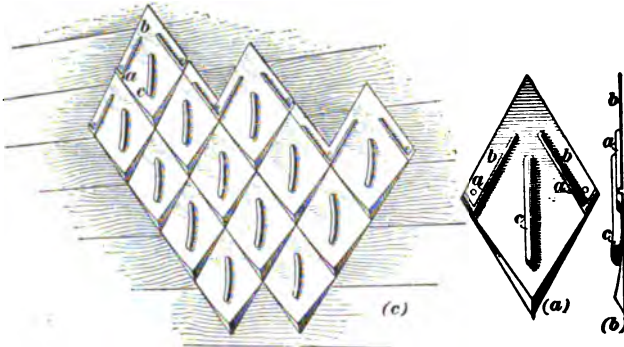


FIG. 60.

joint. The shingle is nailed through the lower edge of the flange *b* on each side. The central longitudinal rib *c* imparts rigidity and adds to the effect.

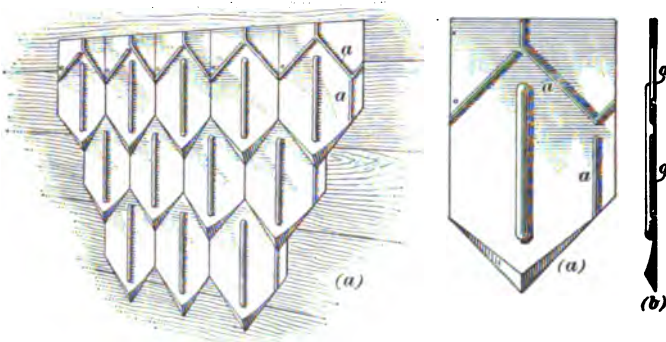


FIG. 61.

Hexagonal shingles, Fig. 61, are of the same construction as the diamond, save for the right-hand flange *a*, which is extended. The additional fillet necessitates the laying of these shingles from the left to the right.

71. The method of laying tile shingles, from the ridge to the eaves, is shown in Fig. 62. The ridge cap is the same

as that used in the other methods. The lower flanges *a* of the shingles are made with a groove *b* into which the next

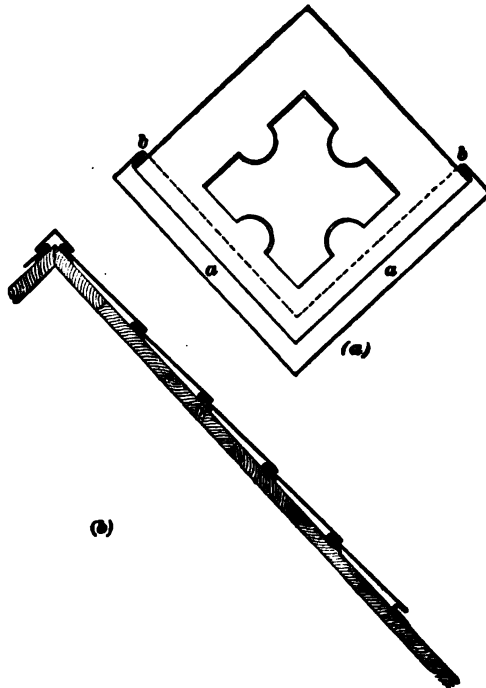


FIG. 62.

course fits. The chief advantage of these shingles is that all scaffolding is removed as the roof is laid, and all difficulty in making a tight joint at the point of support for the scaffold is obviated.

COPPER ROOFING.

PROPERTIES OF COPPER.

72. Copper is distinguished from all other metals by its peculiar red color. Its resistance to corrosion when exposed to the atmosphere, combined with its lightness, gives it great value as a roof covering. Copper is very malleable

and ductile, and also tenacious; it is found in most countries, the principal mines being those on the shores of Lake Superior, in the United States of America, and at Corocoro, Bolivia, South America.

73. Sheet Copper.—Copper is obtained from its ore by the following process: First, the ore is roasted or calcined; after the roasting, it is melted in a reverberatory furnace, whence it issues in the state called *coarse metal*; this metal is then stamped and pulverized, passed through a furnace, and afterwards melted; the resulting pure metal is roasted and then refined. The copper is then cast into ingots and afterwards rolled into sheets, which are cut to market sizes, varying from 24 in. \times 48 in. to 48 in. \times 72 in., and are supplied in two forms, soft or annealed, and hard or cold rolled. Both varieties may be tin plated or "tinned," when desired.

74. Tests.—The qualities determining the suitability of the sheets for roofing are ductility and strength, and uniformity of gauge or thickness. The sheets must stand bending with and across the fiber, without yielding even to repeated attempts at splitting and breaking. The gauge, which varies from 1 to 30, must be as represented, and tested with a wire gauge, and the sheet must be of the full weight, corresponding to the gauge, which, in common use, ranges from 10 to 20 ounces per square foot. When a piece is broken off, the fiber should present a bright, lustrous, and silky appearance, if the copper is of the best grade. The metal should also bear stamping into form without developing fractures.

LAYING COPPER ROOFS.

75. The methods employed in laying copper roofs are usually the same as those required for tin roofing, though the flat roof laid with a lap seam is not to be commended. It is weak, and, being soldered and nailed, will not permit sufficient expansion and contraction. Where solder is used, the lock seam with cleats is best. The edges of the sheets

and all surfaces with which they come in contact should, before the seaming and folding are done, be thoroughly cleaned with chloride of zinc. When the sheets are in place, mallet them down to the roof. In case the metal is tinned on one side, the folds should be turned so that the tinned surfaces shall face each other. Tinning is resorted to so that the solder may flow or sweat more freely than it will on the copper. The solder used for copper roofs is the same as for tin roofing, but with a flux of sal ammoniac.

The standing seam method of laying should be employed where extra strength and stiffness are required, on very steep-pitched roofs, and on flat surfaces where work without solder is to be carried out.

76. Roll-joint copper roofing is laid in two different ways. In the one the roll is hollow and is secured to the roof by clips or tingles; in the other a solid roll is used, set with a trough or nailed directly to the roof. Fig. 63 shows the hollow roll. The clips or tingles *a, a* are nailed to the roof before each sheet is laid; against the clips or tingles the edges of the sheets *b* are turned, and the left-hand sheet is bent over to form the lock *c*. This joint or lock is seamed and then turned over in a roll, as indicated by the dotted lines and the completed roll *d*.

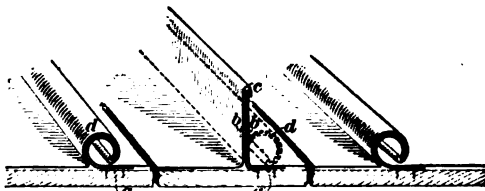


FIG. 63.

77. The trough method is illustrated by Fig. 64. The

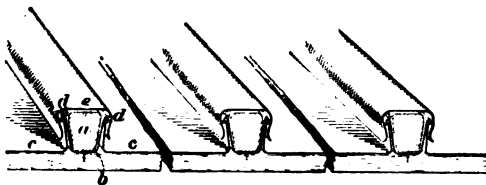


FIG. 64.

wood rolls *a* are $1\frac{1}{2}$ in. \times 2 in. The trough *b* made of copper, in which the rolls are set, is nailed to the roof boards; the sheets

c are then bent up to the top of the trough and the edges *d* of the trough are locked or turned down over them. The cap *e* is made as indicated, and is sprung tightly over the roll. The other solid roll, shown in Fig. 65, has the roofing plate *a* bent up and over it, the upper sheet being the last

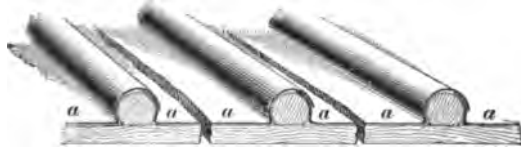


FIG. 65.

put in place between the rolls as the covering is laid. This, under ordinary circumstances, makes a good roof.

78. To save time and labor, flashings or other vertical jointed work should be soldered, when required, before being taken on the roof. When the sheets are in place, the solder will not flow into the vertical joints; but on the ground, the seams may be laid flat and the solder will readily soak in.

Connections between the flashings of the walls, chimneys, etc. and the gutters should be double locked, and to permit free movement, they should be unsoldered.

79. The gauge, thickness, and weight per superficial foot of copper used for roofing purposes, are given in the following table:

TABLE 8.

Gauge Number.	Thickness in Decimal Parts of an Inch.	Weight. Ounces per Square Foot.
29	.0134	10
27	.0161	12
26	.0188	14
24	.0215	16
23	.0242	18
22	.0269	20

COPPER TILES.

80. Copper roofing tiles are made in imitation of most of the different forms of terra-cotta tiles. They are extensively used, principally on account of their cheapness and lightness. Like all other tiles, they are generally laid by beginning at the eaves and continuing to the ridge. Great care must be taken in laying the first course, called *starters*. On this depends the appearance of the entire roof, for if the starters be out of line horizontally, the finishers at the ridge show the same defect; and should there be intercepting roofs, the defect will show at the valleys as well.

81. The most popular form used is the imitation of the Spanish clay tile, as shown in Fig. 66. This pattern is inter-

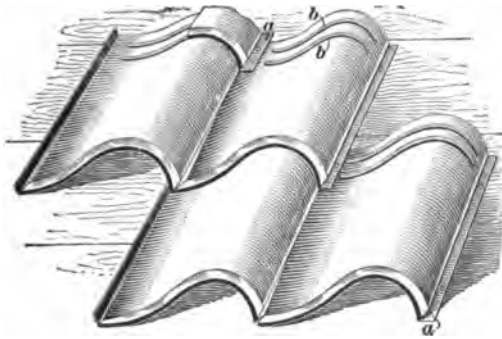


FIG. 66.

locking, and is secured to the roof with nails driven through the right-hand flange *a*. The fillet collar *b* near the upper end forms the horizontal joint with the tile above, and the sides connect with a vertical side lock, as shown at *a*, Fig. 67, rendering them water-tight. At *b*, Fig. 67, is the flange, which is nailed to the roof.



FIG. 67.

82. *Ridges and hips* are made in different forms to go with the tiles; the most common one is shown at *a*, Fig. 68.

On the hips the tiles must be cut to the proper angle and fitted to the hip strip *b*, the roll being placed over them and nailed through its flanges.

The valley tile must be cut in the same way, the open ends of the tile being closed with pieces cut to the shape of the tile and soldered in. Where these tiles are used, the valley flashing should never be less than 20 inches wide, and in nailing the tile over it, the nails must be well driven.

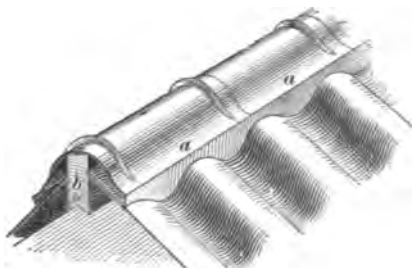


FIG. 68.

In nailing the gutter tile in place, care must be taken not to drive the nails into the gutter, under the side lock, as it would cause the roof to leak.

Flashings should be constructed in the manner shown under the head "Tin Roofing," and of 14 or 16 ounce metal. All valleys and gutters should be 16 or 18 ounce metal.

83. Conical-tower roofs may be covered with two kinds of special tile, graduated to correspond to the pitch; of these, one is made flat and the other round, as shown at (*a*) and (*b*), Fig. 69.

The roof is prepared for these tiles by attaching wedge-shaped strips, as *a*, Fig. 70, to the sheathing, the edges of the flat portion of the tile being nailed to the strips

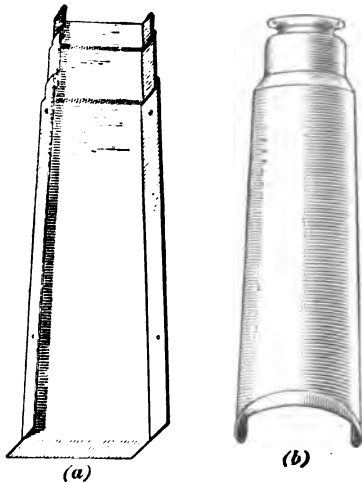


FIG. 69.

as shown at *b*. The round tiles are placed over the strips, lapping the upturned edges of the flat tiles. They are nailed through the strips at the upper end *c*, and the lower, or butt, end *d* nailed into the end of the strip.

84. For straight surfaces the following sizes of tiles are used: 7 in. \times 10 in., 10 in. \times 14 in., and 14 in. \times 20 in. The last is better adapted to large roofs, but for ordinary roofs 10 in. \times 14 in. is the size recommended. These tiles may be made of 12, 14, or 16 ounce copper.

A square will require four hundred 7 in. \times 10 in. tiles; one hundred and seventy-four 10 in. \times 14 in. tiles; or seventy-two 14 in. \times 20 in. tiles.

These quantities allow for laps, waste, cutting, etc.

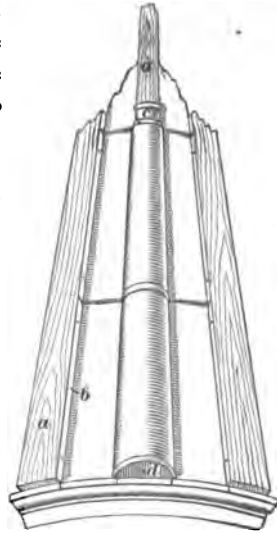


FIG. 70.

GALVANIZED SHEET-IRON ROOFING.

85. Galvanized iron is iron coated with zinc, the object being to protect its surface from the rapid oxidation taking place when it is exposed to atmospheric influences. The zinc coating is applied to the plates while they are heated, the plates being previously prepared by cleaning and dipping in various chemical solutions, as sulphuric acid, and the salts of chloride of zinc, or sal ammoniac. The coating should be of uniform thickness and should cover the entire surface.

86. To test the quality of galvanized iron, make a double seam and mallet it down close; if it shows no fracture the iron is of a good quality. A more severe test is to again flatten out the joint or seam so made, without the material showing fracture. Samples may be tested for thickness of coating by greasing them and holding them

over a gas jet with a pair of pliers; the amount of fusible metal flowing off will determine the character of each sample.

87. The ordinary sheets in use are from No. 16 to No. 28 gauge, and vary in weight from No. 16 at 3 pounds per square foot down to No. 28 at $\frac{3}{4}$ pound per square foot.

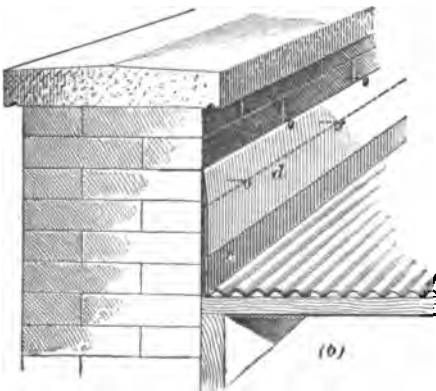
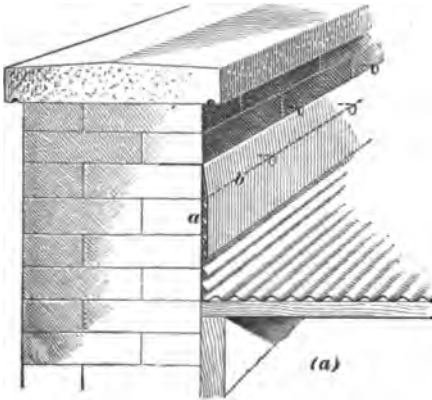


FIG. 71.

with an apron flashing *b*, secured as shown at (*a*), Fig. 71; otherwise, first lay a flashing *c* and carry the roofing over it and counterflash as shown in (*b*), Fig. 71.

89. Ridges should be finished by a ridge roll or cap, as shown in Fig. 72 (*a*), having an apron or wing *b* corrugated

88. *Corrugated* sheets may be placed on boards or applied direct to the rafters; flat sheets may be laid on boards, divided by wood rolls into panels. In either case, felt or paper should be placed under galvanized-iron roofing, to prevent sweating. The sheets should have a lap of at least 4 inches on the roof boards. Where the sheets abut against a fire wall, an edge *a* should be turned up about 6 inches, secured to the wall with wall hooks, and covered

to suit the corrugations of the sheets, or, as indicated at (*b*), Fig. 72, a ridge board *c* having its lower face corrugated to match the sheets, may be attached to the roof and then covered with a plain cap *d*.

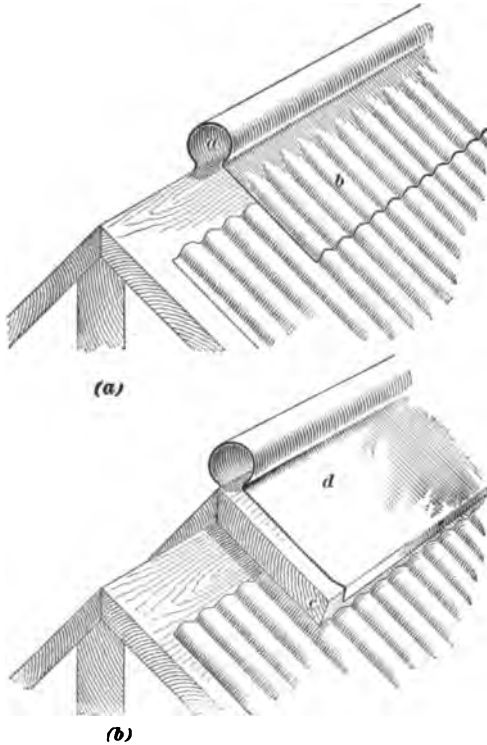


FIG. 72.

Hips should be finished as shown in Fig. 73, by cutting the iron sheet *c* to connect with the hip strip *b* and then covering the joint with a hip cap *a*.

Valleys should be formed of plain sheets of galvanized iron, from 18 to 24 inches wide, the ends being lapped at least 6 inches. Corrugated iron is cut to the proper angle and fitted over the valley, the sheets lapping for a distance of 6 inches over the edges. In fitting around chimneys, bulkheads, etc., the sheets on the lower side *a* and flanks *b*,

Fig. 74, should abut against the chimney; a flashing should be turned up against the chimney 5 or 6 inches, as at *c*, and counterflashed, as at *d*. The tops of the two flashings are secured with wall hooks.

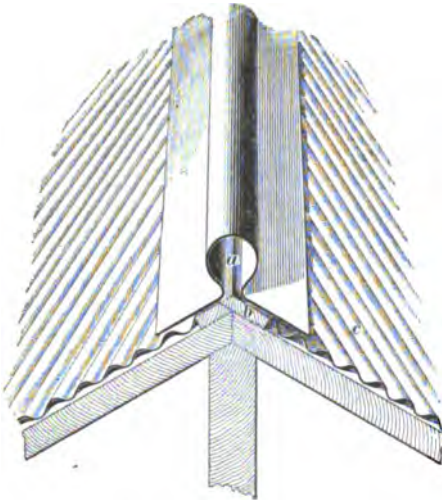


FIG. 73.

90. When used for siding, the sheets should have a lap of at least 1 inch at the ends and one corrugation at the edges of the sheets. The edge laps should be nailed every 6 inches, and the end laps in every other

corrugation. If the metal is put on studding, the studs should be spaced to suit the width of the sheet used. If the height

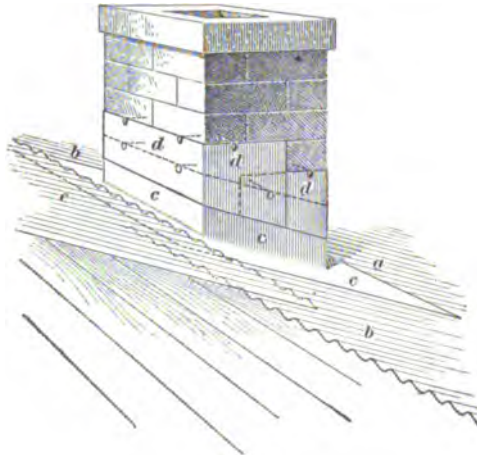


FIG. 74.

is greater than one sheet, a piece of studding should be put in horizontally, at the proper height, to take the end laps.

If applied to rafters without boards, the rafter must be spaced to suit the width of the sheets, and a piece of studding must be put in between each rafter where the sheets join at top and bottom, and also midway between, to prevent sagging.

Another method is to set the rafters to suit the width of the sheet and cover them with strong slats, bringing up the rafter edge with a piece of the same material.

91. In preparing the material for flat sheets laid with wood rolls, the sheets are riveted together, end to end, making a continuous sheet from eave to ridge; or each sheet may be laid with a lock seam, as described for copper roofs. The rivets should not be more than 1 inch apart.

The eaves gutter, or flashing, must be attached to the roof before laying the roof proper, and must lap the roof boards not less than 4 inches.

The wood rolls or strips *a* in Fig. 75 are attached to the

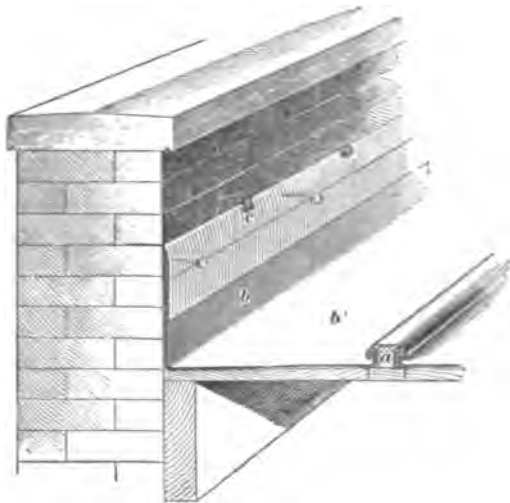


FIG. 75.

sheathing, and spaced to suit the width of the sheets. Against a fire or parapet wall, a sheet *b* will be required,

which will be counterflashed as at *c*. Clips 2 inches wide by 5 inches long should be attached to the edges of the rolls. The method of securing the sheets by the clips and rolls is shown in Fig. 76, in which *a* is the clip; *b*, the sheet; *c*, the

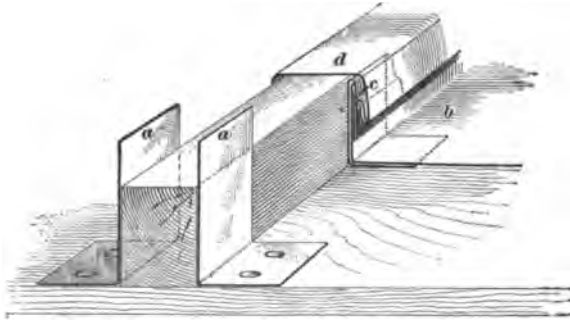


FIG. 76.

lock; and *d*, the cap roll. The cap roll is slipped over the wood roll, the edges of the roll passing over the throating formed by the ends of the clips *a, a*, which thus hold it in place. The horizontal end joints are made with a single lock and are secured to the roof by clips, in the same manner as in the roofing.

92. The following table gives the amount of galvanized corrugated sheet iron required to lay one square:

TABLE 9.

Side Lap.	Corru- gation.	Length of End Lap.					
		1 in.	2 in.	3 in.	4 in.	5 in.	6 in.
One Corru- gation Lap.	$2\frac{1}{2}$ in.	110 ft.	111 ft.	112 ft.	113 ft.	114 ft.	115 ft.
One and one-half Corru- gation Lap.	$1\frac{1}{4}$ in.	110 ft.	111 ft.	112 ft.	113 ft.	114 ft.	115 ft.
	$\frac{3}{4}$ in.	105 ft.	106 ft.	107 ft.	108 ft.	109 ft.	110 ft.

The following table gives the width, depth, and number of corrugations to a sheet and the covering width, deducting lap.

TABLE 10.

Width of Corrugation. Inches.	Depth of Corrugation. Inches.	Number of Corrugations to Sheet.	Width of Sheet after Corrugation. Inches.	Covering Width after Lapping One Corrugation. Inches.
2½	½ to ⅝	10	26	24
1½	⅝ to ¾	19½	26	24
¾	¾	34½	26	25

The following table gives the gauge, thickness, and weight, in pounds per square foot, of galvanized sheet iron:

TABLE 11.

Gauge Number.	Thickness. Inch.	Weight. Pounds Per Square Foot.
16	.065	3.00
17	.058	2.69
18	.049	2.31
19	.042	2.07
20	.035	1.75
21	.032	1.50
22	.028	1.32
23	.025	1.19
24	.022	1.06
25	.020	1.00
26	.018	0.96
27	.016	0.88
28	.014	0.75

BLACK SHEET-IRON ROOFING.

93. Black sheet iron for roofing is furnished cold rolled and annealed, in gauges ranging from 16 to 26 and in weight from ¾ pound to 2½ pounds per square foot. Anything lighter

than gauge 26 is not recommended. The sizes of the sheets vary from 24 in. \times 72 in. for the lighter gauges to 30 in. \times 84 in. for the heavier weight. The sheets should be free from flaws or holes, and uniform in thickness and ductility.

Paper and felt are not, as a rule, used under iron, but their use, it should be observed, tends to make the roof more enduring, protecting it from gases underneath and from sweating.

94. Sheet iron is usually laid with some form of standing seam, with or without a cap, on the interlocking pattern, with the same kind of joint as in the case of metal tiles or shingles.

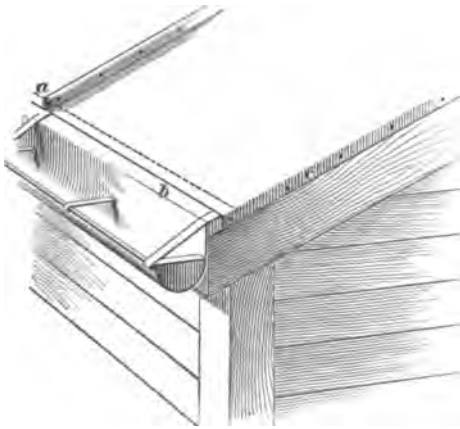


FIG. 77.

Standing seam roofing with cap is prepared by locking and seaming the sheets together, end to end, thus forming a continuous sheet the full length of

the slope of the roof. The edges are then turned up or flanged 1 inch high (see *a*, Fig. 77). The flange *b* of the eaves gutter should lap on the roof 4 inches. The outside edge *c* is bent down over the gable facia at least 1 inch, and nailed. The standing seams are secured with cleats *a*, Fig. 78; these are made of metal 2

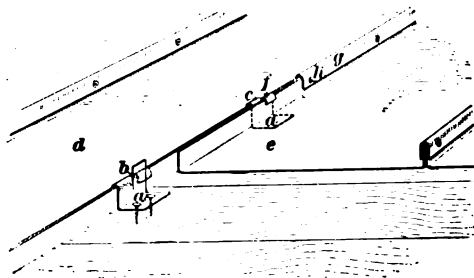


FIG. 78.

inches wide, having a bearing on the roof of 2 in. \times 1 $\frac{1}{2}$ in. The upstanding part of the cleats is cut down the middle, as at *b*, 1 $\frac{3}{8}$ inches, and one section *c* of the divided cleat is bent over the flange of the sheet *d* first laid. The sheets of the second row *c* are then flanged and placed against the clip *a*, whose other half *b* is turned over this flange.

The flanges are then gone over, clamped or seamed up close and tight, and the cap *g* is put on. This cap should be clamped securely in place. Holes *h* are then punched through the cap and flanges about 15 or 16 inches apart, and $\frac{1}{2}$ -inch rivets are used to bind the parts together. A washer should be placed on each end of the rivet, and the head should be formed with a rivet set.

Hips, in this style of roofing, are made by cutting the sheets to the proper angles, but making an allowance of 2 inches, then turning or flanging this 2-inch section, and capping it in the same way as the other joints.

Valleys are formed of full-width sheets, 24 inches broad. A $\frac{1}{2}$ -inch single lock is formed on the sheets on each edge of the valley, which should be secured to the roof with clips to fit the lock, as in flat seam tin roofing. A flat lock is then formed on the roofing sheet, and both are locked together and seamed down.

Flashings are constructed in the same manner as for the metal roofs already described.

95. *Double-seamed* roofing, shown in Fig. 79, has another form of standing seam. This roofing is put up in rolls, the same as capped roofing, and the sheets are joined end to end by a single lock seam. It may be at once seen that with this roofing no caps or fastenings of any kind are used, except the cleats *a*, which are nailed to the roof at the same centers as for cap roofing. The sheets are turned up 1 $\frac{1}{4}$ inches on one side *c*, and 1 $\frac{1}{2}$ inches on the side *b*. The 1 $\frac{1}{2}$ -inch side is turned over the 1 $\frac{1}{4}$ -inch side, as at *d*, and the whole seam is then turned over and down again, forming the double seam *e*, from which the roofing obtains its name. The flashings are the same as those before described. This

method guarantees an enduring and perfectly water-tight roof.

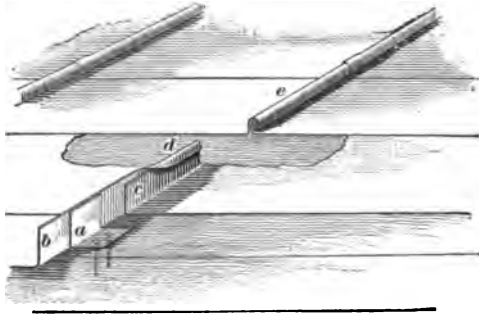


FIG. 79.

96. The *interlocking* pattern (see Fig. 80) consists of sheets with a single lock *a* at the top and bottom of the sheets, and at the sides a vertical lock *b*. The plates are attached to the roof by nailing through the side flange *c*. The chief merits of this method are that no cleats, rivets, or anchors are employed, and a great saving of time and labor

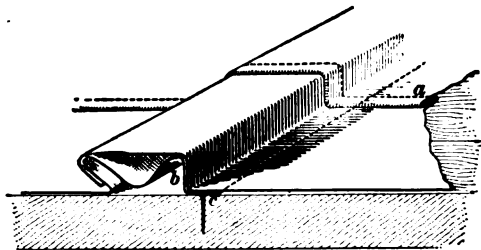


FIG. 80.

is effected. The roof appears as if laid with rolls, and the peculiar pattern of the side lock gives the roof strength and makes it very rigid and durable.

97. The following table gives the gauge, thickness, and weight, in pounds of black sheet iron per square foot:

TABLE 12.

Gauge Number.	Thickness. Inch.	Weight. Pounds per Square Foot.
16	.065	2.61
17	.058	2.33
18	.049	1.97
19	.042	1.69
20	.035	1.40
21	.032	1.28
22	.028	1.12
23	.025	1.00
24	.022	0.88
25	.020	0.80
26	.018	0.72
27	.016	0.64
28	.014	0.56

SHEET-LEAD ROOFING.

98. **Lead**, the softest metal in general use, is extremely plastic, very malleable, flexible, and heavy, but lacking in tenacity and elasticity. It is mostly found in combination with other ores, the principal mines being at Leadville, Col.; in Derbyshire, England; the Harz Mountains, Germany; and in the south of Spain.

Lead is reduced from the ore called galena, by roasting or smelting in a reverberatory furnace furnished with long flues, to catch the particles of lead precipitated by the fumes.

Sheet lead is either cast or milled. *Cast* lead is thicker and heavier than milled lead, and has a harder surface. Being, however, liable to flaws, such as sand holes, etc., and irregular in thickness, it should therefore not be used if lighter than 60 pounds per square foot.

Milled lead is rolled thin, is more uniform in thickness

than cast lead, bends easily, and when worked gives neater and better results, but cracks if much exposed to the sun.

Lead is always described by its weight per superficial foot, and not by gauge.

99. Roofs covered with lead should not have a pitch of more than 1 inch to the foot. Boarding under a sheet-lead roof must be more carefully laid than for any other metal; the boards should be narrow and matched, and run with the current or pitch. If the boards are not blind nailed in the joints, the nails should be set. The boards should also be well planed at the joints, to make a smooth surface, and, to prevent warping, should be thicker than is usual in such places. Planking $1\frac{1}{2}$ inches thick gives good results.

In sheet lead, it is best not to use sheets measuring more than 3 ft. \times 8 ft., or $3\frac{1}{2}$ ft. \times 10 ft., the expansion and contraction being in such a case liable to make the roof defective. The usual size is $2\frac{1}{2}$ ft. \times 6 ft. The sheets of lead should not be secured by nailing or by soldering, but should be left free, to allow of sufficient movement.

100. The *junctions* employed in lead roofs are called **rolls** when laid in the direction of the pitch, and **drips** when laid at right angles thereto. The rolls are from 2 to 3 inches in diameter, having the upper surface round and the lower corners left square. See Fig. 65. The edges are called overlap or overcloak, the latter being the edge of the sheet turned over the edge of the succeeding sheet and dressed down, forming the roll. *Hollow rolls* for sheet lead are constructed in the same way as for copper roofs. See Fig. 63.

The *clips* or *tingles* between the sheets of a lead roof must not be spaced more than 20 inches apart.

Nosings (see Fig. 81) are the rolls formed at the angle between the horizontal surface of the flat and the sloping sides of the roof. The flashing *a* on the sloping surface is turned up and nailed to the edges of the flat or deck plank, and over this is nailed a wood nosing *b*. The edge of the sheet of the flat is locked into and secured by clips *c*, *c* let

into a rebate in the edge of the flat; the sheets *d* are then bent over the nosing in the form of a drip. See Fig. 81.

A lock or welt is an ordinary single lock joint used instead of a roll on flats, where there is a sufficient pitch; though it takes less metal, it is not recommended.

On hips and in valleys, a lapped joint is used. This is made by lapping one sheet 5 or 6 inches over

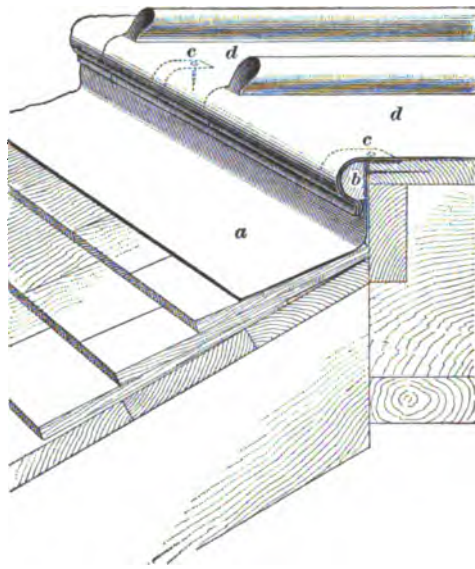


FIG. 81.

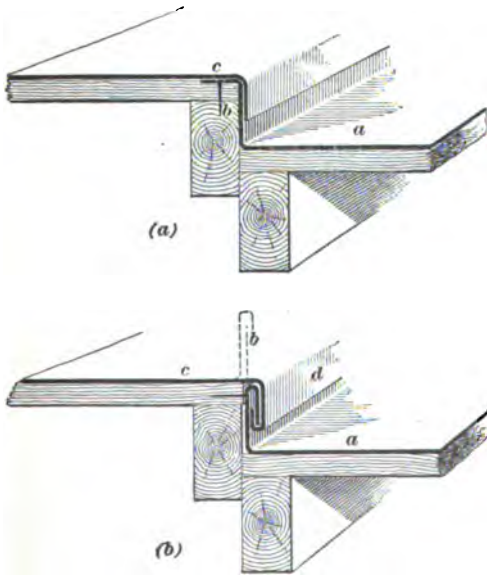


FIG. 82.

an adjacent one, dressing the edges and malleting them down flat.

Drips are joints made across the current of the roof, and are located according to the length of the sheets used. They are constructed in two ways, as shown in Fig. 82 (a) and (b). In the *first* method, the sheet on the lower level *a* is bent up and over the step *b*, let into

a rebate cut for it in the boarding of the higher level, and is nailed securely. The upper sheet *c* is lapped over it and turned down. To avoid capillary action, there should be at least $\frac{1}{4}$ inch between the edge of this sheet and the sheet on the lower level.

In the *second* method (*b*) the lower sheet *a* is bent up, $1\frac{1}{2}$ inches above the upper level, as indicated by the dotted line *b*. Sheet *c* is bent up and over the edge of the lower one; the two sheets are then folded over and downwards, forming a lock *d*, as shown.

101. In covering small angular or curved surfaces of woodwork, it is necessary to screw the lead to the woodwork, to keep it in place. This is done as shown in Fig. 83. The boarding *a* is countersunk, and the lead *b* is formed into the cavity, and screwed in place with screws *c, c*. The cavity *e* in the lead is then filled with molten solder, to protect the screw heads and render it water-tight. The lead should be made to flow under the screw heads to prevent the sheet from tearing.

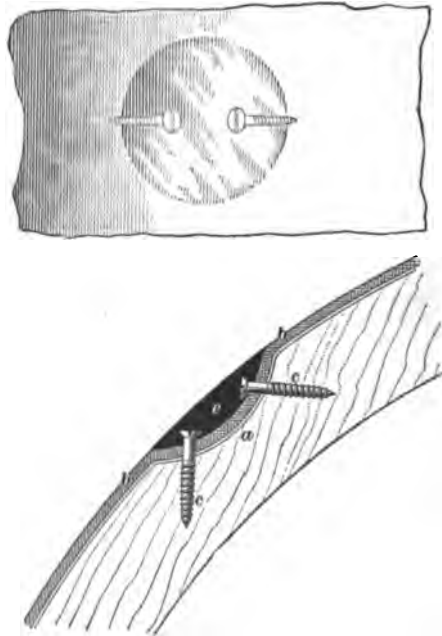


FIG. 83.

102. Lead flashings are constructed in nearly the same manner as other metal-roof flashings, the chief difference being the manner of securing the upper edge to the masonry or brickwork. As with other metal flashings, wall

hooks may be driven in the joint over the apron or counter-flashing. Plugging with lead is, however, preferable to all other methods. The plugs are about $1\frac{1}{4}$ in. \times 2 in., made to suit the joint in the masonry, or the raglet cut therein to receive the flashing. After the plugging, the joint or raglet must be pointed up with mastic or elastic cement. Burning in makes the most permanent joint. The flashing is inserted in the raglet, which is then filled with molten lead and calked in. This method is, in most cases, very difficult to execute properly, on account of the position of the joint. Unless the joint is in a very exposed location, the plugging will be sufficient.

103. *Lead gutters* should have a current or fall of at least $\frac{1}{4}$ inch to the foot, and the joints between the sheets

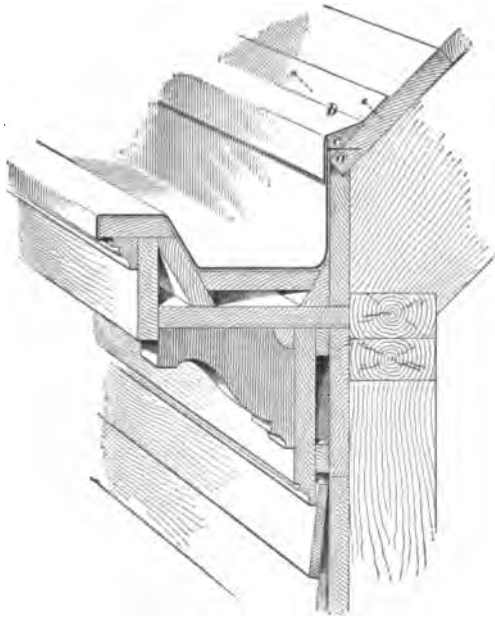


FIG. 84.

should be formed where possible with drips, the same as mentioned for flats. The sides of gutters abutting the

walls should be turned up 6 or 7 inches and counterflashed, the ends of the gutters being bossed, or folded up, and soldered.

Trough gutters should have the outside edge turned over the wood or stone crown member, and left without fastening. The inner side should be carried up at least 4 inches above the outer and over a tilting fillet on the roof, or otherwise stopped off at the board line. Where the gutter is not very wide, the counterflashing may be dispensed with, and the gutter lining, as shown in Fig. 84, may then be simply flanged over the tilting fillet and covered with a counterflashing *b* nailed over the tilting fillet *c* to the roof boards *a*. When a gutter comes against the back of a horizontal parapet wall, the wall should be pierced about 5 inches above the lowest part of the gutter, and an overflow should be provided to take off an occasional excessive fall of rain water, or an overflow caused by the leader being stopped at the eaves or drip. If the gutter is very long, there should be more than one outlet.

In working lead flashings around corners and in angles, great care should be taken to avoid sharp angles, otherwise the lead is likely to be cut.

104. The following weights of lead for the different parts of a roof are generally applicable: For flats and gutters, 6 to 8 pounds per square foot; for flashings, 5 pounds per square foot; for hips and ridges, 6 to 7 pounds per square foot.

Where the roofs are very much exposed, or where temperatures are extreme, heavier lead should be used.

105. For lead roofs or flats much worked over, a wooden-slat floor should be laid. In using lead for gutters with slate or tile roofing, the more the latter can cover and protect the lead from the sun, the longer the lead will endure. In using lead for apron or center flashing, on very steep gables, the stepped or skeleton-flashing method is to be preferred, as it keeps the lead in a horizontal position;

otherwise, the lead is apt to stretch and crawl until it becomes too thin to be of any value.

106. The thickness and the weight per superficial foot of lead used for roofing purposes are given in the following table:

TABLE 13.

Thickness. Inch.	Nearest Simple Fraction.	Weight. Pound per Square Foot.
.068	$\frac{1}{18}$	4
.085	$\frac{5}{64}$	5
.101	$\frac{8}{82}$	6
.118	$\frac{7}{64}$	7
.135	$\frac{1}{8}$	8
.152	$\frac{9}{64}$	9

SHEET-ZINC ROOFING.

107. Zinc, one of the useful metals, generally extracted from mountain limestone and magnesium limestone in conjunction with galena, is met with abundantly in the form of a sulphuret. The ore is roasted, mixed with charcoal, and heated in peculiar retorts. The zinc is converted into vapor, condensed, and fused.

Cast zinc is brittle when cold. Heated to 200°, it is ductile as well as malleable, and may be rolled into sheets retaining these properties at that temperature; while, if the temperature be allowed to exceed 400°, the zinc returns to its original condition of brittleness. When exposed to the air, at a high temperature, it will burn and be consumed.

Zinc is easily acted upon by moist air, but a film of oxide is soon formed, protecting the metal from further action. Its expansion and contraction are greater than that of any other metal. Zinc is nearly as durable as lead or copper, and is not as liable to be affected by the sun's heat. In its

metallic form, zinc is largely used for roofing and cornices, and also for galvanizing iron.

Good zinc should be free from iron, and zinc containing more than 1 per cent. of lead should be rejected, the lead making it brittle. Good sheet zinc is uniform in color, tough, and easily bent backwards and forwards without cracking. Inferior zinc is dark in color and of a blotchy appearance, caused by the presence of other metals. The conjunction of the dissimilar metals is liable to set up galvanic action, which soon destroys the zinc.

Zinc should not be secured by, or connected with, iron, copper, or lead, for, in either case, voltaic action is induced, which destroys the zinc.

108. Zinc is described by the weight and thickness of the sheets to the superficial foot. The gauges used for roofing run from 13 to 16. The weights of these gauges run from 1 pound to 1 pound 8 ounces per square foot.

The size of sheets varies from 24 to 52 inches wide by any length ordered. The ordinary length of sheet varies from 6 to 10 feet, but zinc may be obtained in long roll lengths.

109. Solder should never be used in zinc roofing except for the small vertical joints of flashings. Before soldering, the joints are fluxed with muriatic acid.

Paper or felt should always be used under zinc where it comes in contact with woodwork containing acids, as, for instance, oak; otherwise, these acids cause the zinc to corrode.

110. The methods employed in laying zinc roofing are hollow roll, wood roll, trough and cap, and standing seam. Where there is no boarding, corrugated roofing is generally employed; the corrugations give the plates strength. Soldered or rigid connections are to be particularly avoided, and the joints must be so arranged as to be weather-tight, but allowing free movement for expansion and contraction.

Hollow-roll zinc roofing is constructed in the same manner as with copper, as shown in Fig. 63.

Wood Roll.—Same as copper roofing, Fig. 65.

Trough and Cap.—This method is much the same as that

used for copper, the difference being that the cap *a* is slipped over the lock *b* of the trough, as in Fig. 85, clips not being required to keep it in place. The flat portions of the roof are secured with clips at the head of each sheet, made to fit into the lock seam, the clips being nailed to the roof boards. The sides of the sheets are secured by the locking or seaming over them of the edges of the trough *b*. The ends of the rolls should

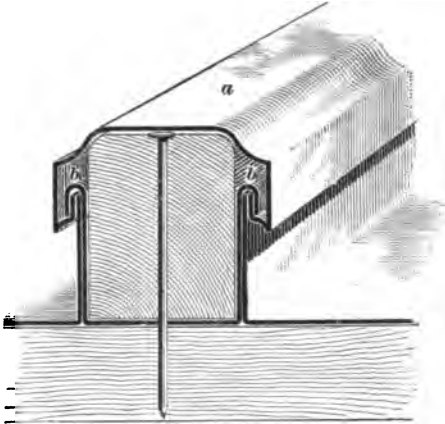


FIG. 85.

be closed or stopped by turning down a portion of the roll cap *a* against the wood roll, and by folding the corners of the sides of the cap *b* and trough *c* under this end. See Fig. 86.

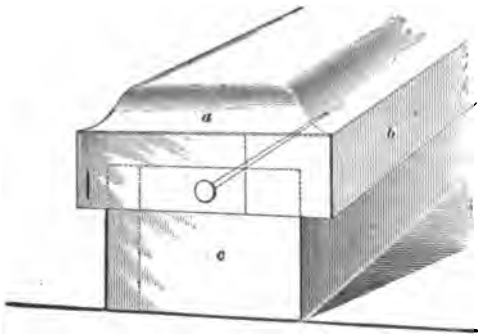


FIG. 86.

If the roof is very flat, drips should be used at the end of each sheet, as described and shown for lead roofing in Fig. 82. The lower edge of the sheets, next to the eaves, should be strengthened by turning or doubling it back so

as to form a bead, or by locking it to the gutter edge, where it joins the roof.

Standing Seam.—Same as described and shown for tin roofing. See Fig. 49.

Corrugated zinc is laid with the flutes running up and down the incline. The sheets overlap to the extent of one

corrugation at the sides, and 4 inches at the ends where connections are made. This method is shown under galvanized-iron roofing.

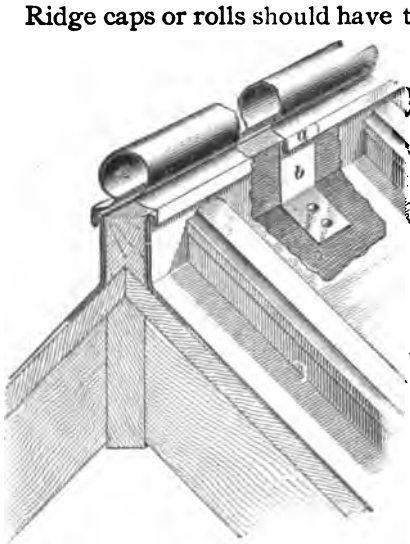


FIG. 87.

up and under, to make a strong edge, and should be secured in place by slipping the edge over the clips *b*, which are placed at intervals of 15 inches and nailed to the ridge. The cross-seams, where the lengths of the caps meet, are closed with a single lock seam.

Flashings for Chimneys, etc.—The same as for other metal roofs, save that no other metal but zinc should be used, on account of the great

difference in the expansion and contraction.

111. The gauge, thickness, and weight per superficial foot of zinc used for roofing purposes, are given in the following table:

TABLE 14.

Gauge Number.	Thickness. Inches.	Weight. Ounces per Square Foot.
13	.0311	10
14	.0457	12
15	.0534	14
16	.0611	16
17	.0686	18
18	.0761	20

SLATE ROOFING.

PROPERTIES OF SLATE.

112. Slate used for roofing purposes, commonly known as *clay slate*, is obtained from an argillaceous or clayey rock, of a compact and fine-grained texture. This rock is formed through the deposition of matter by the action of water, and belongs to a class geologically termed *sedimentary* rock, which split very readily into thin laminæ or slabs, along parallel planes, called the cleavage planes—a characteristic that renders slate very valuable as a roofing material.

The cleavage planes do not run in any fixed direction with respect to the beds, but incline at various angles, from perpendicular to horizontal. The slate whose cleavage planes are most nearly horizontal or parallel to the natural bed, is unfit as a roofing material, as the slabs will have a rough and irregular surface, which will prevent them from being fitted closely when laid.

113. Good slate should possess both toughness and hardness, and a very fine, but easily distinguished grain. The slates should be tough enough to be easily punched for nailing, and should cut to standard sizes, without splintering or becoming friable at the edges; and they should be hard enough not to absorb much moisture, as the action of frost upon the moisture will cause the edges to crumble and will also tend to enlarge the nail holes, and thus cause the slate to loosen from the roof.

The *grain* should run lengthwise of the slate. Veins or ribbons are objectionable markings, especially when parallel with the grain. Crystals of pyrites are sometimes found in slate, the yellow variety of which is not very injurious, but still objectionable, except in those qualities classed as second rate. Slate containing white pyrites, however, should always be rejected. The *color* of slate varies considerably, and is in no way indicative of the quality of the material. Blue, blue-black, purple, gray, green, and red are the

commonest tints, though cream color is occasionally but rarely found.

114. Qualities of slate vary with the characteristics of the rock, as above described, as do also the straightness, smoothness of surface, and uniformity of thickness of the quarried product. All qualities are obtainable in various market sizes from 6 in. \times 12 in. to 24 in. \times 44 in., all $\frac{1}{8}$ to $\frac{1}{4}$ in. thick, the common average being $\frac{3}{16}$ in. Tests to determine the quality of slate are sometimes made, but cannot be relied upon, though they are of value in some instances where certain characteristics are to be determined.

The *porosity* and amount of absorption may be obtained by weighing a dry slate, as delivered from the quarry, and reweighing it after soaking for 24 or 36 hours in water; the difference in weight shows the amount of water absorbed. Or a slate may be permitted to stand on edge, in a shallow dish of water, the height to which the water rises in the pores being noted; if the absorption is great, the slate is not suited for roofing, as the frost would tend to splinter the edges.

Slate submitted to the action of dilute sulphuric acid, will, if of a proper degree of hardness, remain unchanged for several weeks, but if of soft quality, it will decompose and crumble in a few days. Powdered slate, submitted to the action of muriatic acid, will effervesce strongly when it contains carbonate of lime, and should not then be used for roofing purposes. Powdered slate submitted to a high temperature, will give off a yellow sublimate of sulphur, when it contains pyrites, and should not be used, as it is not of a durable quality.

Though the above tests tend to show some of the characteristics of different qualities of slate, they are not entirely reliable as determining the value of the slate as a roof covering, as some of the hardest slates will undergo decomposition on the roof, even after passing all of these preliminary tests.

A good slate should present a bright, silk-like luster, and

should emit a clear metallic ring when struck with the knuckles, showing that it is hard; if it is soft, it will have a dull lead-like surface, and will give out a muffled sound. When cut, the edges should show a fibrous-like texture, free from splinters, and the material should not show signs of being either brittle or crumbly.

No better test of the wearing or weathering qualities can be contrived than the simple and effective one of examining roofs where the slate has been in service for several years.

LAYING SLATE ROOFING.

115. Terms Used in Slating.—The terms applied to the different parts of roofing slate are: the *gauge*, or *weather*, which is that part of the slate which is exposed when laid, as shown at *a*, Fig. 88; the *lap*, which is the distance that each slate overlaps the second one below it; the *head*, or upper end of each slate, as at *c*; and the *tail*, or lower end of each slate, as at *d*. The *bed* is the under surface of each slate when laid. The *back* is the upper surface when laid.

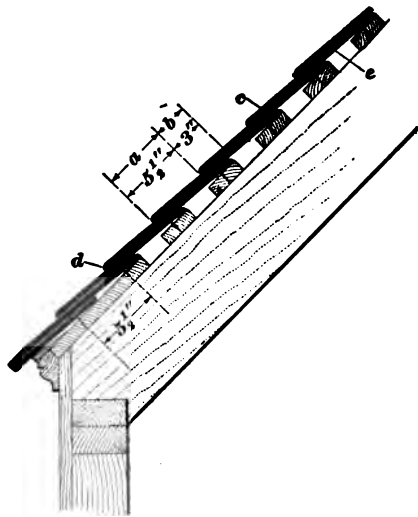


FIG. 88.

Rendering consists in covering the under side of the slate with haired mortar, especially when the slates are laid on battens, though it is sometimes done when the roof is boarded, by laying the slate on the mortar, which has been applied directly to the boards. Rendering prevents the wind from blowing the rain or snow through the crevices when felt is not used over the boards. It is not effective when the slate is laid on

lath or battens, as they are likely to settle and crack the rendering.

Shouldering consists in applying to the head of each slate, to a depth of 2 inches, a thin bed of haired mortar or slater's cement. Shouldering is resorted to only in very exposed situations.

Torching consists in pointing the joints between the heads and tails of the slates from the under side with haired mortar or slater's cement, and is done after the slates are laid; it is of little value, as it soon falls out, leaving the joints open.

116. Nailing.—There are two methods of nailing slate: *head* nailing and *shoulder* nailing. In head nailing, which is the usual method employed, the nail holes are punched about two inches from the top, as at *a*, Fig. 89, and the tails

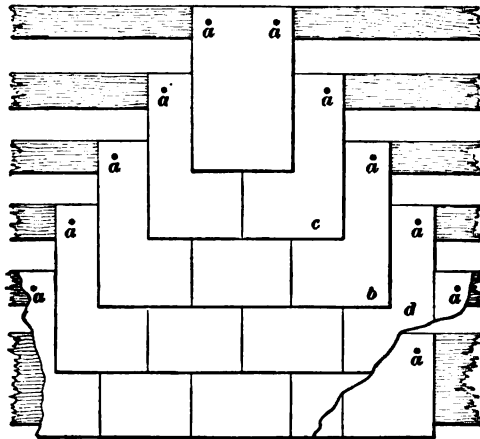


FIG. 89.

of the next two courses, as *b* and *c*, lap over the nail holes. Should the first-covering slate *b* become broken, the nails are thus still protected from the weather by the lap of the second-covering slate. The objection to this method is the leverage exerted by the wind. In shoulder nailing, Fig. 90, holes are punched at a distance from the tail of the slate equal to a little more than the gauge plus the lap.

117. The tail ends of slates are sometimes cut on the corners so as to give, when laid, a semi-octagonal or triangular gauge, and when so treated are termed *cut* slates.

Cut slates tend to shed the water more rapidly than square-end slates, as their form acts as a guide, carrying the water to a point, which it readily leaves, thereby clearing the roof.

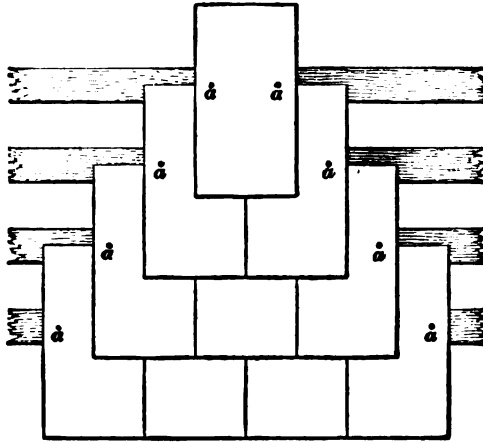


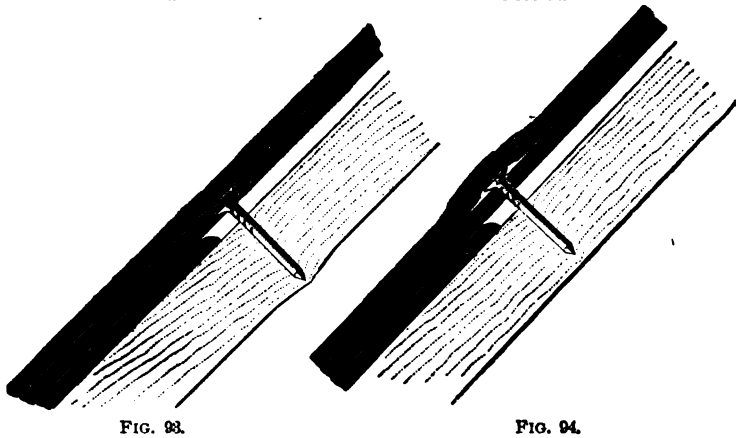
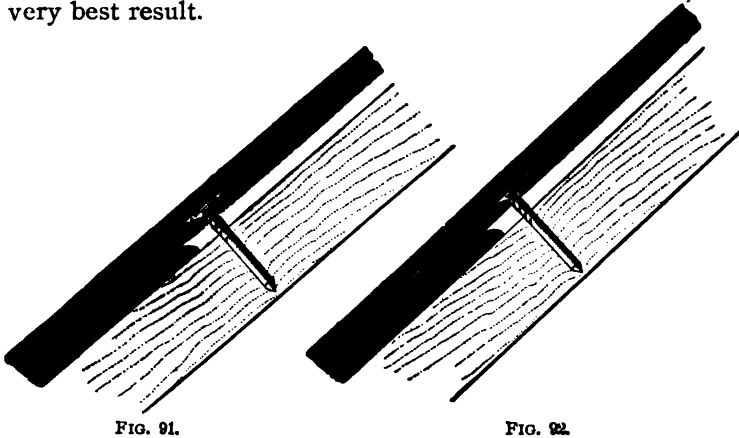
FIG. 90.

quickly; while, with square slate, the water lodges in the joints and accumulates on the lower edge and drips off so slowly that the joints are wet when the rest of the roof is dry. In winter, the alternate freezing and thawing is likely to loosen the slate and cause the edges to crumble. A roof covered with cut slate is, however, not so strong, as so much of the material is cut away.

118. Sorting and piling slate preparatory to laying is a most important detail of the roofer's work. Slates should be piled with their edges up, the pile in no case being more than 3 feet 6 inches in height; the ends of the tiers may be held up by laying a pile of slates on the flat, while the top of the pile should be covered with slate laid flat, with broken points, so as to keep out moisture. The slate should be sorted or selected by grades of thickness, the thin slate being piled first and the thicker ones next; or, if there are three grades, the medium thickness should be piled before the thickest.

The thick slate should be punched first, then the thinner ones, as the thick slate should be laid on the lower part of the roof and should be taken up first.

119. *Machine-punched* slate make a better job than *hand-punched*. In Fig. 91 is shown a section through a machine-punched slate; the hole is clean cut and gives the very best result.



In Fig. 92 is shown a hand-punched slate whose edge is ragged and flaked, the slate consequently being weakened. In Fig. 93 is shown another machine-punched slate, but with the nails driven too tight. The result is as indicated. The

slate having sprung to its natural position, the under side is splintered and the value of the nailing is lost. In Fig. 94 is shown a machine-punched slate with the nail insufficiently driven, causing the nail head to be forced through the upper slate by pressure from above.

120. There are three methods of laying slate roofing: (1) on laths or battens; (2) on boards covered with felt; and, (3) a method called half slating, on either battens or boards.

With the *first* method, of lath or battens, the roof is prepared as for shingles laid on lath, as previously explained.

For the *second* method, where the slates are laid on boards, the best results are obtained by covering the roof with $1\frac{1}{4} \times 6$ " matched boards. The objection to wider sheathing boards is that they are likely to shrink, curl on the edges, and lift some of the slates, thereby giving the roof a rough, uneven appearance. If wide boards are used, however, they must be well nailed at both edges. More care in this respect is needed when the sheathing is applied to curved roofs, or round towers, in which cases the sheathing must be perfectly solid and smooth. When the sheathing is not solid, the driving of a nail is almost sure to loosen the slate which was previously nailed, and a uniformly tight job is impossible.

The sheathing felt should be applied parallel to the eaves, if possible, but if the roof is steep it may be laid at right angles to them. In either case it must be lapped 2 inches



FIG. 95.

and fastened to the roof with nails having large flat heads. The tilting fillet at the eaves, valleys, gable ends, etc., the saddles and cant boards at the back of chimneys, flashings, etc., as previously described, should all be well secured to the roof boards.

In commencing to slate, the first course is laid double, the lower, or "undereaves" course being laid with the back of the slate next the boards; the length of the slates in this course will be equal to the gauge plus the lap, as seen at *a*, Fig. 95, and should project over the eaves or gutter edge from $1\frac{1}{2}$ to 2 inches, as at *b*. All the courses must be laid with broken joints, as shown at *c*, up to the ridge; the last course, as at *d*, is known as a "finisher," and is put on to receive the ridge roll.

121. The *third* method, known as *half slating*, is generally used on cheap buildings, where great economy of material is required. If laid on battens, half-slating should be used only where a perfectly tight roof is not necessary; but if laid on boards covered with felt, it makes a good serviceable low-priced roof. The lower courses should be laid double, as in the other methods. The courses above this have a space between the edges of the slates equal to one-half the width of each slate. The whole surface is thus laid, up to the ridge, the last course, or finisher, and the ridge roll being completed as for the other roofs.

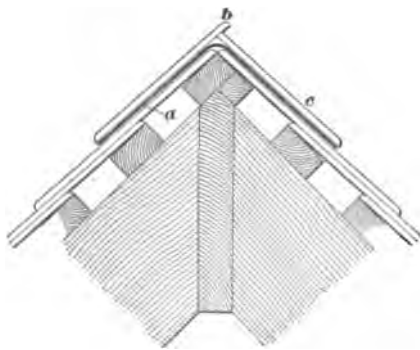


FIG. 96.

one slate lapping over the other $\frac{1}{2}$ inch, as at *b*. The wings of

122. The *ridge* on a slate roof may be finished in various ways. A method used on cheap buildings has a metal saddle flashing, as at *a*, Fig. 96, with the slate finished over it,

the metal flashing are just equal to the length of the ridge slate *c*. The objection to this form is that the nails securing the ridge slates are driven through the metal flashing.

Another method consists in nailing to the roof boards a wooden ridge saddle or strip *a*, Fig. 97, on each side of the

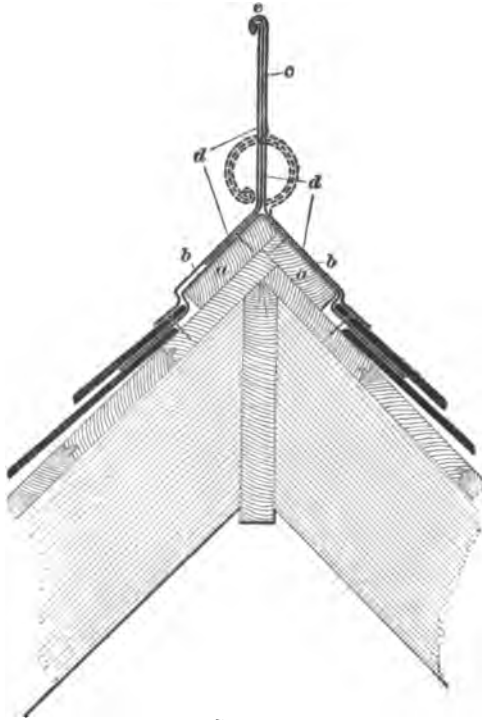


FIG. 97.

ridge. A saddle flashing *b* is then bent over this, with the wings extending 4 or 5 inches down the roof and under the last course of slates, which are laid up to the edge of the saddle *a*. Strips of metal *c*, 8 in. or 10 in. \times 2 in., are nailed along the saddle at intervals of 16 inches, and a wing piece *d* is then laid on each side, lapping over the slate 2 or 3 inches, and is bent and shaped up to the top of the clip *c*, over which it is turned and locked, as shown at *c*. The whole is then bent and formed into a roll, as indicated by the dotted lines.

A third method, much the same in principle, is shown in

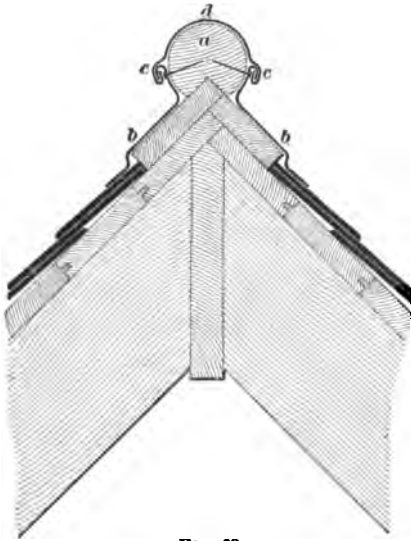


FIG. 98.

Fig. 98. The metal saddle flashing over the wood saddle is omitted, and the slate is carried up to the wood saddle, on which is nailed a wood roll, as shown at *a*. A wing flashing *b* is placed each side, overlapping the slate 2 or 3 inches, and is bent up against the roll and lock seamed as at *c*, with its upper edge against the side of the roll; this flashing is then secured by nailing

under the lock seam into the wood roll. A metal roll cap *d* with lock-seam edges, slipped over the wood roll, interlocking with the edges of the wings, completes the ridge. A cheaper roll is constructed as shown in Fig. 99, the roll *a* being kept in place by its natural spring.

Methods of capping with slate rolls and wings are seldom used on account of their expense, but when necessary should be constructed as shown at (*a*) and (*b*), Fig. 100.

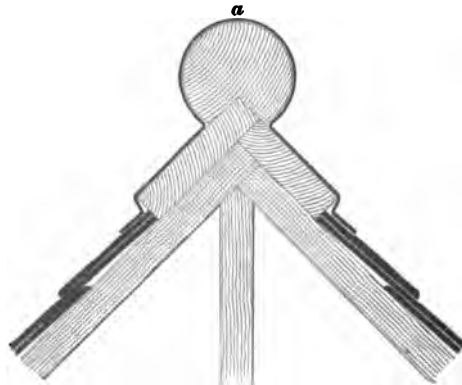


FIG. 99.

At (*a*) the wing pieces *a* are cut from solid slate; they are screwed together with brass screws *b*, and the cap *c* is placed

over them. At (*b*) the wing piece *a* has the roll cut on it and laps the wing *b* on the other side. Both ridges must be set in cement, without nailing to the roof.

A good rule to follow for proportioning the wings to the roll is: with a 2-inch roll use a 5½-inch wing; with a 2½-inch roll use a 6-inch wing; and with a 3-inch roll use a 7-inch wing.

123. Hips and Valleys.—Hips in slate should be finished the same as described for shingle roofs. If a roll is applied, the simple method shown at Fig. 99, with a short flat wing, will serve all purposes and will give a neat finish.

Valleys may be constructed in the same manner as those described for shingle roofs, as may also the flashings around the chimneys, skylights, bulkheads, ventilators, etc.

Where a slate roof finishes against a parapet, gable, or other wall of brick or stone, there should be provided both flashings and counterflashings, the flashings to be cut in short lengths, 2 inches longer than the unexposed part of the slate, and to be laid as each course of slate is put on, as shown at *a*, Fig. 101. This flashing should have a lap on the roof equal to the width of half a slate, and should turn up against the wall at least 4 or 5 inches. The flashing against the wall must not then be nailed, for if the roof settles, the flashing will lift the slate or break them. This flashing is sometimes called a "soaker." The counterflashing

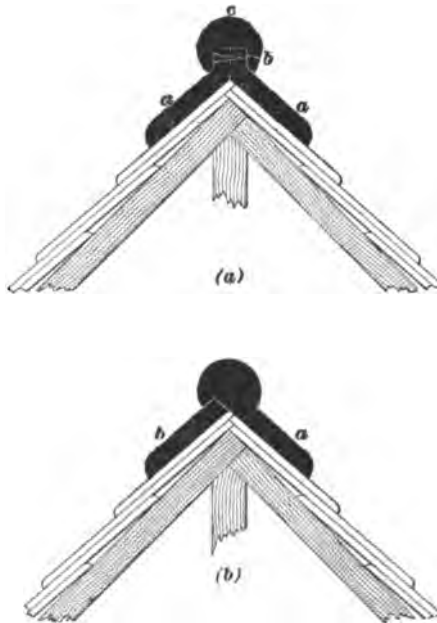


FIG. 100.

b, which covers the soaker flashing, is either let into a raglet cut 1 inch deep in the stone or stepped into the joints, as shown. This stepped counterflashing is secured at the top



FIG. 101.

by wall hooks, and the joints are well pointed up with elastic cement.

When lead is used for flashing instead of tin, zinc, or copper, it should not weigh over 5 or 6 pounds to the square foot, as the thickness will give an uneven appearance to the slate.

124. Colored or ornamental slate should be used with great care, as color never increases the utility of the roof and is more likely to spoil an otherwise respectable roof by a poor and gaudy design, while the cutting of the slate

to any shape that tends to carry away the water from the joints, as before described, is the only recommendation for ornamental forms. Colored slate is necessary for certain buildings, but the color should be uniform.

In slating curved surfaces, follow the directions given for shingle roofs, commencing at the lower course, with slate from 6 to 10 inches wide, and gradually taking off until a slate 2 inches in width is reached. This is about the limit that will safely cover a nail hole and keep the weather from affecting it; even with this width the upper courses should be well bedded in slater's cement (which is generally composed of paint skins and refuse lead), as should also all hips, ridges, and joints around chimneys, bulkheads, gables, and parapet walls.

125. The nails used for slating have large, flat heads, so that they may get a good hold on the surface of the slate. The proper length of a nail is twice the thickness of the slate, plus the thickness of the boarding or lathing; this length will give the full amount of hold that can be secured. The nails generally used are threepenny, which are $1\frac{1}{8}$ inches long, and fourpenny, which are $1\frac{1}{4}$ inches long.

WEIGHT OF SLATE PER
SQUARE FOOT.

Thickness. Inches.	Weight. Pounds.
$\frac{1}{8}$	1.82
$\frac{3}{16}$	2.73
$\frac{1}{4}$	3.64
$\frac{5}{8}$	5.46
$\frac{1}{2}$	7.28
$\frac{5}{8}$	9.06
$\frac{3}{4}$	10.87
1	14.50

126. Slating is calculated by the square of 100 square feet. To ascertain the number of slates of a given size required per square, subtract 3 inches from the length of the slate, multiply the remainder by the width and divide by 2; this will be the number of square inches of roof covered by the gauge of each slate. Then divide 14,400, the number of square inches in a square, by the number of square inches covered by each slate, and the result will be the number of slates required for a "square" of roof.

TILES.

127. The clay used in the manufacture of tiles is composed of aluminum and silicic acid, forming two-thirds of its bulk, with about 10 per cent. each of water and quartz, and very small quantities of potash, titanitic acid, and oxide of iron. To prepare the clay for use, it is weathered, which means exposing it to the frost or sun, then mellowed or allowed to stand for a period, tempered by additional working of the clay, plugged, and cleared from stones. It is then ready for molding, after which it is burned in a kiln, glazed, and fired.

128. *Salt-glazed, vitrified* tile are subjected to intense heat, the glazing being accomplished by throwing salt on the tile in the fire, creating a vapor which unites chemically with the clay and forms a glazing which is affected by

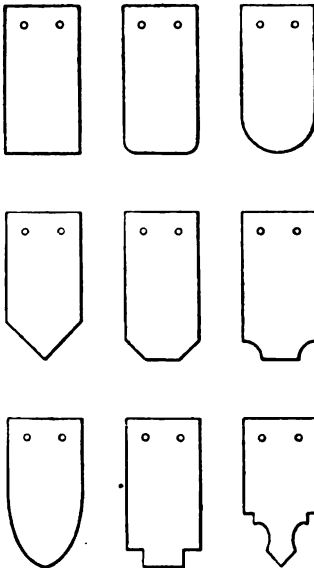


FIG. 102.

neither gases, acids, nor steam, and is practically indestructible. *Slip-glazed* tile are what are known as firebrick clay tile; they are very porous, and are glazed with another clay known as slip, which is applied under heat; the slip, however, being a foreign body is liable to chip and scale off. For this reason, vitrified tile should always be used in preference to the slip glazed.

Tiles of good quality emit a clear ringing sound when struck together, or with a steel tool. The gauge of tile is the same as of shingles, and refers to the exposed portion of the tile.

129. The styles of tile manufactured are very

numerous; they are, however, generally of the interlocking pattern, and made so that they may be laid either on boarding or on battens. The following varieties are generally used: the plain surface tile, with the eave hips; ridge or cresting tile; and finial to suit. Shingle tile are called *square*, *round corner*, *round end*, *hexagon*, *octagon*, *scallop*, *Gothic*, *Grecian*, and *Persian*, and are shown in the order named in Fig. 102. Those used for laying on boards are flat, as at *a*, with two nail holes in the upper end, and those for hanging on lath have the rib or lug *b* cast on the back, as well as having the nail holes. The French tile

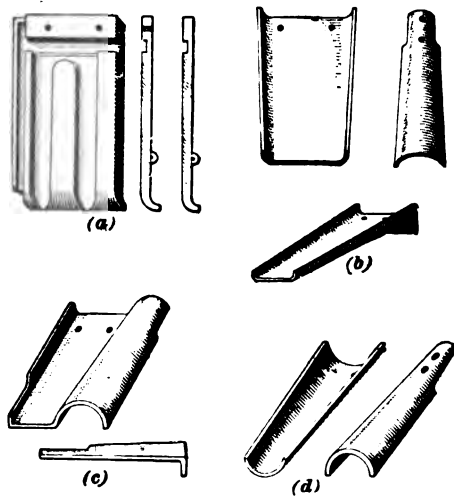


FIG. 102.

shown in Fig. 103 (*a*) may be used for laying on boards or battens; the Roman, Fig. 103 (*b*), for boards or battens. The modern Spanish tile is shown at (*c*), and the old Spanish, at (*d*), Fig. 103.

In Fig. 104 (*a*) is shown the Corean or Oriental ridge tile to be used with modern Spanish tile shown at (*b*); the caves or starter tile is shown at (*c*). Ridge tile should be special, and when so made, the wing of the ridge takes the form of the tile at its lower edge. Eaves tile may be made with

antefixas, as shown at *(d)*, Fig. 104, which enrich the appearance of the eaves and take the place of the plain finish.

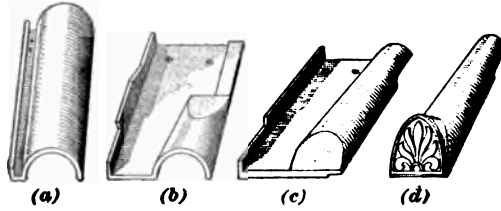


FIG. 104.

These tiles are sometimes inserted at intervals on the roof to act as a snow guard. *Hip-roll* tile

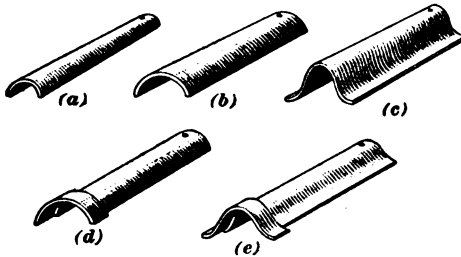


FIG. 105.

to act as a snow guard. *Hip-roll* tile [see Fig. 105, *(a)*, *(b)*, and *(c)*] are overlapped 3 inches when laid, while the roll tiles shown at *(d)* and *(e)* have lap joints cast on them; these tiles are secured to

the wood hip roll by nails at the lap.

Plain overlapping cresting, or ridging, is shown at *a*, Fig. 106, and consists of rolls and covers with a plain cresting

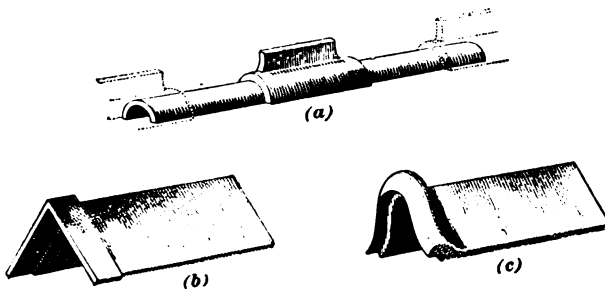


FIG. 106.

cast on the cover tile. At *(b)* and *(c)*, Fig. 106, are shown two styles of lap-joint ridge cresting.

At (a), Fig. 107, is shown a ridge roll made to receive the

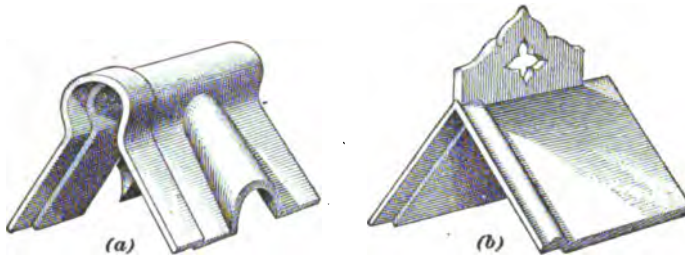


FIG. 107.

tile and also having a lap joint, and at (b), an ornamental ridge cresting with lap joint.

At (a) and (b), Fig. 108, are shown two styles of gable finials. At (c) and (d) are shown two hip finials—one with

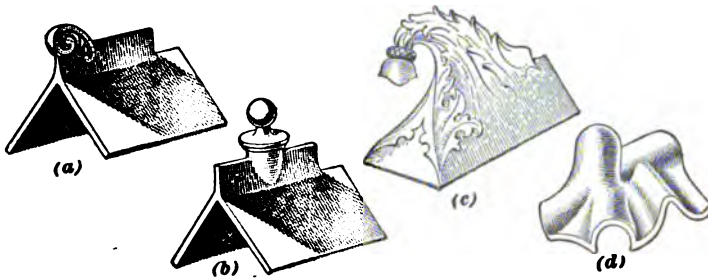


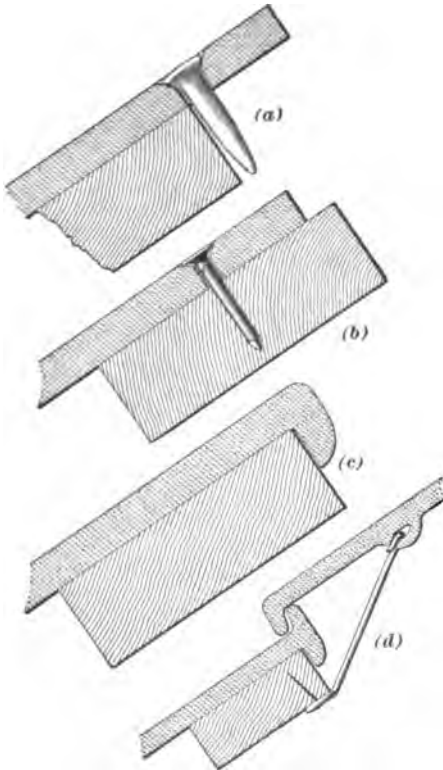
FIG. 108.

plain wings and the other with wings made to receive the hip-roll tile, the center tile of the front slope, and the first continuous row of tile of the side pitches.

130. The thickness as well as the length and breadth of tile varies; they run from $\frac{3}{8}$ to $\frac{3}{4}$ inch in thickness, from 3 to 9 inches in breadth, and from 10 to 16 inches in length; the $\frac{3}{8}$ -inch thickness is generally used.

131. There are four methods of securing tiles to the boards or battens: (1) by hanging with oak pegs as shown in Fig. 109 (a); (2) by nails as at (b); (3) with a rib or lug

and nails as at (c); and, (4) as shown at (d), with a rib or lug and also by a wire loop, which is nailed to the lath or batten.



, FIG. 109.

to $1\frac{1}{2}$ inches thick and 6 or 8 inches wide, tongued and grooved, and laid on diagonally, well nailed at each bearing and at the edges to prevent curling.

Tilting fillets should be nailed at the eaves, valleys, gutters, gables, etc., as described for shingle roofing. When battens or lath are used, especial care must be taken to see that the proper distance is secured between the lath for the tile to be used, and that the lath are horizontal to the eaves, so that the vertical joint of the tile will be at right angles to the eaves. If the tiles are laid on boards, the roof should be covered with two thicknesses of single-ply or one thickness

Rendering is used with flat tiles, and torching and shouldering with all tiles in very exposed places, or on flat-pitched roofs; under ordinary conditions, however, these processes are not necessary. When used, they should be applied in the same manner as described for slate roofing.

The roof should be prepared to receive the tile by covering the rafters with either boards or battens, as the kind of tile to be used requires. If boards are to be used, sheath with plank $1\frac{1}{4}$

of double-ply fibrous roofing felt, and after the felt has been applied, the gutter and other flashings should be constructed—as described under “Shingle Roofing”—and put in place.

132. The gutter flashing should be of 16-ounce copper, well nailed with copper nails over the eaves tilting fillet, and locked to the gutter proper with a lock seam unsoldered; or it may be turned down over the upstand of the gutter. The first method is used for a gutter nearly level with the eaves, and the second when the gutter is slightly below the eaves.

For valley gutters, 10-ounce copper can be used in 6-foot lengths. It should be laid with a lock seam, fastened to the roof boards with cleats, soldered and sweated on the back of each length, and nailed with copper nails to the roof back of the valley tilting fillets, or screwed down with copper screws. The valleys should be 20 or 24 inches wide.

The hips do not require to be flashed. A wooden hip fillet as at *a*, Fig. 110, of sufficient height to receive the tile and give it bearing, is at-

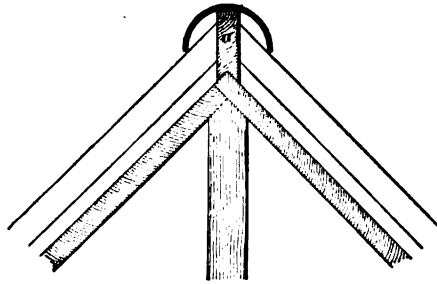


FIG. 110.

tached to the sheathing, and to this fillet the hip tile is secured.

Where a roof comes against parapet, or gable walls, the junction should be flashed with 14 or 16 ounce copper, nailed to the roof back of the tilting fillet. The flashing should be allowed to lap on the roof a distance equal to the width of a tile over the fillet, and should be carried up against the wall at least 7 inches. From the under side of the wall coping, or from a raglet cut in the wall, a lead apron should overlap the copper upstand at least 3 inches, and should be secured to the wall with lead plugs.

133. The ridge does not require flashing, but should be prepared to receive the tile ridge roll in the same manner as was shown for the hips.

Where the tile come against the wood hip roll, they should be cut off to the proper angle and bedded in elastic cement. The valley tile should be made at the works, to conform with the proper angle of the roof, and should have closed ends. Around all chimneys and other openings in the roof, as well as at the finishing course along the ridge, the tile should be well bedded in slater's cement.

Where the ridge tiles have a very deep wing, they should be specially cast with a lap joint, and should be laid in courses the same as the tile. See (a), Fig. 111. They are

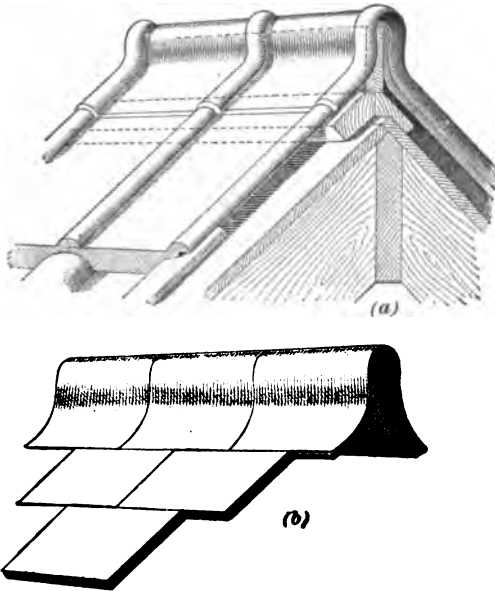


FIG. 111.

sometimes built up of flat pieces of tile, as at (b), Fig. 111, with rabbeted joints, and laid with the vertical joints broken; the former tile is preferable.

Very heavy hip or gable finials should be well braced with brass or galvanized-iron rods, and the sections of terra-cotta finials should be securely wired or anchored to the braces, and well cemented. If necessary, a wood cradle should be built on the roof to receive the finials.

The finials on hips and ridge ends may be secured with a tripod form of brace. For a vertical finial the tripod may be made and secured to the roof as shown in Fig. 112, the ends of the iron being held in place with brass or galvanized-iron screws. For an overhanging hip finial the brace may

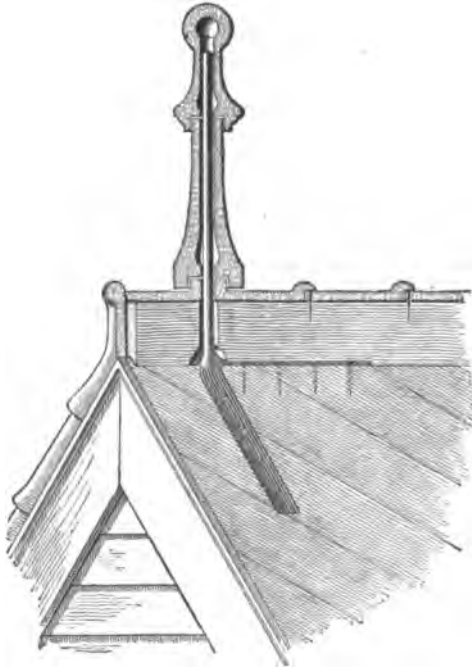


FIG. 112.

be constructed as in Fig. 113, the top of the rod being carried to the ridge of the finial. Where the finial is on the apex of a tower, the brace may be constructed with a galvanized-iron pipe of dimensions to suit the size and shape of the finial, and stiff enough to resist the wind pressure. The construction of such a brace is shown in Fig. 114.

134. A roof may be covered entirely with ornamental roofing tile, or they may be used at intervals among flat tile

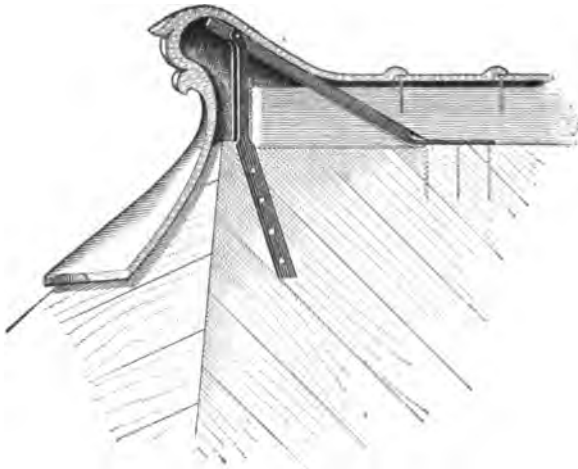


FIG. 113.

to break the monotony of the system. When mixed with the plain tile, they may be arranged in pattern or figure shape, but care must be taken to retain uniformity of color in both kinds, as mentioned in "Slate Roofing."

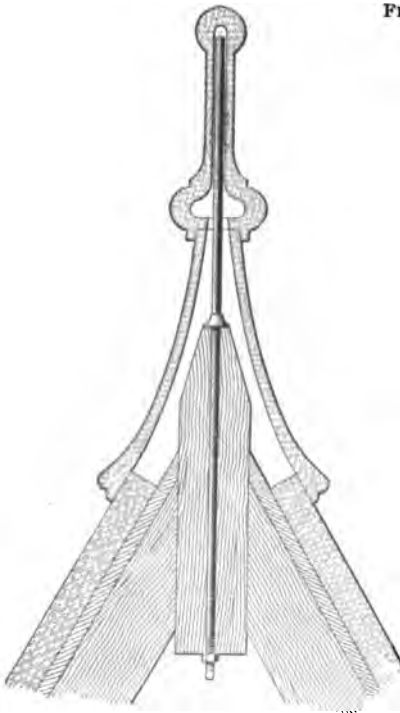


FIG. 114.

135. The tiles for conical roofs must be made to suit the requirements of each case. It is, however possible, with some varieties of tile, to use a uniform size for four or five courses, or tiers, and a smaller one for the next four or five courses, and so on until the base of the finial is reached.

Shingle tile may be cut on the sides so as to make them conform with the radial lines from the apex, in the same manner as was described for slate and shingles. If, however, the butt of the tile is formed with a pattern, this method cannot be used, and special tile must be made. The eave tiles and the upper courses adjacent to the apex should be well bedded in slater's cement.

GLASS ROOFS.

136. Glass as a roof covering may be used to great advantage for inside halls and passageways, picture galleries, and extensions where ordinary windows cannot be inserted, for dome lights, greenhouses, railroad stations, etc. Whenever used, the construction should be what is known as "puttyless," that is, no putty should be used in bedding the glass whether the bars are of metal or of wood.

137. The frame for all house work except greenhouses, and even the better class of these, should be, preferably, of copper, galvanized iron, or zinc.

The construction of these frames or bars consists of a gutter composed of three pieces, the *flange*, the *gutter*, and the *cap*. In Fig. 115 is shown the general construction of

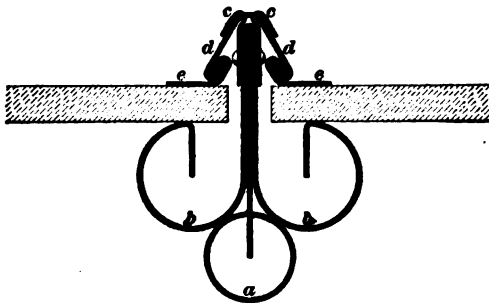


FIG. 115.

the complete bar. The center member *a* has a straight web about $1\frac{1}{4}$ inches high, with a circular tube $\frac{5}{8}$ inch diameter

formed at its lower edge. The gutter or outer member *b* consists of one piece, bent at the center, capped over the web or centerpiece, and having the edges formed into $\frac{3}{4}$ -inch tubes which rest on the tube of the web member. The upper flanges of these tubes support the glass. The cleats or hold-fasts *c*, which bind the cap, are secured by the rivets which join the web and gutter members, and the cap *d* is made of one piece, in the shape of an inverted **V**, with a simple lock on the two lower edges to receive the flashings. The flashings *e* are strips of lead, locked at the upper edge into the cap, and bent down close to the glass, in order to make a water-tight connection. The cap is secured to the bar by passing the clips through a slit cut in its apex, the ends being turned down and soldered and wiped to the cap. In some cases, the ends are simply turned down over the cap.

This system of construction may be applied to the whole or a part of a roof, and also to skylights. It may also be used in conjunction with iron or wood framing for the roof proper.

For small skylights, where an under support may be dispensed with, the light bar, as shown in Fig. 115, may be used. For larger openings, a heavy iron bar incased with sheet metal, as shown in Fig. 116, will give the requisite strength.

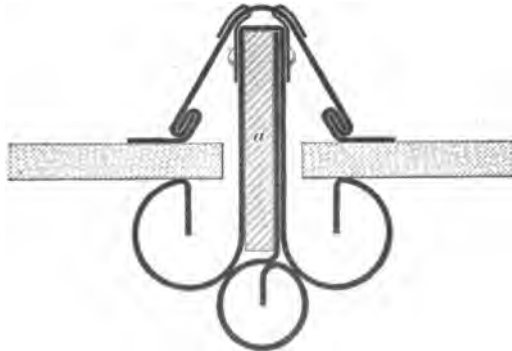


FIG. 116.

Fig. 117 shows an iron rafter for a roof; it is composed of a

web plate *a*, $3\frac{1}{2}$ in. \times $\frac{1}{2}$ in., and two angles *b*, *b*, 2 in. \times 2 in. \times $\frac{1}{4}$ in. bolted together. The portion *a* projects beyond the flanges

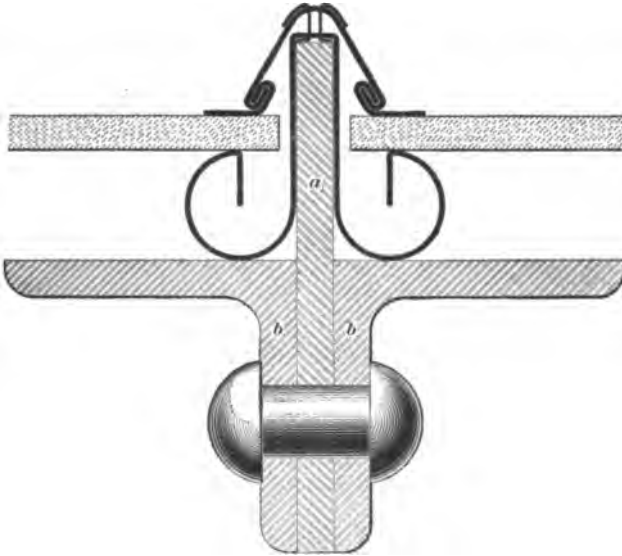


FIG. 117.

of the angles and a gutter is formed over it with caps, etc., as in the previous example.

The tubular construction imparts strength and rigidity and provides for the expansion of the metal and glass. Provision is also made for condensation, as all the bars, vertical and horizontal, act as branch gutters, which are connected to a main gutter.

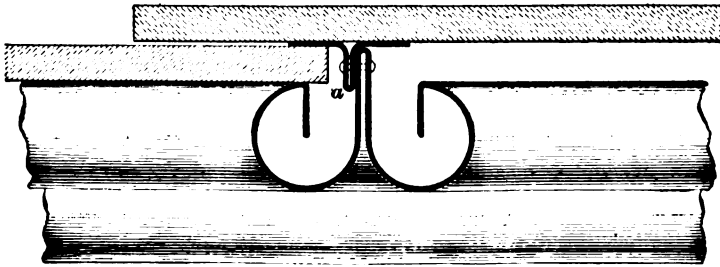


FIG. 118.

138. The glass may be made $\frac{1}{8}$ to $\frac{3}{8}$ inch thick and of any pattern. For plain work, ribbed or hammered glass may be used, the rough surface being placed on the outside. The use of a minimum thickness of glass should, for two reasons, receive consideration: first, the cost of repairs, and, second, the dead load to be supported. The size and strength of the rafters and purlins supporting the ribs must be regulated by the weight of the glass, wind pressure, and snow load.

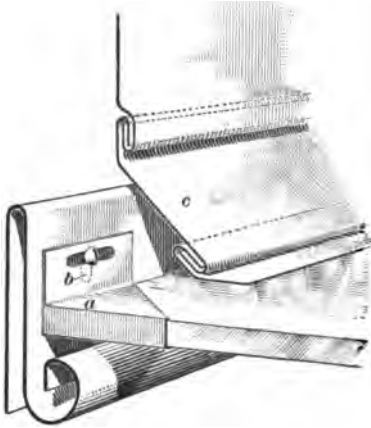


FIG. 119.

139. The horizontal lap joint of the glass, as shown in Fig. 118, is of the same

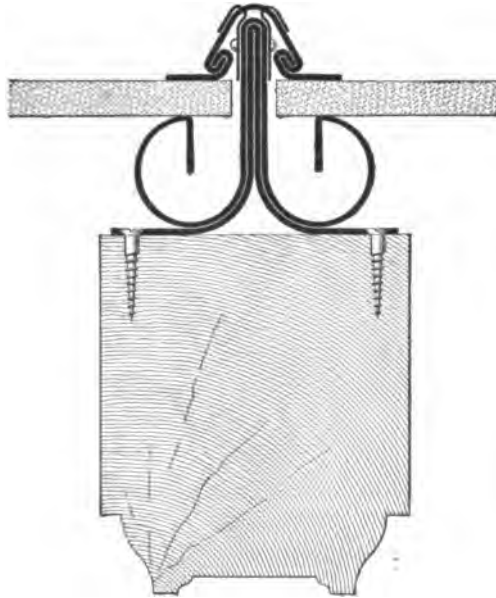


FIG. 120.

construction as the gutter proper, but has a lead fillet *a*, which acts as a cushion and takes up any unevenness of the glass. The lower glass rests on the tube, and the upper on the lead cushion on the top of the rib. The glass should overlap from 1

inch to $2\frac{1}{2}$ inches, according to the pitch. At the end of each light of glass is a stop, or holdfast, made and placed as shown at *a*, Fig. 119. These stops

are placed on each side of the vertical ribs, and are secured to the flanges by small screw bolts about $\frac{1}{8}$ or $\frac{3}{16}$ inch diameter. The slot *b* in the flange is cut vertically and is about three times as long as the diameter of the bolt. The

slot in the stop or holdfast is cut horizontally and is a trifle longer than the other. These slots provide for ad-



FIG. 121.

FIG. 122.

justment and for any movement that may take place by settlement, and expansion and contraction.

The ribs that come against parapet, fire, or other walls are similar to those shown in Fig. 119. The

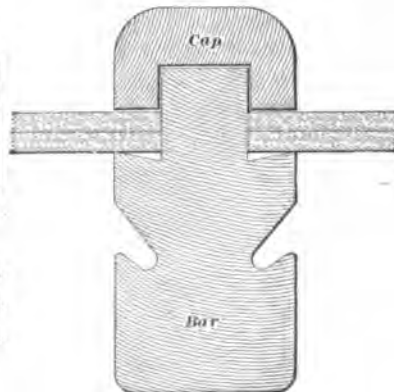
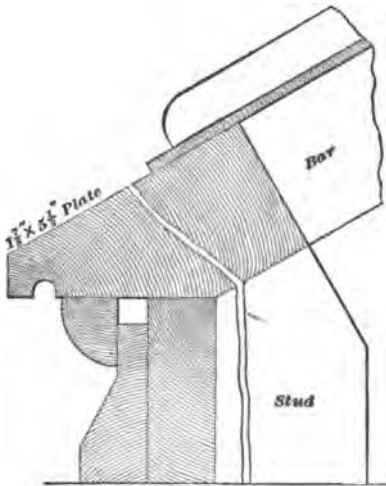


FIG. 123.

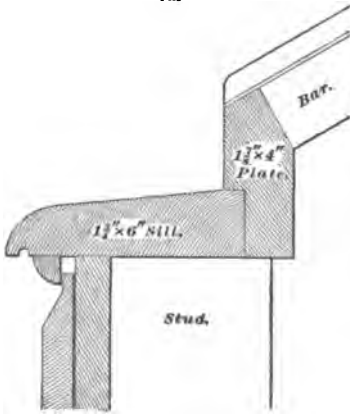
other walls are similar to those shown in Fig. 119. The

cap piece *c* is extended and formed into a flashing; it is let into a raglet, and may be covered with a counterflashing.

When the construction to which the glass is applied is of wood, the flange piece is omitted, and the gutter piece rests in and is secured to the woodwork, as shown in Fig. 120.



(a)



(b)

FIG. 124.

140. There are other methods of construction, based upon the same principles, but varying in detail to meet different conditions. For the roofs of greenhouses, etc., where wood construction is used, the durability of the wood should be considered. It has been found that cypress has given better results than any other material. The sash bars may be made, as shown in Fig. 121. The rabbets are $\frac{5}{8}$ inch deep, allowing for the two thicknesses of double-thick glass at the lap, and also for the nailing. The rabbet is formed with a slight bevel, thus forming a channel which carries away any moisture that may enter.

The end or gable bars must

also be rabbeted, for the roof glass; and where there is a glass gable, these bars must also be rabbeted, to receive the vertical glass.

In Fig. 122 is shown a rafter bar with grooves run in the

sides, to take off condensation; and in Fig. 123 a similar bar fitted with a cap.

141. There are several methods of constructing the plates into which the bars are framed. At (a), Fig. 124, is shown a plate made of $1\frac{1}{8}'' \times 5\frac{1}{2}''$ material, beveled and throated to form a drip. At (b), Fig. 124, is shown a different construction, in which the plate piece is $1\frac{1}{8}$ in. \times 4 in., and the sill $1\frac{1}{4}$ in. \times 6 in. The plate is beveled on the top to receive the bar, and rabbeted on the outside to receive the sill. The sill is beveled to allow the water to flow off, and throated to form a drip.

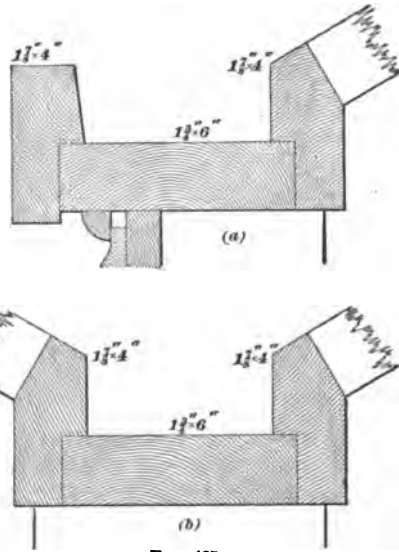


FIG. 125.

At (a), Fig. 125, is shown a plate and gutter, the inside or plate having the same construction as (b), Fig. 124. If there are two pitches coming together between two ranges of roof, the construction may be as at (b), Fig. 125. Gutters, however, should be avoided as much as possible.

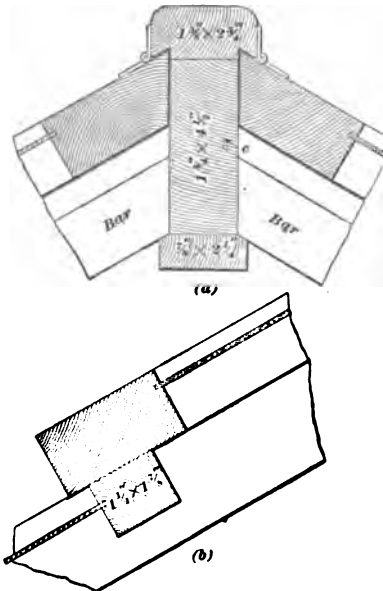


FIG. 126.

142. At the ridge there may be either a single or

double row of ventilators. At (*a*), Fig. 126, is shown a 3-piece ridge, made up of a ridge piece, a shoulder cleat, and a cap. The ridge piece is $1\frac{3}{4}$ in. \times $4\frac{1}{2}$ in.; the shoulder cleat, $\frac{7}{8}$ in. \times $2\frac{1}{4}$ in., and the cap, $1\frac{3}{8}$ in. \times $2\frac{3}{4}$ in., rabbeted to receive the ventilator sash. This ridge is made for a double row of ventilators; if used for a single row, it would be rabbeted on one side for the glass, as indicated by the dotted lines at *c*.

The ventilators should be hinged to the ridge, close against the bars, and a header should be inserted as shown at (*b*), Fig. 126. The header may be rabbeted or grooved to receive the glass. Where the bars are more than 8 feet in length, they should be supported by purlins.

In glazing the sash, the glass is laid from the bottom up, the sheets lapping each other from $\frac{3}{4}$ inch to $1\frac{1}{2}$ inches. The lap is regulated by the pitch, which, in any case, should not be less than 20° .

STONE ROOFS.

143. Stone roofs are not much used at the present time, except for covering small vestibules, porches, turrets, towers,

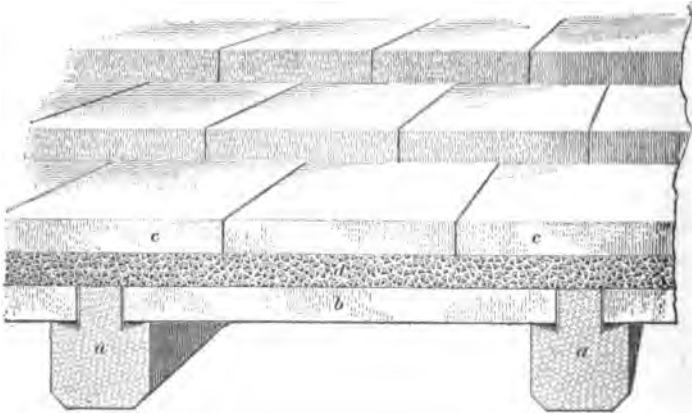


FIG. 127.

and monumental buildings. They may be flat or pitched. Large slabs are used for flat roofs, and small ones for pitched

roofs. They may be laid either with lap or butt joints on a filling resting on the vaulting beneath. For towers and spires, the stone is laid in tiers, either with or without a lap joint.

144. In Fig. 127 is shown the construction of a flat roof, which may be applied either to vaulting or stone purlins, the latter being shown. The purlins *a* are rabbeted to receive the ceiling slabs *b*, and the roof slabs *c* are laid and bedded in cement concrete *d*.

The Greeks, and the Romans after them, used the same method of supporting and laying the roof slab, with this difference, that they cut the slabs, as shown at *a*, Fig. 128, so

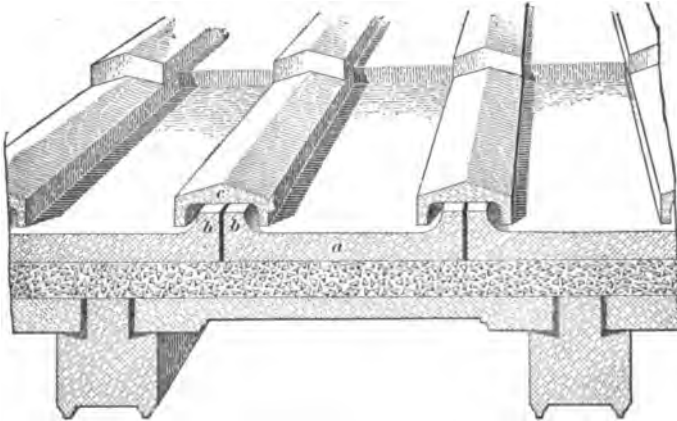


FIG. 128.

that they formed a channel with fillets *b* on each side, and covered the joint with a cap *c*.

For pitched roofs, ashlar slabs are used, laid as shown at (*a*), Fig. 129, in the same manner as shingles with broken joints; the slabs are bedded or laid in cement on the filling over the vault.

At (*b*), Fig. 129, is shown a much better slab roof; the slabs are cut with a rabbet and a lap joint *a*. The cap or ridge stone is made with a rabbet and a lap joint *b* on each side at the edge of the wing, the same as the lower edge of

the slabs. The advantages of the rabbet and lap joint are, that the stones cannot leave the roof if they should work loose, as they would if laid with a simple lap, and there is no open vertical joint for the passage of water.

The plain butt-joint roof is shown at (c), Fig. 129.

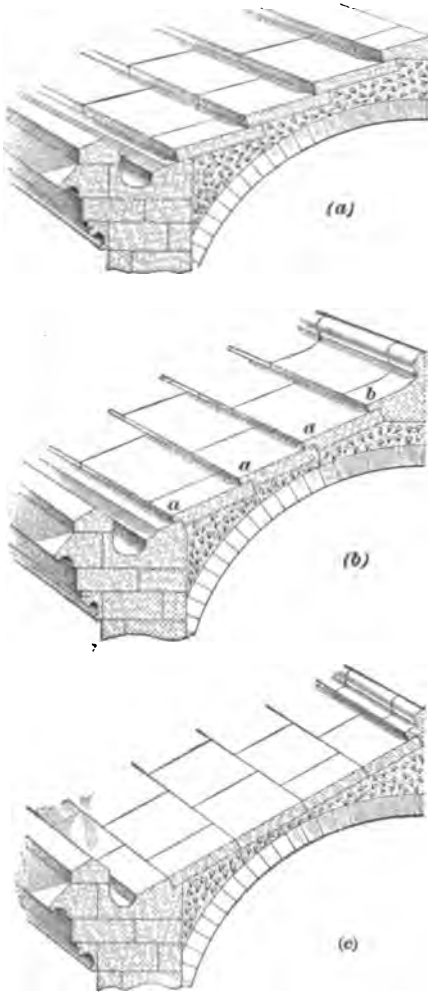


FIG. 129.

The gutters are cut out of a single stone, as at *a*, Fig. 130, the roof slab overlapping it. The water is carried from the gutter through a channel cut in a stone extending the full width of the wall. This channel *b* meets the outlet of the gutter, and extends through the stone to a point outside the wall and discharges into the leader head *c*.

145. For turrets, towers, and spires, the roof, when built of stone, is complete without the

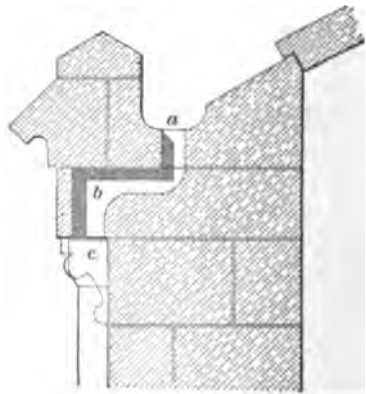


FIG. 130.

interposition of framing. At (a), Fig. 131, are shown a one-half

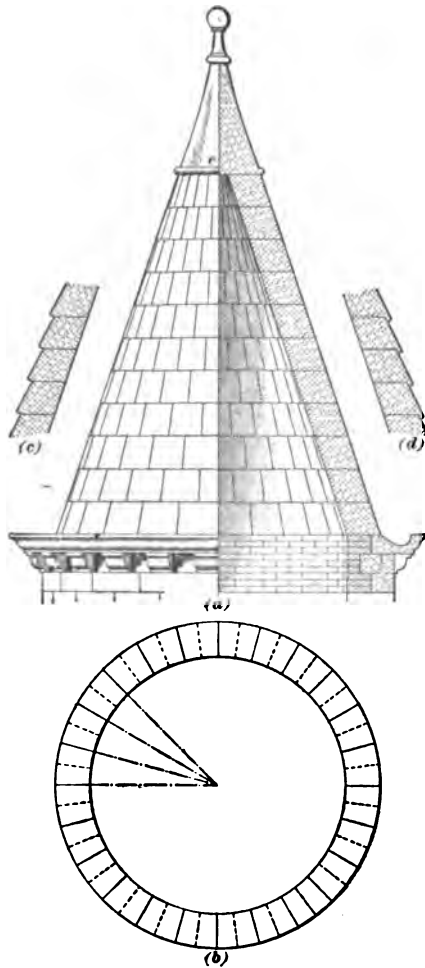


FIG. 131.

elevation and a one-half section of a smooth, flush-faced, conical roof; the beds of the stone are kept level as in regular walling, while the vertical joints radiate from the center of the plan, as shown at (b), and bonding as indicated by the dotted lines. The outer surface of the stones used for such roofs may advance, giving the suggestion of a lap only, as at (c); or they may be rabbeted and lapped, as at (d). The terminal, cap, or finial should commence at a point where the roof stones become too small to look well, as at *e*, and should be, preferably, of one piece of stone.

FLAGPOLES.

146. The curve, taper, or entasis of a flagpole may be devel-

oped by the following method: the diameter at the base where it emerges from the roof should be about $\frac{1}{8}$ of the height, and the diameter at the top or head should equal $\frac{1}{2}$ the lower diameter. Assume a flagstaff 50 feet, or 600 inches, long; its diameter would be $\frac{1}{8}$ of this height,

or 12 inches, while the diameter at the head would be 6 inches.

To obtain the entasis, draw a center line ad through the pole. See Fig. 132. Divide cd the lower half diameter as follows: from d mark a point equal to one-fourth of the lower diameter, as de ; divide the remaining distance ec into two equal parts as at f , and divide the distance cf into two equal parts as at g , and again, divide cg into two equal parts as at h . Divide the vertical height of the shaft into four equal parts by horizontal lines; transfer the distance de to $d'e'$; df to $d'f'$; dg to $d'g'$; and dh to $d'h'$; then through the points marked, draw the curved outline.

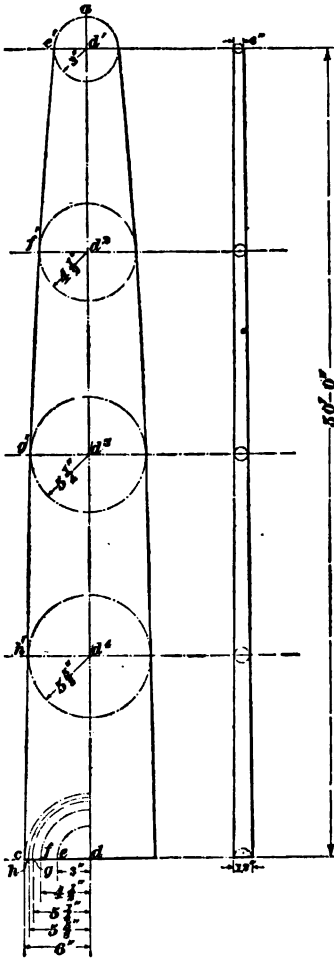


FIG. 132.

SNOW GUARDS.

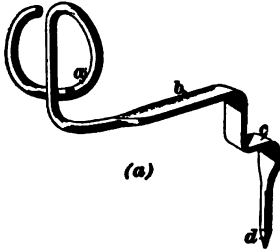
147. Snow guards made in various forms are used on all kinds of roofs to prevent the snow from sliding down into the gutters, thus clogging them, and causing the water to overflow outside of the building. Where snow accumulates and freezes in a gutter, it is likely to form a dam and back the water up under the slate, tile,

or shingles, as the case may be, and eventually finds its way into the interior of the house. Snow guards also prevent the dislodgment of large quantities of snow, which

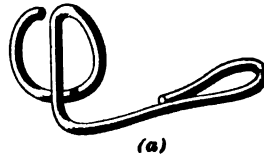
might cause injury to persons in the vicinity, as well as to ornamental shrubbery. For these reasons they should be applied to roofs having a steep pitch towards the street.

148. The guard generally used is made in four different styles, and is constructed with galvanized-iron or copper wire.

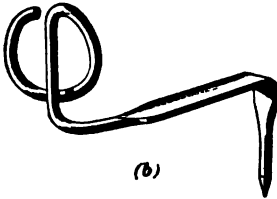
At (a), Fig. 133, is shown a



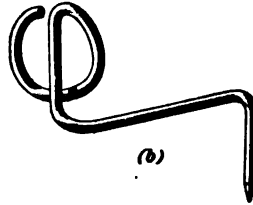
(a)



(a)



(b)



(b)

FIG. 133.

FIG. 134.

guard used with convex tiles; the loop *a* acts as the snow stop and stands above the tile about 2 inches; the shank *b* is of sufficient length to extend well back on the tile, and is made flat so that it presents the least thickness at the tile lap; the end is turned down and out and is kept flat at *c*, to give a driving surface over the nail point *d*, and to raise the guard to the height of the tile.

At (b), Fig. 133, is shown a guard made for flat or concave tiles; the loop and shank are the same as at (a). The nail point is turned down without forming a knee, because the tiles do not stand more than $\frac{3}{8}$ inch above the roof.

At (a), Fig. 134, is shown a guard used for metal roofs, with lock seams. It is secured to the roof under the lock by a galvanized-iron nail driven through the loop at the back.

At (b) is shown a guard used for slate or shingle roofs. This guard is set between the edge joints of the slates or

shingles, and the nail point is driven into the roof boards. Should this form of guard be bent down by the weight of snow and ice, it may be readily pressed back, without breaking, into its proper position. Guards are also manufactured of cast iron, but, being clumsy, they are not to be recommended.

Guard rails are also clumsy and unsightly; they gather the snow in a drift, which dams up the water, with the result before mentioned; on the other hand, the wire snow guards placed all over the roof are almost invisible, and hold the snow until it melts and disappears.

SHEET-METAL WORK.

USES OF SHEET METAL.

1. The greater part of sheet-metal work used in building construction is employed for the following purposes:

1. For covering and flashing roofs and their intersections, so that the roofs may conveniently be made watertight.

2. For wall covering and the formation of columns, cornices, balustrades, and string and molded courses. In some cases the entire outer surface of the walls of a building is covered with sheet metal, the material being made to resemble masonry or brickwork, an effect produced at low cost. Frame buildings may also be covered with sheet metal in order to render them less liable to fire from adjacent structures.

3. In forming gutters, valleys, or other water channels that are graded down to certain points of outlet, so that the rain which falls upon the roof may be conveniently drained away, thus preventing the roof water from being shed upon the ground around the building.

4. For conductor pipes, sometimes called leader pipes, which are commonly secured against the outside walls of a building to connect the lowest points of the roof gutters with an underground drainage system, or simply to a drainage

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above the surface of the ground, so that the roof water may flow freely away from the gutter.

5. For covering domes and lanterns, and in forming crestings and finials.

6. For interior decorations, such as the covering of walls and ceilings where first cost is an important factor; or, for the covering or formation of the inside trim, doors, windows, casings, etc.

7. For flues and other conduits commonly employed for purposes of ventilation.

While there are other positions and features where sheet metal may be employed, a thorough knowledge of the foregoing examples should enable the student to reason out, and solve, any special problem that may present itself.

EXTERIOR SHEET-METAL WORK.

INTRODUCTION.

2. The general subject of sheet-metal work for roof coverings, flashings, etc., has been treated in the section on *Roofing*, and the application of sheet-metal work for ventilating purposes is dealt with in the section on *Heating and Ventilation*; consequently this portion of the subject will not be considered in this section.

3. The kind and class of exterior sheet-metal work required, will of course depend upon the character and purpose of the building. Mills, factories, workshops, warehouses, etc. are often covered with galvanized sheet iron in the plainest possible manner, with no pretensions to artistic treatment, while store and office fronts are often covered with sheet metal bent and formed into elaborate moldings, or pressed and stamped into ornamental details, which are grouped so as to form decorative features. Generally speaking, sheet-metal coverings for buildings are imitations

of brickwork or masonry, and when properly arranged and attached to a good solid backing and carefully painted, they make, for some time, successful deceptions.

Sheet-metal fronts and other wall coverings are employed only when the desire for ornamentation exceeds the owner's willingness or capability to pay for the genuine article. From a speculative point of view they may be paying investments, providing the metal is protected against corrosion; but from an architectural or engineering standpoint, they are utter failures.

WALL COVERINGS.

4. Wall coverings may be classed as plain and ornamental. Plain wall coverings are used chiefly on buildings intended for manufacturing purposes and for such structures as are erected for temporary use; while ornamental coverings are generally used on the fronts of cheap city buildings, such as warehouses, stores, theater fronts, etc.

5. The sheet metal employed for this purpose is usually galvanized sheet iron or steel, the sheets being either **plain**, **crimped**, or **corrugated**.

Plain sheet iron is seldom used except for the most ordinary work, where appearance is not at all considered. The sheets are simply nailed to a backing of matched lining or ordinary sheathing, the object usually being to prevent the building from readily becoming ignited, should an adjacent building be on fire.

The chief objection to plain sheet siding, is the fact that the metal will bulge and become distorted in many different ways, until the whole side of the building will actually appear to be covered with large blisters.

6. *Crimped* sheet iron is superior to plain sheet iron for covering large flat surfaces, because the crimping helps to prevent the sheets from bulging, and thus, to

a certain extent, avoids the blistered appearance so pronounced on plain sheet-iron siding. A clipping of crimped sheet metal is shown in Fig. 1. The sheet is crimped by passing it through ribbed or roughened rollers, which give it the appearance of being slightly corrugated. Crimped metal, however, differs from corrugated metal in that sheets of the former, after treatment, are practically as long as they were before the process, while in corrugating the sheet is shortened. The crimps are usually made across the sheet, while corrugations are run lengthwise.



FIG. 1.

Crimped sheets may be nailed to furring strips, or to studs or posts set at from 12 to 16 inch centers, providing the grooves run at right angles to the strips or studs. Thus, if furring strips are nailed on the studding, the grooves would be vertical, but if the sheets are nailed directly on the studding, the grooves would be horizontal. It is best, however, in every case to provide a solid flat backing for crimped sheet-metal work.

7. Corrugated sheet iron is preferable for siding where there is an extensive, unbroken surface. The corrugations not only strengthen the sheets, and thus enable them to be attached to furring strips as far apart as 4 feet, but they also relieve, by the play of light and shade, the monotony incident to a flat surface.

Corrugated sheet iron should always be fastened with the corrugations vertical, not so much for appearance as to

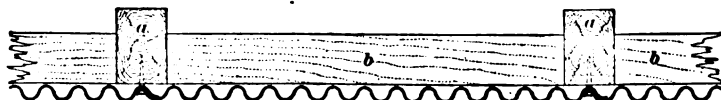


FIG. 2.

obtain a perfectly water-tight siding with ordinary lap joints. Fig. 2 shows the method of forming vertical joints. The corrugations are simply lapped and the two sheets are nailed

to the posts or studs *a, a* with flat-head galvanized-iron nails. The top edge of each sheet is nailed to cross-pieces *b, b* which are spiked or framed in between the posts. The horizontal joints of the sheets are lapped as shown in Fig. 3; cleats are riveted on as shown at *a* to bind the lower end of the sheet so as to make a close joint and also allow for expansion and contraction of the sheets. The top sheet should lap at least $\frac{3}{4}$ inches over the nails.

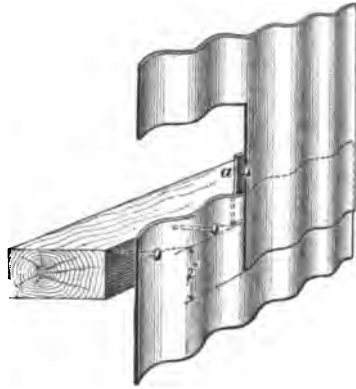


FIG. 3.

Corrugated-iron sheets are often secured against sheathed walls, and the common practice is to nail them all around the edges, but, in this case, expansion and contraction soon loosen the sheets either by drawing the nails or by tearing the nail holes. The plan of attachment described above and illustrated in Fig. 3 is to be recommended even when the sheets are secured against a flat surface.

8. Fig. 4 shows how the corrugated sheets may be put on at the base of the framework. A **base strip *a***, made in the form of an offset, is securely nailed to the wooden sill ***b***, the strip being flanged so that it may cover the exposed portion of the wall. The sheets are clamped to the top edge of this strip with cleats 1 inch wide by $\frac{1}{4}$ inch thick, similar to that shown in Fig. 3.

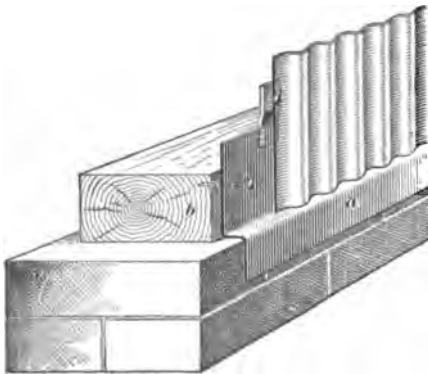


FIG. 4.

9. Fig. 5 shows the finish of the sheets at the eaves. The top edges are nailed to the plate *a*. A strip of wood *b* about

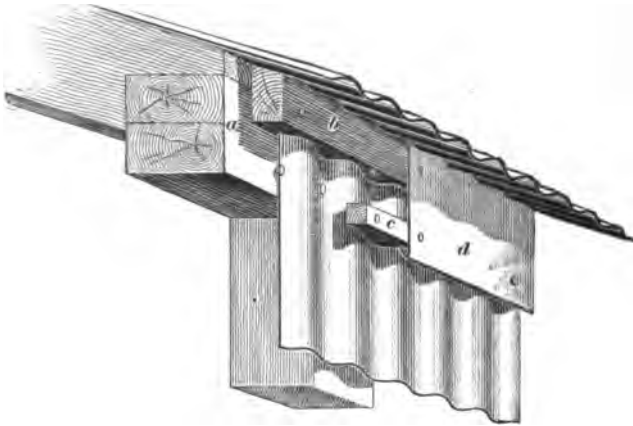


FIG. 5.

$1\frac{1}{4}$ inches thick, cut on one edge to fit the profile of the corrugations of the roof, should be nailed to the upper edge of the plate. Another strip *c* of the same material is nailed to the lower edge of the plate. A fascia of crimped sheet iron *d* covers both strips and forms a drip at its lower edge, as shown. This arrangement makes a neat, water-tight, and wind-proof connection between the siding and the roof.

10. Fig. 6 shows the finish at the corners of the building; this makes a water-tight junction and presents a neat appearance.

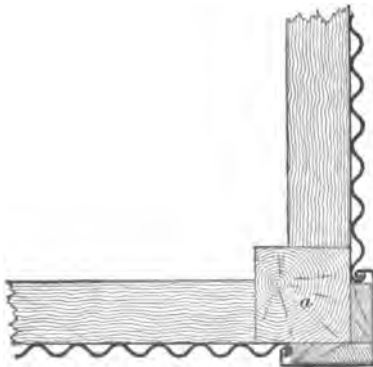


FIG. 6.

Since the corrugated iron is laid against the framework, it is necessary to nail $\frac{7}{8}$ -inch wooden strips on the outer faces of the corner post *a*. The corrugated iron butts against the edges of these strips, and a crimped sheet-iron corner piece, is sprung over and locked into the corrugated wall sheet, as shown.

This arrangement can also be used around any window or door opening. The arrangement shown in Fig. 4 may also be used over the lintels of any door or window opening.

11. Corrugations in common use measure about $2\frac{1}{2}$ inches, from center to center, and are about $\frac{1}{2}$ inch deep.

Black corrugated iron should always be painted with metallic paint of the best quality before it is secured in place.

12. Stamped siding is most commonly employed for covering large flat surfaces of outer walls, the sheets being pressed to such a shape that they resemble **rock-faced**, or **tooled**, stonework or brickwork. This siding is stamped in plates 10 feet long by 2 feet wide, and the plates are sold by the lineal foot. Like crimped sheet metal, it is nailed to furring strips, to ordinary sheathing, or to brick walls, the vertical joints being lapped and closely nailed.

Particular care should be taken to lap all the vertical joints in sheet-metal work so that the heaviest rain storms will blow with the laps and not against them. It is noticeable in nearly every district that the strongest winds and greatest rain storms nearly always blow from certain directions; these directions should be determined, and the sheet-metal work should be arranged to prevent the rain from blowing into the seams.

Brick walls should always be thoroughly furred to receive the sheet-metal work. It is a mistake to suppose that sheet-metal work can be securely nailed into the joints, because expansion and contraction will very soon loosen the fastenings.

CORNICES.

13. Sheet-metal cornices are made in such a variety of patterns, in such a wide range of sizes, and are required to be placed in such a diversity of situations, that there must be a great variation in the methods of construction. Very many designs, however, correspond as far as having moldings continuous throughout their lengths. All are supported

by projecting brackets or lookouts. The joints, shape, and material of the cornice proper, and the construction of lookouts, are the features in cornice work which we will consider in particular.

Cornices are made at the cornice factory according to drawings and specifications, and are shipped in parts to the building.

Brackets, modillions, dentils, etc. are usually secured to the cornice at the factory. Trusses and check or stop blocks are shipped in separate packages. Thus it will be seen that the cornice setter or tinsmith is only required to assemble the several parts and erect them in place on proper supports. The supports in general use are wood or iron, the latter being employed in the better class of buildings.

14. Cornice Erection on Wood Supports.—Fig. 7 shows the parts and joints in a sheet-metal cornice as ordi-

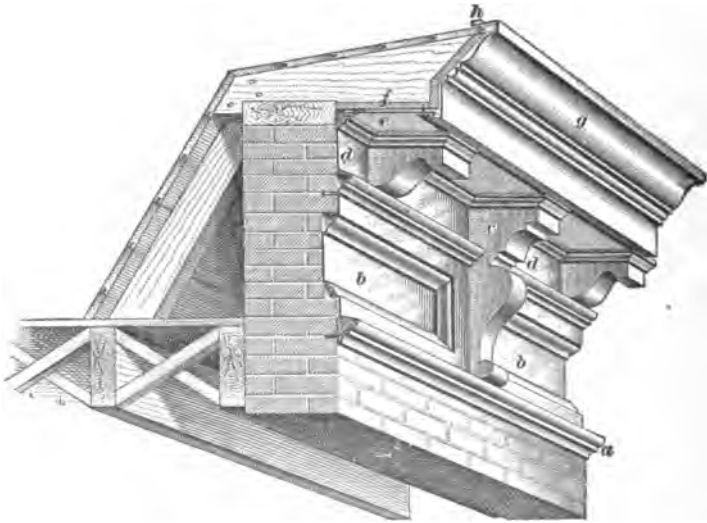


FIG. 7.

narly constructed in small sections on a brick wall. The foot molding *a* is fastened to and supported by a board and wooden lookouts, the lower member being allowed to hang down below the raglet or groove which runs along the joint

of the brickwork at the underside of the lookouts. The top of the foot molding enters the raglet in the next joint above. The paneled frieze *b* is made up in one piece between the trusses or brackets *c*, the edges being doubled over and secured into raglets as shown. The modillion course, which generally includes the small moldings above and below the plain surface from which the modillions project, is attached to the brickwork in a similar manner and is secured in place with a long, narrow, metallic wedge. If the cornice is erected while the walls are being built, the upper flange of each piece is usually bent over far enough to be safely bedded in; the lower edge of the sheet above being bent over and pushed into the same joint as the work progresses. The soffit *e* may be bent up out of the same piece with the bracket molding. The drawing, however, shows it separate, and secured to the board lining *f*.

The **crown molding** *g* is bent over the top of the roof boards, leaving an edge turned up as at *h* for easy connection to the sheet metal of the roof. The lower edge of the crown molding should be made to form a drip, as shown, and should be securely nailed to *f*.

The brackets and trusses which are hollow and built up from stamped sheet metal are riveted and soldered in position. It is difficult, however, to properly attach them when the cornice is put up in sections, as shown, so it is advisable to have these projections riveted and soldered on before the cornice is put up. In the construction of cornices, particular care must be taken to avoid pockets in which water may accumulate. If there is any suspicion of a water-tight pocket, a small hole should be punched at the lowest point to allow any water to drain out. If this is not attended to, these pockets may fill up with water, freeze, and burst.

15. Another plan for securing cornices against brick walls is to spike boards against the face of the walls, plant the cornice on top of the boards, and nail it in place. The former method, however, is preferable, not only because the nails must show by the latter method, but chiefly because

the boards will warp and the cornice will consequently become distorted and loosened.

The cornice work shown in Fig. 7 is attached to a brick building with a flat roof. The roof pitches down to the back of the building and the conductor pipes, of course, are in the rear. When the roof pitches in the direction of the cornice, a gutter is usually formed at the back of the crown molding.

16. Iron Supports.—It is comparatively easy to secure a sheet-metal cornice to a wooden building, or even to woodwork which is spiked to brick buildings; but it is considerably more difficult to properly secure a cornice to brick, stone, terra cotta, or to the structural ironwork of the modern fireproof building.

Fig. 8 shows a system of bracing well adapted for a cornice at the top of a brick wall. The framework or bracing



FIG. 8.

shown, which is mostly composed of angle irons, should be built into the wall. These frames should be placed from 2 to 4 feet apart, according to the projection. The cornice is sometimes bolted to the framework after the wall is finished.

The strongest and best plan, however, is to attach the iron frames to sections of the cornice about 14 feet long and hoist the sections up, and set them on the wall

when it has been leveled at the required height as at *a*. When lined up and in proper position, the frames are tied

temporarily in place to keep the cornice from toppling over until the brickwork *b, b* is all filled in and has set. This mass of brickwork must be sufficient to more than counter-balance the weight of the cornice. If there is any danger of the cornice being too heavy for the counterweight, the legs *c* must each be tied separately to some beam or other rigid part of the building.

There are, of course, many kinds of iron supports for cornices other than that shown in Fig. 8, but with a little judgment the student should be able to design a lookout for any position. The principal points to be considered in such a design are: (1) to obtain a band of iron which will follow, in a general way, the contour of the cornice; (2) a means to brace this iron band and prevent it from changing its shape; (3) a means of rigidly securing the iron band to the building; iron beams, or columns, being preferable for anchoring points.

17. Joints in Cornices.—Different mechanics have different methods of making vertical joints in cornices; some of these are very neat, strong, and durable, while others should not be tolerated. The only two joints worthy of mention here are the *butt joint* and the *lap joint*.

18. A butt joint is shown in Fig. 9. The edges of the sheets *a, a* which form the cornice are trimmed perfectly square and straight, so that when brought together they will fit closely. A strap *b*, which is made from the same metal as the cornice, is then riveted the entire length of the vertical seam, and its edges are soldered to the back of the cornice, as shown.

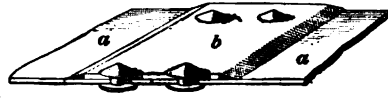


FIG. 9.

The rivet heads are all on the outside, and the process of riveting draws in the heads and makes them scarcely visible. The rivets should be as close together as possible.



FIG. 10.

Fig. 10 shows a **lap joint**. The sheets are lapped over one another for a distance of

$1\frac{1}{4}$ inches and then riveted closely. The back sheet is dressed forwards to be flush with the other, as shown, and the back edge is then soldered, as at *b*.

19. Both of these joints are strong and durable. The butt joint, however, is neater than the lap joint. A first-class mechanic can make one of these joints so that a perfectly smooth surface will be obtained.

The *rivets* for galvanized-iron cornices should weigh $1\frac{1}{2}$ pounds per thousand, for Nos. 24, 26, 28, and 30 sheet iron. The rivets for copper cornice work should weigh 1 pound per thousand.

20. **Cornice seams**, or horizontal joints, are also made in a variety of ways, but the following methods illustrate good practice when the joints must be made on the job.

Cup joints are shown at *a* and *b*, Fig. 11. The position of the copper in these joints shows how they appear when the cornice is being fitted up.



FIG. 11.

After the cornice is lined up in place and the vertical joints are all made, the edges are bent over twice, thereby locking the seams. These joints are necessary only in large cornices.

When a seam must be made on a flat surface, such as on a wide frieze, either of the methods shown at *c* or *d* may be employed. The seam at *c* is lapped and riveted like that shown in Fig. 10; a stiffener, however, is bent at the back to keep the seam straight.

This is the stronger seam of the two. It is preferable to that shown at *d* in places where rain will wash over it. When it is desired to form a very close horizontal joint, the **clinch seam** at *d* may be used. The edges of the sheets

are bent over and butted together in position. The cap is then slipped over the seam as shown. When the work is all lined up, the seam is closed by flattening down the cap. This process draws the sheets together and makes a very close seam.

21. Miters.—All miters in cornice work, pediments, and elsewhere may be classed as *lap* miters or *butt* miters.

Outside miters are made in different ways, but there are only two reliable methods. The first, or lap miter, is made by returning a $\frac{1}{4}$ -inch flange on the inside of the miter, as shown in Fig. 12. This flange must be riveted closely and soldered on the inside. The chief objection to this miter is that the edge of the sheet is visible.

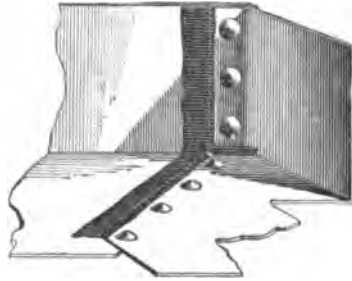


FIG. 12.

To make a close miter it is necessary to bevel and butt the edges as shown in the butt miter, Fig. 13. In this figure the edges of the copper are fitted closely together.

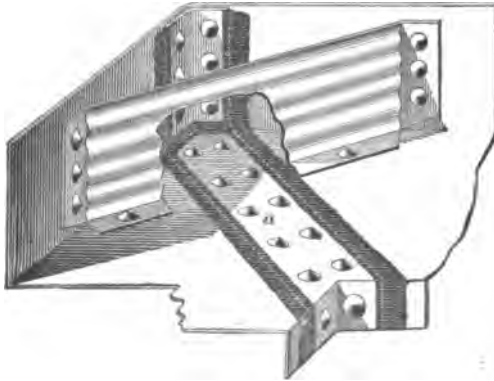


FIG. 13.

A copper angle strap *a* is then riveted and soldered securely in the inside angle the full depth of the cornice. A few gussets are then riveted and soldered across the inner

corners as shown. They help to keep the cornice square during shipment and prevent the edges from being pulled apart by expansion and contraction. The method shown in Fig. 13 should be used on all first-class work.

Inside miters are made and reinforced in a similar manner, but owing to the fact that gussets cannot be used, it is advisable to rivet a reinforcing angle strap over the half-inch flange.

22. Iron-Beam Cornices.—In some buildings the iron-work of the first story or “store front” does not project beyond the wall; and the iron beams, such as those over store windows, often require to be covered with a metal panel or cornice, or both combined.

Fig. 14 shows a **panel course** attached to an iron **I** beam.

A series of bar-iron braces *a* are fastened to the web of the

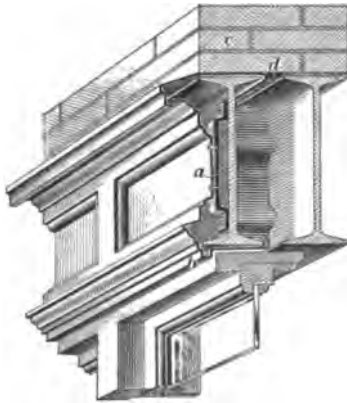


FIG. 14.

I beam and the panels are secured to them with counter-sunk screws, so that the heads will finish flush with the face of the panel. A rebate is formed at *b* to cover the joint between the top of the window frame and the iron beam. When the beams are in place, and before the brickwork *c* is built thereon, the sheet-metal panel course is pushed over the face of the beam and doubled over at the back edge of the upper and lower flanges, as

shown at *d*. The braces *a* thus merely support the frieze and prevent it from sagging. If desired, a plank instead of iron straps may be bolted to the web of the beam to support the panels.

23. String-Course Cornice.—A string-course cornice, or store cornice as it is often called because it is so commonly used over store fronts, is shown in Fig. 15. The lookouts are

made of band iron $\frac{1}{4}$ in. \times $1\frac{1}{4}$ in. and are tied into the brickwork at *a* and *b*, these ends being built into the wall. The lower ends of the lookout frames are continued down over the face of the beams and along under their lower flanges, and are then bent up at the back, as shown at *c*. An angle iron at *d* running the whole length of the cornice is bolted to the ends as shown at *c* and keeps them in place. A sloping platform of matched boards is screwed on the top of the

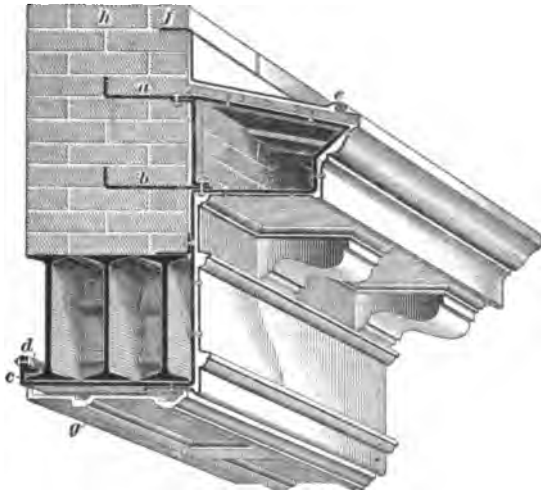


FIG. 15.

lookouts. The sheet-metal work is bolted to the band iron in the usual manner, a soldered double seam with cleats is made at *e*, and the top covering enters the wall at *f*. An iron plate, either plain or ornamental, is usually secured at *g* to form the soffit of the beams over the opening.

After the beams are set on their columns, and before the mason begins to build on them, the cornice must be set in position. The cornice being set true and level, the mason finishes the wall up to the course *h*; then the flashing is put on, the top edge *f* being bent over about 3 or 4 inches, as shown. When this is finished the mason proceeds to build the superstructure. If the wall is built before the cornice lookouts are ready, the anchors *a* and *b* must pass through

the wall and be bent over at the back, and the flashing *f* must be let into the raglet and be battled with lead, the raglet being filled with mastic or other cement in the usual manner.

24. In many cases it is advisable to make the lookouts of cast iron instead of wrought iron, as, for example, when a very large number of small lookouts having the same shape are required. If the molding is small and extends as a belt, or string, course around the building, it is certainly advisable to use cast-iron lookouts. The chief advantages of cast-iron lookouts are accuracy in the lines of the cornice, economy in construction, and durability.

Accuracy is insured when the lookouts are properly lined up, because each lookout is a duplicate of the others, they being all cast from the same pattern. Economy of construction lies in the fact that the labor of making the lookouts and of fitting the sheet metal to them is reduced to a minimum. And the durability lies in the fact that cast iron is less corrosive than wrought iron. Iron lookouts should always be coated with asphalt or other protective covering in order to prevent rapid corrosion.

25. Galvanized iron should never be used for cornices except in the very cheapest work, and even then it should be thoroughly painted on both sides. Sheet copper (cold rolled) is preferable, however, in every case. The metal itself costs considerably more than iron, but the labor and other expenses, relative to its construction and installation, are about the same.

26. Copper cornice work does not require to be painted for protection. It is, in fact, better practice to leave the metal thoroughly scoured, clean, and uncovered, and allow the weather to slowly change its color. Copper sheet-metal work has naturally a dark-green tint, but it often takes a very long time to get that color. The time required will depend considerably upon the climate, the weather, and the composition of the atmosphere. Where the rain becomes acidified, by falling through air charged with sulphurous

gases, the color changes rapidly, but where it falls pure and clear, the copper changes color very slowly.

When it is desired to hasten the color it is customary to produce an *artificial* color by washing the copper with acids. One method is to thoroughly scour all the copper work to remove any grease or acid spots, then wash the entire surface with a solution composed of 1 pound of sal ammoniac to 5 gallons of water. This solution should stand about 24 hours before it is applied. After the copper has been uniformly covered with the solution, it should be allowed to stand for a day or two and should then be lightly sprinkled with clean water. If the water is put on too freely, it will run in streaks. After a few days the copper work should have a beautiful and uniform greenish-brown color which will stand the weather. The same effect may be produced by using vinegar and salt in the proportion of $\frac{1}{2}$ pound of salt to about 2 gallons of vinegar.

27. Soldered Seams.—Although it is advisable in all sheet-copper work to solder the seams on the back where they cannot be seen, it nevertheless often happens that some parts must be soldered on the front. The solder does not change color like the copper, and, consequently, when not properly treated, such seams tend to spoil the appearance of the work.

To give solder a copper color, it is necessary to deposit a copper plating upon it. This is accomplished by first thoroughly scouring the seams, then washing them with a solution of *sulphate of copper* and water. The solution should be strong. When applied with a brush to the solder, a film, or plating, of metallic copper is immediately formed over the solder, and, by repeated applications, a fairly substantial coating of copper is obtained.

WINDOW SILLS, LINTELS, AND CAPS.

28. Window sills are made of sheet metal to represent cut-stone sills. They should be filled in behind with timber of the proper size. The metal sills are usually slipped over

the wood backing and secured to the wall by nailing closely through the flange *a*, Fig. 16, which extends along the bottom and up the sides.

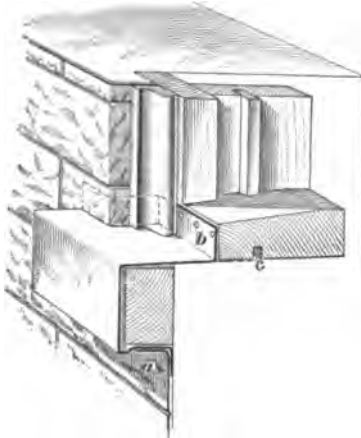


FIG. 16.

The top flange *b* is made wider than that at *a*; it is nailed against the window frame and is bedded in white or red lead to make it watertight. A better plan, however, is to bed the window frame over the metal sill with red or white lead, the metal being flanged and passing up into the groove *c*. Metal window sills are generally used on galvanized-iron fronts. Copper is seldom used for this work.

29. *Window lintels* are covered in a similar manner, the chief difference being that the top flange of the lintel is overlapped by the metal siding above it. The soffit of the lintel flanges down against the top of the window frame and is nailed to it. Particular care, however, should be taken to have a well inclined wash on the lintel. Horizontal surfaces, particularly pocketed surfaces, are very objectionable and should always be avoided.

30. The covering of bay windows, architraves, pediments, etc. depends altogether upon the design. An important point to be considered in the line of sheet-metal work for bay windows, pediments, etc., is the provision for lookouts and other projections to which the cornice and other moldings must be attached. Small moldings are usually planted on the flat, sheathed surfaces, while lookouts are required for the cornice and other large projections. It is advisable, on all the work, to provide solid backing for the sheet metal. When wooden lookouts are used, they should be so made that the metal work can be nailed across the

grain of the wood, not with it. The expansion and contraction of the metal soon draws out and loosens all nails which are driven in the direction of the grain.

31. *Window caps*, like all other ornamental parts of sheet-metal work, are made up from stock sizes and shapes of bent or stamped sheet metal. Fig. 17 shows a sheet-metal



FIG. 17.

window composed of an architrave *a*, a frieze *b*, and two impost blocks *c, c* supported by brackets or trusses *d*. The impost blocks support the pediment *e*, and a counter-flashing at *f* makes the top water-tight against the brick wall. If the cap is put on after the walls are up, it is customary to secure it in place against wooden look-outs, as shown at *b*, Fig. 18. Furring strips *a, a* are nailed to soft pine plugs, previously driven into the wall, and the lookouts *b*, Fig. 18, are set about 1 foot apart along the line of the furring strips and nailed



FIG. 18.

to them. Two special lookouts are secured to support the trusses. The sheet-metal cap is then set over the lookouts and is rigidly nailed to them. The metal is extended under the soffit of the lintel and flanged down against the hanging tile of the window frame, and is neatly finished with an angle molding bedded in white lead and well nailed in place. The wash *c* of the cornice is turned up against the wall and is counterflashed in the usual manner.

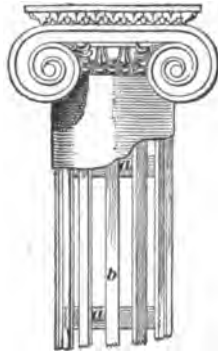
If the wall has not been built, it is advisable to use iron lookouts and build them in the brickwork when the wall has been brought up to the proper height. The upper surface of all window caps, sills, and cornices should be carefully protected during the erection of the building. Every window cap, and indeed every other projecting molding or cornice, should be closed water-tight on top with a sloping deck or wash, and should be sufficiently strong for a man to walk along the projection.

COLUMNS.

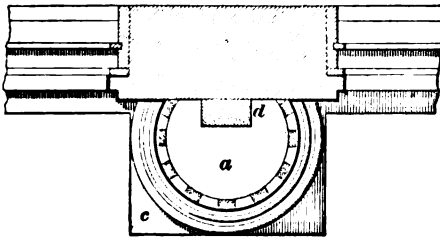
32. There are many different kinds of columns and pilasters, and different methods of constructing them. In a general way, however, Fig. 19 illustrates common practice. This figure shows in elevation at (*a*), and in section at (*b*), a three-quarter column, such as is used on the front of a building. The column is braced by wooden blocking, composed of 1½-inch or 2-inch horizontal blocks *a, a* which are spiked to an upright post *d*, and spaced at intervals of not more than 2 feet. Vertical strips *b, b* are nailed to the face of the blocks, and are run from the square plinth *c* to the top of the capital. The sheet metal which forms the column is continued down to the plinth, and up to the block or other member over the capital, the seam on *c* being soldered water-tight. The back edges of the sheet are nailed to the face of the wall in the ordinary manner. The base is then put in place and soldered to the column. The capital should then be soldered to the column. This is one of the best methods of bracing sheet-metal columns.

In fireproof construction the same method is employed, except that iron is used instead of wood. Pilasters are

formed and covered in the same manner as columns. In all column and pilaster construction, avoid the formation of pockets wherein water may accumulate.



(a)



(b)

FIG. 19.

FIRE DOORS AND SHUTTERS.

33. Wooden fire doors may be covered with any kind of sheet metal which has a high temperature of fusion. Copper and zinc are not suitable for this work; galvanized iron and tin are therefore used, though tin seems to have the preference. The covering is generally put on as follows: The outer edges of the door are covered first with a strip of tin, which is returned over both faces to a distance of about 6 inches, the edges being nailed to the woodwork and turned over, as shown

in Fig. 20. The flat part of the door is then covered with sheets 14 in. X 20 in., in a manner similar to that employed

on flat roofing. This arrangement avoids seams around the edges of the door, and allows it to shut with a close contact.

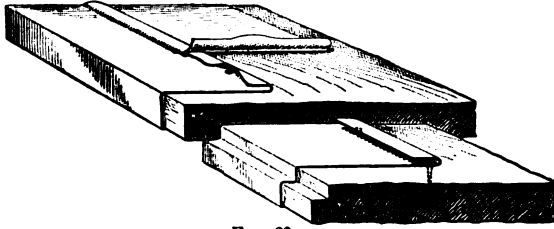


FIG. 20.

A heavy body metal should be employed for this work, because the efficiency of the covering in case of a fire depends upon the thickness of the metal, and not upon the thickness or quality of the protecting coat. The seams should all be

closely nailed, and then locked and thoroughly pounded down. A layer of asbestos cloth should be placed between the tin and the wood.

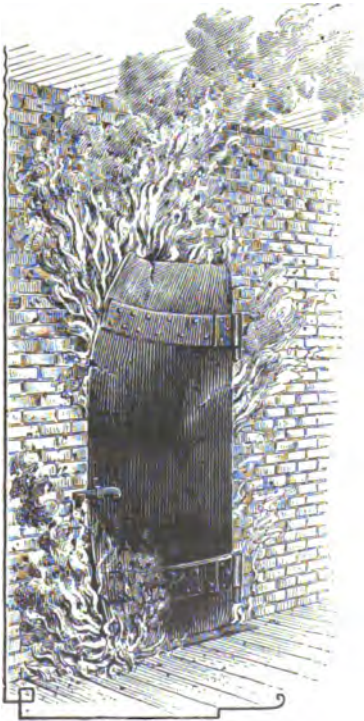


FIG. 21.

Corrugated-iron doors and shutters are also extensively used, but they do not form as efficient fire stops as ordinary wooden doors or shutters which are properly covered with tin and asbestos. The corrugated iron must be thoroughly braced with an angle-iron or T-iron frame.

The chief objection to iron fire doors and shutters is that they warp very easily when the flames touch them. Plain iron warps so much that it is practically useless as a fire

stop. Fig. 21 furnishes a good illustration of this. The door shown is composed of one sheet of thick metal, and is provided with iron cross-pieces to which the hinges are riveted. The fire plays against the inside of the door and warps the sheet outwards, thus allowing an opening for the flames, as shown.

COPINGS.

34. Wall Copings.—The tops of all brick walls must be made water-proof, otherwise the rain will soak into the wall heads and ultimately ruin them. When cheap, light coping stones are used, it is necessary to lay a sheet of metal (preferably lead or copper) under them, as shown in Fig. 22. The sheet metal is simply laid on the brickwork and bent over about 1 or 2 inches at each edge.

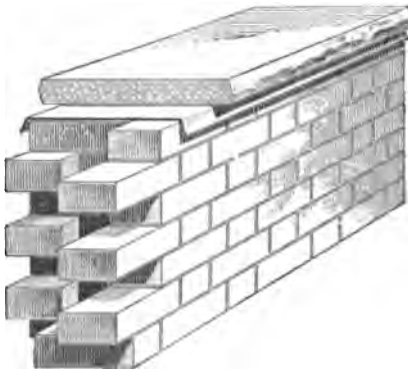


FIG. 22.

The stones are then bedded in place in the usual manner.

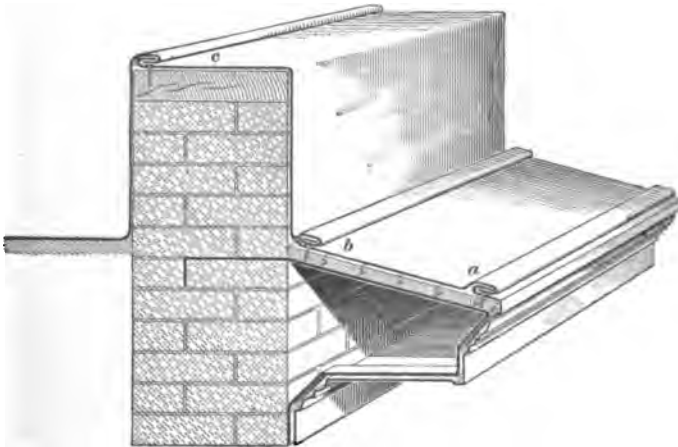


FIG. 23.

35. Coping Blocks.—When coping blocks are used to surmount cornices, the flashing or wash of the crown may be extended through to the back of the wall, where it may connect to the roof covering, or to a gutter lining, as the case may be. When it is necessary, however, to entirely cover the blocking course with the same kind of metal as the cornice, the metal work of the cornice may be extended up and continued over the blocking course, as shown in Fig. 23; the sheets being crimped and held in place by cleats in the seams *a*, *b*, and *c*. A wooden wall cap is placed on top of the brickwork to protect the top course and take the cleat nails.

36. Stone cornices may be flashed as shown in Fig. 24. The copper is bent over the face of the stone and doubled over with a beaded edge on the under side to form a drip. This

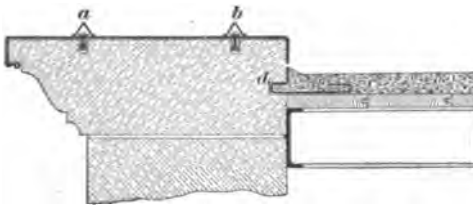


FIG. 24.

also prevents the flashing from rising in front. When the top surface is narrow—i. e., less than 12 inches—it does not need to be held down, but when it

is wide, the copper should be held down with fastenings, as shown at *a* and *b*.

The arrangement shown in Fig. 24 is used at the junction between a stone cornice and an asphalt roof laid on fireproof construction, the asphalt covering being shown at *c*. Sometimes the copper is bent down flat over the back of the stone, but the best method of attaching it is to groove the stone at the back and let the copper into it, as shown at *d*. This holds down the flashing at the back.

37. The common method of fastening the sheet to the stone is to drill $\frac{1}{2}$ -inch or $\frac{3}{8}$ -inch holes at intervals over the surface of the stone. These holes should be cut wider at the bottom than at the top, so that the lead plugs cannot be pulled out. An iron rod, whose diameter is less than that of the screws to

be used, is greased and placed upright in the hole. Molten lead is then poured around the rod until the hole is full. The rod is then pulled out, and when the flashing is all laid and neatly set in place, it is screwed down to the lead plugs with brass screws.

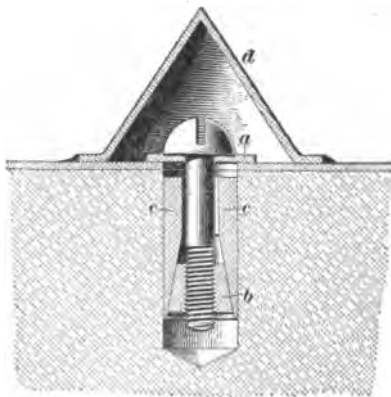


FIG. 25.

Expansion bolts (see Fig. 25) are now generally used for fasteners. After the holes are drilled and the stone covered, the holes are "found" and the expansion bolts are inserted. A washer *a* is placed between the bolt head and the copper, and the bolt is screwed down tight. This draws up the tapered, or wedge-shaped, nut *b* and presses the sides *c, c* against the sides of the hole. A cone *d* is then soldered over the fastener, as shown, to make it water-tight. If fasteners are not used, the copper is likely to rattle when the wind blows.

38. Chimney caps are made in different styles. The most simple, and perhaps most common, form is a plain sheet-metal cap which is slipped down over the brickwork

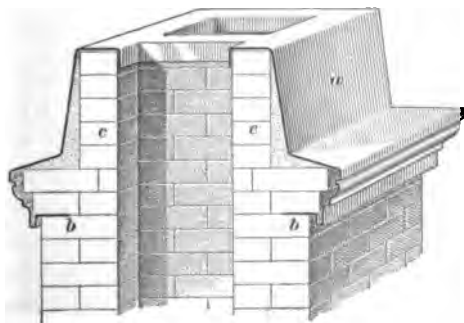


FIG. 26.

about 6 inches, the sides of the cap being nailed into the joints of the brickwork. A superior chimney cap, however, is shown at *a*, Fig. 26. The brick chimney is built up to the course *b*, then the cap is bedded on, and finally the brickwork *c* is filled in

from the top, so that its weight on the flange, which is turned over the course *b*, will prevent the cap from being blown off. The moldings of the cap, being of small projection, do not require any lookouts. The brickwork must, however, be built up tight to the top of the cap to prevent it from settling down and flattening the molding.

BALUSTRADES.

39. Balustrades, like cornices, etc., are constructed either with wooden or with fireproof supports; the kind to be employed will depend upon the construction of the building. Balustrades, pedestals, etc. on non-fireproof buildings are usually backed with, or secured to, woodwork, while those on fireproof buildings are nearly always supported by iron or brickwork.

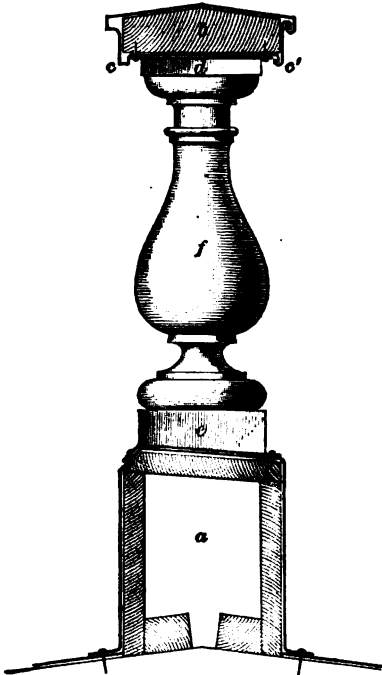


FIG. 27.

Fig. 27 is a section through a balustrade which is commonly employed where the cornice deck pitches to the front and the roof pitches to the rear. The bottom rail *a* extends down to the deck, the metal being flanged over and soldered to the roofing.

When the deck over the cornice grades back towards the balustrade, and when the base rail extends down to the deck, it is necessary to solder in some drain tubes to take away the water. This will prevent a pool of water from forming against the base of the balustrade. The trouble, however, with such tubes is that they will become clogged

with snow, etc. The best arrangement is to elevate the base rail a distance of 2 or 3 inches above the deck. Roof-cornice decks, in fact, should always pitch back to the roof to prevent rain from dripping over the cornice. When the base rail does not extend down to the deck, the sheet-metal backing is composed of solid timber entirely covered with metal.

To prevent the rail from sagging, wooden blocks which are covered with sheet metal are inserted under the rail at distances of from 6 to 8 feet apart. The coverings of these blocks are bent over at the top and nailed to the under side of the base rail, while at the bottom they are bent out and soldered as a flange to the deck.

The cap rail *b* is usually made of wood and covered with two pieces of sheet metal, with drips formed at *c*, *c'*, as shown. The seams are made at the rear.

40. The balusters *f* are either spun, pressed, or cast. If they are spun or cast, there will be no vertical joints in their length. If they are pressed, they are put together in halves, which necessitates two vertical soldered seams. Pressed metal is generally used on ordinary work because it is so much cheaper than the spun or cast metal. The top member *d* and the bottom member *e* of the baluster are usually square. All the different members are securely riveted and soldered together before the baluster is set in position. After the cap and base rails are in place and lined up properly, the balusters, which are hollow and flanged at top and bottom, are pushed into place. The flanges are securely nailed to the under side of *b* and to the top of *a*, as shown, the bottom flange of each baluster being soldered water-tight over the nail heads. The top flanges are not soldered, because the drips protect them.

It is generally understood that sheet-metal balusters are strong enough to support the top rail under ordinary conditions; but in cases where a load is liable to be placed on the cap rail, it is advisable to put a strut inside of each baluster, which will take the load off the metal and prevent the baluster from collapsing.

In fireproof construction the general arrangement is the same, the principal difference being that iron backing is used instead of wood, and the metal is bolted to it in a manner similar to that prescribed for cornices.

41. A pedestal, as ordinarily constructed, is composed of a framework made of 3"×4" timber, spiked to the

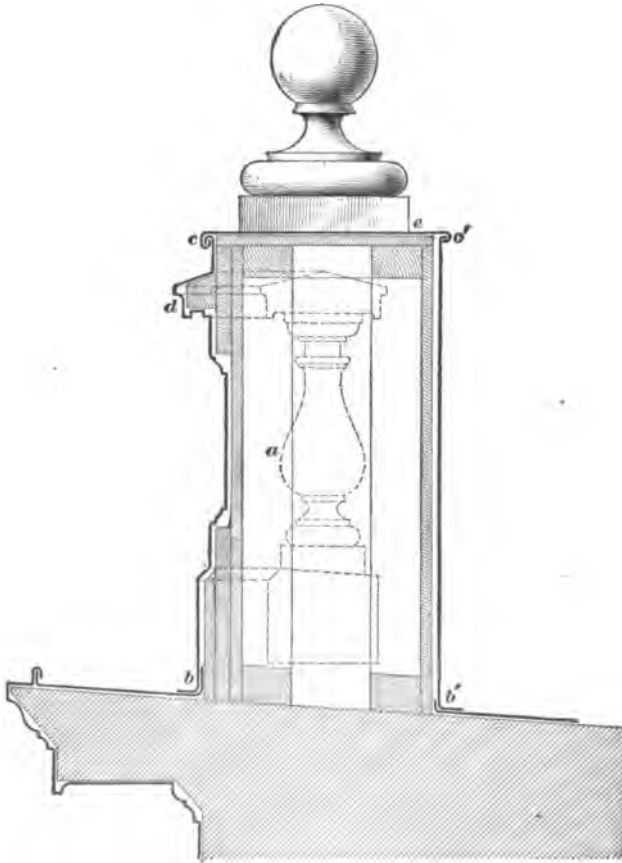


FIG. 28.

roof and sheathed, as shown in Fig. 28. The projections necessary for the moldings, etc. are blocked out. In the

figure the pedestal is provided with a panel face and a flat back. The sides may be paneled or plain. The dotted lines show the relative position of the balusters *a* and the cap and base rails with respect to the pedestals.

The sheet metal for the front and sides is made to fit the pedestal and is then put on in one piece. The back piece is then put in place and double seamed to the sides, flanges *b*, *b'* being formed at the base and soldered to the deck. The top is then put on and double seamed over a flange, as shown at *c*, *c'*. The double seam is shown turned down and finished at *c*, while it is only half finished at *c'*. The molding, or projection at *d*, is returned on the pedestal and miters with the top rail. The base block, in a like manner, returns and miters with the base rail of the balustrade. If a finial or vase is to be set on the pedestal, the connection should be made with a flange at *e* and should be lock seamed and soldered water-tight.

Corner pedestals are paneled on two sides; this necessitates a vertical seam on the outside and inside corners of the pedestal.

In fireproof construction, the backing for the pedestals is usually composed of brickwork when they are located immediately over the wall head. The sheet-metal covering is then made up in one piece and is slipped down over the brickwork, being secured to the deck with a flanged seam, as shown in Fig. 28. The top sheet, also, is secured in a manner similar to that shown in Fig. 28.

When a tall finial, which requires a support, has to be set, it is advisable to run a tube up through the center of the pedestal and screw the top member of the finial to this support.

When a solid brick backing cannot be obtained, it is necessary to construct a framework of wrought iron, which is thoroughly braced diagonally and bolted to the roof. The metal covering is then placed around the frame, and bolted or riveted in position in the ordinary manner.

GUTTERS.

42. The varieties of gutters that will be treated of in this section are: *eaves gutters*, *roof gutters*, *parapet gutters*, and *belt-course gutters* of various materials and for various classes of buildings. A little has already been said about valleys, flanks, and other sheet-metal roof work in *Carpentry*, and need not be repeated in this section.

An eaves gutter of the simplest kind, is shown in Fig. 29; it is known as a *half-round hanging*, or *trough*, gutter, and

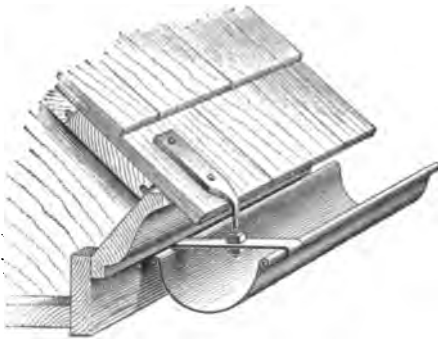


FIG. 29.

is commonly used on ordinary frame buildings. The standard widths are 3, 4, and 5 inches measured across the top of the inside. The bead is about $\frac{1}{2}$ inch in diameter and is turned outwards. These gutters are suspended from the eaves with adjustable malleable-iron hangers set

at about 3 feet centers. When they are secured to shingle roofs, the hangers may be simply nailed or screwed on to the shingles as shown in Fig. 29. A better method, however, is shown in Fig. 30, where the hangers are firmly nailed to the roof-boarding before the shingles or slates are laid.

The pitch or grade of hanging gutters should not be less than 1 inch in 8 feet and the gutters should be hung low enough to allow the snow to slide over them. Three-inch gutters are useful only for porches, bay windows, and other small roofs. The 4-inch size should be used on the main roof when the horizontal or projected area does not exceed 500 square feet. The 5-inch size is used chiefly on factories, warehouses and at the rear of large city buildings, where the projected area does not exceed 1,500 square feet. Hanging

gutters of this class should be used only when the eaves overhang the wall.

When a hanging gutter is attached close to the wall, the back of the gutter is extended up under the shingles or slates at least 6 inches, as shown in Fig. 30, the object being to prevent heavy winds from blowing the rain drops against the siding. The gutter is held up in front by tension straps *a, a*. The lower ends of the straps are soldered to the bead,

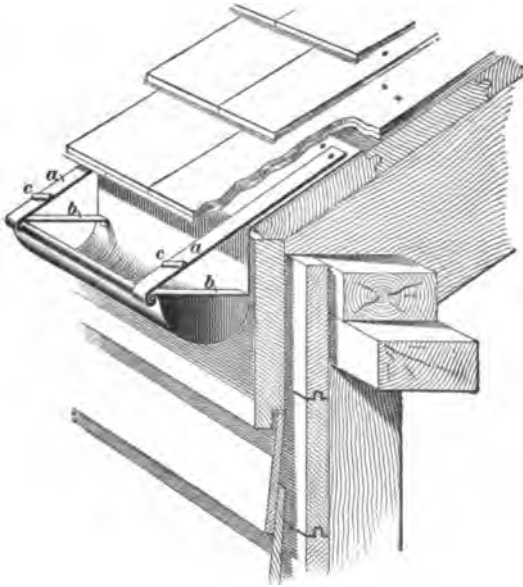


FIG. 30.

and the upper ends are nailed to the roof. Braces *b, b* are soldered inside, and above the water line, to prevent the gutter from collapsing and sagging. Small clips *c, c* are soldered on the straps at an angle, to divert any current of water which may flow along the strap and thus escape over the edge of the gutter. This gutter should be graded about the same as that shown in Fig. 29.

43. Molded Eaves Gutters.—Molded, i. e., ornamental, eaves gutters are often attached to buildings in a manner

very similar to that shown in Fig. 30, but while the gutter in this figure is laid with a pitch, such molded gutters are laid perfectly horizontal. In this respect they are defective, because all gutters should pitch down to the outlet pipes. In good practice, it is advisable not to run a gutter with a horizontal bottom, not only because the gutter is liable to overflow during heavy rain storms, but because a pool of water will remain in the bed of the gutter after the rain has ceased. To prevent an overflow, it is necessary to make molded eaves gutters quite large; and to properly drain them, it is necessary in some cases to install a false bottom which will grade down to the point of outlet with a suitable pitch.

When the gutters are made of iron, they should always be graded in order to prevent deposits of mud, which hasten corrosion.

44. Fig. 31 shows a copper molded eaves gutter set on the top of a brick wall of a fireproof building, which is provided with a terra-cotta roof. The bed of the gutter



FIG. 31.

rests on a board *a* which is inclined, to give the proper pitch. The face of the gutter forms a continuous horizontal molding and is made from cold-rolled sheet copper. The front

edge of the gutter lining is bent down over the face and is lock seamed to the copper molding as shown.

The back of the gutter is extended up over the terra-cotta slabs *d* and under the slates *e*. A series of brass straps *c* are spaced off along the gutter and secured at distances of not more than 3 feet, being bolted to the plank *b* in front with brass lagscrews. The rear end of each strap is run up under the slates and bolted through the terra-cotta slabs with brass bolts of proper length, large brass washers or plates being used under the slabs to prevent the nuts from sinking into them. Each strap is twisted one-half of a turn, as shown, to prevent roof water from working over the face of the gutter. The sheet copper is doubled and pinched at *i* to form a drip. In cold climates it is advisable to slope the back of the gutter, the space behind being thoroughly filled in solid. This will prevent the gutter from bursting with the formation of ice, if the conductor pipe should choke and the gutter fill with water.

45. Roof Gutters.—Fig. 32 shows a simple form of roof

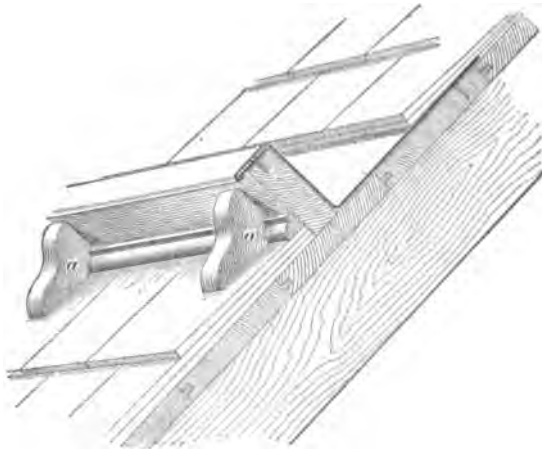


FIG. 32.

gutter. It consists of a board nailed to the roof and braced by brackets *a, a*. The board is laid on an incline to form the

proper grade, and the lining, which is usually bright tin or terne plate, is continued up under the shingles, and nailed down. The front edge is doubled over a strip of metal which has previously been closely nailed to the woodwork. This is called a *blind edge*.

The necessary incline of this gutter spoils its appearance; to form a roof gutter which will appear parallel with the roof, it is necessary to build it in a manner similar to that shown in Fig. 33. A tapering gutter strip *a*,

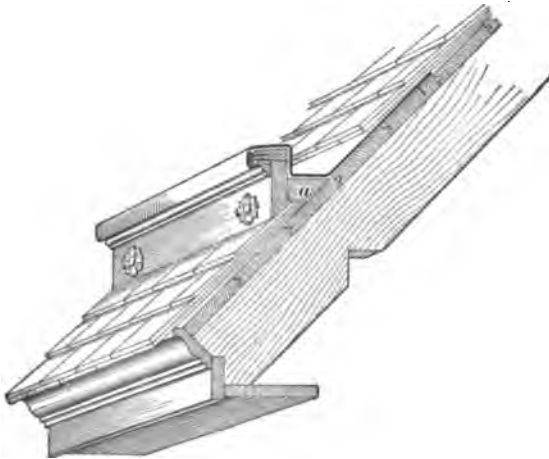


FIG. 33.

usually 2 inches thick, is laid to run the whole length of the gutter, and grades the bottom in a proper manner. These gutters really form snow boards, and during winter often become so clogged with snow that the water from melting snow cannot run off the roof freely, but is forced to pass through between the shingles or slates and thus cause a temporary leakage. For this reason, they are not to be recommended.

46. Cornice Gutters.—The cornice of a building very often does duty as a gutter also.

A wooden cornice gutter, sometimes called a *box*

gutter, as shown in Fig. 34, is employed in the construction of the better class of framed buildings. The carpenter completes the cornice and forms the bottom of the gutter with the proper grade. The tinsmith then lines the gutter before the shingles or slates are laid. The lining, like those in Figs. 32 and 33, is nailed to the roof and over the front edge of the gutter with a blind edge, as shown.

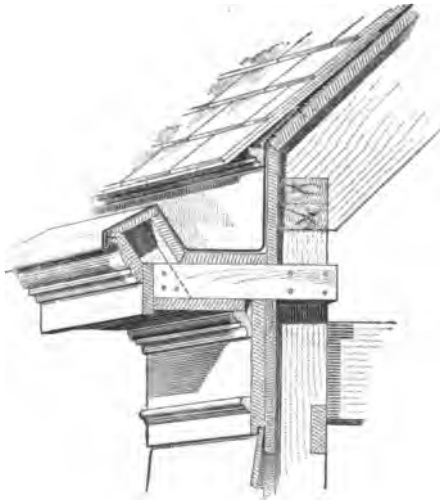


FIG. 34.

Sheet-metal cornice gutters are constructed on the same general principle.

47. Terra-Cotta Cornice Gutters.—This kind of a gutter, for a fireproof building, is shown in Fig. 35. The

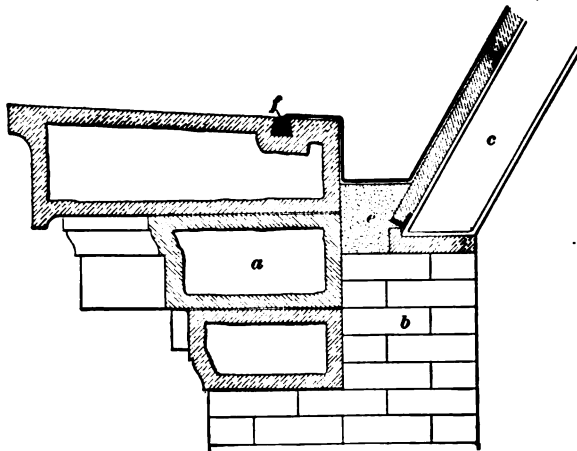


FIG. 35.

terra-cotta slab *a* of the cornice is backed by brickwork *b*, upon which rest the **I** beams *c* of the roof trusses. The usual angle or **T** iron purlins support the porous terra-cotta slabs. The mason fills in the gutter bed *e* with cement concrete and grades it to the proper pitch. The sheet metal, which is generally 16 or 18 ounce soft or hot rolled copper, is then bent up and laid into the gutter, the front edge being bent down into a groove *f*, which is molded in the terra cotta, and the back edge is run up the roof and overlapped by the slates or tiles in the usual manner. The connection

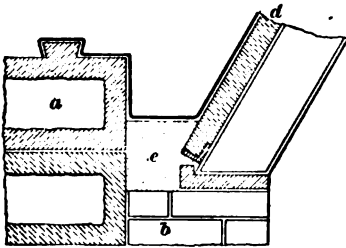


FIG. 35.

between the copper and the terra cotta is made water-tight by filling the groove full of molten lead, which, when cold, is solidly battened with a hammer and calking tools. If this method of attachment is not desired, the cornice may be molded with a dovetailed projection, so that the metal may be sprung over it as shown in Fig. 36. This will hold the copper down, but it is not as solid as the calked joint shown in Fig. 35.

48. Parapet Gutters.—A parapet gutter for a building of modern fireproof construction is shown in Fig. 37. The only notable difference between this and the other box gutters, already described, is the fact that the gutter is located behind a wall which is higher than the point to which the gutter is extended under the slates. It will be readily seen that there is great danger of the building being flooded if the leader opening should become covered with leaves or dirt, so that the rain water cannot escape down the conductor pipe *a* as fast as it flows into the gutter. To avoid this difficulty an **overflow tube** *b* having a sectional area at least equal to, but preferably greater than, that of the conductor pipe, should extend through the wall as shown.

The bottom of the overflow opening should not be less than 5 inches above the lowest point of the gutter bed, but

not high enough to cause the water to overflow any upstands or flashings that the gutter may be provided with. In the figure, the sheet copper composing the gutter and the rear covering of the parapet wall is all in one piece, consequently,

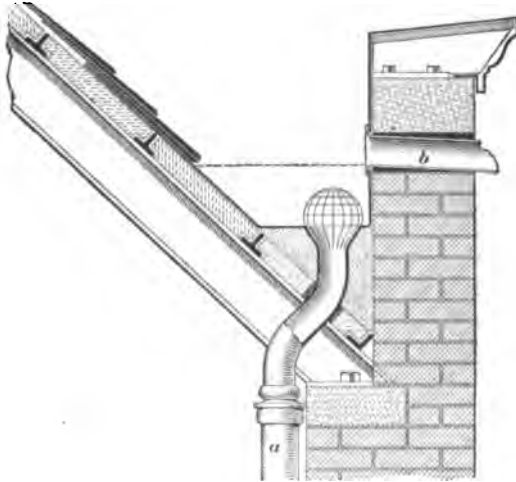


FIG. 37.

the main consideration in locating the overflow tube here is to prevent the water from backing up under the slates and leaking over the top edge of the flashing. The sill of this gutter, like that shown in Fig. 35, is filled in with cement and graded down to the conductor opening.

When the parapet wall is extended higher than about 18 inches or 2 feet above the gutter, it is customary to flash the back into the wall, as shown at *a*, in Fig. 38. A joint in the brickwork is raked out to a distance of about $1\frac{1}{2}$ inches, and the copper is bent over and let in as shown. Soft cast-lead bats *b, b* are then driven solidly into the raglet, about 6 or 8 inches apart, and the raglet is then filled with elastic

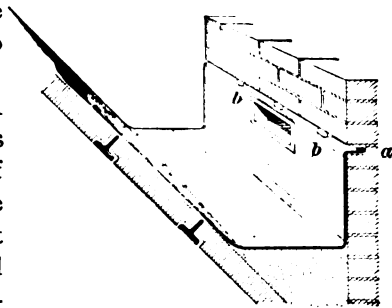


FIG. 38.

cement. The objection to this arrangement, however, is that the expansion and contraction of the gutter is likely to loosen the bats, and the raglet joint may leak.

49. A better arrangement is shown in Fig. 39, in which



FIG. 39.

the gutter is not nailed down or secured at any point except at the conductor opening. The upstand *a* back of the parapet is held down by a number of cleats *b*, of which the tops are doubled over the top of the upstand and the lower ends are bedded in the cement sill. A counterflashing *c* of lead or copper is batted into the raglet and overlaps the upstand at least 3 inches. The top of the overflow tube *d*

should be on a line with the top of the upstand or a little below it. To avoid nailing down the gutter at the back, also to prevent it from rising or shifting, an iron or brass **tilting fillet** *e* is bolted to the fireproof roofing. The sheet copper is bent under and doubled over this fillet, as shown. The tilting fillet is also advantageous to the slater, because it enables him to start his bottom course with the proper cant.

50. **Wood Tilting Fillets.**—These fillets are used when the roof is covered with boards. The fillet is shaped as shown at *a*, Fig. 40, and extends the full length of the gutter. A number of strong cleats *b* are nailed to the roof and bent over the fillet. The gutter is then laid and the cleats are doubled back over the edge, as shown. This is considered

first-class practice. The method of laying slates or shingles flat on sheet-metal gutters, valleys, flanks, or other flashings

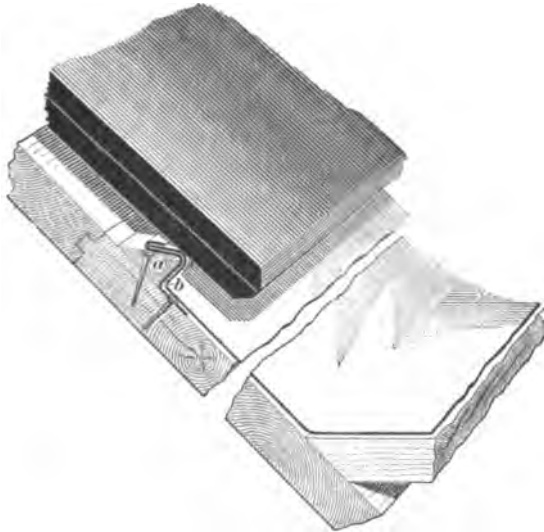


FIG. 40.

should never be followed. Water will work up between them by capillary attraction.

51. Corbel-Table Gutter.—A corbel-table gutter is shown in Fig. 41. It is supposed to form a belt all around the building, being located about 4 or 5 feet below the eaves. Such gutters, being so far below the eaves, do not carry much water at any time; they simply serve to carry off the drip. The greater part of the water shed by the roof during heavy showers, shoots over the gutter, this action being most pronounced when the roof covering is of a corrugated character.

A corbel table *a*, which rests on corbels *b, b*, forms a support for the gutter. The lookouts *c* are made of cast iron and are set at about 2 feet centers all along the table, their prongs being let into the mortar joint at the back about 2 inches. The crown molding and its wash are made of copper, the lower edge being lapped about 4 inches over the top

of *a*. The top edge is secured by cleats to an iron bar. Another iron strap, or bar, at *e* runs the full length of the gutter, and the copper is secured to it with brass bolts. When the molding is in position and properly lined up, the

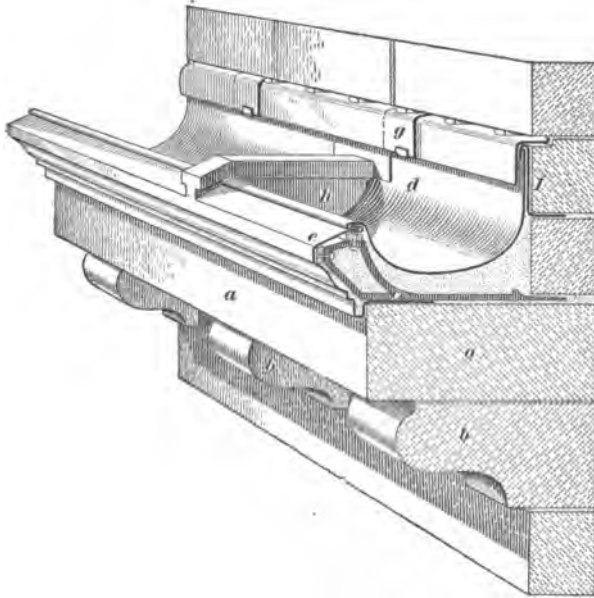


FIG. 41.

mason fills in the gutter with cement to form a curved bottom with the proper grade. Strong cold-rolled copper cleats *f* are secured to the wall to hold down the back of the gutter *d*; the front edge is double seamed and soldered as shown. The back is counterflashed in the ordinary manner. If the counterflashing is of lead, the top joints *g* should be locked into one another at the lower edge, as shown, to prevent the wind from raising the corners.

52. When such gutters are long, some provision must be made for expansion and contraction, otherwise they will soon tear apart and leak. In Fig. 41 this is accomplished by introducing a **saddleback** joint at *h*, a cross-section of which is shown in Fig. 42. A plank *i*, 2 inches thick, which

has been previously soaked in oil or asphalt, is set on edge and bedded in the concrete. If the gutters are laid during hot weather the upstands *j, j* should be fitted to almost touch the plank, so that during winter, when the gutter becomes intensely cold and contracts, the upstands will be drawn away from the board and take the position shown by the dotted lines. This forms an expansion joint of the best type. The cap, being short, is nailed to the wood and the nail heads are covered with a copper disk, which is soldered water-tight around the edge.

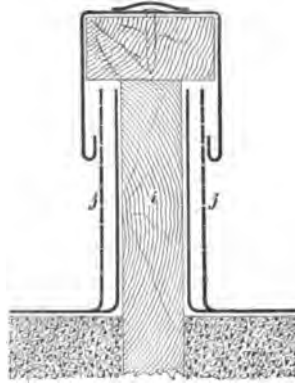


FIG. 42.

CONDUCTORS.

53. Conductors, or *leaders*, as they are often called, are the pipes which conduct or lead away the water from the gutters. They may be classed as *inside* or *outside* leaders. Inside leaders will be treated in *Plumbing and Gas-Fitting*.

54. Outside Leaders.—Outside leaders are fitted up against the outside of the building. They are made in many shapes and of different metals. Fig. 43 shows the *round-pipe* leader as usually erected. These leaders are usually made of tin by the tinsmith, who also makes the elbows *a, a, a*, which, usually, are altogether too sharp. Tin straps *b, b* are soldered to the leader at intervals of about 6 or 8 feet and are nailed to the walls, as shown. Round leaders are not suitable for outside service in cold climates because they persistently freeze and burst.

Fig. 43 illustrates an ever recurring spectacle in cold weather, when snow lies on the roof, and the temperature of the air is below freezing point. The sun shines

on the roof, but not on the leader. The snow on the roof

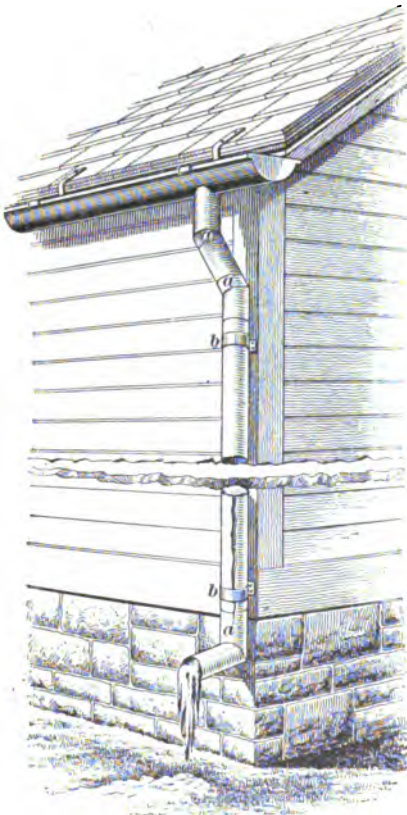


FIG. 43.

melts and the water trickles down the leader, and, by the time it nearly reaches the bottom, it becomes frozen to the sides of the leader. This ice slowly thickens until the leader is entirely choked at that point which, in Fig. 43, is the lowest elbow.

The remainder of the melted snow then gathers in the leader and fills it. This water now solidifies and bursts the leader as shown. The pipe has burst because it could not stretch enough to accommodate the increase in volume of the water as it was changed into ice.

55. Expanding Pipes.—Expanding pipes should be used to

overcome the trouble from frost. A common form, shown in Fig. 44, is simply a corrugated round pipe. The corrugations allow the pipe to increase enough in diameter to compensate for the formation of ice inside, without bursting the pipe. If the pipe is frozen repeatedly it will ultimately burst, because it takes a permanent set every time it is thus expanded. These pipes are usually made of galvanized iron or cold-rolled copper, in 8 or 10 foot lengths.

56. Square or Rectangular Leaders.—These leaders are made of crimped or corrugated sheet metal, and are often

used to obtain a more ornamental effect than is produced by round leaders. They should be supported by ornamental bands in a manner very similar to the plain straps shown in Fig. 43, the straps being made so that the leaders will hug the wall. If the walls are built of masonry or brickwork, it is necessary to drill holes at the back of the bands, then drive soft-pine plugs into the holes and cut them flush with the face of the wall for the purpose of receiving the spikes; for good work expansion bolts should be used.



FIG. 44.

In climates where there is no danger of outside leaders being frozen, the best method of attaching rectangular leaders in a neat and strong manner to brick, stone, or terra-cotta walls, is shown in elevation at (a) and in section at (b), Fig. 45.

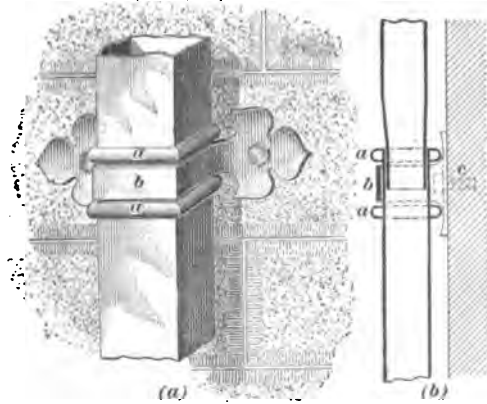


FIG. 45.

Two copper beads *a, a* are soldered around the top edge of each leader and a cast-copper band *b*, provided with ornamental lugs, clasps the top of the leader against the building.

The lugs are secured to the walls with expansion bolts, as shown by dotted lines at *c*. The leaders are connected together by slip joints as shown in the section. Each band thus supports a section of the leader, which should not exceed 8 feet in length. This arrangement allows each section to expand and contract freely; if all the joints are soldered together, the leader is

secured to the walls with expansion bolts, as shown by dotted lines at *c*. The leaders are connected together by slip joints as shown in the section. Each band thus supports a section of the leader, which should not exceed 8 feet in length. This arrangement allows each section to expand and contract freely; if all the joints are soldered together, the leader is

formed into one long, rigid line, which soon becomes loosened by expansion and contraction. These leaders should be made with the crimps running across them, not lengthwise, so as to secure a very neat, flat, and stiff surface.

Beaded tops and cast bands are not adapted for outside leaders in cold climates, because the beads and the bands are not pliable enough to resist the action of frost. The best attachment for such climates is composed of a brass or copper eye, which is riveted and soldered securely to the back of the top end of each section of the leader. These eyes are bolted to bronze hooks which are secured to the wall. An ornamental stamped sheet-copper band is then slipped on between the heads to conceal the real rigid attachment. The lugs of the band should be attached to the wall by expansion bolts. This arrangement gives a pliable joint. The corrugations in this leader, however, must run lengthwise, and all the joints should be slip joints. Iron supports should never be used in or against a stone wall, because they rust and stain the masonry.

57. Offsets in leaders should always be avoided. It is common practice to offset the leaders at stone, brick, and terra-cotta moldings, but in good practice they should be fitted up straight and plumb, the necessary holes being cut through special blocks formed in the molded courses for the passage of the leaders. It is customary to discharge sheet-metal leaders into a cast-iron pipe which is continued up about 4 or 5 feet above the surface of the ground, the object being to prevent the leader from being flattened or otherwise injured. Rectangular leaders should, for the sake of appearance, connect at the bottom with a rectangular cast-iron pipe, and not with a round pipe.

58. Size of Leaders.—The proper size of leaders, of course, will vary with the climate, the amount of rainfall, and the manner in which the gutter catches the water; but a good safe rule for every-day practice is to allow 1 square inch of sectional area of conductor pipe for every 75 square feet of flat roof area. No leaders, however, should be less

than 2 inches in diameter, and even this size should be used only for small roofs, such as those over bay windows, small porches, etc.

The *underground pipe* (often drain tile), into which the leaders discharge, should not be less than 4 inches, inside diameter, and they need not be more than 8 inches in diameter for any work where the roof area is less than 1 acre. In measuring the watershed of pitched roofs, calculate the projected or horizontal area—i. e., the area on the plan.

59. Rain-water heads, sometimes called *conductor heads*, are often employed on the top of a leader, and treated as an architectural feature by forming a graceful outline to the receptacle for the gutter discharge. Two or more leaders may deliver into one head, as the conditions may require.

Fig. 46 shows a conductor head in section. It is set on top of a rectangular corrugated sheet-metal leader *a*, which should be securely fastened to the wall by a band on top. The lower end of the head slips into the conductor, and the top is secured against the stone wall with expansion bolts or other fasteners. A brass angle should be fitted inside the rim. The roof gutter empties into the head through a large lead or copper pipe *b*, which runs up a chase in the back of the wall, thus concealing it from outward view. The top of the head should be covered to prevent birds from building their nests in it, or in the pipe *b*.

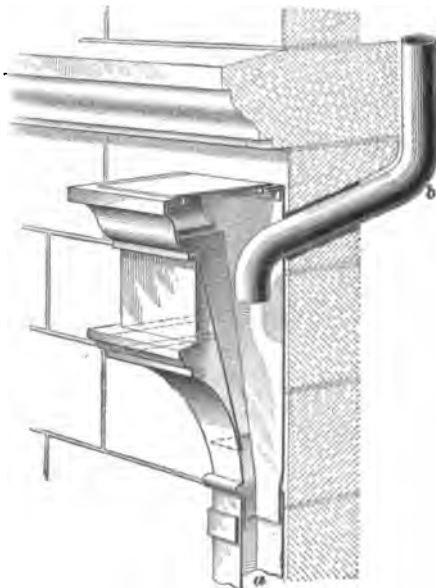


FIG. 46.

The proper position for a rain-water head should be carefully shown on the elevation, as mechanics are prone to set them at the handiest place, without reference to the architectural treatment of the facade. All rain-water heads should be lined inside with a tapering box to extend below all moldings and prevent possible leakage, and also to prevent noise during heavy rains.

60. Strainers.—Every leader opening in a gutter must be provided with a strainer to hold back leaves, twigs, etc., and to prevent birds from building nests in the leaders. The best strainers are those constructed of a ball or hemispherical form, like those shown in Figs. 37 and 39.

For ordinary purposes, where the roof water flows to waste, wire ball strainers, put together something like bird cages, are generally used. But in cases where the roof water is gathered into cisterns or tanks, and stored there for domestic use, the strainers must be very close in order to prevent pieces of leaves, etc. from being washed down into the cisterns. Such vegetable matter soon decays and pollutes the water. The strainer *b*, in Fig. 47, is specially made for this service. It has a very large straining area, which is closely perforated with holes not larger than $\frac{1}{8}$ inch.

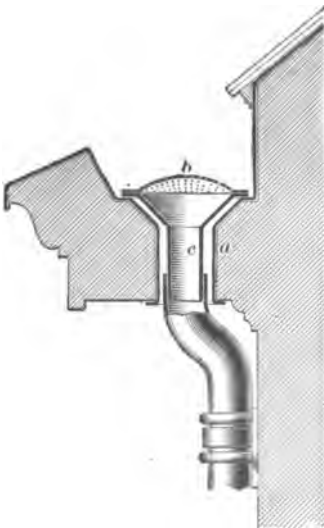


FIG. 47.

61. Gutter connections to leader pipes are very important details and should be carefully considered. The offsets necessary for cornice and overhanging gutters should have a good grade from gutter to leader, and should be composed of easy bends—not sharp elbows. Owing to the fact that leaders are liable to freeze, it is advisable to provide outside gutter connections with a slip tube,

as shown at *a*, Fig. 47. This tube is soldered to the gutter lining on top, and is flanged over the face of the soffit of the cornice at the bottom, and thus forms a water-tight channel through which the leader pipe passes. If the leader should freeze and burst between the gutter lining and the soffit of the cornice, this tube will prevent the water from leaking. In the event of the cornice being made of woodwork, such a leak would soon cause the decay of the material.

When copper leaders connect with tin-lined gutters, or vice versa, an **insulation joint** should be made at a convenient point to prevent a too rapid destruction of the metal by galvanic action. Thus, in Fig. 47, a slip joint should be made at *c*, with a sleeve of tarred or painted burlap inserted between the gutter tube and the leader pipe.

62. Leader Cut-Off.—When the leaders discharge into cisterns or tanks, it is advisable in all cases to provide them with cut-offs, so that the water may be discharged to waste or into the cisterns, as desired. Every roof is foul, to a certain extent, with decaying vegetation, bird lime, etc., and all this matter is washed off during the first few minutes of a rain storm. If a cut-off is not used, the dirt, of course, goes into the cistern. It is customary to leave the cut-off free for rain to flow to waste until the roof is supposed to be washed clean, then it is turned so that the remainder of the water will flow into the cistern.

There are many different kinds of cut-offs on the market. Some are made to be operated by hand, while others are intended to operate automatically, when a certain volume of rain water has passed through to waste. The latter are preferable, if reliable, because the hand cut-off is likely to be neglected.

DOMES AND LANTERNS.

63. In many parts of Europe it is customary to cover domes, lanterns, cupolas, etc. with sheet lead; but owing to the great variations in temperature which are encountered in the United States of America, it is necessary to use a

metal which is better adapted to withstand the unavoidable expansion and contraction.

Sheet copper or galvanized iron are the best metals for use in countries where excessive changes in temperature occur. The latter, however, is not durable enough for covering domes, lanterns, or cupolas, and, consequently, sheet copper is generally employed.

There are different methods of covering domes, but the following four may be considered preferable: namely, *plain* or *smooth*, *ribbed*, *paneled*, and *metallic shingle* or *slate* coverings.

64. Smooth covering is usually put on domes in a manner similar to that employed in flat-roof covering, with flat locked seams, each sheet being well tied down with strong cold-rolled copper cleats. If the dome is large the ordinary flat sheets about 20 in. \times 28 in. are generally used, the curvature of the dome being so slight that the soft copper will easily adapt itself to the shape. When the dome is small, however, each sheet must be blocked out to the proper curve, so that the covering, when finished, will have a neat, smooth appearance and be free from buckles. The chief objection to locked-seam covering is the liability to leakage, chiefly through the seams, on the nearly horizontal parts of the dome. The solder will spoil the appearance of the dome if the copper work is allowed to retain its natural color.

65. Ribbed Surface Covering.—To avoid leakage on domes by the effects of expansion and contraction, and to prevent any solder from discoloring the copper work, some form of ribbed covering is employed. This requires the use of a standing or a roll seam, as the character of the building may demand.

The space between the standing seams or rolls should not be more than 2 feet wide, and the sheets should not be more than 4 feet long. They must be securely supported from the top edge, preferably with heavy cold-rolled copper cleats.

It is advisable in all first-class sheet-metal roofing to avoid driving nails through the sheets at any point. The

sheets are thus permitted to freely expand and contract without tearing the metal.

An excellent roll seam is shown in Fig. 48. The batten, or roll strip *a* is nailed down over a long cleat strip *b*. The sheets *c, c* are then sprung in between the rolls, and the cleat strip is doubled over the upstand. The roll cap *d* is then put on over the roll, and locked into the cleated upstand as shown. The roofing sheets, cleat strips, and roll caps are thus all locked together

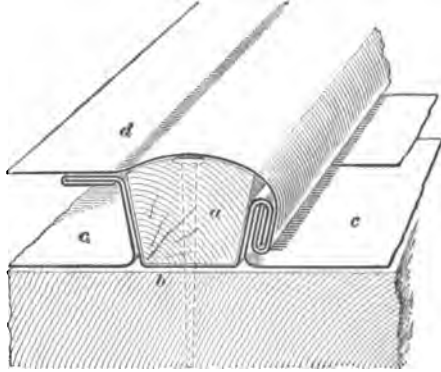


FIG. 48.

and made water-tight, and yet are free to expand and contract individually. The batten nails combined with the outward curvature, which the sheets *c* must necessarily have, will prevent a gale from rattling or loosening the sheets.

66. Horizontal Seams.—The best form of horizontal seam that can be made on domes is shown in Fig. 49. A strong cold-rolled copper cleat strip *a* is nailed to the roof with flat-head brass or copper nails; and the top edge of the under sheet, the bottom edge of the upper sheet, and the cleat strip are all locked together as shown.

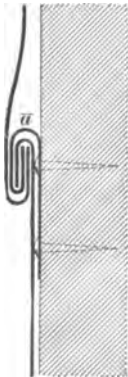


FIG. 49.

With this arrangement, each sheet



FIG. 50.

can expand and contract lengthwise without affecting the stability of the support. If the sheets are simply lapped at this seam, the wind will get underneath and raise them in the middle, thus opening the seams and making them visible from the street.

When it is required to set the rolls more than 2 feet apart, it becomes necessary to support the sheets between the rolls. This is accomplished in different ways. The sheets may be laid so that the horizontal locked seams will be about 18 or 20 inches apart, the rolls being perhaps 4 or 5 feet apart. When very large sheets must be used, however, *secret tacks* *a*, Fig. 50, are riveted and soldered to the back of the sheet *b* at intervals, which will allow about 2 or 3 square feet to be supported by each tack. As the sheets are being put on, the tacks are pushed into long, narrow holes in the woodwork, and then pulled through and nailed to the inside of the dome as shown.

67. Location of Rolls.—In locating the position of the rolls it is necessary to consider the general construction of the edifice, both above and below the dome. The ribs or rolls should not be put up



FIG. 51.

to suit the standard stock sizes of copper sheets, but they must be located to harmonize with the leading architectural features of the composition.

For example, consider the dome of the cupola, or lantern, shown in Fig. 51. The ribs here divide the dome surface into equal sections, two sections being immediately over each window opening. Every second rib is directly in line with the center line of a column. When the sheets are drawn closely together at the top, as shown, the ribs are usually tapered, being wider at the bottom than at the top, but when there is considerable space between the top ends of the ribs, they are usually made the same width throughout their length.

68. Paneled Dome.—A paneled dome is shown in elevation in Fig. 52.

The lantern under the dome is octagonal in form, with a window *a* in each side. The dome, however, is round in plan with a panel *b* located directly over each window. The top of the dome is surmounted by a statue, the base of which is shown at *c*. A vertical section through the dome and a few details are shown in Fig. 53. The elevation, Fig. 52, shows ribs *d, d* running from the cornice of the lantern up to the base of the statue, but these may be omitted.

At *e* in the detail (*a*),

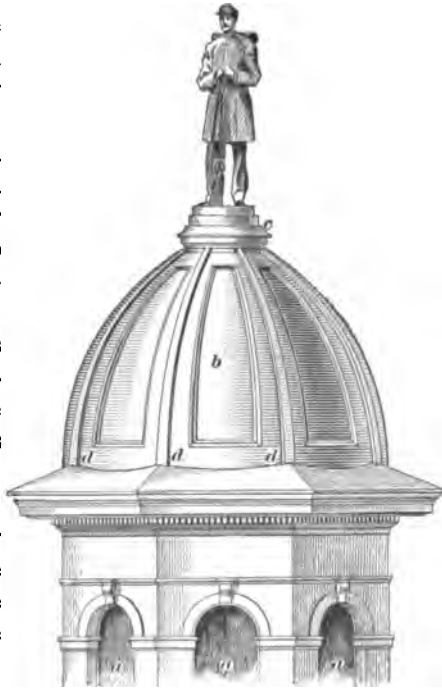


FIG. 52

Fig. 53, is shown a method of securing the panels in place without ribs, when there is no panel molding. The panels are simply double seamed with cleat strips to the stile strip *e* as shown. But where ribs are desired on the stiles, or when moldings must be run around the panels, the con-

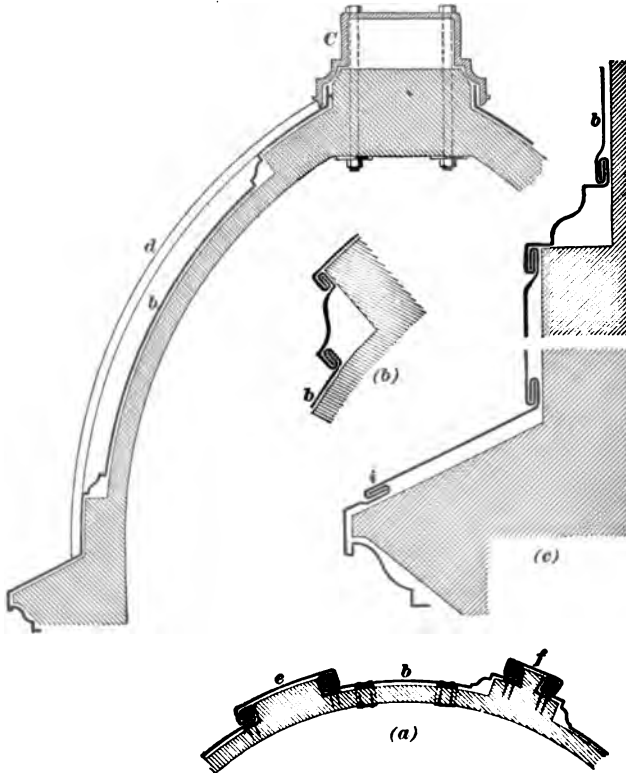


FIG. 53.

nections may be made as shown at *f* in the same detail. If the panels have a larger surface than 3 or 4 square feet, secret tacks may be employed to advantage, as shown by dotted lines. A detail of the top molding of each panel is shown at (*b*), and a detail of the bottom and the wash over the corona of the lantern is shown at (*c*). These seams are all made in the shop, being locked and thoroughly soldered at the back, with the exception of *i*, which is made in place

and is thoroughly cleated and soldered. The statue base is slipped down over a sheet-copper collar, and is secured to the top of the dome with four bronze bolts, which are threaded close under the head to make a permanent water-tight connection. Fish-plates and nuts are employed underneath in the ordinary manner.

69. Flagpole Flashings.—These flashings, and those around all other forms of movable finials, require much attention to detail, as they must be made water-tight, and remain water-tight under peculiar conditions. Every flagpole sways more or less, according to its strength, the pressure of the wind, etc., and, therefore, a rigid flashing at its base cannot be durable. The liability of the pole to “settle down” is another item to be considered. On this account it is advisable to use **slip joints** or telescope flashings, which are provided with enough clear space or “play” to allow the pole to move or sway in any direction without touching or affecting the sheet-metal covering of the dome. A good arrangement is shown in Fig.

54, which is, in fact, a detail of the intersection between the flagpole and the cupola shown in Fig. 51. The rolls of the dome finish inside of the bead *a*. The copper work finishes around the top member *b*. An 8-pound per square foot sheet-lead bonnet *c* encircles the pole and covers the member *b*. The top of the bonnet is “dressed” close into a small groove in the pole, which is cut just deep enough to allow the lead to finish flush, a bed of red and white lead being used to make the connection water-tight. The bonnet is nailed to the

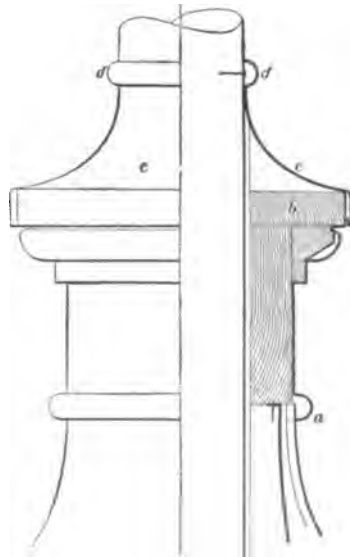


FIG. 54.

pole with a ring of 1-inch, pointed, flat-head copper nails, which may be concealed with a bead *d* if desired. The lower edge of the bonnet overhangs the block *b* and forms an open lap joint around the top of the copper. The top of the block *b* is well greased, and the bonnet is free to slide as the pole sways.

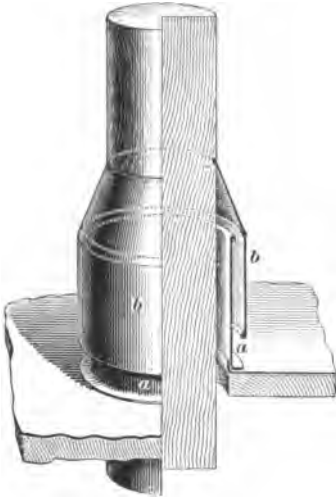


FIG. 55.

its flashings to move in any direction.

70. Flagpole Cap.—The top of a pole should always be protected either by a sheet-metal flashing or by a cap. A flagpole cap, with regulation ball, is shown in Fig. 56, which is a detail of the cap shown in Fig. 51. A brass casting *a* fits snugly over the top of the pole and is secured to it with brass screws. An eyebolt at the left holds the flag pulley. A piece of brass tube *b* joins the cap to a brass spud *c* which is soldered to a seamless copper ball.

This style of cap not only protects the pole from the weather, but provides a suitable pulley connection, and gives an artistic treatment to the apex of the flagpole.

When the pole intersects a flat roof, a plain slip-joint connection, like that shown in Fig. 55, may be used. A cylinder, or upstand, *a* is soldered to the roof. A sleeve *b* overhangs the upstand and is nailed to the pole as shown, a space being provided on each side of the upstand to allow the pole and

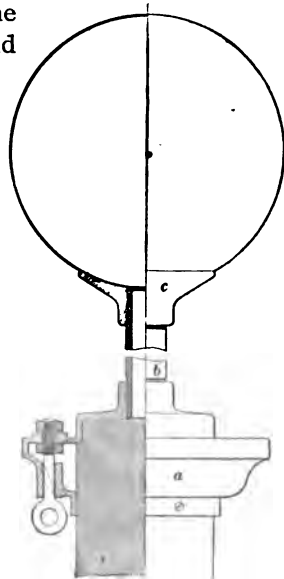


FIG. 56.

CRESTINGS.

71. Sheet-metal crestings are of varied design and construction. They can, in fact, be made in any design which is adapted to stone or terra cotta.

The most important features to consider in crestings are the method of support and the connection to a slate or shingle roof. Ordinary crestings are so constructed that the nail heads in the top course of slates are exposed to the weather. This is a mistake, as the rain will certainly follow the nails and cause slight leakage, which may not be visible, but which, nevertheless, hastens the decay of the timber and rusts the nails.

72. Attachment.—Fig. 57 shows a method of attaching sheet-metal cresting on ridges and hips in such a manner that

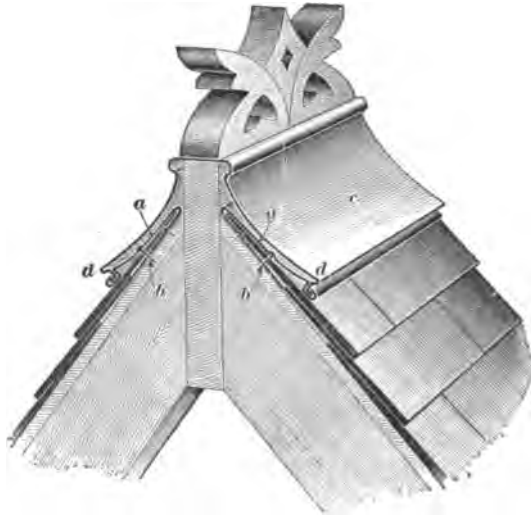


FIG. 57.

the nail heads are all concealed. Channel strips *a, a* of strong sheet metal are bent to the shape shown and nailed on the roof close to the ridge pole. The top course of slates is then pushed in the channel and secured with the nails *b, b*, which are driven through two thicknesses of slate and two

thicknesses of sheet metal. The cresting *c* is then sprung over the channel strips and the lower edges are closed into them, thus locking them together. The edges *d, d* are double seamed together to prevent wind from lifting or rattling the cresting. When the ornamentation projects more than 9 inches, it is advisable to nail suitable lookouts on the top of the ridge pole.

The joints in crestings should be made in a manner similar to that already prescribed for cornices.

FINIALS.

73. Finials which are less than about 7 feet in height are usually built in the shop to conform with the drawings of the architect, and are taken to the building and erected in one piece. Larger finials, however, are usually set up in two or more pieces, according to their height, weight, and form. All the joints should be double seamed and soldered inside, in the same manner as cornice joints.

Finials having round members are built up from *spun* or *pressed* metal. Spun metal is preferable. Other forms are built together in different ways according to the shape of the members.

All finials must be securely supported to prevent them from sagging, and braced to prevent them from leaning out of plumb. The system of supporting and bracing required will depend upon the shape and size of the finial. In some finials a straight iron pipe alone will form a satisfactory support, while others must be provided with lookouts, like cornices, and often with braced framework. Fig. 58 shows a simple and efficient method of supporting a long, narrow finial on the peak of a conical roof. This finial is taken to the building in two pieces, and is joined together in position, with a lock seam around the ball. A 2-inch or 3-inch galvanized-iron pipe *b* is securely supported and braced to the framework of the roof. Horizontal partitions *c, c* are soldered to the inner surface of the finial and snugly fit the

iron pipe. These form braces and keep the finial straight.

A few vertical gussets are soldered inside the ball to strengthen it vertically. A threaded pipe coupling is soldered inside the top ball so that this ball may be securely attached to the top of the pipe *d*.

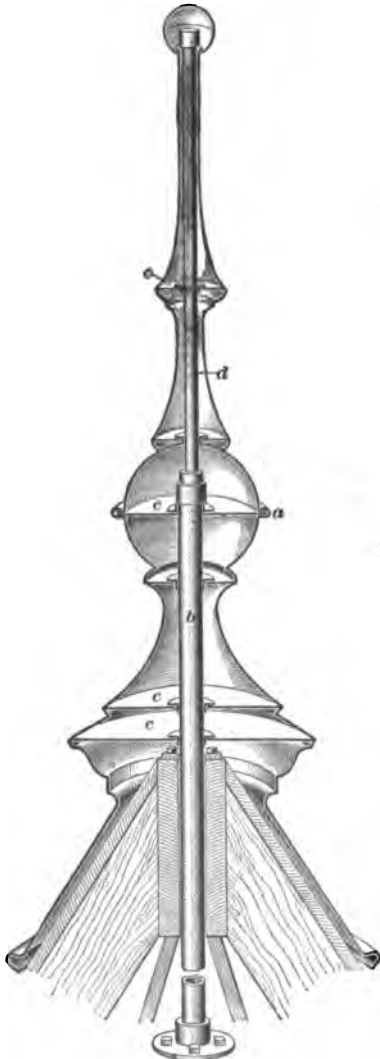


FIG. 58.

a solid footing, passes vertically through the apex of the roof. A collar at *b* and a cross-beam at *c* rigidly secure the pipe and keep it plumb. A special fitting called a double

74. Weather vanes are a class of finials provided with a movable part which rotates on a vertical axis by the force of the wind. They are employed to show the direction in which the wind blows and consequently are provided with the letters N, S, E, W, located respectively north, south, east, and west of the axis of the finial. These letters are secured to the stationary part of the finial. An arrow, or some other form of indicator or pointer, is also employed in the construction; this is attached to the movable part of the finial. Fig. 59 is a vertical section through a simple weather vane. It is similar to the finial shown in Fig. 58 except that the top part is made to rotate. An iron pipe *a*, which rests on

cross receives the arms which support the four letters already mentioned. These arms also reinforce the ball. The top of the stationary sheet-metal work is riveted to a brass ring *e*.

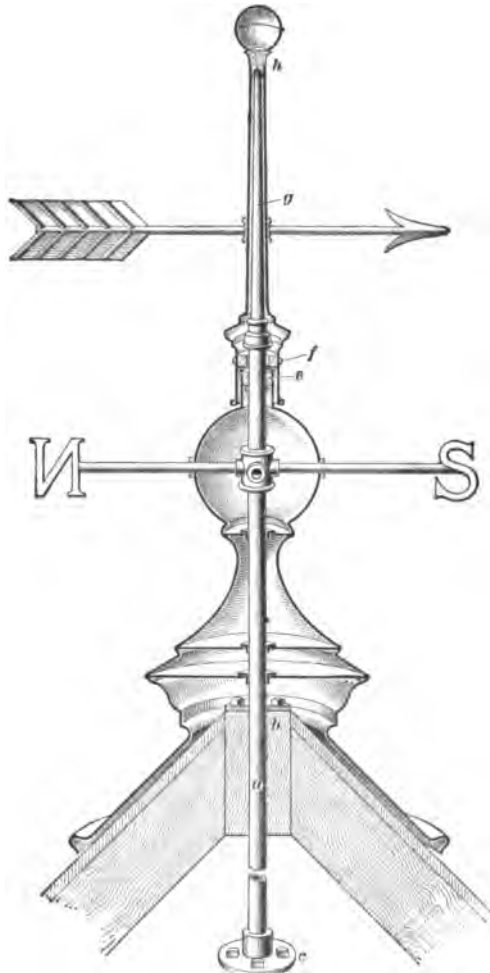


FIG. 59.

The bottom of the movable part of the vane is bolted to a brass ring *f*. These rings keep the copper in proper shape at the slip joint. The lower end of a tapered steel bar *g* is

screwed into the reducing socket on top of the pipe. The top end of the rod is tapered off to a sharp pivot point, and works in a brass socket *h*. This rod must be free and clear from the copper shell around it, so that the arrow may swing around to face the wind with the least possible resistance. The movable section must be carefully balanced; it should be so sensitive that a man can move it with his breath. The ring *f* is located under the reducing socket, and prevents the movable section from being thrown off in a storm.

INTERIOR SHEET-METAL WORK.

75. Sheet metal is seldom used in the interior of buildings except for covering walls, ceilings, etc., and even then it is only used for a cheap grade of work, so as to obtain an elaboration of ornamentation at a very low cost. The principal items for consideration are the methods of securing the sheets to the building and the selection of a design from manufacturers' stock.

It is customary for the sheet-metal worker to nail furring strips on the ceiling and walls at such distances apart as will conform with the design stamped on the sheets, but in no case should they be more than 1 foot apart. In selecting the furring strips for ceilings, particular care should be taken to allow for sufficient depth for any electric-wire conduits or gas pipes. The sheets are laid on the walls to overlap one another, and the nails are driven through the ornamentation in such a manner as to apparently form a part of the decoration. The lap seams should all be laid so that the light from the windows will shine against the edges of the sheets and thus avoid shadows which would indicate the location of the seams.

All sheet-metal wainscoting, baseboards, dados and chair rails, and, in fact, all ornamental sheet-metal work which is likely to be damaged by rough treatment, should be "pugged" behind with Portland cement.

All heavy moldings and cornices must be backed by

lookout brackets which are cut to the proper profile. All wood backing should be covered with asbestos sheets when it is desired to form a fireproof enclosure. Plain black-steel sheets should be dipped in iron oxide and linseed oil before they are put up. In all damp places it is advisable to use bright tin or zinc; the latter is preferable.

MATERIALS USED IN SHEET-METAL WORK.

76. Black Iron or Steel.—This form of iron or steel is used only for the very cheapest roofing and siding, also for interior decoration or fireproofing. No. 26 gauge is generally used. In all cases the sheets must be protected against corrosion by metallic paint or other suitable coatings.

77. Galvanized iron is used for sheet-metal siding, cornices, plain brackets, plain trusses, plain modillions, corrugated roofing, etc. No. 26 gauge metal is generally used throughout. No. 24 metal, however, is preferable for all large moldings.

78. Zinc is seldom used for covering buildings in the United States. But owing to the fact that it can be pressed into ornaments better than iron, it is employed for ornamental trusses, brackets, modillions, rosettes, festoons, etc., in galvanized sheet-metal fronts, and for balusters in balustrades. All zinc and galvanized sheet-metal work may be soldered on the face. All galvanized ironwork should be painted with a zinc body paint.

79. Cold-rolled copper is always used for copper cornices, moldings, columns, and all plain surface work which is to be formed in copper. The weight of the copper should not be less than 14 ounces, and it need not be more than 20 ounces on the very best class of buildings; 16-ounce copper is commonly used on good work, while 18-ounce is reserved for heavy moldings. All cold-rolled copper work

should be secured in place with brass or copper nails, screws, or bolts, as the conditions may require. All soldering should be concealed. When it is desired to paint copper work, the metal should be tinned all over the face, to prevent the copper from coming in contact with the paint.

80. Soft-Rolled Copper.—This copper is often called hot-rolled copper and is used for lining gutters, valleys, etc., and for pressed or hammered ornaments. The weight generally specified is 16 ounces, and 18 or 20 ounces on such work as may be subject to much wear and tear, either by expansion and contraction or by rough usage.

Soft copper, tinned on both sides, is best adapted for gutters and all other work which depends upon solder for tightness and strength. Copper cleats should always be cold rolled.

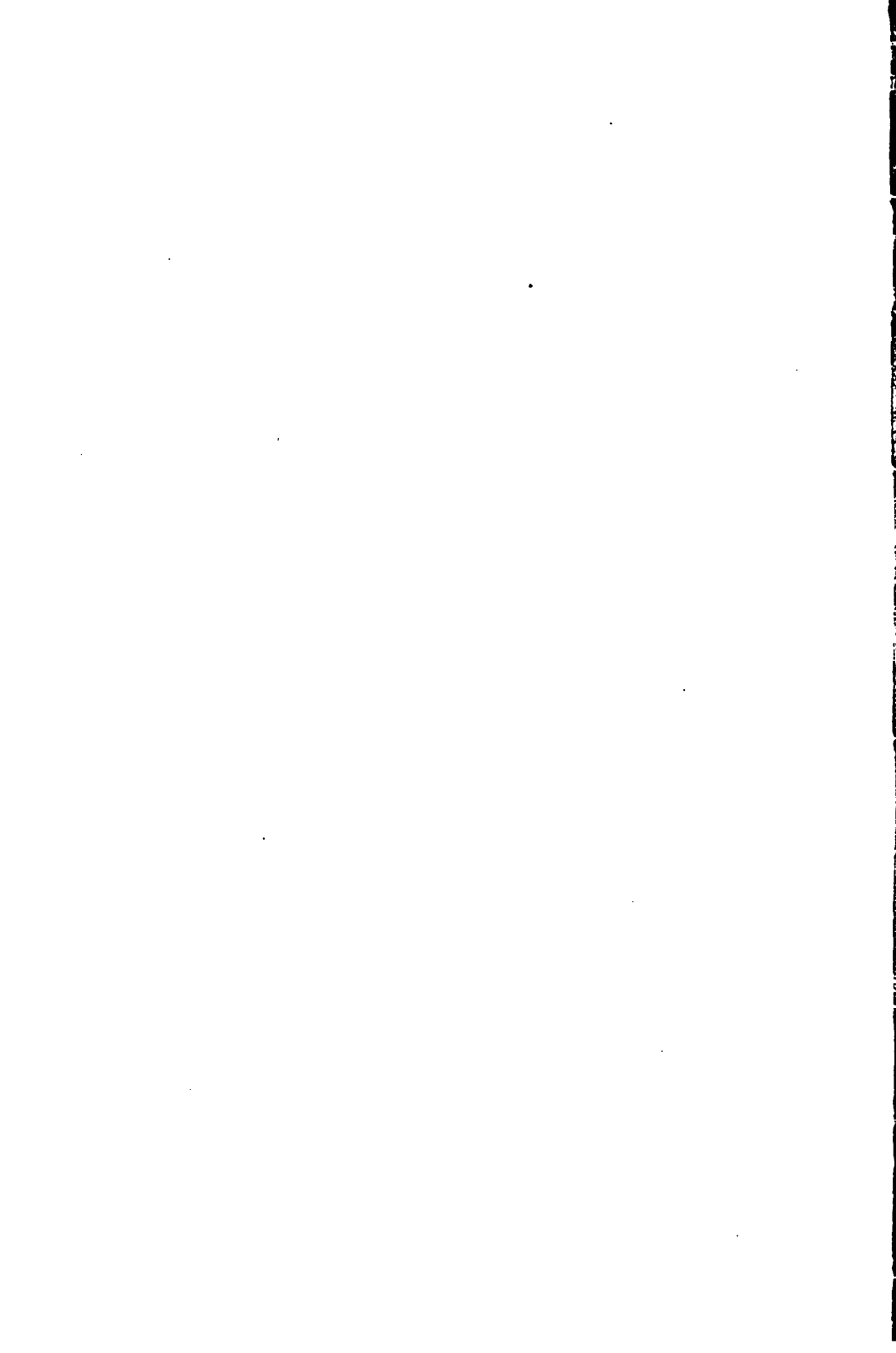
81. All sheet-metal seams should be soldered very slowly, because it takes time to properly sweat a seam; and very hot, well tinned soldering irons should be used.

Any mechanic discovered "rushing" a seam or hastily skinning it over with solder should be immediately discharged and all his work should be resweated by a careful man, as the durability of sheet-metal work depends chiefly upon the soldered seams.

Resin should be used as a flux for all tinned copper, and chloride of zinc for all plain copper, galvanized iron, and zinc. Raw muriatic acid or sal ammoniac should not be used as a flux.

82. Tarred Roofing Felt.—This form of building paper should be laid under all sheet-metal roof work and gutters to protect the under side of the metal from moisture and deleterious vapors, also to form a soft, protecting cushion for the metal.

83. All woodwork under sheet-metal roofing should be smooth and evenly laid and properly graded by the carpenter. Nail heads, knot holes, and sharp corners are detrimental to sheet-metal work.



BUILDING SUPERINTENDENCE.

INTRODUCTION.

1. Scope of Subject.—It is a difficult matter to formulate rules to be observed for the direction of building construction that would be applicable to all cases. Each problem of construction must be considered separately, and a system of inspection decided upon to suit each particular portion of the work. It is necessary, however, to lay down a fixed plan to follow in supervising the work, in order to give proper notice to the innumerable points in construction which require immediate attention. It is a fact well taught by experience, that work once finished is not always easily changed, and if ordered to be changed, or replaced by other work, will generally give rise to disputes and dissatisfaction, and often cause expensive alterations; all of which could have been obviated by attention at the right time to defects or mistakes. In many cases, the services of the architect include all the supervision considered essential for the structure, but in works of importance it is absolutely necessary to engage a *building superintendent*, who is well versed in building construction, to constantly supervise every detail of the work. The building superintendent is under the immediate direction of the architect, whom he represents, but his services, being special, are paid for by the owner. It will be assumed that a building superintendent has been engaged for the work, herein considered, who has undertaken the supervision of several buildings in the vicinity, and that his

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entire time will not be devoted to the buildings under consideration. Under this arrangement, he will examine the work from time to time as it progresses, and inspect the materials as they are delivered on the premises.

The object of this section is to direct the attention of the superintendent to all the various details which should be observed, as well as to remind him of the defects to be looked for at each stage of the construction.

THE DUTIES OF A SUPERINTENDENT.

2. Drawings.—The superintendent should study the drawings and specifications well, in order to become as familiar with them as possible, and to form a thorough understanding of the projected buildings and surroundings, and the materials that will enter into their construction. He should not trust blindly to the accuracy of the drawings, for mistakes are liable to occur, no matter how accurately the drawings have been made, or how thoroughly they have been checked in the drafting room; he should check all measurements, and satisfy himself as to their accuracy, before allowing the work to be laid out or erected.

3. Inspection.—It is imperative that the superintendent should inspect all the work at each visit and not leave any part of it to be inspected at some future time; he should ascertain what each workman is doing, and should see that he is doing it properly, and when he visits the building the next time see that the work in progress on the occasion of his last visit has been properly done. By following up the work in this way it will be, comparatively speaking, an easy matter to detect any work poorly or improperly done.

The superintendent should endeavor to establish a standard by which each kind of work can be judged; that is, a uniform standard of practice in executing the work, so that the architect or the superintendent and the builder may better understand each other. The superintendent should not exact more than the contract and specifications call for.

It is good practice to examine and pass on all materials soon after they arrive at the building site, and if any are defective, to mark them and have them placed to one side, so that there can be no mistake as to what are rejected, or liability of their being used in the structure. The superintendent should see that the damaged or rejected materials are immediately removed from the premises, for, if allowed to remain for any length of time, some of them are likely to be smuggled into the work, unless the contractor is exceptionally conscientious.

4. Condemning Poor Work.—If the inspector is satisfied that a certain piece of cement work, for instance, contains poor material, or has been reworked, he should order its removal and not trust to the statements of the workmen, who, very often, rather than replace the work, will try to convince him that the material is as called for, and that the cement is freshly made. Another point frequently raised is when a particular brand of some material, such as cement, is called for in the specifications; the contractor, for reasons of his own, may say that the brand cannot be obtained in the local market; in order to get it, the work must be delayed; and, as a substitute, he offers another brand *just as good*. In such an instance it is well for the superintendent to know whether the brand specified can be easily obtained, and if not, satisfy himself that the brand offered as a substitute is as good as that specified. In framing the specifications, if the architect knows what materials can be obtained in the local market and prepares his specifications accordingly, no such question as that just presented will arise.

5. Adjustment of Disputes.—Nothing can be more embarrassing to the young superintendent than to have disputes arise as to the correct interpretation of the specifications between the owner and contractor, such as this: "Execute the work in a good substantial manner," etc. The superintendent in deciding the question—which, by virtue of his position as set forth in the terms of the

specifications and contract, he has a right to do—is liable to be too exacting in his demands for the execution of the work, in that way establishing a precedent, which he will have to maintain; and this stand, if he has to abandon it in any question which may arise later, is liable to place him in a position detrimental to his authority and perhaps his reputation. He is not likely to be too lenient in his exactions regarding such work, but rather the reverse, from an innate desire to make the work as nearly perfect as possible, as far as the specifications demand.

The superintendent should remember that he is working in the interest of the owner and under the direction of the architect, and should not be led into making any concession to the contractor that would be injurious to the owner's interest; at the same time, he should be perfectly just and reasonable in passing upon any of the work, or in deciding a disputed point.

It very often happens that the owner, when visiting the work while the building is in course of construction, happens to notice some particular part that is not in accordance with his preconceived idea, and he immediately assumes the right to notify the contractor that the work is not what it should be, or, in other words, not up to his expectations; the contractor will very naturally defend his work and himself, claiming that it is. Instead of doing this, the owner should have notified the architect, who is the proper authority to adjust matters between the two parties. His judgment and experience would soon convince the owner whether he was right or wrong. In such a case, whoever the decision sustains should abide by it, as it will be given according to general practice and local custom, and with a view of commanding the respect of both.

The foregoing remarks are intended to assist in the supervision of the work on and about the buildings treated of in this section, and are also applicable to other kinds of buildings. In the course of the subject, further remarks will be added in connection with any particular part of construction, if necessary, and in that way be better understood and remembered.

SUPERINTENDENCE OF THE WORK.

PRELIMINARY CONSIDERATIONS.

6. Site and Survey.—The problem of determining the site on which to locate the building is often a difficult one, as many things must be taken into consideration in order to make a good selection. This applies mainly to cases where the extent of the ground is not limited to small spaces, as is the case with city lots. The ground should be surveyed and staked out by a competent surveyor, and grade lines and levels established, that the general contour of the premises may be readily figured or mapped out. The location of the building on the lot should be determined as nearly as possible before the drawings are prepared, that the heights of walls, and basement windows, the number and size of exterior steps, etc., may be readily laid out and figured.

As, in the case under consideration, there is to be a number of terraces, roads, paths, etc., it would be advisable to place the work of grading lawns, planting shrubbery, etc. in the hands of a competent landscape architect, who would work in connection with, and subject to, the architect in charge. The work of the landscape architect is subject to the approval of the supervising architect, and the construction of masonry, terraces, steps, and other outside work on the premises should be supervised by the building superintendent.

The site for the building should be selected with the view, *first*, of obtaining good drainage; *second*, of placing the building in a position easily accessible from the entrances to the grounds, and, if possible, without the necessity of making tortuous ascents by means of planes or steps; *third*, to provide the most pleasing outlook for the principal rooms, and to place the building in such a position with regard to the points of the compass that the principal rooms may have good light at all hours of the day; *fourth*, the nature of the soil should be considered as to the possibility, during excavation, of encountering wet or marshy ground or an excess of

rock; such conditions should be kept in mind and obviated as much as possible, that unnecessary expense may be avoided. In latitudes between 38° and 48° north, the position described in *Architectural Design* would be the most desirable, for reasons therein stated.

7. Sounding and Excavation.—After the site for the building has been definitely determined, soundings should be made to form a basis of an estimate of the quantity of rock to be excavated. In a case of this kind, when soundings of a moderate depth only are to be made, a long steel crowbar and a heavy striking hammer are generally employed for the purpose, such as shown in Fig. 1. The bar should



FIG. 1.

be driven at intervals of 10 feet each way and down to the depth required for the excavation, or until it strikes solid rock, as the case may be. If solid rock is found, the depth of each sounding below the surface grade should be noted in a field book, and, after all

necessary soundings have been made, the amount of excavation, whether of earth or rock, may be determined from the established grade level of the proposed excavation, and the top of some designated stake or other mark. The expense of sounding, digging, test pits, or boring are generally charged under the head of surveying, and paid for separately by the owner, unless some arrangement is made to the contrary.

There are several methods by which the nature of the subsoil may be ascertained. A common way, and perhaps the best where boring appliances are not obtainable, consists in sinking trial pits to the depth required at various points. If, however, a very important or heavy structure is to be

erected, it is usual to bore the holes with an auger operated by hand, or by an artesian-well apparatus. It frequently is found that wet ground or free water exists below the top soil in elevated places, though no indication of it may appear on the surface of the ground. This is usually due to natural depressions in the surface of the rock or hard subsoil, as shown in Fig. 2. The existence of damp or wet soil a foot or two below the foundation of an ordinary building when the soil is firm over it is not a serious condition provided the cellar bottom is well concreted, and the foundation walls are built with a suitable *damp course*.

If, however, wet clay overlays the rock, it is not advisable to build upon it, for soils of this nature are treacherous; the rock being also wet, the superimposed weight gives the clay a tendency to slide, the water on the rock acting as a lubricant.



FIG. 2.

8. Cellar Excavation.—In excavating for a cellar on the slope of a hill, solid rock is often encountered, as the earth is thinner near the top of a slope of any extent, than it is at the base. In locating a building in such a position, it might be advisable to excavate some of the rock, in order to expose any crevices or open seams from which water might flow and collect in the cellar bottom. This would be likely to cause considerable damage to the foundation walls and cellar bottom, and by keeping the walls continually wet would render the house practically unfit for habitation from a sanitary point of view, and menace the stability of the foundations. If the water flows to any extent from these crevices,

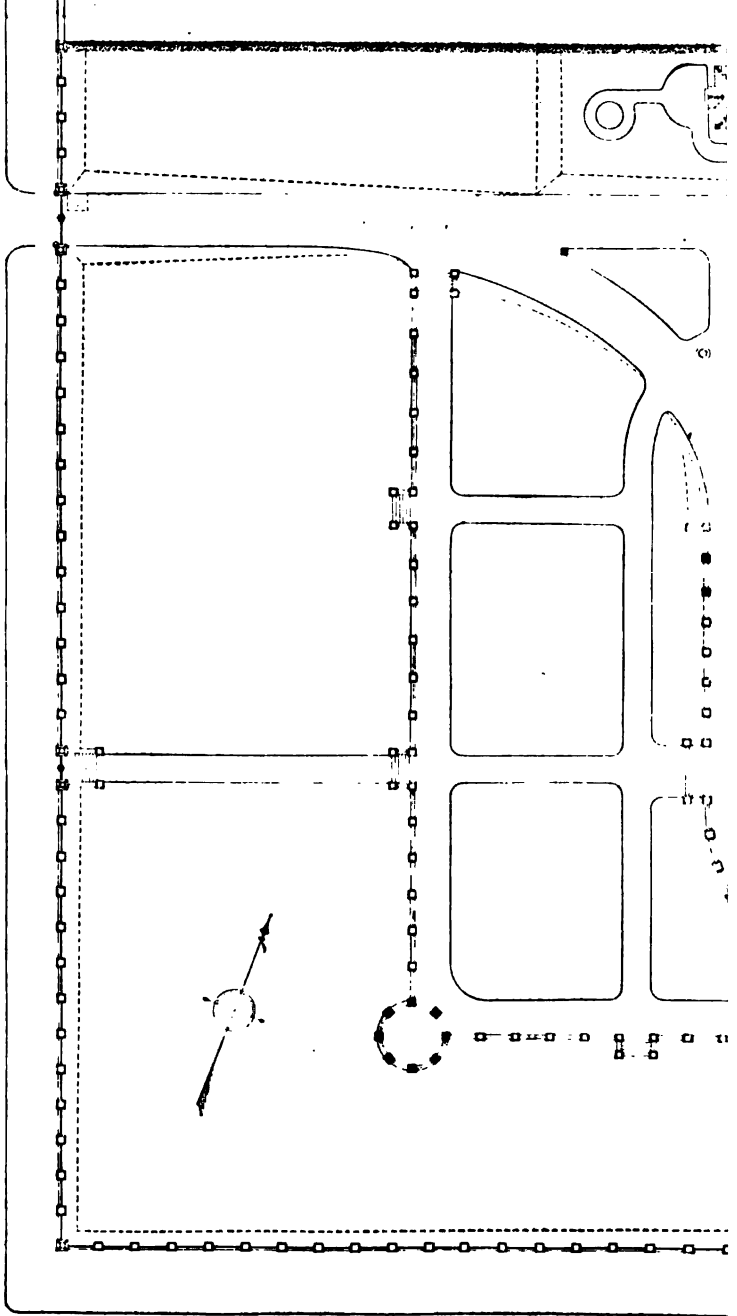
provision should be made to divert it from the masonry and give it a proper outfall away from the building. It is perhaps needless to say that a location of this kind should be avoided as far as possible, because cellars cut in rock in most cases are liable to dampness, for reasons previously stated.

If the conditions are such that rock is encountered a short distance below the surface, the necessity of cutting through it may very often be avoided by merely shelving the rock to secure a level bed for building the walls upon, and then grading up around the house and forming terraces. In this way the whole effect may be better than with all the rock excavated, the grade kept lower, and the terraces omitted. The cost of rock excavation is generally charged for extra, unless provision is made to include it in the specifications. The price per cubic yard to be paid for rock excavation is usually agreed upon between the owner and the contractor, and varies according to location, nature of rock, price of labor, etc., the quantity being measured in its natural bed before excavating.

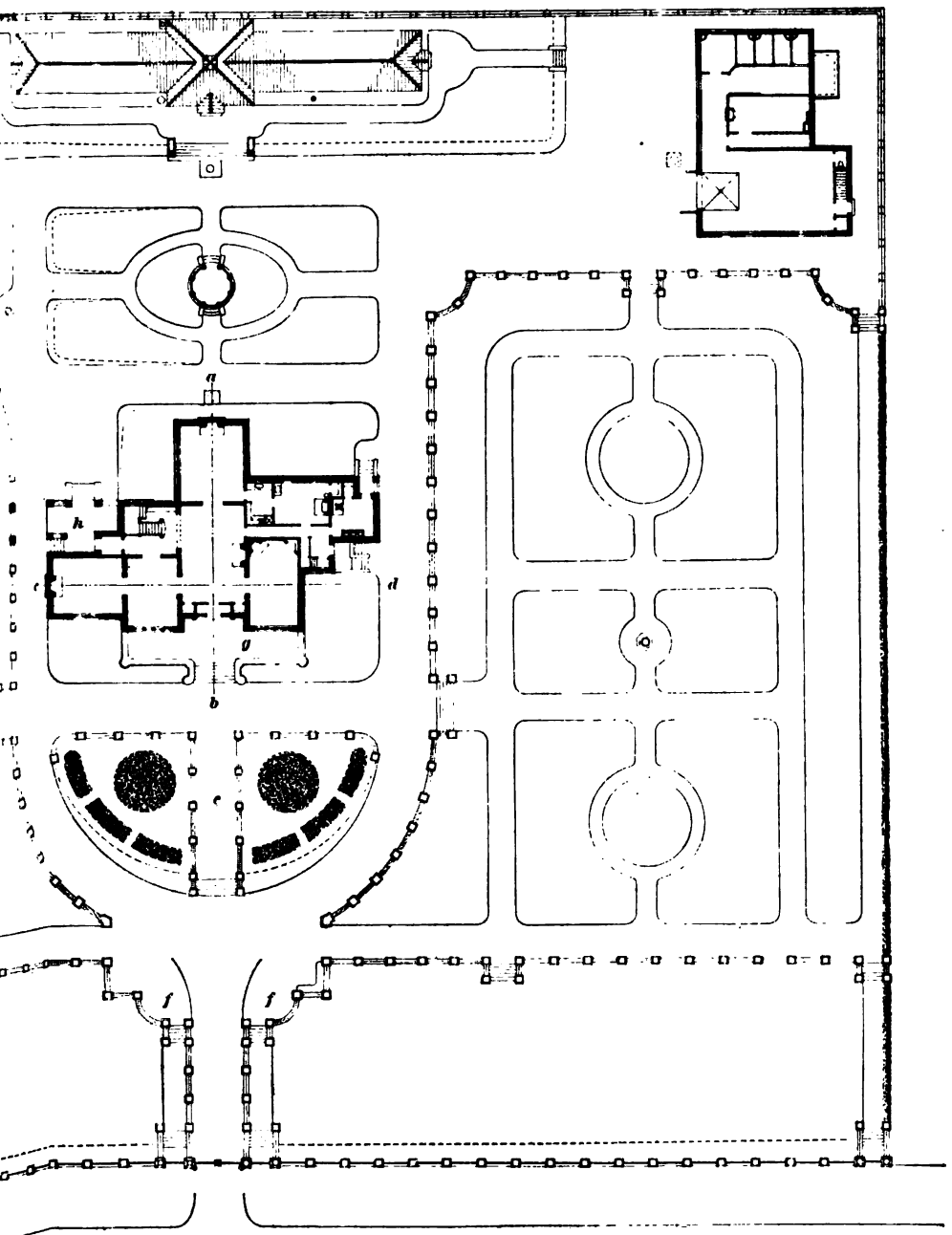
Sometimes the architect does not call for any rock excavation in his specifications, preferring to leave that until the earth has been removed, when, if solid rock appears, he or an engineer can survey it, and, after ascertaining the amount, fix upon a price per cubic yard for excavating it, and make a separate contract for its removal. In some instances the changing of the site of the building but a few feet one way or another, or the changing of the level of the cellar bottom a few inches above that proposed, will insure a dry cellar and avoid considerable rock excavation, with its consequent expense.

9. The Lot.—The lot herein considered will be ground sloping gently from the main building in a southeasterly direction, towards Thoroughfare Avenue, and in a southwesterly direction towards Station Street; the ground on the other side of the main building is generally level and slightly undulating; all of which is to be graded to level planes, as required by the drawings. The lot comprises about 4 acres, with a frontage of 450 feet on Thoroughfare Avenue, as

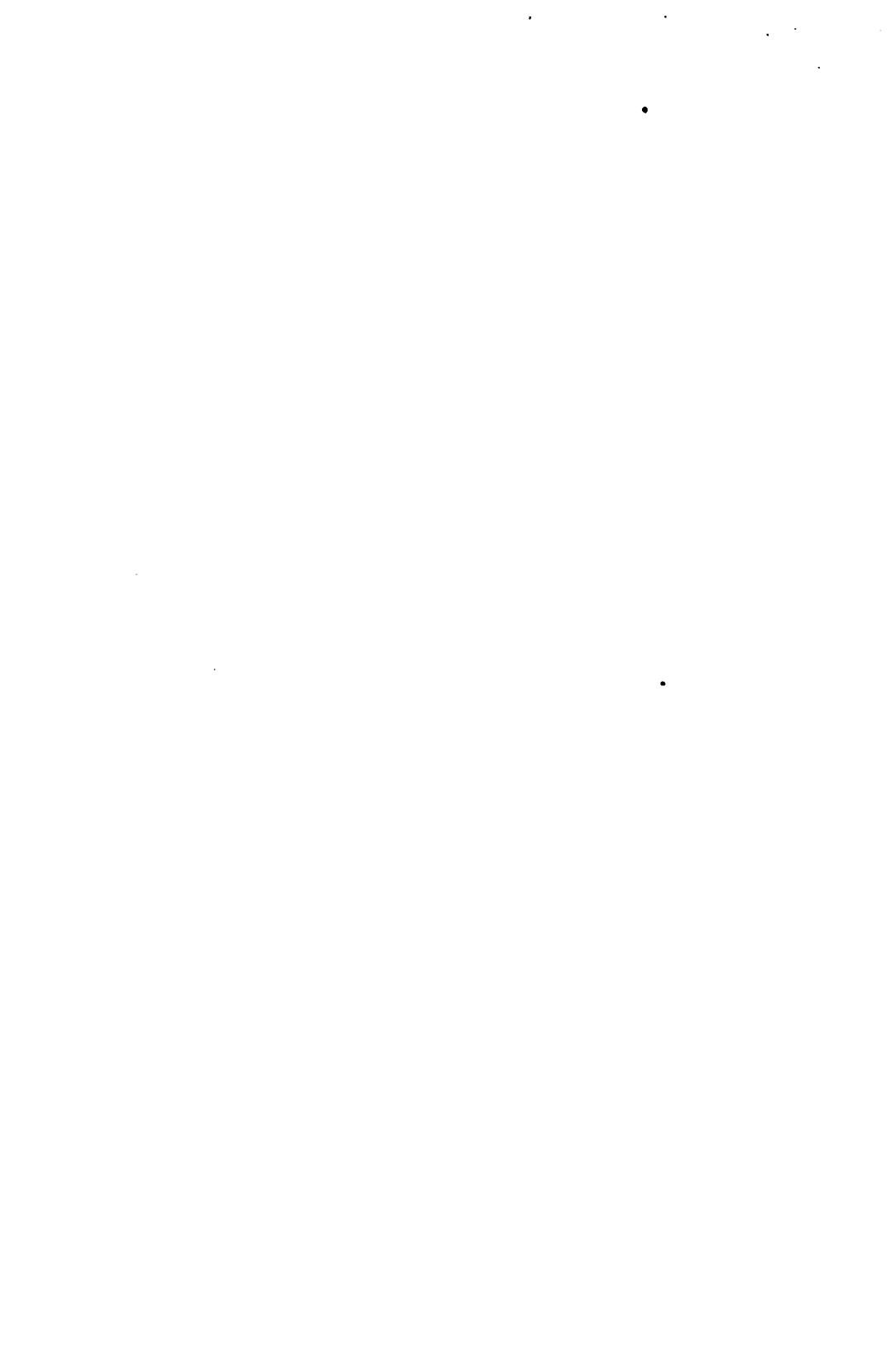
STATION STREET



THOR



BOROUGHFARE AVENUE



shown in Fig. 3. A terrace is formed back of the wall and along the street sides of the property, and graded down along the driveway and from the terrace, back to the lawns. The ground on the easterly side of the lot is slightly depressed and damp, which would indicate the presence of water below the surface. A system of porous-tile drains must therefore be provided to meet this emergency, the pipes to discharge in a main or trunk line, which in turn discharges into a large, dry cesspool near the front of the property. The front line of the building is approximately 160 feet from the avenue line.

10. The House.—The house has been designed with the object of exposing a large frontage towards Thoroughfare Avenue, and of giving a picturesque view of the building from every point. The first story contains a large entrance hall in the central part of the building, opening from which is the dining room; the stair hall is separated from the main hall by a large flat arch supported on columns; to the left of the main hall is the reception room and parlor, in the order named, and to the right is the library. All four apartments are connected with arched openings; from the main hall, immediately opposite the main stairway, a door opens to the rear hall, from which the kitchen, laundry, and servants' quarters may be reached; a large pantry connects the kitchen and dining room. The part of the building devoted to the main and rear stairs are carried up in the form of towers; a large veranda and porte cochère on the west, a plaza on the south, and entrances to the servants' quarters on the east and north sides, complete the plan of the first story.

The second story contains a spacious hall with a gallery overlooking the main flight of stairs. Through a door on the north the guest chamber is reached; on the right, and opening on the gallery, two large chambers are reached; through an archway on the right of the main hall and passing through the hallway, the owner's bedroom is reached; opposite the owner's bedroom are the principal bathroom, toilet room, housekeeper's closets, and linen closet; at the end of this hall and separated from it by a door is the rear stair

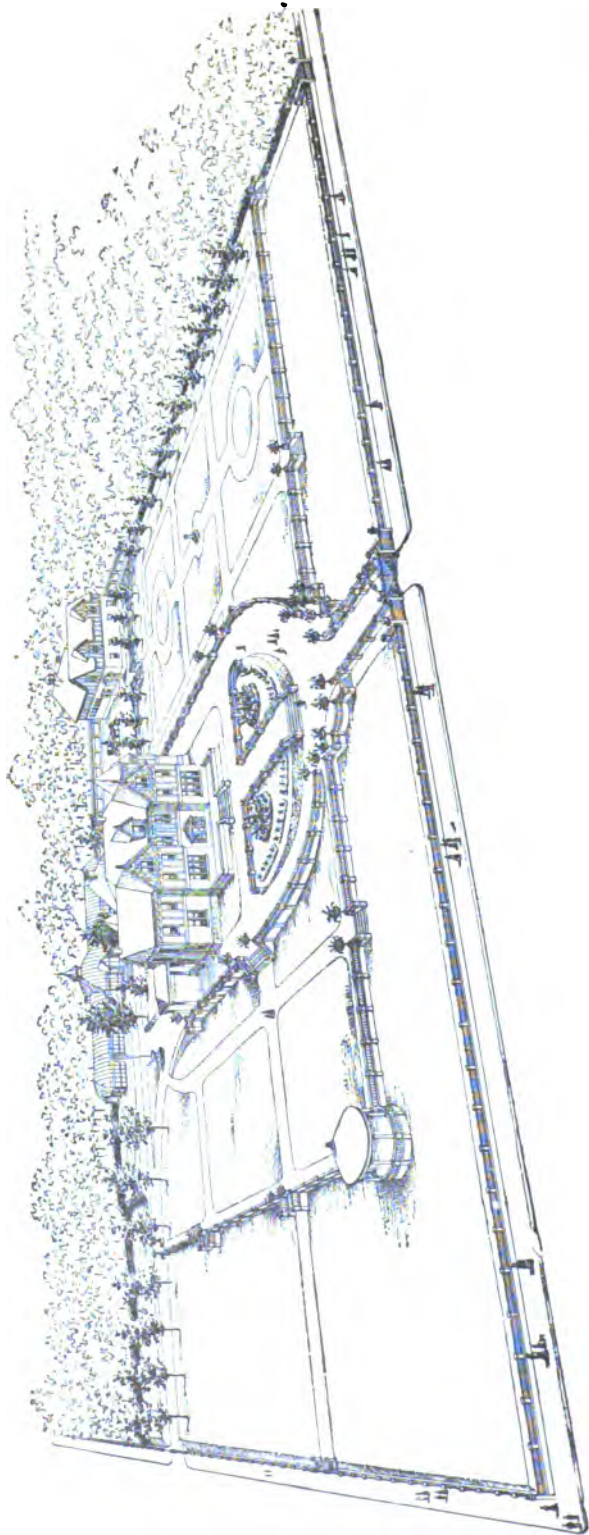


FIG. 4.

hall, from which the nursery and housekeeper's bedroom are reached. Between the owner's bedroom and the first chamber, opening on the gallery, are two large dressing rooms with a lavatory, clothes closet, and mirror in each. The guest chamber is provided with a dressing room, and that, as well as all other rooms, are provided with ample closet room.

The attic contains the bedrooms and a bathroom for servants, together with closet and storage room. The bedrooms, halls, and closets and the large storeroom are plaster-finished and trimmed. The remainder of the floor is left unfinished.

In the cellar a cold-storage, general storeroom, and wine room are provided, and are placed in a position accessible to the outside cellar entrance, as well as to the rear stairs.

The heating plant is centrally located, to afford as short and direct lines of service pipes to the various rooms and halls as possible. Ample room is provided for the storage of fuel, etc. The cellar has a concrete floor, the dumb-waiter shaft is built of brick in the cellar, and with a framed and plastered partition above this to the first story.

The exterior of the building is finished in open timber work, as shown in Fig. 4. The cellar walls above grade to the sill line are faced with *block-in-course ashlar* rough-pointed; the water-table is finished with $1\frac{1}{4}$ -inch clean-cut wash, and the face rough-pointed. The walls of the first story are to be faced with squared random ashlar, fine-pointed, and jambs and reveals of window and door openings being *clean cut*. The second story and all gable and dormer fronts are finished in open timber work, forming panels which are afterwards plaster-finished. The roof is covered with red-cedar shingles laid 5 inches to the weather; the flashings, gutter lining, etc. are of copper; the chimneys above the roof line are faced with fine-pointed ashlar.

11. The Plaza, Etc.—The face walls of the plaza from grade to the coping are rough-pointed; the inside of the plaza wall is rough-pointed also; the plaza pavement is Portland cement pitched to a grade of $\frac{1}{4}$ inch per foot and false-jointed, to represent stone slabs.

All terrace foundation walls are of rubble to within 6 inches of grade level, rock-faced to coping under foot rail, and the copings, balusters, pedestals, etc. all clean cut; all terrace and entrance steps, and all platforms, are of stone in one piece, *fine-axed*. Flower pots, urns, pedestal and post caps are furnished in one piece, *all clean cut*. The north and east side walls are built of rubble to within 6 inches of the grade, and faced with random-coursed ashlar above grade. The front walls on Thoroughfare Avenue and Station Street are built of rubble below grade, and above grade are faced with rock-faced, random-coursed ashlar, backed with rubblework; the copings, etc. are to be clean-cut finished.

12. The Stable.—The stable, which is designed to conform to the style of the treatment of the exterior of the main building, has the following accommodations: The lower story contains a carriage room sufficient for the storage of four or five ordinary carriages; cut off from the carriage room on one side are four single stalls and one box stall. The stall partitions are 6 feet high, built of 2-inch matched Georgia pine, housed into posts and fitted into a cast-iron socket plate bolted to the brick wall, the partition being finished with a heavy Georgia pine cap and crowned with a wrought-iron stall guard. The posts are of oak 6 inches in diameter, and the floor of the stalls is of hard clay, and is drained into a covered cast-iron stall drain which discharges into the general drainage system. Each stall is provided with a cast-iron manger, wrought-iron bar hay rack, and a hitching ring. A manure vault is located at the rear of the stable, the walls of which are carried 4 feet below grade and 3 feet above, the bottom finished with concrete, and the vault covered with a heavy frame and a hatchway door. A small, tight-fitting door near the floor of the stable is provided for access to the vault. Between the carriage house and stalls is a harness room, tool room, and stair hall, all plaster-finished. The upper floor of the stable provides three sleeping rooms, a bathroom, and a toilet room, all

lathed and plastered, as well as storage room for hay and feed. The inside walls of the carriage room are faced with white enameled brick, with a white-marble base 9 inches high. The ceiling is divided into panels with false beams and finished in white oak. There is no cellar under the stable. Girders resting on piers support the 3"×12" Georgia-pine floor joists, spaced 12 inches on centers, over which is laid 2"×2" tongued-and-grooved clear Georgia-pine flooring, blind-nailed to every joist, and top-nailed at all butt joints. Auger holes $\frac{3}{4}$ inch deep are bored for the top nailing, and after the nails have been driven, the holes are filled with wood plugs. The joints are calked with oakum and filled with hot tar.

13. The Greenhouse.—The greenhouse is built upon a continuous foundation wall, which is started 4 feet below grade and carried 12 inches above grade. A stone water-table 12 inches high is built in the wall all around the building. Under the central pavilion the earth is excavated to provide 8-foot headroom, and the cellar bottom is finished with concrete; space is provided for a hot-water heater and for fuel; the remainder of the cellar is devoted to storage room for herbs and roots, flower pots, etc., and a potting table. The floor in the central pavilion is of concrete, supported on brick arches and steel I beams; this part of the building is devoted to the larger plants and shut off by a glazed-sash partition from the other parts of the building. The floor in both wings is of natural earth, and slat-floor walks, in portable sections, are placed along the aisles. The greenhouse is built upon a plane, elevated about 3 feet above the north driveway, and a broad flight of steps is built immediately in front of the central pavilion, which adds very materially to the general appearance of the greenhouse. The work on this building will be inspected for the purpose of detecting faulty construction only, as the plans and details of it are assumed to have been approved by the architect and owner.

Other structures on the premises, such as the summer

house, fountain, wrought-iron gates, etc., will be explained in detail at the proper time.

14. The Specifications.—The specifications are drawn up as follows: (1) A general mason's specification covering all the excavations except that included under the contract for greenhouse work, and the grading. The mason, as principal contractor, will sign the contract covering the entire work, except the greenhouse and other special work, and shall be held responsible for the due performance of all the carpenter work, plumbing work, and work of other subcontractors on the premises. (2) The grading, filling, earth terracing, road and path building, sodding, and setting of trees and shrubs are made the subject of a special specification, and the work executed under the immediate supervision of the landscape architect, who will superintend this part of the work, subject to the direction of the supervising architect. (3) A general specification covering the entire carpenter and joiner work in and about the premises, with the exception of that in the greenhouse. (4) A general specification for each of the other trades, covering all labor and materials required, and to be furnished on or about the premises.

The horticultural contractors will furnish the specifications covering the work to be done on the greenhouse, etc., which, after the architect has approved it, will be regarded as the official specifications for this work.

15. Scale and Detail Drawings.—Scale drawings for all work, and detail drawings of important parts of the work, will be furnished; or any special information tending to facilitate the execution of the work will be given by the architect in charge.

The architect should endeavor to have all matter pertaining to the work, and the different features that are indicated on the drawings and called for in the specifications, fully explained to the owner, when the latter is a person inexperienced in building construction, taking particular note of his preferences regarding all features of the work. A little

patience on the part of the architect at this time in fully explaining his work to the owner, and on the part of the owner in studying the plans and specifications, may save a great deal of subsequent trouble and annoyance and avoid the possibility of altering work to suit the owner's taste after it has been finished.

16. The Contractor.—Much may be said and many theories advanced in favor of making one contractor solely responsible for the work, or in dividing the work up among two or more of the trades and in that way dividing the responsibility and increasing the cares of the owner and architect. It is a well known fact that work divided up among a number of men on the same job, although generally productive of well executed work, is seldom completed without serious debates arising as to who should do certain pieces of work, and when the work is done wrong who is the guilty party; in fine, one will shift the responsibility to another in the effort to save himself. Perhaps the best plan is that of giving the work to one man, making him directly responsible to the owner for every part of the work and for all subcontractors and artisans under his charge. In the event of mistakes, bad work, or the like occurring, there is then but one man to look to for their correction, or for the replacing of work improperly done that has been condemned by the architect.

The owner has had the ground surveyed and staked out, the architect furnishing the engineer with necessary information as to the location of the building, terraces, etc. The more important grade levels established, and the various points and levels indicated on the survey, are marked by *red stakes*.

The contract has been made with one man for the execution of all work in and about the premises, as called for or shown, with the exception of (1) the greenhouse, which is let under a separate contract; (2) the heating apparatus selected by the architect, which will be built under another contract; (3) the sodding, tree and shrub planting, etc., which has been let under still another contract.

There are thus four contractors, each working independently of the others; but in all the specifications there appears a clause which stipulates that they shall work in harmony with one another and shall not in any way hinder or retard the progress of the work. Any question of right or authority, or disagreement of any kind pertaining to the work and which is likely to impede its proper execution, shall be referred to the architect for adjustment or decision, which shall be final and binding on all parties concerned. The work of the minor contractors shall not be considered at present, but will be discussed in the proper form when that stage of the work is reached.

17. Clerk of Works.—A clerk of works is a person employed by the architect and paid by the owner, and, although paid by the owner, he is subject to, and responsible for the execution of the work under his immediate care, in strict accordance with the drawings and specifications and such written or verbal instructions as he may receive from the architect during the progress of the work. He should be paid a good salary, to raise him above the many temptations that are liable to beset him. He should be strictly honest and watchful in the performance of his duties, and should possess a knowledge of building operations, materials, market prices, etc., and should be able to read plans or other drawings submitted to him, and to make sketches of any detail of the work as occasion demands; he should understand the measuring and valuing of executed work. He should take charge of all drawings on the works, and if loaned to the workmen or others on the premises, see that they are returned to him at the close of the day's work. The contractor should always lay out his work, take all necessary measurements, and order all materials, and the clerk of works should never place himself in a compromising position by ordering any material, or by furnishing measurements, thus placing himself in the position of contractor's agent, in that way jeopardizing the owner's interest. The clerk of works should keep a daily record of the progress of the work, the materials

delivered, their quality, etc., and any order to alter work or valuation made of any work, the number and trades of the workmen engaged on the premises, submitting a weekly or monthly report to the architect, setting forth the items just enumerated and calling for additional drawings or advice, and making such remarks as the circumstances warrant.

The clerk of works should give particular attention to extra work, to see that all is properly done, taking measurements of the work, if necessary, and keeping an itemized account of everything pertaining to such work, as well as any work altered or omitted, so that when the time arrives for the settlement of the account, his notes may be produced, avoiding any chance for dispute or difference of opinion as to the value or amount of the work executed.

The clerk of works should never attempt to reach subcontractors except through the principal contractor. Should the work of a subcontractor be done in such a manner as to justify condemning it, the clerk of works should notify the contractor to alter it; if the notice is not complied with within a reasonable time, the principal contractor should be served with a *written* notice without delay, and, if he should refuse or neglect to make the change within a specified time (generally about three days), the architect should be notified and full information given him on the case. Should it be required to make any alterations in the work, or to press forward the execution of some particular part of the work, a letter sent to the principal contractor is generally sufficient. The clerk of works should avoid all disputes in regard to the work, and in deciding a disputed point he should make sure that he fully understands the situation. After giving his decision he should maintain his position in the matter; in fact, he should establish his authority at the beginning, and once established, it is a comparatively easy matter to maintain it throughout the work.

18. Report of Work.—The following form of report will meet all requirements under ordinary circumstances:

No. *To Mr. John M. Smith, Architect, No. 25 Exchange St., Boston, Mass.*
Report of work in progress at No. Street or Avenue, for to 1898.

WORKMEN EMPLOYED.		NUMBER OF DAYS.	VALUE OF WORK SINCE LAST REPORT.	WEATHER.	
No.	Trade.			From.....	to.....
	Masons.....				
	Stone Cutters.....			Monday.....	
	Stone Carriers.....				
	Bricklayers.....			Tuesday....	
	Terra-Cotta Hands.....				
	Plasterers.....			Wednesday..	
	Plumbers.....				
	Gas-Fitters.....			Thursday....	
	Steam Fitters.....				
	Slaters.....			Friday.....	
	Tile Setters.....				
	Carpenters.....			Saturday....	
	Joiners.....				
	Wood Carvers.....			Sunday.....	
	Painters and Decorators.				
	Electricians.....				
	Bell Hangers.....				
	Glaziers.....				
	Engineers.....				
	Blacksmiths.....				
	Tin and Copper Smiths..				
	Iron Setters.....				
	Riggers.....				
	Apprentices.....				
	Watchmen.....				
	Excavators.....				
	Miscellaneous Laborers..				
	Value of work previously executed.....				
	Total.....				
	Value of materials on the ground.....				

DRAWINGS RECEIVED. DRAWINGS REQUIRED.

REMARKS.

.....

PRACTICAL WORK.

FIRST VISIT.

19. The principal contractor is furnished with a copy of the survey and a full set of drawings and specifications covering the work under his charge, and an appointment is made with him to meet the superintendent on the ground for the purpose of staking out the building and establishing lines

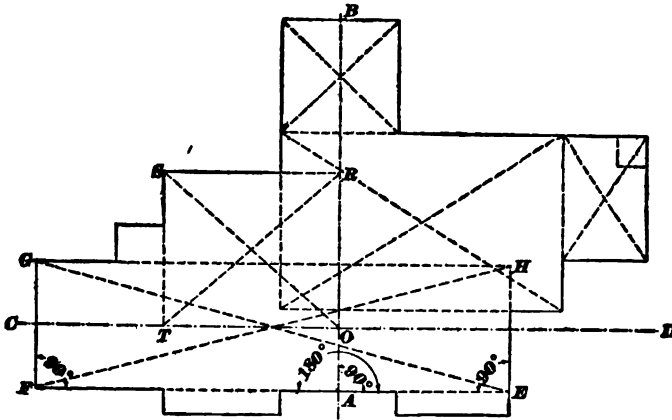


FIG. 5.

and levels. On the appointed day the contractor and superintendent meet on the ground. The contractor has brought a carpenter along, and also several pieces of studding pointed at one end, a number of rough pine boards, a bundle of stakes, a hatchet and a plumb-bob; the superintendent has brought a 100-foot steel tape, which should be divided into feet and inches (not feet and tenths), a builder's level or a transit with which to turn the angles for the building, and a field book. From the foregoing list of accessories it might appear that many of these things were not necessary; but as the work is laid out, the part each is to play will be readily seen. In setting out a small country cottage, a number of these things might be dispensed with. Where an architect's or builder's level cannot be had, a very simple method, for

ordinary work with simple outlines, is to take a long straight-edge and a carpenter's spirit level; then fix one end of the straightedge on the stake and place the level on the top of the straightedge; after being adjusted, in each case, simply sight the bottom of the straightedge to each corner. Square the rectangle by making the diagonals equal, as shown in Fig. 5. The level of the foundation wall or sill, as well as the position of each corner of the building, can then be very readily determined.

20. A Simple Rule.—A building of moderate proportions may be squared by what is commonly known as the *3, 4, 5 rule*, which is applied in this way: At one corner of the proposed building set a mason's square, such as shown in Fig. 6, and stretch a line each way from the corner and

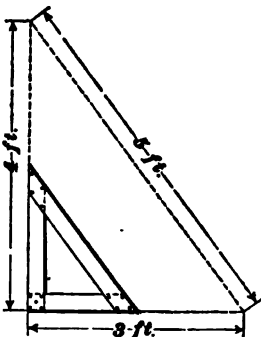


FIG. 6.

coinciding as nearly as possible with the side of the square; then on one line measure off 3 feet, on the other line measure off 4 feet, and then adjust the two points so measured, until the distance between them will measure exactly 5 feet, as shown in Fig. 6. The size of the triangle may be increased by multiplying these dimensions by a common multiplier, which can be checked by the measurement of diagonals, or otherwise, after

all the corners of the building have been fixed. The accuracy of the angles laid out in this manner may be checked by the rule (*The square of the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides*).

The survey of the property gives the lines and levels and locates the axial lines *AB* and *CD*; see Fig. 5. The axial line *AB* is perpendicular to the avenue front and 250 feet from the Station Street property line. The axial line *CD* is parallel to the avenue front, 179 feet from it, and crosses the line *AB* at right angles. According to the survey, the

top of stake *A* is on the neat or ashlar line of the building, and is figured as being 10 feet from the axial line *CD*. It is also on the axial line through the center of the main hall, 3 feet 8 inches below the level decided upon for the top of the stone foundation wall, or 1 inch above the lowest line of the water-table course. Stake *A* is therefore the point from which the building will be laid out. Setting the level over stake *A*, and plumbing it until the point of the suspended plumb-bob is directly over the tack in the stake, the telescope of the level is adjusted until the vertical cross-hair corresponds with a plumb-line or target pole held over stake *B*, this then is the axial line *AB*. The telescope is then revolved horizontally through an arc of 90° around towards point *E* on the right, and measuring with the tape the distance *AE*, a stake is there driven and a tack in the top marks the exact distance. To maintain the tape in a level position, it should also be held taut, and a plumb-line used to locate the exact point to which the measurement is taken. This will be one point on the front main line of the building; the telescope is now turned a full half circle, or 180° , and the point *F* is marked by a stake and a tack, in a manner similar to that at point *E*. The line *EF* then is the neat front line of the building. By setting the level over the points *F* and *E*, respectively, and turning an angle of 90° at each point as shown, then measuring the distance *FG* and *EH* and placing a stake at each corner, the first rectangle on the site will be completed. To check the accuracy of the measurements taken, and of the position of the stakes, measure the diagonals *FH* and *GE*, and if they are found to be of the same length, the corners will be right angles, and will form a perfect rectangle. The same method may be followed until all the points have been obtained, laying out the smaller rectangles by measurement of the diagonals, if so desired. By measuring from the point of intersection of the axial lines the distance *OR* equal to *TS*, which may be obtained from the plan, and the distance *OT* equal to *SR*, setting the level at these points and turning an angle of 90° at each point, the point of intersection of these two lines

at *S* will be a corner of the building. Thus, by working from the axial lines *AB* and *CD* in the manner just presented, the remaining angles of the building may be readily set out.

The arched openings between the parlor, reception room, hall, and library are respectively centered on the axial line *CD*.

The batter boards, which were built of the rough boards and secured to the pointed pieces of studs acting as stakes, having been set up in position and marked with the neat line of the building all around, nothing remains to be done but to mark off on each board the outside and inside footing lines

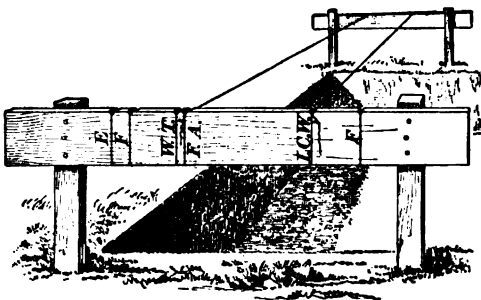


FIG. 7.

and the inside line of the foundation wall, making the marks permanent by means of V-shaped cuts, as shown in Fig. 7, which also shows the batter boards in position at the corner of a build-

ing, with the notches cut and the lines strung. The position of the footings and wall in the excavation is determined by plumbing down from the lines stretched between batter boards.

21. Levels.—At least one of the batter boards should be placed so that its top edge is on the level determined upon for the top of the foundation wall, water-table, or some other important level. It will, however, be found of great advantage to have all the batter boards set to some uniform level, such as that of the top of the foundation wall (if such a thing is possible), as the masons in leveling up the last course of stone can then bring the walls to a uniform height without the extra labor of leveling all from one bench mark, or calculating the height from some other fixed level. It

might be well to mention here that the supports for batter boards or bench marks should be well driven into the earth to guard against possible shifting of the lines through dislodgment of the stakes. After the batter boards and bench marks are all set in position, a line is cut with the spade all around the building at a distance of, say, 12 inches beyond the ashlar lines. The temporary stakes marking the angles of the building may be removed, as lines strung between the batter boards from the notches on the ashlar lines crossing each other at the corners will mark the angles. The lines and levels for the stable, as well as those for the terraces, street walls, etc., may be laid out in a manner similar to that adopted for the laying out of the main building.

Staking out the buildings is the duty of the contractor, unless the building is of sufficient importance to warrant the employment of an engineer for the purpose. The architect or his superintendent merely verifies the correctness of the work as laid out by the contractor, and gives him all necessary assistance, but in no way assumes any responsibility therefor. The earth will be excavated to the rough line marked by the spade cuts. The object of excavating beyond the wall line is for the purpose of allowing room to build the wall to a line on the exterior, pointing up the joints, and allowing space for gravel or other special filling, if such is required.

22. Commencement of Work.—When it is found that the natural sod is good and suitable for future use in sodding after the grading is done, the laborers should be instructed to cut the sod from the building site in long strips about 10 inches in width and in lengths of from 4 to 6 feet, and to roll them up. The sods should be placed on the north side between the site for the greenhouse and the street. The top soil, loam, and gravel should then be placed in separate "spoil banks," or heaps, away from the building and at a point to be convenient when required for grading or road building. The excavated material should not be nearer the

edge of the excavation than 6 feet, to allow for the erection of staging and space for mortar troughs and supplying the masons with materials. It is very important that the excavated materials be deposited at a point which will be as convenient as possible when they are wanted again. It is a common occurrence to find the earth heaped up to a considerable height without any regard to the position of the porch piers and trenches, and when the time comes to excavate for the piers, etc., it is necessary to dig clear through this pile as well as into the undisturbed earth, necessitating an extra expense which by a little forethought could be avoided. Handling any material two or three times adds a considerable amount to the labor and expense, as well as tending to reduce the net profit of the contractor. It is important also that the different soils should be piled up separately. The large stretch of nearly level ground along the west side of the property is suitable for piling of lumber and framing. The north end of the property immediately at the rear of the main building is suitable for the piling of stone and brick—one end being reserved for stone dressing and the other for mortar mixing. In fine, all materials should be deposited on the ground in a position easily accessible and arranged to avoid rehandling.

It is presumed that all the necessary preliminaries have been arranged, and nothing now remains to be done but the actual work of excavation and the delivering of materials on the ground. The contractor promises to deliver on the ground all necessary scaffolding, implements, etc. without delay, and the work of excavation is to commence immediately.

It should not be inferred that the first visit, second visit, and so on, made at intervals of several days, would be sufficient for an undertaking of the magnitude presented in this section, as a work of that kind would require constant or daily attendance on the part of the architect or superintendent, and a clerk of works, with an office established on the premises, would be a necessity. For ordinary buildings it is usual for the superintendent to visit the works once or twice

a week, depending upon the importance of the work and the amount of supervision required and paid for by the owner; for instance, in the building of a small country house, it would not be reasonable to expect an architect or his superintendent to visit the work every day, as the commissions received for the work would not warrant it.

SECOND VISIT.

23. Allowing the contractor one week or ten days to have all necessary implements, etc. on the ground, and to get the excavation for the main building nearly done, the superintendent should visit the premises for the second time and find a large force of laborers is at work, and the excavation for the main building nearly done. Looking around, the superintendent should see that the sods, top soil, loam, and gravel have been placed in separate heaps in the proper places. One great pile of rough quarry stone, another pile of ashlar, and a third pile from the appearance of which should contain some three thousand brick; a large quantity of rough plank, sand, lime, cement, and other material should also be found on the ground. Carpenters should be busily engaged erecting a shed at the rear of the main building for the storage of the lime, cement, etc. The superintendent should now examine the sand, taking a handful at random, rub it between his hands, and find if it pricks the skin and has a sharp crackling sound; he should then wet a handful, which, after it is compressed in the hand, should not cake or cling together, thus indicating that it contains very little loam, or is, in a word, *clean*. The superintendent should also notice that it does not discolor the hand, which is another test for the presence of loam. This sand being clean and sharp will require less cement than if it were finer or contained a greater amount of loam or other inferior substances. The coarser grades of sand are preferable to other kinds, and that obtained from quartz sand pits is undoubtedly the best. This sand, if used for plastering and being unusually clean and coarse, will very often require the

addition of a little finer sand or loam, especially when no hair is used for the mortar. The sand should be screened to remove the coarser gravel, which is deposited in one end of the cellar for future use in preparing concrete and for filling trenches, etc.

24. Testing Cement.—Many methods are resorted to in order to determine the best properties of cements, their resistance to the action of the atmosphere, water, etc., and their compressive and breaking strength. There is a wide diversity of opinion as to the best methods of testing cement, and this question has been under discussion for many years, the results being given in a number of works on masonry and construction. In engineering work of magnitude, such as masonry bridges, abutments, retaining walls, drains, etc., very rigid specifications are drafted covering the tests for this particular material, and a time test varying from a week to a month or more is insisted upon—the contractor being required to have the cement delivered on the ground a sufficient length of time to permit of the tests being made, previous to that fixed for the laying of foundations. The manufacturers of cement very often publish tables compiled by some eminent engineer, setting forth the properties of their material, which may be accepted or not; engineers, however, generally prefer to make their own tests. In work where a great deal depends on the construction and bonding of the walls, rather than on the strength of the cement, a slight variation will be of no consequence, provided the cement is of some recognized brand that has withstood the test of market competition.

25. Results Obtained From Tests.—It would hardly be necessary to dwell on the various methods employed by engineers in testing cement, as an explanation of these may be found in the reports of The American Society of Civil Engineers, and in a number of standard works on building construction as well. The superintendent should know, however, how to test the cement at the work in as short a

space of time as possible. It very often happens that he finds the cement on the ground one day while the actual work of wall construction is to commence the next or even the same day. If, on looking over the ground, he finds in making his tour that a large quantity of cement has been delivered, and that there are four brands of it, representing the product of as many manufacturers, the cement should then be passed upon, and should there be any brand on the ground not called for in the specifications, or a brand the quality of which the superintendent is in doubt about, he should test it. In a case of this kind the following simple test might be applied: Mix a stiff mortar in the proportion of 1 part cement to 1 of sand of each kind of cement furnished, and form of each kind two "briquets," or cakes, from 2 to 3 inches in diameter and $\frac{1}{4}$ inch thick, and spread them out on a board exposed to the sun for about an hour, or until they become firm enough to handle, after which take one sample of each and immerse in water for about two hours. Care should be taken to mark each sample, that the different varieties may be easily distinguished. After this time has elapsed, the superintendent should examine the samples. Suppose that he finds sample No. 1 had become quite hard in the air and resisted the tensile strain exerted by pulling it apart with the hands before breaking, and the fracture was then clean with sharp edges, it proves the sample of cement No. 1 sets well in the air and under water, and for this reason it is suitable for masonry below grade. He then finds that sample No. 2 left in the air has become very hard, in fact harder than No. 1, but he also finds that sample No. 2 in the water has crumbled into a heap, indicating that though the action of this cement in the air was very encouraging, it is entirely unsuitable for use in positions where the mortar is to be depended upon to resist water. Sample No. 3, air set, is soft and crumbles at the edges, it breaks very easily, and upon being pulled apart, it breaks in small pieces. This sample in water is no better, showing that it is a slow-setting cement, and though in time it might attain a hardness equal to the other, it is not desi-

rable for the work. Sample No. 4, air set, and the others in the water, are both very hard and resist the breaking tests very well. The No. 4 sample, being Portland cement, to be used in pointing, etc., is accepted at once. The Vicat cement which is specified, and which will be used for the setting of ashlar, etc., having qualities peculiar to itself which renders it valuable for use in setting limestone, etc., is accepted.

26. Judging the Quality of Cement.—A few cement barrels are broken open, and in one or two instances the cement is found to have partly set or caked around the edges. In this instance the superintendent should order the barrels removed, or caution the contractor to use none but the free cement. It very often happens that the cement becomes hard around the edge of the barrel and should not be used, although the balance of the cement in the barrel is in good condition.

The superintendent should not be induced to accept cement on the recommendation of the masons or contractor, nor accept their tests, which very often are worthless. Masons have been known to declare that cement when placed on the tongue should have a biting taste, the intensity of the bite indicating the strength of it; then, again, many say that it should be of a certain yellowish tinge and have a soft greasy feeling when allowed to run through the fingers, and so on. Such tests are useless, and are offered through ignorance or with the idea of deceiving the superintendent. The color of cement varies, according to the grinding and the locality of the quarry from which the stone is taken, from a light to a dark gray, very often having a greenish or bluish tinge. The dry cement should be uniform in color and entirely free from streaks, which indicate impurities or imperfect grinding.

27. Limes.—Limes may be said to be either common or hydraulic, according to the amount of silica, alumina, etc. they contain. The best common limes, frequently termed

fat, or rich, limes, are manufactured from limestone and marble that contain less than 5 or 6 per cent. of impurities. After calcination, the lime is broken up and put on the market in lump form to prevent *air slaking*. Fat limes slake quickly when immersed in water or when exposed to the air, and harden slowly in the air and not at all in water. Lime becomes hydraulic when it contains 15 per cent. or more of silica and alumina; it slakes slowly and quietly, and hardens under water, hence is adapted for use in damp situations. Lime having a percentage of silica, alumina, etc., varying from 6 to 15 per cent., is poor, and does not augment in bulk to any great extent when slaked with water. Ground lime contains a large percentage of silicates, approaching the nature of cement, and will not slake when mixed with water, but will set rapidly in air or water.

28. Inspection of Lime.—On the occasion of the superintendent's second visit, after completing his tests of cement for the time being, he should proceed to test the lime to be used in the mortar for brickwork. He should observe that there are several brands of lime on the premises, and in glancing over the barrels may discover that two or three of them have burst open, and the lime, as far as can be seen, is in powder; the barrels are opened, and, on examination, it is found that the lime has for the most part crumbled, indicating that it has become *air slaked*. A few lumps, taken at random, are immersed in water and do not slake immediately; the barrels from which these are taken are then ordered from the premises as being *unfit for use*, although the lime may have been of excellent quality when the barrels were filled. A sound barrel is next broken open and a few lumps of the lime are immersed in water; two or three of the lumps begin to slake immediately, but the others remain inert for some time and then slake slowly, leaving a hard center or core, indicating that these lumps are *underburnt*, which, if allowed to be mixed in the mortar, would continue to slake slowly and swell, thereby causing the mortar to crack. This lime then is *entirely*

unfit for use, and should be condemned and ordered off the ground.

Overburnt lime is even worse than underburnt, for the lumps, being hard, resist the action of the water and do not slake readily; the slaking process commencing slowly and a great deal of time being consumed in the process. *Any lime, then, that is overburnt should be rejected.*

On opening a barrel of first-class lime and immersing several lumps in water, it is seen that the slaking process commences almost immediately; the action, due to the oxygen of the water combining with the lime in slaking, gives forth a hissing sound, and a warm white vapor arises. This lime, then, is satisfactory, and may be used with an admixture of cement in making mortar for brick walls in the cellar or such places where dampness is liable to occur.

29. Hydraulic Properties of Lime.—The hydraulic properties of some particular brand of lime may be unknown, and if it is desired to ascertain whether it is suitable for use in damp situations or under water, a test should be made. The following test, though very simple, should be sufficient under ordinary circumstances: A stiff mortar mixed in the proportion of 1 part lime paste to 2 parts clean, sharp sand, thoroughly incorporated by continual working until all streaks disappear, should be formed into a cake, as was done with the cement, and immersed in water. After at least 24 hours, if the cake has hardened perceptibly, it may be reasonably inferred that the lime is hydraulic.

30. Excavation.—Nearly all soils in a vertical bank, except dry sand, will retain their shapes unless disturbed or acted upon by frost or moisture. The earth, acted upon in this way, assumes its angle of repose, which varies according to the nature of the soil itself—usually about 30°. In excavating earth to any great depth, when the excavations are to be left open for a long time, the bank should be held in place by means of sheet piling, or the sides of the excavation should be dressed down to a slope of at least 60°.

Ordinary clay or kaolin strata in an embankment are a constant menace, as they are liable to act as a lubricant. Under such conditions the bank is likely to slide in, thereby causing a great deal of unnecessary work, unless provision is made to avert it. In the case under consideration the earth in the excavation is assumed to be a firm loam with strata of coarse gravel; a finer and harder stratum appears lower down, which gradually merges into a clayey nature at the bottom of the excavation. At the southwest corner the soil is found to be quite wet, which indicates the existence of a spring or a rock depression in the immediate neighborhood. This ground looks treacherous to build upon, especially on account of the wet clay; for this reason it will be necessary to dig trenches down to solid rock, which is found at a distance averaging about 2 feet below the line of the finished cellar bottom. The soil changes gradually from hard, coarse sand to a light-colored clay in the rock depression, which is quite wet. On excavating to clear the rock, we find a small stream of water flowing from a crevice in a southwesterly direction, which indicates that it probably comes from a spring or the high ground adjoining. It will be necessary in this case to divert the flow of water, that the foundation wall may be kept dry, and to do this it will be essential to excavate a pit in the rock, 2 or 3 feet outside the foundation wall, and sink it at least 2 feet below the level of the cellar bottom. The foundation walls may then be carried down to solid rock, but laid dry with large, sound, flat stones to the level of the adjacent footings, and laid up from there in mortar.

31. Trenches.—Trenches are now cut in the rock from the bottom of the wall trench, at different points, to the pit just mentioned, and filled in with broken stone and covered with a layer of straw. The pit is drained through a close drain of 6-inch vitrified earthen pipe laid with a good grade, and the joints made tight with cement mortar. The extension of this drain forms the trunk, or main, for the discharge of the subsoil drain pipes laid under the terrace on the west

side of the premises, all of which will be subsequently considered. In this way the water may be diverted to the pit, and should the flow of water increase in volume, as it is likely to do in the spring, the outlet drain pipe will carry it to the blind cesspool. But should any water remain in the trenches, the cellar may still be dry, as the substructure of the wall, being laid up without mortar, will allow the water to flow in and around the stones, without causing any damage to the work or soaking the cellar floor or walls.

Now, as the specifications do not require the contractor to carry the walls down below the level of the footing course, nor to cut the pit and drains in the rock, and not being called for or included in the contract, the owner will be required to pay him *extra* for this work. It is then agreed to pay the contractor 12 cents per superficial foot for the dry wall, the stones to be large and with a reasonable number of through stones. On figuring up the extent of the wall from the rock bottom to the underside of the cellar concrete, and deducting the footings, it is found that 138 superficial feet will be required, which at 12 cents per foot would be \$16.56. A special contract is drawn up and signed by both parties, and a note made on the cellar plan and in the superintendent's field book; it is agreed that the payment shall be made (ten) days after the last payment on the original contract shall have been made, and after the final acceptance of the work by the architect and owner.

The excavation for the pit and trenches are next measured up, and, as this work could not be foreseen at the time or previous to the signing of the original contract, the owner will be required to pay for this extra work also. By measurement it is found that the top of the rock near the pit is 4 feet 2 inches below the natural surface grade, which at this point is uniformly level. After measuring at several other points along the trenches, it was found that a fair average of the depth of the earth above bed rock is 3 feet 6 inches; taking this as the depth, the superficial area of the trenches and the pit measured—making trenches 2 feet wide to allow a workman sufficient room—amounts to 81 square feet. The

price for earth excavation agreed upon is 30 cents per cubic yard; thus,

$$\frac{3 \text{ ft. } 6 \text{ in.} \times 81 \text{ sq. ft.}}{27} = 10\frac{1}{2} \text{ yd.} \times 30\text{c.} = \$3.15.$$

The rock excavation in the pit and the cut to the pit is found to contain approximately $3\frac{1}{4}$ cubic yards, which, at \$2 per cubic yard, the price agreed upon, will give \$7.50 for rock excavation; this amount added to that for earth excavation brings the total to \$10.65. The coarse gravel filling which he will get after screening that taken from the excavation for the cellar is not charged for, and the contractor agrees to furnish the necessary straw.

On the north side of the excavation, in the dining-room extension, a clump of rock appears above the level of the cellar bottom, and measuring it by means of a straightedge, level, and rule, it is found to contain approximately 4 cubic yards; it will be necessary to remove this to a depth of 1 foot below the level of the finished cellar bottom to allow for leveling up the bed and for the concrete to be laid to the full depth, as required by the specifications.

Now, as the specifications do not call for the excavation of solid rock, the clause being "excavate all earth and loose rocks," etc., the owner will be required to pay the contractor extra for this work. The contractor is consulted, and a price of \$1.50 per cubic yard is agreed upon; hence, 4 cubic yards \times \$1.50 = \$6. To cover this work, a special agreement is drawn up, similar to that provided for the work in the pit and trenches. A detailed specification is also drawn up, and both of these papers are signed by the owner and contractor. The superintendent makes a marginal note on the cellar plan and keeps a record of the transaction in his field book, which may be produced when the time arrives for settling the accounts. These matters being satisfactorily adjusted, the contractor may proceed with the work.

32. Rock Excavation.—Rock excavation being too small an amount to warrant the use of steam or compressed-air drills, and too extensive for wedging, hand drills will

have to be resorted to. The small holes are driven by one man with a small jumper and a hand hammer; the larger and deeper holes require three men, two with sledge hammers and one holding the jumper, which he lifts up slightly and turns at each stroke of the hammer to keep the hole round and prevent the jumper from jamming. A small amount of water is poured into the hole at intervals to wet the pulverized stone; this is cleaned out several times in the course of sinking, and when the hole has reached a sufficient depth, the pulverized stone and water is removed by means of a rod having a valve or a spoon-shaped piece on the end. The hole is then cleaned out with a rod or strong wire having straw or rags wrapped around the end. After throwing in some fine, dry sand or some such material to absorb the remaining moisture, the hole is ready for the charge. Coarse gunpowder or dynamite is generally used for the charge, the latter being preferable where it is required to shatter the rock, on account of its great strength and also its comparative safety in handling and storing. If a heavy charge of black powder is used and the charge improperly covered, the rock fragments are likely to be thrown in all directions, while dynamite has an apparent tendency to work downwards, due to the greater rapidity of the combustion and consequently a greater resistance of the atmosphere. The size of the cartridge depends on the depth of the hole, the amount of rock to be blown out, and the nature of the rock itself; harder rock very often requiring less than rock of a softer nature. Where a comparatively small amount of rock is to be excavated, the charge is generally set off by means of a fuse, cut to a sufficient length to allow the workmen to reach a place of safety before the explosion occurs; but if dynamite is used as the explosive, the charge is fired by electricity, a cartridge being secured to the end of the wires which are strung along to a suitable distance to insure safety, and the charge exploded by means of a button or plunger handle.

Electricity is used almost entirely where a great deal of blasting is to be done, the holes being driven during the

morning hours and the charge inserted and connected up with the battery to be set off at once, generally at the noon hour when the men have quit work for lunch; the same procedure is gone through with in the afternoon and the blasts all set off at 'the quitting hour. Where a great deal of rock is to be excavated to a reasonable depth, it is worked to a face and the holes are sunk at a distance back and parallel to the face; in this way the rock may be excavated with economy, and the rock excavated will be of greater value for building purposes. When rock excavation is done on a large scale, steam or compressed-air drilling machines are used, the work being done with greater rapidity and economy. Rock excavation in the larger cities is done by men who follow that business entirely, being licensed and placed under a penalty for noncompliance with the local ordinances, or for carelessness. In work requiring a great deal of rock excavation, the quarryman becomes a subcontractor, unless the contracting mason himself is a licensed stone quarryman.

33. Quarry Stone.—After completing arrangements for the blasting of rock and special work in trenches, etc., as previously described, the superintendent examines the quarry stone delivered, and finds that it is for the most part sound and of sufficient size. With an admonition to the contractor to allow no shaky or unsound stone to be used anywhere in the buildings, and to see that all stones are laid with a good flat bed, he passes on to inspect the footing stones and finds that they are flat, sound, and up to the requirements. Some pieces found to be only 6 inches thick are condemned, as the specifications require that they shall be at least 8 inches thick. The superintendent orders these stones broken up for use in the walls, or removed from the premises; the remainder of the footing stones are found to conform to the specifications. The footing stones should be laid on the undisturbed earth, and if the earth in the trenches has been disturbed, all loose earth must be removed to obtain a firm bed, even if takes an extra course of stonework to do it.

34. Ashlar.—The part of the ashlar facing and dimensioned material delivered is next inspected, and is found, with few exceptions, to be clear, sound, and free from seams or other defects. Sand holes, or pits, very often occur in sandstones, the color of the stone varying to some extent; single pieces are often found having two shades of color. On sounding the pieces of ashlar with a hammer, the superintendent may discover that some pieces, which look in every way as good as the rest, give forth a dull sound, indicating that they contain hidden seams which are liable to open after the stones have been set; these stones he orders to be removed immediately. Sound stone should have a clear ringing sound on being tapped with the hammer. The same method may be employed in testing granite and blue limestone for copings, steps, etc. Good granite should be free from black or white lumps, generally of quartz, called *knots*, and also from seams or discolorations. Bluestone should be free from discoloration, which generally appears in streaks, and from decided laminations. Generally speaking, a newly fractured piece of stone should show bright, sharp, and in most cases crystalline. A reasonable period of time should be given after the stone is quarried and before it is set, to allow for the evaporation of *quarry sap* or natural moisture in the stone. Sandstones, limestones, etc. can be prepared and finished at the works by the use of saw planers, cutters, and grinders, but granite, trap rock, or similar hard stones must be finished by hand.

It is the duty of the architect to see that a copy of the working drawings, having every dimensioned stone designated by some distinctive mark, is furnished to the foreman setter by the stone contractor or quarryman, and each stone should have a corresponding mark upon it. It is also important that the clerk of the works should examine the marks on the stones as they are delivered on the ground, and see that it is placed in a position to be accessible when wanted, without the necessity of rehandling.

35. Brick.—The brick are next examined by striking two of them together. If they give forth a clear ringing

sound and the corners do not break off easily, they may be considered good, and in compliance with the specifications. Some may be of a light color, indicating that they are underburnt; others of a purplish tinge, giving forth when two are struck together a metallic ring; these bricks then are overburnt and should not be used except perhaps as *bats* in the body of the wall, or for paving. Excessive burning generally reduces the bricks in size and often distorts them. The contractor should be notified to remove from the premises the underburnt brick and all the overburnt that are distorted, and he should be cautioned to get a better quality for the balance of the work, under penalty of having the entire lot condemned. After these instructions have been given, the second visit may be considered at an end.

The superintendent should follow a systematic tour of inspection; probably the best being to examine all outside work about the excavation, such as lines, etc., then the excavation itself, examining the soil, the nature of the ground on which the footings will rest, and finally the materials in and about the premises. Each successive visit should be followed in the order named, and in this way very little will escape his notice.

THIRD VISIT.

36. The superintendent finds on the occasion of his third visit that the foundation walls have been started, a short section being built varying in height above the footing course from 2 to 5 feet; he examines the lines stretched between batter boards to see that they are in the proper notches, and then sights along the partly built wall to ascertain if it is built to the lines; finding it to be properly lined up, he enters the excavation.

The masons are busily engaged in one corner setting footing stones, and the superintendent finds that this is a good opportunity to observe how they are being laid. He sees that the stones are good, sound, and of sufficient size; he stands on each stone in turn, and tries to rock it; one stone rocks perceptibly, indicating that it is either unfit as a footing

stone or improperly laid. The stone is ordered taken out, and it is found to be slightly rounded on the under side; the masons are instructed to scoop out the gravel bed to conform to the shape of the stone, which is then replaced and is found to bed firmly. The superintendent directs the workmen to heap fine gravel and sand around the stone, and tamp it under the edges for the purpose of filling up empty spaces and improving the bed.

Another method for bedding footing stones very often resorted to is this: Sand or gravel is heaped around the stones and water is poured on it, generally by means of a hose; the water, settling under the stones and following the open crevices, carries the grains of sand or gravel with it, filling the voids and interstices between the stones and the earth beds, in this way forming new beds to conform to the uneven surface of the stones.

The superintendent finds in one place a small clump of soft rock, some 10 inches high and 3 feet long, that has not been excavated to the level nor even shelved to receive the wall; he immediately calls the foreman mason's attention to this point, and on being asked why he allowed such work to be done, replied that the rock being so near the level of the cellar bottom and the wall bed portion of it nearly level, he did not think it necessary to cut it out; for if on finishing the cellar bottom it was found to come above the floor, the projecting part might easily be knocked off with a chisel. Now it can be readily seen that if this was allowed to remain, any surface water finding its way down to this rock, would follow it and enter the cellar. The superintendent should order the wall above the rock taken down and rebuilt; the rock, which is found to lay in seams, is easily prised out with a crowbar until the required level is reached.

37. Damp-Proofing.—It very often happens that damp or wet soil is encountered in excavations for buildings, and many methods are adopted to keep the cellar walls dry and prevent the entrance of surface water. Under ordinary circumstances gravel filling and a porous tile drain along the

footings are sufficient to carry off the water, but when the soil is wet a damp-proof course of some substance that is impervious to water is applied. Asphaltum is perhaps the best known substance for the purpose, and when applied hot in layers, alternating with tarred felt paper at the footings and at a point about 6 inches above grade, the exterior walls below grade plastered over with cement mortar to even up the surface and then coated with asphalt, a water-tight job will result that under ordinary conditions will last for an indefinite length of time. Many other methods are employed in damp-proofing, but that work is discussed in another section.

Damp cellars, however, are usually an inexcusable condition, and should not be allowed to occur under any circumstance, as they are likely to cause an unhealthy condition in the house. In cold weather such houses are hard to warm, and in summer they are damp and the air has a stale, musty odor. Damp cellars result from spring or surface water penetrating the foundation walls or concrete of the cellar bottom. Water soaking through the foundation walls may be prevented by damp-proofing, as already described, but when a running stream of spring water finds its way across the building beneath the concrete bottom, it should be confined in a close drain and never carried through an open drain. The drain being open would offer the same objection as though it were omitted entirely. Where the earth in the cellar bottom is generally wet, a series of porous-tile drains should be laid connecting with a trunk drain, which in turn should be carried to some convenient place on the premises to discharge into a dry cesspool, or some such collecting basin, and where the water may soak away into the soil below.

38. Walls.—The superintendent observes that the brickwork for the cross-walls in the cellar, as well as that for the enclosing walls of the ash-pits and around the jambs of the cellar entrance door, have been started and are properly bonded into the stonework, the bonding courses of the brickwork are laid at proper intervals, and that the joints are

struck in a proper manner on each side of the wall, that is, by holding the trowel in a diagonal position, so that the joints will be *weathered* against possible water or dust. The superintendent passes on and finds that the foundation wall in course of construction is well built, that the stones are generally of good size and laid with a level bed, that there are no long vertical joints which would be objectionable, that the wall has the requisite number of through stones

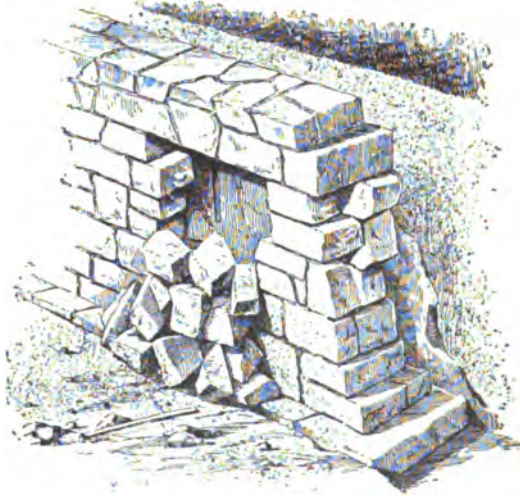


FIG. 8.

built in, that it is weather-pointed on the outside as required by the specifications, and that the footings are all that might be wished for. The filling outside the foundation wall has not been done, it being required by the specifications to leave the excavations open for at least three days to allow for inspection of the work, and also to allow the mortar to partly set.

A trick practised by some irresponsible builders, to be guarded against, is this: Where the cellar excavation is cut in rock it often happens that the rock when it shows a good vertical face is not excavated far enough to admit of the foundation wall being built to its full thickness; the rock is faced, as it were, instead, and, unless the superintendent

has been fortunate enough to discover it in time, no indication of the sham work will appear unless perhaps at some future time when it may fall away below the top of the rock, due to the action of water keeping it constantly saturated, or due to a great superimposed weight; the wall may fall away gradually or collapse suddenly to the possible risk of human life, and damage to the building, as shown in Fig. 8. A deception of this kind may be discovered as follows: The superintendent should procure a steel rod about 5 or 6 feet long and from $\frac{3}{16}$ to $\frac{5}{8}$ inch in diameter. If the wall is properly built to a line on the outside, the rod may be easily driven down to the required depth, and if the rod strikes solid rock at more than one trial before reaching the footings, the wall should be ordered taken down, and no doubt the discovery will be made that the wall is faced as shown, or else the wall is built against the face of the rock without any intervening space, which is almost as bad. In cases of this kind the only remedy is to take down the wall to the bottom and remove the rock sufficiently to leave a space of at least 8 inches outside the wall to allow for pointing up the joints, and afterwards fill with gravel or broken stone. Another common occurrence is to build the wall to one face only, that is, to a line on the inside or cellar side of the wall, allowing the stones to project out beyond the outer face of the wall as they will; the reasons for doing this are very readily understood. It not only saves a considerable amount of stone dressing, but also a great deal of time in lining up the wall, as well as saving the labor of pointing on the outside. When work is done in this way, the earth bank, if of loose material, will, when it settles, tend to force the joints in the wall by the leverage on them, and again, the projecting rock forms ledges inviting the water to penetrate the joints which cannot be well pointed to prevent its entrance. It might be well to mention here that due precaution should be taken to see that the pointing up of the outside of walls is properly done; workmen as a rule seem to shirk this part of the work, preferring to expend their skill in making the inner and actually less important surface appear well to the eye.

39. Mortar.—The lime to be used in mortar should never be slaked on the bare ground surrounded by a ring of sand as is often done in rural districts, but seldom where the best results are required. A rectangular box of plank should be constructed for the purpose; four or five planks laid on the ground with their edges butted close together, and the sides and ends formed by planks about 10 inches wide set on edge are sufficient. The box is made about 4 by 7 feet, this size being large enough for slaking and working one barrel of lime. Some masons have well constructed boxes and carry them about from place to place. Should it be required to mix the mortar in quantities requiring more than one barrel of lime or cement at a time, the boxes may be increased in size to suit the conditions.

The superintendent should make sure that the sand, lime, cement, etc. are mixed in the proper proportions. In mixing the mortar, the workmen or foreman should be instructed to put all the water on the lime at once, instead of by bucketfuls or by means of a hose. The best method is to provide a barrel that is large enough to hold a sufficient quantity for the complete slaking of one barrel of lime; the barrel may be refilled by a hose while one batch of mortar is being prepared, and in that way the water will be at hand when it is required for the next barrel of lime. If the lime has partly slaked and water is then added, the process of slaking will be stopped and the lime is liable to become chilled, and a granular paste will be the result. If this is used in wall plaster, it will cause the surface to chip off, due to the small particles of lime slaking on the wall.

It would help the quality of the lime paste very materially should the pen be covered with a canvas tarpaulin or some such device while the lime is going through the slaking process, for lime in slaking generates considerable heat and vapor, which if confined in the manner described, will tend to reduce the mass to a smooth paste free from lumps or grit. The slaked lime should be allowed to stand as long as circumstances will permit before adding the sand, which, when added, should be in a proportion of not more than 2 parts to

1 of lime paste; if the sand is added to the dry lime, it may be 5 to 1 of lime, as the lime attains, approximately, $2\frac{1}{2}$ times its bulk in slaking.

For cement mortar the superintendent should see that the sand and cement are well mixed in the dry state before any water is added. Of course it would be impracticable to make a cement mortar by reducing the cement to a paste (neat cement mortar) and then adding the sand, for the cement would begin to set before the sand could be added. The proportions of cement and sand are usually measured by shovelfuls, or barrellfuls, the former being objectionable for the reason that in making mortar in the proportion of 3 of sand to 1 of cement, the mason foreman will, as a rule, put a small, weak man shoveling the cement and three large, strapping fellows shoveling sand, with a result which is obvious to any one. Again, the cement should not be added to the lime mortar until it is desired to use it, as the cement will begin to set as soon as it is wetted. The presence of streaks of lime or cement in the mortar is an indication that the mass has not been thoroughly mixed. Lime paste if allowed to stand will remain practically unchanged for months. Machine-made mortar is the best for all purposes, as the ingredients mixed in that way are more thoroughly incorporated than is possible by means of the hoe and shovel.

40. Concrete.—Although no concrete will be laid at this stage of the work, the methods employed in preparing it and the proportions of its ingredients might better be explained at this time, while the student's mind is occupied with allied subjects following mortar, that this class of work may be kept together for convenience in referring to it at some future time.

According to the specifications covering this work, the concrete is to be prepared as follows: (1) Body of the work, Rosendale cement 1 part, sand 3 parts, and 5 parts of clean broken stone of a size to pass through a 2-inch ring. (2) Top dressing or finishing coat of Saylor's Portland cement, and sand in equal proportions, measured dry. Care

should be taken to see that the cement and sand are well mixed in a dry state; the water is then added, and when the mass has been thoroughly worked, the broken stone is added. The stone should be washed with a hose, to remove any dust that may have collected on it and to facilitate the work of mixing. The concrete is mixed in plank boxes similar to those used for mixing mortar; where a great deal of concrete work is to be done, machines are generally employed for the purpose as a matter of economy.

The method of laying the concrete will be explained when the building has advanced to construction to the stage when concrete should be laid.

FOURTH VISIT.

41. The specifications require that no filling shall be done outside the cellar walls for three days after the walls are built; the reason for embodying such a clause in the specifications was to give the superintendent due opportunity to inspect the outside face of the wall, to see that the stones were properly laid and pointed up, and to allow the mortar to partly dry out. If this clause had not been provided and the contractor wished to cover up the poor work, the filling would in all likelihood have been done as the walls were built, and the superintendent would have to resort to a steel rod or a crowbar to probe for projecting stones; by this method of sinking the bar at intervals, to say 1 or 2 feet, along the wall, the existence of projecting stones would be readily ascertained, in the event of which the filling should be ordered removed or the wall taken down and rebuilt. (Another method of inspection when the filling in is done before the walls have been inspected, consists of excavating pits at intervals along the wall.) If the walls are built and the filling in hastily done, the superintendent's suspicions should be aroused and he should satisfy himself by testing, as just described, to ascertain if the walls are built to a line on the outside, rather than take it for granted or accept a workman's word for it. The superintendent then inspects the walls—part of

which by this time have been built up to the grade of the lawns and leveled to receive the ashlar facing. He examines the lines and satisfies himself that they are at right angles to each other; that they are parallel to the axial lines *AB* and *CD*, Fig. 5, respectively; that they are at the proper distance from the building, measured from the axial lines, and that the top of the rubble wall is finished at the proper level. Satisfying himself that all the lines and levels of the terrace walls and trenches are correct, he next examines the walls as far as built. The stone is good, and the mortar which had partly set is of good quality; he passes on and inspects the trenches which have been excavated to the proper depth all around and the bottom leveled to receive the footing course; the soil here is, for the most part, of hard gravel, or fine sand with occasional indications of marl. The soil in the bottom of the trench at the southwest corner, directly opposite the parlor extension of the building, is of a clayey nature, and is wet and soggy, which no doubt is caused by the same spring which was encountered in the cellar excavations. The superintendent directs the workmen to dig deeper here and very soon rock is encountered; the water which has collected is bailed out to determine in which direction the water flows, and when the rock is exposed, it is found that it enters at the east end of the pit, just excavated. The workmen dig along the trench down to the rock in the direction from which the water enters until the water oozes from the side of the trench; on digging a little further it is found that the rock surface rises towards the normal bed of the trench. The workmen are ordered to stop digging here and to start at the other end of the pit; after digging a few feet it is found that the soil becomes drier, and digging a little further to make sure of getting firm good earth bottom, the workmen are ordered to stop. Now, as was explained heretofore, this extra digging and the subsequent work of footings and wall below the level of the trench bottom, will be charged for extra; it is necessary, then, for the superintendent to measure the pit in order to ascertain the amount of earth to

be excavated and the amount of extra masonry required to start the walls from the rock bottom. Footings will be charged for extra, as the superintendent decides to put in an extra course, laying the first course longitudinally in the trench without mortar, the upper, or regular, footing course laid in the regular way to break joints with the lower course. The upper course should be leveled up in the usual way with spalls and cement mortar, and the rubble walls then built to grade. If it was found that the water entered the trench to any extent, the only satisfactory way to overcome the difficulty would be to divert the flow of water in another direction. It has been found by experience to be almost an impossibility to confine the flow of water from springs in excavations so that it will find an outlet through the earth in some other direction.

In one of the excavations for the New York and Brooklyn Bridge piers, springs were encountered, and in laying the concrete for the substructure, the water forced its way through in several places and finally broke through solid concrete 2 feet thick. After several attempts had been made to control the flow of water, provision had to be made in the foundations to allow the water to follow its course.

42. Settlement in Masonry Walls.—A very important point in connection with masonry construction is the settlement of walls, piers, etc., due to the mortar joints being compressed by the superimposed weight and the contraction of the mortar joints in setting. If walls are built having sections varying in height to any great extent, this matter of settlement will become an all-important one. It is very readily understood that a wall 20 feet high will settle considerably less than a similar wall 50 feet high. This application of the laws of gravitation should be kept in mind in the setting of stone lintels, sills, mullions, and columns, the last named in connection with a built-up wall. For instance, if a mullion stone or one-piece column is set in an opening, the jambs of which are constructed of a large number of stones and no provision is made to make a thick mortar joint top and bottom,

the weight of the wall above is liable to crack the mullion or column, as the case may be; or, if they are strong enough to withstand the weight, the sills on which they rest are liable to be broken. A clear space of $\frac{1}{2}$ inch, if possible, should be left under all sills and other stones in like position, bedding them in mortar only on the ends, to be underpinned and pointed at completion of the work. If this precaution is taken, the likelihood of their being broken is lessened considerably. Stonework laid with joints of different width would be objectionable on account of its unsightly appearance. Lime-and-cement mortar for the higher walls, and cement mortar for the lower walls, used with the view of their construction in settlement, would be objectionable on account of the difference in color of the mortar, and the judgment required as to the proportions of lime, cement, etc. that is needed in the mortar to produce the desired result. It is claimed that lime-mortar joints will contract from one-eighth to one-quarter of their thickness according to the weight imposed upon them. To obviate excessive settlement the superintendent should see that the requisite number of through stones are built in at proper intervals and that suitable long stones are built in at all external angles of the walls as far as practicable. .

A practice which is very common among masons, and which should be prohibited, consists of scraping up trowelfuls of small fragments of stone, brick, and dirt from the ground or scaffold and filling the interstices between the wall stones, then covering them up with mortar. A wall built in this way is not nearly as strong as one in which the crevices are first filled with mortar, a spall of suitable size fitted in, pressed or hammered down, and then covered over with mortar, putting in more spalls if necessary to bring all to a uniform level. No two pieces of stone in a wall built with mortar should be laid without having a cementing layer between, in this way bonding all well together. Another point to be guarded against is the practice of disregarding the lines through negligence or carelessness and getting the wall out of alinement and afterwards bringing it up to

the line, thereby causing a depression or other such fault which at a glance betrays the existence of poor workmanship.

No stones having a concave bed as shown at *a*, Fig. 9, should be allowed in any part of the work, for in settling, the weight above is liable to break the thin edge.

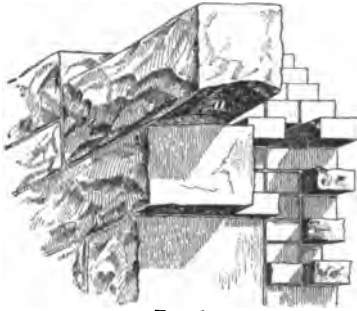


FIG. 9.

Suitable openings, covered by a good stone lintel, should be left in the walls, where indicated, for all pipes, etc. passing through the wall. These openings are often overlooked in preparing the

drawings, and when it is required to lay the pipes, large ragged openings are broken through the wall at the risk of starting the joints in the wall above; besides this, breaking through the wall and rebuilding incurs needless expense and delay.

43. Refilling.—The superintendent having inspected the foundation walls of the building and found them to be properly built to a line and pointed up, notifies the foreman mason that the filling in may be done, at the same time cautioning him not to use any clay for the purpose; as clay when packed against the foundation will hold the surface water, and keep the foundation wall constantly damp. Gravel or broken stone is specified for all filling against masonry walls, and is to be tamped down at every foot in height up to grade. The object of using gravel or broken stone is to allow the water to percolate through to the bottom of the footings and soak away in the soil. Puddling clay and sand are very often used for filling against walls, but where good coarse gravel is to be had in abundance, it is well to use it in preference to any other material.

Having inspected the terrace walls and given instructions in regard to the footings, the superintendent figures up the

earth excavation and extra stonework in the walls, going through the same procedure as he did in connection with the extra work of the foundation walls, including the apportioning of cost, etc. All these points being settled, he proceeds on his tour of inspection.

44. Placing Cellar Windows.—Looking over the walls of the building, he finds that the walls are for the most part built up to grade and at the southeast corner the sill-course is in position and the ashlar work has been started. Two window frames have been set in position and the carpenter who is on the ground for the purpose informs the superintendent that he has the frames set according to dimensions in the plan, checking the position of the stone sill as set by the mason, taking care to properly set and level up the frame correctly. It is very important that the mason set the stone sills correctly, that the window frames may be set in position exactly and the dimensions marked on the plans. Sometimes the setting of the frames are intrusted to the mason, and the carpenter very often discovers afterwards, perhaps too late to correct the error, that the cellar windows have not been properly centered, which, if the windows are to be centered over each other, will necessitate moving the frames above and crowding the window to one side or other of the rooms, thereby sacrificing symmetry on the interior in order to preserve vertical alinement on the exterior. If the work is properly started, and all openings properly centered in the cellar walls at the outset, the centering of windows above will be a very simple matter.

The superintendent enters the cellar and finds that the cast-iron clean-out frames and doors for the flues and ash-pits have been properly set; the pipe openings have been left in the walls, and the rest of the work has been done satisfactorily; the section of the foundation wall condemned has been properly rebuilt; the dumb-waiter shaft is built up several courses, as are also the brick piers; the footings which may be seen are of sufficient size and laid as required.

45. Derricks.—Three derricks have been erected for laying of ashlar, sills, etc., as stone, heavier than one man can handle, are to be used in the construction of the walls. The superintendent should examine the derricks, ropes, etc., to make sure that they are sound. Although this comes, strictly speaking, within the province of the contractor, it is the superintendent's duty to satisfy himself that no accidents to life or material will occur, caused by the possible breaking of a boom or a worn-out rope; he should also examine the guy lines, which are generally of steel-wire rope, to see that they are properly anchored. A good-sized tree is perhaps the best anchor for this purpose, and if it is desired to preserve the tree, it should be protected from the guy line by pieces of wood, ordinary barrel staves being generally used for the purpose. If, however, there are no trees in the vicinity of the derrick, a pit should be dug in the ground about 5 feet deep, a heavy log or timber put in, and after the line is made fast, the hole may be filled in with large pieces of quarry stone. The superintendent examines the guy lines and finds that they are sound and properly anchored. A traveling derrick is being set in position for the setting of ashlar, coping, etc. of terrace walls; the derrick is so constructed that guy lines are unnecessary. Stone cutters are busily engaged preparing material for the building, and the dimension stonework, details for which were furnished to the contractor, is well under way. The superintendent asks to see the details, and comparing them with the stone already cut, satisfies himself that the work is being carefully done; with an admonition to the stone cutters to be careful to select good sound stock for ashlar, and especially for dimension stones, he passes on to where the carpenters are at work. The corner posts, girts, etc. are cut and piled up ready for erection; the carpenters are sizing the floor joists, and it is clear that this part of the material will be ready for erection when required. The superintendent inspects the lumber that has arrived since his last visit and finds that it is straight and sound with a few exceptions; the defective pieces, some having bark edges and

others shaky with a loose core, unfit for use, are ordered to be removed. The brickwork is next examined, and it is found that the bricks are sound, hard, and satisfactory in every respect and greatly superior to the first lot. The steel **I** beams which are to be used as girders supporting the first floor joists have been delivered, and also a sufficient number of bar anchor rods bent to a **V** shape. The superintendent's tour being completed for the day, nothing remains to be done until the work shall have progressed further.

FIFTH AND SIXTH VISITS.

46. The fifth visit being made a short time after the fourth, it will be well to pass on to the sixth visit to allow more time for the work to reach a stage of advancement in construction, to offer problems for the superintendent to decide upon. By this time the ashlar work in the terrace walls all around is pretty well along, and the walls are finished up to the terrace grade on the (west) side of the building. Rock-faced regular-coursed ashlar, pitched 2 inches on the face and having beds of 6 and 10 inches, respectively, at each alternate course, is specified for the face of terrace walls below the coping line. The coping, balusters, pedestals, and rail are to be clear-cut finished (see Fig. 13); the ashlar as far as set is as nearly perfect as it can be and care is being taken evidently to make this wall a first-class job. A few pieces of coping and foot rail are set in position, and the pedestals started; the pedestals are 21 inches square, and the specifications require that each course shall not be in more than two pieces. The work on the belvedere at the south corner of the terrace has progressed very well; all the pedestals here are set in position and everything is ready for the setting of balusters.

The circular terrace work has been started now, and this work should be laid out accurately on account of its being circular as well as being stepped down to follow the grade of the road. The superintendent sends for the mason foreman

and questions him about it; the foreman tells him that the center stake was set, the lines struck, and the center of each pedestal was designated by a stake set by the engineer who is on the ground for the purpose of testing the lines and levels of the several terrace walls with reference to their proper alinement and levels; and to locate stakes to which the ground shall be graded. The engineer is sent for and asked to test the accuracy of this circular wall, for the benefit of the superintendent. According to the drawings the center line of the pedestals is 64 feet $1\frac{1}{2}$ inches from the center, which in turn is a fixed distance from the front of the building. The end of a steel tape is held on the center stake, and the tape is run out until the required radius has been found; this is applied in turn to each stake, representing the center of the pedestal, and all being found correct, the foreman is told to proceed with this part of the work with all possible dispatch consistent with good workmanship. The superintendent proceeds to the building and finds that the walls under the plaza at the front of the building have been built up above grade, stone templets inserted on the inside of the walls, and pockets left for the I beams which are to carry brick ashlar to support the concrete floor above. The porte-cochère foundation wall, as well as the rubble-stone piers for the veranda, are built up to grade; the superintendent satisfies himself that they are properly built, and, putting down his extension rule, finds that when the grading is done their depth will be 4 feet as required. He passes on around the building, and finds that the porch piers and cellarway have been built, and the coping set in place. In passing around, the superintendent, while critically examining the exterior walls of the building, observes that the sill of one library window looks as though a chip were knocked off; he keeps this in mind, and on entering the building he mounts the staging and finds that a large piece has been knocked off the sill; the foreman is called and told to have the damaged sill removed although the window jambs have been built up more than 2 feet above it.

47. Protection of Stonework.—If this sill had been protected with a piece of board as soon as it had been set in position, the expense of replacing it with a new one and rebuilding the wall would have been saved to the contractor. The foreman is cautioned to cover all the projecting stonework with boards, to protect them from falling pieces of stone or other material. It might be well to mention here that no boards, such as Georgia pine or other such woods, containing a large amount of resinous sap should be used; for the action of the sun is likely to drive the sap from it and discolor the stonework which it is intended to protect. Hemlock also discolors some stones, and should not be used; white pine is perhaps the best.

All flights of steps in the premises should be protected by a substantial boarding, and all such flights that are not required to be left open shall be railed off until all the work is completed and the cleaning down commenced. The windows and door openings are all built up several courses above the sills, the sills are looked after to see that a space is left beneath them; the brick joints should be plumb and built up on a line with the check of jamb stones in window and door openings, so that, when the time arrives for setting the frames, they may be put in without cutting them or the brick jambs.

A tour of the walls is made by the superintendent, and the backing and ashlar, as well as the mortar, are critically

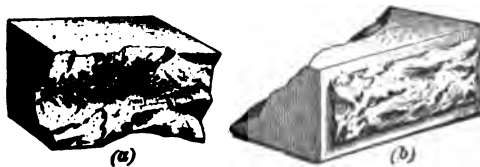


FIG. 10.

examined. The superintendent discovers, in his journey around the walls, a piece of ashlar which when first looked at appeared all right, but which proved afterwards to have a

deep concave depression at the back as shown at (a), Fig. 10. The bed of this stone is only 6 inches and at the center cannot be more than 4 inches owing to the depression; it is therefore condemned and ordered removed. Another form of defective stone is shown at (b); although the lower bed may be large enough, the upper thin corner is weak and not up to the requirements, the specifications stating distinctly that the stone shall be from 6 inches to 10 inches deep in the wall. The object of specifying ashlar to be furnished in two thicknesses and to be laid in alternate courses is for the purpose of obtaining a bond with the backing which is not possible when ashlar of uniform thickness is used.

48. Anchors.—The ashlar having a wide bed, very few anchors will be necessary except where very high stones are used, and any stone more than 12 inches in height must be anchored. In the body of the wall the anchors are to be spaced at intervals of 4 feet in length and 2 feet in height. The anchors are usually made of flat pieces of galvanized strap iron, about 1 inch wide, and from $\frac{1}{8}$ to $\frac{3}{8}$ inch in thickness; a good anchor being $\frac{1}{8}$ inch thick. They are turned up about 2 inches on the inner end and down about 1 inch on the outer, or ashlar, end; this end of the anchor is hammered together to fit into a hole drilled in the top of the ashlar. The thinner the ashlar used the more anchors will be required, and, for fronts of marble or other expensive stones where an ashlar sometimes as thin as 2 inches is used, every piece of ashlar should be anchored to the backing. Knowing that the walls below the water-table were built to the correct lines, all that remains to check the accuracy of the first-story walls is to measure the projection of the water-table on the exterior beyond the face of the first-story wall. The walls of the main building, from grade to the top of the water-table, projects 2 inches beyond the foundation and first-story walls, both of which are on line. In a heavy, driving rain storm the water flows down the face of the wall, and, if a drip is provided as shown in the cut at *a*, Fig. 11, the water

will drop off and soak away in the ground instead of following along down the walls. Pockets are left in the wall to receive the ends of I beams, girders, and joists. The I beams and the joists have been set, and the framing of the first-story floor as well; carpenters are cutting in bridging between the joists as required by the specifications; one stage has been erected for the masons to work from, the wall averaging, in height, about 5 feet above the first-story floor. Anchor bolts have been built into the walls of the dumb-waiter shaft for the purpose of anchoring a 4"×8" plate; this plate to be laid so that the top will be in line

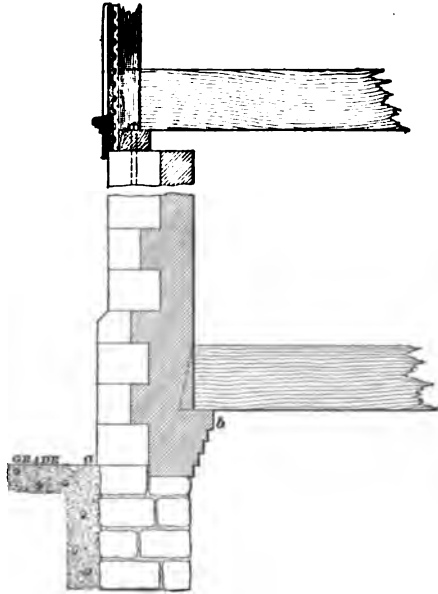


FIG. 11.

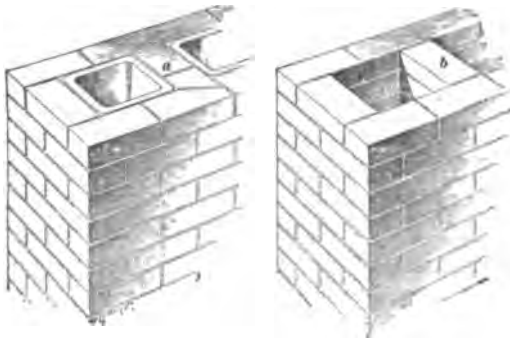


FIG. 12.

with the floor joists and acting as a sill for the frame walls to be erected upon it. The interior chimneys have been stopped off at the first-floor level, and the flues are lined with

fireclay pipe as required. The superintendent examines the flues of all chimneys to see that all are lined with fireclay pipe and that the withes are bonded into the body of the work as at *a*, Fig. 12, and not merely set in as at *b*.

49. Corbels.—The brickwork has been corbeled out at the first-floor level shown at *b*, Fig. 11, which forms a fire-stop as well as affords additional bearing for the joists and girders. The superintendent enters the cellar and finds that laborers are at work leveling up the earth bottom; two laborers are at work collecting and breaking up the fragments of rubble stone, left by the masons, to be used in connection with gravel in making concrete for the cellar bottom. The stones are being shoveled against a screen having a 2-inch mesh to get them as nearly uniform in size as possible, and to remove dirt and grit.

The brick piers are completed and have the bond and capstones built in as required. The cellar window openings have a three-row rowlock arch over each, and the door opening to cellarway, and interior door openings are arched over with a rowlock arch of four courses. The sill and lintel in dumb-waiter shaft are of the requisite size, and are properly built in with a 4-inch bearing on the ends.

50. Other Stonework.—Having inspected all the work on the building, inside and out, the superintendent walks over the premises to inspect any new materials that may have arrived in the interval; he finds that a number of finished balusters, coping, foot rail, and upper rail, in dimension blocks and caps for the pedestals of the terrace balustrade, have been delivered on the ground. This stonework was cut and dressed at the quarry, shipped by railroad, and the cars run onto a side track. The stones were hauled to the premises in wagons, each stone is marked in the back, or bed, with a number or letter, which designates its ultimate location when set in place, and *lewis holes* are cut in all except the balusters, which have round holes drilled in for dowel-pins.

The under side of upper rail and top of foot rail also have

holes drilled at regular intervals for dowels. The workmen are laying the long pieces of rail and other members in tiers of two or three high, with a piece of board between, as these stones, being long and small in cross-section, are liable to break easily. The superintendent examines these stones and finds that all are of good sound stock and have no broken edges, or corners which if found would render the stones as unfit for use. A large quantity of cement has arrived and is placed on the ground as it is unloaded from the wagons; the superintendent examines the labels on the barrels and finds that they are of the brand selected at the time the tests were made; he directs the workmen to remove the cement at once to the temporary shed prepared for it. A number of steel I beams have arrived, and judging from their height and length, the superintendent decides that they are for the plaza at the front of the building. Further on, a large number of square fireclay flue linings of different sizes are tiered up; two or three of these have large pieces broken off the corners, and for this reason are condemned; a workman is called and told to set these to one side for removal, as they are unfit for use; a small corner or a chip knocked off would be of no consequence. There appears to be a great deal of activity along the street line of the premises as a large force of workmen are excavating the trenches for these walls. Rough quarry stone is heaped along the line of this trench several feet inside the property line, and for the most part this stone is found to be sound and excellent for the purpose of building the rubble part of the walls. Going along the trenches, the superintendent finds that the soil is mostly of a sandy loam, approaching to gravel as a greater depth is reached, with boulders of varying sizes here and there; the soil in the trenches, as far as they are excavated, is found to be dry. Passing around to the avenue side of the premises, the superintendent notices that a large quantity of floor joists, studding, and other lumber has been delivered, and has been deposited directly in line with the main entrance. The foreman carpenter is called and shown that the lumber cannot remain here for more than a few days

at the most, as the masons will be along to excavate for and build the walls. He is therefore ordered to remove all this lumber to a clear space out of the way of other trades, and cautioned to see in the future that his lumber is deposited at the proper place. Having attended to all these matters, it is safe to say that the superintendent has finished his labors for the day.

SEVENTH VISIT.

51. The superintendent visits the premises again after a few days and finds that, with the exception of two lengths of rail and three pedestal caps, the west terrace wall is completed. The

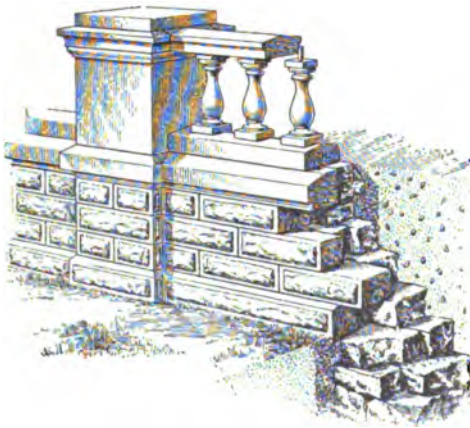


FIG. 18.

method of jointing the work in construction is shown in Fig. 13. The piers, columns, and lintel course on the belvedere are set in position, ready for the wood framing of the root.

Quite a stretch of coping and foot rail has been set and the pedestals started on

the south-front terrace wall near the belvedere. The curved terrace walls have been built; especial attention having been given to rush this part of the work, as the stakes indicating the centers of the pedestals were liable to be dislodged by wagon wheels or otherwise. The wall at each side of the main-entrance driveway is to be built of coursed ashlar, clean-cut finished; the rubblework has been built up to grade, and preparations are being made to start the ashlar.

The terrace walls on the east side and the stretch of wall on the end near the stable are pretty well along; the ashlar is being set, and the coping, rails, etc. are being deposited

along the line of this wall to be at hand when required. The superintendent observes that but a few men are at work on the main building. On asking the foreman mason for an explanation of this, he is informed that very little headway could be made on the building, as neither the capping course, or facia, nor the voussoirs for door arches had been delivered. On the contrary, a large quantity of the stone for the terrace walls was on the ground, and for this reason the men were ordered to push work on that section of the work in order to dispose of the accumulated material. Very little work has been done on the building since the superintendent's previous visit. The arches and lintels over the openings have been set with the exception of those over the doors; the templets for which are in position.

52. Street Wall.—Nothing further being done on the building, the superintendent proceeds to the Station Street side of the premises, where the masons are at work on the street wall. This wall is stepped up 8 inches at intervals of about 50 feet, in order to conform to the grade of the street, and no part of the foundation wall is to be nearer than 4 inches to the finished grade of the sidewalk, that no rubble-work will appear. The wall on the front, or avenue, side of the property is being pushed along rapidly. The base course along the street walls is to be of bird's-eye granite, clean-cut finished, having $1\frac{1}{2}$ inches projection, and leveled on top, and the balance of the stonework of the same kind of limestone as that used in other walls on the premises. All street-wall pillars to be capped with a single piece of stone, those for gate pillars to be molded and finished with a ball on top, and all coping between pillars to be in one piece, having a 4-inch cover at each end; granite wheel-guards to be built in at each pillar, flanking the carriage entrances. By constant observation of the quality of the stone on the ground, and mortar used in the work, as well as occasional investigation with a light steel rod driven down into the crevices from the top of the wall, for the purpose of testing the bonding, it will be a comparatively easy matter to follow up the work and

see that no sham, dishonest, or careless work is being done.

53. Stable Foundations.—Proceeding to the rear of the premises, the superintendent finds that the work on the stable foundations is being properly done. It is not our intention, however, to dwell on this part of the work, for the general methods of construction are the same as those in the main building. Only such details of construction as are not covered in the main building will be explained. The same remarks may apply to the greenhouse, the construction of which, as was previously mentioned, is the subject of a separate contract. This class of work is done, as a general rule, by men who make a specialty of it, and as a number of devices used in this construction are patented and controlled by the horticultural builders, it is advisable to let the work absolutely to them. The excavation for the wall at the rear of the stable and greenhouse is being done; the soil here is found to be dry, and solid rock is struck about 2 feet below grade, immediately at the rear of the greenhouse. As the solid rock affords the best known foundation, the wall may be built upon it without laying footing stones, the rock to be shelved to form a level bed for the stones of the wall. This wall is built of ordinary rubble stonework up to grade, and with buff pressed brick above grade. The capping consists of limestone coping with cover joints, as shown in Fig. 14, and each end of the wall is finished and strengthened by a pier

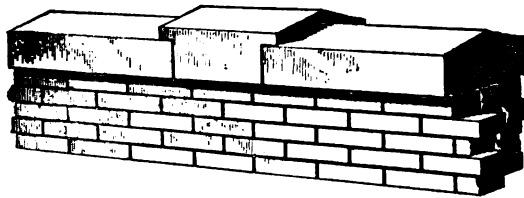


FIG. 14.

capped with a single stone and ball top to conform to the other work. This wall is built for the purpose of screening this section of the premises from the view of the adjoining estates.

54. Hedge.—Instead of building this wall the full length along the dividing property lines, a hedge of a close growing shrub will be planted, which, if kept neatly trimmed, will serve the purpose of a wall or fence. The inspection of the work being concluded for the day, the superintendent makes a tour of the premises with the view of examining any new or additional materials delivered since his last visit. He finds a number of large casks marked enameled brick, "bull noses," "stretchers," arch "A," etc., each barrel being marked to designate what form of brick it contains. This enameled brick is to be used for facing the inside walls of the carriage room in the stable, and as they are not to be used for some time, and are very liable to be damaged if the casks are left open, it is decided to inspect them when they are to be used, for any damaged brick is very easily detected; those having chipped edges should be rejected. The window and door arched brick, should be laid out on a platform to ascertain if all required for the arches are at hand and that they are molded to the proper form, so that when assembled they will fit the opening exactly.

The carpenters have stopped work, as the framing timbers required for the floors, roof, etc. are ready for erection when masons have finished their work on the main walls of the building.

A large quantity of sheathing boards have been delivered and are found to conform to the specifications; being matched-surfaced one side and of good sound stock; a few boards have split on the ends, due to improper handling perhaps, but these may be easily culled when the time arrives to cover the frame with them. These damaged boards may be used for bracing of staging, rough bracketing, or some such purpose.

Several thousand buff hydraulic-pressed brick have been delivered, plank have been laid on the ground to protect them from the earth and dampness, and they are tiered up with fine salt hay between to prevent breakage. These bricks, being pressed in a mold under great pressure, are uniform in size, and when pressed in the same mold seldom vary

more than $\frac{1}{8}$ inch in size. The inspection of this quality of brick is a comparatively easy task. They should be sound, have sharp angles and corners, free from flaws and from lumps of gravel, etc., at least three faces smooth and true, and all be of a uniform color.

55. Drain-Pipe Trenches.—The trenches for subsoil leader and sewage drain pipes on the premises are being excavated, but only the laying of drain pipes required to be done by the mason will be considered at this time. The iron drain pipes and other work of that nature will be explained under the head of plumbing work, to which they properly belong. Nothing more remains to be done for the day, so the superintendent's visit may be considered at an end.

The work on the remainder of the terrace and other walls on the premises being practically a repetition of that previously described, nothing further need be said on the subject, except, perhaps, as regards some details of construction not previously described.

EIGHTH VISIT.

56. During the period occupied by several visits of the superintendent to the premises, following the seventh visit, which was described at length, a great deal of work has been done. The street walls are all built up to the level of the terrace slope, the coping set in position, and the pillars completed with caps set in position; the caps for the pillars at the carriage entrances have not been set, and the superintendent learns that they had been delivered and they were found to be too small, having been cut to the same dimensions as those for the intermediate pillars, while they should have been much larger.

The superintendent passes all along the street wall and examines critically that part of the work done since his last visit, and not finding any improperly done or faulty in any way, he proceeds to inspect the terrace walls which are completed all around with the exception of the sections at the

steps. He discovers in one flight that a step has been set which has a large piece broken off near one end. Work on this section has been stopped; the foreman probably discovered the broken step and expected that it would be condemned. The foreman is called and is told to have the step removed. On looking over the plans, the superintendent notices that the entrance steps at the front carriage gate are of the same rise tread as in the flight mentioned above, and, as the condemned step is sound, the foreman is told that it may be used in the front flight of steps by cutting it to the right length.

Passing on, the superintendent's attention is attracted to a workman who seems to be busily engaged in rubbing on one corner of a pedestal; this arouses his suspicion, and going over to him finds that a piece was broken off the corner, and this man had patched it and was trying to cover up the joint when discovered. The superintendent orders the man to desist, and notifies the foreman to remove the stone and replace it with a sound one.

57. Laying Bricks.—The manner of laying bricks depends largely on the character of the work. As a general rule, all joints should be filled with mortar and made as small as is consistent with good work. They should never be less than $\frac{1}{8}$ inch in thickness to insure a good bond. Nine courses of standard size common brick laid up in an ordinary wall should not measure more than $23\frac{1}{2}$ inches. When the outside courses have been laid the full length of the wall, the bricklayer should fill the space between with mortar and then lay the heart bricks, pressing them with a downward diagonal motion so as to press the mortar into the joints. The surplus mortar is scraped off and thrown ahead. This method of laying is conceded to be the best. On account of the true rectangular form of pressed brick, they may be laid with a close joint, but $\frac{1}{8}$ inch should be the minimum. Before laying face brick in the wall a sample should be laid up in the colored mortar to determine the height of a fixed number of courses and get the proper

tint, after which the proportion of mortar stain can be determined.

58. Rear Wall.—The brick wall at the rear of the premises is seen to be built up several courses above the stone base course, and as this wall is to be faced on both sides with the light pressed brick previously described, it is well to look after this work and see that the bonding is properly done, and that the wall is built to the proper lines. The superintendent examines the lines and finds them to be in the proper position with reference to the stakes set for the purpose, and the wall at the corners and the ends is carried up several courses above those in the body of the wall. A careful workman is generally put at each corner or end of the wall, so that they may adjust the lines as the courses rise up; the men on the intermediate sections then have only to work to the lines as they are set for them, as shown in Fig. 15.

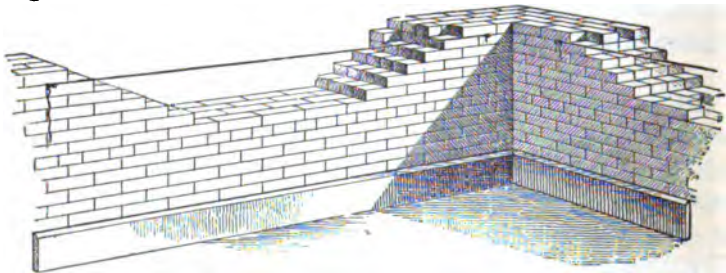


FIG. 15.

The body of this wall is laid up in lime-and-cement mortar, and the face brick in mortar tinted with mineral mortar stains to match the brick. The face brick being of standard size, a good bond with the common brick filling may be very easily obtained; about every sixth course the wall is laid up in regular bond, every sixth course in height being a header course. The wall is capped with a 5-inch coping with cover pieces 7 inches thick, having a 2-inch lap as shown in Fig. 14.

59. Greenhouse Foundations.—Work on the greenhouse foundations is in progress. At one end, towards the

stable, considerable rock is encountered, in one place appearing above the surface, but as the greenhouse floor and the exterior grade about the greenhouse are to be fully 3 feet above the driveway, which is nearly on grade here, the walls may be built upon the natural rock by shelving it to form an even bed for the first course of stone.

Some rock will have to be excavated in order to get 8 feet of headroom in the cellar under the central pavilion, as required by the drawings, but as the rock appeared above the surface at this location, the contractor for the work will have to excavate it at his own expense. The earth in the trenches at the western end is of a sandy loam and is firm and dry; a footing course will have to be laid here, but where the rock occurs none will be required.

60. The Main Building.—The superintendent goes to the main building, the mason work on which by this time has to all appearances been completed. Passing clear around the building, he sees that all the stone facing voussoirs in door arches, and the belt course capping the wall have been set in place.

The steel **I** beams and brick arches for the support of the plaza are in place, and all properly set and lined up; the walls here have been built up and part of the coping is set in position. The porte-cochère, veranda, and porch pillars have been set, and the **I**-beam framing for the veranda floor is being set. The stone slabs forming the floors of the porches, and the balustrades at the sides are in position.

Having completed for the day the inspection of the works in course of construction, the superintendent looks about him for new or additional material that may have been delivered in the interval. He finds that the stone caps for the pillars flanking the carriage entrances have been delivered, and applying his rule to them, finds that they are of the proper dimensions. A gang of laborers are at work breaking stone which is to be used for laying the bed of the driveways. The engineer and his assistant are at work staking out the driveways, and, on consulting the

landscape architect, who is supervising this work, the superintendent learns that the excavation and rough shaping of the driveways is to commence at once.

NINTH VISIT.

61. On the occasion of his next visit, the superintendent finds that the street walls and entrance steps are completed; the terrace walls, with the exception of a few details, are completed; and as the rubble foundations of these walls have dried out, the foreman is called and told that the filling in should be done at once, that the work of road building may not be delayed, as this work is being done by another contractor. The rear dividing wall is built about half way up and the work is being pushed rapidly; the superintendent inspects this work, and finds that in one section of the wall a joint three courses from the top is found to be too wide—the specifications requiring that all joints in face brick in this wall shall not exceed $\frac{3}{16}$ inch in width. The courses above this point are ordered taken down, that the objectionable joint may be remedied. Passing on, he watches the bricklayers and finds that one of them is simply filling the walls with bats without using any mortar until he has a number of them set, when he throws a trowel of mortar on, and working it back and forth with his trowel, trusting to luck that the joints will be filled; then scraping off what remains, he throws it ahead, and spreading some more mortar further on, attempts to repeat the process, but is stopped by the superintendent, who asks him how much work he has done in this way. The foreman is called and questioned about this work, and he assures the superintendent that the rest of the work was properly done. The latter, to satisfy himself, orders the wall taken down for two or three courses and he finds that the work here was done as required. He then cautions the men that the bricks must be shoved, as required by the specifications. The superintendent directs the foreman to allow no more work of this kind to be done under pain of being compelled to

tear it down again; he makes a note of this order in his field book for future reference.

The wall coping and cover pieces of same are on the ground, and are up to the requirements of the specifications. A V-shaped groove is cut under the projecting edge to form a drip. The stable walls are pretty well along, the corbel in the walls on the inside for the support of the first-floor joists is built in, the marble base has been set, and the enameled brick are well laid and properly bonded into the body of the wall. The superintendent passes all around on the interior of the carriage room to see that no chipped or otherwise damaged brick is used. The foundation walls of the greenhouse are built and leveled ready for the superstructure; a large number of cases containing glass has been delivered and also a large quantity of painted structural iron.

Going around to the front of the building, the superintendent sees that men are at work laying the cement top dressing or floor of the plaza; at one end the cement is laid and a man is marking it off with V-shaped channels to represent a pavement.

62. Fireclay.—Fireclay is a composition having as its principal ingredients aluminum and silicic acid, which form about two-thirds of the mass; it also contains water, quartz, and oxide of iron. The clay is mixed with sand and water, molded into the required shapes, and burnt at a white heat; this product is called "firebrick." With an addition of about 40 per cent. of sawdust, or some other combustible material before burning, the product is called "porous terra cotta" or "terra-cotta lumber." Pipes are made from this material in a variety of sizes and shapes, but usually round. They should be straight, sound, and of a uniform thickness in cross-section. Pipes, for the purpose of sewerage, or other uses where a tight job is required, should be formed with a socket at one end and a spigot at the other, and when fitted together should show a circular space, or ring, of at least $\frac{1}{2}$ inch clear all around between the two. These pipes

should be glazed with salt put on before burning, and then fused in.

63. Laying Pipes.—The work of laying earthen pipes should be carefully done, and the superintendent should pay a reasonable amount of attention to see that the bed of the trench is made smooth and with a uniform pitch. If the trench is cut through rock, the bottom should be covered with a layer of sand about 6 inches deep; the sand is scooped out for the hub or socket, and the pipe should be laid so that its entire length will have a bearing; mortar is then placed around the bottom half of the socket, and the top half of the spigot and the pipes are set in. The mortar should be pressed back into the joint to fill all crevices, and then the scraper drawn ahead, as shown in Fig. 16. The scraper may

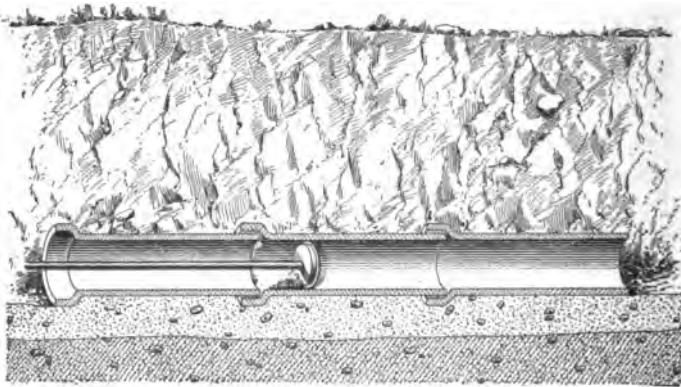


FIG. 16.

be made in different ways, but the one shown in the figure is very easily made and serves the purpose very well. A circular piece of wood with a leather or sheet-rubber edge tacked on, is attached to a handle, and as each length of pipe is laid, the scraper is drawn ahead and takes any mortar, that may have entered through the joint, with it. As soon as three or four lengths of pipe are laid, they should be covered with a layer of sand free from large stones to a depth of 2 or 3 inches, to protect them until they are inspected by the

superintendent, after which the filling in may be done with any degree of rapidity desired.

Porous or agricultural drain pipes are laid in much the same way. The pipes are made in various forms and sizes, and usually without hubs. They are often laid on rough planks in the trenches in order to prevent settlement or dislocation. The ends are simply butted, leaving about $\frac{1}{4}$ inch between, and the joints are covered with a strip of oilcloth or paper to prevent the entrance of earth into the drains. The filling over these pipes generally consists of gravel sand, broken stone, or similar material, that the water may find its way to the drain and in that way be carried off.

64. Road Building.—The position and grade of the roads and paths were determined at the outset and indicated on the drawings. The first part of the work consists in removing the top soil along the line of the roads and adding it to the pile already taken from the several excavations, to be used for the final grading. After this is done, the roads are cut through the high ground and brought down to the required grade, always working to the stakes set by the engineer. Trenches, 18 inches wide and 2 feet deep, are dug on each side of the roadway, as shown in Fig. 17, the excavated clay or loam being thrown to either side, and the gravel or sand into the middle of the roadway. The trenches are then half filled with broken stone over which a layer of straw is laid, and then topped off with gravel sufficient to fill the trenches. These trenches, sometimes called “French

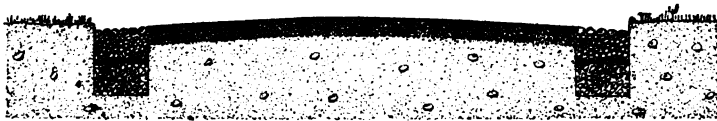


FIG. 17.

drains,” should be continuous, crossing one another under the road at intersections, if necessary. If broken stone and gravel are not available, an agricultural tile drain may be used instead.

The object of providing the trenches is to protect the road from the undermining influence of water entering at the sides. It is often found to be economical to construct the roads while the excavation for the building is being done, so that the excavated gravel, sand, or loams may be used immediately, and thereby save rehandling it. After the work on road beds and drains has been completed, work should be suspended until the time arrives for final grading; the road bed being finished to an even surface 6 inches below the finishing level. The drains will keep the roads dry, and the constant traffic over them will compress the beds so that when the top dressing of gravel is applied and brought to a neat surface, the finished road will be durable and with a reasonable amount of attention will require no repairs for some time. The gutter formed at each side of the road is paved with small cobblestones, as shown in Fig. 17, for the purpose of carrying off excessive water during heavy rain storms.

65. Pointing.—All joints in stonework should be raked out to the depth required by the specifications and pointed up with Vicat Portland cement. This, and also a compound of cement, lime, plaster of Paris, and marble dust, called La Farge, are both used for setting and pointing up the joints of stones that are likely to be discolored by ordinary cement. The mortar should be well pressed into the joint and “tucked” with a steel jointing tool having a converse working edge. The work of pointing should be carried on simultaneously with that of cleaning down. The horizontal joints in coping, as, for instance, the plaza coping, or other joints in a similar position, where the mortar is liable to drop or work out in the course of a few years, should be calked with oakum to a depth of 2 inches and then be filled with about $\frac{3}{4}$ inch of mastic cement having asphaltum as a base.

If it is desired to clean down old walls, a sand blast is generally used; the sand being driven against the wall in a spray by compressed air or steam. By this means a layer is removed from the stone, which may be increased until all

stains or nicks are removed, leaving a surface similar in appearance to that on the stone when first cut. When carving is to be cleaned down by this process, it is necessary to have a careful man to do the work, as the fineness of the carved forms may be very easily destroyed.

66. Cramps, Joggles, and Dowels.—The methods of tying or linking stones together by means of stone or metal are various, and as an adjunct to, or even sometimes in the absence of mortar, have been practised for ages. Theoretically, blocks of stone used in the construction of buildings should, when their beds are level and their faces vertical, preserve their position from the fact of superposition in obedience to the simple laws of gravitation, without a binding medium between them, such as mortar or mechanical devices.

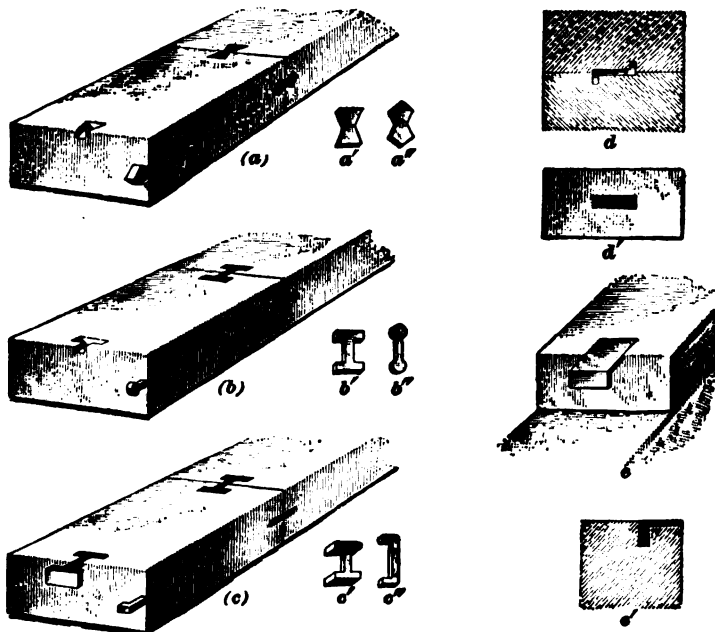


FIG. 18.

In Fig. 18 several forms of cramps are shown; *a'*, *a''* represent cramps which are made of a tough stone, and at *b*, *c*, *d*,

and *e* the forms shown are usually made of metal, and for this reason they are not as large as stone cramps; at *d'* and *e'* are shown how the stones are cut to receive the cramp.

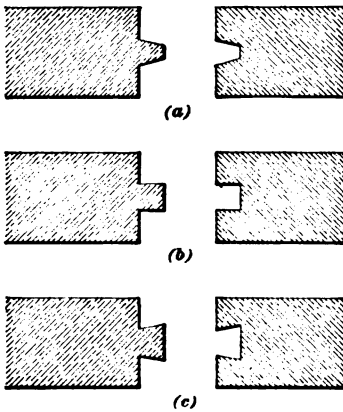


FIG. 19.

Bronze is generally used for making these cramps, and is perhaps the best metal for the purpose; iron or steel will rust and discolor the stone.

Joggles in stone jointing are cut in various shapes, but the slip, or mortised, joint shown at (a) and (b), and the dove-tailed joint at (c), Fig. 19, are the forms most common.

Dowels are made of metal, stone, or wood. The common form of metal dowel and its

use in jointing stonework is shown at *a*, Fig. 20, while *a'* shows the dowel itself. At *b* a square dowel serving a similar purpose is shown. At *c* and *d* two pieces of stone cut to receive dowels are shown, *c'* and *d'* being the dowels. It is always well in constructing stonework to use mortar to insure a perfectly secure job, but dowels, joggles, and cramps are necessary and are used very extensively in the construction of intricate stonework, such as in the tracery of Gothic windows. The fitting of dowels, etc. should be very accurately and carefully done, especially when they are exposed to view. The cramps should fit neatly, be flush with the surface of the stone, leaving an annular space around the cramp to receive molten lead. When the lead has cooled, a sharp cold chisel and hammer should be used to chip it down to a smooth surface. Dowels or cramps, when in a position where lead cannot be poured in, should be fitted snugly and set in cement to fill the crevices about the dowel.

67. Concrete Work.—The specifications require that the body of all concrete shall be mixed in the proportion of 1 part Rosendale cement, 3 parts sand, and 5 parts of broken

stone of a size to pass through a 2-inch ring; the finishing coat, or top dressing, to be mixed of sand and Portland cement in equal bulk, measured in a dry state before mixing. The bottom for all concrete work should be prepared and tamped down thoroughly before laying concrete anywhere on the premises.

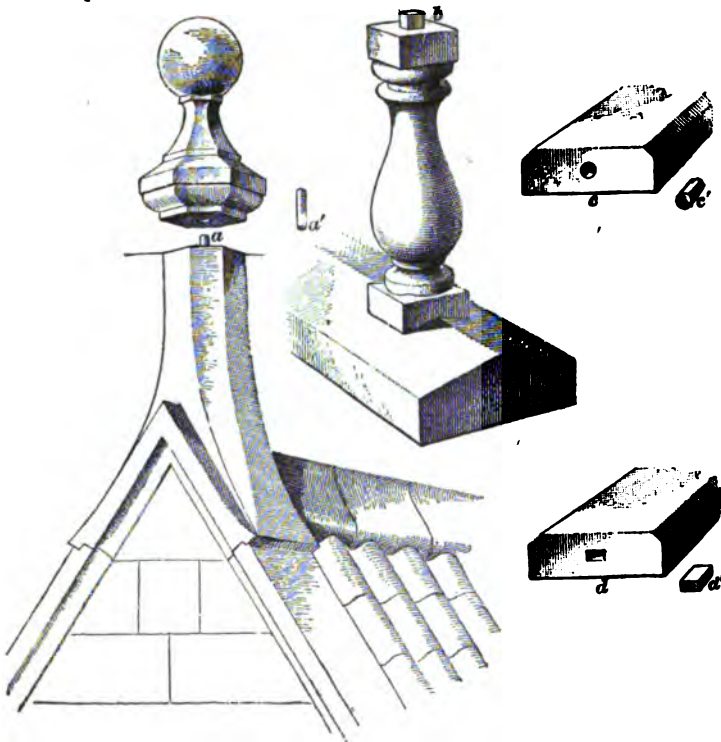


FIG. 20.

The bottom for the concrete in the carriage wash consists of 2-inch tongued-and-grooved plank, supported by 4" × 8" girders, which in turn are supported on a stone wall built around under the carriage wash. The top of this rough flooring is 6 inches below the finished floor of the carriage house. A water-tight bed is laid over this, consisting of alternate layers of tarred paper and asphaltum; these layers are turned up 4 inches all round. A $\frac{1}{2}$ " × 2" wrought-iron

bar secured with screws is placed around the edge of the floor to form a stop for the concrete and to preserve the edges from breakage. After the waste-pipe connection and the strainer have been set by the plumbers, the body concrete is laid and tamped down, the top being graded to conform to the required finished grade, but 1 inch below it. After this has set sufficiently, the top dressing is laid, smoothed down nicely, and graded to the strainer. A series of V-shaped diagonal channels 4 inches on centers are marked on the surface of the concrete, to prevent the horses from slipping and to drain the stand, as shown in Fig. 21.

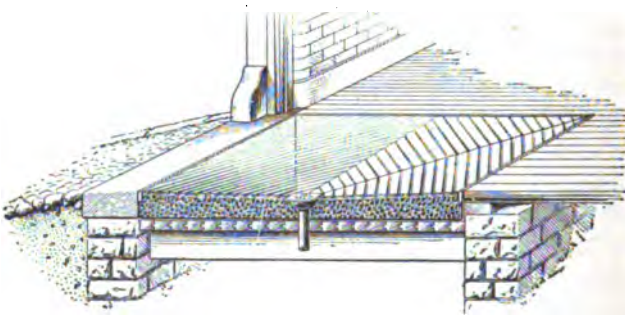


FIG. 21.

The concrete in the cellar bottom and area is specified as being 6 inches thick including a 1-inch top dressing. The superintendent should see that the body of the work is well tamped down, graded as required, and worked up close to the foundation walls, piers, etc. The laying of the finishing coat must be carefully watched to see that no depressions occur on the surface, that the required thickness is put in, and that the top is properly floated to a perfectly smooth surface and finished neatly around all angles and corners. The walk *e*, Fig. 3, leading to the front entrance; the platforms *f*, flanking the front carriage entrance; the plaza floor *g*, previously described; the veranda floor *h*; the bottom of trap wells for the service and drainage lines and the bottom of the manure vault—are all laid and finished in a manner similar to the cellar bottom. The platforms *f* are finished

with a rounded edge at the sides adjacent to the drive, and these platforms, as well as the walk *e*, are squared off to represent flagging.

The superintendent should, during the laying of the concrete work, pay strict attention to the proportions of ingredients used and the methods of laying it, as perhaps no other work in masonry can be skimmed more than this. It might be well to add that all concrete work after completion should be protected from damage by covering it with boards, and, if necessary, fenced off with a rough temporary guard.

68. Flagging.—The platform in front of the greenhouse is laid with flagging in two pieces the full thickness of the steps; the pieces to be of equal length with the joint in the center; these stones are to rest on the foundation walls of the greenhouse on one side and be upon the steps at the other. A manhole, 20 inches in diameter, is to be cut on the left side where indicated, and a cast-iron frame and flush cast-iron manhole cover to be inserted. All this work is included in the contract for the greenhouse work, but the laying of the platform, with respect to getting proper grade and beds on supports, should be closely watched by the superintendent. The flagstone covers over the trap wells for the service-pipe lines are specified to be 6 inches thick and in one piece, with a full 8-inch bearing on the walls all round, and to have a manhole with cast-iron flush frame and cover; the top of these stone covers to finish 10 inches below the finished road bed. The superintendent should see that the stones are sound, of sufficient size, that they are properly bedded, and laid at the proper level.

INSPECTION OF LUMBER.

69. Classification of Lumber.—The *inspection* and *classification* of lumber, or its valuation according to the uses to which it may be put in house building or elsewhere, is, for the most part, a matter of judgment. In every locality, however, there are certain rules adopted by the lumber

exchanges and associations which the inspector must follow, as far as his judgment will allow, in classifying the lumber. It would require too much space to give the rules of inspection in each state or locality, so that those of only three lumber centers will be given—the Maine inspection for the East, the Baltimore inspection for the South, and the Saginaw inspection for the West. These will serve to give the student a general idea of the grading of lumber, and will enable him to read, intelligently, specifications or proposals making use of such classifications.

MAINE INSPECTION.

70. Pine.—No. 1 pine is entirely dispensed with, and the first quality recognized is called No. 2.

No. 2 pine may be of any length or width, provided, however, that short lengths and narrows must be good; the shorter and narrower the board, the better is the quality required. A board 12 feet long and 5 or 6 inches wide must be entirely free from knots and sap, and must be straight in grain. Larger boards must be nearly free from knots, sap, and shake.

No. 3 pine must be free from shakes, but a few knots or a little sap will not condemn it. The size of the board goes far to determine the quality; very small pieces, otherwise up to grade, would be classed as No. 4.

No. 4 pine is a small board usually free from knots, but with some sap. If large boards are put in this number, it is because one-quarter or one-third of the piece is shaky, although the remainder may be good.

The market recognizes, also, two kinds of shipping boards, designated "Shippers"; viz., smooth and common. *Smooth shippers* are boards without shake or case knots, or any large knots. *Common shippers* are boards coarse and knotty, 8 inches and upwards in width, and 12 feet and upwards in length. (These are sometimes manufactured under special orders, when they may be 9 inches, 10 inches, or even

greater widths.) In this grade splits, red streaks, or very shaky boards are objectionable.

Narrows is the term of the next grade below common shippers, and consists of boards too small for shippers. These must not be very coarse, and must be suitable for floor boards.

Poor fours consist of sappy, shaky, and knotty boards, not suited to be classed in any of the foregoing descriptions.

Scoots are the lowest grade; rotten boards and all others not admissible in other grades are surveyed as scoots.

The market also handles what is termed *sapling pine* or *gang boards*. These are usually manufactured in gang mills, the survey as to quality being about the same as the balance of the grades described, except as to designation, the twos, threes, and fours being put together under the one term *planers*. The *shippers*, *narrows*, *poor fours*, and *scoots* are surveyed as described in those heads.

71. Spruce.—Spruce is known in the two qualities of *merchantable* and *scoots*. The scoots comprise boards which are cross-grained or rotten. In surveying, the grades are divided into two qualities; viz., *floor boards* and *coarse*. The floor boards must be nearly free from knots; all others are considered coarse.

BALTIMORE INSPECTION.

72. Rules.—The following rules for the inspection of lumber were adopted by the lumber exchange of Baltimore:

In the inspection of hard-wood lumber it is essential that the inspector use his best judgment, based upon the following rules laid down for his guidance.

The standard knot must be a sound one, and not exceeding $1\frac{1}{4}$ inches in diameter. Splits are to be considered as defects, and usually reduce the piece to a lower grade. Mill culls are never regarded as marketable, and any cull which will not work to the use for which the size is applicable, without

wasting more than one-half, is a mill cull. The standard lengths are 12, 14, and 16 feet, but 15 per cent. of 10-foot lengths may be allowed.

In black walnut and cherry, 10-foot lengths are considered as standard, and 15 per cent. of 8-foot lengths may be admitted in the first and second grades.

All badly manufactured lumber should be reduced in grade, and that for newels must be inspected with a view to the adaptability of the piece for the intended use, as in many cases it cannot be utilized for other purposes. They shall be cut outside of the heart to square the following sizes: 5, 6, 7, 8, 9, 10, and 12 inches when seasoned. The lengths must be 4 feet or the multiples thereof.

All rotten, shivered, and shaky ends shall be cut off in measurement when the board or plank will make 8, 10, or 14 foot lengths, clear of the bad end, and be classed in the grade the part will make, except culls, which shall be counted full in all cases.

Face cracks in all cases will reduce the stock one grade; if badly face-cracked, so that one-half of the board or plank cannot be used without waste, then it shall not be counted.

The inspector, in all cases, is to keep a separate tally of each size and quality. All boards and plank should be measured and graded on the inferior side.

The recognized standard thickness shall be 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, 4, and 5 inches in all classes of hard woods, and in all cases the board or plank shall be of full thickness, parallel in width and have square edges and square ends.

All tapering pieces of lumber shall be measured one-third the distance from the narrow end, when 12 inches and over in width at the center; when less than 12 inches wide at the center, they must be measured at the narrow end.

Worm holes are to be considered one of the most serious defects in hard-wood lumber.

All inspectors of hard wood under these rules shall mark the quality upon the lumber so inspected, when required. Lumber inspectors are required to use due care in handling and marking lumber, that the stock is not damaged in any

way, or its fitness for use impaired by careless handling or marking.

73. Black Walnut.—Black walnut shall be inspected in three grades—firsts, seconds, and culls.

Firsts shall not be less than 7 inches wide, and must be free from defects, but at 10 inches wide will admit of defects equal to 2 inches of sap on the edges. Defects may increase with the width, but not such as to cause waste when used for first-class work.

Seconds shall not be less than 6 inches wide, and at 6 inches may have one knot. Defects may increase proportionately with the width. Sap on the face side shall be measured out.

Culls shall include all lumber not up to the standard of seconds. Mill culls to be excluded from this grade.

74. Poplar or Whitewood.—Inspection grades shall be known as firsts, seconds, and culls.

Firsts shall not be less than 10 inches wide, and at this width shall be free from all defects; at 12 inches wide, 2 inches of white sap, and at 16 inches wide, 4 inches of white sap shall be allowed; proportionate increase of sap to be allowed according to the width. In lieu of the sap one standard knot shall be allowed for each 4 inches of sap.

Seconds shall not be less than 6 inches wide, and must be clear up to 8 inches. When over 8 inches they may have two sound knots not exceeding $1\frac{1}{4}$ inches in diameter, and 2 inches of white sap. At 10 inches, defects equal to 3 inches of white sap, or two sound knots $1\frac{1}{4}$ inches in diameter are admissible. Defects may increase with the width, but two-thirds of the entire piece must be suitable for use in first-class work, without waste.

Culls shall comprise all widths and sizes not up to the standard of second grade. Lumber usually designated as mill culls is not included in this grade.

For poplar, regular marketable thicknesses shall be $\frac{5}{8}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, and 4 inches; $\frac{1}{2}$, $\frac{3}{4}$, $1\frac{1}{4}$, 5, and 6 inches and

up are classed as special sizes. When squared, the sizes in inches shall be 3×3, 4×4, 5×5, 6×6, 7×7, 8×8, 9×9, 10×10, etc. All square stuff to be cut clear of the heart, clear in quality, and cut large enough to hold sizes when seasoned. Such as are not designated as prime shall be graded as seconds or culls.

75. Ash.—The inspection grades shall consist of firsts, seconds, and culls.

Firsts shall not be less than 8 inches wide, and free from all defects. Sap shall not be considered a defect, if bright and sound.

Seconds shall not be less than 6 inches wide, and at 8 inches may have two standard knots; must also be free from heart, dry rot, dote, and worm holes.

Culls shall include all grades not up to the standard of seconds.

76. Oak.—Inspection same as ash, excepting timber, in which sound knots, and heart not showing on the outside shall not be considered defects. For birch, beech, maple, elm, and hickory, the same inspection as for ash. In first-grade hickory, 6 inches in width and 8 feet in length shall be allowed. Quartered oak shall be inspected as firsts, seconds, and culls.

Firsts shall be 5 inches and over wide, and clear of all defects. At 10 inches wide will admit of defects equal to 2 inches of sap on the edges. Defects may increase with the width, but not such as to cause waste when used for first-class work. Gum spots are excluded from this grade.

Seconds must be 6 or more inches in width; will admit of two standard knots; sap on the face side to be measured out. Defects may increase with the width in proportion. Small proportion of gum spots will be allowed, but in no case shall they be of such a character or quantity as to seriously damage the piece.

Culls shall include all not up to the standard of firsts and seconds.

77. Cherry, Ash, and Walnut.—Counter tops shall be 12 feet long and over; 17 inches wide and over; 1, $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 inches thick, and must be clear of all defects.

Cherry, ash, and walnut strips 6 inches wide and under, when in separate lots, shall be counted as firsts, seconds, and culls.

Firsts shall have one face and two edges clear. Sap on face side of ash, when bright, to be counted.

Seconds will admit of two standard knots or sap, which on face side of cherry and walnut shall be counted out.

Culls.—All not up to the standard of seconds shall be designated as culls.

Cherry strips shall be 6 feet long and over.

SAGINAW INSPECTION.

78. "Clear."—*First clear* is not less than 8 inches in width, and is free from imperfections, the term *clear* implying freedom from defects.

Second clear is not less than 8 inches in width, at which it must be so nearly perfect as to fall but a trifle short of first clear. As the width increases, a larger range of defects may be allowed, so that at 12 inches wide, a piece may have two knots of 1 inch diameter, or two narrow saps on one side; at 16 inches wide, especially if the piece is more than 1 inch thick, two knots may be allowed, or one knot and one sap not over $1\frac{1}{2}$ inches in width. At 20 inches in width, the two knots may be larger, or the saps may increase to $1\frac{1}{2}$ inches.

Third clear is supposed to admit of three defects, but up to 10 inches, knots should not exceed $\frac{3}{4}$ inch in diameter, or the sap should not exceed $\frac{3}{4}$ inch on one side. With increasing width, knots may increase to three in number, not over 1 inch each, or sap equal to $1\frac{1}{2}$ inches in width on two edges of one side; with narrower saps a small knot showing on the face side might be allowed; but as a rule, the three upper grades demand one perfect face.

In the Saginaw and some other markets the term *good* is

used in designating the upper grades, and purchases are sometimes made in *good, select, fine common, common, and culls*; but unless these terms are specified, the quality *good* in common use will include not only the three upper grades, but also the next grade below, or selects.

79. "Selects."—Selects is a term which allows of four defects in a piece of lumber. Four knots not over 1 inch in diameter, according to the size of the piece; or two saps on one side, which in pieces 12 inches wide, should not exceed 3 inches in the aggregate, or embrace more than one-quarter the sap side, the heart side being the face. With increasing width, the proportion of sap may increase; or with narrow saps, the face side may have some knots. The general description of this grade, however, is of a class of lumber which has defects of such a character, as, while condemning it for the three uppers, yet mark it as suited for many or most uses to which the three uppers may be put.

Fine common, sometimes known as *select common*, or *select box*, or merely *box*, is a grade of lumber suitable for finishing purposes, yet having too much sap on one side, or too many knots on the other, to admit its entry to the grade of selects. Fine common is usually taken from the lumber cut next to the outside of the log—sometimes known as sap boards—the general character of which is to give one face side, while the other is largely covered with sap, which, if properly piled to dry without mold, is adapted to a large proportion of the finer work where one side only is exposed to view. With this point in mind, the inspector will allow knots in this grade proportioned to the size of the piece. If the sap is narrow, the face may have one or two small knots, but, except in wide lumber, the rule is observed "one side a face." Pieces below 8 inches in width are seldom accepted in this grade, and at that width the defect is in sap, which may embrace not more than one-third the sap side and must not run out to the face side; or a board of that width may have a good sap side nearly, if not wholly, clear of knots and with two small knots on the heart side. In larger pieces, a board or plank

having too many defects, for the grade of selects, and yet approaching almost to the requirements of that grade, is included in the *fine common*. A board 16 inches wide, 1 inch thick, with five knots not over 1 inch, and having no other defect, would be classed with fine common. The same piece, if $1\frac{1}{2}$ or 2 inches thick, would probably be classed as selects by most inspectors. Shaky lumber is not admitted in this or the upper grades.

80. "Strips."—*Strips, first clear*, are 6 inches wide, 1 inch thick, free from all imperfections, and are known as clapboard or siding strips. The term *siding strips* should not be confounded with *sidings*, lumber cut from one side of a log, in distinction from the stock, or lumber cut from the square log.

Strips, second clear, are 6 inches wide, 1 inch thick, and may have two small sound knots, or if there are no knots, then sap equal to 1 inch in width on one edge of the one side may be allowed.

Strips, third clear, are 6 inches wide, 1 inch thick, and may have three small sound knots and upon one side in addition, sap equal to 2 inches in width. All strips in these three grades must be free from rot, split, or shake.

Strips, Flooring and Fencing.—These terms include all strips not as good as third clear, yet free from rot and split. Flooring strips must be of full thickness and width, except where a narrower width is desired, when they may be of the uniform width of 3, 4, or 5 inches. All knots in flooring strips must be sound. Fencing strips include all coarse-grade strips not good enough for flooring and above the grade of culls, or strips not up to the standard thickness, and their inspection is less rigid than the other grades.

Common.—This term includes all boards, plank, scantling, strips, joists, timber, and lumber not otherwise defined, which do not come up to the select-box grade, but are of a generally sound character, well manufactured, of full thickness, and free from large, loose knots and bad shakes. Scantling joists and timber must be free from knots or

imperfections which involve or weaken the piece for substantial building purposes. Pieces containing worm holes and small sap streaks, which do not materially damage the piece for the uses in which it is usually employed, belong to this grade. One straight split, not more than one-quarter the length of the board, may be allowed. No lumber under 10 feet in length is considered as merchantable in this or the better grades.

81. Shipping Culls.—Lumber containing unsound knots, or knots which affect the strength of the piece, black or moldy sap, unsound hearts, and badly sawed, is included in this class, the pieces are available for coarse use, and all other lumber not up to the grade of common, is included in this grade. Anything poorer than shipping culls is not recognized in any market. Saginaw lumber is always manufactured in 12, 14, and 16 foot lengths (with an exceptional log of other lengths) in all grades, except dimension stuff where lengths are cut to suit the sizes demanded, but the sidings from such logs are usually cut off to the 12, 14, and 16 foot standard. The thicknesses of the Saginaw lumber, as usually cut, are 1, $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 inches; but with some 3 inches in coarse plank, or in extra nice stock, for thick uppers or deals. All lumber is manufactured in parallel widths, and many mills employ cut-off tables for reducing all lengths to uniformity. The coarser grades are usually cut 1 inch thick, the better grades being almost invariably $1\frac{1}{2}$ and 2 inches in thickness.

SUPERINTENDENCE OF THE FRAMING.

82. Inspecting Material.—In framing the outside walls of this building, a modified form of balloon frame, or, more properly speaking, a combination of balloon and braced framing, will be considered. It is assumed that complete framing plans have been furnished, and the superintendent directs his attention to the inspection of the lumber to see that the several sizes specified have been furnished, and that

the quality is up to the standard required by the specifications. In order to do this, he should have a knowledge of the distinguishing characteristics of each of the various woods specified and should know them at a glance. The difference in texture of the grain, the color and the odor peculiar to each are generally sufficiently marked to enable him to do this. It should be remembered, in measuring lumber for the purpose of determining whether the proper sizes have been furnished, that they shrink to a certain extent in drying; a 12-inch floor joist, for instance, will seldom measure more than 11 $\frac{1}{4}$ inches. Spruce sometimes shrinks more than this. Crooked or warped pieces of timber should be condemned at once, as well as pieces showing shakes, especially those occurring along the annual rings which are very noticeable in average hemlock timbers. Longitudinal cracks that do not extend through the thickness often occur in spruce timber of large dimensions, but are caused by shrinkage or rapid drying and do not seriously impair its strength, but if they occur in a thin piece of timber, as, for instance, a floor joist 2 inches in thickness, and extend through its thickness, the timber should be condemned, as it is liable to fail along this line. Any timber showing dry rot, unless it is possible to cut off the affected part, should be condemned at once. After the superintendent has inspected the lumber and satisfied himself that all of it is up to the requirements of the specifications, his attention should be directed to the fitting together and erection of the work.

The first operation consists of laying the sills which should be of sufficient cross-section to allow for possible cutting and notching. In this case the sills are 4 in. \times 8 in., to allow the anchor bolts to be set back clear of the ashlar facing; the bottom side is to be painted, and the sills bedded in a good layer of Vicat cement mortar. The sill should be leveled up by inserting spalls or pieces of slate under them until all are brought to a uniform level. The corners are to be halved together. The sill is laid on its broad side and back a distance from the face of the wall equivalent to the thickness of the sheathing. As the main sill and that for the dumb-waiter

partition are to be anchored to the walls by means of iron bolts built into the wall, holes are bored through the sills to correspond with the spacing of the bolts, and, after the sills are set in position, nuts are tightened up at the time the sill is being leveled. Before the sills are set, the superintendent should see that they are painted and that a good bed of mortar is spread under them, as mentioned elsewhere. The corner posts are erected, plumbed, and braced, after which the studding, plate, and ribbons, or false girts, are set in place. The superintendent should see that the posts are plumb, as it is very important that they should be; he should also see that the plate, ribbons, etc. are perfectly level and at the proper heights. The floor joists are now set in position, the roof framing erected, and, after all bracing is put in, the building is covered with sheathing lath as shown. This work should also be carefully watched, that no joint occurs between studs, and that the boards are well driven together and secured with the requisite number of nails. All the framing is well spiked together, and in this case, as the sheathing is to be put on horizontally, braces will be necessary. If, however, the sheathing boards were put on diagonally, they would serve as a brace, and, under ordinary conditions, would be sufficient.

83. Bracing, Etc.—Long angle braces are generally used in balloon framing, but pieces of timbers notched into the sill, plate, and post, and secured with oak pins, are perhaps of more value in stiffening a frame, and serve the same purpose. If the long brace is used, the superintendent should see that the studs are cut only enough to allow the brace to come flush with the outside face. He should also see that the requisite number of nails is used at each bearing. The rafters are braced by means of collar beams, and the floor joists are braced and stiffened by means of "bridging" put in rows about 6 feet apart and running in a line across the floor of the building. The bridging is put in as soon as practicable after the laying of floor joists and before partitions are set.

84. Floor Joists.—In the setting of floor joists the superintendent should see that they have a full bearing on the sill, in this case extending to within $\frac{1}{4}$ inch of the sheathing boards, and, although it is a common practice to notch the joists over the sill, it cannot be recommended as good construction. Joists cut in this way depend almost entirely on the section immediately above the sill, and are equivalent to a joist of that depth; for the underpinning—generally of slate or small pieces of stone wedged under the joists—is liable to work loose and drop out, thereby exposing the beam to the conditions cited above, and causing a rupture, as shown in Fig. 22.

The girders under the first floor being of steel **I** beams are set in position by men under the direction of the mason foreman; one end of each is supported on a stone templet in the wall and the other end on the piers or cross-walls, as the case may be. The first-story joists are supported by these girders, and their wall ends are carried on a

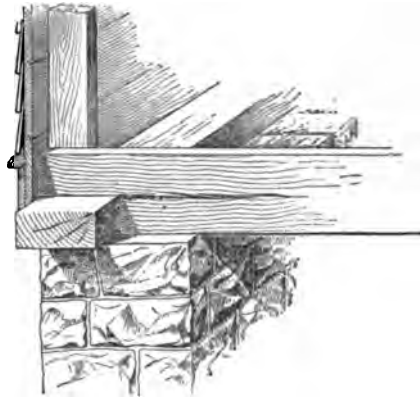


FIG. 22.

brick corbel, as shown at *b*, Fig. 11. The framing of the first-story joists is the first carpenter work to be done, this being laid as soon as the masons have completed the stone walls up to the sill line; in an ordinary two-story frame building, however, when the underpinning is only 2 or 3 feet above grade, the sill would be the first member to lay.

Floor joists are specified to be laid with their crowning or cambered edge upwards; by crowning edge is meant the edge trimmed with an adz so that the joist will be higher in the center, and when a load is imposed upon it, the joist will assume, approximately, a straight line; in other words, it will become level. This proceeding, however, is only necessary where joists have a large span. The joists being spaced

the requisite distance apart (16 inches), a level is applied, and the joists are notched out on the bed side, or a piece of slate or wood is inserted beneath, as the case may be, to bring all to a uniform level; the entire floor is thus brought to a uniform level. The bridging is then cut in after the joists are spiked together where they lap on the girder, or to the bearing where they rest on a sill. The superintendent should follow this work conscientiously to make sure that the floor is perfectly level throughout. The specifications require that the joists shall extend to within $\frac{1}{4}$ inch of the space of the brick backing or the inside line of the sheathing, and this should be carefully looked after. Floor joists are cut on the sill in a number of ways, each builder having his own ideas as to which method is best. Unless the specifications are drafted to cover this work, the architect is likely to be at the mercy of the builder and have the efficiency of the floor joists greatly reduced by excessive cutting or notching. In the building under consideration here, the joists are specified to rest on the sill or corbel in their full thickness without notching, except perhaps that necessary for leveling. Another evil to be guarded against by the watchfulness of the superintendent, is that of allowing the joists to rest on the inner edge of a stone wall without having a full training on the wood sill, for if the stone works loose, or falls out altogether after the building has been completed, the joist will drop down to the sill and thereby cause a depression in the floor above. Another point to observe in laying floor joists, is to have the tail-beams properly framed to the headers around chimneys and stair openings. Where the specifications require that the tail-beams shall be hung in steel bracket hangers of an approved make, the setting of the hangers should be followed closely to see that the tops (if they hang from the top of the header) are let in flush, and if otherwise hung, that they are properly spaced and set, and that the tail-beams are closely butted and spiked to the header, as shown in Fig. 23.

As the work progresses, the superintendent should verify

all measurements to satisfy himself that the openings for doors and windows are of the proper size and properly located; for a mistake made at this stage of the work in the centering of openings will be a difficult matter to rectify, to say nothing of the annoyance it will occasion. Frequently mistakes are made in locating

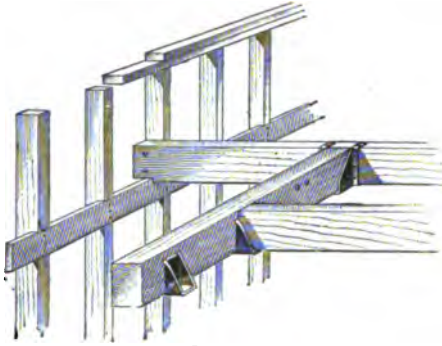


FIG. 23.

the openings in floor framing, for the chimneys and stair wells. Special attention should be given this framing to insure a proper clearance for the chimneys, which should never be less than 4 inches, and also sufficient headroom and width in the openings for stairs.

85. Staging.—Although the quality of the material to be used for staging, and the method of erecting it is usually

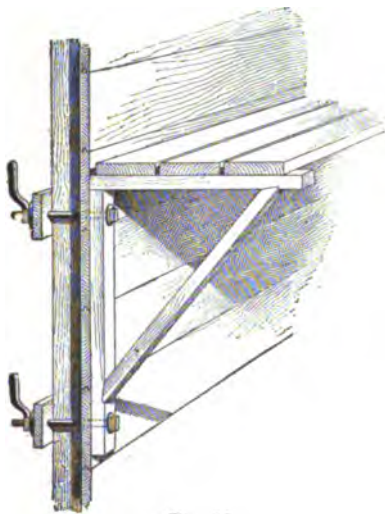


FIG. 24.

the contractor's affair entirely, it would be well for the superintendent to see that strong material is used and that each stage is well supported and a sufficient number of stays or braces are used. Sometimes studding is used for putlogs and very little attention is given to see that sound material is used; a treacherous knot in the center of a putlog may endanger the lives of many workmen.

A common form of staging consists of long pieces

of studs or rough spars set in barrels, and the barrels filled with quarry stone or earth, the uprights, if too short, being lashed together to increase their length. Putlogs, generally of rough sheathing stock, are nailed to each upright and to a cleat secured to the building; over this the stage is laid with plank; a simpler and perhaps better, if not a safer, form of staging consists of portable brackets secured to the frame with setscrews, over which planks are laid, as shown in Fig. 24.

86. Roof Framing.—The superintendent should see that the rafters are all sized to the proper lengths, and that the ridge, eave, and valley cuts are at the proper bevel to make a good fit. He should also see, when the rafters are erected, that the ridge and valleys are perfectly straight and free from waves which are sure to occur unless the rafters are all cut to an exact length for each pitch. The position of the openings for dormer-windows, chimneys, etc., and their dimensions, should be checked and the headers properly framed in. As soon as the roof has been framed together, the collar or tie-beams should be cut in between to tie each alternate pair of rafters, and well spiked thereto, as required by the specifications. The studding forming the cheeks of the dormers should be notched over the rafters, spiked to the sides of same, and extend to the floor to insure a water-tight joint and prevent the sagging of the trimmers.

Nothing need be added by way of instruction to the superintendent for his guidance in supervising the work in the stable framing, as practically the same problems as those met with in the construction of the main building will appear. The framing of the roofs over the belvidere, summer pavilion, porte cochère, and veranda will of course be somewhat different in character. The veranda roof will be constructed as follows: A built-up plate of two 2-inch beams bolted together is secured to the stone columns by means of anchor bolts. The rafters are notched over this plate and against a 3" × 12" ridge pole, which is in one piece and runs clear from

the building to the outside line of the porte cochère; this ridge timber forms a support for the joists forming the floor of the deck over the veranda. The superintendent should see that the plate is leveled up and secured by anchor bolts, and that all is in alinement with the building. The roof over the belvidere and the summer pavilion are built conical in form. The first pair of rafters erected are butted squarely together on a plumb-cut, the second pair are cut in a similar manner, set at right angles to and butted against the first pair. The four remaining principal rafters are fitted in the angle formed by the first four, and the intermediate rafters are fitted in like manner to the angle just formed. As the summer pavilion and the belvidere each have a wood plate anchored with iron bolts, the rafters will be notched over it and no collar beams or braces will be required.

87. Rough Flooring.—The rough flooring of $1\frac{1}{2}'' \times 6''$ surfaced-and-matched spruce is laid after the plumbing and gas pipes, electric wiring, etc. have been set in place. The rough floor is laid diagonally and well fitted around all rising lines. Openings must be left where required by the plumber or electrician for facilitating the erection of his work, and as the running lines of gas pipes and electric wires will be laid along the top of the floor joists, the rough flooring will have to be fitted against them; the superintendent should see that this work is properly done, that the floor is laid up to the sheathing, and that the joints are made on the joists only, and not between them. A furring strip should be nailed on the inside of the studs at the level of the top of the floor joists, to which the rough flooring will be nailed, and to serve as a bearing for it.

The summer pavilion above the piers will be constructed entirely of wood. The superintendent should see that the sill is properly built up of three thicknesses of 2-inch plank well spiked together, the floor joists set level, and spaced the requisite distance between centers, and that the wood columns are sound, turned properly, and have a hole bored through the center as required by the specifications. The

floor of the summer pavilion will be laid as shown in Fig. 25.

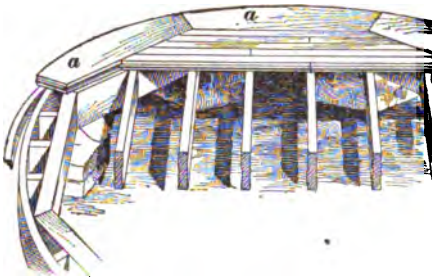


FIG. 25.

The flooring is to be of $1\frac{1}{4}'' \times 3''$ white pine, matched and laid with white lead between the joints. The pieces *a* around the edge are grooved at the back and the flooring is tongued at the ends.

The floor is planed down smoothly, given a good coat of thick paint, and covered with heavy canvas duck; the canvas is stretched down, and tacked under the nosing all round, after which a bed mold is tacked on. The painting of the canvas is described under painting of outside work.

88. Partitions.—It is a common but erroneous custom to place the joists in a building without any regard to the location of partitions, and to draw the framing plans, without provision for the support of the partitions, in a manner to avoid settlement due to sagging of the floor, as shown at (*a*), Fig. 26. Another poor way of supporting a

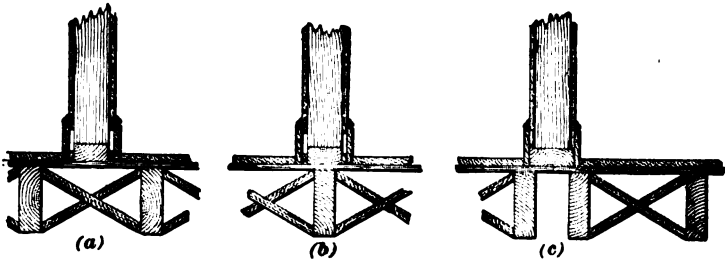


FIG. 26.

partition is shown at (*b*), and in both cases a suitable nailing for the finished flooring is not possible and in time the flooring will work loose and present an uneven surface. The method shown at (*c*) is the best, for the partition above has a good support and a good bearing is offered for nailing the finished floor. It will be noticed at (*c*) that a wide sill is

shown; this piece makes a firm support for the partition, and being made to a width to line with the plastering, it serves as a ground and the baseboard may be nailed directly to it. The superintendent should see that the studs are doubled at all openings for windows and doors in the exterior walls, and for doors in the interior, as required by the specifications, and that the rough sills and heads are put in at the proper distance above the floor to leave sufficient room for inserting the frames.

The specifications require that all partitions shall be trussed over openings 4 feet or more in width; this clause, then, would apply to the framing over the arched openings between the principal rooms.

The method of trussing is set forth on a detail drawing, and the superintendent should see that timber of the proper dimension is used and that the joints are well framed together, spiked and pinned with hard-wood pins. The door and arch openings in the interior partitions should be carefully laid out and their position checked by the superintendent. He should watch carefully the setting of sliding-door partitions, see that these partitions are lined with $\frac{5}{8}$ " \times 3" matched white-pine boards, painted on both sides, and that the hanging timbers and brackets for the sliding-door hangers are set perfectly straight and level, that the doors when set will work perfectly true. The importance of having this work accurately set in place is very often overlooked, and the mistake is discovered only when the door is being hung; the remedy is to remove the trim on one side, and tear down laths and plaster enough to allow the guide, or hanging timber, to be set properly. All partitions are to be bridged once in their height with diagonal, or "herring-bone," braces cut in between and well nailed to them with 10d. nails.

When it is required to run vertical lines of pipes through a partition, the sill and plate of the partition should be cut by the carpenter, but no more than required to allow the pipe to pass should be cut.

In well constructed houses provision should always be

made to prevent or check the spread of flames in the event of fire; several methods are employed, but that of using brick for the purpose is perhaps the cheapest and best; by this means rats and mice are also prevented from going from room to room, and from floor to floor, through the partition.

The spaces enclosed between studs from floor to floor constitute a series of air spaces or flues through which the flames can quickly communicate with the floors above, and, in balloon frames especially, the fire may break out in the attic, when it originated perhaps in the cellar. The superintendent should see, therefore, that all spaces between the floor joists in partitions, and between furring, and around chimneys are filled in with three or four courses of brick laid in mortar, as shown in Fig. 27. Very often the brick

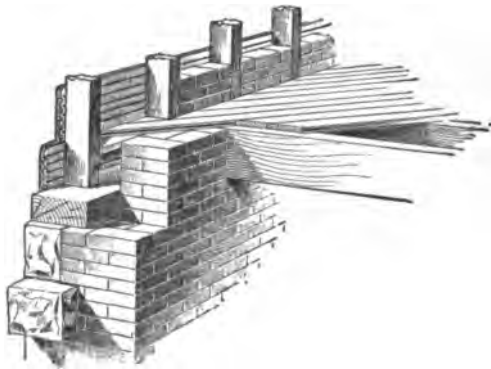


FIG. 27.

plugging is carried up the entire height of partition and walls, serving the purpose of deadening, as well as a fire-stop.

89. Pockets for Hot-Air Ducts.—The plans show the position of all hot-air ducts running through partitions, and as the dimensions of each are marked on the plans, the spacing of the studs forming the pocket for them is a very simple matter to determine; the superintendent, however, should take particular notice that no timbers are in the way, and if

such a condition exists, he should exercise his judgment in shifting the location of the ducts if necessary to avoid cutting the timbers. These remarks may also apply to the location of other service lines in the partitions. The superintendent should also see that the joints in the hot-air ducts are properly fitted and that the air space required is left around them and that the woodwork on all sides of the ducts is protected with tin, having the joints well fitted together, twined around the timber, and tacked down. It is better to carry the ducts up through closets where such a thing is possible.

Of the plumbing work, none but the rough work or that of setting the service lines in place need be done. The superintendence of this work, with a special regard to the quality of the materials and workmanship, will be explained later; but at this time their position should be looked after, with reference to running through partitions, to make sure that no hubs or connection will appear beyond the finished plaster, and that no timbers are cut by the plumber, who, according to the specifications, is required to notify the carpenter when such cutting is necessary.

In putting in gas and water supply pipes, the same precautions should be taken to prevent cutting the floor timbers anywhere beyond a point 2 feet from the bearings, and as a $1\frac{1}{4}$ -inch under floor is laid over the joists, the running lines may be put in and the floor butted against them.

The superintendent should see that the conduits for electric wiring are put in at the proper places, that the main group of risers is placed in an accessible position, and that suitable support is provided for the metal clips used to secure the conduits, and, in setting junction boxes and terminal outlets, that they are in the proper position before any lathing or plastering is done. The general inspection of this work is fully explained under the heading Electrical Work.

The setting in place of speaking tubes should also be followed to see that the proper number are put in, that the joints are well fitted together, and that they are placed in a position to preclude the possibility of being injured during

the progress of the work to follow; they should also be properly secured with metal straps or clips, not staples, and the height and position of the outlets should be checked so that no alteration will be necessary afterwards.

90. Roof Construction.—While the foregoing work of setting plumbing, supply, and waste lines, etc. is being carried on, the outside finish of the building is rapidly progressing; the laying of the shingles on the roof being especially hurried so that when the lathing is completed the plastering may be started without unnecessary delay. The boards forming the bottom of the roof gutters should be graded to the leader outlets; rough unplanned boards being suitable for this work, as the copper lining will cover them. The boards should be closely fitted and well nailed in place, and the false rafter ends, which act as brackets to carry



FIG. 28.

the projecting eaves, should be well spiked to the framing and set in perfect alinement. The gutters being ready, the barge boards are set in place, as shown in Fig. 28.

A $1\frac{1}{4}'' \times 9''$ board is laid along the eaves, valleys, and hips of all roofs to form a good foundation for the copper flashing and covering. While the $1\frac{1}{4}'' \times 3''$ shingle lath are laid and spaced 5 inches on centers, the framing of the veranda, porte cochère, and roof of the belvidere, the setting of the window frames and plaster grounds, the cross-furring of ceilings and first-story walls, the carrying up of the chimneys, as well as similar work on the stable, are all in progress simultaneously.

91. Shingles.—The laying of shingles or slates (in this case shingles) begins at the gutter with a double row, set to a line and having a projection of at least 1 inch over the stop mold on the back lining. The gauge or weather of the shingles are marked off to the top of the roof as the courses are laid, a chalk line being used for the purpose. The specifications require that, "All shingles for covering of roofs on the premises shall be of braced-sawed cedar shingles, 18 inches long and not less than 3 inches wide, secured with at least two 4d. galvanized-steel wire nails, the shingles to be dipped one-half their length in Cabot's creosote shingle stain of an approved tint," and stacked up until dry before being laid.

Although the brand of shingles specified should be sufficient, it would be well for the superintendent to inspect them. The shingles should be entirely free from knots, cross-grain, and of approximately uniform width. The wider shingles should be reserved for finishing hips and valleys where cutting is necessary.

Felt paper is sometimes used for underlaying the shingles, but cannot be recommended; it may be for slates, however, for, where they are exposed, as in an unfinished attic, the warm air of the building will condense on the cold surface of the slate and possibly cause considerable damage to the plastering of the rooms below. Snow guards made of copper wire are inserted at intervals of 1 foot in each course on the main roof, as the roof pitches are steep.

The specifications require that all leaders shall be rectangular in section, with their sides crimped or corrugated,

and of the requisite sizes, as shown. The detail drawings were furnished for the leader heads and wrought-copper straps, and the superintendent should see that the details have been followed, and that all are properly connected with the gutters of the buildings, secured to the building with the straps described above, set perfectly plumb, and connected with the drainage system, described in Art. 111. Provision should be made to carry off rain water temporarily, until the copper conductors are set in position, which is done after the second coat of paint has been applied to the exterior of the building.

92. Window and Door Frames.—In setting the window and door frames in masonry openings, the rough projecting mortar should be cleaned down, the check in the masonry jamb coated with about $\frac{1}{2}$ inch of strong cement mortar (Vicat cement against the stone facing), and then the stonework set in, leveled and plumbed, and secured in place. The superintendent should see that the space between the joint and frame is well filled with mortar so that no space will be left for the wind or rain to blow through; he should also see that the sills of all frames, immediately after being set, are covered with a rough board to protect them from injury caused by hauling timber over them, or otherwise, until the time arrives for painting them.

93. Furring.—Very little attention is required of the superintendent in inspecting this work. The principal points which he should attend to are, that good sound stock of the requisite size is used, that the furring is well nailed to the bearings, and that it is spaced at the proper intervals—the specifications requiring them to be set at 12-inch centers. The furring on the masonry walls in the first story is to be set vertically at the same distance on centers, and the superintendent should see that no wooden plugs are driven into the joints for the purpose of holding the nails; such plugs would be necessary in furring off a very rough rubble masonry wall, but are unnecessary in this instance; the backing being of brick, offers a fairly smooth surface to nail to. At least

12d. nails should be used for this furring, and the strips should be in one piece from floor to ceiling, nailed at frequent intervals. All vertical furring should be plumbed and lined up, to insure a perfectly even and smooth surface where the plastering is finished. Blocks of wood may occasionally be necessary, and, if so, suitable pieces (not "chips") should be used.

94. Grounds and Lathing.—The setting of grounds is also a comparatively easy task when the furring and partitions have been properly set and lined up; the thickness should be looked after, however, as that determines the thickness of the plaster to be put on; their nailing should be well done also, for a loose piece is liable to pull the plaster away from the laths.

Metal or wire lath is undoubtedly the best under all circumstances and should be used when small extra expense

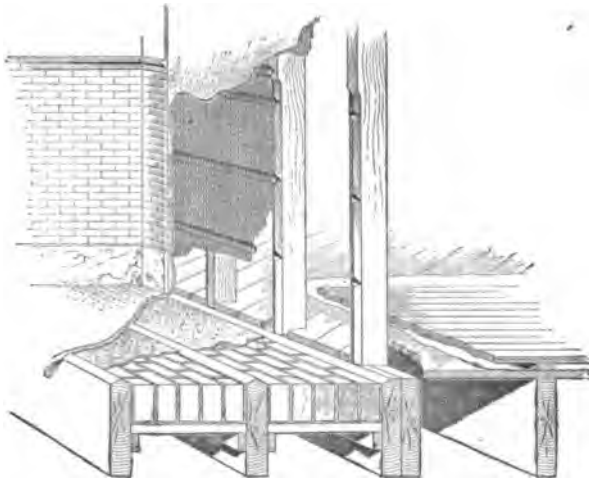


FIG. 29.

is not a consideration. The specifications require that galvanized-iron wire cloth, of No. 12 gauge, with $\frac{1}{2}$ -inch ribs, is to be used for plastering throughout the interior of the building, with the exception of the vestibule and bathrooms, which will be lathed with wood lath secured with copper

nails. The wire cloth is supplied by V-shaped pieces spaced at intervals of about 8 inches and woven into it. See Fig. 29. These pieces keep the lath away from the studs so that the plaster has a good key at all points. The superintendent should see that this wire lath is nailed to every bearing and that the nails are driven up tight and not partly set in, also that the joints are broken and the cloth lapped at least 1 inch; he should also see that the lathing on the ceiling is carried back to the chimneys, and not stopped against the face of the furring around them.

When wood laths are used, the superintendent should see that they are as specified: sound, free from knots, sap, or bark edges, of a uniform thickness, and spaced not $\frac{1}{4}$ inch apart for patent plaster, such as King's Windsor cement or Adamant wall plaster, and for ordinary mortar from $\frac{1}{4}$ to $\frac{3}{8}$ inch apart. For the best work it is required to break joints at every course, but for good ordinary work the joints should be broken every sixth or eighth course.

If the laths are too near together, the mortar will not be sufficiently pressed into the joints, and will not key. On the contrary, if the laths are too far apart, and the mortar is quite soft, it will drop off from its own weight. Care should be taken to see that the laths are nailed to every bearing, that no laths are allowed to fall short of the bearing at the ends, and that no thin or imperfect laths are used in any case; if such work as that just described is allowed to pass, the plaster is liable to crack and fall off when pressed upon or struck with a hammer in putting up trim, etc. In laying laths from one side of a room to another, it very often happens that a narrow space is left, and this space will generally be covered with laths set vertically, for the sole purpose of simplifying the work; this should not be allowed, as cracks will surely appear on the line formed by the change of direction of the laths. In a very narrow space, say 4 to 6 inches wide, the laths may be put on diagonally, and should be cut on the ends with a hatchet to obtain a good bearing for the nails. Any wood lath split in nailing should be removed and replaced by a sound piece.

SUPERINTENDENCE OF THE PLASTERING.

95. Temporary Heating.—If the plastering is to be done during freezing weather, provision should be made to have temporary heat to facilitate the drying of the mortar.

If the building is to be heated by steam, hot water, or hot air, the heating contractor should furnish, set up, and connect in each room temporary radiators or registers of a size requisite to heat the rooms to a normal temperature of 70 degrees; the owner agreeing to pay the heating contractor, over and above the contract price, about \$3.00 for each radiator or register, the owner maintaining a competent man to operate the heating plant, and furnishing all necessary fuel, oil, etc. during the required period agreed upon between himself and the heating contractor.

In small country dwellings with no regular heating system, stoves or fire-pots are employed for the purpose of drying mortar, but this method of forced drying is objectionable. Of the two methods, that with fire-pots is undoubtedly the better, but, if used, the pots should be set in boxes filled with sand, situated in the center of the room. The fire-pot should

be taken out into the open air when the fire is started, as the smoke from the burning wood will discolor the walls and cover them with a greasy film of soot. After the wood has burned sufficiently, to ignite the coal or coke and has ceased to give off smoke, the fire-pot may be brought into the building



FIG. 30.

and deposited in the box of sand. The fire-pot and method of carrying it are shown in Fig. 30. A man should be kept in constant attendance on these fires, and the expense so incurred, as well as that of furnishing fuel, should be paid for by the owner, unless otherwise provided for in the specifications or agreed upon between the owner and the contractor.

96. Plastering Mortar.—The mortar to be used for the scratch and brown coats of plaster should be mixed at least a week before the lathing is started, and stacked in the rough until the time arrives for using it in the building. This enables the lime to slake thoroughly, so that when it is tempered for use by reworking the result will be a fine homogeneous mass. The mortar should be mixed in the open air, and in winter should be protected from rain, snow, and frost; it should never be mixed in the cellar, as the moisture of the mortar will cause the floor joists and other timbers to swell.

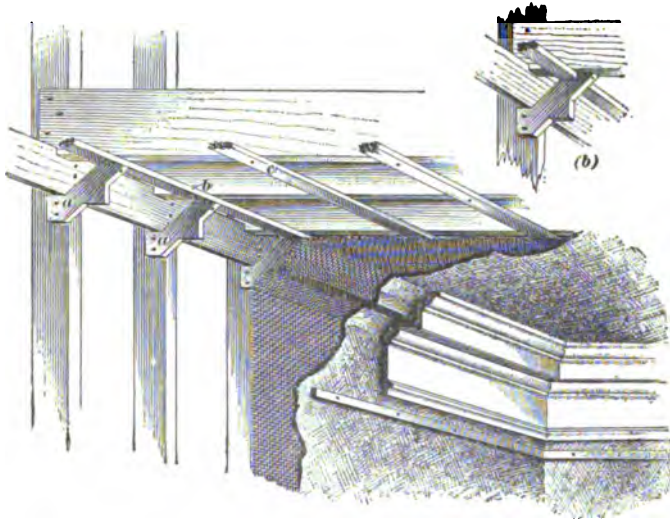
While the mortar is being mixed the superintendent should see that the proper lime and sand are used; the lime should be well burned and slaked thoroughly when covered with water. If underburnt lime is used, "cores," or imperfectly burned pieces of lime, will be scattered throughout the mass and may not slake until after the mortar is applied to the walls, causing what are known as "chip cracks," or "blisters." The sand should be inspected to make sure that it is clean and contains no clay either in lumps or loose.

The superintendent should see that the mortar contains the requisite amount of hair, and that in applying it to the walls, sufficient force is applied to secure strong clinches, or, in other words, that the mortar is squeezed through the joints between the laths so as to bend over on the inside. It is very important, especially in two-coat work, to see that the brown coat is well leveled up and true to a line on all angles and corners, for the white finishing, or skim coat, is merely a thin veneer of plaster and cannot be depended on for truing up the wall surfaces. The scratch coat should be leveled up, trued in the angles, and if three-coat work is called for, scratched to rough surface with a wooden comb of pointed laths nailed together in a row.

97. Screeds.—After the scratch coat has set hard, *screeds*, or strips of mortar, as explained in *Masonry*, § 8, should be run along all margins and down the angles or corners; a long straightedge is applied and the screeds are

worked until a perfectly true surface is obtained; intermediate screeds are put in, especially on large surfaces, the number, of course, depending on the length of the straightedge. For the best work, a spirit level is applied to the straightedge, and by this means a perfect job will result. After the screeds are sufficiently dry, the body of the brown coat is filled in and worked to the plane of the screeds. The screeds in all corners and on angles should be plumbed. In rooms having a plaster cornice, the brown mortar should be scored to a rough surface along the margin of the ceiling and side walls to afford a good key for the extra weight of plaster; at this point it should be observed that both brown coats are carried down to the floor.

98. Bracketing.—If a heavy cornice is to be put on, wood or metal bracketing or cradling, of the same general outline as the cornice, should be provided, and set up. If wood brackets are used, as at *a*, Fig. 31, a strip *b* is first



(a)

FIG. 31.

nailed along the floor joists above, and the brackets are set to it, in that way getting them in a straight line; a cord stretched

across the studs is sufficient to bring the bottom of them into alinement. This strip is put on only where the ceiling is to be cross-furred with the furring strips *c*, and if no furring strips are to be used on the ceiling, the brackets are notched over *b*, as shown at (*b*), or the strip *b* may be omitted entirely. In the setting of cradling and all such work, the superintendent should see that sound lumber is used, that all are set to a true line and well nailed in place. In shaping the rough brackets just described, it should be borne in mind that at no point should the plaster be thicker than 1 inch, except perhaps on acute angles or some such position where it is unavoidable.

99. White Finishing.—After the plaster cornices are finished, the white finishing or “skim coat” is applied. This consists of pure lime, which should be slaked, strained through a fine sieve to remove any grit or unslaked particles of lime, and allowed to stand in a covered trough or in barrels for at least a week before it is used. After standing for a few days, the hydrated lime should be of the consistency of white lead, or firm enough to be carried on a shovel. Washed sea sand and water are then added by the helper, who tempers the mixture to a soft paste. It is supplied to the plasterers in this form and they mix it on the mortar board with plaster of Paris and water, tempering it until reduced to the required consistency. In using this plaster a good workman will exercise great care that all his tools and mortar board are thoroughly clean; but sometimes a careless man will use a rusty trowel, or perhaps the helper will fill his hod with a shovel that has been used for some other purpose. The superintendent should follow this work carefully to see that the plaster is properly applied and skimmed in a manner to hide all brown mortar, scratching down all uneven surfaces of the brown coat, if necessary. He should also see that no iron nails or other metal work that is likely to rust is left in a position to discolor the plaster, as the white skim coat should show a perfectly smooth and unblemished surface at completion. Another and a very important point to

be looked after by the superintendent is that of fires, if the plastering is being done in cold weather; particular care should be taken with the fires while the white finishing coat is damp, for any dust arising from shaking or poking the fires is sure to settle on the walls and do irreparable damage. The fires should be kept as nearly in the center of the room as possible, for if brought too near the wall, the white finishing coat will dry out too quickly, and in doing so the plaster will crack into innumerable shapes and present an appearance similar to alligator hide.

100. Brackets and Centers.—In setting plaster brackets, care should be taken that they are set at the proper height above the floor and that they are plumb to the wall surface. In setting centers, the superintendent should see that they are in the center of the ceiling, which, of course, is previously found by the gas-fitter and checked by the superintendent. It is a comparatively easy matter to find the center of a room, and, although very easily done, is often neglected or carelessly done by gas-fitters and plasterers. The intersection of two strings stretched from the corners of the room and crossing it diagonally will mark the center. Where improved or patent plasters are specified, as in this case, the specifications requiring that the bathrooms and vestibule shall be finished with (King's Windsor cement), the superintendent will only be required to see that the proper materials are used and that they are mixed strictly according to the instructions of the manufacturers. In general, the superintendent should prevent, as far as possible, the use of reworked mortar, or mortar that has become partly set.

101. External Plastering.—Many methods are employed in mixing rough cast and mortar for external plastering and also the manner of preparing the wall surfaces, differing according to locality or custom. A method employed in Canada and in some of the states bordering on the Great Lakes consists of sheathing the frame with matched boards as for ordinary clap boarding, laying over this a layer of tarred paper or other similar material; the

laths are put on diagonally, spaced about $1\frac{1}{2}$ inches apart

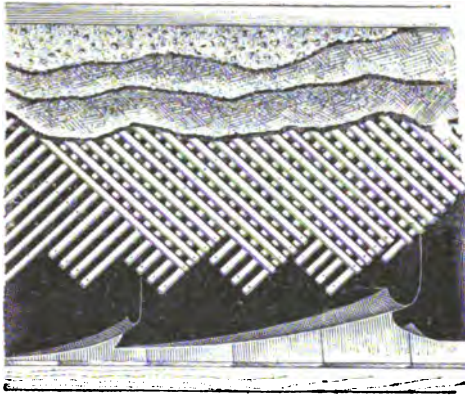


FIG. 32.

and well nailed, after which a second layer of laths is put on in the opposite direction and also well nailed, as shown in Fig. 32.

A coat of lime mortar, well haired, is now put on and scratched to a rough surface to form a key for the second coat; a second coat of lime mortar is

put on after the first has dried out and the work is finished by the application of the rough cast, which consists of screened gravel mixed with strong lime and water to a thick fluid, which is dashed on with a small wooden float. The surface is made comparatively smooth with a brush which is dipped in the liquid, and by this means a uniform color is obtained.

102. Composition and Color.—For the walls of the main building and the stable under consideration in this section, the external plastering is applied as shown in Fig. 33. Grounds are nailed direct to the sheathing lath of a thickness to correspond to the thickness of the plaster. The first coat consists of sharp sand, lime, Portland cement, with an admixture of cattle hair, applied with good pressure to fill the grooves in the

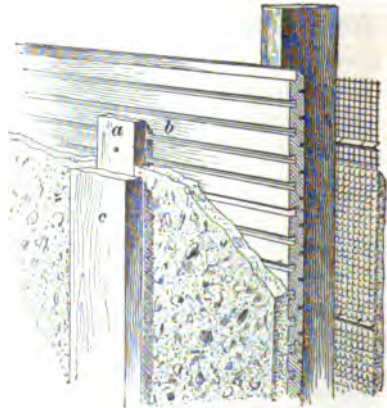


FIG. 33.

sheathing lath; this coat is scratched to a rough surface and allowed to dry. The second coat of mortar is the same as that used for the first coat except that the hair is omitted; this coat is troweled down to a smooth surface. The last coat, called the *rough cast* or *dash*, is mixed and applied in the same manner as in Canadian practice, previously described. This coat is necessarily thin and should finish flush with the grounds, that the open timber staves or battens may be put on without unnecessary scraping of the plaster surface. The dash coat may be colored any desired tint by the admixture of mortar colors. Care should be taken, however, in the selection of these colors, for Venetian red and some other earthy colors fade in a short time and present a dingy or sickly appearance. Metallic oxide and copperas green are permanent colors, and when mixed with lampblack in different proportions a variety of tints may be obtained. It should be remembered that colored mortar does not dry out the same tint as it shows while in a liquid state, and before the amount of color to be used is decided on, several samples should be mixed up and allowed to dry, in that way determining the amount of color to use.

For the inspection of this work, the same general suggestions as those given for inside plastering will apply, and any further remarks are perhaps unnecessary.

SUPERINTENDENCE OF THE BRICKWORK.

103. Chimney Breasts.—The chimney breasts in the kitchen and laundry are to be faced with white enameled brick; a segmental brick arch is turned over the opening, and the springing line is at a point 5 feet 6 inches above the finished floor. The jamb corners are rectangular and the corners around the opening are rounded, or “bull nose,” and a polished white-marble corbel on each side supports a 3-inch polished marble shelf. The enameled brickwork in the laundry is carried up 5 feet high and finished with a

polished white-marble lintel 9 inches high, having a 4-inch beaming on the beds and anchored to the body of the chimney with bronze anchors. The superintendent should inspect this work carefully, to see that the face brick is properly laid and bonded, that the joints are all uniform in thickness, that the marble corbels are properly set, anchored to the chimney, and leveled up to receive the shelf, and that a perfectly tight joint is made between the brick and the range so that no cracks or openings are left to collect dirt or harbor vermin; he should also take particular notice that no damaged or chipped brick is used in this work.

The size of the flues is determined beforehand and shown on the drawings, so that the superintendent need only see that they are built to the requisite size, carried up plumb, and the withes, shown at *a*, Fig. 12, are mitered with the stretchers at least in every sixth course. It is not an easy matter to watch this work, as, in order to see that it is done, the superintendent would have to stand over the men constantly; he must therefore trust to the honesty of the workmen, as no evidence of the bonding will appear on the surface of the chimney. The fireplaces, which are to be faced with tile, are formed roughly during the construction of the chimneys; those faced with brick are finished at once, and the face brick is protected, with boards or otherwise, until it is required to set the mantels.

Two wrought-iron bars, $\frac{1}{2}$ in. \times 2 in., turned up on the ends, are built in each chimney above the fireplace opening, as no reliance should be placed on the arch to support the work above. The splay of jambs should be determined by the style and size of grate, if any is to be used, and if no grate is used the splay may vary, but should never be more than 8 inches in a depth of 12 inches. The back of the fireplace should be built up plumb six or eight courses, and then corbeled forward to form the throat from 2 to 4 inches wide, according to the nature of fuel used and the size of the fireplace. No matter how well built the chimney may be, all should be plastered on the outside, except where faced with a good coat of lime and cement mortar, to

prevent the possible escape of sparks through a defective or improperly filled joint.

104. Chimneys.—The brick courses in the chimneys at the roof line are to be stepped as shown on the detail drawings; the mason shall procure from the coppersmith the apron flashings and build them into the work. The chimneys above the flashing lines are to be built of rough-pointed limestone, well bonded together at each course with bronze cramps; the flue linings to be carried up and the space between them and the chimney filled with Vicat cement. The chimney caps are to be cut in one piece, and the flue holes cut through to exactly the same size as the inside of the flue lining. The superintendent should inspect every piece of ashlar entering into this work, and see that they conform to the specifications in every respect, especially as to thickness, and that they are all cramped and bonded together. The tall chimneys are to be tied back to the roof with 1-inch brass bars, having a nut and washer on the inside and a shoulder welded on to the outside against the chimney; the other end of the rod is flattened and turned up to conform to the angle of the roof, to which it is secured with wrought-iron bolts; these bolts should be put up at the proper time and the roof end covered with lead flashing.

105. Trap Pits.—Trap pits are to be built for the reception of service-pipe fittings, such as valves, traps, etc., that such fittings may be accessible should it be required to disconnect any pipe or make repairs. Footing stones, 2 feet wide and 6 inches thick, are laid at the required depth, and the walls built 8 inches thick, of common brick, laid in Portland cement mortar. The dimensions are given on the working drawings and the superintendent should see that they are built to the proper dimension and levels and located as required. The laying of the brick and the concrete bottom should be watched, that a water-tight job will result; the setting of the flagstone covers is described under "Flagging."

The main lines of sewer and water and gas supply should

all be laid underground at the proper grade, and the traps, fresh-air inlets, etc. on the sewer, and all valves and connections, attached complete. These pipes should then be tested before the trenches are filled in. The electric conduits are then laid at a uniform depth of about 3 feet below the surface—the mason meanwhile building up the manholes—and the electric feed wires having been laid between the manholes, the space around each pipe and conduit in the brick walls is sealed with neat Portland cement mortar. Provision should be made for a controlling switch on the main electric feed wire. The specifications require that all iron pipe and fittings in the manholes shall be cleaned off and coated with

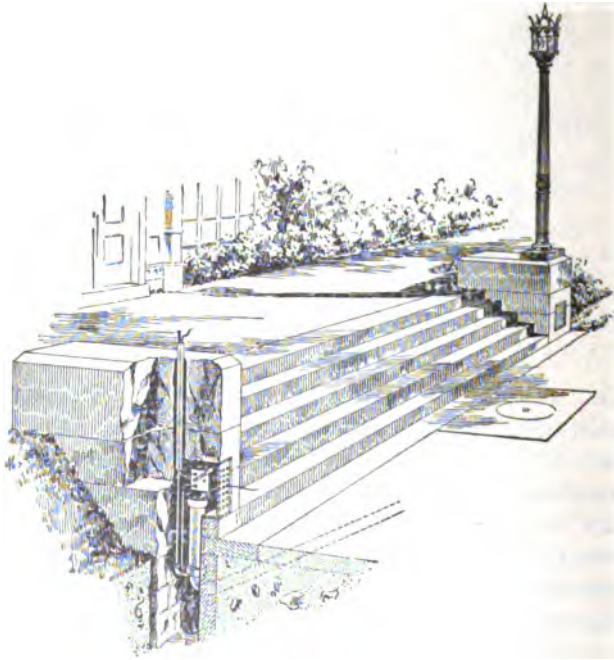


FIG. 84.

asphalt paint. Nothing need be added here to the instructions for inspecting the calking of joints and the quality of the fittings. The fresh-air inlet to the trap on the sewer main at the manhole at the entrance gate is to have offsets

with obtuse-angled bends, and the pipe terminates at a point 12 inches above grade, and in the pocket cut in the check block of the gate post. The gas and electric supply for the lamp also passes through this pocket, the opening in the stonework being covered by a perforated brass plate, set flush with the face of the stonework, as shown in Fig. 34.

SUPERINTENDENCE OF THE PLUMBING, ETC.

106. Pipes.—The next work of importance on the premises, and, in fact, the work requiring the most critical supervision in regard to material and workmanship, is that of putting in the branch waste, vent, and supply pipes from the rising lines to the various fittings.

The lead pipes should be inspected to make sure that they are of the proper weight per foot. The end of each coil is generally stamped with a letter or number denoting the weight; for that reason it is best to inspect the pipe before it is cut for use.

It is a well known fact that water containing certain foreign matter, and especially soft water, will attack lead pipe, and if the water is under heavy pressure there is a possibility of the pipe bursting, unless of extra thickness. Where a first-class job is the main object in view, it is best to use seamless drawn brass tubing, tinned inside and out, the cost over that of lead pipe being very slight. In the case under consideration, the main water-supply pipe to the under side of the first-story floor of the main building and up to the fixtures at other points on the premises, including hot-water piping, shall be of tinned seamless brass pipes of the diameter specified; all the fittings for the supply pipes to be of the same material and finish as the pipes.

The superintendent should examine all the material critically and follow the work of fitting it together, that the joints are set in *red lead*, provided with all the valves and fittings requisite, and graded to an outlet as specified. Where brass or copper piping without an outer plating

of some other metal is used, it should be coated with shellac to prevent discoloration, which is sure to occur unless some preventive is applied. Wrought-iron pipe is used extensively and various coatings of more or less merit are applied, such as ordinary lead-oxide paint, enamel or asphalt paint, and metal plating. Galvanized-iron pipe is perhaps the most common, and is undoubtedly the best for water pipes that are not liable to be attacked by water containing acids.

107. Leaks.—In the best work provision is made for carrying off water from leaky joints, possible bursts in the pipes, or water of condensation. A casing or tube of sheet metal, generally of zinc or light sheet copper, is used; the joints of the tubing are fitted together around the pipe fittings, and the tubing discharges into a sink or connects with the regular drainage system. The importance of putting in this casing is evident, for a leak under the floor, or in some inaccessible position, may cause more damage to frescoes or other decoration than the original cost of the tubing itself.

It is perhaps hardly necessary to say that none other than the most skilled mechanics should be allowed to do the work of plumbing and gas-fitting, for no other work on the whole job can be so easily skimped or improperly done, when the superintendent is not constantly on hand; and as he will have many other things to attend to on the premises, it is imperative that skilled, as well as honest, conscientious workmen are commissioned to do the work.

There is no doubt that the superintendent under ordinary circumstances will have to rely on the honesty of the workmen, but he should devote all attention possible to see that the proper fittings are put in, that they are properly connected, and that the lines are properly spaced apart and supported by straps, hooks, or tacks, as the case may be, governed, of course, by the specification, which should be very explicit in regard to the plumbing work.

The plumber should give due notice to the carpenter to put in boards for the support of running lines of pipes between joists, finished pipe boards where exposed to view,

and for all cutting of timbers or other woodwork in and about the premises, etc.

108. Joints in Cast-Iron Pipes.—All joints between lead waste or vent pipes and cast-iron pipes should be made with heavy brass ferrules calked into the hub of the iron pipe and secured to the lead pipe by means of a wiped solder joint. In common practice the lead pipe is simply dressed down and fitted in the end of the ferrule, as at (a), Fig. 35,

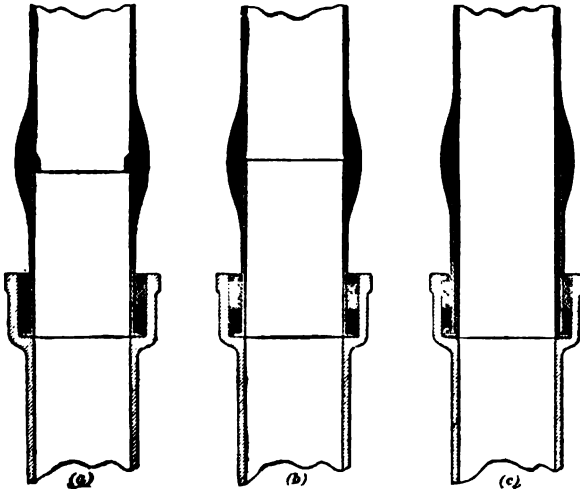


FIG. 35.

or slightly flared, as at (b), the latter being perhaps the better of the two, though there are objections to both methods, as the molten solder is likely to work into the joint and act as an obstruction for solid matter to accumulate against. The best method is to use a ferrule just large enough to allow the lead pipe to be slipped through it, as shown at (c), and then secured by the wiped solder joint.

At the point where the soil and vent pipes pass through the roof, the top of the hub should be located a little above the roof. A piece of 6-pound sheet lead, or of copper, at least a foot square, is dressed down into the hub of the pipe, and, after the length above the roof is set up, the joint is

calked tight with oakum and molten lead, as previously described.

109. Grease Traps.—In the use of kitchen and pantry sinks, a great deal of grease and such matter passes off with the waste water, if hot water is used; this fatty matter is in the form of small globules, which will harden as soon as they meet cold water or air. These small particles soon accumulate on the inside of the waste pipe, and if there is any obstruction to the flow of water, the pipe is liable to become choked and the services of a plumber will be required. To obviate this, various forms of grease traps are placed on waste-pipe systems. The trap known as a chilling-grease trap is, however, the best for the purpose. One of these traps, connected with the waste pipe from the kitchen and pantry sink, will be found of great value and will amply repay the first cost of instalment. These traps will be found very valuable under wash trays also, or in a position where a great deal of grease or fatty matter passes through them; one trap for a set of three trays is generally sufficient.

110. Water Closets.—In first-class work the object always kept in view is to have “open plumbing work”; that is, an arrangement whereby all fixtures and fittings above the floor are in full view and readily accessible. No cased-in fixtures should be allowed where good plumbing is required.

The setting of water closets should be very carefully watched, that there will be no chance for the escape of gas. Brass floor flanges are used for the best work, and by means of these the plates; fitting closely together, bolted up, and set in red lead, make an absolutely gas and water tight connection between the bowl and its outlet. The outlet pipe for these closets generally consists of a short bend of heavy lead pipe, 4 inches in diameter, which in turn is connected by a wiped solder joint to a brass ferrule and the ferrule calked into the hub of the V-branch connection.

The superintendent should see that the supply and back air connections on the closet bowl are of brass, and not the

old fashioned crockery "horns," which are liable to break off and, at the best, are of very little value, as nothing but putty or some such material can be used for making the joint.

111. System.—All offsets and branches in the waste and vent lines throughout are to be made with obtuse-angled bends and V branches; all running lines, whether of iron, brass, or lead, and also all service pipes for water and gas, are to be graded, that they may be drained when so desired.

The first floor, second floor, and attic are each to have a separate rising line of gas and water supply controlled by a stop-cock in the cellar. Connections are to be made in the cellar for hydrants about the premises, for water supply to the heating apparatus, and for faucets in the cellar, and each is to be independent of the other, controlled by a separate stop-cock. The make and quality of all stop-cocks, faucets, valves, and connections being covered by the specifications, the superintendent will determine whether the proper materials have been furnished, that the system is properly arranged to give direct and efficient service, and that the workmanship is up to the standard required by the specifications.

112. Tests.—As soon as the waste and vent pipes with their traps and connections are in position, and before any fixtures are set up, all openings must be closed up; in lead pipes the ends are merely pinched together and soldered, and the openings in iron pipes are closed by means of plugs, screw clamps, or some such device. Many methods are employed to test the system; the peppermint test used to be the most common, but is now rapidly being abandoned. This test consists of filling the traps with water and then pouring a quantity of oil of peppermint into the pipe where it extends above the roof, followed by a quantity of hot water, after which the roof opening is sealed and the inspection of the lines commenced. If the odor of peppermint can be detected anywhere about the building, the plumber will

have to search until the leak or leaks are located, and after making repairs or putting in a new length of pipe or a fitting, the same procedure has to be followed, very often necessitating two or three tests, before the work meets the approval of the superintendent, which, after all, may or may not be right. A simpler, and no doubt better, test is that of employing a testing machine in which smoke is the testing medium. Some such contrivance is to be found in every first-class plumber's shop. It is essentially a machine to blow smoke into the drainage system. Oily waste is used as a fuel, which, on being ignited, emits a dense, pungent smoke. This is blown into the piping system through stout rubber hose. The presence of a leaky or imperfectly calked joint, a sand hole, or a crack in the pipes or fittings is very readily detected by the smoke issuing from it. In this way the leak may be located at once and the trouble of going over the entire system, depending on smell to locate the defect, is avoided. The value of this method of testing is very readily seen. After the system has been tested to the superintendent's satisfaction, the work of setting up the fixtures, previously described, may follow.

113. Gas-Fitting.—The plumber is required by the specifications to apply for tapping the gas main in the street, and pay all necessary charges for putting in the service pipe and connections from the street main to the meter inside the cellar wall; the gas company to set this meter, as well as one in the greenhouse, and one in the stable, on cast-iron brackets furnished and set by the plumber. The same general directions for putting in gas pipes and meters applies also to similar work in the greenhouse and stable. The plumber's work on the gas-fitting commences at the meter, on the outlet, or house, side of which a lead pipe with brass coupling is provided. He connects the house main with this coupling and puts on a stop-cock as near the meter as practicable; there should also be a stop-cock on the inlet, or street, side of the meter. The method of jointing the pipes has been previously described. The location of outlets

for the several gas fixtures should be very carefully followed by the superintendent. The outlets in the principal rooms and halls, for side lights, should be from 5 ft. 6 in. to 5 ft. 9 in. above the floor, and for all other side lights 5 ft. above the floor. The nipples should be put on perpendicular to the wall surfaces. A piece of pipe about 3 or 4 feet in length, with a socket on one end, should be used for the purpose, and by screwing this pipe to the nipples, the outlets may be very easily squared. It is also very important that nipples of the proper length are used, so that they need not be changed or the terminal boxes taken off and replaced.

The fitting up of all gas-pipe branches for lights in the buildings, as well as for exterior lights, should be done simultaneously with the electric wiring for same, and in connection with the electricians.

114. Heating.—The specifications require that the indirect system of hot-water heating shall be used. The boiler is to be of a standard make and subjected to a hydrostatic test of 100 pounds to the square inch before leaving the factory. This apparatus is to have automatic feed and damper regulators, so that no engineer will be required. The battery of sectional heater coils and manifolds are supported on an angle-iron platform at the requisite height above the cellar floor. The specifications also require that perfect circulation be guaranteed and that the system shall be properly connected up and left in good working order. The heating flues are to be made of 18-gauge galvanized iron with closely riveted joints, and run as directly and with as few bends as possible to the registers. The registers are to be set in a metallic box and a suitable frame set in the side wall or the floor, as the case may be, provided with all necessary controlling dampers or regulators, and the perforated face plates set flush with the floor or wall surfaces, and finished in electro bronze, unless otherwise specified.

The superintendent should follow this work closely to see that it is carried out as required by the contract, that the joints in pipes and ducts are all properly fitted, and

connected up and all left in a perfect working condition at completion. He should see also that the cold-air ducts to the heater are of the requisite dimensions, run as direct as possible, and are provided with a damper at the cellar wall and one near the heater; that the openings to the cold-air ducts and the heating coils are protected by wire screens, as specified. He should require a very thorough test of the system in his presence and satisfy himself that the work is up to the requirements.

In regard to a time test, that is not possible under ordinary conditions, unless the heating system has been employed during the construction of the building; in any event, the contractor's guarantee, duly signed by him and given to the architect or owner, is generally sufficient; for in the event of failure of the system or any part of it to do its work properly, the contractor may be called upon to make good, at his own expense, all such work during the period covered by the guarantee.

SUPERINTENDENCE OF THE ELECTRICAL WORK.

115. Specifications, Etc.—The specifications require that the local electric-light company shall connect with the street main and lay the main feed wire to the trap pit in front of the greenhouse. All the work to be done strictly according to the rules and regulations of the National Board of Fire Underwriters, and is to be passed upon and made satisfactory to their inspectors as well as to the satisfaction of the building superintendent. The contractor to pay all charges for inspection by the aforesaid fire underwriters' inspectors and deliver a satisfactory certificate signed by them to the architect, including testing of the system. The carpenter will do all necessary cutting of timbers or other wood necessary to facilitate the installation of the electrical work.

The mains below grade are to be protected by heavy wooden tubing, having a 3-inch bore, the exterior of the pipe coated with waterproof paint, and the joists closely

fitted together. A main switchboard of polished slate and enclosed in a damp-proof box will be set up on the side wall of the trap pit, and from this board all the lights or other electrical fixtures on the premises will be controlled by four main-line knife switches, one each for the main building, greenhouse, and stable, and one for all the outside standard and gate lights. The lights of the first story and the portecochère light shall be controlled by a knife switch located at the rear of the main flight of stairs and each of the principal rooms shall have an independent key switch for direct control of the lights within the room. The second-story floor and the attic will each have an independent switch controlling all the lights on the floor, and the principal rooms of the second story, including the bathroom, shall have a direct key switch as provided for the first-story rooms. A separate key must be provided in the first and second story halls for the control of the automatic lights therein. Each of these main switches will be of an approved pattern and mounted on polished slate or marble in asbestos-lined boxes having a hinged door, the boxes to be provided and set in position by the carpenter, who shall also provide all blocking or other special woodwork required by the electricians. A cut-out box of slate will be placed in each trap pit at the entrance of the feed wire, another at the entrance of said wire on the inside wall of each building, and one hard-wood box lined with sheet asbestos on each upper floor of the main building and second story of the stable. A continuous system of conduits and wiring from the main to the outlets at the fixtures is required.

116. Installation.—All tubing is to be of brass, armored, insulated, and fitted together in a thorough manner to exclude gas and water, or other destructive agents. All mains are to run as direct as possible, so as to avoid sharp elbows. The tubes are to be of sufficient size to insure ease in drawing the wires through them. No conduit shall be less than $\frac{5}{16}$ inch inside diameter. Conduits are to be used for encasing all wires, including those for bells and

annunciators, and all are to be hidden from view in wall pockets or in larger tubes.

The risers for the main building, as well as those for the stable and greenhouse, are to be grouped together to form a single line for each building. The wires throughout for electric lighting are specified to be white-core, rubber-covered, insulated wire of copper 98 per cent. pure.

Carbon cylinder batteries are specified for the burglar-alarm system, for bells, and annunciators. They are to be of sufficient number and power to insure the proper working of the system named. Suitable shelves will be provided for their support and put in place by the carpenter.

The burners in the main halls and principal rooms in the first story are to be automatic; fixtures to be wired inside the shell where possible. All push plates are to be of plain bronze, finished to match the hardware of the room, and have pearl push buttons.

The wiring for the gas lighting to be of No. 18 gauge B. & S. damp-proof wires, put in without staples or tacks of any kind, and run through between timbers and in partitions. The wires must be protected by brass armored tubing against brickwork or pipes.

All lighting wires to be run in sections to an automatic sectional cut-out box where shown on drawings.

117. Fixtures.—The springs and plates required for all windows and doors in the burglar-alarm system, and all plates and mouthpieces for the annunciator and speaking tubes, are to match the hardware in each room and must be furnished to the carpenter, who will set them in position under the direction of the foreman electrician. The same applies to the annunciator box and burglar-alarm indicator box, the location of which is shown on the plans. Each of these boxes is to be provided with a nickel-plated gong; the bell for the annunciator to be $2\frac{1}{2}$ inches in diameter, and for the burglar-alarm indicator to be 4 inches in diameter. All are to be tested to establish satisfactorily their efficiency in presence of the superintendent.

The specifications require that at each outside door a push button and plate is to be placed, connected with a bell to be located as required.

The plate for the front door and rear hall outside door to be a combination mouthpiece and push-button plate of bronze, to match the hardware of the door.

The speaking tubes are to be of heavy weight bright tin, 1 inch in diameter, with a soldered seam, the joints to be well fitted together and the lines to run direct, with no sharp turns or elbows. Where elbows *are* necessary they are to be as gradual as possible. The mouthpieces are to be provided by the electrician and set in position by the carpenter.

118. Superintendence and Tests.—The superintendent should always be governed by the rules of the National Board of Fire Underwriters in passing on the work of electric installation, and in case of doubt, he should consult the duly authorized inspector of the underwriters' association before condemning any work, unless he is absolutely sure of his position in the matter. He should follow the work primarily with the view of having all conduits and service lines continuous and their insulation perfect. He should also see that the conduits, wires, and speaking tubes are protected from injury by water or otherwise, and that they are not otherwise injured by hooks, nails, etc.; after all of this work has been done the electrical system should be tested free from grounds.

SUPERINTENDENCE OF THE JOINERY.

119. Outbuildings.—While the plumbing and electrical work is being set up, much has been accomplished on the exterior of the main building, stable, and greenhouse. The rough-cast outside plastering has been done, the cornice, barge boards, and belt courses have been set in position, and the carpenters are busily engaged in finishing the joiner work on the veranda and porte cochère, and putting up the staves for the open timber work, which are put on as shown

in Fig. 33; the grounds *a* are put on over the sheathing lath *b*, and after the plastering is finished, the staves *c* are nailed to the face of the grounds. After the open timber work on both buildings has been completed, the finishing work on veranda and porte cochère set in position, and the work on the belvidere and summer pavilion completed, nothing remains to be done on the exterior of the buildings except the painting, which will be described at the proper time. On the interior of the building, workmen have started to put in the door frames and other interior finishing wood-work. This work from now on, although not as important as the construction part, will require strict attention on the part of the superintendent to see that no poor material is used, that no bad work is covered before he has seen and passed upon it, and also that all doors and standing trim are set plumb, all horizontal lines, such as wainscots, bases, etc., set perfectly level, and all joints neatly made and closely fitted together. He should visit the shop where the doors and other interior woodwork are being made, so as to satisfy himself that the proper amount of care and attention is given to minor details, such as building of cores for veneered doors, gluing up, wedging, mortising, etc.

120. Examination of Stock.—The stock should be examined for defects, such as sap, knots, etc., and any piece found that does not conform to the requirements, should be condemned at once. In regard to the dryness of the stock, if it does not appear to be thoroughly seasoned, and appears to contain more moisture than the limit prescribed by the specification—that is, 10 per cent. by weight—he should select a few samples, about 6 inches long, cut from the center of the board or molding; by weighing each piece carefully on any convenient scale, marking the exact weight on each sample, and then drying them out in an oven for three or four hours and weighing them immediately on the same scale, before they can absorb the moisture from the atmosphere to any extent, then noting the difference in weight, the percentage of moisture may be found by *dividing the difference between*

the two weights found by the dry weight. Thus, if a sample weighs 66 ounces at first and 60 ounces after being dried, the percentage of moisture contained in the sample before drying would then be $(66 - 60) \div 60 = 10\%$. Wood containing this amount of moisture or less would be accepted, provided, of course, it were up to the requirements in other respects. A percentage greater than ten, however, would be sufficient cause for condemning it, though it might be otherwise perfect.

Although, in general practice, the specifications simply state that the wood for interior trim shall be kiln dried, it does not necessarily follow that the wood is dry when erected in the building; for it is a well known fact that kiln-dried wood will absorb atmospheric moisture rapidly if exposed to the weather or stored in a damp situation, and the object to be attained by placing it in a kiln will have been defeated, the wood returning to a condition very little better than ordinary yard stock.

Rough framing lumber, however, or even finishing lumber to be used on the exterior of the building or where it is not likely to dry out rapidly, may be considered sufficiently seasoned when it contains as much as 15 per cent. of moisture. From the foregoing remarks it may be readily concluded that the best method of specifying finishing lumber is that of applying the weight test to determine the amount of moisture in it.

121. Finish of Surface.—Another part of the work which is sure to be carelessly done or neglected altogether is that of smoothing down the interior woodwork; this applies mainly to bases, trim, etc., as the shop-made work, such as doors, sash, wainscoting, etc., is generally smoothed off before being put together, or at least before leaving the shop.

Raised grain, planer marks, and soiled spots or finger marks from handling are the most common causes, requiring the work to be smoothed or sandpapered. Moldings with small members should be smoothed with sandpaper, while a smoothing plane should be used on flat surfaces and this followed by sandpaper. It is often best, especially when the

harder woods are smoothed down, to use a steel scraper or glass for the purpose; especially is this done where a shaggy knot or curly grain is encountered that may be injured even with the finest set smoothing plane.

122. Inspecting Work.—At this time the superintendent should read the specifications through, and if any work has been neglected or condemned work left standing, either unaltered or repaired, he should make a note of each and have them attended to before the time arrives for painting or otherwise finishing the interior. He should also compare all work with the detail drawings as it is erected or set in place, and allow no bad work to become too far advanced to be readily altered or taken down and replaced. He should see that the door jambs are blocked away from the stud framing, and that suitable blocks, sized for the position, and not chips, are used; that the jambs are set plumb, in alignment with the partition, and that the head casing is perfectly level. He should also check the size of the opening to make sure that a door of the proper size will be put in as required by the drawings. It is best to check the size of the finished openings at this stage of the work, for if a mistake is not discovered until later, the trim may have to be removed to remedy the fault, while the jambs are being set.

The swing of the doors should be determined unless they are shown on the plans, and even if they are shown, the workmen cannot always be depended on to set them in the right way. The superintendent should make sure that the doors are hung on the proper edge of the jamb, so that when hung and swung open they will not strike against a gas bracket or open across a hallway or into a closet. In general, doors should be hung to swing into the rooms and not out into halls or corridors, except perhaps outside doors, which should always open in, and in the case of bedrooms should be hung so that the bed is not visible when the door is partly open. The same idea should be borne in mind in hanging bathroom doors. Closet doors should be hung to swing into the room, and in a manner to reflect the light

from the inner side of the door into the closet, or else they should be hung so that the light from the windows may shine direct into the closet.

123. Trim.—The price of molding and interior trim varies according to the size, and when other than stock molding is required, an additional price to that of the molding itself will be charged for the labor of making a new knife and changing the cutters in the machine. Such moldings or trim are termed special, and add materially to the cost of the building, especially if a great variety is used. In ordinary low-cost dwellings, special moldings and trim are seldom used. The commonest forms of moldings that are recognized by architects and builders as “stock” moldings are shown in Fig. 36. (*a*) represents ogee crown moldings;

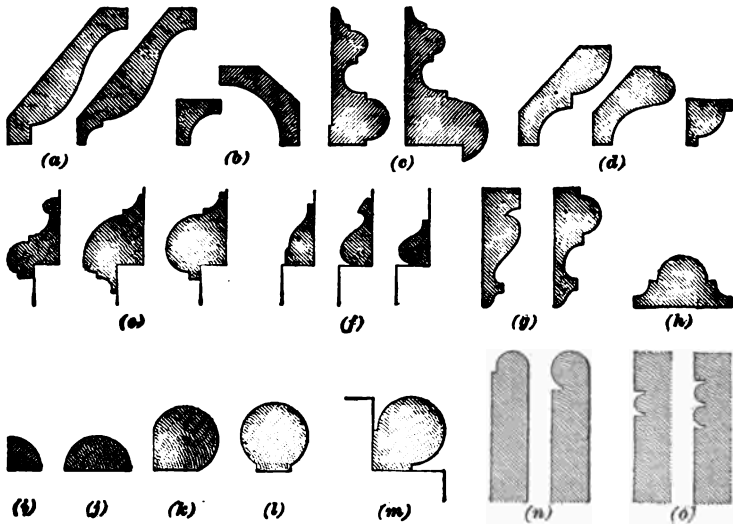


FIG. 36.

(*b*), coves; (*c*), base moldings; (*d*), bed or stop moldings; (*e*), raised panel moldings; (*f*), flush panel moldings; (*g*), band moldings, sometimes used as base moldings; (*h*), astragal; (*i*), quarter round; (*j*), half round; (*k*), three-quarter round; (*l*), full round; (*m*), three-quarter bead; (*n*), bead;

(*o*), single and double center beads. Other stock molds may be obtained, but those shown in the figure are most common.

124. "Finished" Size of Material.—The superintendent should know the "finished" size of material, that is, the size after being run through the planer; these remarks apply principally to moldings, as the piece from which the moldings are made lose $\frac{1}{8}$ inch in dressing both sides and $\frac{1}{16}$ inch more when run through the molding machine; a stock 1-inch molding, therefore, will measure only $\frac{7}{8}$ inch. The same may be said of finished boards or trim, as they are reduced in size in the planer, but charged for as though of full dimensions. Boards or plank surfaced one side will measure $\frac{1}{8}$ inch less, and when surfaced both sides $\frac{1}{4}$ inch less, than the sizes charged for.

125. Standing Trim.—The next work to be done after the jambs are set is that of putting in the *standing trim*, or finish, which consists of baseboards, wainscoting, architraves, etc. In putting in this work the superintendent should see that the baseboards and other trim have been painted on the back before they are set in position, to conform to the requirements of the specification, and in setting them to see that no bad joints are made, no moldings spliced, except on long horizontal runs, and that as few nails as possible are used on exposed surfaces of woodwork that are to be natural finished. In jointing the corners of back-band molded architraves, as specified for part of this building, and the mitered architraves in the stable and in the attic, the work should be watched to see that they are properly done. At (*a*), Fig. 37, is shown

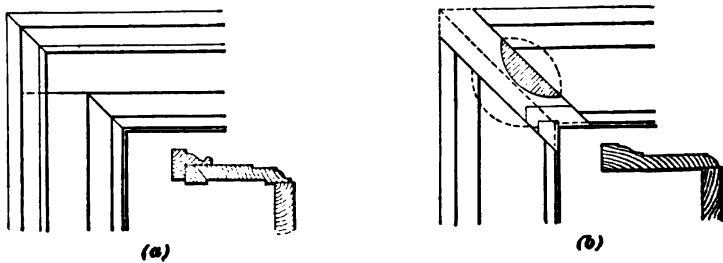


FIG. 37.

the proper way to joint a back-band trim of that particular form; the fillet mold should be mitered, the flat or fascia section butt jointed, and the back band mitered. For a mitered trim, a hard-wood tongue or spline should be inserted as shown at (b), the grain of the spline running at right angles to the miter cut. The groove for the spline is cut in the shop or mill with a circular saw. A joint made in this way, if the wood is reasonably dry, will hold together well. Long, mitered joints, sometimes used in trimming around doors and windows, should be avoided as much as possible, as it is difficult to prevent the opening of the joint due to shrinkage of the material.

126. Stairs.—While the standing trim is being set in place, and before the wainscot is put in, the work on the stairs should be under way.

In general practice at the present day, the stairs are usually figured out for rise, tread, run, and headroom in the drafting room, drawn accurately on the plans, and this preliminary layout is generally supplemented by detail drawings. Stair building has become a distinct trade, and very few carpenters, except those in out-of-the-way places, build their own stairs, as the work can be done cheaper and better by men who follow that work entirely. Mistakes or poor workmanship, however, are always possible, and the work will have to be looked after by the superintendent with as much care and attention as any other. Very often a mistake is made in the framing of the well, the trimmer possibly being put in 6 inches or a foot too far for the sake of making it act as the trimmer for a chimney well. This slight difference in the location of the trimmer may reduce the headroom to such an extent, that a tall person will strike his head against it. To remedy a mistake of this kind will require much extra work and cause considerable delay.

The trimmer may have to be cut out, the flooring removed across the building, and a new trimmer, as well as a header, put in. When a mistake of this kind cannot be easily remedied, the architect may have to modify the design of

the stairs, and his ingenuity will be taxed to fit the work to the new condition. Counting from the head of the flight, thirteen risers will usually give sufficient headroom.

It is often necessary, especially in long flights, to reinforce the stringers with "carriage timbers," and these with the other timber framing of platforms and landings should be well framed and spiked together.

Winders in stairs are at the best a makeshift arrangement and should be avoided as much as possible. Of course stairs are often built in a position that necessitate the use of winders in order to reach the floor above by an easy ascent. In such cases, the winder treads on the line of travel should be the same width as the regular treads.

127. Stair Measurements.—The stair builder should verify all measurements at the building, the distance from floor to floor, especially as the heights of ceilings seldom measure exactly what they are figured on the drawings, varying from 1 to 2 inches either way. The stair builder measures off this height on a rod and divides it into spaces corresponding in number with the risers in the staircase. If the measurements given on the drawing for the height of stories is trusted, and the stringers cut to fit the height thus taken, a stairway resembling those shown in Fig. 38 may result.

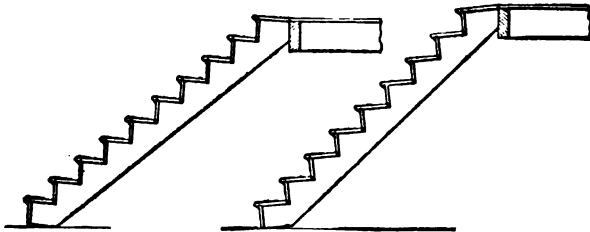


FIG. 38.

Another important point in laying out stairs is that of having all risers of a uniform height, for any change in height, although not apparent to the eye, will be discovered by traveling up or down; for instance, take a staircase having two runs, or flights, with a platform between, in which

the risers of the upper run are $\frac{1}{4}$ inch higher than those below. Now if a person ascends this staircase rapidly he will be checked, as it were, as soon as he strikes the higher risers.

128. Points To Be Observed.—The wedging of the treads and risers, where they are housed into the stringers, should be looked after, as well as their mortising and tenoning. By having this work carefully done and paying especial attention to the quality and seasoning of the stock used, the stairway should hold for years, and be entirely free from any crunching of the treads. The dovetailing of the balusters should also be watched, to see that the cut runs through the tread and is not merely let into it, and, also that the baluster fits the cut snugly, and is nailed in place to prevent its becoming loose. The setting of newel posts and rails should be carefully done, and care taken to have the newels plumb and square with the stringer, or set at the proper angle as required by the drawings; provision should be made for the placing of a half post to receive the end of the hand rail at its termination in the attic or elsewhere, for, if not called for, the stair builder may use a cast-iron or a wood socket. It should be seen that the balusters are matched in color, and that the rails, where they are jointed to ramps or easements, are well fitted, bolted together, and matched in color. Any piece of rail "out of wind" or not perfectly straight should be condemned. As soon as the staircases are built and the newels, rails, and balusters set, they must be protected from paint, plaster, etc. until the painter is ready to apply the wood filler or paint as the case may be.

Building paper, the full width of the stair, should be laid over treads and risers from floor to floor to protect them, and the paper secured in place with laths or light boards. A piece of this paper, or cloths, should be used to protect the rails and newels.

129. Preparing for Tiling.—The specifications require that the carpenter shall make preparation for the floor and wall tiling in the principal bathroom, for the tiling of the

vestibule floor and wainscot, and for the marble safe slabs in the servants' bathroom.

The carpenter prepares the floors as shown in Fig. 29 by first nailing cleats along the sides of the floor joists and over this tight matched boards; over the boards two courses of brick are laid in good cement mortar, the top of the brick to finish on a line with the top of joists, which are beveled on top to an edge. On the side walls the studs are beveled back $\frac{3}{4}$ inch, or a distance equivalent to the depth of the V-shaped stiffening bars on the wire lath, as shown in the cut; by this method no cleats are necessary on the side walls, but, if ordinary metal lath or wood lath were used instead, cleats would be necessary in order to afford a nailing for the laths, and very often pieces put in horizontally and spaced about 12 inches apart are required for the support of the lath; especially is this so when sheet-metal lath is used.

130. Laying Tile.—This does not properly come under the head of Joinery, but as the work is to be done by the mantel contractor, its superintendence would be considered at this stage of the work. When the interior finish is being set in place and after the rough part of the plumbing work has been set up, the mason should prepare the cement bed for the floor tile and the backing for the wainscot. The specifications require that the bed for the floor tile shall be laid by the mason with cement concrete and finished to a point $\frac{3}{4}$ inch below the level of the finished floor, and leveled up with Portland cement mortar. The first coat of mortar for the plaster backing in the side walls is made the same as the scratch coat for outside plastering. The second, or finishing, coat, which should be brought up flush with the grounds, is the same as the second coat for outside plastering. All these surfaces must be leveled up and brought to a smooth, uniform surface. This work completed, the tiler's work may start. The first operation consists in setting the marble safe slabs, which are furnished by the plumber; after these are set the floor tile should be laid, the marble base set, and the wainscot tile put on, all in the order given.

Portland cement and plaster of Paris are used in the setting of this work, and great care will be necessary to insure a first-class job. The superintendent's inspection on this work will be a comparatively easy matter; his attention should be directed mainly to see that the preparation for the tiling is properly done, the quality and kind of materials furnished and set as required by the specifications, and that the floor comes on a level with the finished floor in the hall and the wainscot on a line with the plaster above; also that the tile is laid so that no long joints appear, and that the joints themselves are of a uniform width.

131. Finished Floors.—Before the upper floor is laid, the superintendent should see that the rough floors throughout the building are cleared of all rubbish and swept out clean. The rough floor should then be repaired and patched around all plumbing pipe lines or elsewhere until no openings in the flooring appear anywhere.

A layer of Cabot's "deafening quilt" is laid over the entire first and second floors with a lap of at least 3 inches. Nailing strips are next laid and spaced at the same distance on centers as the floor joists. These pieces are leveled up until perfectly true. The floors of the various rooms in each story are to be as follows:

First story, main hall, quarter-sawed white oak, matched; second story, main hall, quarter-sawed white oak, matched; kitchen, clear maple, matched; laundry, clear maple, matched; pantry, clear maple, matched; rear hall, clear maple, matched; dining room, library, reception room, and parlor to have an upper floor of $\frac{7}{8}$ " \times 4" white pine, matched, laid diagonally and at right angles to the rough underflooring, blind nailed, and tightly driven together and planed down, and a layer of sheathing paper laid down without lapping, to afford a smooth surface to receive the parquetry flooring, which will be furnished and laid by the mantel contractor.

132. The entire floor in the second story, with the exception of the main hall and bathroom previously described, to

be laid with $\frac{7}{8}$ " \times 2" clear, matched, quartered or comb-grained Georgia pine driven together tightly and blind nailed. All the floors in the first and second stories to be planed down—which may be performed at an angle of 45° to the grain—scraped, and sandpapered, and then planed with the grain to a perfectly smooth surface. The butt joints in all floors, with the exception of parquetry floors, to be top nailed with two fine wire nails to each board and the nails set in well. The entire attic floor to be laid with $1\frac{1}{4}$ " \times 3" clear, comb-grained, North Carolina pine, matched boards, blind nailed, and planed down in the hall and principal rooms.

The specifications require that all joints are to be made over bearings and break in every course. The boards around all hearths, registers, etc. are to miter on the corners, and to be rebated to fit the tongue of the flooring. The carpenter is to lay down two thicknesses of waterproof felt paper over all floors as soon as they are planed down and smoothed, and will be held responsible for the care of all floors, including the parquetry floors, until the painter starts the work of finishing them. The superintendent should see that all the flooring stock is uniform in quality and up to the requirements of the specifications; that neat joints are made. For finished or upper floors, a piece of wood somewhat thicker than the flooring as shown in Fig. 39 should be used for driving



FIG. 39.

up the boards, and in that way the edges will not be injured by the hammer. The superintendent should see that the nails are not driven home with the hammer, but with a nail set. Clamps are often used in laying the finer grades

of flooring for the purpose of straining it in place, and are sometimes necessary. If a floor board cannot be driven up easily it should not be used at all; for in driving, the tongue or groove may be split and break off at some future time.

133. Blinds.—The specifications require that all sliding windows in the first story shall have hinged blinds to fold into a pocket formed into a window frame. The center fold in each side is to be provided with revolving slats and the side folds paneled. These blinds, together with the pocket lining, etc., shall be of wood to match the other trim in the several rooms.

The windows in the second story are to be provided with Venetian blinds, and the head casing will have to extend at least 8 inches above the head jambs of the window, so that when the blind is drawn up they will not obstruct the light. These blinds are made by several blind manufacturers who control patents covering them. After passing on the quality of the workmanship and materials, the superintendent should see that the blinds are properly hung and adjusted, so as to operate in a satisfactory manner.

134. Dressers, Etc.—As scale and full-sized detail drawings are furnished for pantry cupboards, kitchen dresser, wardrobes, etc., and all such furnishings of the various rooms, the work of the superintendent will be greatly simplified, and his attention need only be confined to the proper execution and erection of the work and to see that the drawings have been followed.

The pantry closets are built with a wide counter shelf $1\frac{1}{4}$ inches thick in pieces glued together. Below the counter shelf, drawers and cupboards are provided; one large drawer is divided for table linen, and another for knives, forks, spoons, etc. The specifications require that the bottom and inside of all drawers for table silverware shall be covered with black velvet well glued to the wood. These drawers, as well as all other drawers over 12 inches in width, shall be provided with ball-bearing slides, carefully put in, to insure perfect and noiseless working of the drawers. Provision is made to place a dust panel immediately under the drawers, for the purpose of catching dust that would otherwise enter the cupboards below. The cupboards below the counter shelf are to have doors hinged on the sides; the door to the

compartment for soiled linen to be hinged at the bottom with strong spring hinges and the top of the door provided with a spring latch. The kitchen dresser is to be built in a similar manner and provided with drawers and cupboards below the counter shelf. The doors of the closets above are to slide on a brass track and made to fit tightly. Sliding doors are preferable in such positions, as the hinged doors in swinging take up considerable room, the glass is likely to be broken, and the doors in shrinking, or warping, leave chinks or cracks through which dust can filter to settle on the china or other objects stored on the shelves.

The drip boards for the pantry and kitchen sink should be grooved for the purpose of draining them rapidly, and these boards should be set at a slight pitch toward the sink. The pipe boards previously mentioned should be neatly fitted against other woodwork and against floors, ceilings, etc., and set in place with screws. No provision has been made for wainscoting in the kitchen pantry or laundry; it is very objectionable in such positions, owing to the fact that food stuffs and water are known to attract vermin, and if the rooms are wainscoted, especially with ceiling boards, the spaces and cracks will offer a refuge for the vermin and render examination a very difficult matter.

135. Dumb Waiter.—The dumb waiter, although included in the general contract, is usually set in position by men skilled in that particular work. The framing and finishing of the shaft, including the doors and jambs, are done by the carpenters, and the car and its appurtenances put in position by the dumb-waiter men. This work should be followed carefully to see that the car is hung properly, the proper adjustment given to ropes and weights; that the sheaves, safety catches, and running mechanism are properly set in position; and that the car works smoothly and noiselessly. The testing of the ropes or car is not necessary here, as the specifications require that work to be done at the factory. The dumb-waiter shaft above the sheaves is effectually closed by a double matched-board platform with

two layers of deafening quilt between; the shaft above this point serves as a vent for the clothes chute and cupboards of the pantry closets.

136. Other Appurtenances.—A clothes chute is provided, extending from the housekeeper's closet on the second floor to the rear hall on the first floor, tight-fitting doors being provided at each end to prevent odors escaping from the contents. The chute terminates in a compartment under the pantry counter shelf, and a door hinged at the bottom in the pantry, previously described, opens into this compartment, so that all soiled linen may be kept in one place until it is taken to the laundry.

The mantels and hall seats are set in place by the mantel contractor, and the fitting of this work to that already in position is all that the superintendent will be required to look after. When the finished plaster chimney breast is wider than the mantel, extension pieces made to conform with the other work are provided.

The setting of the bookcases should be looked after to see that they are properly constructed according to details, well fitted to the wall, and that the shelves are set level and the doors properly glazed and hung.

At the proper time, the carpenter will furnish the painter with frames made according to details for the dressing-room mirrors, and after the mirrors are set in the frames, the carpenter will place them in position according to directions.

The setting of picture moldings should be looked after to see that they are perfectly level, and instead of trusting to the eye, they should be tested by measuring from the floor.

The superintendent should go over the work carefully and see that all the small details of construction or finish in and about the buildings have been attended to, examining each room in turn. Among other things, he should see that turned corner beads of wood to match that in adjacent doors or trim are put on all plastered corners requiring them; that all doors are properly fitted and hung, and all other

woodwork required by the electricians to protect or cover their work is set in position; and that all doors throughout are provided with strikes either screwed to the floor or baseboard, as he may direct.

HARDWARE.

137. Quality of Hardware.—As the hardware manufactured by different concerns varies greatly in quality, while the names of parts are the same, it is always best to specify the locks and other hardware of some manufacturer, giving his name and the catalogue name and number of the article, unless provision is made in the specifications, stipulating that the builder shall allow a certain amount for the finishing hardware, in which event the architect or owner may select the style of hardware desired. If either of these methods is adopted, mistakes will be avoided, and a uniform grade of goods obtained. As the specifications in this instance call for the hardware of one manufacturer with the catalogue name and number given, the superintendent need but see that the hardware specified is furnished, and this he may easily determine by providing himself with the catalogues or by a personal inspection of the goods at the manufacturer's warerooms. In addition to this he should see that all hardware of the finish specified for the several rooms is furnished. The locks on all principal doors should be placed at a uniform distance of 2 feet 11 inches from the floor to the center of the hub or spindle. This distance varies, however, from 2 feet 10 inches to 3 feet, according to custom and the height of lock-rail or panel above the floor. He should see that the face and striking plates are neatly cut into the door and jambs, all butts set in flush with door and jamb rebates, and that the door is hung to swing clear of the architrave or plinth blocks. He should see also that all windows are provided with sash locks, lifts, etc.; that all cupboard, closet, and wardrobe doors are provided with the requisite locks, butts, etc.; that all drawers, etc. are provided with locks, pulls, and the wider drawers, previously described, set on

ball-bearing slides; that all annunciators, bells, push buttons, and speaking-tube plates, etc., furnished by the electrician, are properly hung in the places designated. He should also see that all closets, cupboards, wardrobes, etc. are provided with suitable hooks, and that all the hardware throughout is put on with screws to match.

138. Rough Hardware.—Usually the first hardware to be applied is that for the windows, which consists of weights, sash pulleys, and cord. The sash pulleys are often put on the window frames at the factory, and generally so with stock frames, but in the best work they are put in at the building, and should be at a uniform distance from the head of the pulley stile; they should be set in flush with the stile that the sash may not be injured after the sashes are glazed, and before they are hung they must be weighed. The size of the weights should be proportioned as follows: The two for the upper sash combined should exceed the weight of the sash by about one-half a pound, and for the lower sash should be about one-half a pound less than the weight of the sash. The other finishing hardware is applied after the first coats, and before the last coat of paint or varnish is laid.

The superintendent should bear in mind that the maker's name on a piece of hardware is not always sufficient, as most manufacturers make several grades of the same pattern, and, unless he is qualified to distinguish between them, he may be imposed upon; another point to look after is that of the hardware finish. He should be able to distinguish between lacquered or plated hardware and the solid metal. Scratching the piece of hardware on the back with a penknife or file is usually sufficient to discover whether it is lacquered or plated. The weight and color also will help to a certain extent, as, for instance, in bronze hardware, a door knob of solid bronze should be quite heavy, and where any milling has been done, as the socket for the spindle, the color of metal may be seen. Sometimes, however, the superintendent will have to be content

with the labels on the boxes in which the hardware is packed to determine its quality.

After all the hardware has been put on, the superintendent should go over the entire building and satisfy himself that all the doors swing properly, that they fit the jambs tightly without binding, and that all sashes, drawers, cupboard doors, etc. work freely and without friction. Having satisfied himself that everything is in good working order and that no planing of doors, adjusting of window stops, or such work is necessary, the painter may proceed with his work.

SUPERINTENDENCE OF THE PAINTING.

139. Method of Procedure.—Although the work of painting is to be described at this period, much of the work should be done previously. The priming coat of paint on the exterior woodwork of the main building and stable, as well as that on the belvidere and summer pavilion, is applied as soon as the carpenter work on the exterior is finished, in order to prevent warping or splitting of the wood. The staining of the shingles on the roof was done before they were set in position, and after the priming coat of paint on the buildings is dry, all nail holes are puttied up smoothly and the second coat applied to all woodwork. The buildings are left in this state until the exterior work of grading, and such work from which dust is likely to arise, is done; the last coat being applied at the time that the sodding and tree planting is being done.

The canvas floor covering of the summer pavilion is treated with a coat of raw linseed oil, and then finished with three coats of paint. In following this work, the superintendent should see that the materials are mixed on the ground, that the proper quality of material is used and mixed in a proportion to produce a paint having a good body. This constitutes the important part of his work, but the method of applying it will also require attention.

140. Exterior Work.—The superintendent should see that all sap or knots are covered with a good coat of strong

shellac before the priming coat is applied, and in applying the paint, that the outside plastering and stonework are protected; that the painting on the sashes is neatly cut in, and if any paint appear on the glass, that the painter be required to clean it off at once. The priming coat of paint for open timber staves and such exterior woodwork will be of a bright Venetian red, ground in pure linseed oil; the two other coats to be of dark olive green. The purpose of using red for the priming coat is to form a base which will lend to the olive green a mellow tone, that it will retain for an indefinite period. The superintendent should see that no crude or fish oil is used, the latter being easily detected by its smell; this oil is inferior and much cheaper than pure linseed oil, but it does not dry so readily. In applying the paint, the best results are obtained by stroking the brush parallel with the grain of the wood, and in the final coat the brush should be drawn along the full length of the piece of wood to produce a uniform effect. No piece of work should be started unless it can be finished the same day, for if the work is left at night unfinished and started again the next day a prominent streak will appear, detracting very much from the appearance of the work. The specifications require the wrought-iron gates, lamps, fence, and grilles to be painted a coat of red oxide of lead ground in linseed oil before leaving the shop. They are to be finished with two coats of white lead and linseed oil paint of an approved tint. The ceiling of the veranda, porte cochère, porch, summer pavilion, and belvidere to be finished natural with one coat of mineral wood filler, one of white shellac, and two coats of best spar varnish. The last coat to be rubbed down with pumice stone and water to a wax finish. The copper rain-water conductors are not painted, as they will assume a green color by oxidation.

141. Interior.—The more important part of the painter's work is that of finishing the interior woodwork, floors, etc., and the attention and watchfulness of the superintendent will be required to see that the proper materials are used, and that they are properly applied, which is almost as important

to produce the best work. Very little paint is used on the interior of the buildings, for the reason that the most of the interior finish is of hard wood, selected with reference to the beauty of its grain and color. For the finishing of white pine, etc. in the parlor or elsewhere on the first floor or above, a priming coat of pure white-lead and linseed-oil paint is applied. The puttying up is done after the first coat is applied, as previously described for outside painting, and then two coats of the same paint are applied, each coat being smoothed down with fine sandpaper as soon as it becomes dry. The woodwork is finished with two coats of paint composed of zinc white and spirits of turpentine. The last coat should not be sandpapered and should show a uniform surface without brush marks. The woodwork in the cellar is primed, the nail holes puttied up, and then finished with two coats of white-lead and linseed-oil paint of an approved tint.

142. Finishing.—The superintendent should see that the hard-wood floors, and all woodwork that is to be finished natural, is protected from paint spots, and if by any chance paint spots should appear, they must be thoroughly cleaned off without delay. The work of finishing the trim, doors, stairs, floors, etc. should be carefully looked after, to see that the specifications are followed and that the finishing material is put on carefully and conscientiously. The superintendent should see that the quartered oak and other open-grained woods are filled, and the work cleaned off as soon after as possible; that the quirks of all moldings are cleaned out before the varnish is applied, that all putty required for the hard wood is colored to match the wood, and that each coat of shellac, varnish, or other finishing material is rubbed down with pumice stone and water before the next coat is applied.

After the finished floors have been properly dressed down and sandpapered to a perfectly smooth surface, the open-grained floors, such as oak, etc., are filled with transparent mineral wood filler, and rubbed off before the filler becomes

hard on the surface. The floors are then finished with two coats of old English floor wax, applied with a woolen cloth; each coat is rubbed down with a weighted brush having a long handle. The last coat, which is polished by means of a piece of soft felt being placed under the brush, is not applied until the building is ready for occupancy. Floors finished in this way, if carefully done, should show a beautiful polish when finished, and after it becomes dull through wear, it may be brightened by another thin application of the floor wax, which may be applied by a servant or other person, no experience being necessary.

In applying fresco or distemper to walls, the superintendent should see that the walls are properly sized, and that careful men are employed to do the work; otherwise, a poor job will result. All rooms are to be finished in two tints.

143. Glazing.—The glazing of sash, etc., if to be done at the building, is usually included in the painter's contract; such is the case in this instance, the carpenter delivering the sash at the building and placing them in a convenient position, with their location in the building marked on each, that the painter may easily distinguish which is to have plain sheet glass, which plate glass, and which leaded or other metallic set glass. For sash having wood stops instead of putty, however, the painter will furnish the carpenter with the glass, placing it in the frame if necessary; but the carpenter is to put on the stops.

CONCLUSION.

144. Grading and Terracing.—The "spoil banks" which were reserved for use in final grading are now drawn upon; as the stakes about the roads indicate the grades and levels, a diagram being furnished by the engineer, no important problems are liable to arise in this work. The superintendent should see that as little clay as possible is allowed to be used, and after the various levels and terrace slopes have been laid out, the earth tamped down, etc., that

the top soil is spread out uniformly in the required thickness—8 inches—and brought to a smooth surface, tamped down, and raked over to receive the sodding. The flower beds are next laid out, and the top gravel dressing is spread upon the driveways and walks.

The sods should be inspected to see that they are free from weeds and that a sufficient amount of turf is taken with them to make sure that the roots have not been destroyed. The superintendent should inspect this latter work as much as possible, always consulting the landscape architect in the event of any part of the work being otherwise than as specified. The sods on the terrace slopes should be secured in place with wooden pins. The mason should maintain a requisite number of laborers about the premises, that any trenching, or other work of a like nature required by the other crafts, may be done without unnecessary delay.

The pits are excavated for the pier foundations under the summer pavilion on the north terrace. These piers are to be built 4 feet below grade of rubble masonry, 20 inches square, laid in cement mortar. Each pier is to be capped with a single stone, 6 inches thick, covering the pier. Two of the piers on each side are extended beyond the other piers for the support of the steps and cheek-blocks. Nothing in the way of hints for the guidance of the superintendent need be added here, except, perhaps, to check the depth of the piers below grade, the centers of each pier, and that the outside faces of the piers are on the same circle.

The fountain at the junction of the driveways is to be built 4 feet below grade and a recess is to be left for the service and waste pipes; the service pipe for the fountain is controlled from the main trap pit in front of the greenhouse, and the water may be shut off at the approach of freezing weather. The foundation below grade is to be built of rubble laid in strong cement mortar, and the pedestal work above grade to be of sandstone; the trough to be of granite, polished, and in one piece; the work above the trough to be of bronze; this work is to be done according to detail

drawings and it will be the superintendent's duty to see that they are accurately followed and that the fountain is in good working order at completion.

A lamp pedestal is built at the junction of the driveways, and the foundation for this is built in a manner similar to that in the fountain. The foundation will be 2 feet square, 4 feet below grade, and provision made for reception of service pipe and conduits. The lamp pedestal will be in one piece of limestone with a hole bored through for the conduit and gas service pipe.

It will be necessary for the mason to have stone cutters at hand for further cutting of the cheek-blocks at each side of steps to the greenhouse, and at the carriage pillar for the vent gratings in the plumbing system, as well as other necessary cutting or fitting required.

The finishing touches are being given to the building by the painter and the work generally is about completed. The superintendent should make a final tour of all the work and make notes of any defective painting, stains on masonry, or patches on woodwork uncovered by the last coat, or in fact any such details that may be readily fixed up, and see that they are done. As nothing further is to be done by the superintendent on the premises after he has attended to all the above small details, his duties may safely be considered at an end.

CONTRACTS AND PERMITS.

INTRODUCTION.

1. Scope of Subject.—Under the above title, this section will treat separately and distinctly of two subjects. “Contracts” will be explained and discussed in such a manner that the student will be able to acquire a practical knowledge of the business relations that exist between the several parties to a building operation, and to comprehend the relative positions of these parties in the eyes of the law. The parties to a building contract are usually the builder, the owner, and the architect, though in some cases the architect is not a party to the building contract at all, and his name does not appear in any of the documents.

Under the head of “Permits” will be considered the application for, and acquirement of, permission or authority, from municipal officers, to engage in certain building operations, which could not be performed without the consent of certain city departments. Small communities seldom require any such formality before building operations are commenced; but in large cities it is necessary to provide for public safety, by causing all operations of building construction to be subject to the approval and supervision of a competent board of inspectors, usually known as the Building Department.

Building contracts are nearly always between owner and builder, with the architect as third party and arbitrator; but

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building permits are business details usually between the builder and the municipal authorities, for which the builder pays the fee, if any is charged. The obtaining of all permits may form a part of the contract between owner and builder, but further than that the owner seldom has anything to do with permits at all.

CONTRACTS.

CHARACTER OF THE AGREEMENT.

NATURE OF A CONTRACT.

2. Definition.—A contract is an agreement between two parties for doing or not doing some definite thing. It is very clearly defined by Woolsey (“Introduction to International Law”) as, “One of the highest acts of human free will, binding itself in regard to the future, and surrendering the right to change a certain expressed intention, so that it becomes morally and jurally a wrong to act otherwise; it is the act of two parties, in which each, or one of the two, conveys power over himself to the other, in the consideration of something done or to be done by the other.”

In the strictest sense, a contract is an agreement enforceable by law—an agreement based upon sufficient consideration, and in such a form, and made under such circumstances, that a breach of it is good cause for action by law. It is this sense of validity before the law which distinguishes it from an agreement, the parties to which are not bound in such a formal way, and are not amenable to one another for its fulfilment.

3. Parties to a Contract.—In the execution of every building operation of any size, there are at least three persons interested—the owner, the builder or contractor, and the architect. The owner is the person vitally interested, because it is his money that is being expended, and it is natural that he should want to receive the best material and

workmanship, consistent with the size and quality of the building to be erected, and the amount of money to be spent. The builder, who is party to the contract, agrees to accomplish certain results for a stipulated amount of money, and, in deciding the extent of his responsibility towards the owner, is apt to interpret the contract to best suit his own interests. The architect is employed by the owner as a person expert in matters of building, and is the judge who decides for the owner whether the builder is doing his duty and fulfilling his contract.

Though all men are deemed honest unless proved otherwise, it may readily be seen that a dishonest builder might, unless some valid agreement existed, make considerable trouble for the owner. The builder is even more at the mercy of a dishonest owner, for he might be led into a building operation which would require the expenditure of considerable time and money, which he would be unable to collect after the erection of the building. This would more than likely put him to additional expense of long and wearisome litigation, which, though the courts sustained his claim, might cause bankruptcy before he could recover it.

Even though each of the parties should be perfectly honest, and inclined to deal fairly with each other, it is necessary to have a contract that will stipulate the terms of the agreement in a perfectly clear and concise manner—drawn up, agreed to, and signed by each party concerned—so that each, over his own signature, will have defined for him his responsibilities and duties in the transaction.

4. Classes of Contracts.—Contracts may be divided into three classes: written, oral (or as it is sometimes called, parol, or verbal), and implied contracts.

A written contract is one wherein the terms of the agreement are written or printed, and signed by the contracting parties.

An oral, or verbal, contract is one in which the parties concerned agree verbally (usually in the presence of witnesses) to transact or perform certain things.

An implied contract is a contract that is *understood* to exist, through the very nature of things, between two parties without any previous written or verbal agreement. For instance, one person employs another to perform a certain piece of work and thereby implies an obligation for reasonable remuneration to the party who performs the work; or a person accepts the benefits accruing from the performance of such work, and thereby implies an obligation to have satisfactorily performed the labor for which he was paid.

Most contracts embody at least two of the above mentioned conditions, for the reason that it is almost impossible to fully cover all the terms of an agreement in a written or oral contract, and much must be implied if a successful performance of the work is understood.

5. Written Contracts.—A written contract is usually regarded, though incorrectly, as more binding than either of the others. Its preference over the other forms lies in the fact that the statements of the agreement are in black and white, and being signed by the parties concerned, cannot well be refuted; and since a certain amount of formality is required, in order to draw up a written contract, the law regards the document as the finished and definite conclusion of all the preceding negotiations of the contracting parties, and as fully expressing the understanding between them in regard to the terms of the agreement.

The fact that verbal agreements are regarded in such an unfavorable light by the law is probably due to the fact that witnesses, and parties to a verbal agreement, when called upon in court to testify, so utterly fail to agree in their statements as to what really was said upon the specified occasion. The court is, therefore, inclined to accept and hold paramount any document that will explain, in any degree, the real understanding between the contracting parties. Hence it is, that even a note in the memorandum book of one of the parties concerned, or in a book of a third and disinterested party, as to the terms of the agreement, will be looked upon with favor by the court, and will usually be held, where it is

proved to be genuine memoranda, as testimony of importance above that of a witness to the verbal transaction.

6. Oral Contracts.—It must not be thought that, in the absence of written documents, verbal contracts or agreements can be broken with impunity by either party, for such is not the case, as it is the custom of the courts, in matters of this kind, to endeavor to ascertain, by witnesses and circumstances, the real understanding existing between the parties to such a contract, and to deal fairly with them, commensurate with the testimony and evidence given.

7. Implied Contracts.—Where the owner of a building stands by and sees certain improvements made, or labor performed, from which he will derive benefit, he implies a contract for the work, and is in duty bound to pay a commensurate price for the same, unless there is some stipulation to the contrary in a definite contract, or where there is some written document, subsequently made, which in some way nullifies this implied contract. For instance, the written contract may set forth that "No payments shall be made for extra work done by the contractor unless authorized, in writing, by the owner," or "by the architect." In this case, if the contractor does any extra work for which he has no written order, he does it at his own risk, and would have no action against the owner in court.

In order to make clear the extent of an implied contract, the following illustration is of interest: A plumber was subcontractor to a builder during the erection of a house; the builder was subsequently discharged by the owner for drunkenness, but the plumber went on with his work, under the observation, and in some instances, under direct orders of the owner. Having finished his work, the plumber looked to the owner for his money, which was refused on the ground that the builder had already been paid for the work. The plumber brought suit for the amount of the job, and, though it was proven in court that the builder *had* been paid enough on the building to cover the plumber's claim, the court recommended that, if the evidence warranted it, the jury should

oblige the owner to pay the plumber for at least such work as he had done subsequent to the builder's discharge. This view of the case was taken by the court on the ground that "Where one stands in silence and sees work done, or materials furnished for work done upon premises belonging to him, of which he accepts the benefit, a promise to pay the value thereof may properly be inferred."

8. Contract by Tender.—Where designs or plans are submitted in compliance with the terms of a circular or printed notice, setting forth an invitation for such designs or plans, and offering some inducement for same, it is regarded and has been declared by the courts to be a contract. In order that the validity of such a proposal be made certain, its terms should be set forth clearly and distinctly, and the person accepting the terms should comply with them strictly and to the letter. Proposals of this kind are advertised by committees or individuals, who call for competitive drawings of some public or private building. The submission of plans or designs in strict compliance with the terms of the advertisement constitutes a contract which is upheld by law, provided that the advertisement is issued by persons of proper authority and responsibility.

Should a committee call for architectural designs which are to comply with certain conditions or requirements; and by subsequent notice modify these conditions to such an extent as to make worthless certain plans partially prepared by one of the competing architects, said architect would be able to recover the cost of such preparation. But if he had not commenced the designs until after the modified circular of advertisement had been issued, the later program would take precedence over the first, and be held as embodying the terms of the contract.

Should the committee set forth conditions that it would be impossible for an architect to fulfil in the design of any one building (such as a demand for certain accommodations, which could not be provided for the stipulated sum of money), the architect should get the vote of the committee

as to which requirement—cost or accommodation—takes precedence, and which he is to disregard. The opinion of any one member of the committee is not sufficient, and only the joint decision of the entire committee should be accepted. Therefore, in issuing circular invitations for proposals, or competitive drawings, great care should be taken to state in clear terms just what is wanted and required, and equal care should be exercised by any one complying with the terms, for not only has the law but little relief for persons who do not know how to express their ideas, but it also extends little hope to those who cannot understand a clear statement and who misconstrue the intent of the published requirements.

THE CONTRACTING PARTIES.

9. Formal Contracts.—A formal contract consists of a direct and pertinent proposal from the one party, and an unconditional acceptance by the other. Such a contract may be made by a letter proposing certain terms, and duly accepted by a letter in reply, or the more usual form of a written agreement, setting forth in full the requirements of the one party, and the unconditional acceptance of them by the other, and signed by both parties. In all formal contracts, the terms must embody every condition that is to be complied with, and should be so explicitly stated as to be clearly understood by the contracting parties, so that there may be no misunderstanding between them in regard to the performance of the one party, and the demands of, and consideration to be paid by, the other.

10. Contracting With Corporations.—An agreement entered into with a corporation differs very materially from one contracted with an individual. Almost any contract (provided it is not immoral) is binding upon an individual, providing the intention is well defined and understood, and a consideration is to be made for its fulfilment. Such, however, is not the case with a corporation. It behooves the person about to make a contract with a corporation to

inquire into the scope of its charter, ascertain the limit of its powers to make such contract, and the authority of its officers who are to negotiate the contract. In England, a contract requires the seal of the corporation, in addition to the signatures of the proper officials, in order to insure its validity, and such was formerly the case in the United States, though in many of the states the signatures of the proper officers are generally considered sufficient, providing they have the required authority through their charters, and by laws. In fact, courts in so many of the states have taken this view, that it is more than likely, should similar cases arise in the other states, the courts would hold the same opinion. Irrespective of the matter of the seal, however, it is of vital importance, in making a contract with a corporation, to ascertain whether the persons representing the corporation are invested with the proper authority to make such a contract, and that the corporation is bound to recognize it. There is no redress, and no action will be sustained, if the person entering into a contract with a corporation has, through his own neglect to obtain such information, entered into a contract with officials lacking the proper authority, and at variance with the charters and by laws of the corporation.

11. Public Contracts.—In entering into a contract with a public body, even when the officials representing such a body are duly authorized, it is imperative to make the contract with due formality, or it will not be legal. For instance, it has been held in several states, that the county was not bound by a contract entered into by the county commissioners unless the commissioners were convened in a regular meeting of the board. A contract entered into informally, even within the legal authority of the officials, is insufficient.

When a contract is made with a public corporation, for work to be performed under the supervision of a committee, such as a town committee, the contractor should ascertain whether the contract is made through the concurrence of a majority of the committee. Not only does this apply to an

original contract, but also to any alterations to be made in one already entered into.

The contractor, in other ways, runs many more risks in dealing with corporations than he does with individuals, for a mechanic's lien is without effect against any public building, such as a schoolhouse, jail, court house, or town hall; and even aside from state, county, and town corporations, no such lien can be maintained against the property of a corporation operating for the accommodation of the public, such as railroad stations, ferry houses, etc.

Again, a public corporation is sometimes *exempt* from fulfilling its contract. An instance of this occurred in New York, when a contract was made for a public building. The erection, however, was postponed, and the contractors brought suit to force the fulfilment of the contract, but, though the contract was drawn with due formality and was perfectly legal, the court of appeals decided that a state could not be compelled by a contractor to erect a building, and that his only redress—providing the state broke the agreement, and he himself was not in default—was a claim for damages, which must be made in the form of a petition to the state legislature.

12. False Representation.—Through lack of caution on his part, a contractor frequently finds he has made an agreement with persons who, though they have represented themselves as authorized to execute the contract, have no such legal authority. The corporation therefore refuses to pay the contractor his consideration, and he has no action against that body, though he may possibly recover damages from the persons who caused him to enter into the contract under false representations. It is therefore a good plan, and a safeguard to both parties, to have this matter clearly defined before the agreement is signed. It is, in fact, sometimes a matter of doubt whether the members of a committee who sign their names to a contract for building, to be paid for by a public corporation, do not sometimes, through the wording of the agreement or the manner of signing it,

make themselves each personally liable for the amount of the contract.

13. The Lowest Bidder.—It is the common supposition that the award of a contract must be made to the lowest bidder, unless there is a statement in the tender for bids which stipulates that the parties making the tender “reserve the right to reject any or all bids.” This is not the case, however, as no such stipulation is required, and the parties making the tender can omit such a clause without being bound to prefer the lowest bidder. The laws of some states, and many public and private corporations, require that bids shall be asked for all work involving an expenditure above a certain amount, and the proposal of the lowest bidder accepted. This being the case, the officials making the contract are bound to award it to the lowest bidder. When the stipulation is made in the tender calling for bids upon certain work, that “the contract shall be awarded to the lowest responsible bidder,” the discretion allowed the parties making the tender is so great in regard to what they may consider as constituting the “responsibility” of the bidder, that the law virtually admits that they may award the contract to whomsoever they may see fit, so long as they have decided truly in their own minds which party is the lowest *responsible* bidder.

The extent to which parties may be held in awarding a contract, by the statement in the tender, that the award shall be made to the “lowest bidder,” is well set forth in the confirmation of a decision by the Supreme Court of Pennsylvania. A case arose in Pittsburg, where the water committee awarded a contract for some mains to a party who was \$5,000 higher than the lowest bidder. The lowest bidders, having complied with all the terms of the tender, and furnished the proper bond, felt that they were entitled to the contract, and applied for a mandamus in order to compel the committee to award the contract to them. The committee, in reply to the court’s inquiry to ascertain if the mandamus should be granted, stated “that it was within their full

knowledge and belief, that upon a previous occasion the said firm had by some means or other attempted and did perpetrate a gross deceit and wrong upon them, in surreptitiously departing from the specifications for a certain contract for the construction of boilers for the new water works, by striking therefrom, without the knowledge or consent of the said committee, the word *mud-drum*; also that it was within the knowledge of some, if not all, the members of the water committee, that the senior member of the firm was a man of intemperate habits, whose character for sobriety was not such as would warrant the committee in giving said firm a responsible contract; that said senior member also had attempted to bribe the mechanical engineer of the water works, who was the inspecting officer of said contract; they further stated that the firm was otherwise disqualified for the proper fulfilment of the requirements of the proposed contract." The report of the commissioner appointed in the case to take testimony, showed that the said firm was the lowest bidder, and from a pecuniary standpoint was responsible; and while, in the opinion of the commissioner, the committee fully believed that the statements made were true, it was found that inquiry on the part of the committee would have shown that none of the three accusations made, as to attempted deceit, intemperance on the part of the senior member, and bribery of the engineer, was substantiated. Notwithstanding this, the court held that the committee's action could not be changed.

The Supreme Court, in the confirmation of the lower court's decision, said: "The learned judge who, as the mouth-piece of the court to which this case was submitted, delivers the opinion, finds that the facts stated in the petition are true, and that the allegations contained in the answer, as above set forth, are wholly without foundation, but that, notwithstanding this, the committee fully believed that what was asserted in the answer was true. We must take this opinion of the court as to the belief of the respondents to be correct; nevertheless, it does somewhat surprise us, that this body of men, intrusted with so important a duty, should

have rested so contentedly under a delusion which a little inquiry in the right direction would have dissipated, and thus save a handsome sum of money to the city treasury. In regard to the word *responsible* the court held that it means something more than pecuniary ability, and further stating the case said, in a contract such as the one in controversy, the work must be promptly, faithfully, and well done; it must, or ought to be, conscientious work; to do such work requires prompt, skilful and conscientious men. A dishonest contractor may impose work upon the city in spite of the utmost caution of the superintending engineer, apparently good, and even capable of bearing its duty for a time, which in the end may prove to be a total failure, and worse than useless. Granted that from such a contractor, pecuniary damages may be recovered by an action at law, this at best is but a last resort, that often produces more vexation than profit—a mere patch upon a bad job—an exceedingly meager compensation, at best, for the delay and incalculable damage resulting from the want of a competent supply of water. The city requires honest work, not lawsuits. Were we to accept the interpretation insisted upon by the relators, the difference of a single dollar, in a bid for the most important contract, might determine the question in favor of some unskilful rogue, as against an upright and skilful mechanic. Again we know that, as a rule, cheap work and cheap workmen are but convertible terms for poor work and poor workmen, and if the city, for the mere sake of cheapness, must put up with this, it is indeed a most unfortunate position. It is settled beyond controversy, that where the complaint is against a person or body that has a discretionary or deliberate function to exercise, and that person or body has exercised that function, according to the best of his or its judgment, the writ of mandamus will not be granted to compel the undoing of what has been done."

Bidders for public work under the statute that work shall be given to the lowest bidder, must comply strictly with the terms of the tender, if they expect their proposal to be accepted, or even considered as the lowest bid.

THE SIGNATURE.

14. What a Signature Implies.—Since a contract is a mutual agreement between two parties, it becomes essential to its legality that there should be available proof of the fact that both contracting parties thoroughly understand it in the same way, and willingly assent to the obligations incurred by the conditions—in other words, that the parties are of one mind. Therefore, when the signatures of all the contracting parties are affixed to the document, setting forth the terms of the contract, they are deemed by law as evidence of this mutual agreement and understanding, and impart validity to the document.

A signature may be the inscribed name by which a party is known, or in case he cannot write, his mark, or cross, will be regarded as legal, providing it is witnessed, and his name is written near it in the customary way and by a duly authorized party. It has been held, however, that a signature “by mark” is *not* valid if made by the other party to the contract, for the one signing the contract by mark.

There are cases where it is not necessary that a person should sign a contract in order to be bound by its conditions. When a person who is a party to a contract is mentioned in it as one of the signers, and acts as attorney for another party to the same contract, he signs as attorney for the other person, and does not sign on his own account; nevertheless, it has been held in court, that since he must have read the document before signing it as attorney, and must have seen that he was personally mentioned as one of the signers, by failing to make any remonstrance against it and by accepting its benefits, he assented to its terms and became a party to its fulfilment, the same as though he had signed it in his own name. It is reasonable, therefore, to suppose that any person, knowing the terms of a contract, and being aware that he is personally interested in it, who stands by, without resistance or remonstrance, and sees it drawn up, and afterwards accepts the benefits recurring from such agreement, will be held responsible by law, and will have no excuse on

the ground that his actual signature is not upon it. Nor will the law excuse a person who has signed a contract, on the ground that he has not read it over, providing it is proved that he is able to read, and had an opportunity to read the document, and that no means were used to prevent him from reading it. The plea that it was written in a foreign language, unfamiliar to him, will not release him from the obligations of the contract. Therefore, before signing a contract, the party about to affix his signature should read it over carefully, in all its parts; not only should he read any printed matters that may be embodied in it, but he should consider carefully any script that may be interlined between the printed substances, as writing is held by the courts to take preference over printed statements, and where there is any inconsistency existing between the two, the written portion controls, as more attention is usually paid by the contracting parties to the written matter. No party is, however, excusable upon the plea that he did not read the printed form. Such a case was tried in the District of Columbia. The party, upon having the written part of an agreement read to him, ordered his signature to be placed on the instrument, without reading or having read to him the printed substance of the agreement. As it was proved that he could read, and had an opportunity to do so, it was held by the court that he was responsible for the agreement, in the terms and to the purport of the entire document.

15. Unsigned Agreements.—A contract signed by one party and then delivered to the other is binding upon the one who signs the agreement, whether the other party signs it or not. Such a case was decided in the Supreme Court of New York. A party, receiving an unsigned agreement by messenger, affixed his signature, and upon handing it to the messenger remarked that he would not be bound by it unless certain things were done. He afterwards wrote to the other party to the agreement that he refused to be bound by it, and withdrew. The court held, notwithstanding the fact

that it was not signed by the other party, that the party who had signed it was bound, and that parol evidence of conditions qualifying the delivery was not admissible.

THE CONSIDERATION.

16. Compensation.—Every agreement, unless under seal, must have some specified consideration, or payment for services rendered, stipulated in its terms, in order to make it valid; for, although a contract may be properly executed and signed in the presence of witnesses, yet, if there is no consideration mentioned—that is, no remuneration to the party for performing labor—or furnishing material—the contract will not be legal, and cannot be enforced in law. The remuneration may be either money, labor, or materials, but there must be some statement to show that neither party is furnishing goods nor working without recompense from the other. An effort is often made in cases involving the enforcement of a contract to prove that the entire agreement, or a portion of it, or some supplementary agreement, was without promise of consideration or remuneration, and therefore of no force; and if the court takes this view of the matter, the contract cannot be enforced.

This is such an important item in assuring the validity of a contract or agreement, that it is wise to commence every agreement, even if involving but a small amount, in somewhat the following manner:

*“For the consideration hereafter to be mentioned
A promises and agrees to deliver certain goods (or do certain work) for B ;”* the consideration should then be specified in detail, in another place in the agreement.

The amount of the consideration matters little, for if a man be so unwise as to offer to build a house for a party in consideration of the sum of one dollar, the court will hold him to do his contract, though he might be ever so much inclined to withdraw from such an unprofitable agreement.

17. Sealed Contracts.—Sealed contracts constitute an exception to this rule; for, in the language of the law, a seal “imports a consideration,” and therefore a seal, placed in a legal manner after each signature upon a contract, will take the place of the stipulated consideration, and make binding all the promises contained in the contract, admitting no opportunity on either side to renounce these promises, or any part of them, even where no consideration is mentioned. Formerly, the seal consisted of a drop of sealing wax, upon which there was impressed the peculiar signature of the party concerned; or in some cases, merely the end of his thumb was applied to the soft wax, and its imprint acted as a signet. In these days, however, the private seal is usually a piece of red paper affixed to the document with mucilage, and even this formality is not required in some states, which consider a blot of ink an adequate seal. It can therefore be readily seen that it would always be best to have the signatures to a contract under seal, as in this case there would be no possible opportunity for dispute in regard to the consideration by the parties, as in affixing their seals to the agreement they mutually consent to its terms, irrespective of a consideration.

PAYMENTS.

18. Entire and Divisible Contracts.—All contracts may be divided into two classes, entire and divisible. *Entire* contracts are those which provide that a certain complete performance shall be paid for upon its entire accomplishment; while a divisible contract is one which is complete in its several parts, the proportionate cost being paid in several instalments. In the *entire* agreement the party performing the contract is not entitled to payment until it is completed, while in the *divisible* contract he may collect part payment at the completion of each stipulated part. A good example of a divisible contract is one which provides for the building of twenty houses at so much for each house. In this case the contractor would be entitled to receive payment for any number he had finished, whether the entire twenty were

completed or only one. A contract, therefore, which consists of an agreement by the one party to perform certain work, complete in itself, and of an obligation by a second party to pay so much for the work, will not allow the first party to collect any portion of the entire consideration before the completion of the work; and, should he fail to complete his portion of the contract, he would be unable to collect *anything* for work done or material furnished, provided his failure to accomplish it was not due to any interference by the second party, or by law. If, however, the agreement should stipulate that payments be made at stated periods, as the work reached certain designated stages, a court may decide that owing to the terms of the agreement the contract becomes a divisible one, and that the builder or contractor can claim payment for such portion as may be completed, even should he fail to carry on the work to completion; but in all probability the courts of the different states would decide differently on this question of divisibility of contract, as it is frequently a difficult one to settle. As a building contract is divided more or less into a number of separate clauses and stipulations, relating to separate parts of the building, quality of material, workmanship, etc., it might be held in some courts that it is a divisible contract, and the contractor has a right to recover for labor performed and material furnished, on a portion of the contract.

THE ACCEPTANCE.

19. Accepting a Contract.—Much uncertainty exists as to how soon a proposal should be accepted, and the courts have spent much time on cases involving this question. In one case a person wrote to another offering employment, and requesting a prompt reply. The offer was accepted by the person to whom it was made on the day following its receipt, and the letter of acceptance was handed to a boy to mail. The boy neglected to mail it until two days later. In the meantime the person offering the employment had secured some one else to fill the place. In the suit which followed

to compel the employer to keep to his proposal, it was held by the court that the time elapsing between the offer and the acceptance was too long, and the proposal did not hold.

In the state of New Jersey, it has been held that where the offer specifies that it is open until a certain date, an acceptance upon that date is binding, unless the offer has been withdrawn previous to acceptance.

The question frequently arises, where the acceptance is made by letter, as to whether it may be considered as taking place, and consequently the contract closed, at the time it is mailed by the party making it, or not until it is received by the proposer. English law considers the acceptance made, and the contract closed, from the moment the letter of acceptance is delivered into the hands of the messenger who is to take it to the party making the proposal. This view seems to be held also in the states of New York, New Jersey, New Hampshire, Illinois, and Mississippi, but may be held differently in other states. The courts of Massachusetts, as well as the federal courts, hold that the contract is not binding until the acceptance is received by the party making the proposal. The posting of a letter of acceptance is usually considered as equivalent to its delivery to a messenger, and binds the contract, even though it is not received by the other party. There are exceptions to this, however, since the New York Supreme Court decided in one case where there was no proof that the postage had been paid, that the acceptance was not complete. It should be remembered that the courts, in dealing with such uncertain questions as the above, are usually governed by circumstances and the intention of the parties concerned, rather than by abstract law principles and rulings.

The decisions of the courts in regard to telegraphic acceptances are quite varied, and, strange to say, are in some cases in opposition to their decisions in regard to acceptance by letter. It has been held in the federal courts that an acceptance by telegram is binding the moment it is placed in the hands of a telegraph company for transmission; while, in acceptances by letter, as previously stated, they

hold that it is not binding until received by the proposing party. Again, the New York courts hold that an acceptance by telegram is not binding until received, while, in regard to letter acceptances, it has been decided in the same state that it is binding at the time it is posted.

20. Extent of Obligation.—It is held by all courts that all bids must be accepted unconditionally as made, without variation from the original proposal. If a person in accepting a bid bases his acceptance upon any conditions differing from, or contingent upon, any change of the original proposal, the bidder is not bound by it, and may refuse to sign the contract; and, even should he remain silent, thus apparently accepting it, he cannot be held to it; and, though the party made a subsequent unconditional acceptance, the contract would not be binding. Such conditional acceptances are of common occurrence among architects and others, who, upon receiving bids for the performance of work, will write to the favored bidder that his proposal is accepted, upon the condition that he will sign a satisfactory contract. Such an acceptance is not binding, and the bidder could withdraw his proposal if he saw fit, and could not be held responsible.

In the acceptance of a proposal the price named is often found to be a little less than the price asked by the contractor for doing the work; whether this is unintentional, or whether it is a trick of unscrupulous parties, the fact remains that an acceptance in this way is not only in no way binding upon the contractor, but actually releases him from his original offer. The assumption of the courts in regard to acceptances, or proposals, is clearly expressed by an Illinois court, as follows: "A proposal to accept an offer, on terms varying from those proposed, amounts to a rejection of the offer, and a substitution in its place of a counter proposition, which cannot become a contract until consented to by the first proposer. The original offer thereby loses its vitality, and is no longer pending between the parties, and it becomes an open proposition again only when renewed by the party who

first made it; hence, the party who submitted the counter proposition cannot, without the consent of the other, withdraw or abandon the same, and then accept the original offer, which he had once virtually rejected."

21. General Conditions.—In order that bids may be comprehensively and understandingly made, the architect usually prefaces the detailed specifications with a clause covering all the *general conditions* which are to be complied with by the contractor. (See *Specifications*, Art. 5.) This portion of the specification includes all general stipulations concerning terms of payments, time of completion, compliance with building ordinances, the obtaining of permits for water, blocking street and sidewalk, etc., together with other stipulations of minor importance. The contractor in bidding on the work accepts *all* of the specifications, including the general-condition clause, and upon the acceptance of his proposal he becomes bound in contract to all the terms of the specifications.

It is sometimes advantageous for an owner to accept unconditionally and promptly an especially favorable bid without the risk of a conditional acceptance, which would give the contractor a chance to withdraw. The owner in such a case runs no risk if proper general conditions have been embodied in the specifications, as a contract thus made is perfectly valid, and the builder in subsequently signing a formal contract that contains additional stipulations regarding insurance, time of payment, etc., usually does so with advantage to himself. Should the specification not embody adequate general conditions, however, and the bid be accepted unconditionally, such a contract is equally valid, but the contractor can be held only for such stipulations as are mentioned in the specification. If the time of completion is omitted, the court will decide that a reasonable time is understood, though the legal idea of "a reasonable time" is likely to be at variance with that of the owner, much to the latter's dissatisfaction. Other terms, of still greater importance, may be found to have been omitted from the insufficient general

conditions in the specifications, which will cause the owner much trouble and annoyance.

22. The Position of the Architect.—The architect sometimes oversteps his authority by accepting a proposal, without having duly consulted the owner. The extent of the architect's power in this direction has not, as yet, been determined by law, and the zealous architect who accepts a bid in behalf of his client, without consulting him, is likely to be placed in an awkward position, should the owner refuse to accept the proposition. Therefore, if the owner is desirous that the architect should be empowered to accept immediately, at the time at which it is made, any proposal which would be to the owner's interest, he should authorize the architect to do so, either giving him full power, or limiting him to such an extent as he may see fit. The authority of the architect to accept bids and proposals is of vital importance to the contractor, who is liable to discover that he has made his contract through a person unauthorized by the owner. Therefore, in all cases where the slightest doubt exists in regard to this, it behooves him to ascertain *at once* that it is the owner's intention that the architect should be so empowered, and that the architect's acceptance will have the owner's subsequent approval. The architect, in accepting a bid for the owner, should exercise due caution in the wording of the acceptance, so that he may not himself become involved in its obligations, and his letter should plainly show that he is acting solely as agent for the owner by stating that "Being duly authorized by Mr. A. B. (owner), I hereby accept in his behalf your proposal;" or, "Through the instructions of Mr. A. B. (owner), I am authorized to accept for him your offer."

23. Withdrawing or Modifying a Proposal.—Although somewhat a matter of doubt, the general rule with regard to the withdrawal or the modification of a proposal is, that until accepted the proposal remains a proposal only, and may, up to the time of its acceptance, be withdrawn or modified. In the case of a proposal sent by letter, there is

no doubt that the offer is open until the letter is received, and if the person making the offer can telegraph his withdrawal so that it will reach the proper person before the original proposal, the offer is nullified, and the parties interested in it are in the same relation as they were before the offer was made. But it has been held that if a person *receives* a proposal and immediately sends an answer accepting it, the offer stands valid, even though the party making the offer has despatched another letter in the attempt to withdraw it.

24. Delivering a Contract.—The formality with which the contract is delivered is of little importance, for if it is left at the place of business of the party concerned, the delivery is deemed complete, unless otherwise stated in the contract itself. A court in Illinois has held that one copy of a contract, between owner and builder, being left in the care of the architect, had, to all intent and purpose, been delivered, and was binding on both parties.

Where there are several copies of a contract, which are presumed to be alike in their terms and statements, but where, in fact, some difference exists between them, either party complying with the terms of the agreement in his possession is responsible only for the terms of his own copy.

MODIFICATION OF CONTRACT.

25. Modifying Contracts.—Though formal contracts are generally made with due consideration and carefulness, and are looked upon by the law as binding and enforceable upon both parties, still it is human nature to be fickle and changeable in mind, and unforeseen events may transpire which change the aspect of affairs entirely; hence it becomes necessary to provide that an agreement may be changed or modified in some manner, if so desired by both parties. This result may be accomplished either by *agreement* or by *waiver*. Where modifications in a contract are desired, such changes may be made by a mutual agreement between the

contracting parties. This amendment or modifying agreement, whether made at the time at which the formal contract is drawn up or later, has equal force with the original contract and is considered together with it. Many courts have held that such an agreement is valid, even when verbally made, unless there is a stipulation in the more formal agreement that no change or modification shall be made in the original contract unless in writing.

Caution must be observed, however, where the contract to be modified is with a corporation (especially so if a public corporation), to see that all such changes and modifications are made with due formality; unless this is done, the contractor may have cause to regret his carelessness.

26. Sealed Contracts.—Since a contract under seal is regarded by the courts to be a more formidable instrument than a simple contract, owing to the formality with which it is executed, most courts are more severe in regard to any change or modification in a sealed contract, as shown by the following opinion of the court: “While a simple contract reduced to writing may be varied or changed in any way by a subsequent verbal agreement, it is otherwise as to contracts under seal, which cannot be varied by a mere parol contract, whether in writing or not, since such a contract is inferior to the original.” Hence, as nearly all formal contracts, whether of corporations or individuals, are under seal, it is evident that great caution should be used, and that no attempt should be made to modify any such contract otherwise than in writing, and with all the formality which attended the execution of the original document. It has been held in court that “a sealed contract cannot be rescinded or released by a parol agreement.” It is admissible, however, according to a decision given in the state of Illinois, to subsequently agree verbally to pay an additional price for the same work as is stipulated in the written agreement, which agreement will remain valid in all particulars, except as to the price mentioned in the original document.

A contract that is not under seal may sometimes be

changed or modified by an implied agreement; that is, should a man by his actions declare certain intentions, which vary from the original contract, and should these intentions be accepted by the other party, also provided there was no stipulation in the contract that required "that all changes from the original agreement should be made in writing," a court may hold that the implied agreement to change the original contract, was the mind and intention of both parties, and was therefore binding. Even when there is a clause in the original contract excluding any change by verbal or implied agreements, the court will, under some circumstances, uphold such changes, providing the intention of both parties can be proven beyond doubt to have been agreeable to such a change.

27. Liability of Owner.—That "silence gives consent" does not always hold good in law; in fact, very frequently the opposite is true, and such a view is usually taken by the courts in cases where it is held that the contract or portions of it have been waived by implication. If an owner should observe, in silence, deviations from the contract, it does not necessarily follow that he must accept or pay for such changes. In the first place he may not be an expert in building matters, and again he may not fully realize the importance of such changes, though, if it could be proven that he favored such changes and assented to them, knowing that there would be additional cost attached thereto, it is likely that the court would hold him responsible. In regard to this a Pennsylvania court held that "it is no excuse for non-performance, that the employer looked on while the work was in progress, unless there be evidence from which his assent may be implied."

28. Invalidation.—Many contractors are of the erroneous opinion, that where there have been a number of changes and modifications from the original contract, that such changes and modifications invalidate it and they are privileged to ignore the original agreement in regard to price and demand day-rate wages for the work. Such, however, is

not the case, and all courts of justice will endeavor to obtain evidence to show what portions of the original contract remain intact, and have not been mutually waived, and will enforce those portions accordingly. Where it is impossible, owing to the complications arising from numerous waivers and changes, to ascertain the terms of the original agreement, and in what relation they exist in regard to the actual work done, the court will endeavor to ascertain the reasonable cost of the work and material, and award the contractor his claim on that basis, holding that, "when the original plans, on which the contract was founded, have, by mutual consent, been so substantially and materially departed from as to amount to a constructive abandonment of its terms and specifications, the case should be regarded as one of general employment, with an implied obligation by the owner to pay what the work and material are reasonably worth."

CARRYING OUT THE AGREEMENT.

DEPARTURE FROM THE CONTRACT.

29. Substantial Fulfilment.—Departure from a contract may be either through carelessness or wilfulness. The decision a New York court has rendered in regard to such departure is well stated in a report as follows: "Parties to building contracts should be exact in the fulfilment of their agreements, even to the smallest particulars; and if they wilfully or carelessly depart from any one of them, they should incur the penalty, however severe it may be. But if a party, while acting in good faith, and with a determination to do all that he has contracted to do, unintentionally, and without any negligence, happens in some trifling matter to vary or depart from the terms of the contract, the law is not so severe and exacting as to deprive him of all compensation; it ever regards the substantial rights of the parties, but overlooks trivial and unimportant matters."

To just what extent the court will hold a person for such

deviations from a contract is somewhat undeterminable. It is, however, a foregone conclusion that the party will be held to the substantial fulfilment of his contract, the court deciding just what is meant by "substantial fulfilment."

The following case will show the position which the court took in regard to an unavoidable deviation in a contract for a block of stores. The contractors, during the erection of the stores, discovered that the city had given them the wrong grade for the sidewalk, thus raising the stores about 8 inches too high. They notified the architect and a representative of the owner, who made no objection at the time. A balance on the payment due on the final certificate given by the architect was refused because of the mistake in the setting of the building. The case was carried to the Supreme Court, which decided in favor of the contractors as follows: "As there has been no wilful departure from the terms of a building contract, nor any omission in essential parts, and the laborer has honestly and faithfully performed the contract in all its material and essential features, he will not be held to have forfeited his right to remuneration by reasons of mere technical, inadvertent, and unimportant omissions or defects." "A substantial compliance with the contract is all that is required to entitle the builder to his reward."

30. Determining the Responsibility.—Deviations from the agreement, due to the contractor's non-compliance with the specifications or drawings, are often held to be the direct cause of poor or insufficient construction, resulting in damage to the building and loss to the owner. Where such is the case, it often becomes the court's duty to fix the responsibility, which, should the damage be proven to have been due to the deviations from the contract, will very likely be placed upon the contractor, even though there were no objections to them by the owner.

The following is an illustration of such a case: A contractor bound by an agreement, supplemented by plans and specifications, erected, or partially erected, a frame church; it was nearly completed when a severe gale blew it down.

Subsequently, the contractor entered suit for the money due him; it was held by the owner that certain deviations were made from the contract which were undoubtedly the cause of the damage; the owner had, however, previously made no objections to the changes. The architect brought evidence to prove that the manner of construction in question, and from which the deviation had been made, was shown on the drawings, though there was no mention of it in the specifications. The evidence of the witnesses was rather unsatisfactory, as they differed in regard to the relative merits of the two constructions, also in their interpretation of the plans. The jury was instructed by the judge as follows: "If the contractors departed slightly from the plans, specifications, and drawings, and yet if such a departure did not diminish the strength of the building, nor contribute to its being blown down, such departure does not deprive them of their right to recover in this action, as the contract appears by the evidence to have been otherwise complied with." The decision was reversed, however, by the Supreme Court of Illinois, which said: "This position is untenable. The contractors had no right to depart from the working plans made part of the contract. If they did so, it was at their peril, and they would become guarantees as to the strength and safety of the structure." "The drawings were made part of the agreement. The contractors could only discharge themselves from liability by constructing the building in accordance therewith, unless a deviation was mutually agreed upon."

ABANDONMENT OF CONTRACT.

31. Reasons for Abandonment.—The abandonment of a contract occurs through the neglect of one or both of the parties to carry on the work for which they contracted. It may occur through the builder being unable to carry on the work, or the owner refusing to longer be a party to the agreement; or it may be that the interference of the law or some irresistible power prevented the fulfilment of the agreement. In any case, where the terms of the contract

are well defined and have not been mystified by many changes and modifications, the court will endeavor to enforce them, or such ones as may still be binding.

Should the work when partially completed, be abandoned by the contractor, without cause, or without consent from the owner, and should the builder refuse to proceed with it, the courts will not allow him a claim. He would not only be unable to recover a reasonable price for the completed work, but would be liable for damages to the owner.

If, however, the owner accepted the abandoned work, and derived benefit therefrom by proceeding to complete the agreement under another contractor, the courts would be likely to hold that, upon the completion of the work and the final payment to the second contractor, the first contractor would be able to recover the balance, if any, existing between cost of the work as done under the second contract and the amount of the original contract, deducting, of course, any damages which the owner might have sustained by delays caused by the abandonment of the work.

32. Responsibility of Owner.—The owner instead of the contractor is often at fault in carrying out the agreement, and in such a case the builder usually has no cause to complain of his treatment by the law. Where the owner is delinquent in the fulfilment of his agreement, the contractor may present his case to the court in two ways. He may hold that the contract is still in force and claim compensation at the contract rates for the work that has been done, together with a claim for damages which resulted to him, due to loss of profit on account of the owner's delinquency; or he may claim that the contract has been abrogated, or annulled, and require reasonable payment for his work and materials furnished. Though he has either of the above paths to pursue in prosecuting his case, it is well defined by law that he cannot present evidence applicable to both, but must accept one or the other and hold to it. He should be governed as to his choice by the circumstances surrounding his claim, and the advice of his counsel.

In regard to a case where a contractor was prevented by the owner from proceeding with the contract, the New York Court of Appeals plainly stated the two grounds upon either of which a contractor could take his stand in presenting his claim; the opinion held by this court was as follows: "Where performance is prevented by one party to a contract, who terminates the agreement against the will of the other party, the latter may either sue for breach of contract, and recover as damages the profits he would have made if allowed to complete the work; or he may waive the contract, and bring his action on the common count for work and labor generally, and recover what the work done is actually worth; but in this case he cannot recover his profits on the unexecuted part of the work."

The owner may abandon his contract by failing to live up to his agreement, or he may prevent the contractor from carrying out the work, and fulfilling the agreement. Such a case as this was decided in Indiana. The owner of a building in course of construction having failed to pay the instalments on the work at the several periods when they were due according to the contract, was sued for damages by the contractor, who claimed he had to abandon the work because of the non-payment of the instalments. The court's opinion in the matter was somewhat to the effect, that if the owner had really prevented the contractor from fulfilling the agreement, then he should be able to recover, as damages, the profits that would have accrued to him, providing he had completed the job; but that the mere non-payment of instalments due on the contract before the work was finished, did not constitute such prevention.

There are numerous other instances where it has been held that the contractor was unable to fulfil his part of the agreement on account of the owner failing in some way, either avoidable or unavoidable, to live up to the contract. In all such cases, it seems to be the opinion of the courts, where it can be proven that the contractor was willing and ready to comply with his part of the agreement, and was prevented by the owner from doing so, that he is entitled to

recover, not only for the actual work done, but also for any profit which he would have received upon the completion of the contract. For instance, should certain ironwork be ready for a building at the stipulated time, and should the building, which was not in a condition to receive it, burn down, the parties furnishing the ironwork would undoubtedly be able to recover the contract price, less the cost of erection; for they had completed their agreement as far as it was possible, within their power, to do so; further completion being impossible, owing to the failure of the owner to have his building ready in time.

33. Death of Either Party.—Death of the contractor ends the contract, unless some provision is made in the agreement by which his heirs or executors become responsible for its completion, and it has been decided by the court in Missouri that no lien can be taken out against the building for work or materials thereafter furnished under the contract. The contractor seems in this case to have the advantage, as the death of the owner does not affect the contract, because it is binding against his estate.

Where the contracting parties wish to guard against any of the above mentioned contingencies, all that is required is the insertion of a clause in the contract which will convey their mutual intent and meaning in regard to the matter considered, and the court will see that it is enforced irrespective of general principles and precedent.

34. Abandonment Not Always Justified.—The contractor, before taking so serious a step as the abandonment of a contract, should be sure of his position, and determine whether he is justified in such a proceeding; for, as the Supreme Court of Missouri expresses it, “a mere breach of contract does not entitle the other party to stop work and recover for unperformed work. He might stop work and recover for what he has already done, but not for what remained to be done. To recover for that, he must have been prevented from going on by the unauthorized interference of the other party. The measure of damages on the

contract, in such cases, is the contract price, less what it would cost to complete the work."

35. Forfeiting of Contract.—It sometimes occurs that one of the parties of a contract may find it impossible, owing to the conduct of the other party, to fulfil the terms of the agreement. In such a case he should notify the other party immediately, declaring his unwillingness to be bound by the contract, or at least by certain stipulations in it; if he fails to do this promptly, it may be held that by his silence he waived his right to do so. For instance, a contractor may have been unreasonably delayed and interfered with by the owner's demands requiring a number of changes, or by the owner's withholding his decision on certain important questions, which prevented the contractor from proceeding with the work and completing it in the specified time. This being the case, the contractor is entitled to rescind the agreement, but he should do so at the time, or it may be held that he has waived his right to do so.

Instead of the owner being at fault, the contractor may fail to have the building finished at the stipulated time. This might give the owner the power to rescind the contract, but he should exercise this right at once; for should he fail to do so, and permit the contractor to proceed with the work, it would very probably be held that he had waived his right, and all he could claim would be damages, as provided in the contract, for injury due to the delay caused by the failure of the contractor to complete the agreement at the specified time.

The contractor, before entering upon an agreement, should ascertain whether the plans and specifications call for work that can actually be constructed, and whether the conditions are such that they can be carried to completion. Anything that is not clear to him from the plans or specifications, should be explained by the architect to his satisfaction; otherwise, if he should find, after signing the contract, that he cannot in any possible way carry out the work as shown, the court will very likely hold that he, being a

responsible builder, should have known whether the plans could be carried out, and that he was bound by the contract.

36. Reinstating Contracts.—Any contract that has been declared forfeited under the terms of the agreement, may be reinstated by the mutual consent of the parties concerned; in which case they will no longer be governed by the annulment.

FRAUDULENT CONTRACTS.

37. "Statutes of Frauds and Limitations."—In the several states, there are codes of special laws which are known as the "Statutes of Frauds and Limitations." The particular clause in these statutes of interest to those engaged in building-operations, is here quoted from the statutes of Maine and reads as follows: "No action shall be maintained upon any agreement that is not to be performed within one year from the making thereof." That is to say, no contract shall be valid (unless in writing) that calls for an accomplishment of certain things that cannot be fulfilled in one year from the date of making the contract. The decision of a New Hampshire court is interesting in that it held, that if the performance of the contract could be accomplished within a year (even though it was improbable that it would), the contract was not within the statutes and did not have to be in writing. The language of the court in this case was: "The Statute (of Frauds) does not apply to any contract, unless by its express terms, or by reasonable construction, it is not to be performed—that is, is incapable in any event of being performed—within one year from the time it was made. If by its terms, or by reasonable construction, the contract can be fully performed within a year, although it can only be done by the occurrence of some contingency by no means likely to happen, such as the death of some party or persons referred to in the contract, the statute has no application, and no writing is necessary. If the agreement can be fully performed by either of the parties within one year, and it is so performed, the agreement of

the other party is not within the statute, though it may be impossible to perform it within a year."

A case once arose in New York where the question involved was as to whether the terms of a verbal agreement prevented the possibility of the contract being completed in one year. The contract was made about fifteen months before the date upon which it was verbally agreed that the building should be completed. Some misunderstanding in regard to the agreement arose, and, in the suit which followed, the defendant claimed that the contract was invalid under the "Statute of Frauds." The claim was, however, denied by the statement of the Supreme Court, which rendered the following decision: "The agreement set forth in the declaration in this case is not for the building of a house after the expiration of one year, but is to be performed at the farthest within fifteen months. There is nothing in the agreement prohibiting the defendant from completing the contract within six months, or a shorter period. Suppose he had done so, and sued the plaintiff for compensation for his labor and materials found, would it have been permitted to the plaintiff to have said that the contract was not to be performed within a year, and therefore it was not obligatory on him? Most clearly not. And if obligatory on one party, it is equally so on the other. The defendant might have performed the contract within a year, and it is therefore not within the statutes."

38. Fraudulent Contracts.—It is generally supposed, that where a man has signed a contract he is held responsible, and there is no escaping its conditions. However, if it can be proved that fraud was used in gaining the signature of the party, or that he was wilfully deceived in some manner, the court will deal fairly with him, and, as far as possible, will usually prevent the fraudulent party from gaining an advantage; for the court fully realizes that, no matter how carefully a man may conduct his business transactions, no amount of care will protect him against frauds. The court, however, will have little patience with any one who,

through carelessness, allows himself to be imposed upon. Even in cases where no fraud is intended and a mistake exists, if it can be proved that no usual amount of care could guard against it, the law will make an effort to correct the mistake and release the innocent parties, if it can be done without dealing unjustly with the other parties, who may have been more careful.

When a party discovers, before commencing the work, that he has entered into a contract which misrepresents the amount of labor he is to perform, or materials to furnish, he should, in order to avoid trouble, notify the other parties immediately, that he repudiates the contract. If he should proceed with and perform the work, knowing that the amount to be done had been misrepresented to him, he would be unable to obtain more than the contract price. It has also been held, where a stipulation in a contract, such as the time of completion, is misrepresented, or a mistake in the statement has been made, that the balance of the contract remains intact, and that only such parts as are affected by the erroneous stipulations are invalidated. A contract made on Sunday is invalid.

COMPLETION OF THE CONTRACT.

ACCEPTANCE OF THE WORK.

39. Completion of Work.—The last, or final, stage in the fulfilment of a contract is the completion and acceptance of the work, which is often fraught with more misunderstanding and dispute than any other portion of the transaction.

Most contracts stipulate that the work shall not be deemed as completed until it has been accepted by some designated party, which is usually either the architect or the owner. If the architect accepts the work he should furnish a certificate to the builder to that effect. Should the owner be the one who accepts the work, he should do so in writing. In

some cases it is required that both the architect and the owner should accept the work. It is well to stipulate in the contract that all work shall be subject to the approval or satisfaction of the specified architect or architects. This clause is valuable, in that it leaves all unsettled matters in regard to workmanship and materials to his decision, and sustains his authority as a final judge. If his judgment has been given in good faith, and with an intention to deal fairly with both his client and the contractor, there will be no necessity for subjecting the controversy to settlement by arbitration or trial by jury; for the court nearly always accepts the opinions and decisions of an honest and conscientious architect.

Where it has been stipulated in the agreement that "the work shall not be considered complete until certified to by the architect," it will be held by most courts (though there are exceptions to this rule), that the contractor must present a certificate from the architect before he will be able to claim that the contract has been completed. Even though the contract especially stipulated that the architect's certificate was to be binding and conclusive upon both parties, such is not always the case; for, if it can be proved that the architect fraudulently or unscrupulously withheld it, or, in failing to grant it, he was not acting according to his best judgment and was prejudiced against the builder, intending to oppress him, the court may hold that the architect's certificate is not necessary to the completion of the contract.

The architect is always subordinate to the contract. He cannot cause work to be done at variance with the stipulations in the contract; neither will his certificate for work that does not fulfil the requirements of the agreement be valid, and, though he has the power by the terms of the agreement to reject or accept all work as he may see fit, he is not authorized to reject any work that is done according to the agreement, nor accept that which is not.

40. Accepting the Work.—The acceptance of work by either architect or owner is not always a waiver of the

defects that may exist in it; though it may sometimes be implied from the owner's conduct, where the defects have been obvious and he has made no objections to them, that he accepts the work. But, should the defects be concealed, neither his virtual nor formal acceptance will prevent him from recovering, on the grounds that the contract was not completed. In regard to this the following view is generally taken by the courts: "Notwithstanding acceptance, virtual or formal, unless expressly made in full discharge of the contract, if the work or materials are not as contracted for, the owner may recover damages sustained in consequence."

A case involving this principle occurred in Georgia about the year 1854. It seems that a contractor undertook certain work for the trustees of a university. The contract was made in regard to some repairs and the remodeling of a certain building. It was required that the contractor should "remove certain walls and put in such pillars as might be necessary to support the ceilings"; also, that the work should be completed "in a neat and workmanlike style." The repairs and alterations had been completed and virtually accepted by the trustees, who were present during the time the work progressed, and had made no objections to it. About eighteen months afterwards, one of the wooden girders that were put in under the contract, failed, and so injured a portion of the ceiling that extensive repairs were necessary. In the suit instituted by the trustees for damages, testimony was introduced by the defendants to the effect that several days previous to the accident a leak had been discovered in the roof, and that the leakage so increased the weight upon the girder, as to cause it to fail. The plaintiffs proved, however, that the chestnut girder was of a brashy nature and knotty, and further expert evidence was introduced to prove that it was of insufficient strength and ought to have been supported by several more posts.

41. The Right to Recover.—The lower courts decided in favor of the defendants, but the decision was reversed by

the Supreme Court, which held "that the plaintiffs received the work, and paid for it, does not affect their right to recover in the slightest degree; it is not a circumstance to be considered against that right. They are entitled to recover, unless they, at the time of the acceptance, knowing of the defective and neglected work, and of the non-compliance by the defendants with their contract in all respects, expressly waived a performance of the contract, and agreed to pay the stipulated prices, notwithstanding; all of which must be made affirmatively to appear by the defendants, to be available to them as a defense.

. . . The evidence in this case falls very far short of this. Was the attention of the plaintiffs called to the fact that an important girder was brashy, knotty, and entirely incapable of supporting the weight resting on it? . . . Their attention was not called to it, and they could not see and examine the girder for themselves, for it was concealed from their view by the floor on one side and the overhead ceiling on the other." One of the claims of the defendants was, that the insufficiency of the pillars was self-evident, and that the plaintiffs must have observed the defect. In reply to this, the court said: "True, they could see the number of pillars, but they were not informed as to the number necessary. The defendants undertook specially, in their contract, to put in 'such pillars as might be necessary to support the ceiling'; they were to judge, and to judge correctly, at their peril. . . . The idea that they (the plaintiffs) were waiving any of their rights under the contract, never entered their minds; . . . they accepted the work because they believed that the defendants had complied."

42. Occupancy or Possession.—It is generally understood among builders that the owner, by moving into or occupying the building constructed under the contract, implies an acceptance of the work. Such, however, is not always the case, as many decisions of the courts show. Even should he pay the contractor in full without demanding

the architect's certificate, or otherwise formally accepting the building, it could be held that no implied acceptance was meant.

In a case where a contractor had failed to comply with some material part of the contract, the parties for whom the work was done moved into the building and refused to pay the balance due the contractor; the contractor entered suit on the ground that the parties, by occupying the building, virtually accepted the work. It was held, however, by the New York Court of Appeals, "that if a contractor has neglected, and refuses, to complete his contract in a material point, it does not follow that the owner waives its performance by taking possession of, and occupying, the building in its defective condition." The court also said: "An owner is not put to so absurd an alternative as either to lose and abandon his building, worth perhaps ten thousand dollars, or to occupy it at the peril of paying for work not performed, or of waiving thereby the performance of any substantial covenant of the contractor." The New York courts also hold that: "The occupancy of a building is not a waiver of the plain requirements of the contract."

PENALTIES AND PREMIUMS.

43. Liquidated Damages.—The owner is often put to considerable inconvenience, and in some cases needless expense or loss, by the delinquency of the contractor to have the work finished at the stipulated time. For instance, it may be that the parties are erecting the building for their own occupancy, and that the lease upon the property which they are occupying expires about the same date as that on which the contractor is to have the building completed; or it may be that the new building is to be rented to tenants who expect to occupy it by a certain date, and have made arrangements accordingly. Hence, it is evident that the owner or owners may be placed in a very awkward position, and compelled to sustain considerable financial loss, entirely

due to default of the contractor in not having the work completed on time.

To guard against such a contingency, it is usual to provide in the contract, that the person doing the work shall pay a certain sum of money per day to the owner, for each and every day beyond the stipulated time of completion that the work may remain unfinished. It is generally specified in all contracts that this stipulated sum of money or forfeiture shall not be regarded as a penalty, but is to be considered as liquidated damages (the term, liquidated damages, simply meaning damages that are fixed by the terms of the contract, as opposed to unliquidated damages, which are decided upon, subsequently, by jury or other means). The Supreme Court of Alabama, in regard to such forfeitures, says: "The court must ascertain whether the true intention of the parties was to afford fair and reasonable compensation for the loss sustained, in which case it is a real penalty, which can be apportioned to the actual loss sustained; or liquidated damages, which must be suffered without regard to actual injury resulting from failure to keep the contract. The tendency of the law is to regard the stipulations as a penalty, rather than as liquidated damages, and, if there is any doubt as to the intention of the parties, it will be so construed; and even if the stipulation is for payment of a sum in gross in case of failure to perform, the sum stated will still be considered as a penalty." It would seem from this decision that there is a difference expressed between a penalty and a forfeiture for liquidated damages. A penalty is regarded merely as a sum to be forfeited, out of which the actual damages are to be taken; while liquidated damages are a sum usually agreed to by the contracting parties, as the amount to be considered as actual damage. The purpose in regarding the forfeiture as liquidated damages is to avoid subsequent dispute as to the amount of the real loss suffered by the owner; and it is commonly thought, where it is expressly stipulated that the forfeiture is to be considered as liquidated damages, that the courts would not interfere to invalidate the valuation which the parties had mutually agreed to in the contract.

44. Just Compensation.—Many of the highest courts in the land, however, look upon all time forfeitures as mere penalties, out of which the actually ascertained damages are to be taken, whether they are stipulated as liquidated damages or not. In such decisions the owner is entitled to only such a sum as would fairly represent the loss he had sustained, and no reasonable forfeiture could be collected.

Should it be proved that the owner endeavored to make profit out of a forfeiture clause, even though the forfeiture each day was qualified by the phrase, that it was to be considered not as a penalty but as liquidated damages, it is more than probable that the court would not uphold him, and would decide, as previously stated, that all he was justly entitled to would be damages amounting to the actual loss he sustained by the default of the contractor. This was decisively settled by the Supreme Court of Michigan, which formulated the following rule: "The principle at which the law aims in awarding damages is that of just compensation for the injury sustained; and the parties will not be permitted by express stipulations to set this principle aside."

Even should there be no stipulation in the contract to the effect that the contractor was to forfeit a certain sum as liquidated damages for each and every day the work should remain unfinished beyond the specified time, the owner would be able to recover, as damages, any loss he could bring evidence to prove actually existed through the default of the contractor.

45. Extent of Contractor's Responsibility.—The following assumed case will illustrate somewhat to just what extent the contractor is responsible, in regard to the forfeiture clause in contracts. An owner contracts with a party for the erection of a summer cottage, and stipulates in the contract a reasonable forfeiture, to be paid by the contractor, provided it is not completed on time, thinking that in this manner he will stimulate the builder to an extra effort. The builder fails to have the cottage done on time, and suit is entered by the owner for the amount of the

forfeiture, which is out of all proportion with the importance of the job. The court will very likely hold that he can recover only the day rent of the cottage for each and every day over the specified time, provided the delay has not been serious; and if the time of completion has so far exceeded that specified, that the owner has been compelled to abandon the cottage for the summer, they will more than likely award him damages to the amount that would be required to rent a similar cottage for the season. Again, it may be that the building is to be rented, and for every day over the time specified that the builder fails to have it completed, the owner is out just so much rent; in that case the court will award him the amount that he has lost in rents, with any other loss he may have sustained through invalidated leases with the tenants. Therefore, since it is very generally accepted by the courts that in any case only just damages can be recovered, the best thing that the owner or architect can do in stipulating the terms of the contract, where it is important that the work should be completed by a specified time, is to carefully estimate, as nearly as possible, the actual damage that will occur from the non-completion of the contract, and to add to this a reasonable margin for unforeseen contingencies. This amount should be obtained in a sum of so much a day, and inserted in the contract as a forfeiture clause for liquidated damages, and, were disputes to arise, would be upheld by the law if it is reasonably correct.

46. Unfinished Work.—The stipulation providing that a forfeiture shall be paid for delay in the completion of the building is of some advantage to the contractor; though, at first sight, it might not appear so. This advantage is due to the fact that, as a stipulation is made in regard to the forfeiture of a sum of money for each day that the work shall have been delayed beyond the contract time, and such a forfeiture is agreed to by the builder in signing the contract, the owner must necessarily waive his right to rescind the contract on the ground that the work was not completed on time. If, however, no such forfeiture clause exists, the

failure of the contractor to have the building finished in the specified time is a breach of the agreement, and the owner may rescind the contract. Thus the builder or contractor loses his final payment for the unfinished portion of the work. Should the owner, however, fail to notify the contractor of the termination of the agreement on the day specified for the completion of the work, and allows him to proceed with the job, he cannot do so subsequently, as he has waived his right in this direction. The courts have ruled in regard to this, that "when the owner permits the contractor to continue work after the expiration of the time within which the work was to be completed, he waives the right to rescind the contract on that ground, but does not thereby waive such damages as he may have sustained by reason of the delay."

47. "Reasonable Time."—When no specified time for the completion of the work has been provided in the contract, it might be supposed that the contractor could dawdle over his work indefinitely; such, however, is not the case, for it is presumed that a reasonable time is always understood, though just what constitutes a reasonable time is a little uncertain, and will depend upon the jury before which the case is tried. It would not be safe, therefore, where there is no time stipulation in an agreement, for a contractor to delay very considerably the completion of the work; for, should the owner's patience fail, and he bring suit, the jury is likely to decide that the contractor had been allowed more than a reasonable time for the performance of the work, and the owner could recover damages for the delay over the time held by the jury as being reasonable.

Should the owner waive the stipulation in regard to the time of completion, or his claim for damages due to the delay, or any other stipulation or clause, it must not be thought that the other provisions in the contract are waived, or that the contract is invalidated thereby. Such is not the case, and it may be expressly stated that the waiver of one stipulation of a contract does not affect the others.

48. Delays.—It is not unusual for the contractor who has agreed to have the work completed by a certain date, to be delayed, and thus prevented from complying with the contract, through the fault of other contractors or of the owner. Where the delay has been caused by the default of other contractors, it seems to be held as a rule, that the contract is subjected to implied modifications in regard to the time limit; an extension of the time being allowed to the principal contractor, equal to the delay caused by the other's, fault. This is substantially the same as was held in Illinois when the court stated: "Where one contracts to do certain work in such a way as not to delay other contractors, and to have it done on a certain day, and, by delays of other contractors, is unable to commence it until near the time of completion, he is still held to the contract, except as to time of completion, and for unnecessary delay on his part will be liable to his employers for damages."

Should the delay be caused through the fault of the owner, the contractor will not only be entitled to an extension of the time limit, but should he on the same account be put to additional expense, he will be able to hold the owner for such; unless it is provided in the contract that the owner shall have the power to postpone or delay the work as he may see fit. When, however, the contractor finds that the owner or the other contractors are causing him delay and additional expense, he should notify the owner to that effect immediately, so that the owner can take steps to prevent the delay, or so enjoin the other contractors that they will remove the cause of the complaint, and hence the additional expense to the complainant.

49. Non-Fulfilment of Contract.—The owner, upon finding that the work is not progressing rapidly enough, due to neglect or inability on the part of the contractor, may, upon giving due and proper notice to that effect, employ other parties to finish the contract, and in due justice to himself may, in order that he will not lose the advantage of the contract, pay these parties out of the contract

price, or charge the cost to the original contractor. It is usual, in carefully written contracts, to provide in some manner for this contingency, and to make special provision in regard to the terms and circumstances which will authorize the owner in taking such a step. The rights of the contracting parties in regard to this are clearly expressed in the following decision of the Supreme Court of Illinois: "If one party induces the other to believe that he has withdrawn from the contract, the other need not wait for the day of performance before making new arrangements, nor does he lose his remedy against the delinquent party by providing at once against losses likely to arise against such delinquencies."

The owner, in taking the work out of the delinquent contractor's hands and completing it himself, or through another contractor, must see that it is done within a reasonable expense. In fact, since the original contractor has to pay for the subsequent work, it is really his money that is being used, and the owner should guard it as he would his own, avoiding extravagant or wasteful expenditures; for, should it be proven that he was careless in this respect, and attempted to charge an unreasonable sum against the original contractor, the courts will not uphold him. The owner may, if he deems it advisable, complete the building by day work, or he may make arrangements with another contractor to do so at a reasonable price; but he must keep careful account of the actual expenditures, and charge nothing else against the original contractor.

Should the owner, after rescinding the contract according to the provisions in it, or upon good and sufficient reasons, find that some of the original contractor's work is defective, he may make good such work, and charge it to the cost of completing the building. If there are materials upon the site of the new building furnished by the original contractor, and these materials are good in every respect and substantially as specified or contracted for, the owner is bound to use them in completing the work, and thus avoid charging the original contractor the cost of such materials, that may be of less or no value on other work.

In well drawn contracts, however, provision is generally made that where the contract is forfeited, and materials are left on the ground by the original contractor, they shall be used at the discretion of the owner or architect.

Even where the contract has granted them the authority, the owner, and the architect as well, should carefully consider the circumstances, and all of the stipulations relating thereto, before taking so serious a step as the forfeiture of a contract. Where no provision has been made in a contract with regard to the contingency of its forfeiture, the owner or architect, as the case may be, should, when he has good reason to do so, notify the contractor that he has forfeited his right to complete the contract. He should also endeavor to show an intention of finishing the work, according to the terms of the contract, at a minimum cost to the original contractor, and protect his interest in every possible way.

50. Terminating a Contract.—An architect was once authorized in a contract to terminate it if he should see fit; the contractor applied to court for a decision as to whether the architect had a right, under the circumstances, to forfeit the contract. The architect held that he had the right to declare the contract forfeited, under the terms of the agreement; but the court decided that the contractor had the privilege to apply to the court for their decision as to whether the architect was justified in terminating the contract.

The termination of the contract, and the completion of the work by the owner or his representative, somewhat changes the position of the architect. A New York court held, in a case where a subcontractor had entered suit and the work was being finished by other parties designated by the owner, who had rescinded the original contract, that the certificate of the architect, which was required under the original contract before payment would be made, was not required as the owner was now his own contractor.

51. Premiums.—Premiums are sometimes offered where the work is of special importance, and are stipulated in the contract as being payable to the contractor at so much

a day for each and every day that he shall have the work finished before the stipulated time. Where such premiums are stipulated in the contract and the owner in some way unreasonably delays the work, thus preventing the contractor from completing it before the stipulated time, and depriving him of the premium, it has been held that he can recover, provided it can be proved that he would have finished before the time specified, if the owner had not interfered.

The difficulty, however, in such cases is in determining just how long before the stipulated time the contractor would have finished, provided the owner had not interfered. This at best is mere guesswork, and depends upon the circumstances surrounding the case. Where the stipulated premium amounts to a considerable sum of money for each day gained, it can readily be seen how important it is to determine correctly the exact number of days. For instance, in one case the stipulated premium was \$500 a day for each and every day the contractor should have the work completed before the specified time; the owner interfered, and the contractor entered suit, claiming that without such interference he would have gained considerable premium; the court decided that he could have finished 30 days before the stipulated time, and awarded him the \$15,000 due him.

EXTRA WORK.

52. Extra Work: Verbal Understanding.—In a case brought before the Superior Court of Massachusetts, where the written contract stipulated that no extra work would be paid for unless ordered in writing, and where the contractor had done extra work on verbal orders and been refused payment, the court held that “attempts of parties to tie up by contract their freedom of dealing with each other are futile. The contract is a fact to be taken into account in interpreting the subsequent conduct of the plaintiff and defendant, no doubt, but it cannot be assumed, as a matter of law, that the contract governed all that was done until it was renounced

in so many words, because the parties had a right to renounce it in any way, and by any modes of expression they saw fit." In expressing the above decision the court was undoubtedly governed by the facts of the case, which were that most of the work was done after the original contract was practically completed, and the extra work, which was done during the completion of the original contract, had been verbally agreed to, and payment promised for the same. Hence it seems that the point to decide was not so much the setting aside of the stipulations requiring all extra work to be ordered in writing, as it was whether the stipulations in the original agreement applied to subsequent and apparently independent work.

A similar case came before the Federal Court, where suit was entered by a contractor to recover payment for extra work, which the government had refused because it was stipulated in the contract that no extra work should be paid for unless agreed upon in writing. The court held that such a clause was inserted by the government in order to limit the powers of the architect and superintendent, and did not bind the parties in such a manner as to avoid a verbal or implied agreement for extra work. The judge further stated: "Courts cannot transmute a contract into a statute of frauds, nor attach to the agreement of the parties the irrevocable mandatory attributes of a statutory provision. A provision in a written contract declaring that no claim for extra work shall be made unless it was required and agreed upon in writing, is merely a condition, which may be waived by a subsequent oral agreement." Also, "Where a public agent requests a departure from an express contract, and the change ordered is of such a nature that he may reasonably suppose that no additional expense will be caused thereby, the contractor is bound to speak, or he will be deemed to have consented to make the substitution at the contract rate. But where the change is of such a nature that it must necessarily involve additional cost, no such notification is necessary, and the contractor will recover reasonable compensation."

It would not, however, be safe to omit the clause in the contract which provides that "no extra work shall be paid for unless ordered in writing," for it has been held by many courts that such a clause cannot be broken with impunity; and where it can be proved that the real intention of the parties concerned was that all such orders for extra work should be made with due formality, the contract is valid and will be upheld by the court.

53. Extra Work: Written Agreement.—Often there is found in the contract two apparently contradictory clauses: one that implies that no extra work shall be paid for unless ordered in writing, and another which states that the engineer or architect shall have power to direct additions to, or alterations in, the work. The court has decided, however, that in such cases the latter clause does not in any manner affect the validity of the first. A New York court refused to admit evidence where the contract provided that "no extra work shall be paid for if not ordered in writing," unless the parties could furnish the written orders for such work.

In emergencies where the safety of the building is at stake, and the architect or the engineer may deem it necessary to verbally order extra work done, to eliminate such danger, the contractor would more than likely be able to recover payment for the extra work, even though there was a stipulation in the contract that written orders would be required for all extra work. In order to illustrate in what light such a condition of affairs is held by a court, the following may be of interest: A county commission in Indiana appointed a supervising engineer to superintend the erection of a certain bridge to be built under contract. During its erection the superintendent thought it advisable to do the work in such a manner that a considerable amount of extra masonry and filling was required. The contractor, being unable to collect for the extra work, entered suit. The county commission claimed that the county could only be bound by the contract, and were responsible for nothing outside of it. The case was carried to the Supreme Court, which based its decision

upon the statutes applying to the erection and repair of bridges, which set forth that "for the erection of any such bridge, the said board shall appoint one or more discreet persons as superintendents thereof," and further authorized that the superintendent should have the power to receive proposals, let contracts to the lowest responsible bidder, and require surety for the performance of the agreement. On this the court found that "it is thus seen that the superintendent has power to let contracts for the construction of bridges, and to superintend the work. We think that this makes the superintendent the agent of the county for the purpose of the construction of the bridge or bridges, and that he may bind the county by requiring work to be done beyond that contemplated by the contract. Such authority in the superintendent is necessary for the county, in order that the structure may turn out to be substantial and lasting; and it is proper, in order that the contractor employed to perform the extra work may have a remedy therefor. If it should be foreseen by the superintendent, after the letting of the contract, that the work performed or contemplated by it would be insufficient or defective, the county might be greatly the loser if he could not require such additional work as would make it substantial and permanent, and bind the county therefor." It should be distinctly remembered, however, that unless the contract expressly stipulates that an architect has power to order additional work, the owner will not be held responsible for payment for such work, unless, as stated in the preceding paragraphs, it is absolutely necessary for the safety of the building and well being of the owner. In such a case the court, if passing favorably upon it at all, will very likely do so on the basis that the architect acted as the owner's agent, and as such had authority in an emergency to order such extra work to save the owner from loss, and hence the owner would be required to pay for such work.

54. Advantage of Observing Extra-Work Clause.—
It would be better for all parties concerned if the contract,

which expressly states that there shall be no extra work done unless ordered in writing, was lived up to, for if such a stipulation is once broken, it is likely that carelessness in this respect will become the rule rather than the exception during the whole of the building operation, and when the settlement comes to be made there is trouble for both the owner and the contractor. It may readily be understood how, during a large building operation, where there is looseness in carrying out the contract stipulations for orders for extra work, there may be numerous misunderstandings in regard to the various verbal orders given. These misunderstandings frequently arise from the fact that, in the hurry and bustle of a modern building operation, the average contractor is likely to interpret the slightest wish or action of the owner as implying an order for extra work, and as the operation proceeds, the careless owner continues to express his wishes for the most trivial variations, not realizing that the possibly unscrupulous contractor is carefully keeping account of all such suggestions and figuring on collecting a good price for them, as orders for extra work. Thus it is that when a contract is broken, in whole or in part, it is difficult to enforce it again. In making the final settlement, the owner is often inclined to admit that certain of the verbal orders were valid, but to claim that others were not, because of no written order being furnished. This very contradictory condition of affairs is obviously unjust, and would be looked upon with disfavor by any court, which would be likely to decide, as in a New York case, that "a written contract may be waived, either in whole or in part, by parol, and after it has been thus waived by one of the parties, neither he nor any one acting under him can reinstate it."

55. Estimating Charges for Extra Work.—Contractors, in estimating the amount to charge for extra work, are apt to base their estimate at day wages; hence it would be well to stipulate in the contract, either that all extra work shall be paid for at contract prices, or furnish some schedule upon which the charge for extra work may be based. When

the extra work is of the same nature as that specified in the contract, it is usual to itemize the estimate from which the contract has been made up, and to charge all extra work accordingly. Usually when this is done the itemized schedule is affixed to the contract, and agreed to by the parties concerned, as the basis upon which all extra work is to be charged.

In a like manner to that in which extra work is ordered, omissions are sometimes made from the work required by the original contract. Where this is done, the amount of the deduction to be made from the contract price, on account of the omitted work, should be immediately agreed upon with the contractor, and he, in deciding what will be a fair price to allow, must be governed by any stipulation bearing on the subject in the contract, and must also, if he wishes to deal honestly with himself, take into consideration any cost that may be caused by such omissions, which should be deducted from the allowance to be made to the owner.

Where no stipulation in regard to allowances for work omitted is made in the agreement, the views of the courts are very changeable as to whether the owner is entitled to any deduction. One court has handed down an opinion, that "the defendant (meaning the owner) had a right to demand the very work specified, and if it accepted anything less as sufficient for the purpose named, has no right to insist that a rebatement should be made for that reason"; whereas another court has held, that "the owner is entitled to a reasonable compensation for work which has, by his desire, been omitted." It is evident, then, that it would be well, and more satisfactory to all parties concerned, if stipulations were made in the agreement in regard to deductions to be made from the contract price for work omitted, and upon what schedule the prices by which the value of such work is to be estimated.

56. Decision as to Estimating.—A case often comes before the court that requires a decision as to how work shall be estimated. In such cases the court is generally guided by

the local custom in figuring such work, provided that this custom is well established among people engaged in building operations, generally understood by them, and reasonable in its results.

The Supreme Court of Missouri is agreeable to the custom which provides that in estimating for the laying of *stonework*, the door and window openings shall be measured as solid, and the corners measured twice. This same view is held in Maryland, with the further provision in regard to curved work, which should be measured at one and one-half times its actual length. However, on account of the widely differing customs that sometimes exist in the same state, too much dependence should not be placed upon the legal validity of any one of them.

57. Plaster Work.—A New York court once admitted evidence to prove that it was the custom among plasterers in Buffalo to charge for the entire surface of the walls, without making any deductions for the window and door openings, cornices, or baseboards. A Pennsylvania court took another view of such work by saying: "A custom of plasterers to charge half the size of the window openings, at the price agreed upon for the work and materials, is unreasonable and bad."

58. Brickwork.—Disagreements have arisen where brickwork was to be paid for by the thousand "in the wall," as to the method of counting the number of bricks, and, though the custom of allowing from 20 to 22 new bricks to a cubic foot of wall, or to a superficial foot of 12-inch wall, is well established among masons and bricklayers, the Supreme Court of Tennessee, in deciding such a case, would not admit it as evidence, and seemed to favor the actual count of the number of bricks used.

59. Excavating.—Before a contractor makes an agreement to do "earth excavation" at so much a cubic yard, it behooves him to ascertain the nature of the soil, as otherwise he may be disagreeably surprised to find that the bulk of it is through hard pan, which will cost much more to move

than ordinary earth, and which he did not figure on. If he should appeal to the court in an attempt to collect payment for the greater amount of work involved, he would more than likely find that his claim would not be sustained. Such a case was settled by the New York Court of Appeals, which decided that "earth excavation" included hard pan. A similar case arose in which an unfortunate contractor, who had failed to examine the nature of the soil carefully, agreed to excavate and back fill a ditch, at what would have been a very low figure even for earth. The contractor subsequently found that considerable of the excavation was in hard pan, and in some places rock. The contractor commenced suit for the extra cost of the excavation, but the court would not admit evidence to prove the additional cost of the excavation, and said "it was the duty of the contractor to have ascertained the nature of the soil before entering into the contract; ordinary intelligence would have enabled him to do so."

60. Using Sand From Premises.—Sometimes a stipulation in the contract provides that "sand taken from the premises shall be used in the masonry." A New York court decided in a case of this kind, where the work was found defective on completion, due to the unsuitableness of the sand used, that the owner had no redress, though there was nothing in the report of the court to determine whether or not the contractor had notified the owner, while the work was under way, that the sand was not suitable. It would, however, be good policy on the part of a contractor to notify the owner in a similar case.

61. Quality of Materials.—It is not unusual in contracts to find that the quality of many of the materials to be used is not specifically stated. A New York court has decided that it is implied that they shall be of fair quality, or at least they shall be sufficient and adequate. The decision of the court, as published in a law journal, is as follows: "In every contract for the furnishing of the materials, and

the performance of the work, in the absence of special provisions, there is an implied agreement on the part of the party who is to perform the work, and furnish the materials, that they shall not be of an insufficient and inferior description and value, and that the work shall not be totally inadequate to answer the purpose for which it was undertaken to be performed; and, though the agreement was that a specific sum should be paid for the work and materials, the claim may be reduced by showing that the work and materials were of an insufficient description and value, or it may be wholly defeated by showing that they were totally inadequate to answer the purpose for which they were to be furnished."

In regard to the stipulations in a Colorado specification that the "best lumber" should be used in a building, the Supreme Court decided that it meant the best that was ordinarily used in constructing buildings in that locality.

62. Old Materials.—A New York court, in regard to the ownership of old materials, said: "If the owner of land covered by houses, enters into a contract for the erection of other buildings on the same land, and does not provide for the use of the materials of the old building in the new, or does not remove them before the contractor takes possession under his contract, he will waive the right to them, and they will belong to the contractor."

63. Estimating Quantities.—The architect sometimes, though it is not usual for him to do so, prepares a bill of quantities of the material and labor that will be required in the construction of a proposed work. The contractor, however, should look with caution upon such an estimate, even though the architect should assent to its correctness, and should verify for himself any such bill of quantities, unless, of course, the contract is simply for the execution of such a bill of material, instead of the erection of the building complete; for should the contractor base his agreement upon this bill of quantities and afterwards find that the actual

amount of material and labor required exceeded the estimate, he would very likely find that nothing could be recovered through the courts.

Even in England, where the profession of "quantity surveying" is practised to some considerable extent, and independent of the architect, the courts have held, time and time again, that no such estimate of the work was a guarantee, and that neither the quantity surveyor, architect, nor owner were responsible for its correctness. Hence, it would seem that it was unnecessary for the architect to prepare any such bill of material, as the courts seem to be of the opinion that builders, as a rule, understand their business, and are capable of making their own estimates, and should be responsible for them, provided the extent of the work is clearly stated to them by the architect or owner, through the plans or specifications prepared for the building.

RESPONSIBILITY AND RISK.

BUILDER'S RESPONSIBILITY.

64. Safety of Building During Construction.—The responsibility for the safety of a building during its construction usually devolves upon the contractor, as has been decided in numerous cases. In a case where a contractor had entered into an agreement to raise a house and build under it another story, the building, while the work was progressing, fell and injured the adjoining property. The owner of the adjoining house entered suit for damages against the owner of the house undergoing alterations, but was defeated. The court held that the contractor was alone responsible, and said: "The distinction on which all such cases turn is this: If the person employed to do the work carries on an independent employment, and acts in pursuance of a contract with his employer, by which he has agreed to do the work on certain specified terms, in a particular manner, and for a specified price, then the employer is not liable. The power

of directing and controlling the work is parted with by the employer, and is given to the contractor." There are exceptions to this rule, however, where the courts have placed the blame upon the owner; such a case was decided by the Supreme Court of Massachusetts. It seems in this particular case a mason contracted to build a party wall. At the time the work was done there was freezing weather, and when the wall had progressed as high as the fourth story, and the floorbeams were in place, the weather moderated, causing the mortar to thaw. The wall, thus softened, fell and damaged an adjacent building. In the suit which followed, the owner of the wall claimed that the contractors were alone responsible. Evidence was introduced tending to prove that the wall had not been properly braced, though it had been accepted by the architect as far as it had progressed; and also that the strength of the wall had been impaired by flues, built in it, at the request of the owner of the adjoining property. The court, however, refuted the claim of the owner, that the contractor was alone responsible, by saying: "The general rule of law is that the person who, for his own purposes, brings on his land, and collects and keeps there, anything likely to do mischief if it escapes, must keep it at his peril; and if he does not do so is, *prima facie*,* answerable for all the damage which is the natural consequence of its escape. This rule has been applied to dangerous animals, cesspools, to reservoirs, and to accumulations of snow and ice upon a building, by reason of the form of its roof."

It has generally been held in court, that where the fault or injury was due to the negligence of a subcontractor, the principal contractor was responsible.

If the contract provided that the building is to be erected according to certain plans and specifications, and the contractor agrees to such a stipulation, with the result that,

*In law, a *prima facie* case is one which is established by sufficient evidence, and can be overthrown only by rebutting evidence adduced by the other side—a case consisting of evidence sufficient to go to the jury; that is to say, one which raises a presumption of fact, and hence will justify a verdict, though it may not require one.

when erected, the building is faulty and unsafe, it has been settled in the courts that the contractor cannot be held responsible if he has fulfilled the contract, and carefully carried out the drawings and specifications. On the other hand, should he change the construction, or deviate from the drawings or specifications, he is held responsible for the safety of the building.

65. Insurance.—The average contractor is called upon to run numerous risks from fire, etc., which, if realized, would more than likely bankrupt him beyond any possibility of recovery. If the building should burn down, or be subjected to destruction by any other unforeseen agency, during the progress of construction, it is generally held that the contractor is responsible, and is bound by the stipulations in the contract; though sometimes it is provided in the contract that should the contractor be delayed by such agencies as fire, water, cyclones, etc., an extension of time will be granted.

Hence it is the duty of the builder, both towards himself and the owner, to guard against such contingencies by taking out the proper insurance on the building. The law is quite strict with contractors who have been unfortunate enough to have the building destroyed for which they contracted, and usually holds that he must finish the building according to the terms of the contract, no matter how severe it may be upon him. It has sometimes been held, when a building has been destroyed by some unforeseen agency, that the builder was released from his contract by the "act of God," that is, by some power beyond human control. Such a case occurred in Connecticut, where a contractor had agreed to build a schoolhouse; it was nearly completed and \$1,000 had been paid on account when it was struck by lightning and burned. The committee with which the contract had been made asked the contractor to commence rebuilding, and offered to extend the time of completing, which was nearly up when the fire occurred. The contractor, however, refused, saying that he had been released from the contract

by an "act of God." The decision of the Supreme Court was against this, however, and held that he was not released.

66. Responsibility for Accidents.—The following rule of the Supreme Court of Illinois in a similar case, where the building under erection was blown down once and fell down the second time, caused, according to the contractors, by unforeseen defects in the soil, is interesting and explains itself: "If a party enters into an absolute contract, without any qualifications or exceptions, and receives from the party with whom he contracts the consideration of such an engagement, he must abide by the contract, and either do the act, or pay the damages; his liability arises from his own direct and positive undertaking." "If the covenant be within the range of possibility, however absurd or improbable the idea of execution may be, it will be upheld; as where one covenants it shall rain tomorrow." "To bring the case within the rule of dispensation, it must appear that the thing to be done cannot by any means be accomplished; for, if it be only improbable, or out of the power of the obligor, it is not deemed in law impossible." "No matter how harsh and apparently unjust in its operation the rule may occasionally be, it cannot be denied that it has its foundation in good sense and inflexible honesty. He who agrees to do an act should do it unless absolutely impossible. He should provide against contingencies in his contract. Where one of two innocent persons must sustain a loss, the law casts it upon him who has agreed to sustain it, or rather, the law leaves it where the agreement of the parties has put it." The court further said, in reciting the case, "If a party for a sufficient consideration agrees to erect and complete a building on a particular spot, and to find all the materials and do all the labor, he must erect and complete it, because he has agreed to do so. No matter what the expense, he must provide such a substructure as will sustain the building upon the spot, until it is completed, and delivered to the owner." "If the difficulties are apparent on the surface, he must overcome them. If they are not, but become apparent by excavation,

or the shrinking of the building, the rule is the same."

"The cases make no distinction between accidents that could be foreseen when the contract was entered into, and those that could not have been foreseen; between accident by the fault of the contractor, and those where he is without fault; they all rest upon the simple principle. Such is the agreement, clear and unqualified, and it must be performed, no matter what the cost, if performance be not absolutely impossible."

"The whole defense was properly overruled, because it did not show the performance of the contract impossible, or any lawful excuse for non-performance of the contract."

ARCHITECT'S AND OWNER'S RESPONSIBILITY.

67. Suits for Liability.—In The American Institute of Architects' and the National Association of Builders' official form of contract, given in full in Art. 76, it will be noticed that there is in Article I a stipulation that the architect is "acting, for the purpose of this contract, as agent of said owner." In case of suit for liability which might be entered against the owner, by persons injured while working on the building, this clause is likely (and especially so under the laws of some states) to cause trouble; for a shrewd lawyer might trace every occurrence about a building as emanating directly through the orders of the architect, who, acting as agent, makes the owner responsible for such occurrences; and hence the particular one that led to the injury of the plaintiff.

Such a calamity may be guarded against by some such clause as is given in the first form of contract hereinafter referred to. This clause places the responsibility for liabilities upon the contractor, and reads as follows: "The contractor shall furnish all transportation, scaffolding, apparatus, ways, works, machinery, and plant requisite for the execution of this contract, and shall be solely answerable for the safe, proper, and lawful construction, maintenance, and use of the same; he shall cover and protect his work from damages, and all injury of the same, before the completion of this contract, shall be made good by him; and shall be solely

answerable for all damage or delay to the owner or his property, to other contractors or other employes of the owner, to neighboring premises, or to any person or property, due to the improper, illegal, or negligent conduct of the contractor, or of his subcontractors, employes, or agents, in or about the said building or the execution of the work covered by this contract or any extra work undertaken as hereinafter provided."

The architect is thus relieved of his position as agent in all cases that might place the responsibility for liabilities upon his client, by that portion of the clause in the same contract which reads: "Neither the architect nor any person employed by him shall have any control or direction over the progress of the work, excepting the power of rejecting it, nor any control or superintendence over the scaffolding, apparatus, ways, works, machinery, or plant, the sole responsibility for which shall rest with the contractor; and further, the architect shall not be deemed the agent of the owner for any purpose whatsoever, except as the owner may in fact give him a special and express authority."

Since most first-class builders have their liabilities insured, they would have no incentive to throw such responsibilities upon the owner; but in order that the owner may be secure against any legal action by injured employes, it would be best to insert such clauses as are given above.

68. Importance of Insuring.—Where the rules of the insurance companies will allow it, the owner should insure his own and also the risks of all the contractors engaged upon the work, which, in case of loss by fire, will be paid according to the particular interests of the parties engaged. Should the laws of the insurance companies not permit them to issue a policy in the names of more than one person, the builder should be required to insure to the full amount of his interest; and, since they are apt to neglect doing so for the sake of the financial saving, the architect should demand this policy and see that it is all that is required, retaining it in his hands for safe keeping.

The importance of a stipulation to this effect is evident; for if the builder should neglect to insure, and the partially erected building should burn down, he would, in many cases, be thrown into bankruptcy and the owner would be compelled to finish the contract with the assignee or some other contractor.

LEGAL MEANING OF WORDS.

69. "Commencement" and "Erection."—A question sometimes arises as to when a building is properly *commenced*; whether it is when the batter boards are set, when the excavation is started, or when the first footing stone is laid. The New Jersey Supreme Court held the opinion in two cases that a building was commenced when the excavation was begun.

The direct meaning of the word *erection* is somewhat obscure, and, while it is a word much used in contracts and specifications, there seems to be a great difference of opinion in regard to what may be inferred by the phrase *upon the erection of*. Some hold that it means the completion of the building or structure; others claim that something else is meant. A case in Illinois called for a decision from the Supreme Court as to when a building should be considered as being erected. The court decided that the building in question be considered as erected, although it had no roof on, and not one gable or chimney was built; the flooring had not been laid, but the materials for the roof, floor, and windows had been delivered on the ground. In Indiana, it was held by the court that a house had been erected wherein the plastering had not yet been done, and some of the windows had not been placed; and most of the states in which such cases have arisen have held the opinion that a building was erected where the walls were up and materials on the site with which to complete it.

70. "As Directed."—The expression *as directed*, as pertaining to its use in specifications in connection with the manner in which work shall be done, was passed upon by the

Supreme Court of Missouri, during a controversy as to whose directions were meant, and was held to imply those of the owner.

71. "Not Less."—The phrase *not less*, which is much used in specifications, hence forming a term in the agreement, seems to be rather unnecessary in most cases, and liable to cause trouble. It is principally used in making some such stipulation as this: "The cellar shall be excavated to a depth of not less than ten feet." A stipulation like this was made in a contract for the erection of a building in the state of New York. After the contractor had excavated to the required depth, it was found that the nature of the soil required further excavation in the footing trenches, and in consequence the cellar wall had to be extended. In the suit brought by the contractor to recover the cost of the extra work, it was decided by the Supreme Court that it was due him. In all cases of this kind, the court will carefully consider the meaning of the contract to determine whether the contractor really intended to bind himself to do the work beyond the given dimensions should the architect, in the execution of the work, deem it advisable, owing to the conditions unforeseen.

72. "More or Less."—A contract will sometimes stipulate that a certain amount of material *more or less* shall be furnished. A New York court held that the term as used implied the delivery and acceptance of just the actual amount of material required for the work, and that the term as used did not mean any definite quantity.

73. Other Phrases.—In most formal contracts, it is usual to refer to the specifications, which constitute part of the agreement, as the *specifications hereto annexed*. It is held by the courts that it is not necessary that the specifications should be actually attached to the formal contract; for so long as the particular specification referred to in the contract can be proved as the one meant, it is all that is legally required. Also, if the phrase, *the specifications signed herewith*, is used in the formal contract, it is not actually required that they should be signed, provided the ones

intended in the formal contract can be identified without such signatures. It undoubtedly would be advisable, however, to have all specifications, and even plans, signed, so that there may be no controversy in regard to the ones designated in the formal contract.

FORMS OF CONTRACT.

74. Specimen Contracts.—The preceding pages have been devoted to points of law likely to be raised in respect to contracts, the study of which will enable the student, when he is called upon to become a party to a contract, to do so intelligently.

The two forms of contract which are now given in full are representative and legally correct. The first form is very complete, provisions being made in it to cover every contingency that is likely to arise in an important building operation, and which long experience in building transactions has demonstrated should be guarded against. The second form is more brief, and not so complete in the extent of the ground covered, but is the one that is generally used. This contract is the official contract of The American Institute of Architects and National Association of Builders, and, being copyrighted, can only be used in the printed form, which is obtainable at nearly all stationery supply stores. It has been carefully compiled by a joint committee of the Institute and Association, and is subject to such change and modification each year as may be deemed necessary to make it more complete or binding.

75. Building Contract.—The text of the ordinary building contract herein first referred to follows:

BUILDING CONTRACT

between.....of.....
 hereinafter called the Owner, and.....
 of.....hereinafter called the Contractor, made
 at.....the.....day of.....18,....

The respective parties hereto, each in consideration of the agreements of the other herein set forth, agree each with the other as follows:

THE CONTRACTOR'S AGREEMENT.

The Contractor agrees to.....

.....
 according to certain plans and specifications prepared by.....
of.....Architect. Said plans and specifications, together with this contract, of which they are to be deemed a part, are to be construed together, so that any work shown on the plans, though not mentioned in the specifications, or vice versa, or any provision of the contract not repeated in the plans or specifications, or vice versa, is to be executed by the Contractor as a part of this contract. Figured dimensions are to prevail over scale measurements. All things which in the opinion of the Architect may fairly be inferred from the plans and specifications, are to be executed by the Contractor as a part of this contract. If complete drawings of details have not yet been made, the same, when made and conforming to said plans and specifications, are to constitute a part of this contract, the Architect being the sole judge as to whether said detailed drawings conform to said plans and specifications. All the plans and drawings received by the Contractor at any time during the continuance of this contract are at its termination to be returned to the Architect.

All material and work, where the quantity, dimensions, and quality are not shown on the plans or specified in the specifications, are to be furnished in sufficient quantity and of sufficient dimensions for the proper execution of the work as determined by the Architect, and the quality and workmanship are to be the best throughout and satisfactory to the Architect.

The Contractor is to take out at his own expense all necessary permits from the municipal or other public authorities, to give all the notices required by law or municipal ordinance, and to pay all fees and charges incident to the due and lawful prosecution of the work covered by this contract.

If this contract involves excavation or masonwork, the Contractor is to execute the same without encroaching upon adjoining public or private property, and shall procure for the Owner the certificate of some competent surveyor, to be selected by the Owner, that there has been no such encroachment; unless the plans themselves provide for such encroachment, in which case the Contractor shall be relieved from all responsibility as to the correct location of the walls and foundations in this respect.

The Contractor shall devote his time and personal superintendence to the execution of this contract, and shall employ a competent foreman or clerk of the works, who shall at all times be present while any work is being done under this contract, at the building.

The entire work and all its parts, including material, workmanship,

and rate of progress, shall be satisfactory to the Architect. All materials rejected by the Architect, whether worked or unworked, and whether affixed to the building or not, shall be removed from the premises (and for that purpose taken down if already attached to the building) at the request of the Architect; and all work condemned by the Architect, as in any way unsound or as not conforming to the terms of this contract, shall be taken down forthwith and rebuilt by the Contractor in accordance with the contract and in a manner satisfactory to the Architect. The Contractor shall dismiss any of his employes if the Architect considers said employes incompetent or careless and so informs the Contractor.

The Contractor shall clear away all dirt and rubbish caused by his operations as often as requested by the Architect or Owner, and shall leave the premises at the termination of this contract free from such dirt and rubbish and in a neat and clean condition.

The Contractor shall prosecute the work speedily and continuously

and the entire work covered by this contract shall be finished by theday of.....18.... The damages for default are fixed at.....dollars for every day thereafter that the said work shall remain unfinished.

The Contractor shall make good all defects, omissions, and violations of the terms of this contract whensoever discovered, during the progress of the work or afterwards, notwithstanding any payments that may have been made, or any certificates that may have been given, or any possession or acceptance of the work by the Owner, and shall be responsible for any damages that may be caused in making good said defects, omissions, or violations.

The Contractor shall comply with all the laws, ordinances, and regulations for the time being in force in the city or town where the building is situated and relating to the building or other work included in this contract, and shall satisfy all the requirements of the Inspectors (if there be such).

The Contractor shall furnish all transportation, scaffolding, apparatus, ways, works, machinery, and plant requisite for the execution of this contract, and shall be solely answerable for the safe, proper, and lawful construction, maintenance, and use of the same; he shall cover and protect his work from damage, and all injury to the same, before the completion of this contract, shall be made good by him; and shall be solely answerable for all damage or delay to the Owner or his property, to other Contractors or employes of the Owner, to neighboring premises, or to any person or property, due to the improper, illegal, or negligent conduct of the Contractor, or of his subcontractors, employes, or agents, in or about the said building or the execution of the work

2. Unless the Contractor shall deliver to the Owner the written certificate of the Architect that the work to the stage in question has, in his opinion, been done in the manner herein agreed.

3. Unless (if the contract includes excavations or masonwork on outside wall) the Contractor shall deliver to the Owner the written certificate of some competent surveyor to be selected by the Owner that there has been no encroachment upon adjoining public or private property.

4. Unless the property is free from all lien for debts due or claimed to be due from the Contractor, and satisfactory evidence thereof furnished (if requested) to the Owner.

ALTERATIONS AND EXTRAS.

The Architect may, in writing, and from time to time, order the Contractor to make any changes in the work which do not increase the cost to the Owner or affect the time of completion. In case said changes make the work less expensive to the Contractor, a proportional deduction shall be made from the contract price above specified. In no case shall any change be made in the work which shall increase the cost of the work to the Owner, or involve any extension of time, without his express and special consent; and, if the Contractor shall proceed to execute such change without first obtaining such consent, he shall be concluded against making any extra charge for the said change or any claim for further time.

In case of any change ordered by the Architect as aforesaid, or in case any other changes in the work are made by the mutual consent of the parties hereto, whether affecting the contract price or not, or the time of completion or not, all and singular the other provisions of this contract shall remain in force, and apply to the contract as thus altered.

ORDERS.

If any orders are accepted by the Owner (and it is understood that he shall be under no obligation to accept any), such acceptances shall be conditional on the due performance by the Contractor of all and singular the provisions of this contract, and subject to alterations as aforesaid.

THE ARCHITECT.

The Architect mentioned in this contract is understood to beof.....or such other Architect as the Owner may hereafter select; any change to be notified to the Contractor in writing.

The Architect shall have authority to enter and inspect the work at all times, to reject all material (whether set up or not) and to condemn

all work which in his opinion is not in conformity with the provisions of this contract, and to do all the things hereinbefore set forth as within his powers. Neither the Architect nor any person employed by him shall have any control or direction over the progress of the work, excepting the power of rejecting it, nor any control or superintendence over the scaffolding, apparatus, ways, works, machinery, or plant, the sole responsibility for which shall rest with the Contractor; and neither of them shall have power to order extras or alterations, except as above provided, or any authority other than that expressly set forth in this contract. The Architect shall not be deemed the agent of the Owner for any purpose whatsoever, except as the Owner may in fact give him a special and express authority.

MISCELLANEOUS PROVISIONS.

No payment of money under this contract, nor any acceptance or possession taken of the work done by the Contractor, nor any certificate given, shall be evidence of the performance of this contract or be construed as a waiver of any of its provisions by the Owner; nor shall any waiver of any breach of this contract be held to be a waiver of any other or subsequent breach.

If, in the opinion of the Architect, the Contractor is obstructed or delayed in the prosecution or completion of the work by the neglect, delay, or default of any other contractor, or by any damage which may happen thereto by fire, or by the unusual action of the elements, or by the abandonment of the work by the employes in a general strike, then the Contractor shall be entitled to such extension of the time specified above for the completion of the work as the Architect shall in writing certify; provided, however, that claim is made by the Contractor at the time and in writing.

If at any time before the completion of this contract the Contractor becomes bankrupt or insolvent, or makes an assignment for the benefit of creditors, or assigns this contract or sublets any part of it without the consent of the Owner first obtained in writing, or becomes incapable of completing the contract, or shall at any time for six days refuse or neglect to proceed with the contract work in the manner herein agreed to the satisfaction of the Architect, then the Owner may at once terminate this contract by a written notice delivered to the Contractor in person or at his usual place of business, and proceed to complete the work with other mechanics or contractors, and account to the Contractor or his legal representatives as follows: The Owner shall be credited with all payments theretofore made by him to the Contractor, with the entire cost of completing the work with said other mechanics and contractors, and with all damages by delay or otherwise, caused by the default of the Contractor, including reasonable expenses of counsel. If the contract price exceeds the total amount of

these credits, the excess shall be paid to the Contractor or his legal representatives. In case orders accepted by the Owner are outstanding, the holders thereof shall be entitled to such excess in preference to the Contractor or his legal representatives. If, however, the total amount of the said credits exceeds the contract price, the excess shall be due from the Contractor to the Owner. In such accounting, the Owner shall not be held to obtain the lowest figure for the work of completing the contract; but all sums actually paid by him for such completion shall be credited to him.

All material delivered at the building by or on account of the Contractor, and intended to be incorporated with the building, shall become the property of the Owner as delivered; but the Contractor may repossess himself of any surplus left at the completion of the contract. All scaffolding, apparatus, ways, works, machinery, and plant brought upon the premises by the Contractor, or used by him, shall remain his property, but in case of default and a completion of the contract work by the Owner, the latter shall be entitled to use the said scaffolding, apparatus, ways, works, machinery, and plant without cost or liability for depreciation or injury by use.

If the Owner does not make the payments herein provided as and when the same shall become due and payable he shall be liable to the Contractor for interest on the same; and if such default continues for a period of ten days, the Contractor may, by a written notice delivered to the Owner in person or at his usual place of business, terminate this contract. But the acceptance of any money under this contract subsequent to such defaults shall operate as a waiver thereof and of the right to terminate this contract by reason thereof.

The Owner shall keep the building and the material on the premises insured against fire in such companies as he shall select, for the benefit of himself or any mortgagee and of any and all contractors on the building who shall request such insurance in writing. The expense of said insurance shall be borne by the Owner; but he shall not be responsible for carrying too little insurance, unless the Contractor has requested him in writing to insure in a certain specified amount, and the Owner has neglected to do so for an unreasonable length of time. In the event of a fire, the insurance shall be divided between the Owner and any mortgagee and those contractors for whose benefit the insurance was taken out, as their interests may appear; and the parties hereto shall respectively proceed to the completion of this contract.

All disputes arising out of this contract or the performance or breach thereof shall be settled by mutual agreement or in a court of law or equity before a single justice, auditor, or special master, and no claim shall be made for a trial by jury on the whole case or special issues.

In witness whereof, we, the said
 and the said.....
 hereto set our hands and seals this.....day of18....

76. "Uniform Contract."—The so called "Uniform Contract" adopted by The American Institute of Architects and the National Association of Builders is a printed instrument with spaces left for filling in the specific details peculiar to each case, as shown in Form I. The six lines left blank for the names of the contractor and owner, are ample for the name and address of either party when it consists of a firm or long-titled corporation. The fourteen lines at the bottom of Form I are for a complete description of the building to be erected, together with its location.

Form II is printed on the second page of the "Uniform Contract" and continues the terms of the agreement down Art. VI, where five lines are left for the dates at which various portions of the building shall be completed; and six additional lines are left blank to insert provisions for contingencies of delay, such as strikes, interference of other contractor, severe weather, etc.

Form III constitutes the third page of the "Uniform Contract" and contains in Art. IX space for the gross amount of the contract to be written in; under which are provided blank lines whereon to state the number, amount, and time of payment of each instalment of the contract price.

Art. XI provides the insurance clause and leaves spaces for special conditions of insurance, if such are required. Then follows the space for the signatures of the contracting parties, while under the words "In presence of" is placed the signature of a witness, who is usually, though not necessarily, the architect.

The contract is folded twice, after it has been signed, and on the outside of the fourth page is a blank form, which, when filled out, gives information regarding the document, as shown in Form IV. This is not necessarily a part of the document, but it is simply an indorsement or index by which the contract may be recognized without unfolding it.

PERMITS.

INTRODUCTION.

77. Granting of Permits.—After the plans and specifications have been prepared and the contract has been drawn up and signed, and before the actual work can be commenced, it is necessary for the contractor to comply with the ordinances of the city in regard to the securing of the proper permits. The laws and ordinances governing the granting of permits vary somewhat throughout the country; hence it will only be possible to consider the permits granted by some representative city.

New York being the largest building center in the United States, and the city from which many smaller cities and towns have modeled their building laws and ordinances, the permits there required will be taken as a model and considered in detail.

78. New York Practice.—The building laws of New York City require that: "Before the erection, construction, or alteration of any building, or part of any building, or any platform, staging, or flooring to be used for standing or seating purposes, in the City of New York, is commenced, the owner or his agent or architect, shall *submit* to the superintendent of buildings a detailed statement in writing of the specifications, and a full and complete copy of the plans of such proposed work, which shall be accompanied with a statement in writing, sworn to before a notary public or commissioner of deeds, giving the full name and residence (street and number) of the owner, or of each of the owners of said building, or proposed building, platform, staging, or flooring. If such erection, construction, or alteration is proposed to be made by any other person than the owner or owners of the land in fee, the person or persons intending to make such erection or alteration shall accompany said detailed statement of the specifications and copy of the

plans, with a statement in writing, sworn to as aforesaid, giving the full name and residence (street and number) of the owner or owners of the land and also of every person interested in said building or proposed building, platform, staging, or flooring, either as owners, lessee, or in any representative capacity. Such statement may be made by the agent or architect of the person or persons hereinbefore required to make the same. Said sworn statement, and detailed statement, and copy of the plans, shall be kept on file in the office of the superintendent of buildings, and the *erection, construction, or alteration of said building, platform, staging, or flooring, or any part thereof, shall not be commenced or proceeded with, until said statements and plans shall have been so filed, and approved by the superintendent of buildings.*"

APPLICATION FOR PERMIT FORMS.

79. The Statement or Affidavit.—The sworn statement required by the above building ordinance is obtained in a printed form from the department of buildings of the City of New York. These forms may be obtained either for the "Erection of New Buildings," as shown in Form V, or "Alterations to Existing Buildings," as shown in Form VI.

The architect fills out either of these statements, according to whether it is the construction of a new building, or alteration, for which the permit is desired. This statement must be sworn to by the owner, before any duly authorized notary public or magistrate. But in regard to the securing of permits, the building laws of New York City state: "But the superintendent may, in his discretion, and for reasons to be stated in writing by the applicant, and filed with the plans and detailed statements, dispense with the making of said sworn statement in any case. Nothing in this action shall be construed to prevent the superintendent of buildings from granting *his approval for the erection of any part of a building*, where plans and detailed statements have been presented for the same,

before the entire plans and detailed statements of said building have been submitted. Any false swearing in a material point in any statement submitted in pursuance of the provisions of this section shall be deemed perjury, and shall be punished as such. *Ordinary* repairs may be made without notice to the department of buildings, but such repairs shall not be construed to include the cutting away of any stone or brick wall, or any portion thereof, the removal or cutting of any beams or supports or the removal, change, or closing of any staircase."

The specifications mentioned in the preceding ordinance are in the form of blank applications, which should be filled out by the architect. These printed application blanks may be obtained from the department of buildings, and are in two different forms; one for the erection of new buildings, and the other for alterations to existing buildings, whichever may be required.

80. The Application.—The "Application for Erection of New Buildings," the first page of which is shown in Form VII, is filled out by the architect and submitted to the department of buildings, with the plans of the proposed structure and the affidavit of the owner.

The second page of the application, shown in Form VIII, calls for additional information concerning the occupancy of the building and the use of party walls. On this page is also printed an extract from the building laws regarding bond stones, fire-escapes, etc., so that there may be no excuse for not carrying the work out in accordance with the regulations.

The third page of the application, shown in Form IX, is reserved for the building inspector's report, wherein he calls to the attention of the department any violations of the laws or regulations committed during the erection of the building.

The fourth page of the application, shown in Form X, is reserved for the indorsement or title, together with a blank form on which the superintendent of buildings signifies his

approval or disapproval of the application and states his reasons therefor.

If *disapproved*, the application and plans must be altered so as to conform to the requirements of the department, before the permit to build will be granted. When all the requirements have been fulfilled and the application is signed by the superintendent, it becomes a *permit*, and a copy of it is given to the architect (or the builder) to show, in case his authority to build is questioned.

81. Permit for Alterations.—When the permit required is for an alteration to an existing building, then the first page of the application is as shown in Form XI, and the second page as in Form XII. The information demanded in this application pertains almost entirely to the character and condition of the existing building, as no matter how well a building may be constructed, the law requires that any alteration in it must comply with all the latest regulations of the building department. A building erected twenty years back as a private residence may be altered at present to be used as a factory. Then every regulation, regarding fire-escapes, ventilation, plumbing, etc., must apply to this structure as a factory, and its existence as a residence ceases when the alteration in *purpose* is made, whether any material alteration to the building has been made or not. The third and fourth pages of the "Application to Alter, Repair," etc. are similar to Forms IX and X.

82. Plumbing Permits.—The permit required for alteration or erection of plumbing work, is in the form of a specification of the materials and fixtures to be used. This specification is obtainable in blank from the building department, as shown in Forms XIII to XVII. It contains eight pages, three of which are omitted herein. These three pages follow between Forms XV and XVI, and contain the fourteen articles of regulations governing the plumbing, drainage, water supply, and ventilation of New York buildings.

When the plumbing specifications are signed by the commissioner of buildings they constitute both a permit and a specification by which the work must be done.

83. Light and Ventilation Permits.—If the building to be erected has the character of a hotel; apartment house, tenement or lodging house; office building; theater; or, in fact, any building wherein there is likely to be assembled a large number of people, either for living, business, assembly, or amusement, there will be required from the architect a filled-out application for the approval of the plans for light and ventilation of the proposed tenement or lodging house, etc. This application, which is obtainable in a printed form from the department of buildings, is shown in Forms XVIII to XXIII.

84. Other Permits.—Before the actual building operation can be carried on, it is necessary that permits shall be obtained for the obstruction of the street and sidewalk, due to the process of excavation, and to materials lying thereupon. Permits must also be obtained for opening the street, and tapping the water main in order to get a supply for building purposes; and also to make connections for the service pipe, and connections for the drainage to the sewer. These permits are usually obtained by the contractor, as stipulated in the general conditions of the specifications. The other permits for opening the streets, to tap gas and steam mains, and to make electrical connections, are usually taken care of by the gas, steam, and electrical companies who are going to supply the gas, steam, or electricity.

85. Plans and Affidavits.—It will be necessary for the architect, after he has drawn up these application forms, to send with each a complete set of plans, setting forth all the information that will be required by the particular application blank.

For instance, with the "Application for Erection of Buildings," there should be sent a complete set of plans, together with a survey of the ground plot showing the

buildings located upon it. The plans should set forth the dimensions of the building, show the size of foundation and foundation piers, window and door openings, thickness of walls, design of floor system, beams and girders, etc., supporting piers, columns, roof construction, and, in fact, all necessary information in regard to the general plans and construction of the building. All plans must be drawn to a uniform scale and must be on tracing cloth, or cloth prints, properly designated and colored. The plans, which accompany the specifications for the plumbing and drainage, should be made in ink upon tracing cloth, or cloth prints should be provided, and should show in full particulars all the sanitary arrangement of the building with all supply, sewer, and vent pipes, together with all particulars in regard to how they are connected and run, also all partitions and method of ventilating water-closet apartments, and in what portion of the building these are located.

In order to clearly show all that is required, it will generally be necessary to furnish plans, a longitudinal and transverse cross-section, and detail sections where required.

The application to the superintendent of buildings, to approve plans for light and ventilation, should be accompanied by drawings which should include the plans for all floors, including the cellar and basement, and, if necessary, transverse and longitudinal sections of the building; each shaft and court should be shown and the dimensions of the same clearly marked. All plans must be drawn to a uniform scale, not less than one-quarter inch to the foot, and be tracings on cloth or cloth prints.

Where the plans prepared to accompany the general "Application for Erection of Buildings" clearly show all that is required under the application for light and ventilation, it is seldom necessary to prepare additional plans as above mentioned, as the one set will answer both purposes, though it is sometimes advisable to prepare the additional plans where there is likely to be complication and confusion in the attempt to show the features of both applications on the one set of drawings. Other particulars in regard to

making drawings, to accompany the application, which shall fulfil the requirements of the building department, are stipulated on the printed forms, and must be complied with.

It is necessary, therefore, before a building permit can be secured for the architect, to prepare a sworn statement or affidavit. He will also be required to fill out and prepare triplicate copies of the application for "Erection of Buildings" together with triplicate copies of the "Specifications for the Plumbing and Drainage," and where the building is a lodging, tenement, apartment house, or some similar structure, triplicate copies will be required of the application for the approval of plans for light and ventilation. Of these triplicate copies, *one*, signed by the superintendent of buildings, called the *original*, is kept on file in the building department; the other two are considered copies and are given, one to the architect as his permit, and the other to the building inspector, in order that he may see that the terms are properly complied with.

With the sworn statement and the triplicate copies of each of the applications there should be furnished the requisite plans pertaining thereto; only one set of plans being required to accompany the three copies of each of the application blanks.

One plan or survey of the lot or plot of ground, with the plan of the building outlined upon it, shall also be furnished and sent with the applications and sworn statement. It is required that the building lines be shown upon the ground plan sent with the general "Application for Erection of Buildings."

GRANTING OF PERMIT.

86. Department of Buildings.—After the affidavit, application, and plans have been filed, the department of buildings will, in due course of business, consider them. If they are approved the architect will be notified to that effect, and upon applying at the department will receive one of each of the applications. These applications will be marked

approved and signed by the commissioner or his deputy, and thus signed will constitute the permits.

Should the plans and applications be disapproved, the architect will be so notified. Upon applying at the department, the plans and specifications will be handed to him, the particular items or details that have been disapproved will be marked on the applications and upon the drawings, and the applications will be marked disapproved upon the back. The architect after noting the items that have been disapproved should, upon an amendment blank furnished by the department, correct each item, successively, in such a manner as he may think will meet the approval of the department; and he may, if it will not confuse the drawings materially, correct such details upon them as have been disapproved. All the above must be attended to at the department, as they will not permit the plans and applications to be taken away: though the architect may, if the changes in the original drawings are considerable, make new drawings at his office that will embody the changes required by the department, and file them with the amendment.

When the amendment blank has been finished by the architect, and the changes have been made upon the drawings, they will be returned to the clerk, who will stamp the amendment with the date, and the application will be again considered. If the amendment is approved, the architect will be notified, and upon applying at the department he will copy the items of the amendment upon the back of the application blanks and sign his name. The applications will then be signed by the commissioner or his deputy, and will constitute the permits.

Sometimes the department will approve the application for "Erection of Buildings," when the application for "Plumbing and Drainage," or "Light and Ventilation" may still be held by the department under advisement; in such a case, the architect may make arrangements with the contractor to proceed with the work. This, however, is not always advisable, for should the application for "Plumbing and Drainage" or "Light and Ventilation" be afterwards

disapproved, and require amending before they are granted by the department, it may materially affect the work already started and cause considerable trouble and expense. Therefore, whenever possible, it would be well to obtain all of the required permits before commencing the work on the building. The excavation may be commenced, however, and in most cases the foundations laid without great risk of having such work affected by the subsequent "Plumbing and Drainage" or "Light and Ventilation" permits.

NEW YORK BUILDING LAW.

POWERS OF SUPERINTENDENT OF BUILDINGS.

87. The Superintendent of Buildings.—In connection with the application for permits, it will be interesting to note the powers of the superintendent of buildings, and the provisions made by which the building laws may be modified, also the penalty for violating the same. Therefore, the following is quoted from the building laws of New York City.

"The superintendent of buildings shall have power (except as herein otherwise provided) to pass upon any question relative to the *mode, manner of construction, or materials* to be used in the erection or alteration of any building, or other structure, provided for in this title, in any part of the city of New York, to make the same conform to the true intent and meaning of the several provisions of this title.

"He shall also have the power to vary, or modify, the provisions of this title, upon application to him therefor, in writing, by an owner of such building or structure, or his representative, where there are practical difficulties in the way of carrying out the strict letter of this law, so that the spirit of the law shall be observed, the public safety secured, and substantial justice done.

"But *no such deviation* shall be permitted, unless a record of the same shall be kept by the said superintendent of buildings, and a certificate to be first issued to the party applying for the same."

BOARD OF EXAMINERS.

88. Certificate of Board of Examiners.—“Certificate shall not be issued by the superintendent until a board of examiners, consisting of a member of the ‘New York Chapter of the American Institute of Architects’; one member of the ‘New York Board of Fire Underwriters’; two members of the ‘Mechanics and Traders’ Exchange’ of said city, one of whom shall be a master mason and one a master carpenter; one member of the ‘Society of Architectural Iron Manufacturers’ of said city; one member of the ‘Real Estate Owners’ and Builders’ Association’ of said city, who shall be an architect or builder; one member of the ‘New York Real Estate Exchange, Limited,’ who shall be an architect or builder; and the chief of said fire department; all of whom shall be appointed by their respective organizations (and so certified to annually to said superintendent of buildings), shall also approve the proposed modifications of the law. The said examiners shall each take the usual oath of office before entering upon the performance of their duties. The superintendent of buildings shall be, ex officio, a member of said board of examiners, and be chairman thereof.

“In cases in which it is claimed by an owner, in person, or by his representative, that the provisions of this title do not directly apply, or that an equally good and more desirable form of construction can be employed in any specific case than that required by this title, then such person shall have the right to present a petition to the board of examiners, through the superintendent of buildings, and may appear before said board and be heard; and said board shall consider such petition in its regular order of business, and, as soon as practicable, render a decision thereon.

“The said board of examiners are hereby authorized and empowered to grant or reject such petition, and their decision shall be final. If such decision is favorable to said petitioner, a certificate shall be issued by the superintendent of buildings in accordance therewith. At least five affirmative votes shall be necessary to the granting of any application or

petition by said board. No member of said board shall pass upon any question in which he is pecuniarily interested. The said board shall meet once in each week or upon notice from the superintendent of buildings.

“The chief clerk in the office of the superintendent of buildings shall be the clerk of the said board, and shall keep a record of its proceedings, which shall be kept in the office of the superintendent of buildings.”

VIOLETIONS AND PENALTIES.

89. Penalties.—“The owner or owners of any building, or part thereof, upon which any violation of this title may be placed, or shall exist, and any architect, builder, carpenter, or mason, who may be employed or assist in the commission of any such violation, and any and all persons who shall violate any of the provisions of this title, or fail to comply therewith, or any requirement thereof, or who shall violate, or fail to comply with, any order or regulation made thereunder, or who shall build in violation of any detailed statement of specifications or plans, submitted and approved thereunder, or of any certificate of permit issued thereunder, shall severally, for each and every such violation, and non-compliance, respectively forfeit and pay a penalty in the sum of fifty dollars, except that any such person who shall violate any of the provisions of this title as to the construction of chimneys, fireplaces, flues, hot-air pipes, and furnaces, or who shall violate any of the provisions of this title, with reference to the framing or trimming of timbers, girders, beams, or other woodwork in proximity to chimney flues or fireplaces, shall forfeit and pay a penalty in the sum of one hundred dollars.

“But if any said violation shall be removed or be in process of removal within ten days after the service of a notice as hereinafter prescribed, the liability for such penalty shall cease, and said department shall discontinue any action pending to recover the same, upon such removal or the completion thereof within a reasonable time.”

90. Failure to Comply With Notice.—“Any and all of the afore mentioned persons, who, having been served with a notice as hereinafter prescribed, to remove any violation, or comply with any requirements of this title, or with any order or regulation made thereunder, shall fail to comply with said notice within ten days after such service or shall continue to violate any requirement of this title in the respect named in said notice, shall pay a penalty of two hundred and fifty dollars.

“For the recovery of any said penalty or penalties an action may be brought in any district court, or court of record, in said city, in the name of the department of buildings; and whenever any judgment shall be rendered therefor, the same shall be collected and enforced, as prescribed and directed by the Code of Civil Procedure of the State of New York.

“The department of buildings is hereby authorized, in its discretion, good and sufficient cause being shown therefor, to remit any fine or fines, penalty or penalties, which any person or persons may have incurred, or may hereafter incur, under any of the provisions of this title; but no fine or penalty shall be remitted for any such violation until the violation shall have been removed.”

THE UNIFORM CONTRACT.

FORM OF CONTRACT

ADOPTED AND RECOMMENDED FOR GENERAL USE
BY THE
AMERICAN INSTITUTE OF ARCHITECTS
AND THE
NATIONAL ASSOCIATION OF BUILDERS.

ARCHITECTS.

This Agreement, made the _____ day of _____
in the year one thousand eight hundred and ninety _____

by and between _____

_____ party of the first part

(hereinafter designated the Contractor), and _____

_____ party of the second part

(hereinafter designated the Owner),

Witnesseth that the Contractor, in consideration of the fulfillment of the agreements herein made by the Owner, agrees with the said Owner, as follows:

ARTICLE I. The Contractor under the direction and to the satisfaction of

_____ Architects,
acting for the purposes of this contract as agents of the said Owner, shall and will provide all the materials and perform all the work mentioned in the specifications and shown on the drawings prepared by the said Architects for the _____

which drawings and specifications are identified by the signatures of the parties hereto.

ART. II. The Architects shall furnish to the Contractor, such further drawings or explanations as may be necessary to detail and illustrate the work to be done, and the Contractor shall conform to the same as part of this contract so far as they may be consistent with the original drawings and specifications referred to and identified, as provided in Art. I.

It is mutually understood and agreed that all drawings and specifications are and remain the property of the Architects.

ART. III. No alterations shall be made in the work shown or described by the drawings and specifications, except upon a written order of the Architects, and when so made, the value of the work added or omitted shall be computed by the Architects, and the amount so ascertained shall be added to or deducted from the contract price. In the case of dissent from such award by either party hereto, the valuation of the work added or omitted shall be referred to three (3) disinterested Arbitrators, one to be appointed by each of the parties to this contract, and the third by the two thus chosen; the decision of any two of whom shall be final and binding, and each of the parties hereto shall pay one-half of the expenses of such reference.

ART. IV. The Contractor shall provide sufficient, safe and proper facilities at all times for the inspection of the work by the Architects or their authorized representatives. He shall, within twenty-four hours after receiving written notice from the Architects to that effect, proceed to remove from the grounds or buildings all materials condemned by them, whether worked or unworked, and to take down all portions of the work which the Architects shall by like written notice condemn as unsound or improper, or as in any way failing to conform to the drawings and specifications.

ART. V. Should the Contractor at any time refuse or neglect to supply a sufficiency of properly skilled workmen, or of materials of the proper quality, or fail in any respect to prosecute the work with promptness and diligence, or fail in the performance of any of the agreements herein contained, such refusal, neglect or failure being certified by the Architects, the Owner shall be at liberty, after _____ days' written notice to the Contractor, to provide any such labor or materials, and to deduct the cost thereof from any money then due or thereafter to become due to the Contractor under this contract; and if the Architects shall certify that such refusal, neglect or failure is sufficient ground for such action, the Owner shall also be at liberty to terminate the employment of the Contractor for the said work and to enter upon the premises and take possession, for the purpose of completing the work comprehended under this contract, of all materials, tools and appliances thereon, and to employ any other person or persons to finish the work, and to provide the materials therefor; and in case of such discontinuance of the employment of the Contractor he shall not be entitled to receive any further payment under this contract until the said work shall be wholly finished, at which time, if the unpaid balance of the amount to be paid under this contract shall exceed the expense incurred by the Owner in finishing the work, such excess shall be paid by the Owner to the Contractor, but if such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner. The expense incurred by the Owner as herein provided, either for furnishing materials or for finishing the work, and any damage incurred through such default, shall be audited and certified by the Architects, whose certificate thereof shall be conclusive upon the parties.

ART. VI. The Contractor shall complete the several portions, and the whole of the work comprehended in this Agreement by and at the time or times hereinafter stated _____

provided that _____

ART. VII. Should the Contractor be obstructed or delayed in the prosecution or completion of his work by the act, neglect, delay or default of the Owner, or the Architects, or of any other contractor employed by the Owner upon the work, or by any damage which may happen by fire, lightning, earthquake or cyclone, or by the abandonment of the work by the employees through no default of the Contractor, then the time herein fixed for the completion of the work shall be extended for a period equivalent to the time lost by reason of any or all of the causes aforesaid; but no such allowance shall be made unless a claim therefor is presented in writing to the Architects within twenty-four hours of the occurrence of such delay. The duration of such extension shall be certified to by the Architects, but appeal from their decision may be made to arbitration, as provided in Art. III of this contract.

ART. VIII. The Owner agrees to provide all labor and materials not included in this contract in such manner as not to delay the material progress of the work, and in the event of failure so to do, thereby causing loss to the Contractor, agrees that he will reimburse the Contractor for such loss; and the Contractor agrees that if he shall delay the material progress of the work so as to cause any damage for which the Owner shall become liable (as above stated), then he shall make good to the Owner any such damage. The amount of such loss or damage to either party hereto shall, in every case, be fixed and determined by the Architects or by arbitration, as provided in Art. III of this contract.

ART. IX. It is hereby mutually agreed between the parties hereto that the sum to be paid by the Owner to the Contractor for said work and materials shall be \$ _____

subject to additions and deductions as hereinbefore provided, and that such sum shall be paid in current funds by the Owner to the Contractor in installments, as follows:

The final payment shall be made within _____ days after this contract is fulfilled.

All payments shall be made upon written certificates of the Architects to the effect that such payments have become due.

If at any time there shall be evidence of any lien or claim for which, if established, the Owner or the said premises might become liable, and which is chargeable to the Contractor, the Owner shall have the right to retain out of any payment then due or thereafter to become due an amount sufficient to completely indemnify him against such lien or claim. Should there prove to be any such claim after all payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging any lien on said premises made obligatory in consequence of the Contractor's default.


ART. X. It is further mutually agreed between the parties hereto that no certificate given or payment made under this contract, except the final certificate or final payment, shall be conclusive evidence of the performance of this contract, either wholly or in part, and that no payment shall be construed to be an acceptance of defective work or improper materials.

ART. XI. The Owner shall during the progress of the work maintain full insurance on said work, in his own name and in the name of the Contractor, against loss or damage by fire. The policies shall cover all work incorporated in the building, and all materials for the same in or about the premises, and shall be made payable to the parties hereto, as their interest may appear.

ART. XII. The said parties for themselves, their heirs, executors, administrators and assigns, do hereby agree to the full performance of the covenants herein contained.

In Witness Whereof, the parties to these presents have hereunto set their hands and seals, the day and year first above written.

In presence of



THE UNIFORM CONTRACT.

FORM OF CONTRACT
ADOPTED AND RECOMMENDED FOR GENERAL USE BY THE
AMERICAN INSTITUTE OF ARCHITECTS
AND THE
NATIONAL ASSOCIATION OF BUILDERS.

AGREEMENT

BETWEEN

_____ *Contractor*

AND

_____ *Owner*

FOR

_____ *AT*

DATED

_____ 189_____

ARCHITECTS,

AMOUNT OF CONTRACT,

\$ _____

FORM IV.

DEPARTMENT OF BUILDINGS OF THE CITY OF NEW YORK.

Boroughs of Manhattan and the Bronx.

Plan No. _____ NEW BUILDINGS OF 189 _____

STATE OF NEW YORK }
City and County of New York, } ss.:

_____, the _____ of premises hereinafter described, being duly sworn, deposes and says: That _____ who resides at No. _____ in the City of _____, in the County of _____, in the State of _____, is the owner in fee of all that certain lot, piece or parcel of land, shown on the diagram annexed hereto and made a part hereof, situate, lying and being in the City and County of New York, known and designated as No. _____, and bounded and described as follows, viz.:

BEGINNING at a point on the _____ side of _____ distant _____ feet _____ from the corner formed by the interreccion of _____ running thence _____ thence _____ thence _____ thence _____ to the point or place of beginning.

Deponent further says that the _____ proposed to be erected upon the said premises in accordance with the accompanying detailed statement in writing of the specifications and plans therefor, will be erected by or on account of the following person, whose full name, residence and interest _____ as follows:

- _____ No. _____
- as _____
- _____ No. _____
- as _____
- _____ No. _____
- as _____
- _____ No. _____
- as _____
- _____ No. _____
- as _____
- _____ No. _____
- as _____

_____ being the only person interested in said proposed _____

Sworn to before me, this _____ }
day of _____ 189 . }



DEPARTMENT OF BUILDINGS OF THE CITY OF NEW YORK.

Plan No. _____

ALTERATIONS OF 189 .

STATE OF NEW YORK, }
City and County of New York, } ss.

_____, the _____ of premises
hereinafter described, being duly sworn, deposes and says: That _____
who resides at No. _____ in the City of
_____, in the County of _____
in the State of _____, is the owner in fee of all that certain lot, piece
or parcel of land, shown on the diagram annexed hereto and made a part hereof, situate, lying and
being in the City and County of New York, known and designated as No. _____
_____, and bounded and described as follows, viz.:

BEGINNING at a point on the _____ side of _____
distant _____ feet _____ from the corner
formed by the intersection of _____
running thence _____
thence _____
thence _____
thence _____
to the point or place of beginning.

Deponent further says that the alterations proposed to be made, in the building erected upon the
said premises, in accordance with the accompanying detailed statement in writing of the specifica-
tions and plans therefor, will be made by or on account of the following person, whose full name,
residence and interest _____ as follows:

_____ No. _____
as _____
_____ No. _____
as _____
_____ No. _____
as _____
_____ No. _____
as _____
_____ No. _____
as _____
_____ No. _____
as _____

_____ being the only person interested in said building.

Sworn to before me, this
day of _____

189 . }



APPLICATION FOR ERECTION OF BUILDINGS.

Application is hereby made to the Superintendent of Buildings of the City of New York, for the approval of the detailed statement of the specifications and plans herewith submitted, for the erection of the building _____ herein described. All provisions of the Building Law shall be complied with in the erection of said building _____, whether specified herein or not.

(Sign here) _____

New York, _____ 189 _____

1. State how many buildings to be erected. _____
2. How occupied? If for dwelling, state the number of families. _____
3. What is the street or avenue and the number thereof? Give diagram of property. _____
4. Size of lot. No. of feet front, _____; No. of feet rear, _____; No. of feet deep, _____
5. Size of building. No. of feet front, _____; No. of feet rear, _____; No. of feet deep, _____
No. of stories in height, _____; No. of feet in height from curb level to highest point of roof beams, _____
6. What will each building cost exclusive of the lot? \$ _____
7. What will be the depth of foundation walls from curb level or surface of ground? _____
8. Will foundation be laid on earth, sand, rock, timber or piles? _____
9. What will be the base, stone or concrete? _____ If base stones, give size and thickness and how laid. _____ If concrete, give thickness. _____
10. What will be the sizes of piers? _____
11. What will be the sizes of the base of piers? _____
12. What will be the thickness of foundation walls? _____ Of what material constructed? _____
13. What will be the thickness of upper walls? Basement, _____ inches; 1st story _____ inches; 2d story, _____ inches; 3d story, _____ inches; 4th story, _____ inches; 5th story, _____ inches; 6th story, _____ inches; 7th story, _____ inches, and from thence to top, _____ inches. Of what materials to be constructed? _____
14. State whether independent or party walls. _____
15. With what material will walls be coped? _____
16. What will be the materials of front? _____ If of stone, what kind? _____
Give thickness of ashler. _____ Give thickness of backing in each story. _____
17. Will the roof be flat, peaked or mansard? _____
18. What will be the materials of roofing? _____
19. Give size and materials of floor beams. 1st tier, _____; 2d tier, _____
_____; 3d tier, _____; 4th tier, _____; 5th tier, _____
_____; 6th tier, _____; 7th tier, _____
_____; 8th tier, _____; roof tier, _____
State distances from centres. 1st tier, _____ inches; 2d tier, _____ inches; 3d tier, _____ inches;
4th tier, _____ inches; 5th tier, _____ inches; 6th tier, _____ inches; 7th tier, _____ inches;
8th tier, _____ inches; roof tier, _____ inches.
20. If floors are to be supported by columns and girders, give the following information: Size and material of girders under 1st floor, _____ under each of the upper floors, _____
_____. Size and materials of columns under 1st floor, _____
_____ under each of the upper floors, _____
21. If the front, rear or side walls are to be supported, in whole or in part, by iron girders or lintels, give definite particulars. _____

22. If girders are to be supported by brick piers and columns, state the sizes of piers and columns. _____

23. State by whom the construction of the building is to be superintended. _____

If the Building is to be occupied as an Apartment or Tenement House, give the following particulars.

1. State how many families are to occupy each floor, and the whole number in the house; also, if any part is to be used as a store or for any other business purposes, state the fact, _____
 2. What will be the heights of ceilings? 1st story, _____ feet; 2d story, _____ feet; 3d story, _____ feet; 4th story, _____ feet; 5th story, _____ feet; 6th story, _____ feet; 7th story, _____ feet.
 3. How are the hall partitions to be constructed and of what materials? _____
 4. How many buildings are to be taken down? _____
- Owner _____ Address _____
Architect _____ Address _____
Mason _____ Address _____
Carpenter _____ Address _____

If a Wall or part of a Wall already built is to be used, fill up the following.

The undersigned gives notice that _____ intend to use the _____ wall of building _____ as party wall in the erection of the building hereinbefore described, and respectfully requests that the same be examined and a permit granted therefor. The foundation wall _____ built of _____ inches thick, _____ feet below curb; the upper wall _____ built of _____ inches thick, _____ feet deep, _____ feet in height.

(Sign here) _____

NOTE—In making application for the erection of buildings, the following drawings must be furnished: Plans of each and every story, front, rear and side elevations, and longitudinal and transverse sections. All plans must be drawn to a uniform scale, and must be on tracing cloth, properly designated and colored.

THE BUILDING LAW REQUIRES:

- 1st.—That all stone walls shall be properly bonded and laid in cement mortar.
- 2d.—That all skylights having a superficial area of more than nine square feet, placed in any building, shall have the sashes and frames thereof constructed of iron and glass.
- 3d.—That every building which is more than two stories in height above the curb level, except dwelling-houses, hotels, school-houses and churches, shall have doors, blinds or shutters made of iron, hung to iron hanging frames or to iron eyes built into the wall, on every window and opening above the first story thereof, excepting on the front openings of buildings fronting on streets which are more than thirty feet in width. Or the said doors, blinds or shutters may be constructed of pine or other soft wood of two thicknesses of matched boards at right angles with each other, and securely covered with tin, on both sides and edges, with folded lapped joints, the nails for fastening the same being driven inside the lap; the hinges and bolt, or latches shall be secured or fastened to the door or shutter after the same has been covered with the tin, and such doors or shutters shall be hung upon an iron frame, independent of the woodwork of the windows and doors, or two iron hinges securely fastened in the masonry; or such frames, if of wood, shall be covered with tin in the same manner as the doors and shutters.
- 4th.—That outside fire escapes shall be placed on every dwelling-house occupied by or built to be occupied by three or more families above the first story, and every building already erected, or that may hereafter be erected, more than three stories in height, occupied and used as a hotel or lodging house, and every boarding-house, having more than fifteen sleeping-rooms above the basement story, and every factory, mill, manufactory or workshop, hospital, asylum or institution for the care or treatment of individuals, and every building in whole or in part occupied or used as a school or place of instruction or assembly, and every office building five stories or more in height, all to be constructed as follows:

BALCONIES MUST NOT BE LESS THAN THREE FEET WIDE.

- BRACKETS** must not be less than $1\frac{1}{2}$ x $1\frac{1}{2}$ inches wrought iron, placed edgewise, or $1\frac{1}{2}$ inch angle iron $\frac{1}{2}$ inch thick, well braced, and not more than three feet apart, and the brackets or braces must be not less than $\frac{3}{4}$ inch square wrought iron, and must extend two-thirds of the width of the respective brackets or balconies. In all cases the brackets must go through the wall, and be turned down three inches.
- BRACKETS OF NEW BUILDINGS** must be set as the walls are being built. When brackets are to be put on old houses, the part going through the wall shall not be less than one inch diameter, with screw nuts and washers not less than five inches square and $\frac{1}{2}$ inch thick.
- TOP RAIS**—The top rail of balconies must be $1\frac{1}{2}$ inch x $\frac{3}{4}$ inch wrought iron or $1\frac{1}{2}$ inch angle iron $\frac{1}{2}$ inch thick, and in all cases must go through the wall, and be secured by nuts and a $\frac{1}{2}$ inch square washer, at least $\frac{3}{4}$ inch thick, and no top rail shall be connected at angles by the use of cast iron.
- BOTTOM RAIS**—Bottom rails must be $1\frac{1}{2}$ inch x $\frac{3}{4}$ inch wrought iron or $1\frac{1}{2}$ inch angle iron $\frac{1}{2}$ inch thick, well laced into the wall. In frame buildings the top rails must go through the building and be secured on the inside by washers and nuts as above.
- FRILING IN RAIS**—The fliling in bars must not be less than $\frac{1}{2}$ inch round or square wrought iron, placed not more than 6 inches from center, and well riveted to the top and bottom rails.
- STAIRS**—The stairs in all cases must be not less than 18 inches wide, and constructed of $1\frac{1}{2}$ x $3\frac{1}{2}$ inch wrought iron sides or string. Steps may be of cast iron of the same width of string, or $\frac{3}{4}$ inch round iron, double ranze, and well riveted to the string. The stairs must be secured to a bracket on top and rest on and be secured to a bracket or extra cross bar at the bottom. All stairs must have a $\frac{3}{4}$ inch hand rail of wrought iron, well braced.
- PLACES**—The footing of balconies must be of wrought iron $1\frac{1}{2}$ x $\frac{3}{4}$ inch plate, joined not over 14 inches apart, and secured to iron bottoms $1\frac{1}{2}$ x $\frac{3}{4}$ inch, not over three feet apart and riveted at the intersection. The openings for stairways in all balconies shall not be less than 30 inches wide and 36 inches long, and have no corners.
- DROP LADDERS**—Drop ladders from lower balconies where required shall not be less than 14 inches wide, and shall be made of $1\frac{1}{2}$ x $\frac{3}{4}$ inch sides and $\frac{1}{2}$ inch range of wrought iron. In no case shall a drop ladder be more than 12 feet in length. In no case shall the ends of balconies extend more than nine inches over the brackets.
- LITTLE LADDERS**—Ladders to scuttles shall be constructed in all cases the same as the stairs or step-ladders from balconies of fire escapes.
- THE HEIGHT OF BALCONIES** around balconies shall not be less than two feet nine inches.

No Fire Escape will be approved by the Superintendent of Buildings if not in accordance with above specifications.

In constructing all balcony fire-escapes, the manufacturer thereof shall securely fasten thereto, in a conspicuous place, a cast-iron plate having suitable raised letters on the same, to read as follows: Notice! Any person placing any incumbrance on this balcony is liable to a penalty of ten dollars and imprisonment for ten days.

- 5th.—That all exterior and division or party walls over fifteen feet high, excepting where such walls are to be finished with cornices, gutters or crown mouldings, shall have parapet walls carried two feet above the roof, and shall be coped with stone, well-burnt terra-cotta or cast iron.
- 6th.—That every building and the tops and sides of every dormer-window thereon shall be covered and roofed with slate, tin, copper or iron, or such other quality of fire-proof roofing as the superintendent of buildings, under his certificate, may authorize.
- 7th.—That all exterior cornices shall be fire proof.
- 8th.—That the stone or brick work of all smoke flues, and the chimney shafts of all furnaces, boilers, bakers' ovens, large cooking ranges and laundry stoves, and all flues used for a similar purpose, shall be at least eight inches in thickness. If there is a cast-iron or burnt clay pipe built inside of the same, with one-inch air space all around it, then the stone or brick work inclosing such pipes shall not be less than four inches in thickness.
- 9th.—That before any iron or steel beam, lintel or girder intended to span an opening over ten feet in length in any building, shall be used for supporting a wall, it shall be inspected, tested and approved as provided by law.

REPORT UPON APPLICATION.

Department of Buildings of the City of New York.

New York, _____ 189

To the Superintendent of Buildings:

I respectfully report that I have thoroughly examined and measured the wall _____ etc., named in the foregoing application, and found the foundation wall _____ to be built of _____ inches thick, _____ feet below curb, the upper wall _____ built of _____ inches thick, _____ feet deep, _____ feet in height, and that the mortar in said wall _____ is _____ hard and good, and that the wall _____ built as party wall _____ and _____ in a good and safe condition.

What is the nature of the ground? _____

What kind of sand was used in the mortar? _____

(The Inspector must here state what defects, if any, are in the wall.)

(The Inspector must state the thickness of wall _____ in each and every story.)

Inspector.

FINAL REPORT OF INSPECTOR.

New York, _____ 189

To the Superintendent of Buildings:

Work was commenced on the within described building on the _____ day of _____ 18 _____ and completed on the _____ day of _____ 189 _____, and all the iron and steel girders, beams and columns are properly set, and of size as per application, and all the work upon said building has been done in accordance with the foregoing detailed statement, except as noted below.

Respectfully submitted,

Inspector.

REMARKS.

Department of Buildings,
CITY OF NEW YORK

Detailed Statement of Specifications

NEW BUILDINGS.

No. _____ Submitted _____ 189
LOCATION.

Owner _____
Architect _____
Builder _____
Received by _____ 189
Returned by _____ 189
Report _____ favorable.
Referred to Inspector _____ 189
Returned _____ 189
Inspector.

New York, _____ 189
This is to certify that I have examined the within
detailed statement, together with the copy of the plan
relating thereto, and find the same _____
to be in accordance with the provisions of the laws
relating to buildings in the City of New York; that
the same has been _____ approved,
and entered in the record of the Department of Buildings.

Superintendent of Buildings.

Plan No. _____

APPLICATION TO ALTER, REPAIR, Etc.

Application is hereby made to the Superintendent of Buildings of the City of New York, for the approval of the detailed statement of the specifications and plans herewith submitted, for the alteration or repair of the building—herein described. All provisions of the Building Law shall be complied with in the alteration or repair of said building—, whether specified herein or not.

(Sign here) _____

New York, _____ 189 _____

1. State how many buildings to be altered. _____
2. What is the street or avenue and the number thereof? Give diagram of property. _____
3. How much will the alteration cost? \$ _____

GIVE THE FOLLOWING INFORMATION AS TO THE PRESENT BUILDING :

1. Size of lot on which it is located, No. of feet front, _____; feet rear, _____; feet deep, _____
2. Size of building, No. of feet front, _____; feet rear, _____; feet deep, _____ No. of stories in height, _____; No. of feet in height from curb level to highest point of beams, _____
3. Material of building, _____; material of front, _____
4. Whether roof is peak, flat, or mansard, _____
5. Depth of foundation walls _____ feet; thickness of foundation walls, _____; materials of foundation walls, _____
6. Thickness of upper walls, _____ inches. Material of upper walls, _____
7. Whether independent or party walls, _____
8. How the building is or was occupied, _____

IF TO BE RAISED OR BUILT UPON, GIVE THE FOLLOWING INFORMATION:

1. How many stories will the building be when raised? _____
2. How high will the building be when raised? _____
3. Will the roof be flat, peak, or mansard? _____
4. What will be the thickness of wall of additional stories? _____ story, _____ inches; _____ story, _____ inches.
5. Give size and material of floor beams of additional stories; _____ 1st tier, _____, _____ x _____ 2d tier, _____, _____ x _____ Distance from centres on _____ tier, _____ inches; _____ tier _____ inches.
6. How will the building be occupied? _____

IF TO BE EXTENDED ON ANY SIDE, GIVE THE FOLLOWING INFORMATION.

1. Size of extension, No. feet front, _____; feet rear, _____; feet deep, _____; No. of stories in height, _____; No. of feet in height, _____
2. What will be the material of foundation walls of extension? _____ What will be the depth? _____ feet. What will be the thickness? _____ inches.
3. Will foundation be laid on earth, sand, rock, timber or piles? _____

IF TO BE EXTENDED ON ANY SIDE GIVE THE FOLLOWING INFORMATION.

4. What will be the base, stone or concrete? _____ If base stones, give size and thickness and how laid, _____ If concrete, give thickness, _____
5. What will be the sizes of piers? _____ What will be the sizes of the base of piers? _____
6. What will be the thickness of upper walls? 1st story, _____ inches; 2d story _____ inches; 3d story, _____ inches; 4th story, _____ inches; 5th story, _____ inches; 6th story, _____ inches; 7th story, _____ inches; from thence to top, _____ inches; and of what materials to be constructed, _____
7. State whether independent or party-walls. _____ If party-walls give thickness thereof. _____
8. With what material will walls be coped? _____
9. What will be the materials of front? _____ If of stone, what kind? _____ Give thickness of front ashlar. _____ Give thickness of backing. _____
10. Will the roof be flat, peaked or mansard? _____
11. What will be the materials of roofing? _____
12. Give size and material of floor beams, 1st tier, _____, _____ x _____; 2d tier, _____ x _____; 3d tier, _____, _____ x _____; 4th tier, _____, _____ x _____; 5th tier, _____, _____ x _____; 6th tier, _____, _____ x _____; 7th tier, _____ x _____; roof tier, _____, _____ x _____ State distance from centres on 1st tier, _____ inches; 2d tier, _____ inches; 3d tier, _____ inches; 4th tier, _____ inches; 5th tier, _____ inches; 6th tier, _____ inches; 7th tier, _____ inches; roof tier, _____ inches
13. If floors are to be supported by columns and girders, give the following information: Size and material of girders under 1st floor, _____, _____ x _____ under each of the upper floors, _____ Size and material of columns under first floor, _____ under each of the upper floors, _____
14. If the front, rear or side walls are to be supported, in whole or in part, by iron girders or lintels, give definite particulars, _____

15. If girders are to be supported by brick piers and columns, state the size of piers and columns. _____
16. How will the extension be connected with present or main building? _____

17. How will the extension be occupied? If for dwelling purposes, state how many families are to occupy each floor. _____
18. State who will superintend the alterations. _____

IF ALTERED INTERNALLY, GIVE DEFINITE PARTICULARS AND STATE HOW THE BUILDING WILL BE OCCUPIED:

IF THE FRONT, REAR, OR SIDE WALLS, OR ANY PORTION THEREOF, ARE TO BE TAKEN OUT AND REBUILT, GIVE DEFINITE PARTICULARS, AND STATE IN WHAT MANNER:

Plan No. _____ B, 199 . Filed _____ 199 .

NOTICE—This permit expires by its own limitation six months from date of approval of the plan by the Commissioner of Buildings for the Boroughs of Manhattan and The Bronx.

THOMAS J. BRADY,
Commissioner of Buildings for the Boroughs of Manhattan and the Bronx.

SPECIFICATIONS

FOR THE

PLUMBING AND DRAINAGE

OF THE BUILDINGS HEREIN DESCRIBED.

Location _____

Number of Buildings _____ Description of Buildings _____

Dimensions of each Building _____ Dimensions of each Lot _____

Owner _____ Address _____

Architect _____ Address _____

Plumber _____ Address _____

	Cellar.	Basement.	First Story.	Second Story.	Third Story.	Fourth Story.	Fifth Story.	Sixth Story.	Seventh Story.
Number of families on each floor.....									

Pursuant to the requirements of law, the accompanying plans for the plumbing and drainage of each of the above-mentioned buildings, and the following description thereof, is hereby submitted for the approval of the Commissioner of Buildings for the Boroughs of Manhattan and The Bronx, the undersigned hereby agreeing to cause the work to be done and the material to be furnished in accordance therewith, with such modifications as may be required by the said Commissioner of Buildings. No modifications of the plans, or of the work described herein, will be made, unless the same is previously allowed by the said Commissioner of Buildings, on the written application of Owner or Architect; and all work pertaining to the proper plumbing and drainage of the buildings and premises which is not covered by the plans, but is found necessary during the progress of the work in order to carry into effect the true intent thereof, will be executed in accordance with the directions of the said Commissioner of Buildings.

It is expressly understood that these specifications and the drawings submitted herewith to the Department of Buildings for the Boroughs of Manhattan and The Bronx, for approval, constitute together, as approved by said Commissioner of Buildings, the plans for the plumbing and drainage of the buildings herein described; and in respect to all work not covered thereby, the Plumber is to be governed by the Rules and Regulations as to plumbing and drainage established by the said Commissioner of Buildings.

Drawings and specifications constitute plans. Rules and regulations to be part of specifications.

Privy vault and Cesspool—Material _____ Dimensions, \times \times _____

How made water-tight? _____

Location _____ Distance from building _____ feet.

Private sewer—Material _____ Diameter _____ inches.

Where does it discharge? _____

How many buildings now connect with it? _____

Fall per foot _____ inch. Length _____ feet.

Old sewers—If old sewer is to be used, state its diameter and character _____

House sewers—State number for each building _____ Diameter _____ inches.

Material _____ Fall per foot _____ inch.

Where connected? _____

House traps—Material _____ Diameter _____ inches.

Fresh-air inlets—State number for each building _____ Diameter _____ inches.

Material _____ Location of inlet _____

How will they be protected against obstructions? _____

House drains—State number for each building _____ Diameter _____ inches.

Material _____

Area shaft, court and yard drains—Material _____ Diameter _____ inches.

How trapped? _____

Cellar drain—Material _____ Diameter _____ inches.

How trapped? _____

How will the yard, area, shaft, court and cellar drains be protected against obstructions? _____

Catch basins—Where located? _____ Material _____

How will they be made water-tight? _____

Dimensions, \times \times _____

Sub-soil drains—Material _____ Where connected? _____

How arranged to maintain permanent trap seal? _____

Floor, stable and stall drains—Material _____ Diameter _____ inches.

How trapped? _____

Material of soil, waste and vent pipes _____

Soil pipes—Number in each building _____ Diameter _____ inches.

Number extending above roof in each building _____

Diameter and material of outlets and branches up to traps _____

Waste-pipes—Number in each building _____ Diameter _____ inches.

Number extending above roof in each building _____

Diameter and material of outlets and branches up to traps _____

Vent-pipes—Number in each building _____ Diameter _____ inches.

Number extending above roof in each building _____

Diameter and material of outlets and branches up to traps _____

Refrigerator waste-pipes—State number in each building _____ Diameter _____ inches.

Material _____

Will they extend through roof? _____

Roof drainage—State number of outside leaders _____ Material _____

Diameter _____ inches. Diameter of traps _____ inches.

State number of inside leaders _____ Material _____

Diameters _____ Diameter of traps _____ inches.

How will all the above soil, waste, vent and other pipes be supported? _____

Safes—Material _____ Where located? _____
 Diameter and material of safe waste-pipe _____
Drip trays—Material _____ Where located? _____
Water-closet cisterns—Material _____ Dimensions, x x _____
 Diameter and material of supply-pipe _____ inches.
 Diameter and material of flush-pipe _____ inches.
House-tank—Material _____ Dimensions, x x _____
 Where located? _____
 Overflow pipe, where discharged? _____
 Emptying pipe, where “ _____
 Tell-tale pipe, where “ _____
Pump—Is a pump necessary? _____
 Where will it be located? _____
 State character of same? _____

FIXTURES—Where located:

	Yard.	Cellar.	Basement.	First Story.	Second Story.	Third Story.	Fourth Story.	Fifth Story.	Sixth Story.	Seventh Story.	Eighth Story.	Ninth Story.	Tenth Story.	Eleventh Story.	Twelfth Story.	Thirteenth Story.	Fourteenth Story.	Fifteenth Story.	Sixteenth Story.	Seventeenth Story.	Eighteenth Story.	Nineteenth Story.	Twentieth Story.	
Water-closets																								
Urinals																								
Wash-basins																								
Bath-tubs																								
Wash-tubs																								
Sinks																								

Description of water-closets _____

Description of urinals _____

Description of wash-basins _____

Description of bath-tubs _____

Description of wash-tubs _____

Description of sinks _____

Water supply—Will all fixtures be water supplied? _____

Give general description and character of same _____

NOTE.—On this and the next two pages of the original permit, are printed the rules and regulations of the department with regard to Plumbing, Drainage, etc.

Then follows, on the fourth page from this, the blank shown in Form XVI, upon which the Inspector makes his report at the completion of the job.

Department of Buildings of the City of New York.

BOROUGHES OF MANHATTAN AND THE BRONX.

Plan No. _____ 189 . Filled _____ 189 .

NOTICE.—In making application for the approval of plans for light and ventilation of new tenement and lodging houses, or for alterations of existing tenement or lodging houses, the following drawings must be furnished: Plans of all floors, including cellar and basement, and, if necessary, transverse and longitudinal sections. All plans must be drawn to a uniform scale, not less than one-quarter inch to the foot, and be on tracing cloth or cloth prints, and each shaft or court properly designated and dimensions of same plainly marked thereat.

NOTICE.—This permit expires by its own limitation six months from date of approval of the plan by the Commissioner of Buildings, unless the building is then begun.

THOMAS J. BRADY,
Commissioner of Buildings.

APPLICATION

TO THE

COMMISSIONER OF BUILDINGS

TO APPROVE PLANS FOR LIGHT AND VENTILATION OF PROPOSED
TENEMENT OR LODGING HOUSE.

Pursuant to law, application is hereby made to the Commissioner of Buildings to approve plans herewith submitted for light and ventilation of the buildings described in the following specifications, which are made part of said plans. The plans and specifications are to be construed together, but in case of any difference between them these specifications, subject to such conditions as may be imposed by the Commissioner of Buildings, are to govern.

Location _____ Number of Buildings _____

Owner _____ Address _____

Architect _____ Address _____

Dimensions of each Lot _____

Dimensions of each Building _____

Dimensions of each Extension _____

Number of floors above cellar or basement of main building _____ of extension _____

If it is proposed to alter an existing tenement or lodging house, or to convert a dwelling house or other building into a tenement or lodging house, state in what particulars:

Cellar—How to be occupied? _____

Basement—How to be occupied? _____

Cellar ceiling—Height above sidewalk _____

Basement ceiling—Height above sidewalk _____

	Cellar.	Basement.	1st floor.	2d floor.	3d floor.	4th floor.	5th floor.	6th floor.	7th floor.
How many families will occupy each floor.....									
Height of ceilings.....									
Number of living rooms opening on shafts and courts.....									
Number of living rooms opening on street and yard.....									

Halls—How lighted and ventilated? _____

State dimensions of ventilating skylight over main hall _____

Dimensions of windows for living rooms _____

Dimensions of windows for water-closet apartments _____

Dimensions of fanlights over doors of living rooms where marked on plans _____

Cellar—How lighted and ventilated? _____

Basement—How lighted and ventilated? _____

“ How made water-tight? _____

Cellar—How lighted and ventilated? _____

“ How made water-tight? _____

Will cellar or basement ceiling be plastered? _____

What additional structure, if any, will be on lot? _____

Distance from extreme rear of main building to rear line of lot. _____

Distance from extreme rear of extension to rear line of lot _____

	Cellar.	Basement.	1st floor.	2d floor.	3d floor.	4th floor.	5th floor.	6th floor.	7th floor.
Number and location of water-closets..									

How will the floor and sides of water-closet apartments be made water-tight? _____

How will water-closet apartments be ventilated? _____

DIMENSIONS OF LOT, SHAFTS, COURTS, YARDS, ETC.

NOTE.—If several buildings and lots are of same dimensions throughout, one statement is sufficient. ALL COMPUTATIONS MUST BE MADE ON LEVEL OF FIRST STORY. SHAFTS LESS THAN TWENTY-FIVE SQUARE FEET IN AREA WILL NOT BE COMPUTED AS UNCOVERED SPACE.

NOTE.—Section 661, Laws 1897, as amended 1898, restricts the occupancy of any tenement or lodging house on any ordinary city lot to sixty-five per centum of the area of said lot, when such lot is not a corner lot, and empowers the Commissioner of Buildings to extend such occupancy to seventy-five per centum of the area of the aforesaid lot, provided "the light and ventilation of each tenement or lodging house are, in the opinion of the Commissioner of Buildings, materially improved." The same section also provides that no tenement or lodging house shall occupy more than ninety-two per centum of the area of a corner lot above the first story.

The limiting percentages that will be allowed under this provision of law is as follows:

Up to 80 feet.....	75 per cent.	Up to 120 feet.....	67 per cent.
" 90 ".....	73 " "	" 130 ".....	65 " "
" 100 ".....	71 " "	and above.....	65 per cent.
110 ".....	69 " "		

For corner buildings upon lots less than 80 feet frontage, the maximum area that may be covered will be determined as follows.

Up to 80 feet.....	88 per cent.	Up to 120 feet.....	84 per cent.
" 90 ".....	80 " "	" 130 ".....	82 " "
" 100 ".....	85 " "	" 140 ".....	80 " "
" 110 ".....	88 " "	" 150 ".....	78 " "

For buildings greater than 80 feet frontage, the former tables of percentages will apply to that part which is in excess of 80 feet, and the latter scale for that which is under 80 feet.

While the uncovered area cannot be less than the above it must be greater where required by the further regulations for shafts and fixing distance required at rear.

House No. 1.		House No. 2.		House No. 3.	
	Sq. Ft.		Sq. Ft.		Sq. Ft.
Shaft				Shaft	
No. 1,	x	No. 1,	x	No. 1,	x
" 2,	x	" 2,	x	" 2,	x
" 3,	x	" 3,	x	" 3,	x
" 4,	x	" 4,	x	" 4,	x
Court		Court		Court	
No. 1,	x	No. 1,	x	No. 1,	x
" 2,	x	" 2,	x	" 2,	x
Front Yard, {	x	Front Yard, {	x	Front Yard, {	x
Rear Yard, {	x	Rear Yard, {	x	Rear Yard, {	x
Alley Yard, {	x	Alley Yard, {	x	Alley Yard, {	x
Total area of Shafts, {	_____	Total area of Shafts, {	_____	Total area of Shafts, {	_____
etc.	_____	etc.	_____	etc.	_____
House,	x	House,	x	House,	x
Lot,	x	Lot,	x	Lot,	x
Per cent. of lot covered {	_____	Per cent. of lot covered, {	_____	Per cent. of lot covered {	_____

Remarks _____

And it is further understood by the owner and architect that these plans for light and ventilation of the above-described buildings are approved, and this permit is issued and accepted upon the following conditions in addition to the foregoing, and are hereby incorporated therewith, according as the same is a tenement or lodging house.

That strict adherence to the plans and specifications on which this permit is granted will be required by the Commissioner of Buildings unless permission in writing has been previously given by him allowing their modification.

That no part of the collar or basement will be constructed during the erection or after the completion of these buildings, to be occupied wholly or in part as a dwelling, unless the same be approved herein, or a special permit in writing has been previously obtained from the Commissioner of Buildings, nor unless the same comply with the

Strict adherence to plans required.

Collar, permit to occupy as a dwelling.

Conditions necessary to obtain permit.

following conditions : 1st. That it be at least seven feet in height in every part. 2d. That the coiling thereof be at least two feet above the street or curb. 3d. That the space beneath the floor is cemented ; and, 4th. That the area extend along the full frontage thereof and be at least two feet six inches wide, six inches below the floor level of the part occupied, and properly graded and drained, and that the steps leading thereto will have open risers and be so arranged as not to obstruct the light and ventilation thereof.

Air space required.

That no habitable room will have a smaller air space than six hundred cubic feet.

Windows.

That every habitable room and water-closet apartment will have a window opening directly upon the street, yard, shaft or court, and such windows will be at least twelve square feet in area for living rooms, and three square feet in area for water-closet apartments, measured between the stop-heads. Said window will be hung with weights and made to slide vertically ; and, in addition, each room, except those opening upon the public halls, will have a ventilating or transom window so arranged as to produce a cross-current of air.

Transoms.

Alcove rooms.

Alcove rooms will conform to all the requirements of ordinary rooms.

Area of shafts and courts.

Except as hereinafter otherwise stated, every light and air shaft or court for habitable rooms will be at least twenty-five feet square in area up to and including five stories in height, and be increased five square feet in area for each additional story beyond the fifth, and not less than two feet four inches wide in the clear at every point up to and including five stories in height and be increased four inches in width for each additional story beyond the fifth. Shafts or courts between two houses, and common to both, will be double this area and not less than four feet eight inches wide up to and including five stories in height and be increased eight inches in width for each additional story beyond the fifth. Where there are five interior rooms in a line on a floor the area of each shaft or court will be fifty per cent. greater than above described, and where there are six interior rooms in a line on a floor the area of such shaft or court will be at least one hundred per cent. greater than the minimum above stated.

Increased areas of shafts and courts.

Where there are twelve rooms on a floor of a tenement-house erected on an ordinary city lot, except a corner lot, the shafts and courts to light and ventilate the interior rooms will have an area equal to two hundred and fifteen square feet, and where there are fourteen rooms on a floor of a similar tenement-house the area of such shafts and courts will not be less than two hundred and sixty-five square feet, and these shafts or courts will be enlarged at their central portion so as to provide windows at the ends of each set of rooms where there are front and rear sets of apartments on a floor.

Where shafts will be enlarged.

Shafts in corner houses.

In every corner house on an ordinary city lot having four families on a floor, and six rooms on the inside portion thereof the shaft to light and ventilate interior rooms will have an area equal to one hundred and seven and one-half square feet ; and where there are seven rooms the area of such shaft will be one hundred and thirty-two and one-half square feet, and these shafts will be enlarged at their central portions to provide end windows as above described.

Shafts to be free from obstructions

All shafts over ten square feet in area will be free and clear from skylights or any other covering or obstruction at the top, and all shafts and courts will be of the same area throughout.

Ventilating sky-light.

That the main hall will be lighted and ventilated by a sky-light provided with louvres or ridge ventilator.

Space at rear.

At the rear of every tenement or lodging house on any lot other than a corner lot there will be and remain from the ground upward a clear space of not less than ten feet between it and the rear end of the lot. At the rear of every tenement or lodging house on any corner lot there shall be and remain above the first story a clear space of not less than five feet between it and the rear end of the lot, up to eighty feet in height and

Over 80 feet, five feet four inches.
" 85 " five feet eight inches.
" 90 " six feet.
" 95 " six feet four inches.
" 100 " six feet eight inches.
" 105 " seven feet.
" 110 " seven feet four inches.
" 115 " seven feet eight inches.

Over 120 feet, eight feet.
" 125 " eight feet four inches.
" 130 " eight feet eight inches.
" 135 " nine feet.
" 140 " nine feet four inches.
" 145 " nine feet eight inches.
" 150 " ten feet.

Where the width of a corner lot is greater than an ordinary city lot it will have a clear space of not less than ten feet in the rear of that portion in excess of an ordinary city lot, or, in lieu thereof, an open court not less than one of the same widths as above, and beginning at the street or avenue, which will extend the full width of the lot and continue to the first interior room. And such interior portion of a corner tenement or lodging house will conform to all the requirements of a tenement or lodging house situated on an inside lot.

Privy vault. No privy vault or cesspool will be maintained on the premises if a connection with any public sewer can be made.

Water-closets. The general water-closet accommodations will not be placed in the cellar and no water-closet will be placed in the yard. In tenement houses there will be one water-closet on each floor, and where there is more than one family on a floor there will be one additional water-closet on that floor for every two additional families.

In lodging houses there will be one water-closet on each floor, and where there is more than fifteen persons on any floor there will be an additional water-closet on that floor for every additional fifteen persons or fraction thereof.

Floor and sides of water-closet apartment. That the floor and sides of each water-closet apartment in every tenement and lodging house will be made water-proof with some non-absorbent material.

Water supply. In every tenement house connected with any public sewer, running water will be provided over a sink in each set of apartments.

Isolation room. Each lodging house will be provided with an isolation room, arranged as follows: 1st. It will be located on the uppermost floor and its air space will not be less than one thousand cubic feet. 2d. It will have a window opening on the street or avenue and a louvred skylight on the roof. 3d. It will be provided with a water-closet apartment having its partition, extended to ceiling and a window opening on the outer air, also a sink with running water; and, 4th: The walls and floor will be rendered impermeable to liquids or gases.

Drains, etc. Yards, areas, light-shafts and courts will be properly graded, flagged or concreted and drained.

Restrictions. Where the premises are occupied as a tenement house no part thereof will be used for a lodging house or private school. Nor will they be used for the storage and handling of rags.

No stable or coal yard will be maintained on any lot whereon it is proposed to erect a tenement or lodging house or convert any building to the purposes of a tenement or lodging house.

And, finally, the undersigned hereby agrees to faithfully comply with all the laws relating to the erection of tenement or lodging houses, or to the conversion of other buildings to the purposes of a tenement or lodging house, or to the maintenance of such tenement or lodging house, and also the rules and regulations under which this permit is issued.

Owner.

Architect.

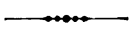
Dated _____ 189__



These plans and specifications were referred to Inspector _____

_____ District, on the _____ day of _____, 189__.

Clerk.



FINAL REPORT.

NEW YORK, _____, 189__.

To the Commissioner of Buildings:

SIR—I have the honor to report that the above described premises were begun on the _____ day of _____, 189__, and completed on the _____ day of _____, 189__, and that said premises conform in all respects to the conditions of the above permit and also the laws and rules and regulations relating to the light and ventilation of tenement and lodging houses.

Respectfully submitted,

Inspector, _____ District.

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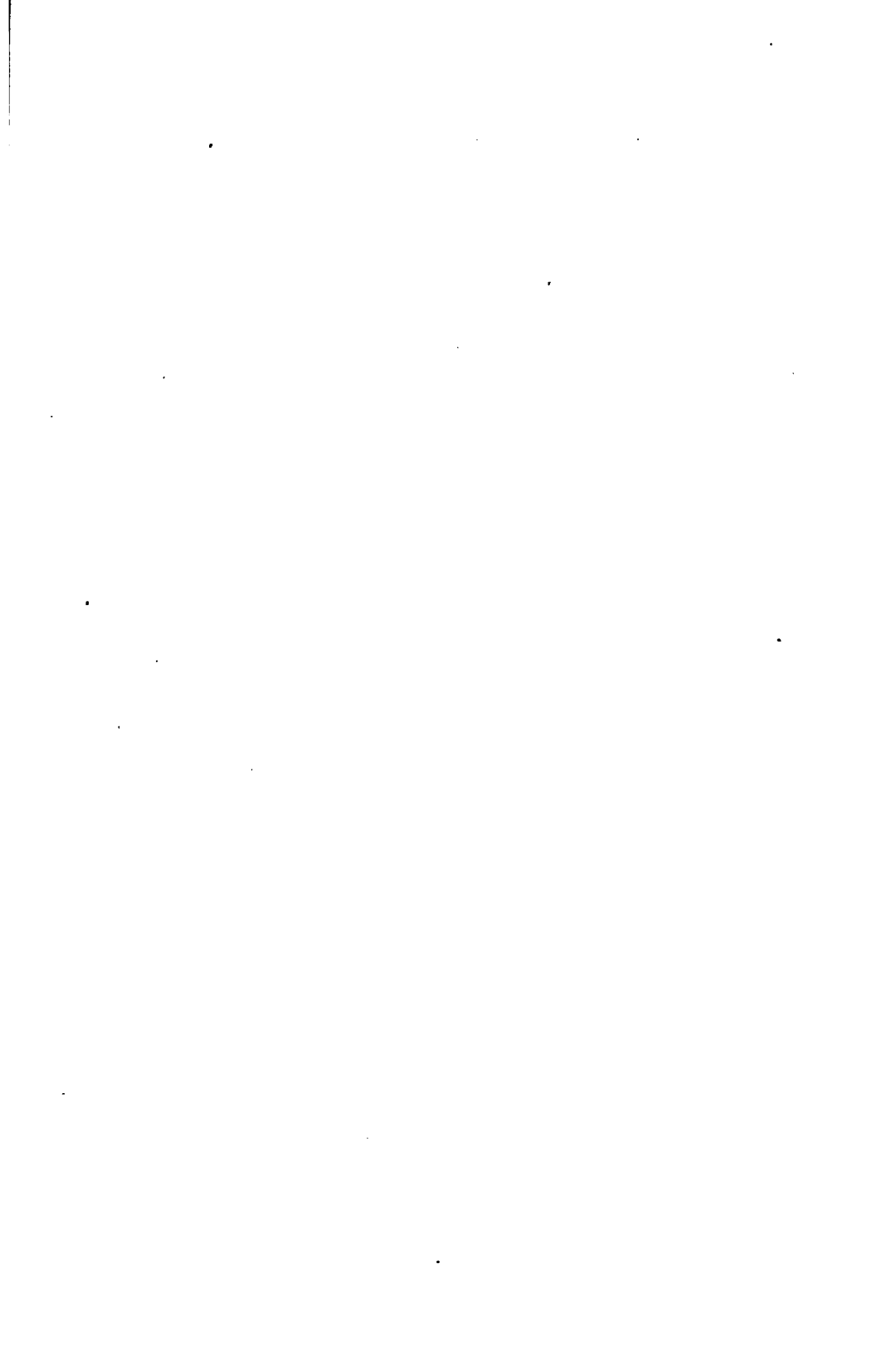
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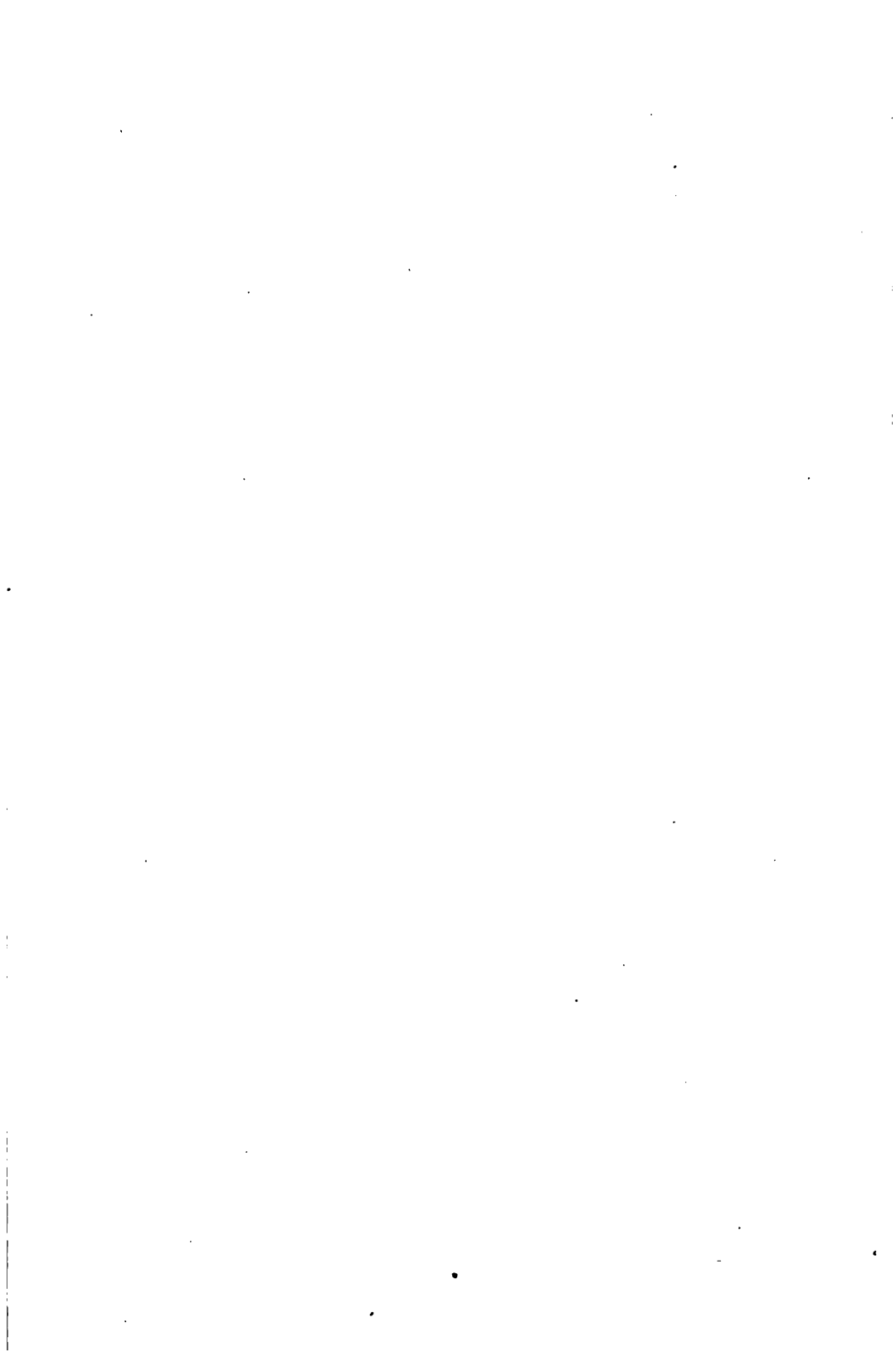
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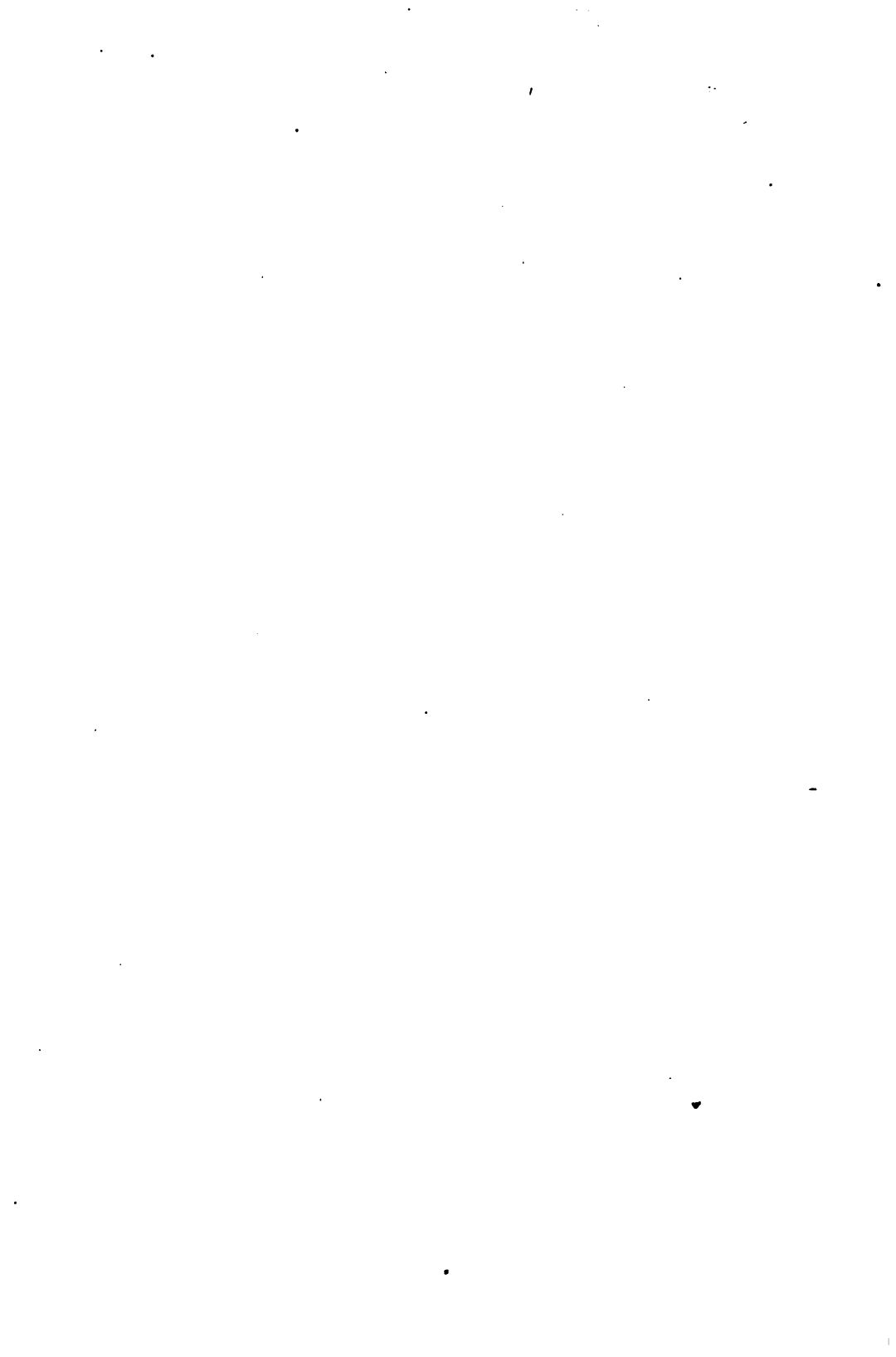
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