ESTIMATING THE COST OF BUILDINGS

ARTHUR W. JOSLIN

Estimating the Cost *of* Buildings

A Systematic Treatise on Factors of Costs and Superintendence, With Important Chapters on Plan Reading, Estimating the Cost of Building Alterations, and on System in the Execution of Building Contracts

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PREFACE TO FIRST EDITION

All of the matter contained in this volume appeared in substantially its present form in *Carpentry and Building* during the three years just passed. At the time of its writing I had no idea of its appearing in book form, but the articles were so well received that I have listened to the publishers of *Carpentry and Building* [*Building Age*], and numerous acquaintances among builders and architects, and have slightly revised the various papers for publication as a book under the general head of "Estimating the Cost of Buildings." Unfortunately, I have been obliged to undertake this revision at a time when I have been very busy in the conduct of our business. Had this not been the case I should have liked to have enlarged upon a number of the subjects treated, and may do so at some future time.

This volume is dedicated to my wife, whose loving presence in my home has made it possible for me to find pleasure there and the time to undertake such matters as this.

Boston, November 22, 1909. ARTHUR W. JOSLIN.

PREFACE TO SECOND EDITION

At the time of writing the first edition of this book I started out with the assumption that its circulation would be almost wholly among those who understood "plan reading." It has since developed that there is a demand for the book in evening classes in Industrial, Trade, Y. M. C. A. and similar schools where the students have little or no knowledge of plan reading and must of necessity acquire such knowledge before taking up the study of estimating from plans. I am therefore starting the Second Edition with chapters on this subject and have endeavored to treat it in language so simple that it will be readily understood by all. Suitable illustrations accompany these chapters, and it is hoped by both Publishers and Author that a much more useful book is being offered in this edition.

Boston, July, 1913. ARTHUR W. JOSLIN.

CONTENTS

PART I

Reading Architects' Drawings

PART II

Masonry, Iron Work, Marble Work, Metal Work

PART III

Carpenter Work

PART IV

Miscellaneous Sub-Contracts

PART V

Estimating the Cost of Building Alterations

PART VI

System in the Execution of Building Contracts

PART I

Reading Architects' Drawings

CHAPTER I

Definition of a Plan and General Explanations

A plan is a set of "conventional" signs usually drawn to scale, to illustrate the design of the structure that is to be built. A properly drawn plan, correctly read or understood, conveys a perfect mental picture of the completed work.

Scale of Drawings

The ratio of the plan to the work is as the scale of the plan to 12 inches. Thus on a $\frac{1}{8}$-inch scale plan every part that can be measured is 1/96 of the intended length, width, height or thickness, for there are 96 one-eighth inches in 12 inches. Likewise a $\frac{1}{4}$-inch scale plan shows everything reduced 1/48 from the intended size or dimension. A $\frac{1}{2}$-inch scale shows things reduced to 1/24 actual size. A $\frac{3}{4}$-inch scale to 1/16 actual size. A $1\frac{1}{2}$-inch scale to $\frac{1}{8}$ actual size. A 3-inch scale to $\frac{1}{4}$ actual size. A 6-inch scale to $\frac{1}{2}$ actual size. Drawings made the actual size of the parts are termed "full size details." Drawings made to $\frac{1}{2}$-inch scale or larger, up to but not including full size, are termed "scale details."

Most building plans are drawn $\frac{1}{4}$-inch or $\frac{1}{8}$-inch scale. This means that each $\frac{1}{4}$-inch or $\frac{1}{8}$-inch, as the case may be, on the plan, represents one foot in the structure. Therefore a floor plan that measured 10 in. on one of its sides, if drawn to the scale of $\frac{1}{4}$-inch, would mean 40 ft. in the actual building, as there are 40 one-quarter inches in 10 inches.

If the plan was drawn to the scale of $\frac{1}{8}$-inch and measured 10 in. on one of its sides, it would mean 80 ft. in the actual building, as there are 80 one-eighth inches in 10 inches.

Full Size Drawings

Details drawn to large scale or full size are made to show essential particulars that it is impossible to show on $\frac{1}{8}$-inch or $\frac{1}{4}$-inch scale plans. On all drawings where figures are supplied they are given in numerals followed by the customary signs for feet and inches; thus a dash to the right of and just above the figure signifies feet, two dashes similarly placed signifies inches; six feet and nine inches would be written on a plan as follows 6′-9″, or twenty-one feet and three-fourths of an inch, thus 21′-0$\frac{3}{4}$″.

The different plans usually furnished for a building are floor plans, elevations, sections and more or less scale details. Basement and cellar plans come under the head of floor plans.

Elevations are plans of the sides of buildings, and they show doors, windows, pitch of roofs, etc., which can not be fully shown or made clear on a floor plan. Thus, a floor plan can, by the conventional sign, show the location of a window in a wall, but it can not show its height, width of casings, thickness of stool, whether having backband molding or not, manner of cutting up sash into lights of glass, etc. All of these things must be determined from the elevations, and in particular work these $\frac{1}{4}$-inch or $\frac{1}{8}$-inch scale elevations are further supplemented by large scale or full size elevations and sections.

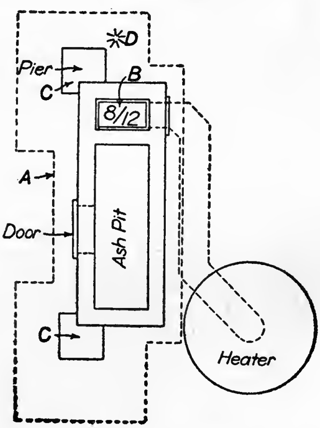


Fig. 1—Part of Cellar Plan showing Chimney, etc.

A sectional drawing is a representation of the construction of a building, or part of same, showing of what members or parts the building, or part of same, are made up.

"Cross hatching" is a series of diagonal lines filling in the entire space between two or more lines defining the outline of any member or part of the building cut through and brought into view by a sectional drawing. Where members abut each other, the direction of the cross hatching lines is changed to more clearly define or emphasize each separate part. Portions of a building brought into view by a sectional drawing, but not cut through, are elevations. Thus a drawing taken on an imaginary line through a building would be in part a sectional, and in part an interior elevation, drawing.

Public improvements sometimes require the literal cutting in two of a building and the destruction of one part. The part left standing, showing the ends of joists, walls, partitions, etc., and the walls of various rooms with doors, base, trim, mantels, etc., all in plain view, is a living example of a sectional drawing.

All parts actually cut through would be "cross hatched" on a sectional drawing.

A cellar, basement or floor plan is the view of a building if it were sawed in two horizontally somewhere about half way between the floor and the ceiling, and the upper part removed.

Parts Represented by Dotted Lines

Objects above the imaginary line upon which the plan is made, or below the floor, have their outline or form shown by dotted lines.

There are cases where parts shown dotted mean something else, and this will be explained later.

Plans are usually accompanied by specifications, which in great measure describe at length the kind and quality of the materials to be used in carrying out the work, and the methods and order of performing it.

Assuming that the reader knows very little about plans, the first thing he should do is to read the specifications carefully. This will help him to determine the meaning of some of the lines or signs on the plan.

To illustrate the point made above Fig. 1 is a part of a cellar plan showing a chimney, piers built in connection therewith, and the heater and smoke-pipe.

You probably found in reading the specifications that all walls, piers, chimneys, etc., were to have footings. Now, as footings are below the cellar floor and cannot be seen on the plan, and as you probably know without being told that they extend beyond the parts over them, you at once identify the irregular dotted line "A" as the outline of the footing for the chimney and the two piers built in conjunction therewith. If you know so little about a plan as to be in doubt as to how a chimney is shown, the fact that the inner rectangle is marked "Ash Pit" ought to help to identify the pair of parallel lines inclosing it as a chimney, shown in plan.

Details of Chimney

Having made up your mind it probably is a chimney that is shown, the parallel lines, which will be found by using a scale rule, are 4″ apart, it is at once determined that it is the brick wall which makes the chimney. It is recognized that an ash pit must have walls of some kind around it; that presumably they would be brick and being brick they would be 4″ thick. Now observe the smaller rectangle inclosed in double lines (B) about one inch apart by scale and above the ash pit as you look at the plan. It is known that a chimney has a flue or flues, and you should readily identify this as a flue having a flue lining. The double lines, one inch apart by scale, with the four inch wall around it, should convince you beyond a doubt that it is a chimney that is shown. If further evidence is necessary there is the circle marked "Heater," and the dotted lines from heater to flue, meaning of course the smoke pipe leading as they do from the heater to the flue. The figures within the flue "8/12" signify that it is an 8″ x 12″ flue, which you know to be one of the sizes in general use.

The method of noting size on the plan (8/12) is a sort of short hand, as there is not room to write out the size in full with "inch signs" added to numerals (8″ x 12″).

The extensions on the two corners of the chimney, marked "C," are piers built up with and bonded to it.

The cleanout door for the ash pit is indicated by a line on the outside wall of the chimney. It is marked "Door," is 15 in. in length by scale, and its size is probably given in the specifications.

The asterisk at D, denotes a gas or electric light outlet and fixture; the method of lighting is determined in the specifications.

This covers everything shown in Fig. 1, and by using a scale on the drawing the size of the chimney, piers, heater, etc., is found, and the work can be laid out accordingly.

Use of a Carpenter's Rule

If, using a carpenter's rule, each one-fourth (1/4″) of an inch means one foot (1′-0″) in the actual work, it naturally follows that one-sixteenth of an inch represents three inches; one-eighth of an inch six inches, and three-sixteenths of an inch nine inches in actual work. Such dimensions as 1″, 2″, 4″, 5″, 7″, 8″, 10″, 11″ are determined by "eye" when using the carpenter's rule. If a scale rule is used there are graduations reading to each inch.

Having thoroughly analyzed the small portion of a plan shown in Fig. 1, we will now analyze a complete set of plans for a small dwelling. The set of plans are shown in the following diagrams, of which

Fig. 2 is Foundation and Cellar Plan.
Fig. 3 Section of Foundation Wall.
Fig. 4 Elevation of Pipe Column.
Fig. 5 is the First Floor Plan.
Fig. 6 is the Second Floor Plan.
Fig. 7 the Attic Floor Plan.
Fig. 8 the Front Elevation.
Fig. 9 the Rear.
Fig. 10 the Side (Left) Elevation, and
Fig. 11 the Side (Right) Elevation.

All of these drawings are made to scale of $\frac{1}{4}$″ to 1′. Each drawing is supplemented by numerous notes and figures, also by detached sections and elevations from $\frac{1}{4}$″ to $\frac{3}{4}$″ scale.

CHAPTER II

Analysis of the Foundation and Cellar Plan

Probably the first thing observed upon looking at the cellar plan, Fig. 2, is that two parallel lines form a somewhat irregular rectangle. The outer line represents the outside of the founda-

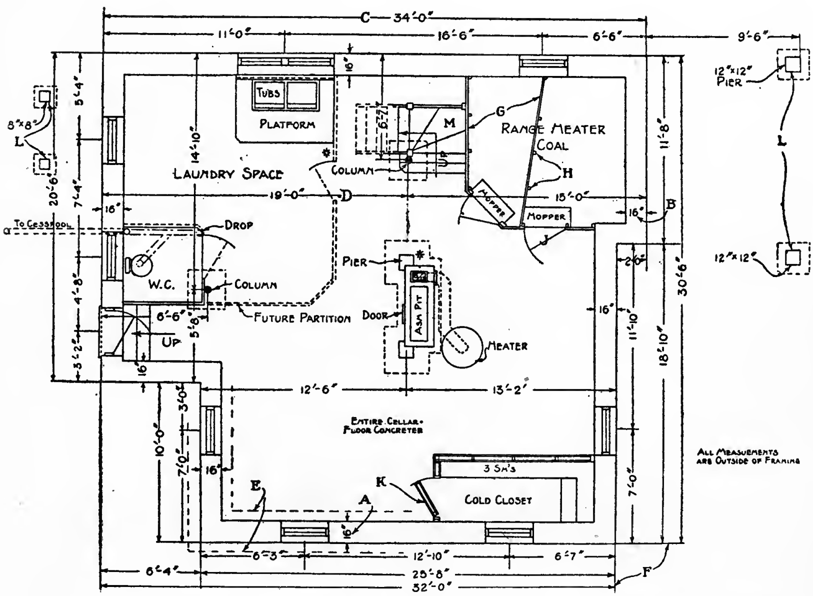


FIG. 2—PLAN OF FOUNDATION AND CELLAR—SCALE 1/12 IN. TO THE FOOT

tion upon which the house is to be erected. The inner line, which is figured in several places as being 16" from the outer line (see A-B), represents the inside line of foundation. The figures 16" between these lines at several places call attention to the fact that the foundation wall is 16" thick.

Notice that wherever this dimension is put on the plan between lines representing the outside and inside lines of the foundation, there are small arrows, thus: → 16" ← These arrow points are called "witness marks," and they convey the information that the 16″ is from one of these marks to the other. Ordinarily the shaft of the arrow would be towards the figures, as in the case of the dimension 34′-0″ at the top of the plan "C," which, by the location of the witness marks at the right and left of it, shows that these figures represent the length of the building on that side.

The reason for reversing the arrows in the case of the 16″ dimension is that the two parallel lines are so near together that there is not room to continue the shaft lines towards each other and leave room for the figures. The usual custom in regard to the "extended arrows," or dimension lines, put on plans is to make them of red or diluted black ink, so that when the blue print is made they come out as a faint line. While faint they are easily distinguishable, but not heavy enough to be confused with the full prominent lines of the plan.

The witness marks or arrow heads are put on drawings in black ink so that when blue-printed they will stand out prominently and call particular attention to the points between which the dimension is taken. In laying out work from a plan figures should always be followed in preference to dimensions obtained by scaling the plan. In using the figures particular care should be taken to note to which lines or points the witness marks refer.

Where intermediate measurements, as well as over all, are given, as in the dimension next below the 34′-0″ referred to, the said intermediate figures should be checked to see that their total agrees with the "over all" figure. Thus the figures (on the line of figures under 34′-0″) 11′-0″ from outside of wall to center of mullion window, 16′-6″ from center of mullion window to center of single window, and 6′-6″ from center of single window to outside wall are found to total 34′-0″.

Go down further on the plan to the line of figures D, and we find the figures 19′-0″, witnessed from outside of wall to a line continued from the center of a column, followed by the figures 15′-0″, witnessed from center of column to outside of the opposite wall. We find that the dimensions 19′-0″ and 15′-0″ added also give us 34′-0″. As the outermost witness marks in the case of the last two of these lines of dimensions are from the same lines on the plan as those of the line C, each should total 34′-0″, as in C.

Failure to do so is evidence that there is an error somewhere in the figuring. By comparing plans over and under the one in question, checking their figures, and by using the scale rule where figures are manifestly incorrect, a correction can usually be made by the person attempting to lay out the work from the plans. Failing to discover the error by the above method the matter should be referred to the architect or his representative who will determine the corrections to be made.

To study the outside wall further we have recourse to the section of the foundation wall shown in Fig. 3. We will assume that the specifications call for footings. To make the plan Fig. 2 correct, the footing lines should show as at E, but as the addition of unnecessary lines makes the plan complicated, and it is made plain in other places that footings are required, the plan is just as clear as though they were shown.

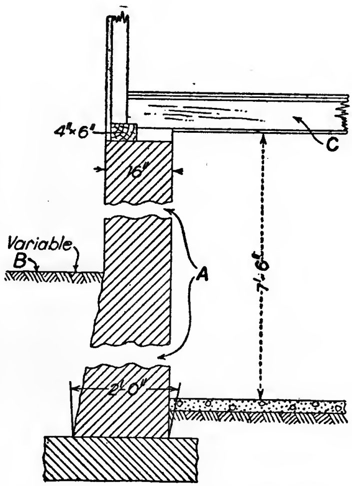


FIG. 3—SECTION OF FOUNDATION WALL—SCALE 1/4 IN. TO THE FOOT

Now look at Fig. 3, which is a section through the foundation wall. The thickness of wall at the top and bottom, respectively 16″ and 2′-0″, is shown here; also the depth of the cellar from under side of first floor construction when plastered to the top of concrete (7′-6″); the shape and location of footing; size of the sill and its location on the wall; and several other points of construction. You have probably noticed that the vertical lines representing the wall are not continuous as at A. The lines are "broken," as it is called to compress the drawing into a smaller space. If you scale the distance figured 7′-6″ you will find that it falls short of this figure. The height of wall as shown in this section being broken twice, once above and once below the line B, which denotes the outside grade, establishes the fact that the amount of wall above and below the grade is variable, as is noted on the drawing. In order to determine the relation of the grade to the top of the wall, reference must be made to the elevations.

Also notice that this section shows a 4" x 6" sill laid flatways on the wall and far enough from the outer edge of the wall, so that when it is studded up above the sill and outside boards put on, the outside line of boarding is flush with the outside of the foundation.

Now to refer back to Fig. 2 in the lower right-hand corner, we find the note, "All measurements are Outside of Frame." If you look carefully at the dimension lines you will see that lines extending from the corners to which dimensions are figured, are by scale, about 1" short of the full line representing the outside line of the foundation (see F).

A glance at Fig. 2 shows that the floor joist C is sized onto the sill about 1", that there is an under and upper floor, denoted by the two lines drawn parallel to the line representing the upper edge of the joists; and that the ceiling of the cellar is sheathed or plastered, as denoted by the line below and parallel with the line representing the bottom edge of the joist. The specifications probably confirm the matter of the two floors and state whether ceiling is sheathed or plastered. The plans have frequently to be considered with each other and with the specifications, and then coupled with some little knowledge of construction, in order to have them convey to the person attempting to read them what the architect intends to have built.

In the upper right-hand corner of Fig. 2, and within the pair of parallel lines representing the foundations, are two divisions plainly marked "Range and Heater Coal." The lines which bound and form the partitions are about 1" apart by scale, indicating that the partition G would be composed of 1" or $\frac{7}{8}$" boards, which should be nailed to the studs H, about 30" apart by scale. The door is at J, partly open to show the swing, and behind the door is the "Hopper."

In the lower right-hand corner of Fig. 2 is another compartment, marked "Cold Closet," shown by lines similar to those denoting the coal bin, except that there are two parallel lines on each side of the studs. This, of course, means that the cold closet partition is boarded on each side of the studs, and an examination of the door K shows that this is of double construction also. The lines inside of the cold room are to represent shelves, and as a plan could not show how many and there is no section given, the note "3 Sh's" (3 shelves) is added. Possibly the specifications would mention this, but whether they did or not, the note settles the question of how many shelves, and the drawing shows the width.

In the upper left-hand corner is the note "Laundry Space," and parallel dotted lines enclose it. This is one of the cases referred to where dotted lines may mean something else besides things under the floor or above the imaginary line upon which the plan is supposed to be taken. In this case the information is given in the note "Future Partition."

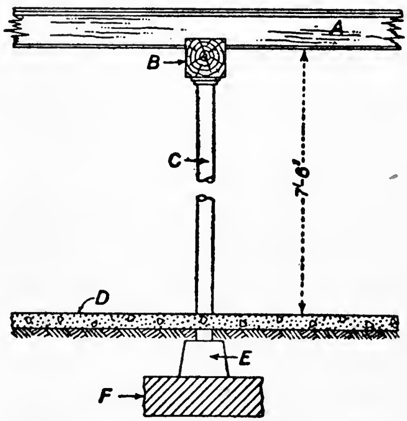


FIG. 4—ELEVATION OF PIPE COLUMN—SCALE ¼ IN. TO THE FOOT

Notice the tubs under the windows and the platform upon which they set, also the water closet (W. C.), which is also shown on a platform, although it is not noted. Study the plan carefully at this point and you will see that a platform is shown here as well as at the tubs where the fact is noted.

Fig. 4 is a typical column like those on the cellar plan Fig. 2 near W. C., and foot of stairs. The detail illustrates a side elevation of floor joist A; section of girder B; elevation of column C; section of concrete floor D; elevation of small block of cast concrete usually sold with columns E, and a section of the footing under the column F. For convenience in drawing, this column is shown "broken," but the figures give the correct dimension between floor and ceiling, and agree with the section shown in Fig. 3.

Outside of the lines representing the foundation on Fig. 2, to the right and left at the top, are the piers supporting the front and rear porches. The size of the piers is figured as well as drawn to scale, and the footings in all cases are shown dotted.

We have now examined in detail nearly everything shown on this cellar plan except the stairs indicated at M, which start straight with two steps, take a right angle turn with "winders" and continue up to the first floor. See bent arrow marked "up." The stairs are shown in full lines about halfway up, when they change to dotted lines. The upper part of these stairs can be seen on the First Floor Plan, where the arrow is noted "Down."

The height of the foundation out of the ground, the style of the cellar windows and other similar particulars are obtained by referring to the elevations which show all four sides of the building.

CHAPTER III

First, Second and Attic Floor Plans

In Fig. 55 we see a pair of parallel lines which except for the front porch, rear porch and bay window (B. C. D.) conform to

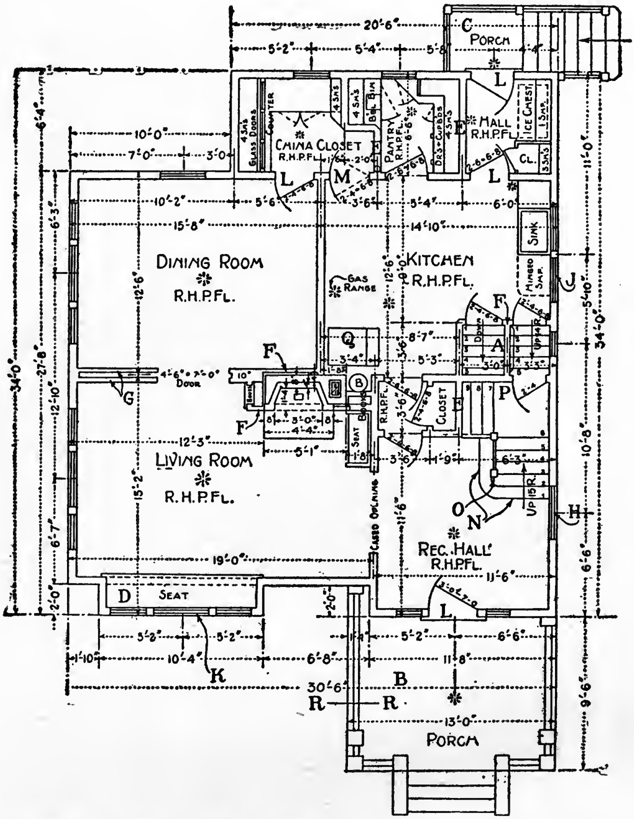


FIG. 5—FIRST FLOOR PLAN—SCALE 1/2 IN. TO THE FOOT

the same outline as the foundation and cellar plan shown in Fig. 2. Notice, however, that the two parallel lines are much nearer together than on the foundation plan. If you try a scale rule on these lines you will find that they scale 6 in. apart. In an ordinary frame house or other structure the outside is assumed to be 6 in. through. This thickness is made up as follows: Studding, 4 in.; outside boards, 1 in.; plastering, 1 in.; total, 6 in. To be accurate the studding is $3\frac{3}{4}$ in., the outside boards $\frac{7}{8}$ in., the plastering $\frac{3}{4}$ in. The shingles, clapboards or other outside wall covering and the base inside are not taken into account in making $\frac{1}{4}$ in. or smaller scale drawings. The draughtsman assumes that you know of the existence of these parts and that you will look to the elevations, large scale and full-size details and the specifications for more particulars in regard to them. All interior partitions that are built of 4-in. studs are also assumed to be 6 in. and are so drawn. Partitions shown a little less than 6 in. by scale are of 2 in. x 3 in. studding, and if shown even thinner than those implying 3-in. studding, they may be assumed to be built of 2 x 3 or 2 x 4 set flatways.

Partitions marked E on the plan Fig. 5 are of 3-in. studding; those marked F are of studs set the 2 in. way. The partition which divides the dining room from the living room and is figured 10 in. is for a large single sliding door. When the door is opened, it slides into a pocket, about 3 in. wide, made by the two partitions G.

Windows in general, on small scale drawings for frame buildings, are shown by two parallel lines between the lines representing the outside wall, the length of these lines being the scale width of the sash. A typical window is shown at H. Where windows are grouped they are shown as at J, representing a mullion window, and at K, representing a triple window. These same parallel lines between partition lines would represent a sash in a partition. To find the style, height, etc., of these windows shown in the outside wall, the elevations must be referred to.

Doors are shown by an opening in the parallel lines representing a wall or partition as at L. From these openings there are lines at an angle with a segment of a circle faintly shown. The line at an angle represents the door and the faint line shows which way it swings. Notice that each door is figured for size. Wood, style and thickness or any other particulars must be obtained from other drawings and the specifications.

The door marked M represents a double swing door. Notice that the angular line is dotted, shows both sides of the partition, and that the segment of circle, showing swing of door, continues each way from the partition. At the outside doors (from reception hall to porch, and back hall to rear porch) you see a line about 2 in. by scale from the outer line of the two denoting the outside wall and running 5 in. or 6 in. by scale beyond the opening shown for the door. This shows the threshold and also implies a riser or difference in height between the levels of the floor in the building and on the porch. If you will step outside of your own front door and look at the threshold of it, I think you will see at once the conditions just explained and the logic of the method of showing them on the drawing.

The kitchen, back hall, pantry and china closet have shelving and equipment of various kinds.

Next examine the stairs going up from the reception hall. The first riser N is carried around at right angles until it stops against the partition that follows down under the second run of stairs X, the corner being a quarter circle. This is called a block step. The newel O starts on this block step, the next riser (2) is also a block step, and ends in a small quarter circle against the newel. Next are the risers Nos. 3, 4, 5, 6, a platform, a right angle turn and risers 7, 8, 9, where the stairs have reached a height somewhat above halfway to the second floor, and a closet is put in under them.

The balance of these stairs will be seen at A on the second floor plan, Fig. 6, where the riser numbers are picked up at No. 9, and continued to No. 15. Notice that the arrow at the start of these stairs on Fig. 5 says "Up 15 R." Now look at the stairs going up out of the kitchen where arrow says "Up 14 R." Here we find five risers up to the level of the platform of the front stairs. There is a door from the kitchen to these stairs, also a door at the top, on the platform, to cut them off from the kitchen and the front stairs. This part flight to the platform is called a "box flight," as it is between two walls; consequently it does not require posts, rails and balusters, but has a wall rail on the right as you go up, shown by the parallel lines close together. The lines representing the rail turn with a quarter circle at right angles into the partition, which denotes that the rail turns into the wall at each end, and is fastened there to the partition.

As we have six risers from the reception hall, and five risers from the kitchen, the fact is established that the height of each riser in the box flight from the kitchen is increased enough to

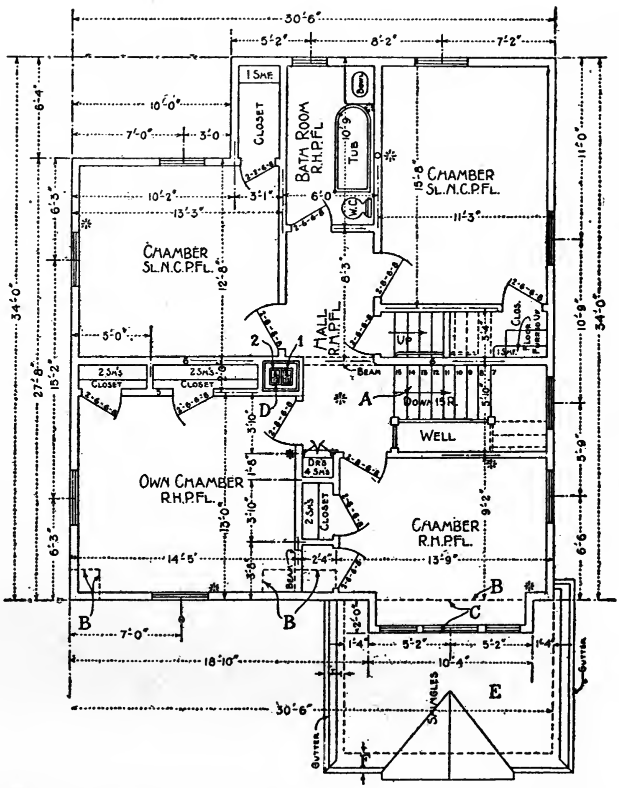


FIG. 6—SECOND FLOOR PLAN—SCALE 1/12 IN. TO THE FOOT

cover the distance from the first floor to the platform. An arrangement of stairs like this is called a "combination stair." Besides the box flight from kitchen to the platform, there is the flight of stairs leading to the cellar (A). Here the arrow says "Down." This is between partitions and is a box flight at the start, but as you go down into the cellar it becomes an open flight.

The partition between these stairs and the front stairs at P, would have to stop even with the under side of the stringer of the upper run of the front stairs (risers 7, 8, 9, etc.) in order to make "head room" for the cellar flight. At the point where this partition occurs we have gone up 7 risers and down 5 risers from the first floor. As the average riser is about 8 in. high we have in the 12 risers about 96 in. or 8 ft. Out of this must come the depth of the stringer under risers 7, 8, 9, etc. As this would be only 5 in. or 6 in. you readily see that there is ample head room for the cellar flight. There is no way that this stopping of the partition under the upper run can be shown on the floor plans, but when the arrangement of stairs is studied the fact must be evident.

The chimney in the corner of the living room is clearly indicated. The 8-in. x 12-in. flue shown on the cellar plan Fig. 2 is in evidence. As the corner of the chimney having this flue comes into the kitchen the inference may be drawn that this flue also serves for the kitchen range, which is shown in the corner of the kitchen Q. The kitchen boiler marked B is in a niche back of the range.

Notice that the part of the chimney showing in the kitchen and boiler niche has no line enclosing it as in the dining room at F. This shows that this much of the chimney is exposed and requires the brickwork to be laid up neatly and possibly of better brick than the rest of the chimney. This is one of the points that is undoubtedly settled by the specifications.

The Bookcases and Fireplace

The fireplace is fully shown and carefully figured even to the face brick lining, hearth, dump to ash pit under, etc. Notes on the plan at this point show that a seat and bookcases are worked in around the chimney corner. The large scale or full-size drawings do not come as a rule until after a contract with the builders is made and it is about time to build in the special parts; in consequence the estimator has to determine the requirements from the small scale drawings, the specifications and his experience with work in general and his consultations with the architect.

A study of the porches B and C shown in plan Fig. 5, and reference to the elevation will show which of the various lines represent steps, posts, rails, etc. Large scale details are shown of the front porch and living room bay, and these will be taken up later and references made to the first floor plan.

The Second Floor Plan

We will now study the second floor plan, Fig. 6, but at much less length than was devoted to the first floor plan. Here we see the same outline as the first floor, except the front of the building, where the dotted lines B show the outline of the first floor. As the parallel lines representing the front wall of the building show, the second floor overhangs to the face of the two projections on the front wall of the first floor, and the part of the second story front wall over the porch has a still further overhang or projection in the form of a square bay C. Everything in regard to partitions, doors and windows explained in connection with the first-floor plan applies to the second floor.

In the bath rooms a bowl, bath tub and water closet are shown. As each of these fixtures is noted, you cannot help locating them on this plan. The conventional methods of showing these fixtures never varies much from the way they are shown here, and, even if the fixtures were not noted, no difficulty should be experienced in identifying them.

The Chimney

Notice the chimney D. Here we have a plain rectangular-shaped affair with two 8 x 12 flues. If you look at the drawing carefully you will see that the two flues are side by side, having no brick withe (partition) between them. The flue No. 1 is the same one shown in the plan of the chimney on both the foundation and first-floor plans. The other flue, No. 2, is for the fireplace. As this starts midway between the first and second floors, drawing the flue on the first floor over all the lines showing the fireplace would only serve to complicate the first-floor plan, and no attempt is made to show it there.

The part of the plan marked E is the front porch roof. The roof and gutter lines are shown, and the fact that it is a shingle roof is noted. The dotted line shows the outline of the frieze of the porch cornice. The distance from the dotted line to the outer edge of the gutter is the overhang of the cornice (F).

While discussing the foundation and cellar plan attention was called to the fact that all dimensions were to "the outside of frame." This note applies throughout all the plans. Take the dimension 34 ft. referred to on the foundation plan; compare the same side of the first and second-floor plans and you will see that it is the same on both. You will also see that the 11-ft. dimension at the left, and 6-ft. 6-in. dimension at the right, which are to the center of the windows, or mullion windows, also applies to all three plans. An examination of the elevations of this side of the

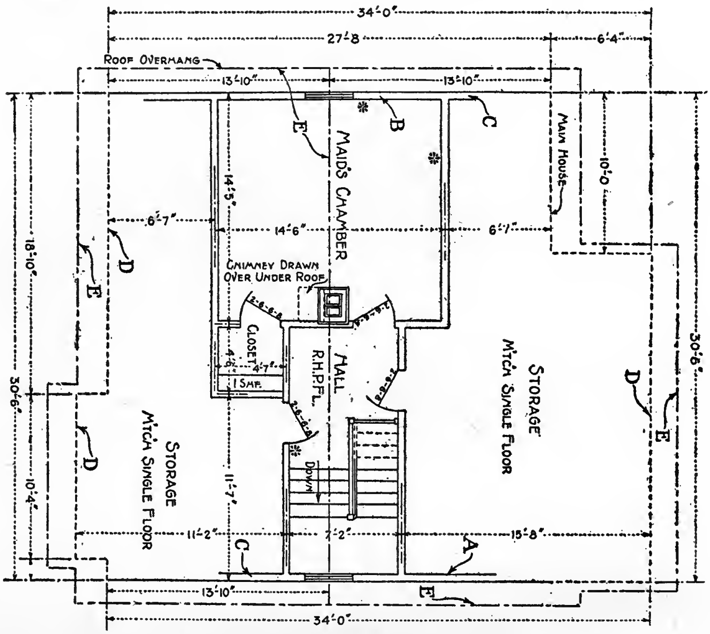


Fig. 7—Attic Plan—Scale 1/12 In. to the Foot

house will show by the lines drawn over the plan, running through the center of the windows, and groups of windows, that they center over each other and at the same figured distance from the corners of the building called for by the floor plans.

The sides A and B, in the attic floor plan, Fig. 7, are the gable and sides indicated in the elevations in Figs. 10 and 11. Notice that the line representing the inside line of the wall is discontinued shortly after it passes the partitions that intersect it as at C, but that the line denoting the outside of the wall is continued to the corner. This is to show that while the studding, boards, wall shingles, etc., continue to the outside corners, the plastering occurs only when the inside of the wall is in a room or finished part of the attic.

The balance of the outline of the house at attic floor level is shown by a dotted line D. The dot and dash lines E show the roof plan, those around the outline being the line of the outside of cornices and rakes, and the one through the center being the ridge of the roof.

Everything else necessary to know on this plan can readily be determined by applying the explanations given with the first and second floors and by reading the notes.

CHAPTER IV

Elevations, Roofs, Block Plans, and the Use of Colors on Drawings

We will next take up for consideration the various elevations, of which Fig. 8 represents the front, Fig. 9 the rear, Fig. 10 the left side and Fig. 11 the right side elevations. These are all drawn to $\frac{1}{4}$-in. scale, but are here reproduced one-third that size or to a scale of $\frac{1}{12}$ in. equals one foot. An elevation drawing of

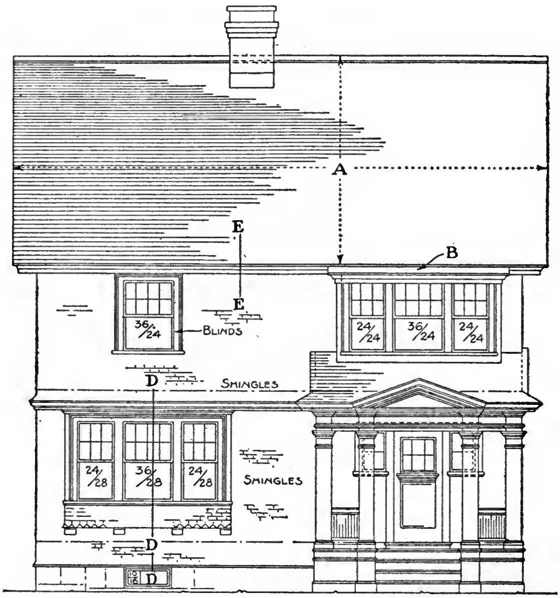


Fig. 8—Front Elevation—Scale $\frac{1}{12}$ In. to the Foot

the side of a building is one in which every part that can be seen, if you were standing directly in front of the center of a side of a building, and at sufficient distance so that all perspective effect was lost, was brought forward into a vertical plane and pictured as though it was a flat surface.

In drawings of this kind true heights, widths and other measurements may be obtained, whereas a perspective drawing like a photograph, cannot be measured in the ordinary way. Look at the upper part of Fig. 8 at A, where the front slope of the roof is shown. As far as this drawing goes it might be a vertical surface. Now look at the left side elevation in Fig. 10 and you will see that it is a sloping surface.

If you scale the vertical distance A on both Figs. 8 and 10 you will find that they are the same. As you look at this elevation (Fig. 8) your judgment must tell you that the surface A is the

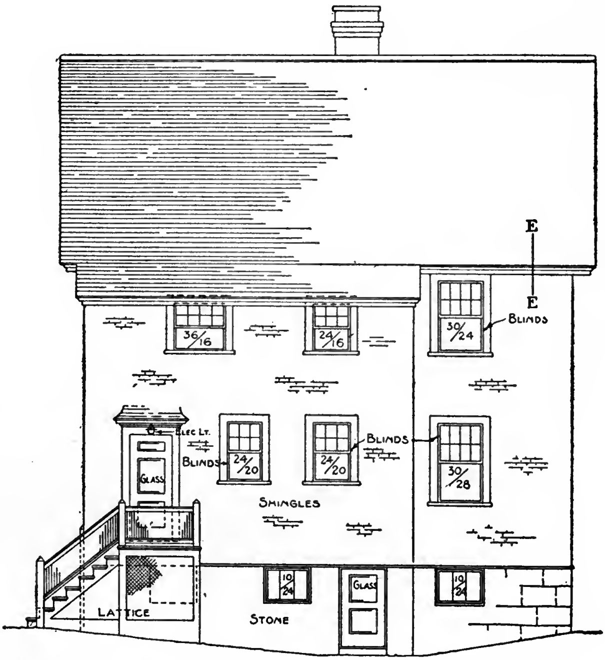


FIG. 9—REAR ELEVATION—SCALE 1/12 IN. TO THE FOOT

main roof, the surface B the bay-window roof, and the surface C the porch roof. From this drawing you may scale the true vertical height of these roofs, but to get the pitch or slope of them you must refer to either one or the other of the side elevations which are at right angles to the front. Look at the side elevations, Figs. 10 and 11, where the roofs are marked B and C.

Thus from the elevation drawings you can obtain all information relative to door and window heights, widths, style, etc., size and slope of roofs, style of cornice, porches, balustrades and outside trim generally, so far as such parts may be intelligently shown at such a reduction from the full size. Conventional methods of drawing or notes also make clear the materials used for wall and roof coverings. When all of the above are taken with the floor plans and specifications, a true mental picture of the structure is produced, and all of the drawings may be read as figured, or

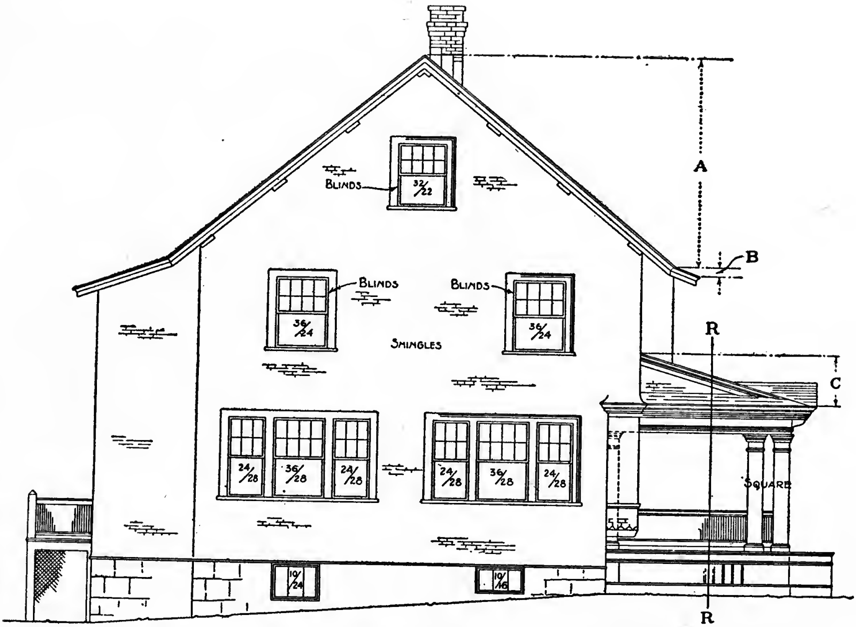


FIG. 10—LEFT SIDE OR SOUTHEAST ELEVATION—SCALE 1/12 IN. TO THE FOOT

scaled if not figured, for actual dimensions to use in estimating upon or carrying out the erection of the building.

To make perfectly clear to the estimator or builder the style and construction of cornices, porches, bay windows, etc., large scale drawings are given as follows: $\frac{3}{4}$-in. scale section and elevations of front porch, Fig. 12; $\frac{3}{4}$-in. scale section through living room bay, Fig. 13, and $1\frac{1}{2}$-in. scale section through main cornice, Fig. 14. The $\frac{1}{4}$-in. scale typical section through wall and roof of house, from footings to roof (Fig. 15), provides an opportunity to show size of joists and rafters, and heights of stories properly figured. For purposes of publication these drawings are presented to a scale one-third of that mentioned.

There is also shown, at a scale of 40 ft. to the inch, a "block plan," as in Fig. 16. The main purpose of this plan is to show the location of the house on the lot. It should, and usually does. show many other things necessary to know and inconvenient to

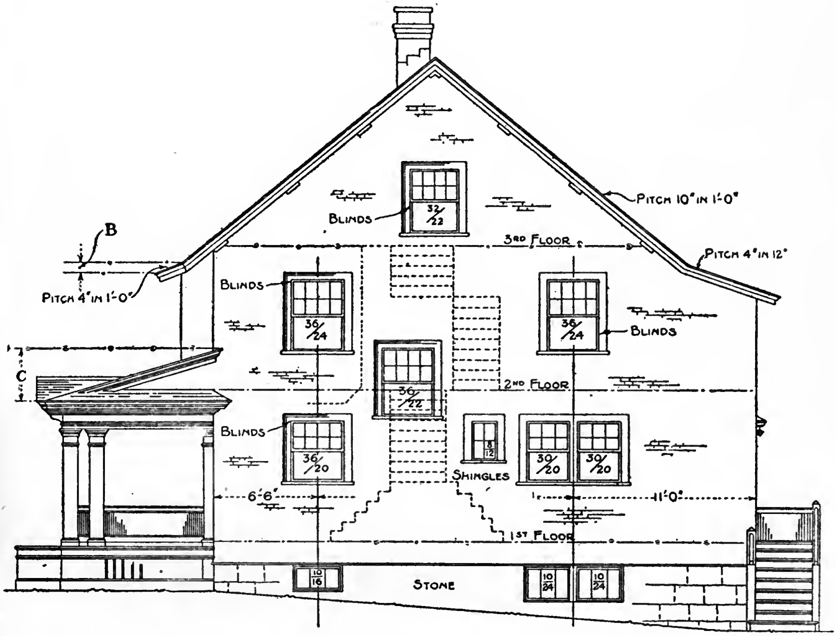


FIG. 11—RIGHT SIDE OR NORTHWEST ELEVATION—SCALE 1/12 IN. TO THE FOOT

put on the general plans. Among these things are the following: Dry wells and locations; sewer, gas and water mains, their distances from the house and the direction in which connections of the above take to reach the house; cesspools and locations; walks, retaining walls, driveways and fences; size and shape of lot; points of the compass, etc.

All of these matters must be known, and the block plan shows them and their relation to each other. So much has been offered in explanation of the several floor plans, small sections and elevations that it would seem that further words would only confuse the reader. However, a few words in explanation of some of

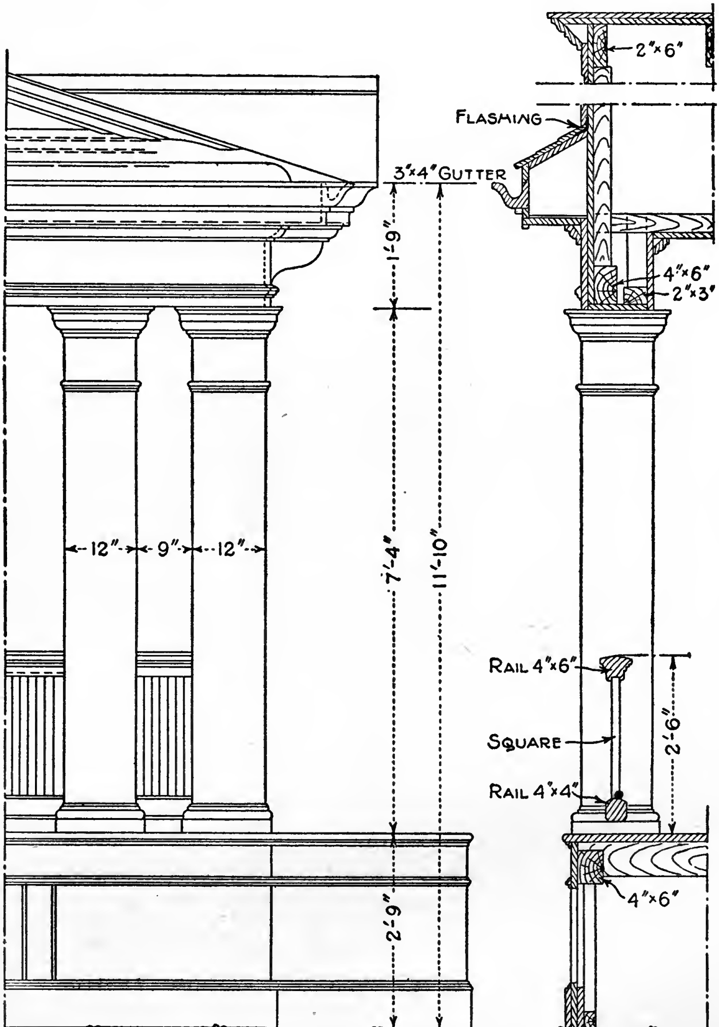


FIG. 12—ELEVATION AND SECTION OF FRONT PORCH—SCALE 3/8 IN. TO THE FOOT

the large scale drawings may possibly be of assistance in helping the reader to understand them.

Take Fig. 12, which is drawn to a scale of $\frac{3}{4}$ in. to the foot, but published to a scale of $\frac{3}{8}$ in. equal 1 ft. On the left we have an elevation of the porch as seen from the side. On the right is a section through the porch taken about on line R-R of Fig. 5, and R-R on the elevation Fig. 10 shows about where this section is taken.

You will see, if you look at the porch on this elevation, Fig. 10, that the large scale drawing presents about that part of same to the right of the line R-R.

The principal advantage of this large drawing of the porch is that the draughtsman is enabled to show moulding profiles, cornice projections, etc., and give dimensions that, on account of the small scale, could not be made evident on the front or side elevations. The section also enables him to show the construction and size of frame members. These latter points of information cannot be shown on the floor plans or $\frac{1}{4}$-in. scale elevations.

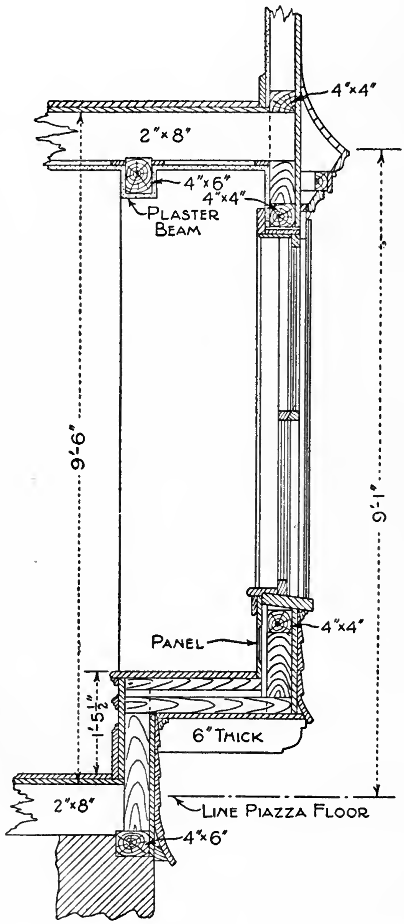


Fig. 13—Section Through Living Room Bay—Scale ⅜ In. to the Foot

Fig. 13 is a section through the living room bay and is also drawn $\frac{3}{4}$ in. to 1 ft., but published one-half this size. It shows the bay as it would look if cut in two on the line D-D, Fig. 8, and the left-hand piece was removed, so that you would see the construction from the main sill on the foundation up through to a point a foot or so above the second floor.

Everything revealed by this "autopsy," that is actually cut through, is cross-hatched, or in the case of large members like the sill and girt, shown in imitation of a large piece of end wood, the growth rings and checking being simulated. The joists and studding, the sides of which stand revealed, are drawn in imitation of a large piece of timber or plank as seen sideways, the side grain being simulated.

Fig. 14 shows a section through the main cornice on the front or rear of the building as at E-E, in Figs. 8 and 9. Remarks in

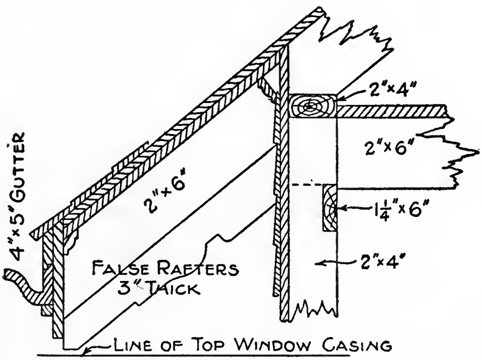


Fig. 14—Detail of Main Cornice—Scale ¾ In. to the Foot

explanation of Fig. 13 apply here with equal force. This drawing was made to a scale of 1½ in. to 1 ft., but is here shown one-half this size.

Fig. 15 is a scale section through the house, from footing course to roof, making no attempt to show anything except story heights, joists and rafter sizes, height of rough window openings, etc.

Many architects and draughtsmen use colors and different types of cross-hatching to show the materials of which the various parts are constructed. For instance, red is used to show brick in plan or section, yellow to show wood, and blue to show stone, etc. While these different colors and the several types of cross-hatching are frequently used, custom varies as to their use. While an aid to reading plans they are in no sense a necessity.

The proper reading or understanding of plans is a progressive study. As you grasp the meaning of one thing shown, the meaning of other parts adjacent, become apparent. As knowledge of actual construction and architecture is acquired, the meaning

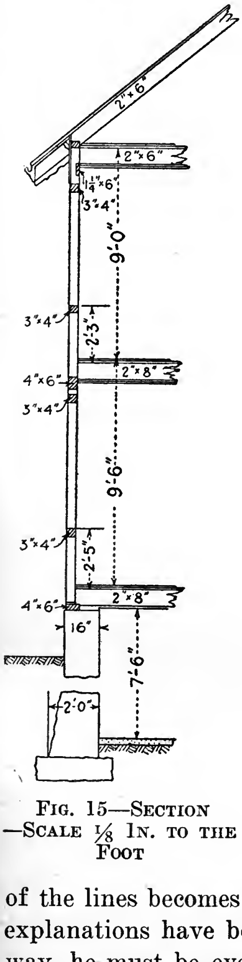


Fig. 15—Section—Scale ⅛ In. to the Foot

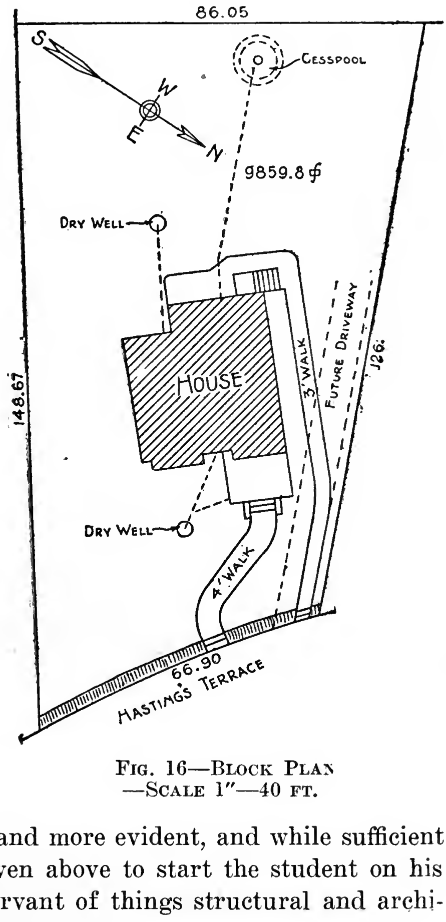


Fig. 16—Block Plan—Scale 1"—40 ft.

of the lines becomes more and more evident, and while sufficient explanations have been given above to start the student on his way, he must be ever observant of things structural and architectural if progress is to be made.

PART II

Masonry, Iron Work, Marble Work, Metal Work

CHAPTER V

Knowledge Required by the Estimator

No one should undertake to estimate quantities from plans until he has reached a point where a drawing is as easily read or comprehended as so much printed matter is read and understood by a person taking up a book or paper dealing with a subject with which he is familiar.

It is to be hoped that a careful study of the preceding chapters, and the drawings which accompany same, will have prepared the student to come up to the above requirements and thus enable him to follow the subject intelligently.

There have been a number of books written on this subject, but in the main they tell how many brick there are to the foot in various thicknesses of walls, how much waste there is on lumber, how much work of various kinds a man ought to do in a day, and so on. Now all of this is very essential, but the problems that confront most beginners when a large plan is given them to estimate on are more like these: Where am I going to begin? How am I going to know when I have taken off all the materials of a given kind? And how shall I go at it to know that I have omitted no important item?

Most men engaged in any of the various trades connected with the building business who get to positions where it becomes a part of their duty to "survey" quantities, and estimate costs on same, I assume are able to perform the ordinary operations of arithmetic, such as addition, subtraction, multiplication and division, both of simple numbers and of fractions or decimals. I shall also assume that they understand more or less of mensuration, or the methods of obtaining the areas of various shaped planes and the contents of various shaped solids.

In the chapters dealing with "estimating" I shall not enter into the matter of "costs" any more than to try and show how you can work out for yourself the cost per unit of the various items going to make up a building. As the cost of the various commodities entering buildings, also the labor necessary to install them, are so variable in different parts of the country, my reasons for this must be plain.

I shall treat the question from the point of view of the man figuring the "general contract." In the natural order of things he has either been a journeyman mason or carpenter before circumstances placed him in the lists as superintendent or contractor.

No one man can know everything about all trades, and so it will be impossible for him to figure everything. Nevertheless, if he has had his eyes and ears open he should know enough to estimate at least two-thirds of everything entering a building. Such items as electric work, plumbing, heating and ventilating and a few others require to be figured by men having an intimate personal knowledge of these trades. It is very embarrassing, when called upon to submit a bid for a building, to have to chase all over town to get sub-bids to cover three-fourths of the job before being able to make up a figure. Your own judgment and ability should enable you to make a figure on the work with but little assistance from others.

It is an unwritten law in the building trades that if a subbidder has figured some portion of the work for you, and you have used his bid in making your figure, he should be awarded that part of the work in event of your success in obtaining the contract. This is only just and proper, as he has given of his time and brains to assist you in making a price for the work.

My experience has been that you can get closer bids for such parts of the work as you wish to sublet if the parties estimating know that you have actually got the work to let out.

I trust that the above remarks have prepared the reader to take up with me the actual study of the subject in hand. Please bear in mind that opinions vary and that none of us are perfect.

I am not claiming to know all that there is to know on this subject, but having for more than 14 years done enough figuring to keep about 150 men employed, on the average, and the firm's accounts showing credits on the profit side of the ledger, I feel that what I may have to say will be of help to many.

CHAPTER VI

Method of Estimating

In general practice no two buildings which you are called upon to figure will be exactly alike; nevertheless, you can have a general system or method and vary it to suit individual cases. By having such a system and always following it as closely as circumstances will permit, you become more expert and eliminate the possibility of errors. Bear with me for stating some things that are obvious to the average reader, and remember that there probably will be, among those who follow this subject with me, men to whom very little is plain. It is in order to make things clear to them that I go into these seeming trifles.

When a plan and specification is handed to you and you are requested to make a bid for the work, the first thing to do before commencing to figure is to look the plan over for 15 or 20 minutes, or longer if necessary, until you have a sort of "mind picture" of the building. The next thing in order is to view the site. It is not safe to put in a figure on a job if you have not seen the site, unless it is in a locality with which you are entirely familiar. The circumstances of site may make a good deal of difference in your prices per unit for materials. For instance, the structure may be on a side hill, or removed from the traveled road; there may be no water near, or the site may be covered with trees; or in the case of a town or city building you may be so hemmed in with buildings as to make the handling of materials very difficult. All of these things are going to affect your price and you should know them. I have often gone 100 miles to have a look at the site of some structure on which I was figuring, not staying at the site more than half an hour, but always coming back with enough extra information to feel amply paid for the time and expense.

Next read your specifications all through, not only those parts that you intend to figure yourself, but everything. You can conveniently use the time you are traveling to and from the site for doing this. You will now have an intelligent idea of what you are about to estimate upon.

Provide yourself with a suitable book for your estimates. I have found that the most convenient book for this purpose is one of the loose-leaf kind, with pages about 6 x 9 in., also having an index. Number your estimates, as for instance, No. 51; put down the title of the building, together with owner's and architect's names, the date, etc.; and as your estimate will use up several pages, number the pages. You will find that keeping an index of your estimates under the owner's or architect's name, or both, will be valuable to you if you should want some time afterward to refer to them. With the loose-leaf book you can take out several sheets and take them with you to an architect's office, home of an evening, or anywhere else without carrying the book with you. When your book becomes full you can remove everything but your index, and by running tapes through the holes bind a hundred or so estimates and file away.

Now take the plans apart, and if you have space to do it, spread out your several elevations and sections, or better still, tack them up in front of your table. Leave all of your floor plans on the table, with the foundation or cellar plan on top, first floor next, and so on.

Now open your specifications at the first item, which will probably be "clearing the site." Having visited the site, you can now set a price on the work you will have to perform before you can begin your excavation. The cost of this item will be largely a matter of judgment. We will assume, for example, that it is a suburban site; perhaps there are 10 large trees to cut down and the stumps to remove, a lot of underbrush to be cut, and the limbs and brush from the trees to be burned up or otherwise disposed of. Then reason as follows: The average tree will require a day's time to cut down and lop off the limbs and brush; to get out the stump it will take two men a day; this makes 30 days' time for the 10 trees. Now for the brush: After sizing it up you conclude that a couple of men can cut it all down in a day, and that it will take them another day to gather it up, together with the limbs of the trees, etc., and burn it up. Thus you have a total of 34 days' work, which, if done by laborers at $2 a day, would be $68, giving you the cost of this item.

Before starting the excavation you will put up "batters," and if the work is large you will probably require the services of an engineer and his helper for a day. A few minutes' study of the plan will tell you how many posts you have got to drive and how much lumber these and the boards for them will require. Picture yourself there with a carpenter or two and a laborer, and determine how long it will take to put up the batters and get the marks on them; then the cost of the lumber, plus the amount you have determined upon for labor, plus the cost of the engineer and his helper for a day, gives you the cost of this item.

CHAPTER VII

Excavation and Ground Work

The common "unit of measure" used in estimating excavations is the cubic yard, or 27 cu. ft. Look up your sections and see how much larger than the size of the building your excavation will have to be on account of the projection of the footings. This determined, get the area of the building, allowing sufficiently all around for projection of footings, and consult your elevations for the natural grades and the depth of the cellar, taking the depth to the bottom of the concrete for the general cellar level, and put it down on the estimate sheet (Fig. 17, for example, sizes assumed). Now, if there is some deeper part, as, for instance, a boiler room, take this area by its depth below the former depth used. Now take your footings, which are probably below the depths just figured, taking the outline of the building first, then your cross walls, and pier and chimney footings next. Then if there are areas, bulkheads, etc., set down their dimensions. Continue thus through the entire excavation. Now I would advise that you do not proceed at once to carry out the result of these measurements, getting the number of yards and putting a price on them, but proceed to the next item, putting down the dimensions for it as I have done for excavation. There are several reasons for this: First, you want to get through with the plan as soon as possible, roll it up and have it out of the way. Second, you can take the estimate sheets with you in your pocket and figure up an item at your desk, at home of an evening, while on a railroad train, or anywhere, in fact, that you happen to have a few minutes, thus utilizing a lot of time that you usually let go to waste. Third, I find that without the plan in front of you to distract your attention, you can concentrate your thoughts upon the figuring much better, thus carrying out your results quickly and accurately. Fourth, by this method of taking off the quantities you can drop the work at any stage of the surveying of the plan or carrying out the results of the measurements and figuring the cost, by finishing the item you are working on and take it up again later the same day, or a week from then, a glance at your estimate sheets showing you just where you left off.

Notwithstanding that I advise you to delay figuring out the

Mercantile Building at Dorchester, Mass. for John Smith C. S. Jones Architect Jan. 15th '07 E #51		1
Clearing site	68	—
Batters 500 ft Spruce. 16 hrs. carpenter 16 hrs. laborers 4 hrs. engineer and Helper	33	50
Excavation 64' × 83' × 5'-6" 18 × 24-6 × 3-0 286 × 4-0 × 1-0 62 × 3-0 × 1-0 81 × 2-6 × 1-0 4 × 6 × 1-0 6 × 8 × 5-0 4 × 12 × 3-6 1204 cu. yds. @ 35 cts	421	40
Shoring and pumping	220	—
Spruce piles 10" top; 6" bottom 758 about 30 ft long @ 4.25 Furnished, driven and cut	3221	50
Concrete footings. 1 P.C. : 3 S. : 5 B.S. 290' × 3'-6" × 1'-4" 60 × 3-0 × 1-0 79 × 2-6 × 1-0 3-6 × 5-6 × 1-0 2-6 × 2-6 × 1-0 × 12 times 68 cu. yds. @ $6.50	442	—
Foundations Local rubble. 80' × 9' × 2'-4" 139 × 8' × 2-4 59 × 6 × 2-0 36 × 4 × 1-8 mortar 1 P.C. : 4 S. 236 Perchs @ $5.35	1262	60
	$5669	00

FIG. 17—ESTIMATE SHEET NO. 1

results of your dimensions, as a matter of convenience in writing on the subject I shall carry out results and work out the price with each item as we go along.

Now to get back to the item of excavation: By figuring out the dimensions set down under this heading you will find 32,-503½ cu. ft., which makes within a few feet of 1204 cu. yd., so we set down the number of yards as 1204. In putting a price on this work you must consider how you are going to handle the job, whether with wheelbarrows or carts; the kind of soil, wet or dry, clay or gravel, etc.; also, how far you have got to carry the excavated material to pile it up or dump it.

If ordinary digging piled up within 100 ft. or so from the cellar, it will cost you around 30 cents per yard, and if, as it often happens in the city, the excavated material has to be carted a couple of miles to a dump, the cost will be around $1.50 per yard. In this case I have assumed about the first conditions and set the price at 35 cents per yard, making the cost of this item $421.40.

Shoring and pumping is usually all a matter of judgment. You will have to analyze the work to be done the same as I have done on the "clearing the site" item, making up your mind how many days' labor will probably go into pumping, and how much labor and stock it will require to do the shoring. On all such items as this, which are purely the result of analysis and judgment, it is better to reason out and put down the cost while the plan is right before you, and you have reached and are considering the item. As a rule this takes little time.

Piling

Perhaps the building is on piles, and if so there will be a piling plan showing the number and disposition of them. By starting at some corner of the building and going around the outline, taking next all cross walls running in one direction, then cross walls in the opposite direction, then angular cross walls, followed by the isolated bunches for piers, chimneys, etc., it resolves itself into a matter of care and counting to get the total number.

If you are familiar with the locality and are having this work done often you will know the length required and for what you can get them driven. The cutting of piles, after they have been driven and excavated around, is usually done by the general contractor and costs in the vicinity of 20 cents each. If unfamiliar with the locality and costs, you will call upon some one who makes this work his business and get a price per stick, driven, and by adding the cutting you have the price at which to carry out the cost, drawn and cut complete.

Borings

On jobs of any size it is customary for the owner or architect to have borings made. A plan is then made showing location of each boring, with a record of the various soils and substances underlying the surface, and the depth of each is noted on the plan. By consulting this plan you can see just what kind of soil you have to excavate, whether shoring and pumping will be necessary, and at what depth a secure foundation is to be found.

Footings

We will assume that our building has concrete footings, so on the estimate sheet we put down this item, and after it make a "memo." of the mixture, so as to have it before us later when we put a price on the concrete, per cubic yard. The abbreviations as I have written them stand for 1 part of Portland cement, 3 parts sand and 5 parts broken stone. We will commence by taking off the footings the same way we went at the counting of the piles, taking the outline, then cross walls in one direction, and so on. By carrying out the results we find that we have within a few feet of 68 cu. yd., and for such a mixture in this vicinity we make the price about $6.50 per yard.

If there were piles under the building the chances are that the footings or "pile cappers" would be of block granite. This would not change your method of taking off, and in carrying out the result you can make it either cubic yards or perches, according to the way you are in the habit of figuring stone work.

CHAPTER VIII

Foundation Walls, Walks, Grading

The common "unit" in stone work is the perch (24.75 cu. ft.), although many use the cubic yard. In taking off the quantity of stone work proceed about the same as for footings, outline first, etc. If the wall varies in height and thickness on the different sides of the building, set down the number of feet in length of each different height and thickness separately. Reference to the plans and sections will give you the desired information, and frequently the depth of foundations is shown dotted on each elevation, and numerous scale sections are often put on the foundation plans to show more fully all of various dimensions of walls. According to the figures I have assumed, there are slightly under 236 perches, so we carry out the cost on that number.

In order to set a price on the stonework you must know or find out the price per perch, or cubic yard, for the kind of stone called for, delivered at the site; the number of perches that the average mason in your locality will lay in a day; the amount of attendance he will require; the quantity and quality of mortar required per perch, and the prices for sand, lime and cement. Knowing these, you can readily work out the probable cost per perch or cubic yard. For example, I will work out the cost of a perch of wall laid up of local rubble, according to present conditions here. It is customary in this vicinity for the party selling the stone to measure the wall when built to determine the number of perches and charge the purchaser the number thus found. Local rubble per perch, delivered, is $1.75; mortar, 1 part Portland cement at $2.20 per barrel, 4 parts sand at $1 per cubic yard, makes cost of materials for a cubic yard of mortar as follows:

1.7 barrels cement cost	$3.74
.98 cubic yard sand	.98
Total cost of cu. yd. of mortar	$4.72

One mason at 60 cents per hour, one laborer to make and carry mortar, and two laborers to handle stone to the mason and assist him in placing them on the wall, all at 30 cents per hour, should in a day, under normal conditions, lay from six to seven perches of wall; call it six perches, thus:

8 hours mason at 60 cents	$4.80
24 hours laborers at 30 cents	7.20
Cost of labor for six perches	$12.00

making $2 per perch.

Now the result of the above analysis is as follows:

Stone	$1.75
Mortar (1/3 cu. yd. per perch)	1.60
Labor	2.00
Total per perch	$5.35

In case of a wood building where there is an underpinning shown above grade, or a retaining wall, or any other stonework required to be laid up with more care, or of better stone than used in foundations, the dimensions should be taken off separately and price for same made to suit the quality of stone and kind of work required. Many builders figure this kind of work by the face foot instead of by the cubic yard or perch, but if you figure this way the thickness of the wall must be taken into account in making the price.

Concrete or Granolithic Floors, Walks, Etc.

The customary unit of measure for these items is the square yard (9 sq. ft.). The simple operation of getting the square feet in a space inclosed by walls or other bounds needs no explanation. If the plan is irregular in outline, divide by imaginary lines into several squares, rectangles or triangles, and compute the area in square feet, then reduce to square yards.

If there are, as is usual, different thicknesses on differently prepared foundations, with varying top finishes, each kind should be taken care of separately, and then the price of each made to suit the circumstances. See page 2 of the estimate sheet shown in Fig. 18.

Drains

This is simply a matter of obtaining the running feet of each size, and in making price, you must consider the depth the pipes are laid, and the nature of the soil. If your plan is large and

E #51

John Smith Building — 2

Underpinning. Broken coursed ashlar; Quarryface; Backed with rubble.		
280'×3'-0" } 1016 face feet		
66×2-8 } @ 75 cts.	762	—
Granolithic Side walks.		
7'×60' }		
4'×21' } 76 sq. yds		
72'×2'-6" } @ $1.80	136	80
Concrete Cellar floors. 4" thick. }		
1 P.C.: 2½ S.: 4 B.S. }	442	80
59'×75' = 492 sq. yds @ 90 cts }		
Akron drains 4" and 6"		
laid about 3'-6" deep		
198 ft. @ 35 cts	69	30
4 Dry wells. 7'-6" deep from		
grade filled with stone chips.		
3'-0 dia. @ $2.40	9	60
1 Cesspool 8'-0" dia. 10'-0" deep. }		
Rubble wall. Brick domed top. }	85	—
Cast iron cover in Bluestone }		
Grading	120	—
Sodding between side walk		
and curb.		
1050 sq. ft. @ 10 cts	105	—
	$1730	50

FIG. 18—ESTIMATE SHEET No. 2

there are many long runs of drain, a very convenient way to take same off is to use a 5-ft. pocket tape. On a ¼-in. scale drawing multiply the number of inches of drain on the plan by 4 and you have the number of feet and no possibility of making a mistake in addition.

Where roof water is taken care of by dry wells, the specification will usually tell you the depth below inlet of drain, diameter, and whether walled up or filled with coarse stone. By taking one typical well and analyzing as follows, determine the price: Typical well 4 ft. deep below inlet, 3 ft. diameter, filled to within 2 ft. of grade with coarse stone, equals 2 yd. excavation at 50 cents, about 1⅓ cu. yd. of stone, which can usually be gathered up around the premises (chips and refuse resulting from foundation and underpinning work), worth deposited in hole, say, 60 cents, representing 2 hr. for a laborer, plus 1 hr. more for a laborer to fill over and level off surplus earth, 30 cents, plus 1 hr. time for foreman at 50 cents to locate the well and oversee the operation, making total cost $2.40.

If there are one or more cesspools, analyze as above and determine price.

I went to some length in analyzing the stonework and dry well, to give you an idea how to dissect, so to speak, anything upon which you wish to make a price. Consider each component part separately and compile the results. This method must be used to find the cost of any part or unit of measure met with in estimating the cost of building operations.

Grading

This item is largely a matter of judgment, especially if no great amount of earth is to be moved, and you do not have to purchase loam, as is usually the case in ordinary building operations. Thus you size up the situation and make up your mind about how many days it would take a certain number of men to perform the work, assisted, if necessary, by so many days' work for a team, plus a foreman's time to oversee the operation. If a large job, you have excavation of a certain number of cubic yards to bring lot to sub-grade, the purchase, teaming and spreading so many cubic yards of loam, etc., readily found by surveying the plans. You then figure out, at unit prices, the various items covering the work, for your total.

Sodding is always figured by the square foot or square yard. It will vary in cost from 6 to 12 cents per foot, according to circumstances. I shall not offer any explanation as to obtaining the quantity from plans, as it is a simple operation of finding areas.

CHAPTER IX

Brickwork

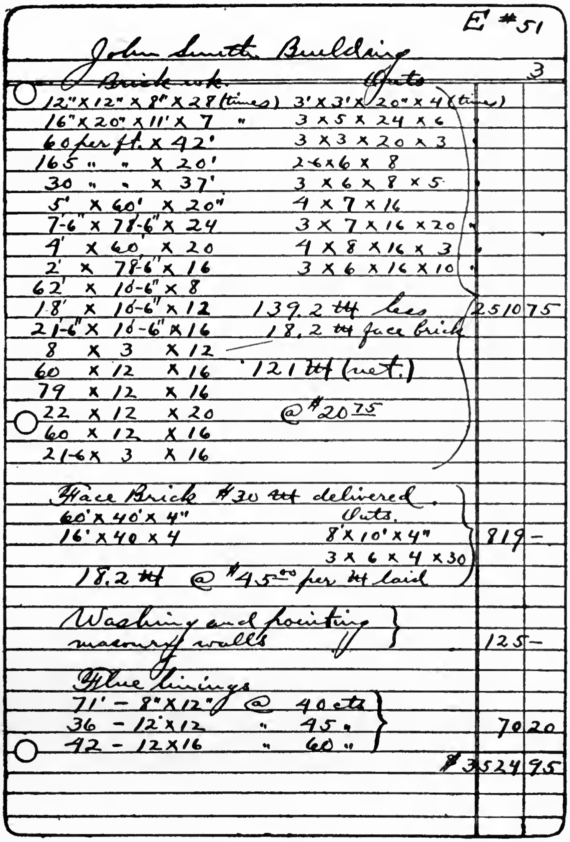
If the building under consideration is a wooden structure, about all the brick necessary will be that for piers, chimneys, fire stopping, and possibly underpinning. For piers and chimneys the best way is to figure the number of brick per foot of height, multiplying by the whole number of feet. For instance, assuming five courses to 1 ft., an 8-in. pier has 10 brick per foot, a 12-in. 22½ brick, a 16-in. 40 brick, etc. Set down on your estimate sheet the number, length and size of piers and carry out result later. See page 3 of estimate sheet, Fig. 19.

It may be here stated that brick from various localities vary greatly in size. The smaller brick lay up about five courses to 1 ft. The larger brick will sometimes lay up 14 in. in five courses. With the smaller ones it requires 22½ brick to lay 1 cu. ft. of wall. As this is the generally recognized number per cubic foot, I shall use it in treating the subject of brickwork; but in actual practice you will have to regulate the number of brick per cubic foot, or face foot for the various thicknesses of wall, to the size of brick you intend using.

Chimneys, especially without fireplaces, are also best figured by finding the number of brick per foot in height and multiplying by total feet in height. If there are fireplaces, find the number of brick per foot in the base and multiply by the number of feet in height to the point in chimney above fireplace, where it is drawn into the flue or flues, with necessary withes (partitions between flues in a chimney), proceeding with balance of chimney as for any ordinary one. You must also add enough brick to head over the chimney under the fireplaces and for hearths.

Brick used for underpinnings comes under the head of walls; thus the explanation on walls will cover this item.

I think the best way to figure walls is to measure the face feet of each thickness, and after taking out the "outs" multiply by the number of brick per foot for each thickness. The prevailing custom in this locality is to allow openings out at about three-quarter their size, unless they are very large, in which case we allow them out at full size. We make no allowance for very small "outs." It was at one time customary to allow the corners



E #51

John Smith Building

Brickwork — Outs — 3

12"x12"x8"x28 (times) — 3'x3'x20"x4 (times)
16"x20"x11'x7 " — 3x5x24x6
60 per ft. x 42' — 3x3x20x3
165 " " x 20' — 2-6x6x8
30 " " x 37' — 3x6x8x5
5' x 60' x 20" — 4x7x16
7-6" x 78-6" x 24 — 3x7x16x20
4' x 60' x 20 — 4x8x16x3
2' x 78-6" x 16 — 3x6x16x10
62' x 16-6" x 8
18' x 16-6" x 12 — 139.2 M less — 2510 75
21-6" x 16-6" x 16 — 18.2 M face brick
8 x 3 x 12
60 x 12 x 16 — 121 M (net.)
79 x 12 x 16
22 x 12 x 20 — @ $20.75
60 x 12 x 16
21-6 x 3 x 16

Face Brick $30 M delivered.
60'x40'x4" — Outs.
16'x40x4 — 8'x10'x4" — 819 —
3x6x4x30
18.2 M @ $45.00 per M laid

Washing and pointing masonry walls — 125 —

Flue linings
71' - 8"x12" @ 40 cts
36 - 12"x12 " 45 "
42 - 12x16 " 60 " — 70 20

$3524 95

FIG. 19—ESTIMATE SHEET NO. 3

double, but I do not think the custom prevails to any extent now.

In a brick building where there are walls of various thicknesses—both outside walls and partitions—I find the best method of surveying the brick is to work from the various foundation and footing levels, at which the brickwork starts, up to the top of the first floor, then from top of first floor to top of second floor, and so on to the top of the structure.

Should the outside or any partition wall be of uniform thickness through several stories you can simplify matters some by taking the total height of the several stories in one measurement. For the purpose of illustration, however, we will assume that the walls, both outside and partitions, are of various thicknesses not only from one story to another, but in each story.

Method of Procedure

Now with the basement or cellar plan before you and sections and elevations where you can refer to them, proceed as follows: Take a prominent corner of the outside wall and work around the entire outline of the building. For instance, on the side you have taken for a start the wall is figured 20 in. The elevation for this side shows from top of foundation (probably about 6 in. under finished grade) to top of first floor to be 3 ft. at one end and 7 ft. at the other, making an average height of 5 ft.; then set down on the estimate sheet as shown in Fig. 3, the dimensions 5 ft. x 60 ft. x 20 in. There are several windows scaling 3 ft. wide and with an average height of 4 ft. 6 in.; then under heading of "outs" put down 3 ft. x 3 ft. x 20 in. x 4 (times); I am assuming four windows, and the size, 3 ft. x 3 ft., saves fractional figuring, and gives about three-quarters actual size.

Proceeding to the next piece of outside wall, set down as above, not forgetting that in taking the first dimension you have got the corner and should allow it off on measuring this wall. This would be 20 in.; but in figuring brick I never work in any fraction of a foot for length, except 6 in. or $\frac{1}{2}$ ft. Life is too short to work down any finer than this on brickwork, and if you were to work down to each actual inch in taking wall lengths and heights on a large building where there were 200,000 of brick, it might make an actual difference of 2000 or 3000 of brick, or from $40 to $60 at current prices of brickwork. This variation on a job of this size is of no moment, and there would be the difference between an hour and six or seven hours in taking off and figuring up the number of brick, to say nothing of the mental "wear and tear." Now, having taken your outside walls, proceed to take off the partitions.

Partition Walls

Begin with the thinnest walls, probably 8 in., taking all that run in one direction first, then all in the opposite direction next, followed by the walls that run at angles, setting down on a scrap of paper each length and adding up. Assume that we total up 62 ft. of 8-in. wall all the same height from a stone or concrete footing to top of first floor, which is 10 ft. 6 in.; then set down on your estimate sheet 62 ft. x 10 ft. 6 in. x 8 in. Now take 12 in., 16 in. and any other thickness of walls, each in their turn, in the same manner that we took the 8-in. walls, and set down the dimensions. Then set down the "outs" for all these walls. Should any of the cellar be deeper than the 10 ft. 6 in.—the general depth assumed—take the one or more places that are deeper and set down the length, by the extra depth, by the thickness. Having gone through the basement in this manner you are not apt to have missed anything or have taken any piece of wall twice. Now take the first story, working from top of first to top of second floors for height, proceeding thus to the top of the wall.

Now after you are through with the plan and are ready to figure out the number of brick, take your estimate sheet and do so, following the dimensions you have set down from the plans. In figuring up the number of brick, work out first the number of brick in chimneys and piers and set down to one side. Now you can figure all of the wall dimensions into cubic feet and add up; take out the total cubic feet of "outs," obtaining the net cubic feet of brickwork and multiplying by the number of brick per cubic foot (22½); or beginning with 8-in. walls, get the total number of face feet less the face feet of "outs" in 8-in. walls and multiply by the number of brick per face foot for an 8-in. wall (15?). Proceed in a similar manner with 12-in., 16-in., 20-in., 24-in., etc., walls, adding the resulting number of brick for each thickness to the number previously obtained in chimneys and piers for the total number of brick in the job.

Price of Brickwork

To obtain the price per thousand for the brick laid complete in the building we must analyze as follows:

Cost per M of common brick delivered at site	$ 8.75
Cost of mortar (made)	3.00
Cost of laying brick and labor of carrying, etc.	8.00
Cost of staging	1.00
Total cost	$20.75

Of course, the prices I have used above will vary with the locality; but by separating 1000 of brick, laid, into the above items and considering each item separately, you may readily obtain the cost in your locality.

Face Brick

In treating brickwork above I have assumed that the walls right through were of one kind of brick. While in some buildings you figure this will be the case, in more of them there will be several kinds of brick. For instance, the exterior on one or more elevations may be faced with selected water struck, or any one of the numerous colored face brick. Then, perhaps, the boiler room, elevator shaft, or some other parts of the interior, may be lined with glazed brick.

I have found by experience that you are less apt to make errors if you take off the brickwork of a building as though they were all of one kind and then proceed to take the face, glazed, hollow, or other kinds, separately; after computing the number of each kind take them out of the total survey of common brick as you would so many "outs." See estimate sheet, Fig. 3.

Ground Brick

Often the arch brick and brick for angular corners, etc., have to be ground to the shapes required to properly execute the work. In cases of this kind, after having estimated the face brick, take off the surface feet of arches, etc., and after computing the number deduct from the face brick, as I have deducted face from common brick on the estimate sheet. Grinding arch and corner brick usually costs us in this locality about 5 cents each (labor of grinding only). We deliver to the parties doing the work sufficient brick and they grind each brick for its proper place in the arch, numbering them to correspond with numbers on a setting plan of arch, and deliver each arch packed in a barrel.

Washing and Pointing

In nearly all cases it will be necessary to point up the brickwork of exterior walls, also, around stone or other trimmings, windows, etc., before the job can be called complete. This is usually called for in the specifications. The only proper way to make a good job of this is from a swing stage, after the regular mason's stage has been taken down. In the large cities there are men who make a business of this class of work, and after talking with most of them in Boston I find that they have no systematic way of arriving at the cost of the work, it being largely a matter of judgment with them as to what a job will cost.

This is one of the items that you can best analyze while the plan is right before you. I go at it as follows: The men work in pairs—mason and helper—on a stage about 10 ft. long. I look at the plan to see how many times they will have to hang the stage and then judge as to about how long they ought to be coming down with the stage each time. For instance, we will say they have got to hang stage eight times, and will be one and one-half days coming down; we then have 12 days for the two men; the 12 days for the mason at $4.80, and 12 days for the tender at $2.40, making a total for labor of $86.40, to which we must add the teaming of the stage to and from the job; use of, and wear and tear to same, say $15; brushes and muriatic acid, $6; a little cement, sand, etc., $5; all making a total of $112.40. Now I assume that the man wants a little profit, and put the job down for $125.

Waterproof Coating of Walls

Occasionally the inside surface of all or a part of the outside walls is coated with hot pitch or asphalt, or some of the waterproof paints now on the market. The cost is usually figured by the square yard. To determine the number of square yards it is only necessary to "survey" the inside surface of such walls as are to be treated, taking out the larger "outs." This being a simple process, will require no explanations. With R. I. W. paint so used on a large job recently done in Boston, the result was as follows:

R. I. W. paint, at 80 cents per gallon, slightly thinned with benzine and two coats applied:

Cost per square yard, stock	$0.11¾
Labor, at 30 cents per hour	.04
Total	$0.15¾

The cost of pitch or asphalt would be from three to five times as much as the R. I. W., as above.

Flue Linings

As a rule, nowadays, chimneys have terra cotta flue linings. In getting the number of feet of each size, refer to the basement plan. Look over the chimneys and see what the sizes are. For instance, you see that some are 8 in. by 12 in., some 12 in. x 12 in. and some 12 in. x 16 in. Set down on a piece of paper each size. Now take one chimney showing, for instance, in the cellar two 8 in. x 12 in. flues, lined; refer to the elevation which shows the top of this chimney; measure from point on elevation where flue starts to its intersection with roof, or to the top, if lining is carried to top, and set down number of feet under 8 in. x 12 in., twice for the two flues. Now follow this chimney up by referring to first floor plan. Here may be a fireplace, in which case the lining would start about 5 ft. up from floor and run to the roof boards or chimney top, as in case of other two flues. Assume this to be a 12 in. x 12 in. flue; refer again to elevation, and scale on same from 5 ft. above first floor to top, and set down the number of feet under 12 in. x 12 in. Follow this chimney floor by floor to the top in this manner, and when completed take the next chimney, and so on until finished. Now add up total feet of each length and set down on your estimate sheet.

In figuring the price I usually add from 5 cents to 15 cents per foot to the cost delivered for handling from team, carrying and setting, loss from breakage, thus getting total cost per foot installed in building.

CHAPTER X

Stone and Terra Cotta, Ornamental and Structural. Concrete Floors

In nearly all cases where there are cut stone trimmings it is safer to get a sub-bid for the work, specially if there are mouldings, columns, brackets, carving, etc. If you have only a few sills, steps, lintels, etc., and have kept your eyes and ears open, you probably know about the price per running foot for the work in various kinds of stone and styles of cutting. Assuming that the trim is simple, take off and set down on your estimate sheet, Fig. 20, the number of feet and sills, lintels, etc., together with a little sketch of same, with a note on the kind of cutting, and later figure same up. Or, if you choose, go to a granite or limestone man and get his figure on your schedule as put down on the estimate sheet.

By careful tabulation of time on an average building containing $4000 worth of cut granite, in just such trimmings as I have used for example on the estimate sheet, I found the cost of all handling and setting of granite was 20 per cent. of the cost of the stone delivered. Further observation on other buildings has verified this cost. The mortar required for setting such granite as I have listed is amply provided for by the brick displaced by the stone, as it is not customary, in taking off quantity of brick, to deduct anything for stone or terra cotta trimmings, except in the case of some very large belt courses. So we put down for setting about 20 per cent. of the cost of the granite delivered at the site, or, in round numbers, $175.

Limestone

Practically everything I have said in regard to granite will apply to limestone, except that the setting, as a rule, I have found will cost only about 7 to 8 per cent. of the cost of the stone. There are several reasons for this, as follows: The granite usually sets in area ways; on top of rough foundation walls; in most cases one or two sides are rough splits, making it hard to handle it on rollers; and in such cases as above it is usually hand set. Limestone, on the other hand, is sawed on the sides where the granite is split, usually sets in brickwork, thus giving a level bed to work from, and in most cases is derrick set, as it usually comes in places accessible to the derrick.

In order to prevent, as far as possible, the discoloration of limestone by the cement used in the mortar of adjoining masonry, it is becoming customary for architects to call for the painting of beds, backs and unexposed ends of all pieces of stone with one of the waterproof paints now on the market, such as "Antihydrene" or "R. I. W." waterproof paint. Where this is to be done you will have to use your judgment as to about how much paint and labor will be required to do the work, as such work as this cannot be put on a yard basis; or in taking a bid for the limestone you can require stone to be delivered at the building painted.

Terra Cotta Trimmings and Floor Arches

In a general way there is no great difference between terra cotta used as trimmings and granite or limestone, except again in the setting. My judgment in the matter is that it will cost to set terra cotta nearly as much as granite, as in the burning a great many pieces are more or less warped, and in order to make courses appear as straight as possible the masons have to spend considerable time with it. Then, too, all of the hollow places in it, except those that overhang the ashlar line, have to be filled solid with brick and mortar; and in the case of cornices, more or less iron work has to be put in to anchor it to the walls. All these things tend to make the cost of setting high, and, as a rule, I figure about 20 per cent. of the cost of the material for handling same from cars to building and setting in place in the wall.

The various forms of terra cotta for floor construction are sold by the square foot, delivered. Any of the large concerns will quote you a square foot price on application. To this must be added the cost of centering, laying and mortar. The quality of mortar will, of course, be determined by your specifications. If you have framing plans showing all floor beams and girders, you can make a more accurate survey of the area than from the regular floor plans, as the floor openings are more clearly and accurately shown, and there is less on the plan to distract and confuse. If your building is irregular in plan, obtain the area of a floor as I have explained under the head of concrete floors. Set down your areas and "outs" on the estimate sheet and carry out the result in square feet and price later.

To determine the cost, erected in the building, we must add to the cost of the material per foot delivered, the cost of centering; carrying blocks; materials for making and the carrying of mortar; and the laying of the blocks by the masons. As the plank for centering can be used several times, it is only necessary when considering this item to put down a fraction of the cost of material. For instance, with spruce at $28 per 1000 ft., I should figure as follows:

Cost per foot of floor arches (delivered)	$0.14
Cost per foot of centering (3 ft. board measure required for each square foot floor), 1 cent per foot	.03
Labor of centering (two men can prepare about 500 sq. ft. in a day of eight hours, wages 50 cents per hour)	.016
Cost of mortar, making and carrying (about one part Portland cement and three parts sand and very little lime)	.05
Cost of laying (good mason can do about 250 sq. ft. per day of eight hours, at 60 cents per hour)	.02
Cost of tending, other than mortar making and carrying; usually three tenders per mason to handle blocks (40 cents per hour)	.05
Total cost per foot	$0.306

Of course, the deeper the block the more mortar will be required, and also, as they are heavier to handle, a mason will lay less in a day. Then other circumstances may tend to slightly increase or decrease the cost of labor and mortar, and these must be considered and price made accordingly for each job.

Terra Cotta Partitions

For obtaining the number of square feet of terra cotta block partitions, begin with the basement plan, or, if there are no block partitions there, with the first floor plan. Take all partitions running horizontally, beginning at the top of the plan and working down to the bottom, setting down each measurement on a piece of paper. Then take all partitions running at right angles to the ones just taken (vertically as you face the plan), also setting down measurements with former figures; then take all partitions running in any other direction. Add these results for total running feet of partition and set down on your estimate sheet the result of your addition multiplied by the height of story. For instance, 92 ft. by 10 ft., as shown on the estimate sheet. Now count your doors and other "outs" and take an average opening; for instance, a 2 ft. 8 in. by 6 ft. 8 in. door. The allowance made in which to set the frame plus the skeleton frame of spruce or coarse pine, usually set up from floor to ceiling before partition is built, will make the actual opening about 3 ft. 6 in. by 7 ft. 6 in. This makes the 26 sq. ft. "out." I find the general custom is to allow about one-half, as there is considerable loss by breakage in cutting blocks, and also extra time is consumed around openings. Thus on the estimate sheet I have allowed 15 sq. ft. per door, multiplied by the number of doors. Openings much smaller than doors I should ignore, and much larger ones set down separately, allowing, as the opening gets larger, nearer to the actual number of square feet in the opening.

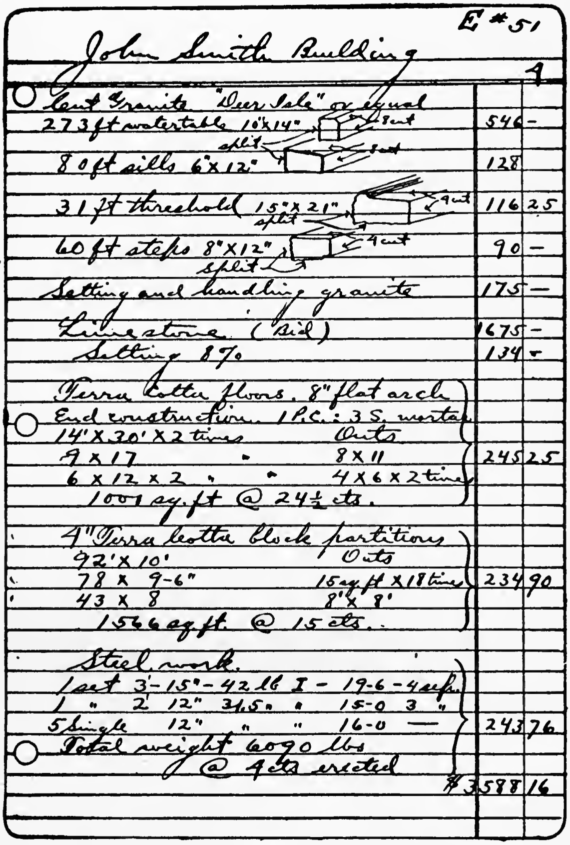
Proceed in this manner throughout the building, floor by floor, until the survey is completed. By taking off the partitions in the manner I have described, you will not be nearly as apt to get confused as you would be if you started at any point and tried to take partitions running in all directions as you proceeded. I should let the figuring out of the number of square feet of terra cotta floors and partitions, the quantities of which we have put down on the estimate sheet, go until you have rolled up and put away your plan.

Price of Block Partitions

In making a price per foot for the blocks erected in the building proceed in the same way we did for establishing the price of floor arches, which, without going too much into detail, would be about as follows:

4-in. blocks per foot, delivered	$0.07
Mortar per foot	.02
Labor, one mason and two laborers average about 200 sq. ft. per day, masons 60 cents per hour and laborers 30 cents per hour	.05
Per foot in building	$0.14

In making the price per foot for labor you must consider the number of feet in the job; the arrangement of the partitions, the height of the building, etc., as all of these are factors in making up your mind as to how many blocks per day a mason



E #51

John Smith Building		4
Cut Granite "Deer Isle" or equal		
273 ft watertable 10"x14"	546	—
80 ft sills 6"x12"	128	
31 ft threshold 15"x21"	116	25
60 ft steps 8"x12"	90	—
Setting and handling granite	175	—
Limestone (bid)	1675	—
Setting 8%	134	—
Terra cotta floors, 8" flat arch / End construction 1 P.C.: 3 S. mortar / 14'x30'x2 times — Outs / 9x17 — 8x11 / 6x12x2 — 4x6x2 times / 1001 sq. ft @ 24½ cts.	245	25
4" Terra cotta block partitions — Outs / 92'x10' / 78 x 9-6" — 15 sq ft x 18 times / 43 x 8 — 8'x8' / 1566 sq ft @ 15 cts.	234	90
Steel work / 1 set 3-15"-42 lb I - 19-6 - 4 sup. / 1 " 2 12" 31.5 " " 15-0 3 " / 5 single 12" " " 16-0 — / Total weight 6090 lbs @ 4 cts erected	243	76
	$3588	16

FIG. 20—ESTIMATE SHEET NO. 4

and his laborers can lay. On some jobs the average will be as low as 125 blocks per day, while on others you can get it up to nearly 300. I have had one mason and one laborer, where conditions were extremely favorable, lay 300 blocks per day.

Reinforced Concrete Floors

As there are a number of systems of reinforced floors on the market, more or less complex, it will be better to get a bid from specialists to cover such parts of the work. However, if conversant with the system called for, and you can subdivide and analyze the materials and labor entering into it, make your own price. The explanations offered for obtaining areas and analyzing costs under the head of "terra cotta floor arches" would sufficiently cover this item.

CHAPTER XI

Steel and Iron Work

Unless the plan calls for a limited quantity of structural steel and cast iron in such simple forms as beams, channels, columns, etc., without complex framing in the case of steel, and plain columns and plates in the case of cast iron, I would advise you to get a sub-bid from some one in this line of business. If, however, the quantity is limited, make a schedule on the estimate sheet, and after you are through with the plans figure it into pounds and carry out the price at so much per pound, erected in the building and painted if called for.

Referring to the estimate sheet, Fig. 20, the first item is one set of three 15 in., 42 lb. beams, having four separators. By referring to Carnegie's, or any other of the rolling mill hand books, you will find tables giving size and weight of standard separators, and tables giving weight of bolts of all sizes, and thus you can readily figure out the weight of this set of beams complete, which would be as follows:

	Pounds.
58 ft. 6 in. of beams, 42 lbs.	2,457
8 separators, 13.51 lbs.	108
8 bolts, ¾ in. in diameter, 14 in. under head	18
Total weight of set	2,583

Now while the cast-iron separators will cost a little less, and the bolts a little more per pound than the steel beams, their weight is so small a part of the whole weight that I would figure out the cost on the basis of the pound price of steel. Thus we would estimate as follows:

Steel beams made into sets and delivered at site, 3¼ cents a pound, erection and field painting ¾ cent a pound, make a total of 4 cents per pound, set in building. On this basis the entire list of steel beams which weigh 6094 lb. cost in the building $243.76.

In the matter of setting steel there will be quite a variation in cost, it making a great difference where and how they are located in the structure, and whether it is necessary to handle with jacks, hand rigging, or steam. Assume that the job is large enough to make it economy to set up a derrick and engine. This set of beams we have figured out come to the site on a team; you put a chain on them, give a signal, and in five minutes they are up 50 ft. in the building, and set on the wall in their place. Now $\frac{1}{4}$ cent per pound, which in this case is about $6.50, will pay the entire cost, including rental of engine and derrick, coal, oil, etc., if your rigging is constantly working. Add to this the cost of painting, which should not exceed another $\frac{1}{4}$ cent per pound, and you have a cost of $\frac{1}{2}$ cent per pound erected in the building.

On the other hand, you may have no steam rigging, and you will have to call out seven or eight laborers to roll the set of beams off the team and then run them 40 or 50 ft. into the building on a block roller, and hoist with a hand rigging 14 or 15 ft.; the whole operation, including shifting your breast derrick around and guying it, consuming three to four hours' time and a couple of hours for the foreman, and costing about as follows:

8 men three hours, at 40 cents	$ 9.60
2 hours foreman, at 75 cents	1.50
Painting, ¼ cent per pound	6.50
Total cost	$17.60

This on the 2583 lb. which the set weighs, making cost about $\frac{3}{4}$ cent per pound.

Thus, in such ways as above, you will have to analyze and work out a cost to suit the conditions confronting you in the job you have in hand.

In regard to putting a steam hoisting rigging on a job, let me say here that unless the building is either high, of very heavy construction, and of considerable area, thus enabling you to keep rigging working practically all of the time, do not install it, but use breast derricks with hand winches. The ordinary charge for use of a large derrick and engine is about $18 per week, the engineer's wages will be about $21 per week; two tag men $18 per week each; coal and oil will cost about $10 per week, which add up to $85. Then the cost of teaming the apparatus to and from the job, setting up derrick, and raising it from floor to floor as the work progresses, will cost perhaps $250 more. Now, perhaps the outfit will be in use 10 weeks, which will make a total cost of $1100. You can readily see that unless there is considerable heavy material to handle, it will cost less to put it up in some other way.

Go through your plan and make a list of the structural cast iron. This you can also figure into pounds and carry out your price, after you have laid aside the plan. Under the same conditions, the cost of setting and painting will be about the same as for steel. As a rule, cast iron costs less per pound, in such forms as I have scheduled, than steel, and you will have to acquaint yourself with the prices in your neighborhood. In carrying out cost on the estimate sheet I have allowed 2½ cents per pound, which is the average for such shapes in this vicinity.

If the plans in hand call for steel that is very complex in framing, or of a decidedly special character, boiler plate or cast iron facias and column casings, fire escapes, iron stairs, cast or wrought iron grills, etc., you will have to have a sub-bid from someone in this line of business. All small iron work, such as anchors, timber dogs, bolts and joint bolts, truss rods and straps, and joist hangers, you can easily figure yourself, first making a list of them on your estimate sheet. Anchors, dogs and standard hangers are sold at fixed prices, which you can obtain. The other small iron can be figured into pounds, and the pound price obtained, the cost determined. The cost of setting all this small iron is ordinarily covered by the prices you will set on the parts of the work in which they are used. For instance, in figuring floor frame, the price you use for labor, per 1000, should include setting hangers, dogs, joint bolts, wall anchors, etc.

CHAPTER XII

Marble, Mosaic and Terrazzo Work

As a rule, most marble work that goes into buildings is of such a character that it will be necessary to get a subbid from a marble worker. However, if it is very plain work, and you choose to inform yourself on the prices per square foot for the several kinds of marble most in use, and your judgment is good in forming an estimate of the labor and materials required to set the work up, you can make a price that is very close.

Mosaic floors are easily figured if they are of the ordinary patterns, such as a plain field, with simple isolated ornaments and line borders of different colors. The prices for field, borders, and ornaments in each locality are practically standard, and thus making a price for a mosaic floor simply resolves itself into the number of square feet of field and border, at their respective prices per square foot, plus so many ornaments at so much apiece, plus so many square feet or square yards of concrete foundation, of a given thickness at its price per square foot or square yard.

Terrazzo floors also are laid at standard prices with which you can easily acquaint yourself. The price will vary from 15 cents per square foot in very large areas, say 5000 sq. ft. or more, to 24 or 25 cents for the ordinary job of several hundred square feet and up. If in very small quantities, say less than a couple of hundred feet, or if laid between strips of marble or slate, cutting the floor up into comparatively small panels, the price will vary from 30 to 40 cents per square foot. This floor, like a mosaic floor, also has to have a foundation of concrete prepared for it, and the cost of same would be worked out as any other job of floor concreting would.

CHAPTER XIII

Roofing and Metal Work

Slate roofing is easily figured by any one who can measure the area of a roof. Quotations can always be obtained from dealers at a few moments' notice, for slate of almost any size or color. Then you analyze as follows, and determine the price per square (100 sq. ft.) laid on roof:

A 10 x 20 in No. 1 Monson black slate bored and countersunk per square, at site, $8.20; galvanized nails, 2 lb., at 5 cents per pound, 10 cents; tar paper at 2½ cents per pound, 1½ lbs. per yard, makes 42 cents per square; labor of putting on paper, handling and laying slate, $3 per square, making total of $11.72 per square complete. Now, this multiplied by the number of squares, of course gives you the cost of your roof. While I have set the labor above $3 per square, this would vary from $2 to $10, according to the shape of your roof.

The former price would pay (in Boston) for a perfectly plain roof, while the latter price would not be high for some roofs which are all hips, valleys, towers, etc. Occasionally in putting on a slate roof a certain number of course at eaves, ridges, valleys, hips, etc., are called for to be bedded in elastic cement. This increases the cost of labor per square, plus the cost of the required amount of elastic cement. In cases of this kind I would put down on the estimate sheet so many squares at the price I had worked out for the roof generally, then put down the number of squares bedded, and multiply by the additional cost per square. To bed slate requires about 100 lbs. of elastic cement to the square, the cost of which would be about $3 and it would make the labor cost from $2 to $4 additional. Now, as we have above assumed, a comparatively plain roof, the additional cost on the number of squares which are bedded would be as follows:

Cement (100 lb.)	$3.00
Labor	2.00
Total additional cost per square	$5.00

The item of slating we will not carry into the estimate sheet, as, while we are dealing with hypothetical building, from the general dimensions and materials I have assumed, such a building would have some kind of a flat roof, such as tin, copper, plastic, or composition (tar and gravel).

In the case of composition roofs, the cost per square will depend upon the quality and number of layers of paper used, whether mopped and graveled in coal tar, pitch, or asphalt, the method of laying and mopping the paper, and the cost of labor. Only an experienced roofer can carefully analyze the cost per square, but in every locality there are standard prices for the several grades of composition roofs most called for, which prices it is your own fault if you do not know and when conditions are normal you may use. If conditions are abnormal, it becomes a matter of judgment with the roofer as to what the probable cost will be, and if your judgment is good you can probably arrive at the result as well as the average roofer. In taking off roofing from plans you would proceed as in any other case where you simply want the square feet. In setting down on estimate sheet I should put the number of squares, as in most cases you will have only to make several multiplications, taking but two or three minutes, and it avoids making your estimate sheets too numerous. If there are skylights, scuttles, etc., in the roof, it is not customary to figure them out, unless they are quite large, say 100 sq. ft. or more, as the extra labor involved cutting and flashing around them offsets any saving in materials effected.

The price per square for the roof usually includes the edge cleat, and flashings around chimneys, scuttles, skylight curbs, party and battlement walls, to a total width of 8 or 9 in.; any more flashing than this must be figured by the square foot or square (100 sq. ft.) at the unit price for the kind called for. Such flashing might be zinc, tin, galvanized iron or copper. Reference to your plans and sections will show you the heights of skylight curbs, walls, pent houses, etc., that require covering, and obtaining the square feet is a simple matter. In this case, as in the roofing, you can set down the number of squares and carry out your price later. Thus, on estimate sheet we have put down seven squares of 16 ounce copper, and four squares 24 gauge galvanized iron flashing. Prices on zinc, copper, etc., per square are also standard for normal conditions, and you should keep informed as to same.

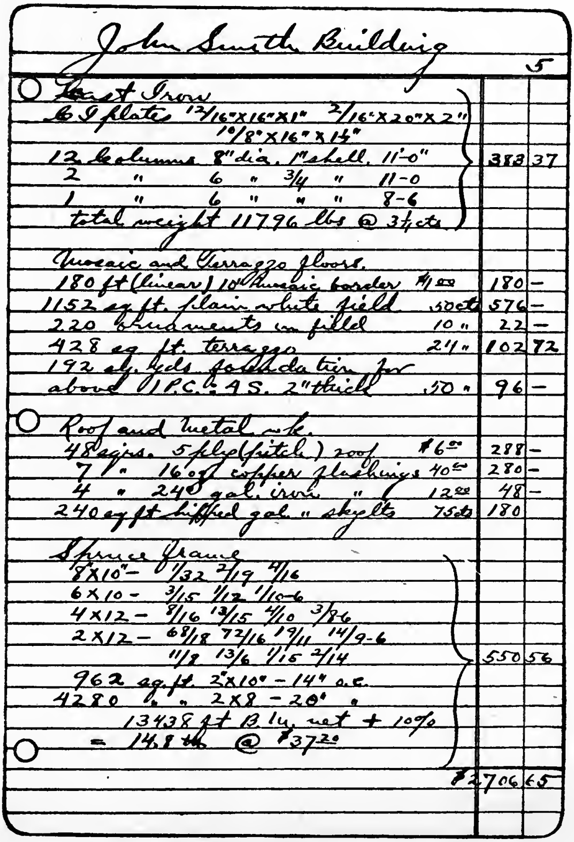
At the present time, in this market, 16 ounce copper flashings, roofing, etc., are worth $40 per square. Zinc, tin and galvanized iron are all worth about the same in the above situations, and a fair price for them to-day would be $12 per square.

Metal Skylights

Ordinary galvanized iron skylights, hipped, with condensation gutters, and glazed with $\frac{1}{4}$ in. wired glass, furnished and set complete on curb already prepared, are worth about 75 cents per square foot measured flat. Thus, if your skylight opening measured over all, on the outside of the curb, 6 ft. by 10 ft., we would call it a 60-ft. skylight, and at the price I have used above would be worth $45. If a skylight of the character just described were either very small or very large the cost per square foot would be greater than quoted. Take, for example, a skylight 3 x 4 ft., which is 12 sq. ft. The laying out would take just as long as for the 6 x 10 ft. one. A brake would bend a rafter bar for the larger just as quick as for the smaller. The difference in labor, making, erecting and glazing might be 12 hr., which at 45 cents per hour would be $5.40. In the stock the savings would be about as follows: About 35 sq. ft. of galvanized iron at 4 cents, making $1.40; 50 cents worth of solder; about 60 sq. ft. of glass at 24 cents per foot, amounting to $14.40. Thus the total saving in cost between the larger and smaller skylights would be about $22. This would make the 3 x 4 ft. skylight cost $23, or nearly $2 per square foot. You can readily see from the above analysis that, as the size decreases, you must increase the price per foot. In the case of very large skylights, the increase is mainly caused by light structural steel reinforcement required to make the skylight not only self-sustaining, but capable of withstanding snow loads.

In the average job the skylights met with are of such ordinary sizes that the standard price, with such adjustments as your judgment dictates, can be safely used. For your guidance, I will give a few more prices on skylights that might be termed

"Standard." A 16-ounce copper skylight similar to the first galvanized iron one described is worth about $1.20 per square foot; skylights that pitch both ways, having gable ends formed by the curb, are worth about 10 per cent. less than hipped sky-



John Smith Building — 5

Cast Iron			
C I plates 12/16"×16"×1" 2/16"×20"×2"			
10/8"×16"×1½"			
12 columns 8" dia. 1" shell, 11'-0"		383	37
2 " 6 " ¾ " 11-0			
1 " 6 " " " 8-6			
total weight 11796 lbs @ 3¼ cts			
Mosaic and Terrazzo floors.			
180 ft (linear) 10" mosaic border	$1.00	180	—
1152 sq. ft. plain white field	50 cts	576	—
220 ornaments in field	10 "	22	—
428 sq. ft. terrazzo	24 "	102	72
192 sq. yds foundation for			
above 1 P.C. to 4 S. 2" thick	50 "	96	—
Roof and metal wk.			
48 sqrs. 5 ply (pitch) roof	$6.00	288	—
7 " 16 oz copper flashings	40.00	280	—
4 " 24 gal. iron "	12.00	48	—
240 sq ft hipped gal. " skylts	75 cts	180	
Spruce frame			
8×10" – 1/32 2/19 4/16			
6×10 – 3/15 1/12 1/10-6			
4×12 – 8/16 13/15 4/10 3/8-6			
2×12 – 68/18 72/16 19/11 14/9-6			
11/8 13/6 1/15 2/14		550	56
962 sq. ft. 2"×10" – 14" o.c.			
4280 " " 2×8 – 20" "			
13438 ft B.M. net + 10%			
= 14.8 M @ $37.20			
		$2706	65

FIG. 21—ESTIMATE SHEET No. 5

lights. Flat skylights, that is, those having only one pitch, and that about the same as the roof in which they are located, are worth in 16-ounce copper about 90 cents, and in galvanized iron about 50 cents, per foot.

Ventilators add to the cost according to size and style; ½ in.

rough plate and $\frac{1}{4}$ in. wired rough plate glass cost about the same, thus the use of either would not affect price; $\frac{1}{4}$ in. rough plate (not wired) would decrease the price about 15 cents per square foot of glass area (not curb opening area).

As wall copings are usually of only three or four sizes, it is not difficult to keep posted on the prices they are each worth a running foot, applied to the wall, both in galvanized iron and copper. In case of any ordinary size, in either metal, the labor is substantially the same. As an example, we will work out the cost on a 24 gauge galvanized iron coping for a 12 in. wall. Allowing 5 in. to turn down each side of wall and bend at edge to form drip we have a total width, extended, of 22 in. The chances are that a 24 in. wide sheet of metal would be used, and if the 2 in. were cut off it would be waste, so that the metal worker would probably turn down a little more each side and use the whole sheet; then we have 2 sq. ft. of metal at 4 cents, making 8 cents, and labor to make and apply 15 cents, making cost per linear foot 23 cents. Now, as the metal man wants a little profit, the fair cost per foot for you to figure would be 25 cents. If copper was used, the change in price would come on the difference in cost between galvanized iron and copper. To-day, with copper at 27 cents per pound, the 2 sq. ft. would cost 56 cents, thus the coping would cost the metal man 48 cents more per linear foot. If you were covering a 16-in. instead of a 12-in. wall, 4 x 12 in. more of metal would be required per linear foot, as 4 in. is one-sixth of 24 in. (the extended width used to make the coping we have worked out a price upon) we must increase the cost of the stock per linear foot one-sixth. So instead of 8 cents we have 9 1-3 cents per foot for stock, labor being practically the same, the cost is increased to 24 1-3 cents per foot. In putting the metal man's profit on to this we will take up the fraction by adding 2 2-3 cents, thus giving us 27 cents as the price to use in our estimate. You can see how easy it is, from the above illustrations, to figure yourself the cost of skylights and copings, if you take the little trouble required to keep posted on the cost of sheet metals and get a line on labor, as performed by metal workers, by keeping your eyes and ears open and asking your metal man a few leading questions now and again.

In the case of metal cornices, bay windows, etc., the work is of such a character that the only sure way of getting a close estimate is to call in the metal man. While you could in most cases figure out the required amount of stock as well as the average cornice maker, only his experience can determine the probable cost of the labor. As the labor on cornices, etc., is frequently from 75 to 95 per cent. of the total cost, you might get very far astray by trying to figure such work yourself.

PART III
Carpenter Work

CHAPTER XIV

Frame, Studding and Furring

As estimating the carpenter work will probably prove of more than usual interest to a large percentage of the readers of this work, I shall try to be a little more explicit and go somewhat more into details.

As my estimate sheets have assumed a brick building, some of the items under the head of carpenter work will not appear on them. Nevertheless, I shall try and make the text so clear as to render it unnecessary.

My observation has led me to believe that a majority of the carpenters, in estimating their work, figure out the quantities of lumber, hardware, etc., and put a price on them, and then "lump" the labor, judging, or guessing, the latter amount. Now, if a man is doing one class of work all the time, for instance, dwellings costing three or four thousand dollars, he can judge the cost with considerable accuracy; but if he was to estimate a wooden building of an entirely different character, such as a freight shed or a coal pocket, his judgment, or guess, in the matter of labor, would probably be far astray.

In the various classes of buildings, the labor bears a certain average ratio to the amount of stock. If you build a freight shed and it costs you $5 or $6 more per 1000 ft. to frame and erect same than the generally recognized cost, you have a poor crew, or they are badly managed, or both. On the other hand, if you can hold the cost down $1 or $2 from the recognized cost, you have an exceptional crew, well managed.

In figuring practically all branches of carpenter work I advise the builder to determine a cost per "unit" installed in the building. By a system of time slips, similar to the ones explained and illustrated in Chapter 25, you can soon establish labor costs upon which to base your estimates.

Frame

Under this head include all girders, sills, floor joists, rafters, and collar beams. The unit of measure I make 1000 ft. board measure. If, as probably would be the case, we had framing plans, the first thing to do is to separate them from the regular plans and elevations, putting the latter to one side for the time being.

Take the first floor frame, and begin with the heaviest timber first, probably the girders. Now, on the estimate sheet put down the heading thus: Spruce (or H. P.) frame; then piece by piece set down your schedule as follows:

6 x 10 in.—3/15, 1/13, 1/10.6.
8 x 10 in.—1/32, 2/19, 4/16. } (See estimate sheet, Fig. 21.)

Having taken all girders, list the sills, beginning at one corner and working clear around building, continuing the schedule on the estimate sheet.

Floor Joists

Look over the plan and see what your largest floor joists are, usually under partitions, or trimmers and headers around stairs or other openings. Put these timbers down next. Now take off the regular floor joists, beginning at one side or the top of the plan, according to the way the joists run; taking each "bay" or division complete before proceeding to the next. In this way continue listing frame on all floors and the roof.

You are probably sufficiently able to figure the schedule into board feet, so I will offer no explanations. This accomplished, we must determine the percentage of waste and add this to the net schedule. On a frame of comparatively heavy timber, if sawed to your order, the waste should not be over 10 per cent. If you do not have time to order the stock in from the mills, but must take it out of stock from local lumber yard or wharf, the waste will run from 10 to 20 per cent. By studying your building a little to see if the time required to put in the foundation is going to permit the ordering of frame from the mills, leaving any leeway for possible delays in freight, you can make up your mind as to the waste. The prices you know or can readily obtain. Such timber as I have listed should be installed in the building for from $8 to $12 per 1000 ft. board measure. Thus the cost per thousand feet in building would be about as follows:

Timber per 1000, delivered at site	$26.00
Labor (average)	10.00
Nails (ordinarily about 40 lb. per 1000)	1.20
Total cost	$37.20

So we carry out the price on the 14.8 M. on estimate sheet at this price.

While the process just described is the most accurate, there are other methods for determining the amount of frame that are quicker, and the results are close enough for all practical purposes.

If the plan is very regular and there is considerable uniformity in lengths of timber, I advise that you schedule the quantities as we have just done. If, however, the plan is irregular and there are all sorts of lengths of joists, the number of board feet can be obtained from the area of the floor. For instance, quite a part of the floor is of 2 x 12 in. joists, 16 in. on centers, and the balance of 2 x 10 in. joists, 14 in. on centers. Then we proceed in this manner: On a scrap of paper set down the several dimensions that will give you the area of that part of the floor that is of 2 x 12 in. joists, thus:

18 x 27 ft.
17 x 43 ft., 6 in.
15 x 14 ft., 6 in.;

figured out they equal 1443 sq. ft. Now, if these 2 x 12 in. joists were 1 x 24 in., and they were all laid down flat, they would not only cover the 16 in. from one center to the next, but lap one-half over on the second space, thus, as the 1 x 24 in. is the 2 x 12 in. joist changed to board feet, and laid flat as above, they cover the whole area one and one-half times, so one and one-half times the area of floor occupied by these joists, or 2165 ft., is the number of feet board measure (net) of lumber required. Now, by adding the percentage of waste you have arrived at a sufficiently correct result with less trouble than by scheduling. By the same reasoning any size or spacing of joists or studding can be figured into the number of feet board measure of stock required to joist a given area. Let me demonstrate further in order to help fix this rule in your mind.

Take an area of 962 sq. ft. of flooring having 2 x 10 in. joists 14 in. on centers; 2 x 10 in. changed to board measure equals 1 x 20 in. joists, thus as 14 in. is to 20 in., so is 962 sq. ft. to the number of feet board measure of timber in the floor. Put in the form of the examples in proportion you used to see in your arithmetic, it looks as follows:

14 : 20 :: 962 : answer; and as performed by the rule of proportion looks thus: $\frac{20 \times 962}{14} = \frac{19.240}{14} = 1374.+$; expressed in words, it is as follows: as to every 14 in. there are 20 in. of lumber, then the relation of the area (962 sq. ft.) is to the result we seek as 14 is to 20, as 14 is seven-tenths of 20, then 962 ft. is seven-tenths of the number of board feet. Work this out and you will find the result to be 1374 and a fraction, as shown by the example in simple proportion.

This last paragraph is somewhat verbose, but I want the less educated of the readers to grasp the principle upon which this method of figuring is based. In using this method of figuring, do not take out the stair, chimney and other openings unless they are very large; even then they should not be taken out of their full size, as the larger joists around the opening usually offsets the difference in board feet that would be saved if they were figured out. In figuring a first floor by this rule the girders should be added to the result obtained, and in case of a frame structure the sills also.

Figuring Rafters

This method is by far the quickest and most accurate by which to obtain the quantity of frame in pitch roofs, but care must be taken to add to the result thus obtained from the area, the hips, valleys and ridges. Any roof that is at all cut up with hips, gables, dormers, etc., must of a necessity have so many different lengths of rafters that the scheduling piece by piece is a laborious job; so also is the figuring of the schedule thus obtained into board measure laborious. These two facts, coupled with the fact that the roof framing plan does not show the rafters at their correct length, makes it almost folly to figure the amount of frame by scheduling.

When we get to the subject of Boarding I will go into particulars about obtaining the areas of roofs.

Special Framing

Any complicated framing, such as trusses, etc., should be considered separately, and the price must be worked out to suit the complexity of the design. In case the building you are figuring has framing of this character, make a new heading on your estimate sheet, such, for instance, as "Truss Framing;" now set down under this the schedule of sizes and lengths and figure out later. The labor of framing and erecting trusses often runs from $25 to $75 per 1000 ft. board measure of stock.

Next time you have a job with one or more trusses to build note the quantity of stock and keep a memoranda of the labor required. You can then figure out a labor cost per 1000 ft. that will guide you the next time you encounter something similar when estimating. Bear in mind, also, in figuring this special framing, that in most cases the stock will cost more per 1000 on account of unusual sizes and lengths, the elimination of certain defects permissible in "merchantable" lumber, the planing of the stock, etc.

If you have ever kept any account of the labor required to install studding and furring in a building you doubtless found that the cost per 1000 ft. was several times that of other framing. Inasmuch as there is so great a difference in cost, I think it advisable to treat the two classes of frame separately on nearly all occasions. Under this head I include all wall framing, including posts and girts, all stud partitions, rafters, collar beams and hanging ceilings where the stock used is smaller than 2 x 6 in., strap furring on ceilings, brick walls, etc.

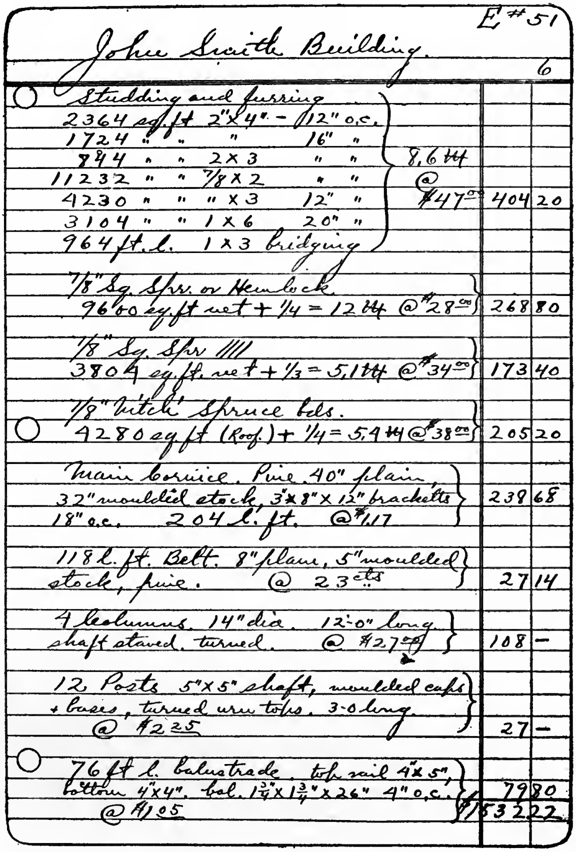
All of the above quantities are readily obtained from the areas.

Outside Walls of Frame Buildings

We will begin with the outside walls of a frame building; usually there would be but two or three heights of plate. Assume the main house, two stories high, with 20 ft. posts and an ell one story high with 10 ft. posts. We begin by obtaining the girt of the main house, say 118 ft.; this multiplied by the height, which is 20 ft., gives us the area of the outside walls of the main house. Now we have for "outs" the windows, doors, and the place where the ell adjoins the main house. As the door and window openings are of no great size, and the studs around them are usually heavier than the rest, we take no notice of them. Where the ell joins the main house is probably a partition, and as this will be taken with the other inside partitions later, we take the space out. Call this space 18 x 10 ft. Now take the girt of the ell, which will be three sides of it; call it 58 ft.; then the area of the ell walls are 10 ft. by 58 ft. For results we have:

	Sq. ft.
10 × 58 ft. =	580
20 × 118 ft. =	2,360
	2,940
Less 10 × 18 ft. =	180
Total net area	2,760

Except for the posts and girts and around window and door openings, the wall is probably of 2 x 4 in. studding 16 in. on centers. Now, if we change our 2 x 4 in. studding to board measure we have 1 x 8 in. Thus, on 16 in. spacing, our area of walls is to the quantity of studding as 16 in. is to 8 in. As 16 in. is twice 8 in., then the wall area (2760) is twice the number of board feet in the walls. But this does not compensate for the additional frame required for posts and girts. We have allowed the area of the door and window outs to compensate for the increased size of studding around their openings. I have found from experience in ordinary frame buildings, with 4 x 8 in. posts and girts, 4 x 4 in. plates and 3 x 4 in. studs around openings, the area, as we have just figured it out, so nearly equals the number of board feet of frame in the walls, plus what we would naturally add for waste, that if you assume the said area to be the number of feet board measure you are sufficiently correct. So under the heading of "Stud and Furring," on your estimate sheet put down this item as follows: 2760 sq. ft. outside walls; this followed by your other items of studding and furring, can be carried out into a total number of feet, board measure, and a price put on same, after you have rolled up and put away the plan.



E #51

John Smith Building. 6

Studding and furring 2364 sq. ft 2"x4" – 12" o.c. 1724 " " " 16" " 844 " " 2x3 " " 11232 " " 7/8x2 " " 4230 " " " x3 12" " 3104 " " 1x6 20" " 964 ft. l. 1x3 bridging } 8,6 M @ $47.00	404	20
7/8" Sq. Spr. or Hemlock. 9660 sq. ft net + 1/4 = 12 M @ $28.00	268	80
7/8" Sq. Spr //// 3804 sq. ft. net + 1/3 = 5,1 M @ $34.00	173	40
7/8" "hitch" Spruce bds. 4280 sq. ft (Roof) + 1/4 = 5,4 M @ $38.00	205	20
Main Cornice. Pine. 40" plain, 32" moulded stock, 3"x8"x12" brackets 18" o.c. 204 l. ft. @ $1.17	238	68
118 l. ft. Belt. 8" plain, 5" moulded stock, pine. @ 23 cts	27	14
4 Columns. 14" dia. 12'-0" long. shaft staved, turned. @ $27.00	108	–
12 Posts 5"x5" shaft, moulded caps + bases, turned urn tops. 3-0 long. @ $2.25	27	–
76 ft l. balustrade. top rail 4"x5", bottom 4"x4". bal. 1 3/4"x1 3/4"x26" 4" o.c. @ $1.05	79	80
	$1532	22

FIG. 22—ESTIMATE SHEET NO. 6

Stud Partitions

In measuring the plans for stud partitions follow the same method that I have used in the case of the brick walls in the basement and the terra cotta block partitions. The chances are that the partitions will be of 2 x 3 in. and 2 x 4 in. studs 12 and 16 in. on centers, and occurring on all floors. Take the floor plan of the basement, first or other floor that you are going to measure and begin at the top of plan, taking all partitions of 2 x 4 in. studding running horizontally as you look at the plan; then take all running vertically, following this by taking the partitions that run in other than these two directions. On a scrap of paper set down the total running feet of partitions; now refer to the sectional plans for the height. Having found same, perform the multiplication, and the result will be the square feet of partitions, of 2 x 4 in. studs, for this story. Next take the partitions of 2 x 3 in. studs in the same manner. Continue throughout the entire building in this manner, floor by floor, performing all the multiplications as you go. When this is done and they are all added up you will have the total area of all partitions of each size of studding. Then we set down on the estimate sheet the resulting areas to be figured into board feet later. You will doubtless note the fact that I have paid no attention to the door openings in these partitions. As the studding is almost invariably doubled around openings, not considering them will compensate for the extra studding thus required. Using the area again as a basis from which to figure, the three items of studding I have entered on the estimate sheet result as follows: 2 x 4 in. studding changed to board measure equals 1 x 8, or 8 in. of stock to every 1 ft. of partition; as an example in proportion expressed thus: 12: 8: 2364: answer; and performed thus, $\frac{8 \times 2364}{12} = \frac{18,912}{12} = 1576$. Our answer, as above, is 1576 ft. board measure. The next item figures as follows: $\frac{8 \times 1724}{16} = \frac{13,792}{16} = 862$ ft. board measure. The third item as follows: $\frac{6 \times 844}{16} = \frac{5064}{16} =$ $316\frac{1}{2}$ ft. board measure. The number of feet board measure for the three items of studding that we have figured out above are "net," and to them we must add a certain percentage of waste. There is no item of stock that goes into a building upon which there is as much waste as studding. Not one man in 20, in ordering studding, gets enough to do the job once in five times. Figuring studding as above, one-fourth, or 25 per cent., will cover the waste, if the pieces are used up as they should be.

Furring

In figuring the quantity of furring, work from the areas to be furred, determining number of board feet by proportion. In taking areas from the plan, work as follows: Take the first-floor plan (or basement plan if there is any ceiling or wall furring required there) and obtain the area of same inside of walls. Of course the ceiling is of the same area as floor, thus in the floor area you have the ceiling area. Now, if any brick or stone walls are furred, obtain running feet of these walls and multiply by the height of the story. These two results added give you the total area to be furred in this story. In this manner continue throughout the entire building, adding all the areas thus obtained together and setting down the result on your estimate sheet as I have done. Now, using the rule of proportion again, taking the first item of furring to demonstrate same, we work out the board feet as follows: $\frac{2 \times 11{,}232}{16} = \frac{22{,}464}{16} = 1404$ ft. (net).

In the same manner you can figure the number of board feet, no matter what the width, thickness or spacing of the furring is.

Hanging Ceiling

Frequently the framework of a ceiling, where there is no attic, is of light members hung from the rafters or roof joists; in such cases obtain the area of the ceiling from the upper floor plan and use the rule of proportion to find the quantity of stock in board feet. Thus, referring to the estimate sheet, we assume a ceiling of 1 x 6 in. rough spruce, 20 in. on centers, of 3104 sq. ft. area. This is expressed and performed by proportion, as follows: $20 : 6 :: 3104 : \text{ans.}, = \frac{6 \times 3104}{20} = \frac{18{,}624}{20} = 931. +$ ft. board measure.*

The stock with which to hang the ceiling frame to the rafters or joists is usually refuse picked up around the building, and your estimate will be sufficiently accurate if you do not consider same at all.

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* All of these examples in proportion may be simplified in figuring by cancellation, but to avoid confusion I have worked them out with the whole figures.

Bridging

If the floor joists are cross bridged in the center of the span, proceed as follows: Beginning with the first-floor framing plan, scale each stretch of bridging, setting down on a scrap of paper; in this way go through the entire plan and add for the total length. Assume the bridging to be 1 x 3 in. and the length measured on plans to be 964 ft. The diagonal distance between timbers (from the top edge of one to the bottom edge of the next joist) is near enough to one and one-half times the straight length to always call it so. As the two pieces of 1 x 3 in. equal a 1 x 6 in., we have one-half of one board foot for each extended linear foot of bridging. Add to 964 ft. 482, or one-half itself, to give us the extended or diagonal length of the bridging, and we have 1446 ft. As there is ½ ft. board measure of each foot in length of bridging, thus one-half of 1446, or 723 ft., is the number of feet, board measure (net), of stock required.

As rough spruce, furring, bridging stock, etc., frequently gets put to a good many uses, such as staying, bracing, staging, etc., before being used where intended, 25 per cent., or one-fourth, is little enough waste to allow over the net survey. As the number of board feet in all of the items under the head of studding and furring is 6875 ft., net, and plus one-fourth for waste makes 8594 ft., we will call the quantity 8600 ft., or eight and six-tenths thousands, expressed decimally 8.6.

The average cost of labor on these parts of a building, with carpenters' wages at 41 cents per hour, should be right around $20 per 1000 ft. The quantity of nails per 1000 ft. of stock will be about double that required for frame. Thus we work out a price as follows:

Stock per 1000, delivered	$26.00
Nails	2.00
Labor (average)	19.00
Total cost installed	$47.00

CHAPTER XV

Boarding and Measuring Roof Surfaces

As there is quite a difference in labor between square edged and matched boards, that may be used for wall and roofing covering and under floors, I think it is advisable to survey and keep quantities separate. Square edged boards are usually used for under floors, pitch roofs and wall covering. Obtaining the areas of floors and walls has been sufficiently explained under other headings, consequently I shall not go into the matter here. However, not having explained the method of obtaining pitch roof

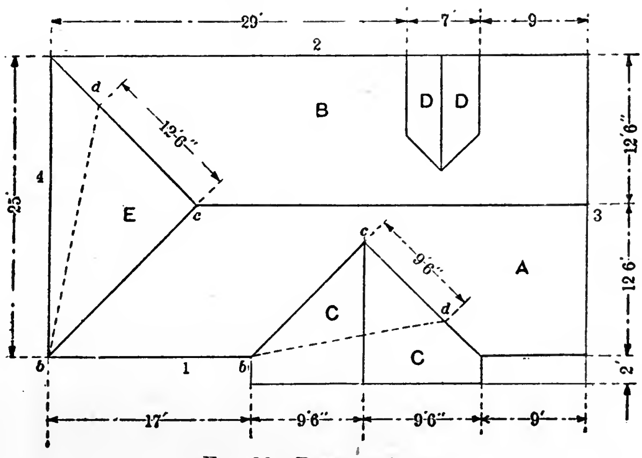


FIG. 23—PLAN OF ROOF

areas, I will endeavor to do so now. With most plans there is a drawing of the roof showing all ridges, hips and valleys. Where there is no such drawing the lines of the roof are sometimes indicated by dotted lines on the attic floor plan. Not infrequently the roof is shown in no other way than by the elevations. In case the roof is shown by either of the first two methods, you must refer to the elevations for part of the dimensions. In order to make matters as clear as possible, I will demonstrate by a few drawings.

In Fig. 23 we have a roof plan. I am paying no attention to architecture in this plan; simply drawing a roof that has hips, valleys and dormers in order to illustrate all ordinary roof forms. Figs. 24, 25, 26 and 27 are the four elevations and are of

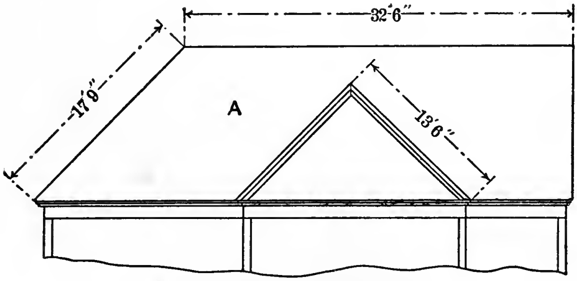


FIG. 24—SIDE ELEVATION

the correspondingly numbered sides as Fig. 23. We will begin by obtaining the area of the section of roof marked A in Fig. 23. By scaling the ridge we get 32 ft. 6 in., and by scaling the roof at gutter line, paying no attention to the wing that projects 2 ft.

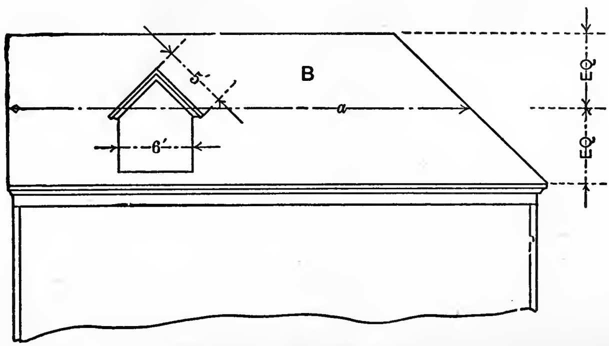
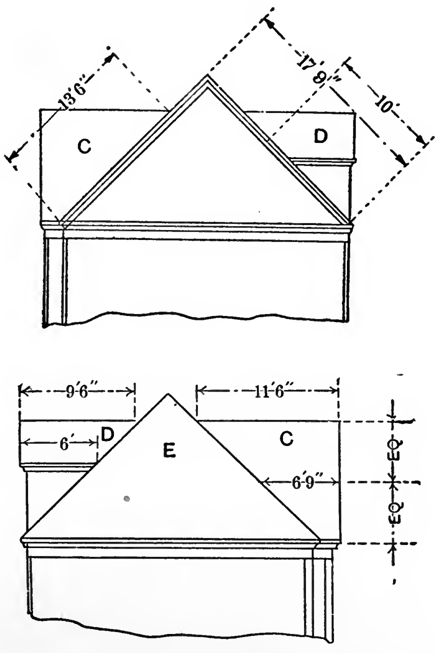


FIG. 25—SIDE ELEVATION

on this side, we get 45 ft. Now, by referring to the elevation of the front, Fig. 26, we obtain the length of the rafter, which is 17 ft. 9 in. This section of the roof, as developed in Fig. 29, is called a trapezoid. We will now obtain the area, for the time being paying no attention to the gap made by the roof over the projection of 2 ft. As the length of roof is 32 ft. 6 in. at the ridge and 45 ft. at the gutter line, we next obtain the average width. This is done by adding both of the above dimensions together and dividing by 2. We find this to be 38 ft. 9 in. Thus this section of roof measures 17 ft. 9 in. by 38 ft. 9 in., making the area 688 sq. ft. Now, out of this area we take the triangle covered by the roof of the projecting wing. Refer to either Fig.



Figs. 26 and 27—End Elevations of the Building

23 or 24 and scale the distance across the projection where it intersects the main roof at the gutter line. We find this to be 19 ft. Refer to Fig. 26 and scale the distance from gutter line to the intersection of the ridge of projecting roof with main roof, which we find to be 13 ft. 6 in. Thus we have a triangle, the base of which is 19 ft. and the altitude 13 ft. 6 in. To obtain the area of a triangle we multiply the altitude (13 ft. 6 in.) by one-half of the base (9 ft. 6 in.), which gives an area of 128+ sq. ft. By subtracting this last area from the 688 sq. ft. we have the net area of this side of the roof, which is 560 sq. ft.

In order that the reader may understand the theory of computing the area of triangles picture in your mind a triangle such as the one we have just figured out, or the one shown in Fig. 28, which is a developed plan of the rear section of roof E. If you were to cut this triangle in two, as shown by the dotted line in Fig. 28, and took the half marked X and turned it around so that it occupied the space marked X′, you would have a rectangle, one dimension of which would be the altitude and the other one-half of the base of the triangle. The same principle applies when we obtain the average length of the roof section shown in Fig. 29. Here the space X, if cut off, turned around, and made to occupy the space marked X′, forms a rectangle, the length of which is obtained on the line a. See Figs. 25, 29 and 30. Of course, in actual practice, you would not lay out a developed plan of the various sides of the roof, as it consumes unnecessary time. The way I should proceed to obtain the area of this side of the roof would be as follows: If the plans are not too large, spread the four elevations out on the table so that you can see them all at once and reach them with your rule to scale lengths. We will take for this illustration the side of the roof marked B in Fig. 23. Either on the roof plan, Fig. 23, or the side elevation, Fig. 25, scale with the rule the distance from gutter line to ridge. The number of feet you read mentally, at once; half this number of feet mentally before lifting your rule and place the point of your pencil at the middle of the distance; now holding the pencil where you placed it a moment, turn your rule around, let the side of it from which you are reading touch the pencil point and lay approximately parallel with the gutter or ridge lines, as drawn on plan. Having done this read immediately the distance from the right angled or rake end of the roof to the point on hip where the rule crosses it. The whole operation is but the work of a moment, and we have obtained the average length of

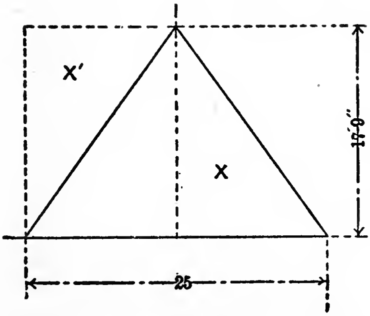


Fig. 28—Developed Plan of Rear Section of Roof E

this section of the roof. We will not bother with inches and will call the length thus obtained 39 ft. Now, refer to the front elevation, Fig. 26, and scale the length of the rafter, which, in round numbers, is 18 feet—again ignoring the inches—and we have obtained both dimensions of the piece of roof, B, and can compute the area. Thus we have 18 $\times$ 39 ft. = 702 sq. ft.

Out of this we must take the area occupied by the walls and roof of the dormer window. Refer again to side elevation, Fig. 25 scaling width of dormer; note mentally 6 ft.; then refer to the

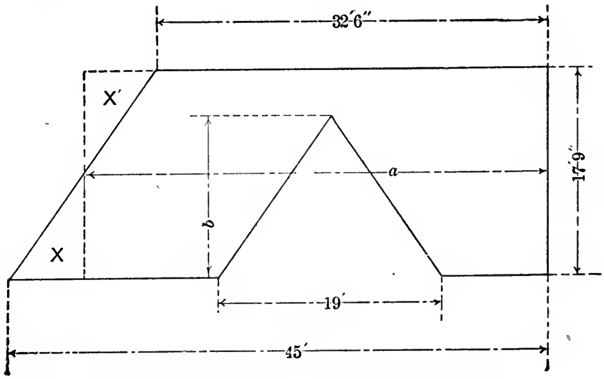


FIG. 29—DEVELOPED SECTION OF ROOF

front elevation, Fig. 26; scale from the intersection of the front wall of dormer with main roof to the average or center of the dormer roof, as seen in the elevation D, Fig. 26; read 10 ft. and mentally calculate the area 6 x 10 ft. = 60 sq. ft. Subtract the latter number of square feet from 702 sq. ft. and we have 642 sq. ft. as the area. Thus we see the whole operation is done in a minute's time, making no drawings, half the calculations being done mentally while shifting the rule from scaling one dimension to another, and a result thus obtained is sufficiently accurate for all practical purposes.

Proceed in the same manner to get the area of the roof of small dormer on this side of the main roof. First refer to the side elevation, Fig. 25. Scale rafter and read 5 ft.; now refer to either of the end elevations, Figs. 26 or 27, or to the roof plan, Fig. 23, and scale the section of roof marked D across the center (that is, half way between the dormer cornice and ridge line), and read

8 ft., the inches again being left out of consideration. Thus one side of this roof is 5 x 8 ft., equaling 40 sq. ft., which multiplied by 2 gives the area of both sides of the dormer roof. Fig. 32 is a developed plan of one side of this dormer roof; the dotted line across it shows where to get the average length.

In carrying the survey of the roof to the estimate sheet you may, if in a hurry to get through with the plan, set down the dimensions and "outs" thus:

17′ 9″ x 38′ 9″ x 2 (times)	Outs.
5′ x 7′ 9″ x 2 (times)	9′ 6″ x 13′ 6″
6′ 9″ x 13′ 6″ x 2 (times)	6′ x 10′
12′ 6″ x 17′ 9″	
1669 sq. ft. (net area).	

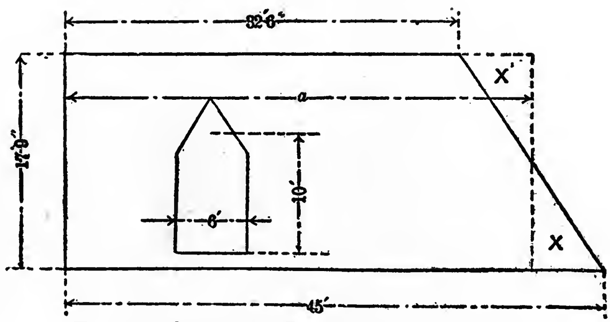


FIG. 30—OBTAINING LENGTH OF ROOF SECTION

As it usually takes but three or four minutes to figure the area of the average roof, I think it better to make the calculations on a scrap of paper and then carry to the estimate sheet the net roof area, as follows: 1669 sq. ft. (net roof area), add to this, if the item is going on to the estimate sheet under the head of frame, the size and spacing of rafters, thus: 1669 sq. ft. (net roof area) 2 x 8 in.—20 in. o. c. Having the information on your estimate sheet as last shown, you can figure the amount of frame by proportion, as previously explained, and your area for boards, and shingles or slates, is right before you. Do not think, because I put down the areas accurately, not eliminating the odd inches, and figure out the result decimally, that I would do this myself in actual practice, or expect you to do it. I do it here because I do not want my mathematics criticised, and in order to carry out an exact result of the area, as shown by the plans and elevations above referred to. It also shows to what accuracy you can go, and without much trouble, if there is any reason for so doing.

The time to make this roof survey is when you have reached it, surveying under the head of "frame." As I explained under that heading, it is necessary in computing the feet, board measure, of the frame in a roof, that there should be added to the result obtained from the area the schedule, or feet board measure, of the hips, valleys, ridges, etc. I will now endeavor to show you how to obtain sufficiently accurate lengths of these members. In doing so I will use Fig. 23 of the diagrams. The lines which represent the hips and valleys on this plan are the bases of right angled triangles, of which triangles the rise of the roof is the altitude and the hip or valley rafter the hypothenuse. Now if

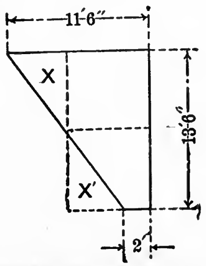


FIG. 31—DEVELOPED PLAN OF ONE SIDE OF DORMER ROOF

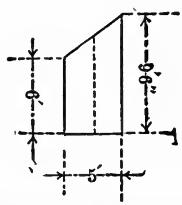


FIG. 32—DEVELOPED PLAN OF ONE SIDE OF DORMER ROOF

we scale the length of the hip or valley as indicated on the plan of the roof, Fig. 23 from *b* to *c,* we have the length of the base of the triangles, after which refer to an elevation (in this case either Fig. 24, 26 or 27) and scale the height, or rise, of main roof, and the lower roof covered by the sections marked C. The results in this case are the altitudes of the triangles. Having the lengths of any two sides of a right angled triangle, the third can be obtained by a process in arithmetic. However, as this involves figuring in square root, and all you want is an approximately correct length of the hip or valley upon which to base an estimate, it may be quickly laid out and the required length obtained on the roof plan, Fig. 23. As the two hips on this plan are at right angles to one another, let one of the hips represent the base of the triangle as from *b* to *c.* As you have scaled the rise of the main roof and found it to be 12 ft. 6 in., scale from *c* along the other hip 12 ft. 6 in., and make a dot with the pencil at this point (*d*); now turn your rule around and scale from *b* to *d*, as indicated by the dotted line, and the distance as read from the rule will be the length of the hip or the remaining side of the triangle called the hypothenuse. The same process applied to the valley, where the rise of roof is 9 ft. 6 in., the scale distance on the dotted line from *b* to *d* gives the length of the short valley. In the case of this roof the length of the long valley, which runs to the ridge, would be the same as the hip.

In the case of roofs of different pitches intersecting, the lines on the plans indicating the valleys would not show at right angles to one another. In such cases assume the line representing one valley to be the base of the triangle and lay off at right angles to this by your eye the rise of the roof, for the altitude of the triangle, making at the point thus obtained a dot with your pencil. Now scale the uncompleted side or hypothenuse of the triangle thus laid out, and you have the length of the valley. All hip and valley rafter lengths may be obtained from the plans in this way and set down piece by piece in your "frame" schedule, to be figured into board measure later. The lengths of the ridges may be scaled directly from the roof plan, Fig. 23, or from the elevations, Figs. 24, 25, 26 and 27, as their true lengths are shown in each.

You will probably notice that in figuring out the wall area of a typical frame house I did not include the gables. All gables being triangles, or in the case of Gambrel roofs a trapezoid surmounted by a triangle, I purposely delayed touching on the subject until after I had demonstrated by the drawings of a roof how to obtain areas of irregular shaped planes. In actual practice the gable areas should be taken off at the time of surveying the walls of the building, the total area being entered on the estimate sheet under the head of "studding." This item of studding should be noted "outside walls," so that it is distinguishable from the partition areas, thus making it possible to look back for area when figuring boarding and clapboards, or other wall covering. Sometimes under floors, and even walls, are boarded diagonally. This increases the waste somewhat, and in most cases about doubles the labor. When the above is the case, make a separate item and figure out the probable cost at which to carry out your price. I usually make a few diagonal lines after the heading of the item covering this part of the boarding to distinguish it from ordinary boarding, thus: "$\frac{7}{8}$-in. square (or m'tch'd) spruce ////."

Matched boards are always used under slate, metal or composition roofs and often for wall boarding. Theoretically there is more waste on matched than square boards, as the loss in milling and matching is surveyed in when boards are marketed. In actual practice, unless the boards are very narrow, say less than 5½ in. face, the waste would not be any more than on square boards used in the same place. The principal reasons for this are that the matched boards are usually of sounder stock, more uniform in widths and lengths, and they are handled and cut with a little more care. If laid at right angles with the nailings 25 per cent. is ample waste allowance, and if laid diagonally 33 1-3 per cent. is sufficient.

With carpenters' wages at 41 cents per hour, an ordinary job of square boards should cost to lay from $5 to $7 per 1000 ft. board measure. Matched boards should cost from $8 to $10 per 1000 ft. If either of the above are laid diagonally the labor would be nearly double. In case of very small jobs considerably cut up the cost would be somewhat more than the maximum price quoted above. If the building was of large, unbroken areas, the cost should be somewhat less than the minimum prices quoted. The work upon which one is engaged must be watched to see what the costs are, and then there is established a basis upon which to work, in arriving at the probable cost of work upon which the estimate is being made.

Forty pounds of nails are usually sufficient to nail 1000 ft. of boards, with studs or joists about 16″ o. c.

Plank Floors

It is almost needless to say that if your floors were of plank you would proceed to obtain areas as for boards, not forgetting to multiply your net areas by the thickness of plank before adding waste. The labor per 1000 ft. board measure would be somewhat less than for 1-in. stock, as the time consumed to lay a plank of a given size, 2 in. thickness, is not double that of a board of same size.

CHAPTER XVI

Shingles, Clapboards and Outside Finish

When you have reached this item in the specifications and entered it upon the estimate sheet, look back under "frame," Fig. 22, and see what the roof area was. Now, knowing what 1000 shingles will lay at various distances to the weather, divide the area by this amount to obtain the number of thousands. Next size up the roof and determine the number of shingles a man should lay in a day and compute from this the labor cost per 1000. With your rule scale the lengths of valleys, dormer cheeks and any other places requiring flashings, and compute the number of square feet of zinc, tin or copper required. This settled, divide the number of square feet of flashings by the number of thousands of shingles, and thus obtain the number of feet per 1000 shingles. Having obtained all of the above, not forgetting nails, though not mentioned, tabulate, and you have the cost per 1000 laid complete, thus:

Extra cedar shingles per thousand (delivered)	$4.50
5 lb. nails	.20
10 sq. ft. 9-oz. zinc, 7 cents	.70
Labor (2000 per day average cut up roof)	1.64
Cost per 1000 laid	$7.04

Wall shingling would be worked out in the same manner as above, the quality of the shingles and nature of the walls to a great extent affecting the price.

Clapboards

In this market clapboards are sold by the 1000 pieces, 4 ft. long. Thus, if they are laid 4 in. to the weather, one clapboard will cover $1\frac{1}{3}$ sq. ft. Refer to the item of "studding and furring" on estimate sheet No. 6, Fig. 22, for the outside wall area. You will remember that in taking the wall area we did not figure out the windows and doors, so with the four elevations within easy reach scale and figure out the area of these openings. In doing this, work in even feet, not bothering with inches. For instance, if an opening scaled 3 ft. 6 in. x 5 ft. 9 in., calculate mentally 3 x 6 ft. = 18 sq. ft. Set this down on a scrap of paper, noting the number of such openings. Continue in this way throughout the elevations; then note any other "outs," such as the parts of wall that are covered by piazzas, wide belts, cornices, etc. Obtain and total all of above "outs" and subtract from the total wall area, thus getting the net surface o be clapboarded. This divided by the number of feet one (or 1000) clapboards will cover, at the distance they are laid to the weather, gives the total number of clapboards.

Usually the clapboards are laid over some specified brand of sheathing paper. Proceed, as in the case of the shingles, to work out a price per 1000 clapboards laid on wall, including paper, nails, etc.

1000 clear spruce clapboards (delivered)	$45.00
Waste per 1000, 5 per cent	2.25
Paper (1000 sq. ft. net, plus 10 per cent. waste), 1100 ft	5.50
Nails, 4 lb	.14
Labor (average about $20 per 1000)	20.00
	$72.89

Coming, as it does, so near to $73 per 1000 laid, carry out the price at the even dollar amount.

Outside Finish

Under this heading we have cornices, rakes, belt courses, balustrades, columns, pilasters, window caps, corner boards, saddle boards, water tables, brackets and so on, almost indefinitely. In some cases you can group several of these items under one subheading and figure at the same price per foot, thus saving time and condensing the matter on the estimate sheets. I find that in nearly all cases it is safer to figure the price per "unit" complete in place on the building. Let us consider each of the subdivisions of outside finish separately.

Cornices

If there are several types of cornice, differing greatly in the quantity of stock and labor to construct each, make several headings, such, for instance, as main cornice, piazza cornice, dormer cornice or rakes. Under each heading put down the number of feet in length of the cornice, with the additional data of the number of inches of plain stock and the number of inches of moulding, size and spacing of modillions, dentils, etc. In speaking of inches above, I mean board measure inches—(1 x 1 in. x 1 ft.). It is possible that somewhere on the plans there will be $\frac{3}{4}$ in. or 1 in. scale drawings of the principal parts of the outside finish, in which case you can scale quite accurately the various members of cornices, etc. In case there is nothing but the small scale drawings, you must be guided as much by judgment as by the plans in figuring out the inches of stock. Let us assume an ordinary cornice with wood gutter, brackets and other usual parts for the purpose of demonstration: Take the plain parts first, facia over gutter 4 in., facia under gutter 4 in., plancier 12 in., frieze, two members, one 8 in. and one 12 in., all $\frac{7}{8}$ in. thick, these making a total of 40 in. of stock per running foot of cornice. Now take the mouldings: Gutter 4 in. x 5 in. = 20 in.; gutter fillet, $\frac{5}{8}$ in. $\frac{7}{8}$ in. = 1 in.; bed moulding, $\frac{7}{8}$ in. x 3 in. = 3 in.; frieze mouldings, one $\frac{7}{8}$ in. x 2 in. and one $1\frac{3}{4}$ in. x 3 in., both equaling 8 in., these making a total of 32 in. of moulding per running foot of cornice.

Next the brackets, say 3 in. thick, 12 in. long and 8 in. deep, 18 in. on centers, with face band sawed to pattern.

Now let us compile the results:

	Sq. ft.
40 in. of ⅞ in. stock + 1/10 waste = 44 in. = 3⅔ ft. B. M., at 8 cents per foot	$0.30
32 in. of moulding + ⅛ waste = 36 in. moulding, at 1 cent per inch (less discount if any)	.36
Bracket 3 x 8 x 12 in. = 2 ft. B. M. stock, + ¼ waste = 2½ ft. stock, at 8 cents per foot, + planing and sawing (say 7 cents) = 27 cents each (18 in. o. c. = ⅔ bracket per foot)	.18
Cost per foot of stock	$0.84

We have now worked out everything but the labor. I find that the best way to arrive at the cost per foot for labor is to look at the elevations, pick out a stretch of cornice shown on one of them, and then try and picture yourself with a good man (carpenters usually work in pairs on such work) putting on this particular piece of cornice. In doing this don't forget that you have got to build a stage; line, cut and fur the rafter ends, and pick out and get on to the stage the boards and mouldings. Suppose this piece of cornice to be 30 ft. long, and you conclude that with one man's help you could do all of the above preliminary work and construct the cornice in a day (8 hr.). With wages at 41 cents per hour, this means 16 hr. at 41 cents = $6.56 ÷ 30 = $0.22 per foot. This represents what you could do yourself. Did you ever hire a man that could, or would, do as much work for you as you can do for yourself?

The pine and mouldings have also got to be taken from a team outside the building and carried in and piled up until used. The cornice is going to require a few nails, some elastic cement, sheet lead, etc.; hardly enough per foot of these latter to make an item under "stock," which we figured out above; at the same time, on the whole cornice, they will cost a few dollars. Considering all these things, probably 33 or 34 cents per foot will be nearer the actual cost per foot for labor and sundries than 22 cents.

I have made it a rule to increase by one-half the labor on any given piece of work after having figured out what I thought I could do it for myself, assuming this increase to cover the items of stock too trivial to figure out at so much per foot (or unit), and the lost labor that goes into every job and must be provided for: I might also add that in actual practice this rule gives nearer the correct average costs than any other that I have used.

Having figured (or reasoned) out the probable cost per foot of labor and sundries on the cornice, we can complete the price thus:

Stock per foot of cornice	$0.84
Labor and sundries	.33
Total cost per foot	$1.17

So on the estimate sheet under the head of "Main Cornice," described and number of feet set down, we carry out the cost at $238.68, as shown in Fig. 6.

It has taken me quite a while to tell you this, but with a little practice you can figure out running foot costs on cornices in about one-half the time you will be reading my explanations and analysis.

Belt Courses

Belt courses can be figured out in the same manner as cornices. If several of the cornices, belts, rakes, etc., are of very similar design and size, they can be grouped in measuring, and the cost on the one cornice or belt, that is the nearest to being the average, be worked out in detail and this cost used for all. In many cases the result thus obtained will be about as accurate as though each different cornice or belt had been considered separately, and varying costs been worked out and used.

Corner Boards

If corner boards are of the usual plain kind they can be taken in linear feet and the number of feet by the inches in width set down on the estimate sheet. For instance, if we had a corner made of one 5-in. and one 6-in. board, both $\frac{7}{8}$ in. thick, and found by measuring plans that there were 124 ft. in length, we would enter same on estimate sheet as follows:

Corner boards (pine) $\frac{7}{8}$ x 11 in. .124 ft. linear.

The stock you can figure readily if you know the prevailing prices, not forgetting to add to the cost per foot a sufficient amount to cover waste. The labor can be worked out the same way I worked out the building of the cornice, unless you have noted the time and figured out the cost per foot on some building, and thus have a basis to work from. The best way to measure the plans for corner boards is to have in front of you the first floor plan, and within sight and reach have one or more of the elevations. Now, look at the floor plan, and take a prominent corner, which locate on one of the two elevations upon which it will show and scale the height. Set down the result on a scrap of paper; then take the next corner (to the right or left, as you choose), locating this corner on the elevations and scale the height, setting down under the former figures. Proceed in this way around the building until you reach the corner at which you started, noting and setting down any corners showing on elevations that are not apparent on the first-floor plan, such as on overhanging second stories, dormer windows, etc., as you have the various elevations before you. Add the figures you have put down on the scrap of paper, and thus obtain the total linear feet of corner board, which latter you enter on the estimate sheet with the total width, thickness and kind of lumber. Having done this, proceed to the next item, leaving the figuring out of the cost until through with the surveying of plan. The above explanation for surveying plans for corner boards would apply where a building was somewhat irregular in plan and with several different lengths of corners. By checking from the floor plan you avoid the possibility of missing any corner and of getting any corner twice. As each complete corner appears on two elevations, there is a probability of the latter error occurring if floor plan is not referred to. Of course, if the building is perfectly plain and all corners run to the main cornice, the latter being level all around the structure, you need only to glance at any floor plan; count the corners; lay your rule on any elevation, scale the height; multiply the height by the number of corners, mentally or otherwise, and thus obtain total linear feet.

Saddle Boards

Saddles can be measured either on the roof plan, if there is one, upon which they all show, or from the several elevations. Some care must be used in working from elevations not to get the same stretch of saddle measured twice, as each run of saddle board will show on two elevations. Enter the total linear feet, width and other particulars on the estimate sheet in same manner as corner boards.

Water Table

This can be more conveniently measured on the first floor plan than from the elevations. In measuring begin at some one corner and work around the outline of the building until you arrive at the starting point, setting down on a scrap of paper each length as obtained and adding for the total. The total number of feet, with the particulars (inches of plain stock and molding), are then carried to the estimate sheet.

In ordinary frame structures the corner boards, saddle boards and water table are usually of dimensions sufficiently alike to permit of their being all surveyed together and the cost carried out at one price per linear foot.

Window Caps

Where windows have molded caps there is usually some one of the cornices that is of about the same section, and you will find that you can simplify matters somewhat by measuring caps with such a cornice. In measuring a cap I always allow 2 ft. extra length over face measurement to cover returns.

Piazza Facia

The plain board or facia that goes over the sill of the piazza I usually make a separate item, and include with it the risers and face stringers of all outside steps and the base board of lattice work. Carry to the estimate sheet the total running feet and make note of the average width and thickness. Most of the measurements for all above piazza and step parts are readily obtained from the first floor plan, but if you choose the elevations may be used. In any case, you must refer to the elevations for the widths.

Piazza Floors and Steps

These are simple matters of areas and should be taken from the floor plans. I usually take both under one heading, measuring the steps double, as the treads are usually of $1\frac{1}{8}$ or $1\frac{1}{4}$ in. stock, and the cost of labor per "square" or square foot is greater than for the piazza flooring. Of course, the result can be worked out more minutely if you make two separate items; but the step area is usually such a small part of the total area of piazzas and steps that the costs carried out will be but slightly affected if you consider them jointly.

Columns and Pilasters

If there are piazza columns and pilasters make a note on the estimate sheet of the number, size and description of each kind. If you are unable to figure out costs for these parts delivered at the building, you can confer with a mill man and obtain prices from him. To the price delivered should be added the cost of the labor handling and setting, thus carrying out the cost for them set complete in the building. In determining the labor cost per column or pilaster for handling and setting, apply the rule I have given for figuring labor on cornices. This rule is readily applicable to any item of outside or inside finish, and in the absence of statistics of costs obtained from actual erection of similar parts in structures you have built, I know of no other way of arriving at the probable cost. Many men take other men's word for the cost of labor per given unit, but so few men make any attempt to prove their opinions in such things that you will do better to rely upon your own judgment.

Balustrades.

Balustrades can be best figured by the linear foot erected. The quantity is most readily obtained from the floor plans, but you must refer to the elevations for the style of rails and balusters. Sometimes in the absence of elevations a full description of balustrades will be given in the specifications. In analyzing a foot in length of balustrade you have 1-0 of top rail of specified section, 1-0 of bottom rail ditto, and as many balusters of the required size and spacing as it takes to make 1 ft. 0 in. The labor you can determine by the rule I have already given. As all ordinary sizes and shapes of rails and balusters are sold at standard prices in each locality, you should experience no difficulty in making a very close estimate of the probable cost per foot.

If the parts are of special design, you must exercise your judgment in working out costs, or refer the particulars to your mill man and get his prices for material delivered, to which must be added the labor. Where small posts or buttresses occur in balustrades count same and make a price each, installed. As an example of entering columns, posts and balustrades on the estimate sheet see Fig. 22.

Lattice.

I find the most convenient way to figure lattice is by the square foot. The quantity you will have to take from the elevations, and in measuring for same remember that the border boards cover up, as a rule, almost their entire widths of lattice. The spruce framing necessary to fur for lattice work is in most cases so small a factor that it need not be considered. If, however, it should appear to you that enough furring will be required to make it worth while to take note of it, take a typical panel of lattice, work out the number of feet board measure of furring and studding necessary for this particular panel, and then divide the quantity by the number of square feet of lattice in the panel. This will give you the quantity of furring per square foot of lattice, and in making your cost it can be put in at its value.

I don't know as it is necessary to further enumerate outside finish, as I have given enough examples to enable you to subdivide and work out costs on the numerous items under this heading. The nature of the plans and details for these parts will have to be the determining factors in the number of subheadings into which you will divide the work for convenience in measuring and analyzing costs. As, in the general run of good work nowadays, no two jobs will be exactly alike, judgment will be a large factor in making the unit prices.

CHAPTER XVII

Windows, Doors, Inside Finish and Floors

Ordinarily the windows of a building are quite uniform in size and detail. This is especially true if we leave out of consideration the basement or cellar windows. In figuring I make one typical window the "unit" upon which to carry out the estimated cost of the windows of a structure. In figuring the cost of a window include the frame, sashes, weights, cord, hardware, blinds and trimmings, stool, apron, casings, edge casings, stop-beads and rough grounds; also in working out the cost of labor per window consider the labor on all of the above enumerated parts, together with the time involved in taking these materials off the teams and carrying them into the building, and the handling and distributing to the various rooms until installed. By taking a window which seems to be a fair average in size and detail and carefully working out the cost on all the parts and operations—as above noted—and using the cost thus obtained for all windows, the resulting figures will be, in nearly all cases, as accurate as though you had made 15 or 20 different prices for as many kinds and sizes of windows. However, if there happens to be several very large and out of the ordinary windows, such, for instance, as a large tripple, with pilaster casings, semi-circular transom, leaded or plate glass, etc., it is wise to leave them out of the general enumeration and figure the cost separately. Also if there are a number of very simple windows, such as small cellar sashes with plank frames and no inside finish, make them a separate item. Thus in the case of almost any building an accurate result can be obtained by making no more than three items of windows.

The costs of stock-size and ordinary detail windows, frames and blinds are standard in every locality and can be readily obtained if you do not already know them. You should also have a common and plate glass price list at hand and keep posted on the discounts; these vary from time to time, but if you are buying much glass you will receive the notice of any change in discounts from your local dealer. The members making up the finish of a window are easily figured at moulding prices, which are usually for a certain amount per square inch of section, per foot of length.

As an example we will work out the cost of an average window, such as would be found in the hypothetical building of which we are making a survey and estimate:

1 box frame (for brick), 15 x 30 in., 4 lights	$ 1.75
1 window (2 sashes), 1½ in. thick, No. 1 single thick glass	1.65
24 lb. weights	.42
1/5 hank cotton cord	.20
1 pair No. 1 blinds, ½ roll and trimmings	1.10
1 piece stool, ⅞ x 4 in. by 4 ft. 2 in.	.17
1 piece apron moulding, ⅞ x 4 in. by 4 ft	.17
15 ft. ⅞ x 5 in. casing	.75
15 ft. ⅞ x 4 in. edge casings	.60
11 ft. ⅞ x 3 in. box veneers	.33
11 ft. ½ x 2½ in. stop beads	.28
3 ft. ½ x 4½ in. stop beads	.14
22 ft. ¾ x ¾ grounds	.07
Locks, lifts and stop bead screws, etc.	.45
Labor (8 hours?), at 41 cents	3.28
Total cost of window installed	$11.35

Having thus worked out a cost on an average window, carry out the cost for all windows as shown on Fig. 33, by multiplying by the whole number. You will find that the result of using this average price will, in most cases, give a probable cost as accurate as you would obtain if you made a dozen different kinds of windows and used a separate cost on each. By including all windows in the count, calling a mullion two, and a triple three windows, etc., and not excepting the simple cellar and attic windows, you save yourself a lot of time, and wearisome figuring. There are almost invariably several windows in a building that are considerably more expensive than the average, and the difference in cost between the cellar and other very simple windows and the average window upon which your price is based will usually compensate for the former.

All I have said about windows will apply to doors, except that in many buildings it may be policy to separate doors into two or more classes. I advise that this be done in the case of doors, because there are usually but two or three classes and sizes of doors in a building, and the same structure would have perhaps 20 kinds and sizes of windows. Thus subdividing the doors will not complicate matters or seriously interfere with speed in figuring. Take one door of each class and dissect and analyze it in the same way I did the windows. Begin with the grounding of rough opening and figure everything to make a complete door and trimmings installed in the building.

Base and Mouldings

Base and moulding should always be figured together and in running feet. In making a price per foot include grounds, base and moulding, and labor for all of these items of stock; not forgetting in determining the labor item to take into account the miscellaneous handling of the stock from a team into the building and its distribution to the various parts of the structure preparatory to actual installation. If there are several kinds of base, measure each kind and work out the cost separately. In measuring the plan I find the best way to proceed is as follows: Assume part of the building to have 8-in. base and $1\frac{1}{2}$-in. moulding of white wood and the balance 9-in. base and 2-in. moulding of quartered oak. Take a piece of paper and at top of same make memos. as follows:

9 in. + 2 in. quartered oak.		8 in. + 1½ in. white wood.	
Feet.	"Outs" Feet.	Feet.	"Outs" Feet.
24	6	26	7
28	9	32	16
32	7	46	9
40	..	18	..
..	..	21	..
124	22	143	31
22	..	31	..
102	..	112	..

Now begin with the first floor plan and take a room in one corner of the plan: Scale one way, say 12 ft., double for the two sides of the room and set down 24 ft.; then scale room the other way, double and set down; note the doors, say two, each eliminating about 3 ft. of base; under "outs" set down 6 ft. If there is a closet to this room, take the base in this next and enter measurements under the proper heading of dimensions and kind of wood. Continue your measurements throughout the entire floor, taking the rooms in the order that the plan suggests to you as being least apt to lead to confusion.

Having completed the first floor, take the second in the same way, also the third, etc., until the whole building is measured. Then, by adding up the gross measurements and "outs" separately, and deducting the latter from the former, you have the net running feet of each kind. I have carried out a few measurements under the headings and performed the subtraction of "outs" to show how it is done. The net amounts thus obtained can now be carried to the estimate sheet and the price per foot and total costs be figured after you are through with the plan. Sometimes a building is laid out so nearly alike on each floor that the result will be sufficiently accurate if a typical floor is measured and the quantity thus obtained is multiplied by the number of floors.

Chair Rails, Etc.

Chair rails, picture moulding, and all similar parts of inside finish can be measured in the way demonstrated above for base and mouldings, the total running feet in each case being carried to the estimate sheet. Where grounds are required, figure both stock and labor in making the price per linear foot installed.

Clothes Closets

Having, in surveying the base, taken care of the closet base, and in making price for doors included all finish and labor for same, all that is left for us to figure in an ordinary clothes closet are the hook cleats, hooks and shelf.

Refer to the floor plans and count the closets, putting down on estimate sheet, Fig. 33, the number. With plans still before you pick out a closet that represents about the average size and on the figuring pad put down the number of feet of hook cleat, length and width of shelf and number of hooks as follows:

10 ft. $\frac{7}{8}$ x $4\frac{1}{2}$ in. cleat.
16 hooks.
1 shelf 12 in. by 4 ft. by $\frac{7}{8}$ in.

Having done this, figure out the cost of these materials and determine the length of time that will probably be required by a carpenter to install same and add for a total cost per closet. It may happen that several closets included in the count of 19, as set down on estimate sheet, have a case of drawers in addition to the cleats, hooks and shelf. In this case enter on estimate

John Smith Building — E #51	7	
42 Windows complete 15"x30"-4 lts. @ $11.35	476	70
12 Cellar windows, 10"x12"-6 lts, plank frames etc. @ $4.50	54	—
4 Ent. and Vestibule doors complete including hdw'r @ $26	104	—
46 Inside doors complete including hardware @ $13.50	540	—
Base and moulding.		
672 ft l. 9" and 2" Qr. oak @ 27 cts.	181	44
1850 " " 8" • 1½" w wood. @ 14 "	259	—
Chair rail, 4½"x7/8" Qr. oak. 650 ft. l. @ 15 cts.	97	50
Picture moulding, 7/8"x2"		
840 ft l. Qr. oak @ 6 cts	50	40
1300 " " w wood @ 4 "	52	—
19 Clothes closets @ $1.40	26	60
Drawer cases in 3 above @ $7.00	21	—
3 Linen Closets @ $40	120	—
3 China closets 12 ft of cases, cupb'ds, and glass enclosed shelves	360	—
3 Pantrys. 1 Case 3 drs. 140 ft B.W. shelving and sheathing, 2 prs panel cupb'd doors etc. in each	135	—
	$2477	64

FIG. 33—ESTIMATE SHEET NO. 7

sheet, Fig. 33, the number, and work out the price, complete, installed. If you are not familiar with mill work and cannot reason out a price for yourself, put down height, width, depth and number of drawers and kind of wood, and after you are through with the plan you can telephone or visit your mill man and get his price, to which you can add labor, hardware, etc., and then carry out the cost.

In the same manner all special closets, such as for china and linen, pantries and pot closets, or any small room with out-of-the-ordinary finish, may be analyzed and a cost worked out to suit the conditions found.

Stairs are now usually built by men who do nothing else, and bids for the stair work of a building can readily be obtained at short notice. However, I think it is better to keep posted as to the cost of rails, balusters, newels and similar parts of stairs, and to take the trouble to see how long a man is occupied in erecting and finishing different staircases on the work, and thus prepare yourself to make sufficiently accurate costs for use in the estimates. There is such a decided similarity in stairs found in ordinary apartment houses and dwellings that in a short time you get well enough acquainted with the costs per flight to look at a flight on the plan and sections, read the specifications covering it and make a price "off the reel" to use a slang phrase, as close as you could get if you figured for half an hour or called in a stair builder. Of course you cannot apply any such snap judgment to complicated and out-of-the-ordinary flights, and on such as these it may be wise to call up your mill man or stair-builder and ask some questions and prices before making out a cost yourself. And so I might go on indefinitely with inside finish, but I think I have given enough examples to "blaze the way" and your own judgment will carry you through any other items under this head that you will encounter. If you do not always feel secure in your own judgment, list the items and write down brief description; then go and talk it over with the mill man. Then, having made a price, if you obtain the job, see how your prices work out, and thus check and correct your judgment. In the long run it is much more satisfactory and safer to figure this way than it is to take a lump sum bid from a mill man for all finishing materials and to try and lump the labor of installing them.

You have noticed that under the various subdivisions of inside finish I include "grounds" in working out a price. This item usually appears in the specifications after "studding and furring,'' but if you were to take up the surveying of the quantity at that time you would have to go all through the plans and spend perhaps 15 minutes' time. By ignoring it then, and taking it with ''doors,'' ''base,'' ''chair rails,'' etc., your survey serves you a double purpose, and it is just as easy to include the cost of grounds and labor in figuring a door, or a foot of base, as not to, and results are more accurate. Upper floors are best figured by the ''square'' (100 sq. ft.) laid and smoothed complete. If there are several different kinds of woods used, some having more labor expended upon them, such as in laying borders, high class smoothing, etc., each kind should be surveyed separately. In cases of this kind the best method in which to make the survey is to take the dimensions of each room or compartment separately, setting same down on a scrap of paper under the head of the kind called for. For example, assume that there are some quartered oak floors, $2\frac{1}{4}$ in. wide, matched, and that the rooms where same occur all have borders 2 ft. wide; other rooms have Rift Georgia hard pine, $2\frac{1}{4}$ in. wide, matched, no borders, and still more rooms with slash North Carolina pine, 4 to 6 in. wide and matched; also that all floors are laid over heavy sheathing paper, and that the oak and Georgia pine floors are to be protected as soon as completed by covering them all over with good serviceable paper, which is to be renewed as often as necessary to keep these floors in condition until building is turned over to the painter. Then proceed as follows: On your figuring pad make the headings thus: ''Oak,'' ''Geo.'' ''N. C. P.'' Take the first floor plan and begin in one corner, scaling dimensions of this room, which we will call ''Geo.,'' and enter dimensions under this heading. If this room was 14 ft. 6 in. x 16 ft. it would go down on the figuring pad thus:

Geo.

14 ft. 6 in. x 16 ft.

Take the next room or closet, scale, and enter dimensions where they belong, proceeding in this way throughout the entire floor, choosing a course from room to room that suggests itself as being least apt to lead to confusion. After all of the floors in the building have been taken in this way, a few minutes' figuring will give the number of squares of each kind, and these totals can be carried to the estimate sheet, Fig.

34, with brief descriptions, and a cost per square for each worked out later. In taking off the floors in this manner there will probably be no "outs" worth taking into account. If there are any of consequence, note of their dimensions should be taken at the time of scaling the compartment in which they occur, and they should be entered on the figuring pad under the head of "outs" and in a parallel column with the particular kind of floor you are surveying. The results obtained by such a survey as just described will be very accurate, if any care is taken in scaling dimensions. To simplify the figuring as much as consistent with reasonable accuracy, work in feet and half feet only. Thus, if a room scaled 14 ft. 8 in. one way, call it 14 ft. 6 in.; or, if 14 ft. 10 in., call it 15 ft. By the time you have been through the whole plan the differences thus made will be pretty well averaged.

If there is only one kind of flooring in the building, or possibly a very little of a second kind, the survey may be made much quicker and with sufficient accuracy by proceeding as follows: Assume a rectangular plan, say, 60 x 80 ft. inside of walls, cut by partitions into numerous rooms or offices, such as would be the case in an apartment block or office building. Look at the floor plan and see about how many partitions there are running substantially parallel with each dimension of the building and practically continuous. Say that there are five partitions more or less continuous the 60-ft. way and four the 80-ft. way. The average partition by the time it is plastered and based will be near enough to 6 in. to call it so. Then cut the 80-ft. dimension five times 6 in. or $2\frac{1}{2}$ ft., making it $77\frac{1}{2}$ ft., and the 60-ft. dimensions four times 6 in., or 2 ft., making 58 ft. Then the area to have an upper floor will be 58 ft. by 77 ft. 6 in., less what "outs," such as stairways, large chimneys, small areas of tile in toilet rooms, etc., there may be. These figured out, and a net area or number of squares is obtained for one floor. If the succeeding floors are of nearly the same area, multiply by the number of stories in the building. Now, if there are a few squares or some other kind of flooring, survey same, room by room, figure a total and subtract from the grand total for the whole building. By this method the floors of a very large building can be surveyed in several minutes. If you are hurried with your plan and must give it up to some one else shortly, the dimensions can go right to the estimate sheet and the computation of areas be left until later.

Having demonstrated the surveying of floors, we will work out the cost per square on the quartered oak:

100 ft. plus ⅓ for matching and cutting waste = 133 ft. B. M., at $120.00 per M	$15.96
4 lb. nails, at 4 cents	.16
Paper under floor ($2 per roll of 500 sq. ft.), allowing 10 per cent. for lapping and waste	.44
Paper for protection (assume that floor will have to be covered twice and with paper at $1.50 per 500 sq. ft.)	.60
Labor laying, smoothing and covering	8.00
Total cost per square	$25.16

Now, as there will be some little handling of the flooring stock and moving of other stock and cleaning up to make room for the floor layers, I should figure $26 per square; thus in the estimate sheet shown in Fig. 34 we carry out the cost of the 21 squares at this price. By analyzing as above, work out the cost, installed complete, of any kind of flooring. In the locality of Boston carpenters never lay floors except small quantities met with in jobbing. We let the labor of laying to a contracting floor layer at so much per square, or in some cases for a lump sum for the entire building. If such is the case in your community and you are not posted on costs, you should become acquainted with the standard prices per square charged for the various kinds of work.

In every building there are miscellaneous special items or parts that must be listed and probable costs be computed. Among these will be such items as store fronts, bulk heads, cabinets of various sorts for gas or electric meters, standards for plumbing fixtures and boards or panel work to cover pipe slots, scuttle and ladder to roof, cellar and coal bin partitions, etc. As you come to any such item in the specifications proceed to list the materials and probable labor on the estimate sheet. Many of these items are so briefly explained in specifications, and so meagerly shown on plans—if shown at all—that their cost is pure conjecture. In making a price in such cases you will of necessity have to be governed by local customs, supplemented by your familiarity with the architects' practice.

PART IV
Miscellaneous Sub-Contracts

CHAPTER XVIII

Plastering

If the plastering in a building is not of a complicated character, it may be easily and accurately figured by any one who can survey the quantities, as the prices per yard for the several kinds of work are standard in every locality. Where there are cornices, panels, enriched mouldings, columns and pilasters with capitals, and all similar parts out of the ordinary, the work will have to be figured by an expert plasterer. For purpose of illustrating methods for surveying quantities, we will assume that the building in hand has no plastering out of the ordinary. Say, for instance, that the boiler room ceiling is two-coat work on wire lathing, and that several sets of steel beams and the cast iron columns are wrapped with wire lathing and plastered two heavy coats for the purpose of fireproofing them; that the balance of the work is two coats—brown mortar, and sand and lime-putty skimming—on 1½-in. spruce lath. Included in the last kind is the cellar ceiling except boiler room.

Take the framing plan that shows location and length of the steel beams; scale the length and note the size and number of beams making up the sets. Assume a set of three 15-in. 42-lb. beams, carrying a 20-in. brick wall over 17-ft. openings; the girt of this set will be 15 in. plus 15 in. plus 19 in., these figures being the dimensions of the two sides and soffit of the set to be wired and plastered; thus the area to plaster is 4 ft. 1 in. by 17 ft. This is so near to 4 x 17 ft. that we put it down so. Now proceed to the other sets of beams, setting down on the figuring pad the several dimensions as for the first set. Having taken all beams, lay aside framing plans and take regular floor plans. Look up the columns next. Assuming the number, length and size of columns shown on estimate sheet No. 5 in Fig. 21, under the head of "Cast Iron," enter the dimensions to be plastered, under the beam dimensions, thus:

2 ft. x 11 ft. x 12 times.
1 ft. 6 in. x 11 ft. x 2 times.
1 ft. 6 in. 8 ft. 6 in.

Of course, you know without my telling you that the circumference of a circle is slightly over three times its diameter—to be exact, 3.1416, or three and one-seventh times. For purposes of estimating such items as we are now considering, three times the diameter is sufficiently correct, as an inch or two, more or less, in the circumference of a column will make so slight a difference in materials and no difference in labor, that it is not worth while to take it into account. Now put all of your dimensions into square feet, and by dividing by nine obtain the square yards, or the unit of measure by which all ordinary plastering is figured. The number of yards thus obtained carry to the estimate sheet and enter with brief description.

The 66 yards entered on estimate sheet No. 8 in Fig. 34 are the result of the dimensions used above and the following:

3 x 13 ft.
2 ft. 6 in. by 14 ft. x 5 times:

these last two dimensions, with the dimension of 4 x 17 ft. assumed above, being for the three items of sets and single beams listed under the head of "Steel Work" on estimate sheet No. 4, shown in Fig. 20.

Next take the boiler room ceiling, ceiling perhaps 17 x 24 ft., which makes practically 45 sq. yd. Enter this on estimate sheet with description. This brings us down to the balance of the building, which is all one kind of work. To be real accurate in obtaining this part of the survey, take the dimensions of ceiling and walls of each room separately, room by room and floor by floor, to the end, setting down dimensions on your figuring pad and computing into feet and yards, which latter quantity, after subtracting the "outs," we carry to estimate sheet.

Example of Measuring

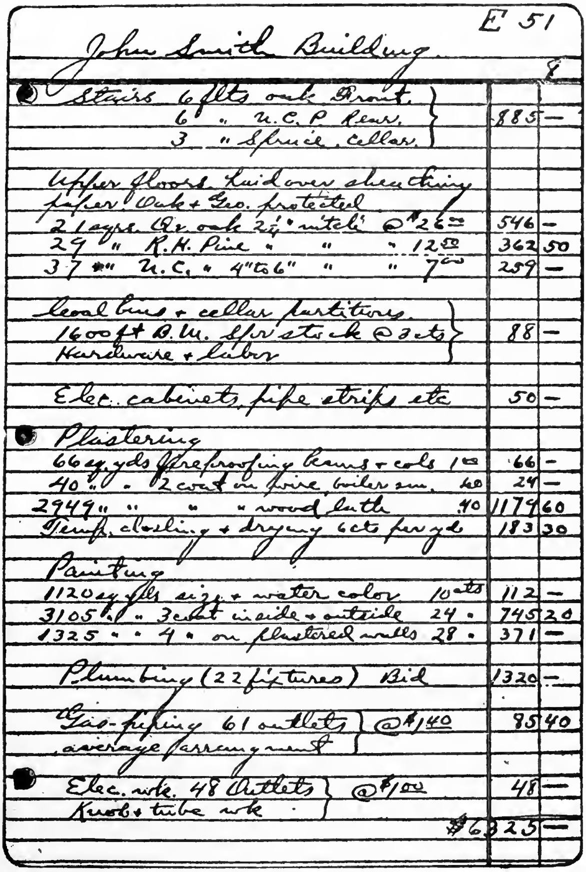
For an example in measuring and setting down the dimensions, assume a room 14 x 16 ft. with a story height of 9 ft.; first scale room both ways and put down ceiling dimension thus: 14 x 16 ft.; then looking at above dimensions compute mentally the perimeter, or outline, of room thus: twice 14 is 28, plus twice 16, which is 32, makes 60 ft.; then under ceiling dimensions enter 9 x 60 ft. for wall dimensions.

Custom with regard to "outs" varies with locality, but in Boston and vicinity plasterers in figuring subtract one-half of the "outs," unless they are of such size as to amount to nearly the whole end of a room, or are of similar proportions. In a building such as the one in hand the only outs will be doors and windows; the average rough door opening will be about 3 x 7 ft., or 21 sq. ft. one side, or 42 sq. ft. two sides; the average window will be about 3 x 5 ft. or 15 sq. ft. In the buildings of this class there are usually about the same number each of doors and windows. Now with the "outs" for doors and windows as assumed above we have 57 sq. ft., total of a door opening (two sides) and a window (one side). This 57 sq. ft. is practically 9 sq. yds., or an average of 3 sq. yds. per door side, or per window side. Then to allow out of the total survey the customary amount, we halve the 3 sq. yds., giving us 1½ sq. yds. per door, or per window, side.

Having obtained the quantity of plastering by measuring each room and computing the dimensions thus obtained into square feet and square yards, no attention, meanwhile, having been paid to doors and windows, we next count the number of doors and multiply by two for the number of "sides," and to this add the number of windows. Thus we obtain the number of "sides" out. Say, for example, that there are 44 doors, two of which are in the outer wall; these would make 86 "sides"; also that there are 42 windows in outside walls that come in plastered compartments; these make 42 more "sides." Thus we have a total of 128 "sides" to allow out at 1½ sq. yds. each, or 192 sq. yds. This quantity we subtract from the whole survey and obtain the number of yards upon which to compute the cost. If there were "outs" other than for doors and windows their dimensions should be set down on figuring pad under this head ("outs") at time of making the room by room survey, and their resulting area in square feet be deducted from the total square feet before reducing to square yards.

Surveying Plastering

All that I have said before in these articles under other heads in regard to figuring in feet and half feet should be applied in surveying plastering. Now that I have shown you how to make an accurate survey of the plastering, which you must admit will


E 51

John Smith Building

	8	
Stairs 6 flts oak Front; 6 " N.C.P. Rear; 3 " Spruce, cellar	885	—
Upper floors laid over sheathing paper Oak + Geo. protected		
21 sqrs. Qr. oak 2¼" match @ $26.00	546	—
29 " R.H. Pine " " " 12.50	362	50
37 " N.C. " 4" to 6" " " 7.00	259	—
Coal bins + cellar partitions; 1600 ft B.M. Spr stock @ 3 cts; Hardware + labor	88	—
Elec. cabinets, pipe strips etc	50	—
Plastering		
66 sq. yds fireproofing beams + cols 1.00	66	—
40 " " 2 coat on wire, boiler rm. .60	24	—
2949 " " " " wood lath .40	1179	60
Temp. closing + drying 6 cts per yd	183	30
Painting		
1120 sq. yds size + water color 10 cts	112	—
3105 " " 3 coat inside + outside 24 "	745	20
1325 " " 4 " on plastered walls 28 "	371	—
Plumbing (22 fixtures) Bid	1320	—
Gas-piping 61 outlets average arrangement @ $1.40	85	40
Elec. wk. 48 outlets Knob + tube wk @ $1.00	48	—
	$6325	—

FIG. 34—ESTIMATE SHEET NO. 8

give you the correct result if the arithmetical operations are correctly performed, I will give you another way to survey the building for plastering that will be nearly as accurate, that you can perform in one-eighth of the time consumed by the first method; neither will it be necessary for you to look at the plan. In making these last two statements I am assuming that you have listed the quantities and areas of materials in the building in the same general way that we have surveyed our hypothetical structure. Taking the building in hand, with materials shown on estimate sheets Nos. 1 to 8, inclusive, and the same plastering specification assumed for the first survey, proceed as follows: Take the fireproofing of beams and columns first. Refer to estimate sheet No. 4, in Fig. 20. Having listed the beams and sets of beams there scheduled under the head of "Steel Work," you will recall, upon looking at same, their location in the building, and how much of them will be exposed and thus require fireproofing. That set of three 15-in. 42-lb. beams 19 ft. 6 in. long you know must be over an opening about 17 ft. wide, because such a set should have bearings on the walls of 14 in. or 15 in. You also know that if bolted close together they would measure about 18 in. from outside to outside of flanges, because the flange on a 15-in. beam is at least 5½ in. So you comprehend in a fraction of the time that I consume in telling you that this set of beams require wiring and plastering of the following dimensions: 15 in. + 15 in. + 18 in. = 48 in. = 4 ft. x 17 ft. long, and you enter these figures on the pad. In this manner you go through the list of steel. Now take estimate sheet No. 5, in Fig. 21, and refer to the list of cast iron, picking out the parts requiring fireproofing, which in this case are the columns. The dimensions for plastering you can read at a glance and immediately enter on the figuring pad, under those for steel. Both items of materials requiring fireproofing having been looked through and the dimensions of quantities obtained, proceed to compute into square yards and enter the number of yards and brief description on estimate sheet No. 8, in Fig. 34, under the head of "Plastering." Now go right through the estimate sheets until you come to the first item that gives you the area of some plastered portion of the building. Begin with the sheet No. 1, in Fig. 17. No dimensions there that indicate plastering. Sheet No. 2; in Fig. 18, an item of 492 sq. yds. of concrete floor is shown. We know that the ceiling is of the same size as the floor, so we have here, all figured into square yards, the area of plastering for basement ceiling. Remembering while on this item that the boiler room ceiling was wire lathing, you probably recall the approximate size of same. If you do not, a reference to sheet No. 1, under the head of "Excavation," may show you the size of the room, measured outside of surrounding walls. You recall that the boiler room was about 3 ft. deeper than the rest of the cellar, and immediately identify the second dimension under "Excavation" as the size of boiler room, measured outside of the walls and their footings; so you shrink the figures about 2 ft. each way and call the size of the boiler room 16 x 22 ft. 6 in. Thus you have the information you were looking for without recourse to the plans, and you can compute it into square yards and carry the number of same, with particulars, to estimate sheet No. 8 in Fig. 34, under "Plastering."

As you have taken the size of the whole basement ceiling from the number of square yards of concrete scheduled, which in this case we are assuming covers the entire floor, the 40 sq. yds. determined upon as the area of the boiler room ceiling must be subtracted from the total of 492 sq. yds., leaving 452 sq. yds. of the two coat on wood lath plastering; this you enter up in the corner of the figuring pad and again refer to estimate sheets for more information as to plastered areas.

On estimate sheet No. 6, in Fig. 22 under head of "studding and furring," we find listed the partition areas. To use these areas for plastering we must double them, for in surveying partitions for studding we measure one side only, whereas they must be plastered both sides; so we take the first three items—2364, 1724, 944—which are square feet of partitions, add them and double them, making 9864 sq. ft. of plastering. This quantity reduced to square yards makes 1096. This we carry to the corner of the figuring pad under the 452 sq. yds. previously set down there.

Looking still further into the schedule of studding and furring, we recognize in the item of 11,232 sq. ft. of $\frac{7}{8}$ in. x 2 in. furring, all of our ceilings—basement excepted—which was lathed directly on the joists, and in the item of 3104 sq. ft. of $\frac{7}{8}$ in. x 3 in., the furring of the exterior brick walls, where plastered. Then the total of these two divided by 9, which makes

1593, are the number of square yards of plastering in ceilings and outside walls. This quantity set down on figuring pad under the other two items, and the three added, gives us a total of 3141 sq. yds.

Drying the Plastering

Next we must find the "outs," so we look along through the estimate sheets until we come to the doors and windows on sheet No. 7, in Fig. 33. Here we find 42 windows, 4 entrance and vestibule doors and 40 inside doors. Assuming that there are two entrance doors, which would be in outside walls and two vestibule doors, which would come in partitions, we figure up the number of sides as follows:

42 windows	42 sides
2 outside doors	2 sides
2 vestibule doors	4 sides
40 inside doors	80 sides
Total	128 sides

Allowing out $1\frac{1}{2}$ sq. yds. per side, we have 192 sq. yds. to deduct from our total yards, which was 3141, making 2949 sq. yds. This quantity we carry to estimate sheet 8, in Fig. 34, under head of "Plastering," and later carry out a price on same. Thus you see it is possible to make a reasonably accurate estimate of plastering from data taken from the estimate sheets, if quantities of materials have been entered as I have suggested.

Under the head of "Plastering" the specifications often call for the temporary closing of the building, also make provision for drying the plaster. The cost of these items is largely a matter of judgment, especially as regards drying. Temporary closing is usually a matter of supplying and installing screens, of cotton cloth on frames of furring, in all window openings, and the making and hanging of batten doors of coarse materials to exterior door openings. Knowing the number and approximate size of windows and outside door openings, you should be able to analyze and determine the cost of same, without any special instructions. To determine the cost of drying plastering you must take into account the size of the job, the length of time required to perform same, the price of coal, the method of drying, whether with the regularly installed heating apparatus or with salamanders, and the probable amount of attendance required. Some plasterers of my acquaintance have reduced the cost of drying to a price per yard (of plastering) basis by keeping a careful account of the total cost of drying on a number of jobs, finding the cost per yard on each job and thus obtaining an average. One plastering contractor of large experience in Boston is figuring the cost of drying at 6 cents per yard for work done in cold weather. Of course work done in late spring, summer and early fall can be dried out for less per yard than this, as Nature lends her assistance to the task.

CHAPTER XIX

Painting

I have discussed the subject of estimating painting with a great many contracting painters, and I find there is a great variation in methods of arriving at probable costs. In one particular only do I find them practically unanimous, and that is that the unit of measure is a square yard. The cost per square yard is determined by the number of coats to be applied. In Boston the generally accepted price per coat per square yard is eight cents ($.08). This of course is for plain work: either painting, filling, shellacing, varnishing, staining, etc. Washing old work preparatory to painting and rubbing down between coats, if thoroughly done in each case, are each usually considered to be worth as much as one coat of paint, thus being worth 8 cents per yard.

Such work as elaborate cornices and other complicated outside finish can hardly be considered on the above basis, and I find that the painters when estimating compensate for extra work at these points by doubling, tripling, etc., the yards of surface, being governed in doing so wholly by their judgment. Thus, if a building wall was 20 ft. high from underpinning to the first member of the cornice, and the cornice was quite elaborate and had a profile of about 4 ft., the painter, instead of figuring the wall 24 ft. high, would double the 4 ft., to compensate for the extra labor involved and figure wall 28 ft. high. He would then multiply by the distance around the structure and reduce to square yards and set the price according to the number of coats to be applied. If this cornice was painted in several colors, he would probably triple or quadruple the 4 ft., according to his judgment. The balustrades, columns, belts, etc., would be treated in a similar manner to the cornice, their complexity and the number of colors being the governing factors as to the amount the actual surface should be increased to compensate for increased labor required.

In speaking above of a wall 20 ft. high I am assuming a plain or flat surface wall. In the case of a clapboarded wall the custom is to increase the height one eighth, to cover the butts of the clapboards. If the wall is of shingles (painted, not stained), or of brick, the height is increased one-fourth. The reason for this larger increase in the case of shingles or brick is because of the fact that walls of these materials are quite rough, and much more brush work, as well as more paint, is required to coat them.

In measuring a wall surface no attention is paid to windows, the wall being considered solid. The windows are then measured over-all, outside of casings, and this surface doubled. Thus a window that measured 4 x 6 ft. out to out of casings would be worked out as follows: (4 x 6 ft. x 2) $\div$ 9 = 5⅓ sq. yd., or practically 5 sq. yd. As it is almost the invariable custom to draw the sash in a different color from the casings, stool and cap, the doubling of the surface is to compensate for extra time involved in cutting in the two colors. You can readily see that if the sash and casings were all one color that a painter could paint both frame and sash in about the same time that it would require to paint each if colors were different. If the windows have blinds they would be figured from $.75 to $1 each pair, according to size and number of coats. Four-fold blinds for one window opening would be counted as two pairs. Except in the case of very large or very small blinds, the size makes so little difference in labor, and still less in quantity of paint, that it is not customary or necessary to take the size into account.

In measuring shingled walls or roofs that are stained (brush coated, not dipped) the surface would be taken as explained above for painting. But as the cost of stain necessary to coat a given surface, also the labor of applying it, is somewhat less than paint, the cost per yard, per coat, is figured less. The customary price per yard for stain as above is about 7 cents per coat.

In figuring plastered walls which are painted, measure the total height from floor to ceiling, not taking out for base and moulding, chair rail and picture moulding. The extra labor cutting up to these parts as a rule involves more time than the painting of the surface under them would consume.

If walls are sized this would count as one coat. If walls were somewhat more than the usual height, thus requiring more than ordinary staging and climbing, the cost per yard must be increased to cover them. This is one of the cases where your judgment will come into play.

In measuring walls no attention is paid to windows or doors. The same rule used for measuring the outside of the windows is applied to the inside of them and also to doors. As doors and windows are generally of about the same size in most buildings many painters in surveying plans, call each side of a window or door 5 yd., and each side of a door with transom 6 yd. of surface, price per yard of course being based on the number of coats.

Either a base and moulding, chair rail or picture moulding is figured 1 ft. wide, the running feet being surveyed and then reduced to square yards. A sheathed dado would be figured into actual surface, the length being multiplied by the height and the square feet thus obtained reduced to yards. In the case of ordinary paneled dado the height would be figured double; and if there were raised panels, carved mouldings, etc., triple or quadruple or even more as judgment dictated.

Pantries, china closets, linen closets, store cases, counters, etc., can usually be worked out in surface yards, following the rule for increasing surface as given above for dado work.

Stairs, elevator fronts, grilles, enriched wood or plaster work are wholly matters of judgment rather than yards of surface.

In figuring tinting of walls and ceilings with water colors, cold water paint, or the various prepared substances of a similar nature, proceed to survey surfaces as above outlined for plastered walls. If plastering is first sized this is taken into account in making the price per yard. Sizing for this kind of work is worth less per yard than for lead and oil painted work, as it is mixed and applied thinner, thus taking less stock and labor. Ceilings and walls of stores, offices or other similar apartments, are usually conceded to be worth from 8 to 10 cents per yard for one coat size and one coat water color. Rooms in dwellings are usually figured somewhat more, running from 10 to 20 cents per yard.

If stories are of unusual height, thus requiring more staging and climbing, the costs or areas must be increased to compensate for the extra labor required. The costs for all substances similar to water colors are about the same as above quoted.

The total cost of any job of painting divides about as follows: 75 per cent. labor and 25 per cent. stock. So you can see that the estimating of costs for this work is more a matter of judgment than actual surface to be coated. By a reasonably close adherence to the above rules one should be able to make a sufficiently accurate estimate of the cost of a job of painting to use in making bids upon a whole structure. When the work is quite complicated you will do better to call in a painter and get bona fide bids.

CHAPTER XX

Plumbing, Gas-Piping, Electric Work, Heating

The plumbing of most buildings is of such a character that in order to get anything like an accurate cost one must call in a contracting plumber and get a figure; or, better still, call in several plumbers, and use the bid of the one who submits the lowest price.

There will be times, however, when the plumbing is quite simple, and so nearly like jobs that you have done in the number, arrangement and quality of fixtures, that you can judge quite closely of the cost. When such is the case and you feel that the job you are figuring is not going to be figured down to the danger point by your competitors, it may be safe for you to use your judgment and make a price yourself. In order to school your judgment on plumbing costs it is a good plan to count, and make note of, the number of fixtures in the building, and then when you have received your bids from plumbers and chosen the one you will use in making up your figure, you can work out the cost per fixture for this job. If this is done on every job you figure or do you will soon have quite a line on the plumbing costs, and as above suggested there will be jobs figuring from time to time that will compare favorably with these first mentioned ones, and then you can make a reasonably close and safe figure yourself. In enumerating fixtures, count one for each of the following: watercloset, bathtub, lavatory, sink, kitchen boiler, set of trays, each urinal in a range of urinals, large house tank, large brick set grease trap, etc.

Gas Piping

In the average run of work the cost per outlet is standard in each locality. Knowing the standard price per outlet, figuring the cost of installing the system of piping then becomes simply a matter of counting the outlets and multiplying by the cost in your locality. Your own judgment will tell you that if the outlets are very much spread out more piping must be run in order to install the system than if of about the average distance apart and arrangement. This state of affairs will of course increase the price per outlet. The same rule carried to the opposite extreme will reverse the matter, making less piping to install a given number of outlets, thus making cost per outlet less.

By counting and entering on the estimate sheet the number of outlets, and then looking over the arrangement of them on the plans, you can readily judge about what proportion to increase or decrease your standard "outlet price" for the job in hand. As the gas-piping is usually such a very small percentage of the whole work a little difference in cost, either way, will have but a very slight effect upon your total figure for the work. When you actually let the piping job take note of the price per outlet and thus check and cultivate your judgment.

Electric Light Wiring

Practically all that I have said in regard to gas piping applies to electric light wiring. There are two classes of light wiring: one called conduit work, which consists of a system of tubes or pipes similar to gas piping, running to all outlets and switches and arranged in such a way that all circuits can be made and into which the wires are drawn by means of a long flexible piece of steel called a snake.

The other system is called knob and tube work, the wires being run on earthenware knobs, and where passing through joists or studs, through short sections of earthenware tubes.

For each class of wiring there is about a standard price per outlet for the general run of work, and by posting yourself on these prices you can make fairly close estimates. If the work is of a complicated character it will be wiser and safer to have sub-bids from electrical contractors, using in your estimate the lowest figure.

If, when estimating a job, you will count the outlets and then work out the price per outlet from your lowest sub-bid, you can obtain information in regard to costs for future use.

Heating

Estimating the cost of heating a building with any degree of accuracy is very difficult except to a trained heating man, and unless the job in hand compares in size, system and general conditions for performing work, with some plant you have recently had installed, it is safer to call a heating contractor and have sub-bids for the work, using, in making up your figures, the lowest bid received, if from responsible parties. There will be times, however, when the plant is so decidedly like something you have done before that you can note any minor changes that would increase or decrease the cost, and use your judgment as to the probable change in price on account of the differences.

Most contracts made with general contractors to-day are exclusive of plumbing, heating and electric work, so you will seldom be called upon to figure these parts of a building. Notwithstanding this you will be wise to make notes as to the quantity and quality of each of the parts of the work and if possible find out what they are costing. The information thus obtained will be of great help to you in judging costs or letting contracts for these parts of a building.

Having now considered all of the various items going to make up the average building we next take up matters that are not often mentioned in the specifications, but, nevertheless, just as necessary to consider, as they add to the cost of the whole work.

CHAPTER XXI

Miscellaneous Expenses, Lockers, Profits, Etc.

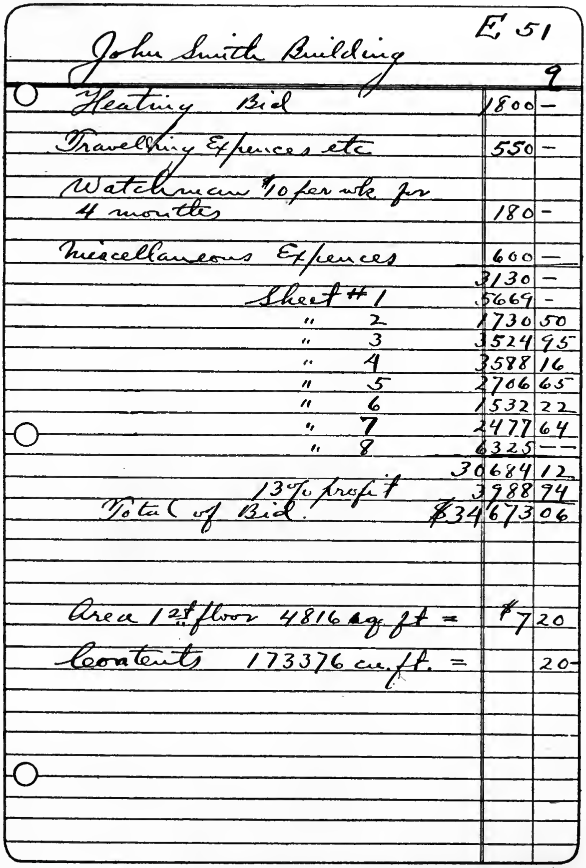
In the very first part of this article I suggested visiting the site for the purpose of seeing under what conditions you would be compelled to work. Having done this you found out the cost of making a round trip, also cost of board and lodging in the vicinity and other similar details. Now make up your mind how long the work will take; how many times you or your superintendent will probably have to visit the job while the work is being put through; how many mechanics you will send whose fare and board you will have to pay, and any other minor items of cost of a similar nature you will be put to on account of the work. Compute these estimated costs and enter upon your estimate sheet under the head of expense.

Watchman

If you are going to employ a watchman figure up his wages for the length of time you expect to keep him, making this an item on estimate sheet, as shown in Fig. 35.

Sundry Expenses

On a job of any size there are a number of little items of cost, each in itself quite small, but in the aggregate sometimes totaling quite a sum. Among them are such items as follows: building plan and tool lockers and sheds to protect materials; fences, walks or barricades over dangerous places to provide for public travel, or your own convenience in handling the work or protecting your help; cleaning up and carting away debris, resulting from building operations, from time to time; protection of trees, shrubbery, lawns, walks, etc.; sanitary provision for the workmen; water for building purposes; final cleaning of building, washing windows, etc.; telephone connections; insurance and bond; and so on indefinitely. On a building we recently constructed, costing about $160,000, I found upon tabulating the cost of the above items that they amounted to nearly 2 per cent. of the total cost of the work. Thus you see that it is wise to consider these items collectively, or in some cases individually, en-



John Smith Building	E 51	
	9	
Heating Bid	1800	—
Travelling Expences etc	550	—
Watchman $10 per wk for 4 months	180	—
Miscellaneous Expences	600	—
	3130	—
Sheet #1	5669	-
" 2	1730	50
" 3	3524	95
" 4	3598	16
" 5	2706	65
" 6	1532	22
" 7	2477	64
" 8	6325	--
	30684	12
13% profit	3988	94
Total of Bid	$34673	06
Area 1st floor 4816 sq. ft =	$7	20
Contents 173376 cu. ft. =		20-

FIG. 35—ESTIMATE SHEET No. 9

tering upon your estimate sheet their probable cost. In determining this amount you will have to be governed largely by your judgment, based on previous experience. By taking these items one by one and judging the cost of each, then adding for a total, you will be apt to arrive at a probable cost much more accurately than by lumping them. Keep the cost of these items on the next job you do and you will be surprised at the amount of money they will run into, on a job of any size.

Total Cost

Now, having considered all the items going to make up the completed structure found in the specifications and some that are not mentioned, but just as necessary to a complete execution of the work within the meaning of the said specifications, plans and contract, we now bring the total of each sheet to the last one, setting them down in their order, and adding for the total estimated cost. This we find to be $30,684.12.

Profit

If you expect to remain long in business you must have profits. Just how much this should be, you are your own best judge. If you are doing business in a small way, are your own foreman and have no office to maintain, bookkeeper to pay, or other kindred expenses, the amount you add to the estimated cost will represent nearly net profit; assuming, of course, that your estimate has been carefully made and that you can make it work out substantially as you have figured.

If you have to maintain offices, superintendent, bookkeeper, stenographer, telephone, team, etc., you have a certain fixed expense per year which you can readily total up. Now this can be figured to a percentage of the total business you can, or do, handle per year. Having ascertained this percentage you must take it into account in putting profit on the job. For instance, if you want to make a net profit of 10 per cent. on the job upon which you are bidding and you find that the office expense averages about 3 per cent., your gross profit should be 13 per cent.; so we add 13 per cent. to the total estimated cost, making the bid for the work $34,673. Our own experience has been that the fixed expenses of doing business, on a basis of our doing about $250,000 per year, are about 3 per cent. This includes a fixed salary for each partner per year and all expenses connected with running the office, shop and yard, etc. In talking with other contractors I find that they have fixed expenses from the above to as high as 7 or 8 per cent. Success in doing business in the contracting lines in a great measure depends upon holding down the fixed expenses, or, in other words, doing the maximum of business with the minimum of expense.

Area and Contents of Building

Now that our building is all figured up it is an excellent plan to make note of the area and cubical contents of the building and to figure out, from the estimated cost, the cost per square and per cubic foot.

In order to have the information thus obtained of any value to you, the method of measuring every job must be as nearly uniform as possible. There cannot be much chance for a lack of uniformity in obtaining areas, but there are great chances in computing cubical contents. I will give you my methods for computing these quantities and trust that they may be of value to you.

Areas

Compute the area of the first floor from outside to outside of walls; if the building is irregular in shape divide by imaginary lines into squares, rectangles, triangles, etc., and compute each division and add for total area. In the case of a dwelling or similar structure with piazzas, measure same and add to area of main building one-half of their area. If the second story overhangs the whole or any part of piazzas, treat that particular part same as main house, adding full area to first floor area. Porches, piazzas without roofs, unless quite extensive, bulkheads, etc., take no notice of.

Enter the area obtained on the estimate sheet. Now divide the amount of estimate, as completed, by the number of square feet, thus obtaining the price per square foot which the building in hand figures. In this case it is practically $7.20.

To obtain the cubic contents multiply the area obtained for the first floor, exclusive of the piazzas, by the height of the building, taken from the bottom of the footings to the average height of the roof. Multiply the area of the piazzas by their height taken from the bottom of the piers, or other foundation, to the average height of their roofs; in case of a flat roof surmounted by a balustrade, take height to the top of balustrade. In case of an uncovered piazza or platform take height from bottom of piers to floor of platform, or top of balustrade if there is one. In a similar manner cube all principal flights of outside steps, bulkheads, etc.

Now add all the cubic contents thus obtained together for the total, entering said total contents on estimate sheet.

Having done this compute from the estimated cost the cost per cubic foot. With the contents assumed for the building we are dealing with, the cost is practically 20 cents per cubic foot, as shown in Fig. 35.

If you will take the trouble to always work out the square and cubic foot costs on every building you figure or build you will find that the information thus obtained will be of great value to you, especially in approximating the cost of prospective buildings for owners or architects.

If you have several hundred estimates to look back to you can always find several that compare favorably with the building you want to approximate, thus having a price at hand to use for such figuring. You can also check your detailed estimate to some extent by the cubic foot price. For instance, if you were to figure a similar building to the one we have just been through together a month from now, when there has been no material change in price of stock and labor, and upon working out a cubic foot price it came out, say, 13½ cents, you should go over your figures again to see if there has not been an error made in some computation; or addition of a column of costs; or some important item omitted. Failing to find any errors, analyze the two estimates side by side and account for any such difference in costs. If there is any such difference in cost there are reasons for it and they can usually be found, if carefully looked for. You will be surprised to find how near the costs per cubic foot will run on similar buildings.

CHAPTER XXII

Examples of Making Approximate Costs

As an example of short methods for determining approximate costs, I will give in detail my answer to a correspondent who wanted information in regard to a building 40 x 70 ft. and about 20 ft. high, structure to be of cheap construction, roof flat, finish plain, etc., same to be built for some summer amusement enterprise.

At first glance I should say in reply to his request that such a building was worth about \$.02½ per cubic foot. The cubic feet may be computed by multiplying the size of the building as given, 40 x 70 ft., by the height of structure from grade to the average height of the roof. Assuming the structure to be built upon posts 7 or 8 ft. apart, the bottom of sill to be about 1 ft. from grade, the roof to have a pitch of ½ in. to 1 ft., the ridge running parallel with the length of the building and the building being 20 ft. high from bottom of sills to extreme height of roof, there is a total height—grade to average height of roof—of practically 20 ft. Thus 40 x 70 x 20 ft. gives the number of cubic feet in building, making 56,000 cu. ft., which at \$.02½ per foot makes \$1400. In this manner an approximate cost is arrived at quickly, but you must be in possession of cubic foot costs that have been worked out in other structures in order to determine about what price to use.

Now to analyze this building for approximate cost a little more thoroughly and thus see how near the mark we come when assuming a cost of \$.02½ per foot let me demonstrate another short cut in estimating.

I will assume a foundation of posts about 8 ft. apart, set about 3 ft. 6 in. in the ground around the entire outline of the building; also two rows of posts, same spacing, the length of the building, for girders under floor joists. This would make 60 posts, which, set in place and cut off to receive sills and girders, would be worth at least \$1 each, making \$60.

Next there is a floor area of 2800 sq. ft. Joists could not be much less than 2 x 8 in. placed 20 in. on centers, and if of this size and spacing each square foot of floor area would require $\frac{4}{5}$ ft. B. M. of frame. In order to cover sills, girders and waste, I call it $1\frac{1}{4}$ ft. B. M. per square foot of floor. Now work out a cost per square foot for first floor complete, thus:

Frame: 1¼ ft. B. M. in place	$.0375
Under floor: cheap sq. edged stock, ⅛ waste, 1⅛ ft. B. M.	.028
Upper floor: No. 1 maple or A Rift Ala. pine, ⅓ waste, 1⅓ ft. B. M.	.073
Total approximate cost per sq. ft. of floor	$.1385

This comes out so near to $.14 per square foot that I figure the 2800 sq. ft. at that price, making $392.

Now I take the outside walls. The perimeter of the building is 220 ft. This multiplied by the height, which averages about 19 ft. 6 in., gives us the area of the walls, same being about 4290 sq. ft. I will assume 2 x 4 studding 20 in. on centers covered with some form of siding, and work out a price per square foot as follows:

2 x 4 in., 20 in. o. c. = $\frac{2}{5}$ ft. B. M. to each square foot of wall.

Allowing something for waste, call it ½ ft. B. M. per foot, costing in place	$.02
1 sq. ft. siding, plus ¼ waste = 1¼ ft. B. M. per sq. ft. of wall. Same of coarse pine or cypress, $.04 per ft. in place	.05
Total approximate cost per sq. ft. of walls	$.07

4290 sq. ft. at $.07 per square foot makes $300.30.

I now take up the cost of the roof, assuming that there is a 40-ft. span, which will require either trusses or columns and girders to support same. I will call the rafters 2 x 6 in., 18 in. on centers, which equals $\frac{2}{3}$ ft. B. M. of frame per square foot of roof. Without going into a lot of figuring to determine accurately how much lumber would be required for trusses, I assume a quantity equal to that already figured out for rafters, thus making each square foot of roof take $1\frac{1}{3}$ ft. B. M. net of frame. Add something to this for waste and call it $1\frac{1}{2}$ ft. B. M., and work out a cost per square foot of roof.

1½ ft. B. M. frame, in place	$.045
1¼ ft. B. M. ⅞-in. match spruce or hemlock covering (waste allowed) per sq. ft. of roof, in place	.0325
1 sq. ft. ready roofing, in place	.03
Total approximate cost per sq. ft. of roof	$.1075

Allowing for slight overhang of roof I call area of it 2900 sq. ft., which at $.1075 per foot makes $311.75.

I next consider the doors and windows. Six windows complete I figure as worth about $5 apiece, not stopping to go into an analysis of the cost, knowing without doing so that anything in the shape of a double hung window of average size is worth at least that amount. This makes $30 for windows. There are to be three doors, and these I figure at $8 each, complete, making $24. Now I allow something, say $40, for such outside finish as would be required, and the whole ground, except painting, is covered with sufficient accuracy for an approximate cost.

Assuming that walls would have two coats of paint outside and that there would be some little painting inside about doors and windows, I refer to my wall area (4290 sq. ft.) and immediately call this 500 sq. yd., which at $.12 per yard for two coats of cheap paint makes the cost of painting $60. Thus I have as costs:

60 posts set complete	$ 60.00
2,800 sq. ft. first floor, complete	392.00
4,290 sq. ft. walls, complete	300.30
2,900 sq. ft. roof complete	311.75
6 windows, complete	30.00
3 doors, complete	24.00
Outside finish, etc.	40.00
Painting	60.00
Total	$1,218.05

To this total must be added something to cover overhead expenses and for profit, and I should consider 10 per cent. little enough, so I add $121.80 to the approximate net cost of $1218.05, making $1339.85. Having arrived at this last amount as representing the cost of the structure plus a fair profit, I would be prepared to tell a prospective owner or architect that a building of this character and size could be built from $1200 to $1400, the exact price depending upon circumstances of site, size and spacing of timber, quality of materials used, etc., and the amount of profit a contractor happened to want at the time of figuring.

Since writing the above I have looked back in my estimates for something similar in the way of a building and found my estimate made in April, 1907, for a structure of the same character, which we built in Wonderland Park, Revere, Mass. This building was 30 x 98 ft., and practically 23 ft. high, and on the basis of our bid figured out \$.02¾ per cubic ft. The building was erected upon 12 to 14 ft. spruce piles, driven into the marsh by a hand machine, and the façade was quite ornamental. Otherwise, the similarity between the two buildings is very marked, if I draw correct inferences from the correspondent's description of his proposed structure. Our price as above gave us a reasonable profit.

I have taken some time and used a good many words in describing this method of making an approximate figure, but I made the actual computation in about 6 minutes before starting to explain them, and if the correspondent is half a mathematician he can do likewise.

PART V

Estimating the Cost of Building Alterations

CHAPTER XXIII

Razing, Shoring and Temporary Protection

In the preceding chapters on the subject of estimating I assumed a new building for the purpose of illustration. I think I made it plain, although I do not recall having expressed it in so many words, that I do not consider the estimating of costs of buildings an exact science. While results are reached, as a rule, by various mathematical processes, the element of judgment enters so largely into each and every item, especially in methods of measuring plans for quantities, allowances for waste and determining cost of labor, that on the whole such estimating may be considered more as an art than a science.

I doubt if it will be questioned that determining the probable cost of alterations and remodeling operations requires the exercise of even greater judgment than new work. Nearly all that I wrote on the main subject in the preceding chapters can be applied in a measure to the work now in hand, and in the matter to follow I will try and bring out details of the subject especially applicable to alteration work.

In the first place, have a method or system and stick as close to it as circumstances will permit. My former chapters suggested taking up the items in the order in which they appear in the specifications, not forgetting meanwhile some matters seldom or never mentioned there. In case there are no specifications take up the items in the logical order in which the work would be done.

Before beginning to figure at all you should visit the building which it is proposed to alter and carefully note existing conditions. This is an absolute necessity, as, at best, it is difficult to make plans for an alteration show with accuracy just what is to be done. The plans usually make plain enough the end sought, but you must see the building to determine with any accuracy the cost of accomplishing it.

It is very important to know whether you are going to have a vacated building or must do the work in such a manner that the business of all occupants can be carried on. If the latter is the case you must find out about how much room you will have given you at a time in which to work, and what measures for the protection of occupants' stocks must be taken.

These two questions settled, you can see what advantages or disadvantages you will have to work under. It is highly probable that some work will have to be done overtime. At "double time" and by artificial light, construction work of all kinds is most expensive—so expensive, in fact, as to be prohibitive at times.

The loose-leaf book sheets described and used in my former chapters are perfectly adaptable for the present case, and as the carrying of quantities to the same was sufficiently described there, I will not use them in this case, but stick wholly to text.

Razing

This is the first and usually a very important item. Generally there is a little of everything to pull down and get into shape to be used over again or be carted away. By taking each part separately; such as stone work, brick work, plastering, frame, etc., and analyzing it to determine the probable amount of labor involved, and adding for a total, a much closer and more accurate estimate will be made than if you try to consider them collectively.

Bear in mind while making this analysis, that such of the razed materials as are to be removed must be brought out to some place accessible to the teams. In some cases this involves considerable handling under adverse circumstances. In any case the probable cost is a matter of judgment rather than mathematics. Where materials are to be used over again it is unwise to make any allowance for them unless there are large quantities in excellent shape. There are any number of little items and wholly unforeseen circumstances that develop in an alteration job, and the salvage on materials is needed to offset them.

Shoring

As the work of razing progresses many existing parts that are to be retained must be shored. As most of the material used in shoring is heavy timber or old steel beams kept in stock for the purpose, the cost of this part of the work is practically all labor and teaming. By making a mental survey of about the quantity of material required one may judge of the teaming to and from the job. Now by taking each separate wall, floor or other part to be shored, and mentally analyzing, we are able to determine the probable labor required to place shores and remove them when other, or permanent, support has been installed. Labor of cutting needle holes in brick or stone, or slots in masonry walls, holes through floors of frame or other construction, must be foreseen and taken into account.

It may be possible to do all shoring on a large job without a great quantity of timber and iron if the work is arranged in such a way as to permit of certain parts being shored and secured and then the material may be used over several times. This saves considerable in teaming, but it must be a matter of judgment with you whether to resort to this saving or not, as it may involve other expenditures that would soon more than offset any saving made. In the large cities where numbers of difficult and extensive jobs of shoring are done every year there are contractors who make a specialty of this work, and there will be cases when it will be advisable for you to take sub-bids and sublet such work to one of these men.

Temporary Partitions

These are usually made of matched stock $\frac{7}{8}$ in. thick. In cases where extreme precautions must be taken against dust it is customary to paste paper on the exposed side. I have found that the cheapest way to paper partitions if there is much area, is to have a paper hanger do the work, using wall paper that can be found in any wall paper store, that is out of style, and can be purchased for 2 or 3 cents per roll. This should be put on with the face of paper toward boards, thus leaving the plain color of back in sight, and two thicknesses should be applied, otherwise the boards will season enough in a few days to break the paper at each joint. By assuming imaginary lines on your plan in the various places where you have concluded that these partitions will have to be erected, it is a simple matter to obtain areas and quantity of stock required.

CHAPTER XXIV

Masonry, Iron and Steel, Roof and Metal Work

Most excavation in alteration work has to be done under very adverse conditions, and the labor involved to get excavated material to the street or to the teams must be taken into account. As the conditions are seldom twice alike the cost is all a matter of judgment. You must frequently excavate considerably more than strictly implied by the plans, in order to make room in which to handle materials or to give the men a chance to work. After listing on the estimate sheet the dimensions of the several excavations you must mentally average the conditions and determine upon a price per cubic yard, or other unit, including the disposition of the material, on the premises or elsewhere. Under conditions frequently occurring in our city (Boston) the cost, including teaming away, will be as high as $2 per cubic yard.

Concrete Foundation Work

It is generally easy to locate on the plan the new foundations, and there should be sections showing thicknesses and other particulars. If no sections are shown you must use your judgment and take the chances. I am sorry to say that the larger part of our architects give very meager sections, either from their inability to foresee conditions or unwillingness to spend the time and money necessary to have test pits dug side of existing foundations, so that it may be known to a certainty what conditions exist. There is no difference in the method of taking off quantities or entering dimensions on the estimate sheet than would be the case in a new building. There may be, however, and there usually is, a great difference in the cost, and practically all of it comes in the labor. Frequently the concrete must be mixed in an alley or a distant part of the cellar, then carried in pails or mortar hods to the location of the work and be deposited in shovelsful. These conditions, coupled with the fact that there is seldom much in bulk in a place, and many places, make the cost run from $8 to $15 per cubic yard for the ordinary mixtures. Pick out what seems to be an average piece of foundation and picture yourself there with the help and putting it in. Arriving at what you consider a fair estimate of the labor, figure out what it would be per cubic yard for the number of yards in the piece of your foundation used for the experiment, and you have a fairly accurate cost per yard for labor, to which you can add costs of materials, which latter would be as usual in any work, old or new, thus obtaining a price per yard to use for the whole quantity.

All my explanations above for concrete apply fully to foundations of other materials. The price might be different on account of local conditions, but the method of arriving at a cost would be the same as for concrete.

Concrete Floors

Areas of new concrete floors would differ in no way but price (and this all on the labor) from new work. In making good existing floors, where they have been broken out to get in new foundations, pipe trenches, etc., do not measure or assume too small an area. Nine times out of ten, unless you are there yourself, about twice as much as was necessary will be broken out. This statement about cutting out to admit of the installation of new parts holds good on more than this one item. In fact, it must be borne constantly in mind when figuring an alteration of any kind. In making price of concrete floors picture to yourself the disadvantages under which the particular job in hand will have to be done and be governed accordingly.

Brick Work

The brick work found in the usual alteration job would not be altogether unlike that in a new building. The only difference that amounts to anything is that instead of the continuous and connected walls, there are detached walls, parts of walls, openings made or filled up, etc. The work being thus disconnected and scattered, will cost a great deal more for labor than would be the case under normal conditions. In making a survey of the number of brick required it is seldom advisable to take into account any old brick taken out, as the cleaning and care of these latter until such time as they can be used, usually costs as much as new brick delivered when and where wanted. Quantities should be entered on your estimate sheet the same as demonstrated for new brick work (see estimate sheets in preceding chapters). In taking off quantities I always disregard all openings cut in existing brick work for doors, windows, etc., and immediately after making brick survey, count and enter on estimate sheet the number of these openings, noting the average size of same and thickness of walls in which they occur.

In making a price per 1000, laid, proceed the same as for new brick work, taking care to fully consider the question of labor before assuming the probable cost. In my judgment a first-class mason will only be able to lay one-half as many brick per day as on new work, on account of the usual peculiar disadvantages attending alteration work. Now consider the openings to be cut in walls: The cost in this case is probably from 90 to 95 per cent. labor, so that in most cases you can consider it purely a labor item. Picture yourself cutting the average opening and toothing and bricking up the new jambs. Having determined to your own satisfaction how long it would take, figure the cost of labor involved, not forgetting before carrying said cost to the estimate sheet, that you are not going to cut these holes yourself, but that some man in your employ about half as interested to see it done as you are, will do the work, and adjust the supposed cost accordingly.

The item of washing and pointing will invariably cost more than on new work of equal area. This work, in either case being almost wholly a matter of judgment as well as labor, must be analyzed as such and in the same manner as in Chapter IX.

Cut Stone

The only difference in cost of cut stone of any kind, or ornamental terra cotta, would be the additional labor involved in setting it under adverse conditions, and with little or no rigging in many cases. Being wholly a matter of judgment, you can see the great benefit of having some reliable data at hand from which to draw conclusions. Otherwise the estimate for cost is a guess, pure and simple.

I do not know of anything I can say in regard to terra cotta floor arches and partition blocks, or reinforced concrete floors, other than that you must fully consider the labor cost per unit of each of the above items, and make it sufficient to cover the cost on the particular job in hand, considering all of the surrounding conditions tending to make whole more expensive.

Iron and Steel

The process of taking quantities from plans would be no different than in the case of new work, except that, as generally drawn, plans for alterations are apt to be somewhat vague, and the architect, to protect himself and the owner, embodies clauses in the specifications that compel the builder to "supply all needed materials whether shown or specified" to accomplish the desired result. While this is decidedly wrong, there seems to be no immediate help for contractors, on account of the general lack of organization among them. This makes it necessary for the builder, when estimating, to foresee the possible wants of the job beyond that shown and listed, and figure upon them. Having found and listed all of the iron and steel shown and "implied," compute into pounds and set a price. The cost of setting will usually be as much as double that of new work for reasons before stated, and not infrequently the handling and setting will cost as much as the material itself.

We recently had occasion to set eight 2-ton girders and six 1-ton columns all built up of structural shapes and costing $70 per ton delivered, where the cost of erection exceeded the cost of material, being about $75 per ton. These girders went into the ceiling and the columns extended through the first floor to the foundations in the cellar, in a large and busy jewelry store, where business was never suspended for a moment during the operation. All handling was done with hand rigging, and everything was taken into the second-story windows and lowered into place, preparations having been made for this by building tunnels on the store ceiling—which fortunately was quite high—for the girders and boxes about 4 ft. square through the store in which to lower and set the columns. While circumstances are seldom as adverse as this, they are usually of such a nature as to require the exercise of fine judgment to arrive at a safe probable cost for labor.

Roofing and Metal Work—Marble and Mosaic Work

Roofing and metal work, and marble and mosaic work, are subject to the same changes in price as most other items entering into alterations, but, as a rule, the increase is not so marked. There would be no material change in method of listing quantities, but care must be used where old and new work join, to figure enough material. There will be cases where it will be cheaper to tear away and dispose of existing work and supply new than to retain same, even though the plans and specifications permit of said retention. A little analysis of questionable parts should determine for you the better course to pursue in estimating.

CHAPTER XXV

Carpenter Work, Plastering, Painting, Plumbing, Etc.

In alteration work that is not too extensive I should make one item of frame, boards and furring, entering on estimate sheet the quantities of each item, care being taken to extend your measurements sufficiently to care for all razing of existing parts thought probable or possible. Compute into feet, B. M., and add for a total and determine upon a price for labor of installation. Having settled this latter, compute total price per "unit" (1000 ft., B. M.) labor and stock and carry out this price.

Materials resulting from the razing of parts of the work and stock bought and used for staging, temporary partitions, may frequently be used, but old and second-hand materials always involve more labor, and to hold same on premises and care for them until such times as they can be used costs money. In nine cases out of ten it is wiser to make no allowance for such materials. My advice would be to consider carefully before allowing anything for salvage on old materials of any kind resulting from the work of alteration.

Outside and Inside Finish

The method of obtaining quantities, also the classification for all work coming under the above head, would be practically the same as for new work. The principal point to keep constantly in mind is to make ample allowance in measurements where old and new parts join. It must also be borne in mind that it usually costs more, both in labor and stock, per unit to match old work than to carry it out entirely new.

The above remarks regarding "outside finish" apply fully to all inside finish. See Chapters XVI and XVII, treating the same items in new work.

Plastering

If an alteration is at all extensive there will be very little plastering left, except in parts of the building that are practically unchanged. There is hardly an item in the building where the increase in cost per unit is as great on diminishing quantities. For instance, in an ordinary case of new work of reasonable extent, we would figure 40 cents per yard for two-coat work on wood laths. If we were going to put a new ceiling on a room of ordinary size in an unoccupied house, say, 25 sq. yd. area, the actual cost would surely be in the vicinity of $25, or $1 per square yard. If we were to go into an occupied house or place of business to put on a patch of a couple of square yards the cost would probably be about $5, or $2.50 per square yard. If there was but a single square yard under the last stated circumstances the cost would not be affected enough to take notice of. In the light of these facts, you can see that in alterations, where the work is in detached areas, frequently joining existing work, that the plastering operation almost becomes patching. Many times it will be cheaper not to try to save much plastering.

In surveying for plastering, if a ceiling or side wall had about half its area of old plastering left, thus leaving about one-half new, I would either measure as though the entire space was new and use 40 cents per yard as the cost (two coats on wood laths), or take as near as possible the actual area to cover and double the price. Such a rule as above would apply to an average case of alteration work, but as each case presents differing circumstances it must not be applied inflexibly, but varied as the dictates of your judgment suggest. The question of drying plaster on work of this character is seldom much of an item, as there is usually an existing heating plant in operation, and the principal items of cost against drying would be setting radiators temporarily. The item must not be lost sight of, however, as in all cases it costs something and under some conditions would closely approximate new work.

Painting

In surveying quantities for painting in remodeling work, provision must always be made to cover the entire walls or wood work of a room with the last coat if a good job is desired. It is practically impossible to paint a part of a room and have it match or look like the part that was left undone, no matter how good the undone part may be. Thus the principal point to remember in measuring painting on an alteration job, is to consider the last coat as covering practically everything usually painted. The price per coat on the several coats preceding the final one will also be more than would be the case in new work; but how much will be wholly a matter of judgment. The increase in cost in average cases would be about 30 per cent.

Plumbing, Heating, Electric Work, Etc.

Plumbing, heating and electric work, etc., would be either figured by men of the respective trades or must be "sized up" as outlined in Chapter XX. This "sizing up" must be on a liberal basis, as considerable of the existing work will be damaged or absolutely destroyed in the performance of the other parts of the work. The above, coupled with the fact that the work usually has to be done in cramped quarters and possibly overtime, makes necessary the careful consideration of the matter before forming an opinion as to the probable cost.

Now, having treated practically all of the items entering into an ordinary alteration job that differ enough from new work to make necessary special treatment, we come to the items of "expense," such as watchmen, telephone, lockers and sheds, insurance and bond, carting debris, etc. All of these should be considered separately, and the estimated cost entered on the estimate sheet.

Having thus determined the probable cost, looking at matters from the safe side, which, by the way, is the only way on remodeling if you wish to make money, add what you think you should have for profit, not forgetting in doing this the fixed office expenses connected with your particular business.

From my own point of view, an alteration, if of any extent or in any way complicated, will require double the personal supervision, involve one in more chances for accidents to workmen and the public, and develop more expenditures for unforeseen conditions than a new operation of twice the size, considered in dollars and cents. I would, therefore, recommend that the margin of profit be figured as large as from 10 to 20 per cent. If you cannot get the work on about this basis let your competitor have it, and put your feet up on the desk and smoke.

CHAPTER XXVI

An Interesting Example of Alteration Work

I have purposely left until the last the consideration of a phase of figuring the above described class of work, and now will try to show you how to arrive at the probable cost of some operations that can hardly be figured on a "stock unit" basis. I do not know of a better way to explain than to cite an instance that came to me several days ago. A man owning a five-story building in a part of Boston where land is worth about $60 per square foot and rents are in proportion, has a first floor occupied as a store, about 18 ft. 6 in. high, and a second story occupied as offices, 12 ft. high. The extreme height of the first story was brought about by lowering the first floor about 6 ft. in the course of remodeling the structure, from a dwelling to a store and office building, some 10 years ago. Now a store of 10 ft. to 11 ft. in height and offices of 9 ft. to 9 ft. 6 in. will bring about as much rent and sometimes more than the higher ones, and he is considering the possibility of working another floor into the space between the street, or first, and the third floors, thus gaining space to divide into offices that would bring in about $4000 more rent per year. The question he asked me was, "What will it cost to put another floor into the building, moving the present second floor up or down, so as to leave an 11-ft. high store, and cut up the new story gained into offices, practically like the present second story?" Now, right here was a matter that could not be figured on a "stock unit" basis or guessed at with any degree of accuracy, namely, the raising or lowering of the present second story. By telling you how I arrived at what I thought would be about the cost you can see how to handle such out of the ordinary operations.

Lowering the Floor

The first question to decide was, whether to raise or lower the existing second floor, and after a half hour's examination of the premises I concluded that it would be more economical to lower the floor than to raise it, as there were no partitions in the store, and the existing second floor had considerable steel and heavy frame in it to take care of the 24-ft. span between party walls and support the partition loads coming over it the rest of the way up in the building. The new floor to be put in could be much lighter on account of the spans being cut in half by the partitions. I then proceeded to analyze as follows: Razing all finish, doors, plumbing and heating, etc., in second story and storing for the time being on the first floor; I pictured myself there with two carpenters and four laborers, and concluded that in one week I could accomplish the above work. This would represent an expenditure of $129.60, made up as follows:

Two carpenters, one week	$ 42.00
Four laborers, one week	57.60
Foreman, one week	30.00
Total	$129.60

I called that "Razing" $130.

The next thing was to shore the present third floor, doing it in such a way as to support the second story bearing partitions and not have shores interfere with the lowering of the second floor. This, I assumed, could be accomplished by putting a 6 x 6 in. strut in the main partitions about every 8 or 10 ft., same running from street floor to the partition cap under third floor joists. As these could not be inserted in one length, I assumed that the most logical way to install shores was to use pieces about 20 ft. long, which could be shoved through a hole cut in the second floor between two joists, the top being placed under the partition cap (the lath and plaster between two studs on one side of partition having been removed to make room for it), and the bottom to rest upon a piece of oak plank with two jack screws under it, and the distance from here to the first floor to be taken up by cribbing. When these shores are all in place I would then turn the jacks all up together, until the weight on the studs nearest the shores had been relieved. There would then remain to be relieved of weight the four or five studs between shores in the middle of the space. I am assuming, as is usual in our construction, that the partition cap is either 2 or 3 in. thick, and, this being the case, you can readily see that, while the shores would relieve the weight on possibly two studs on either side, the center of the partition between shores would surely settle some if not taken care of in some way.

Laying Out Main Partition

I should now lay on the existing main or supporting partition the exact location of the new floor, which is to be inserted when the present second floor is lowered. The top of the joists of this new floor would be about 9 ft. 5 in. from the ceiling. Now I would relieve the weight on the partition from shore to shore (the large ones already in place) by a little temporary shoring of the third floor by a plank on the ceiling and several studs driven in under it, and cut off the studs 3 in. higher than the top of the joists of the proposed new floor. Now I would slip a piece of hard pine 3 in. thick by the width of the studding under the ends of the studs (previously removing the bottom of partition, which was cut loose), letting this piece run tight to each shore. Next I would nail the bottom of all studs to the shoe piece, putting a chunk of studding under where it intersects the main shores, spiking it securely, and then run braces of studding from the shores to the center of the shoe piece in a manner similar to that in which you would truss the space over a large door opening in a partition.

When all of this work is done the weight in the center of the building from the third floor up is all transferred to the first floor, which, if not strong enough in itself, can be shored from the cellar bottom, and we are free to lower the present second floor the required 6 or 7 ft. Now figure up the stock and labor that would probably be necessary to have accomplished the above result. The building is 90 ft. deep.

I assume 10 large shores, 6 x 6 in. x 20 ft., = 600 ft. B. M., at $0.02½ =	$ 21.00
90 ft. 3 x 4 H. P., = 90 ft. B. M., at $0.03½ =	3.15
200 ft. 2 x 4 Spr., = 125 ft. B. M., at $0.02½	6.25
Nails	3.00
Teaming jacks and cribbing stock from locker	10.00
Labor, two carpenters, nine days	63.00
Four laborers, nine days	86.40
One foreman, nine days	45.00
Total	$237.80

Now the next operation to consider is the lowering of the existing second floor about 7 ft. 6 in.

I found upon examination that the second floor had steel girders composed of two beams about every 9 ft., and that the joists between them ran in the same direction. It was fair to assume that the girders entered the party walls 8 in., and the joists 4 in. After consideration, I made up my mind that the easiest way to cut this floor loose for lowering was to slot the walls under the girders down to the new level and to cut the joists off about 6 in. from the wall and to put in a 5-in. trimmer from girder to girder, using hangers to carry the trimmer from the girders and also hanging each joist to the trimmer. Before doing this, however, the floor must be prepared for lowering by running a 3 or 4 in. plank along the ceiling about 3 ft. from the wall and parallel to the party walls, and erecting cribbing at intervals of 8 or 9 ft. from the first floor to within the length of an extended jack screw of the plank stringer. Then place the extended jacks and take the weight with them. Now by taking up a strip of flooring and ripping off a foot of ceiling parallel with the party walls, the framework is exposed and ready for cutting off.

I then proceeded to make the price on this work as follows:

Teaming, cribbing and jacks	$ 25.00
Cutting away floor and ceiling, two carpenters, two days	14.00
Erecting cribbing and placing jacks:	
Two carpenters, four days	28.00
Two laborers, four days	19.20
About 180 hangers	126.00
Slotting wall under girders, 18 days, laborer	43.20
Cutting joists and putting in trimmer, 18 days, carpenters	63.00
950 ft. B. M. H. P. for trimmers	33.25
Labor lowering floor:	
Two carpenters, two days	14.00
Four laborers, two days	19.20
Total	$384.85

Now having in my mind's eye this floor down to the new level, there remains to be done, when the new third floor has been put in and the new second floor studded out, the removal and teaming to the locker of the jacks, crib stock, shores, etc., and this I assumed could be done for about $75. Thus I had costs as follows:

Razing second floor	$129.60
Shoring main partition and work incident thereto	237.80
Loosening and lowering second floor and work incident thereto	384.85
Removal and teaming away of cribbing, jacks, etc.	75.00
Total	$827.25

The new floor and partitions, the repairs to the floor that is lowered and the necessary changes in openings of front and rear walls are readily figured in the usual way on a "stock unit" basis, and the cost thus worked out, added to the $827.25, is the supposed cost of the whole operation, to which should be added profit. On a job of this character 25 per cent. would be little enough, as there are many hazards, and from its being so different from the ordinary operations there is a liability to underestimate in spots.

Thus by dividing a large operation into a number of smaller ones and considering each division separately, a pretty accurate analysis of the cost can be made, when considering the operation as a whole, one would be wholly at sea. In actual practice a number of these minor operations would be carried on simultaneously, thus entailing less time than would appear from the analysis of parts.

I have assumed that the person figuring work of this character is capable of taking a crew of men and superintending the operations, for if he cannot do this it is improbable that he will ever be able to estimate with any accuracy upon such work. I think I may safely say, however, that it is possible for a man to become fairly expert in estimating new work, even if he could not take help and perform it, if he thoroughly understands plans and has access to tabulations of costs that have been worked out by others. Such men should never let opportunities go by to get right onto the work and see it performed, making notes of the time required, methods pursued and order adopted, in the various parts of the work, as information so gained is of vastly more help in analyzing the questions that come up than copious writings such as this.

PART VI

System in the Execution of Building Contracts

CHAPTER XXVII

Steps Necessary to Start Building Operations

A builder who has the reputation of doing good work, finishing it promptly at or before the agreed time, and paying his bills, does not want for plenty of work at good prices. I am going to try and explain to the readers, as I see it, how to secure a reputation for doing good work, how to get the contracts completed on or before time, and in doing both of these things make sure of plenty of work at prices that return something more than a mere living.

To do good work it is necessary to buy first-class materials and take proper care of them after they come into your possession; hire first-class workmen and see that they are properly directed and supervised. Buying first-class materials does not always imply paying the top market price. A builder with a reasonable amount of capital and whose credit is known to be good, usually gets the best materials for less than the indifferent builder of doubtful credit pays for inferior goods.

Care should also be exercised in the placing of sub-contracts, letting work only to such men as are of good character and who have established a reputation in their particular line.

All material purchased for a building should be delivered at such times as will insure some one in authority being present to receive it, and should then be unloaded with such care as the nature of the material requires. If protection from the elements is necessary see that canvas, lumber, sheds, etc., as needed, are at hand. Three-fourths of the jobs I see in process of construction look as if there had been a cyclone in the vicinity the day before. All sorts of stock is strewn through the building and round the premises; window frames are mixed up with brick; outside finish on the floors is being walked over; mortar bed is so placed as to spatter the face brickwork and the debris of several months' operations is still under foot, scattered about the premises. I do not need to tell the reader that the best of stock delivered on one of these jobs soon becomes second or third grade stock, causing annoyance to the owner and architect, and often causing the rejection of material, even after some of it is in place. Replacing stock thus damaged is a constant drain on the possible profit of the job. The improper handling and storing of stock in this way can have but one result upon the labor, and that is to make it cost more than it should.

The cause of most of these evils is the contractor himself. If the foreman finds that the contractor will not stand having stock so handled, he will very soon do differently. If he will not follow suggestions or orders from headquarters, in regard to these matters, it is time to get a new foreman.

When Starting a Job

When about to start a new job of any size go to the site with the foreman who is to be put in charge of the work, taking the plans along, and spend anywhere from an hour to a day right on the spot studying the conditions. Determine the location of the derrick and engine if the work requires them; locate the office locker, tool and stock shanties; pick out a place to make mortar; a place or places to pile brick; places to pile up lumber and a place to frame it; map out a good road to or around the building, locating it in such a way that all materials are readily handled from the teams to the appointed places, or so that heavy materials may be pulled under the reach of the derrick boom and be taken from the teams and piled outside or landed on the building without any unnecessary or double handling.

In locating all piles of materials and shanties try to foresee the various trenches that will have to be opened or yard work that will have to be done and figure out the probable time that such excavations or work will have to be started, taking care not to pile materials in these places that will not be used up before the time for doing the work arrives. For instance, there may be some retaining walls, catch basins and drains which, upon due reflection, you may conclude better be left until the superstructure is up. This being the case, you may safely pile such brick and lumber on this part of the lot as will be used in the superstructure, knowing that they will all be incorporated in the building by the time you are ready to take up the retaining wall and drain work. On the other hand, it might seem advisable to open these trenches for drains and walls and put them in at once thus getting something done while you are assembling the more complicated materials for the principal work. You would then pile stock elsewhere or delay delivery for a few days until such time as the drains were in and filled over, after which you could use the location for piling stock.

Having thus mapped out the matters above referred to, the next step is to put the work in operation. Build the office and install the foreman with a complete set of plans and specifications. Next build the tool shanty and begin installing the equipment of hand tools, such as picks, shovels, bars, barrows, scythes, axes, timber dollies, rollers, peavies, ropes and blocks, winches, lanterns, etc. Everything that there is a possible chance of wanting should be included, so that, should there arise the want of anything, it is immediately at hand. This avoids delay and delay is expense. Enough work can frequently be accomplished with the proper tools to pay for them several times over on a single job.

Now give the foreman as many men as he can use to advantage and begin to pile up stock. Don't be afraid to pile up stock. Lots of time is lost on the majority of jobs by negligence in ordering materials and piling them up in advance of their being wanted. A job that requires 500,000 brick should have at least 100,000 piled up on the premises while the foundation is going in and before a brick is laid. When brickwork is started plans should be made to have about as many brick delivered per day, or per week if they are coming by cars, as will be laid in the corresponding time. The 100,000 piled up will give a surplus to draw upon in case of failure or delay in agreed deliveries.

The Office End

Now that the operations at the site of the work are thoroughly mapped out and started we will deal with the office end of the proposition for a while.

The foreman can accomplish but little on the job if the "office" neglects its share of the work. We have left him on the work with a complete set of plans and specifications, an office locker, tool locker and plenty of tools, and we will assume that some "stock" materials are already arriving and being piled up for immediate and future use.

Among the "stock" materials above referred to would be such as follow: cement, crushed stone, common brick, sand, lime, boards, furring, studding, etc. A reference to the estimate sheets tells the quantities of all such materials, and a little work at the telephone will soon demonstrate who has the particular kinds you want. Get the prices, determine from whom you will buy and give orders for delivering certain quantities in a given space of time.

We neglected to state that we consider it necessary to install a telephone in the foreman's office at the building as soon as possible. We then instruct the foreman as to what has been ordered, as well as from whom, and as to what deliveries have been agreed upon, instructing him to see that the deliveries are kept up as agreed, using the telephone to that end, and notifying the office if his telephoning does not bring results.

But to get back to the office end. Here the work should be divided in such a way that some one man is responsible for each particular job. If there are two or more partners there should be an immediate agreement as to who is to run the job in hand. We do not mean by this that the remaining partners should have nothing to say about the job. They should be advised of all matters of consequence which arise and a free discussion of the best course to pursue, under the circumstances, agreed upon. We all know that two or three heads are better than one. We simply mean that all matters pertaining to the job, whether they are with the architect, owner, city departments, material men, subcontractors or foreman, should be brought before the partner in charge of the job, and all orders, decisions, correspondence, etc., be attended to by said partner. Several men cannot run one job successfully. There will be confusion in ordering material, conflicting orders given to the foreman and sub-contractors, conflicting statements made to the architect or owners, the net result of which will be confusion on the work and loss of confidence of the architect and owners. You can ill afford to have either of the above conditions exist.

Should the builder, or firm of builders, have a superintendent in their employ and he be chosen to run any particular job, all orders and correspondence pertaining to the job should be attended to by him. Otherwise the foreman and other employees on the job and the sub-contractors will not pay the attention to his orders that they should. It is not a necessity that the superintendent transact all the business of the job with the architect or owners, although no harm would be done if he is sufficiently diplomatic and entirely in your confidence. It is fair to assume, however, that a superintendent would refer more matters pertaining to the job to his employer or employers for a decision than a partner would. Especially would this be the case until such time as a superintendent had demonstrated to his employer his ability and fitness to handle all matters relating to the job.

The Man in Charge of the Job

It now having been agreed upon, in the office, who is to handle the job we have in hand, the party chosen must begin his part of the work at once. A full set of plans and specifications should be on file in the office at all times, and if the building is of any size or at all out of the ordinary, a second set of plans is a great convenience, if not an absolute necessity. By having this extra office set you can lend the drawings to material men and sub-contractors with whom you are doing business and not leave the office without plans of the operation. We have seldom seen the time when, the office set of plans being loaned, something did not come up before they were returned which called for a reference to them. If the architect or owners will furnish only one set of plans and specifications we should buy the two extra sets. We have, however, never met a refusal from a reputable architect to furnish three or four sets of plans. As they usually have five or six sets printed to send out for bids, it is not an additional expense to them to supply the contractor's reasonable wants in this respect.

We find the most convenient way to keep plans in the office is flat in a draw. Have a case of large, shallow drawers in the office and take a drawer for each job, labeling it and taking pains to put each plan back in the right drawer when through with it. It is a serious inconvenience to have to unroll plans and weight them down when using them, and the method described overcomes this objection, and is now in use nearly everywhere by architects, engineers and contractors. Another thing is to cut each sheet down to the smallest size possible, without cutting into the actual working drawing. This saves handling lots of superfluous paper every time you refer to the plans.

We left the foreman supplied with tools, help and some materials. It is now necessary to let the sub-contracts, especially those for such parts of the work as will be soon wanted. Among these would be cut stone and steel and iron work. In all cases more or less work must be done on these materials before they can be delivered for installation in the building. The $\frac{1}{8}$ or $\frac{1}{4}$ in. scale drawings, with such larger scale plans and sections as are usually a part of the contract drawings, are sufficient for taking off quantities, and the contracts should be made at once to permit the sub-contractor to purchase such stock as may be required if he does not have it already on hand.

A contract should be drawn up with each sub-contractor binding him to furnish certain materials at certain specified times (erected in the building if his contract covers erection), with a penalty of so much a day for failure to comply with the times of delivery or installation set forth in said contract. You will seldom have to pay any bonus if you take a little care in setting the dates, giving them just about as little time as it is possible in which to get out the material, and, if a part of their contract, to install it. What bonus you may have to pay will be money well spent.

While the sub-contractors are figuring and before the job is a week old, you should carefully study the plan yourself and considering the total time allowed you, for the completion of the whole work, make a written schedule of the condition the job should be in each Saturday from start to completion, setting forth clearly what part of your own and each sub-contractor's work should be done. Set your dates for sub-contractors and deliveries of materials from this schedule. Keep the schedule in your desk and compare the condition of the job with it frequently and *make it a point* to keep the work ahead of the schedule.

If you find you are behind on any particular part of the work, give particular attention to that part until you have caught up and are ahead.

Having thus laid out what *must* be accomplished in order to complete the work on time and knowing the quantities of material required, you can readily figure out about how many laborers, masons and carpenters should be employed to accomplish the required result. Don't forget to take into account bad weather. Provide the foreman with ample help and see that he is kept supplied with sufficient stock to work every man to advantage.

With the ordinary stock materials piling up on the site and the principal sub-contracts let, you must now find time for scheduling dimension frame, window frames, etc., and getting your orders placed in time to have deliveries made that will permit of your keeping, or beating, your scheduled time.

Other matters must also have your attention. You and your sub-contractors must have details and you must foresee those wanted first and take steps with the architect to get them. Don't request him to make them for you "as you will need them soon." Tell him that you *must have them at once* or the work will be seriously delayed. It is well to impart this information to the architect by letter, following the first letter with others if necessary, until such times as you get your details. If it gets to a point where you are actually delayed by his failure to furnish certain details, set it forth clearly in a letter to him and claim an extension of time from date of letter until the drawings required are forthcoming.

By keeping copies of all your letters and preserving all of his, in a file or files provided for the particular job in hand, information that may save you from trouble or lawsuits before the work is completed, accepted and paid for, is in your possession.

All of the office work enumerated above must be done at such times as not to interfere with other jobs you may be superintending, figuring or periodically visiting. The writer makes it a rule to visit one or more jobs every morning before going to the office, spend the middle of the day in the office (say from 10 a. m. to 2 or 3 p. m.) and then visit the same or other jobs in the afternoon before going home. Of course things will come up frequently that upset this routine and this plan must be changed to suit. Whatever comes up, work "under way" must not be neglected and you must plan to take care of it all in some way.

CHAPTER XXVIII

Job Superintendence

Upon visiting the job it is a good plan to go from top to bottom of the building, taking notice of everything that is going on, whether being done by your own men, your sub-contractors, or the owners' sub-contractors. Also look at the stock piles to see that materials are being delivered fast enough so that there is no danger of shortage occurring, necessitating the laying off of help.

Having "taken in" everything about the work, now look up the foreman and give him your orders. If you have seen anything in your rounds of the work that is not going just right call his attention to it, letting him know what you want done, and if it is something concerning the way men are doing some piece of work, let him take it up with the men himself. By permitting the foreman to make all corrections with the help he can maintain a proper discipline on the work. Of course there are cases when you will see something being done so radically wrong that stock is being spoilt, or wasted rapidly, or the men's lives or limbs are being endangered, and in such cases you should either correct things at once or stop all work, get the foreman, and with him straighten the matter out. Storming around and hollering to the help confuses them, and calling the foreman down before the help makes him small in his own and the help's eyes. If the foreman needs censure take him to one side and give it to him; never allow yourself to do so in the presence of the help, owner or architect if you can possibly avoid it.

Go Over the Job with Foreman

Having given the foreman time to straighten out any little matters you have seen that need immediate attention, I would then go over the job with him, pointing out the parts of the work that you want pushed faster or that you want taken up next, suggesting (or ordering if you see fit) that this or that thing be done next, or in a certain way; that certain shifts be made in the help; that this or that stock be used next, or for a particular purpose. Give him directions or orders for the sub-contractors under your control, and any other orders, directions or suggestions that may seem to you to be necessary for the proper conduct and progress of the work. Then ask him if there is any stock wanted, or will be wanted in a few days, which should be ordered at once. Remember that two heads are better than one, even if one of them is the foreman's. You may have thought that you saw everything, but he will undoubtedly call your attention to a number of little things wanted that escaped you altogether, that are just as necessary and important as the big things, if the work is to run smoothly and logically.

The writer frequently finds it necessary to tell the foreman to erect some particular part, or do some certain thing, at once, or within the next few days, the doing of which seems illogical to him. In this case it is probably because we want certain parts erected so that we, or a sub-contractor, may make measurements for something that has to be gotten out or made to order, and we have mapped out in our own mind about when this particular stock will be wanted, and knowing about how long it will take to get it out and deliver it, know best when the work that makes it possible to get measurements should be done. It is just as well to let the foreman know why you want work of this kind done and impress upon him the absolute necessity of its being done on or before a certain time. No one likes to do work that seems illogical, and the foreman will see the logic and necessity of the matter when explanations are made and will accomplish the results you desire with more spirit and dispatch.

You may think these latter suggestions somewhat unnecessary, but we have seen many jobs delayed because nobody gave any attention to matters that required something to be done so that measurements of special material could be obtained, until the work was practically ready for these materials, and then there would be a shifting or laying off of help and a wait of days, or even weeks, for this particular stock.

These delays may be almost or wholly obliterated if you study your plans and specifications sufficiently, running the job from them rather than from the building itself. It is only by determining the wants of your job from the plans and by having scheduled the times at which certain things will be wanted, that you can avoid vexatious delays, assuming, of course, that you get drawing and details from the architect fast enough, and we will go on record as saying that in nine cases out of ten it is your own fault if you do not.

The foreman will probably want decisions as to the exact meaning of the plans and specifications, especially in parts of them where they are a trifle vague or susceptible of a double interpretation. These matters should be gone over with a foreman carefully and a ruling and definite instructions given him by you, unless it appears to be something that should be referred to the architect for a decision. In the latter case the matter should be referred to the architect at once, and by letter if possible, and his instructions or interpretations be obtained and followed unless there is some *very* good reasons for disagreeing with him. In this case have the matter out with him, and after coming to an agreement give orders or directions to the foreman. All these things being looked after, it is time to move on to another job or the office and take up the matters concerning this and other jobs.

Assuming that we are back to the office again, there will be the materials to order that you and the foreman have determined are wanted. The telephone and letters soon take care of this and get them off your mind. Then there are details that are wanted, and you take the matter up with the architect by letter. You also noticed that some of the sub-contractors wanted a little pushing, or some information that you obtained, and you next get these things off your mind by attending to them.

All details for the job should be sent to the office, not to the building. Upon receiving a detail look it over carefully; first to see that it conforms to the general plans, large scale drawings that may have been a part of the contract plan and the specifications; second, to see that the work illustrated by the drawings is so laid out as to be practicable and make a good workmanlike job and will fit into the structure under the existing circumstances, as is intended by the architect; third, to thoroughly familiarize yourself with the detail and all that it is intended to communicate to you, so that you can explain its meaning fully to the foreman and any of the sub-contractors whose work may be illustrated therein.

Consult the Architect

If in looking over the detail you see anything about it that is not clear, or will not work out right, or make a first-class job, or that you think is in excess of your contract plans and specifications, go to the architect at once, or at the very first opportunity, taking the drawing with you, and discuss the whole matter with him and mutually agree upon everything before leaving. If this necessitates corrections or changes in the drawings have them made by the architect. You can then take the drawing back to the office knowing what it all means, and you are ready to distribute, and correctly explain the information it contains, to all parties concerned without further delay. Adopting this course will save you from the possibility of giving wrong explanations and from later misunderstandings with the architect and others.

Having now agreed with the architect in regard to the detail it should be absolutely and faithfully followed, even though you may not see the sense and logic of it all. The architect probably sees it and, if the matters fall within your contract, it is none of your business unless he chooses to explain.

Now, if there are parts of the detail relating to several of the sub-contractors' and to some of your own work, you should make sufficient copies to give each party concerned a drawing and have one left for the office, so that the original can go to the job to be kept there; or better and easier still, trace from the detail only that part which concerns each particular branch of the work, with enough of the adjoining parts of other work in each case to make the copy clear as to the location of the work, and give to each sub-contractor or material man the copy intended for him. Make a complete copy for the office unless you are fully satisfied that, after the thorough study you have given the detail, you will not need it in the office, and send the original to the job to be kept there at all times for the guidance of the foreman and all others concerned. To illustrate the point clearly, let us assume a detail through the outside wall and a window in a brick building, beginning just below the first floor level and extending above the second floor. This drawing would show in section and broken elevations, drawn to full size, the following parts of the structure; stone or terra cotta water table or belt course; stone or terra cotta sill and lintel of window; second story belt or cornice of stone or other material, if there happens to be one; the window frame and sash, with sections of the sill, jamb, mullion, head, sash, stop beads, edge casings, casings, stool and apron; the base and moulding; chair rail; picture moulding; the steel beam or other lintels over windows back of stone work; the size of the brick, with thickness of mortar joints and elevation of the bond; and even other parts not mentioned. But these are sufficient for illustration.

Now proceeding according to the second plan outlined we would take a piece of tracing paper of sufficient size to get off all that concerns the stone or terra cotta trimmings; trace the section of water table, or first story belt, showing the brick above and below it for a couple of inches; then trace the section of stone sill and lintel, showing an inch or two of the brick lines and enough of the window frame sill and head to show the connection between the parts. Next trace the section of the second story belt or cornice, also showing line of brick above and below, and make elevations of any parts necessary to fully illustrate the work shown in section, such, for instance, as the corner of sill showing raised lug, etc. Only a small part of the drawing as a whole has now been copied, but you have everything on this drawing that the cut stone man wants, and you can turn it over to him. In the same way trace section of iron lintels for the steel man, window frame and sash for the sash man, and "finish" for the finish man.

In case you are going to make a schedule of finish yourself to take figures on later, when you have all the details concerning it, take a piece of paper about 3 ft. 6 in. square, place one corner over a pattern of moulding, trace and number it No. 1. Next take another moulding, numbering it No. 2, and so on, until you have traced, one under the other, each different pattern of moulding. Now make a schedule of numbers down in the lower right hand corner, allowing room to increase the size of the schedule later, and in a place for remarks note the purpose of the moulding and kind of wood.

Having gotten all the mouldings in this detail, file the tracing away in the plan drawer for this job, to be taken out a little later when the next detail showing finish comes along and other patterns are to be copied onto it. This method, as can readily be seen, takes a little time, but the labor is well spent and will save the time it has taken ten times over before the end of the job. All the sub-contractors have the information they want as far it goes; you have a copy of members of finish as far as detailed and you have the original for the job, where it belongs. These copies will all serve to save you telephoning and explaining, bothering the foreman and thus interfering with your work; saves the architect's time and patience in explaining things that you should explain; overcomes the possibility and probability of misunderstandings and consequent mistakes, while greatly facilitating the getting out of the several materials and parts. You must admit that all of these benefits compensate for the trouble and time involved in making the copies.

This daily routine of visiting the various jobs; receiving the information for the work from the details; transmitting the information to all parties concerned; purchasing the materials; seeing that the sub-contractors get around as agreed and perform their work properly; keeping the foreman informed as to what you want done; when you want it done, and well supplied with help, as well as with details and stock; all stuck to persistently from the minute a contract is signed until the job is completed is sure to have results.

Guard against one thing, and that is, allowing your energy and persistence to cease when you get along toward the end of a job. By this time you are about starting, or are in the midst of other jobs and are losing interest in the one nearing completion; at least, I am assuming that you are because I always do myself. It is then that I bring all of my will power into action, determined at all hazards to visit this particular job as often, or even oftener, than before and see every single thing done, and that expeditiously, in order that I can have the time that all this is taking to devote to the other, and for the time, more interesting jobs. This almost invariably results in the jobs being done on time, and if I have succeeded in getting ahead of my schedule a little every now and then, in getting an acceptance ahead of contract time.

CHAPTER XXIX

Handling Work at a Distance, Timekeeping and Divided Costs

In writing the above, I have assumed that the job was so located that it was possible to see it every day, or at least three or four times a week. If the building happens to be 100 or 200 miles from the office, the method of handling must be modified somewhat and how we manage such work will now be explained.

It is of course out of the question for you to see such a job daily or even several times a week. I generally plan to visit once a week work that I can readily reach and get back from in a day, getting up early in the morning so as to get a train around 6 to 6.30 A.M., thus getting to the work as early as possible. I choose for the regular weekly trip the pay day, having time taken up to 5 P.M. of the second day preceding the one on which I make my visit, so as to enable me to have all the envelopes made up in the office the day before pay day. These I take home with me the night before going to the job, so as to go direct from home to the station.

Having reached the job, I go through the same routine I have described for the daily visit to the nearby job, except that it takes longer, as there is more to see, more to explain to the foreman and more planning ahead for future work I want done and materials that the work will require. Having established the day for this weekly visit, I make it known to everybody with whom I am doing business, sub-contractors, material dealers, etc., notifying them that if they want to see me at the building about anything to come there that day, and that if there is anything about which I want to see them there I will notify them, giving them as much notice as possible. I also try to have the architect or his representative make his visits to the work on these days. Now I let nothing, except of the utmost importance, interfere with my weekly trip. By making a long day at the job, spending a great deal of time with the foreman and subcontractors, explaining work and ordering materials as far ahead as possible, I find that the job will run nicely until my next visit.

Isolated work like this requires a very competent foreman; one of the kind of men who is resourceful, of good executive ability, temperate and trustworthy. In fact, you want a man as good as yourself, and you cannot expect to find him for $18 to $20 per week. The right man is cheap at any price under $40 per week, plus board and railroad fares, if the job is of any size. If 25 or 30 men are employed, he can handle the work enough better than an ordinary foreman to save you his week's wages every day that the job lasts. If anything comes up between visiting days that cannot be settled over the telephone, which I instruct the foreman to use freely if necessary (preferably in the evening, as it does not then interfere with his or my day's work), then another trip must be made as soon as possible.

If the job is of fair size, say $25,000 or more, enough help will be employed to make a timekeeper desirable, if not an absolute necessity. I find that it is usually possible to employ some young man locally who is well vouched for and with at least a high school education, who will work for from $10 to $15 per week, making as long a day as circumstances require. If one cannot be found locally, there is always one to be found in the city who will go anywhere you want him. In addition to keeping the time he can look up freight that is arriving, arrange for teaming, chase up local sub-contractors and material men, tally and check quantities of materials, check the bills for them sent to the job from the office for this purpose before they are entered in our books to the dealer's credit, assist the foreman in laying out work, take charge of a small crew of men on some kinds of work under direction of the foreman, and so on indefinitely. In fact, it is surprising the amount of petty detail work that such a man can do if properly handled, and it serves to relieve the foreman and give him the greater part of his time right on the job with the help.

The three most important duties that I give to the timekeeper are keeping the daily journal or "log book," keeping the divided time and checking quantities of materials. For these purposes

I provide him with two books and fully instruct him. I give him these instructions in the presence of the foreman, and require him to perform the duties involved under the foreman's superintendence and inspection.

In the journal I have him take a page for each day, putting the date on the top line; follow this with the weather, the number of men of each trade employed—first our own men and then those of all sub-contractors, including any employed by the owner; a complete résumé of all materials received at the job and from whom; a synopsis of the work that is being performed by our own help and all sub-contractors; make note of who visits the job, as, for instance, the architect, owner, sub-contractor, material man, inspector, superintendent, member of firm or any one, in fact, not a regular and daily visitor; also particular record of any accident or unusual happening; in fact, any and everything that suggests itself as of possible value to me to know about, that takes place. This will consume about one hour's time, not all put in at one time, and just about fill one page of the book 14 or 15 in. long, on the average.

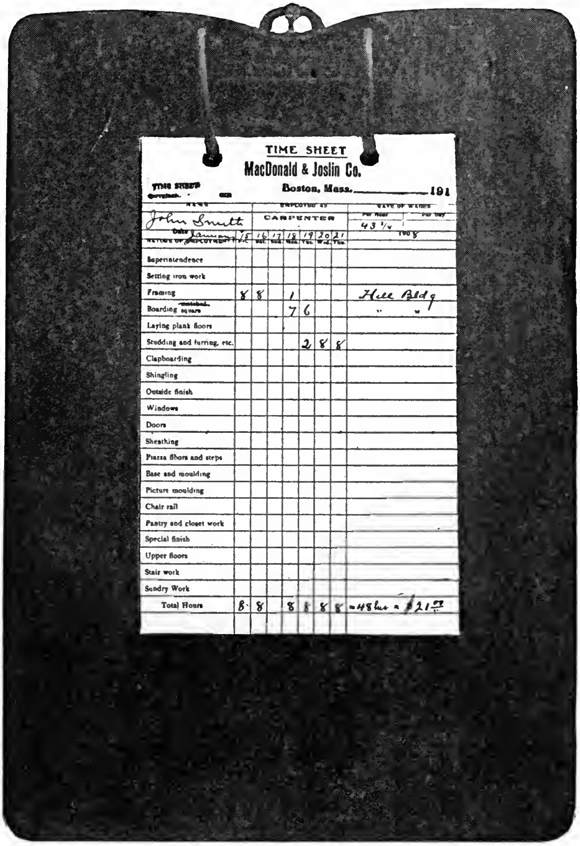
The value of this record may be almost worthless on one job and on the next one contain information that would win you a lawsuit; as, for instance, the information it might contain in regard to delays by sub-contractors working for the owner or delay in delivery of material that he was to furnish; record of visits of an inspector and of some order given by him; particulars of and names of witnesses to an accident of some kind that you might be sued for six months after the work was completed, etc. Taking so little time and liable to be of so much value, under circumstances that might arise, by all means insist upon this journal being kept if a timekeeper is employed.

The checking of bills is very important if you do not want to pay for materials not received. Brick, for example, which are purchased by the thousand delivered, coming in two-horse carts containing from 1000 to 1800 brick, are usually accompanied by duplicate slips, one to be left by the teamster with some one in authority at the job and the other to be signed by said person and returned to the party selling the brick by the teamster. With common brick costing $7 or $8 per thousand it is almost as cheap to permit yourself to be cheated out of a hundred or two of brick to a load as to undertake to count each load, on account of the time and expense involved in doing so. To take the foreman from his work is out of the question. Here the timekeeper can be made use of by giving him a laborer or two and having a load counted now and again, especially, if upon looking at the load before it is dumped, it appears to be small for the number of brick called for by the slips. When a dealer knows that you are apt to count a load at any time and do actually do so every day or two, he will see that every cart going to your job contains full count. I do not mean to imply that all dealers take advantage of contractors in this way, but I do know that some of them do, and when in some distant place, dealing with strangers, it is worth while having the word go abroad that you are going to get what you pay for in quantity and quality.

Brick coming by cars are usually piled regularly, even if only common brick, and always if face brick. In this case, timekeeper should measure and cube the contents of the car before a brick is taken from same. It can readily be determined by the cubic contents if the car contains the number of brick called for by the bill of lading.

In a similar manner lumber can be approximately surveyed on the teams or cars before unloading; sand, gravel and crushed stone checked up with accompanying slips; schedules of steel, lumber, window frames, doors, etc., checked; and all materials be checked and accounted for and practically none of the foreman's time be drawn upon to do so. All shortage, real and apparent, should be called to the attention of the "office" and the shipper immediately, so that the matter can be straightened out at once. Letters or the telephone will accomplish this. All slips received with loads should be retained by the timekeeper, and all bills for materials should be sent to the job as soon as they are received at the office, for him to check and "O. K." if they are correct. The journal and duplicate slips furnish an accurate record of materials received, and in a very little time the timekeeper will go through them all. We do not place the amount of invoices to the credit of the party selling until the bills have been checked and "O. K.'d" as above.

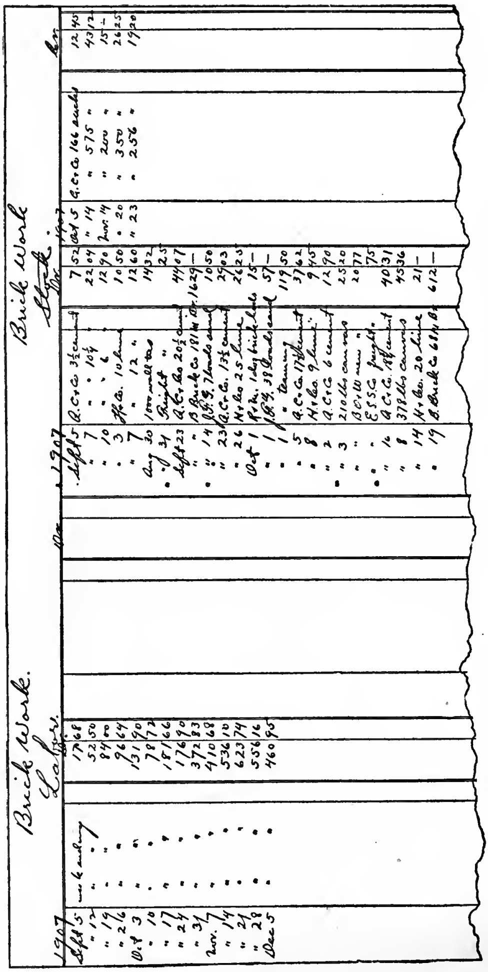
The next and most important duty of the timekeeper is to keep the time, not only getting the total hours that each man works per week, but the number of hours each man has on each division or class of work. For this purpose I have devised time slips, copies of which may be seen in *Carpentry and Building,* June, 1906, page 193. On the first morning of the "work



WEEKLY TIME SLIPS AS THEY APPEAR WHEN PLACED ON WOODEN FILE READY FOR USE

week," which in our case is Friday, the timekeeper makes a slip for each man employed, fills in the dates and rate of wages and puts them all on a Shannon file with those of each class of help together. Our slips are punched on the top edge to fit this file, although the illustration above referred to does not show punching.

Immediately at starting time he makes a round of the job to see who are present and at what they are going to work. He



REDUCED FACSIMILE OF TWO LEDGER PAGES OF COST BOOK

then makes several rounds of the job during the day, one being right after the noon hour and one starting in time enough before the end of the day to see what all of the men are doing and who are there at the end of the day.

Upon coming to each man on this final round he questions him as to the various divisions or classifications of the work he has been engaged upon and how many hours upon each class, entering upon the slip the hours thus obtained under their proper heading. The help are cautioned to notice the time of day if shifted from one class of work to another and the timekeeper's several trips and part that he may take in assisting the foreman at superintendence, also familiarize him with the shifts that are made during the day, and between the individual workmen and the timekeeper a very accurate résumé of the day's work can be obtained and immediately entered.

Should a new man come on at any time during the week, a slip is immediately made out for him and inserted in the file with other help of his class. At the end of the week this file contains each man's total time, from which a report for the payroll can be made out, and a couple of hours' time will pick out the total number of hours and the cost in dollars and cents for each class of work for the week. Now remove the slips from the file, securing pieces of string through the holes, lay to one side and make new slips for the next week and put them on the file.

Now in the book provided for the purpose have the timekeeper record these hours and costs, each under its proper heading. The best book for this purpose is one about 10 x 14 in., with ledger ruling, two columns to a page. On the first page of the book write the heading of the class of work first encountered and under same write the word "labor." On the opposite page write the same heading and the word "stock." The two ledger pages will then have the appearance indicated in the reduced fac-simile presented herewith.

Where the nature of the item is such that there will be stock or other credits, instead of using both columns for charges against the item, the right hand column may be used for "credits," as shown on the reduced pages.

Now on this left hand, or "labor" side, both columns, enter "labor"; on the right hand, or "stock" side, one column, enter all stock, quantity and cost, immediately after checking up the bills and before sending them back to the office. Also on this "stock" side enter all cash expenditures that go to make up a part of the cost of this class of work.

The "labor" if you choose can be subdivided several times for each class of work. As, for example, on a large factory job you might want to divide the cost of the labor under the head of "windows" into handling and setting frames, jointing in sash, stop beads and finish and applying hardware; to enable you at completion of work on windows to more thoroughly analyze and tabulate your costs. This may readily be done by making four entries of hours for the week instead of one, adding after each entry the name of subdivision. Before starting another heading leave room enough to make all probable entries under the classification started. Generally speaking, the two double columned pages will take care of almost any division of the work for a pretty large job.

At the completion of the job, or before, if the work under the heading is completed, the unit costs can be worked out accurately by simply adding up each column, totaling them and dividing by the known unit. Take the item of brick work; run down through the stock side and get the total number of brick, divide total cost of labor and stock by the number of thousands of brick and you have the cost of brick per 1000 laid in the building.

If you want to analyze further it is possible to go down through the "stock" columns and pick out the quantity and cost of lime, cement, sand, stage stock, etc. In the labor column, if you have made provision to do so, you can pick out the labor of making and carrying mortar, handling and carrrying brick, building and taking down stage (unless you make this latter a separate item, which I usually do on jobs of any size), laying brick and washing and pointing. Thus you can work out the cost of 1000 brick, laid in the wall, in detail and with accuracy.

To show to what lengths an analysis of costs may be carried we give below costs that we have recently worked out.

Brickwork 601 M; laid from September 1 to December 20, 1907. Water struck brick 12 in. and 16 in. vaulted walls with some 12 in. and 16 in. partition walls having heat, ventilation and fireplace flues. Mortar 1 part lime, 2 parts Portland cement and sand about 6 parts.

Masons' wages 60 cents per hour; laborers' wages 30 cents per hour.

Quantities and cost in detail as follows:

Lime, 0.74 bbl. at $1	$ 0.74
P. cement, 1.392 bbl. at $1.90	2.645
Sand, 22.7 cu. ft. at $1.50 load of 32 cu. ft.	1.07
Brick per M delivered	9.00
Derrick and engine	2.49
Staging stock and labor	1.224
Sundry expenses	1.08
Labor, all handling, carrying, culling and laying of brick and making and carrying mortar, etc.	8.744
Cost per M complete in building	$26.993

It will be noticed from the time of the year in which part of this work was done that brick would have to be heated, also the water for mortar, and that unusual precautions would have to be taken to protect the work nights. The sundry expense item above is for fuel for this heating, canvas and boards for protection, railroad fares for imported help, etc. This price is for the brick right through, about one-fifth of the total quantity being laid in the exterior face of walls, the brick being culled to get the best for this purpose.

Stonework—Broken coursed ashlar backed with rubble. First story 2 ft. 6 in. thick; second story 2 ft. thick. Mortar, 4 sand to 1 Portland cement, with very little lime. All stone taken from adjoining fields and farms, the maximum haul being about one mile. The only cost of stone was the labor of gathering and teaming. Stone were large field boulders split with plugs and feathers and hammer broken to shape. Total number cubic yards 704.

Quantities and cost per cubic yard laid complete as follows:

P. cement, 0.679 bbl. at $1.90	$ 1.29
Lime, 0.223 bbl. at $1	.223
Sand, 6.59 cu. ft. at $1.50 a load of 32 cu. ft.	.31
Sundry expenses (includes teaming of stone)	1.424
Staging stock and labor	1.044
Derrick and engine	1.108
Labor (includes procuring stone, splitting, laying, mortar making, tending, etc.)	7.44
Cost per cubic yard complete in building	$12.839

From these two examples will be seen the possibilities of obtaining costs if proper care is taken in keeping the divided labor and stock books. It does not seem necessary to discuss the value of this information to a contractor, but I am constrained to add that, out of all the builders in the city of Boston, I only know of four or five who make any attempt to obtain such itemized costs from their work.

In the case of items like excavation, stonework or concrete, where there is apt to be a little difference between the estimated and the actual quantity, and where the stock column does not show up the number of units, the foreman and the timekeeper should take measurements every few days while the work is going on to determine the actual quantity and enter them in the journal, so that at completion the known quantity can be used from which to analyze and tabulate the unit costs.

While the time sheets are divided into the usual classifications made when figuring upon work generally met with, if any particular job calls for some special division not made, one of those not used can be scratched out and the new one written in. In the same manner subdivision of labor on the listed items can be made; thus over "windows" write "frames," "hanging," "casing," etc.

All the information secured in this way is of vast importance. The very fact that builders generally make no attempt to work out these unit costs accounts for the wide range in their figures and the large percentage that find their way into the bankruptcy court. Both timekeeper and foreman should not underestimate the importance of keeping time slips and cost book accurately, entering everything as promptly as possible and questioning men about items of labor, stock or sundry expense if there is the least doubt in their minds as to where it belongs. When the timekeeper attends to all the duties above enumerated he will find that he is occupied every minute. A young man of the right sort, however, will become interested and learn a great deal during the six or seven months' course of a fair-sized job.

On our last large job the timekeeper was a graduate civil engineer earning $30 per week in a city of 30,000 people, and he gave up his position and came to work for us at $20 for the sake of the experience he could get in practical building construction and costs in connection therewith. He made a good man for us, as he could use a transit, understood plans and could assist the foreman materially in laying out work, and he knew the local freight yards, teamsters, material dealers, etc.

On this particular job, which was 250 miles from Boston, we tried an experiment in the matter of handling the payroll, by making a deposit of several thousand dollars in a local bank and arranging for the timekeeper to draw on it by check for his payroll, freights, and sundry small bills with people with whom we did so little business that we did not want to open an account. We required all bills and payroll to be verified by the general foreman or foreman-carpenter, and every check to be countersigned by one of these two men as well as by himself.

Every week, immediately after drawing the payroll, he sent the office a copy of the payroll in detail, together with all cash expenditures for such items as carfares, oil for lanterns, postage, stationery and the like, giving us the amount and number of the check. All bills and freights he paid he sent to us at once (not waiting until reporting payroll), writing any explanation and the number of check on the face of the bill.

In the office when the first deposit was made in the local trust company the bookkeeper charged said "trust company" and credited "cash." Upon receipt of a receipted bill or a payroll report, with amount and number of check with which it was paid, the bookkeeper credited the "trust company" and charged the "job." From the weekly reports and a knowledge of expected freights we in the office were able to tell, without prompting from the timekeeper, when it was time to send more money to the trust company, and accordingly sent it. In ten months' time the trust company handled about $40,000 and there never was a difference between the books in the office and the timekeeper's cash account but once, and that was of about 40 cents. This, upon investigation, our bookkeeper found to be an interest charge for an overdraft that the timekeeper had made when we let the cash get too low.

This job was visited by the writer every two weeks, staying two days, running in an extra trip several times when something came up that made it necessary.

The building was fireproof construction (except the roof, which was mill construction), five stories high, with a ground area of 10,000 sq. ft., and we succeeded in completing same in two months and one day less than the contract time of one year, building for the same people meanwhile two smaller buildings amounting to about $8000. This was made possible by systematic handling of the job through ample stock being supplied in advance of the wants of the work; constant reports of the progress or delays on the job by almost daily letters to the office, followed by advice, suggestions or orders from the office, sent immediately upon receipt of reports from the job.

We have perhaps touched on bookkeeping in these last few paragraphs more than anticipated when the article was commenced, but as this part of the building business is as important as any other part, we do not consider the remarks out of place. If results are to be accomplished there must be system all along the line: in estimating, working out the costs, keeping the books, purchasing the materials, letting sub-contracts, superintending the job and dealing with the owner and architect.

One thing must be guarded against, however, and that is not to have your system too cumbersome or expensive. The narrow margins in the business make it necessary to hold down to the lowest possible level the office or "overhead" expenses. The firm that can do business with an "overhead" expense of 3 or 3½ per cent. of the year's total business has a much better chance to stay in the "game" and make profit than the concern that allows the same expense to get up to 8 or 10 per cent.

The first three pictures shown herewith relate to a wing of the Eastern Maine Insane Hospital at Bangor, the contract for the erection of which was dated August 10 and the building accepted on June 9 of the following year, the cost of the structure complete being about $165,000. The work was done in 62 days less than the contract time, but there was no bonus for completing it before the time called for by the contract. This is the building from which the examples of unit costs on brick and stonework were taken. Of the three views relating to this building, the first two show the condition of the work September 18; that is, a trifle more than a month after the contract was dated, while the third picture shows the appearance of the wing

December 13, practically four months after the contract was dated.

The fourth picture shows a 24-classroom schoolhouse in the Roxbury district of Boston, which was completed in 79 days less than the contract time, the city offering a nominal bonus for finishing the work ahead of time. The contract in this case was signed March 27 and the building was accepted December 12 of the same year. The cost of the structure complete, exclusive of furniture, was $160,000.

We are now nearly at the end of our remarks, and find that we have up to this moment neglected to mention two important points that should have been touched upon before.

First—You will recall my having discussed at some length the necessity of doing some work at seemingly illogical times in order to make possible the procuring of measurements for parts of the work that require considerable time to get out. In many cases it would be physically impossible to do some parts of the work until the building was farther advanced, and at the same time it is desirable, if not absolutely necessary, to have the measurements from which to lay out and get out some special part of the work. This might be some iron stairs up through the building in a masonry well with the walls changing in thickness at different stories; or the exact dimensions of several rooms that are going to be filled with special case work. The architect has probably given the details, but has broken the lines at a number of points, thus "putting it up to" the contractor to give absolute working figures.

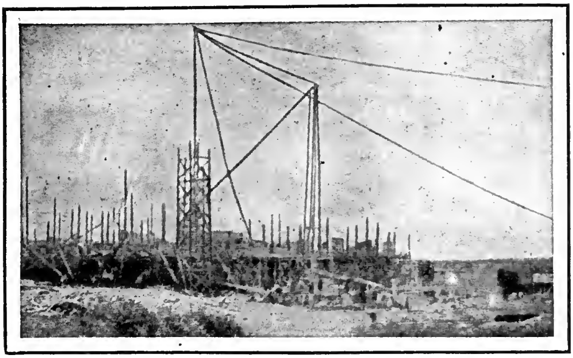
In many cases of this kind that come to my notice the general contractor is waiting for the sub-contractor to assume responsibility and make figures, while the sub-contractor is waiting for the general contractor or architect to do the same thing, and the foreman hardly dares to and is waiting for some one of the first three to take the responsibility. The net result is that the measurements are not obtained until the building has nearly reached a point where the special work must be installed, and then there is a wait of days, or even weeks, for the material.

In a case of this kind the superintendent should "take the bull by the horns" and establish measurements for everybody to follow. Before doing this, study the part of the plan involved carefully, noting fixed structural parts and put figures in ink on the working drawings at the job for every one to follow, with positive instructions to the foreman to see that the parts concerned are built to the figures made, thus becoming responsible yourself to the architect, the owner, the sub-contractor and everybody concerned for the accuracy and reliability of the information imparted. If you do not dare to assume these responsibilities, you need more training as mechanic or foreman.

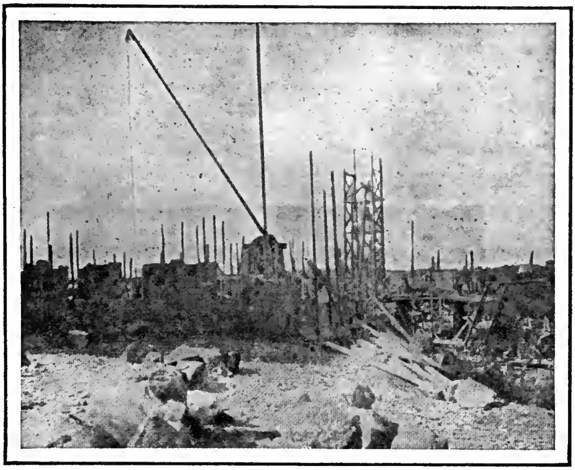
Second—The building business is made up of vexatious things, and it takes courage to meet them all promptly and straighten them out. The first inclination when you hear that something is going wrong, and the architect and owner are kicking, is to keep away from them and the building until the thing straightens itself out. This is all wrong and you hurt yourself in everybody's eyes by doing so. If we hear, directly or indirectly, that something is going wrong at the job, we make it a point to get there as soon as our legs or a car can take us and find out at first hand what is the matter, and follow it right up with the architect, owner, sub-contractor or whoever may be concerned, until everything is settled, and matters left running smoothly. Having done this, we feel better, the load being off of our mind, and the architect and owner respect you for having come up like a man, faced the "music" and seen it through.

The object of this article has been to try and make clear to the reader how system of the right kind in the office, on the job, and in your own handling of both, may be obtained, getting thereby the maximum of results with the minimum of expense.

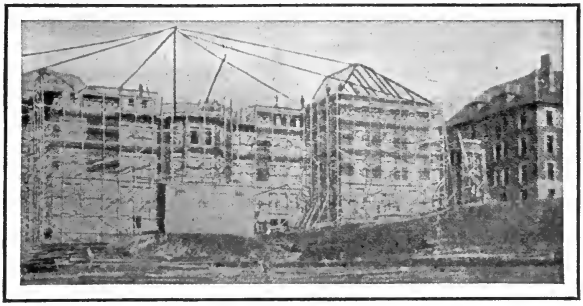
If the foregoing helps any of the readers to obtain these objects we shall be well repaid for the time and thought put into its preparation.



WING "D" OF EASTERN MAINE INSANE HOSPITAL. J. C. AND J. H. STEVENS, ARCHITECTS, SEPTEMBER 18, 1907



ANOTHER VIEW OF THE WORK AS IT APPEARED ON SEPTEMBER 18, 1907



SHOWING PROGRESS OF THE WORK ON DECEMBER 13, 1907. THE BUILDING WAS COMPLETED AND ACCEPTED JUNE 9, 1908

PERRIN STREET SCHOOL HOUSE, ROXBURY DISTRICT, BOSTON. J. A. SCHWIENFURTH AND J. J. CRAIG, ARCHITECTS. (ACTUAL TIME, 8 MOS. 14 DAYS)

INDEX

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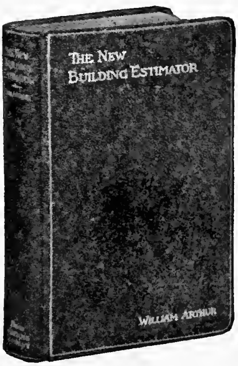

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