HOW TO FRAME A HOUSE

MAGINNIS

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OR

HOUSE AND ROOF FRAMING

By

OWEN B. MAGINNIS

AUTHOR OF

"BRICKLAYING," "PRACTICAL CENTERING"
Etc.

A practical treatise on the latest and best methods of laying out, framing and raising timber houses on the balloon principle, together with a complete and easily understood system of roof framing, the whole making

A valuable and indispensable book for carpenters, builders, foremen, journeymen, etc.

Illustrated and explained by one hundred and fifty-nine arawings of houses, roofs, etc.

SEVENTH EDITION REVISED AND ENLARGED

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PREFACE

In placing the Seventh Edition of this now standard treatise before those interested in building construction, I do so satisfied that it will merit the commendation bestowed on the previous issues.

The matter, both in text and cuts, is the most accurate obtainable from the best and latest practical experience and can be followed with confidence, either in estimating or executing practical work.

I beg to thank the editors and publishers of the journals *Architecture and Building* (formerly *Architects' and Builders' Magazine*), *Building Age* (formerly *Carpentry and Building*), *Carpenter,* and others for permission to reproduce many of my articles contained herein; also the architects, builders, carpenters, engineers and others with whom I have been associated, and who have helped me in accumulating the information embodied herein.

Trusting that the book may prove valuable and profitable to those who purchase and use it, the author remains their obedient servant.

OWEN B. MAGINNIS.

New York City, 1913.

CONTENTS

BIOGRAPHICAL SKETCH

Of the Author

Owen B. Maginnis, whose interesting technical works are so highly appreciated, was born in Newry, County Down, Ireland, on the 2nd of July, 1860, his father being a master baker. His education comprised a term of years at colleges, being principally in a mercantile and mathematical direction, and was obtained at St. Coleman's College, Violet Hill, Newry, and the French College, Blackrock, Dublin, where Trinity professors predominated.

In 1877 he was apprenticed to Mr. John O'Hare, a builder of churches and schools, military barracks and other public structures, and worked manually at the trades of carpenter, bricklayer and draftsman; thus gaining a knowledge of the whole range of building construction.

After completion of apprenticeship he was employed as carpenter by the White Star Steamship Company in Liverpool and being there for three years, worked his passage across to Philadelphia in 1881.

Working here for a short time at the bench he drifted by towns to the East where he was employed in Bridgeport and several Connecticut cities for about two years when the busy season at Coney Island induced him to try that resort, whence he moved to New York in 1884 and has since been continuously employed in that city, as follows:

Carpenter and foreman carpenter outside and at the bench for various first class firms, and writing articles and attending school in the evening. The first article was written for the *Builder and Wood-Worker* and published in 1884, quickly followed by others for *Carpentry and Building* and other technical papers.

He was appointed technical editor of the *American Builder* and *The Carpenter and Joiner* in 1889. Contributed articles to the *Illustrated Carpenter and Builder* of London, England, *The Wood-Worker* of Indianapolis, Ind., *Scientific American,* New York, *The Bricklayer and Mason,* New York, *Clay-Worker,* Indianapolis, and other journals of note continuously since.

In 1891 William T Comstock of New York published and placed upon the market his first book, " Practical Centering," which was a success, also " How to Join Mouldings," the first of his " How to " books. In 1893 the first edition of " How to Frame a House " was issued and has proven so valuable that it is now in its seventh edition and a steady seller. " Roof Framing Made Easy," now in its second edition, quickly followed with various serials and the latest book, "How to Measure Up Woodwork for Buildings," has been most favorably reviewed.

Mr. Maginnis has also been a member of two unions, draftsman in the New York Department of Education, instructor of mechanical drawing in the New York Trade Schools, inspector of buildings in the Borough of Manhattan in the City of New York, and past president of "The Associated Employees" of the "*Bureau of Buildings*" of that city.

CHAPTER I

Balloon and Braced Frame Houses

1. GENERAL DESCRIPTION, FRAMED SILLS AND THEIR CONSTRUCTION.

The economical and excellent structural methods of framing on the balloon system have made it universally popular with all architects, builders and carpenters. So I feel assured that this book will be favorably received. Some readers may, no doubt, criticise many of the methods, and from them I would ask a little consideration, as those which will be illustrated are not my invention, but are in vogue and daily application in many states and localities. However, that readers in general may gain information from them is my great desire.

Balloon frames are probably termed thus because of their extreme lightness and rigidity, as they embody some of the characteristics of the balloon, including simplicity of construction and uniformity of outline, but as Mr. Woodward says in his useful little book, "Modern Homes," basket frames would be a more appropriate name for them, as their construction partakes much of the basket pattern — that is to say, they have upright stays or studs, but wood instead of willow covering. Balloon frames may be divided into three principal component parts, consisting of the floors, the walls and the roof.

Fig. 1 of the illustrations will give the reader a first conception of what is meant by a balloon frame. Taking it for granted that he is a practical and intelligent man who wishes to understand the principal parts of a house, he will readily perceive the parts just mentioned. The floors are made up of smaller pieces, or what are practically called timbers, and each of these timbers has its own appellation, and serves a useful purpose in the construction. A is the cellar or main supporting girder, which is placed in the cellar of the house in order to sustain the weight of the floor joists, partitions, or other weights placed upon it. It is either made up of one stick of timber or built up in thicknesses, of several timbers 2x8, 2x10 or 2x12 spiked or bolted together to form, as it were, one large timber 8x10 or 8x12, as the case may be. It is supported in the center of its length by posts equally spaced between the walls, on which the ends rest and in which they are usually inserted from 6 to 9 inches. The top edges are placed level with the top of the foundation wall, set on the cellar wall or underpinning. B represents the sills, of which there are four for this building, which has four sides. If a building have more sides it must have a sill for

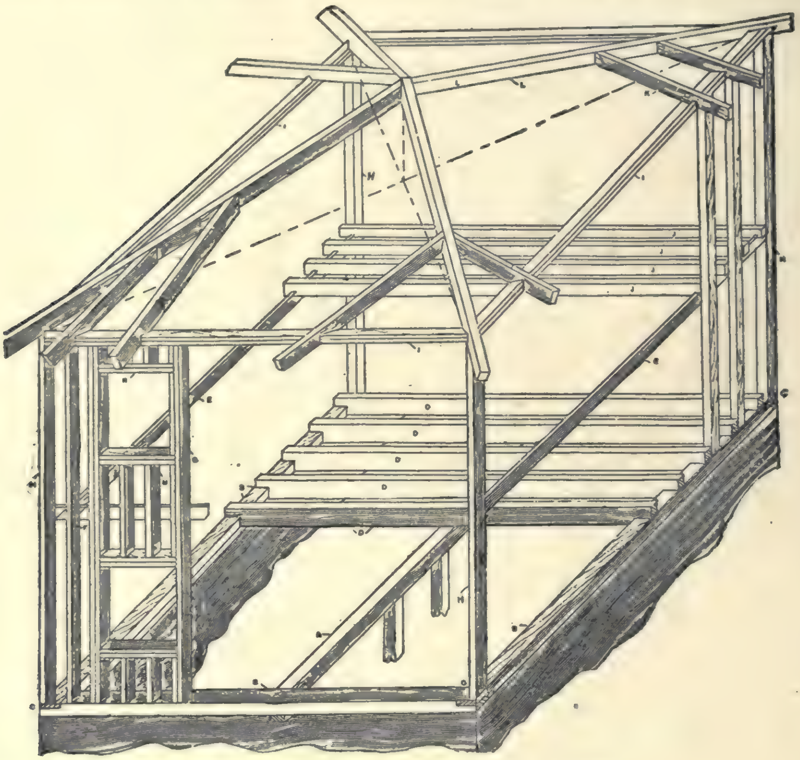

Fig. 1. The Construction of a Balloon Frame.

each on which to rest the posts and studding. They are usually made of timbers measuring 4x6 inches, and are halved together in the corners in the manner shown at C. For the sake of economy, however, some builders prefer to build up their sills in two thicknesses of 2-inch plank, spiking them thoroughly together and overlapping the corners in the manner shown in Fig. 2. This method is not as good as that described before, but it is cheaper, as it saves the cost of thick timbers and the labor of halving the corners.

Fig. 3 is another method of building sills resorted to for the purpose of saving labor. It will be noticed that the floor beams play an important part in the construction of this description of sill, and it is therefore open to criticism. Referring again to Fig. 1, the first floor beams will be seen at D D D. It will be noticed that they rest on the cellar girder, A, are notched or girded over the sills, B B, and their bottom edges rest on the stonework of the foundation or cellar walls.

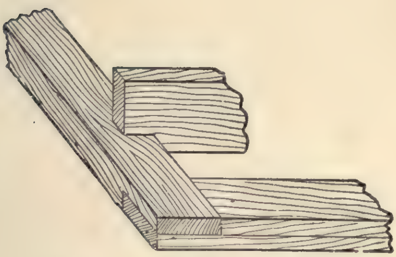

Fig. 2. Sill Framed of Two Pieces.

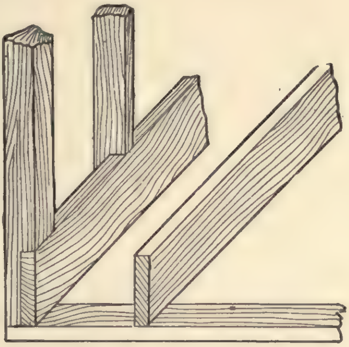

Fig. 3. Sill, Using a Floor Beam to Form It.

In Fig. 4, I show two more arrangements of sills which are even cheaper than the foregoing, inasmuch as they are made up of ordinary floor timbers spiked together, so as to form, as it were, box sills. For very cheap work, as small houses or barns, they can be

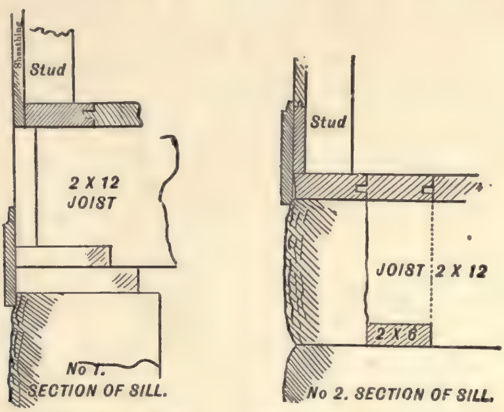

Fig. 4. Cheap Sills.

readily and economically introduced. No. 2 is especially suitable for barns, as it does away with much timber and labor, but it must be remembered that incomplete sills of this description or character should never be introduced when a few dollars can be spared to put in one of a better and more suitable form. Any sensible mind will readily understand that such sills must necessarily follow the settlement of the stone underpinning, and should this be uneven, the whole superstructure will, as a matter of consequence, strain and become injured.

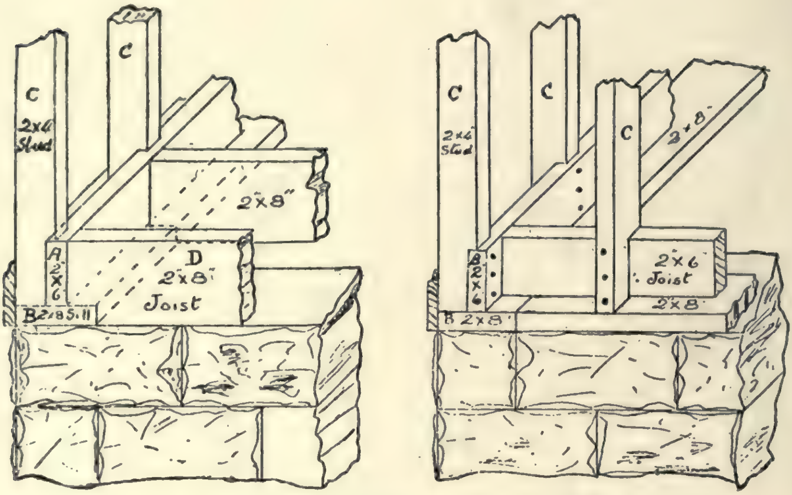

Fig. 5. Two More Examples of Sill Construction.

Fig. 5 shows two other methods of sill construction. At B is a 2x8 placed on the wall, and A is a 2x6 spiked fast to it; C is a 2x4 studding spliced firmly to A and B; D is spiked in the same manner, the end and side sills are both made the same way and spiked well at the corners, making a first class box sill, and one that can be relied on in a cyclone.

In proceeding, I think it best to give the reader, especially the beginner and young mechanic, a general description of the principal component parts of a simple house framed on the balloon system; then to instruct him practically in the various practical means and methods which must be followed when building houses of this class. I therefore most respectfully ask those who wish to apply them in actual practice to become thoroughly acquainted with those important instruments or tools absolutely necessary to proceed accurately, namely: the two-foot rule, ten-foot pole, and steel square. The last almost combines all three.

2. FIRST FLOOR BEAMS OR JOISTS, STORY SECTIONS, SECOND FLOOR BEAMS, STUDDING, FRAMING OF DOOR AND WINDOW OPENINGS, WALL PLATES AND ROOF TIMBERS.

The isometric drawing, Fig. 1, shows how the joists are spaced at equal distances apart, generally 14 inches between the faces or 16 inches from center to center for ordinary dwelling houses, and on them the flooring laid. These beams are framed or sawn out to fit over the sill their own thickness, and to rest on the stone work of the cellar wall or underpinning, also to rest on or be supported by the cellar girder; from this it will be seen that the cellar girder is set fair with the top of the wall. H, H, H, H, are the posts or four main angle uprights of the frame, and, for reasons which I can hardly explain, are made in various ways in different States. Those I have drawn in this sketch are 4x6 timbers, and this is the method usually followed in the Eastern States. In the West, however, the posts are made of two 2x4 timbers, spiked together so as to form one stick or timber, but the solid posts are preferable. These are simply cut to the length required, with the top and bottom ends perfectly square, so that they may be nailed solidly on the sill at the bottom and support the wall plate properly at the top. E, E are the girt strips or, as they are better known, "ribbons," on which the second floor joists or beams rest. They are gained into the posts and studding on the right and left side walls of the frame. A study of the wall section, Fig. 6, will give the student a more comprehensive explanation of the framing of the floor timbers and gaining of the posts and studding, than would be conveyed by Fig. 1.

The second floor joists should be notched out to fit down on the ribbon in the way shown in Figs. 1, 6 and 14, to hold the side walls together. The wall studs are invariably spaced 16 inches between centers; many readers who are young at the business may ask why? The reason is a very simple one. It is because all plasterers' laths are cut or sawn to a standard length, viz: 4 feet long, and it is for the purpose of overlapping and breaking the joints on the lath that they are thus spaced. Of course it will be easily seen that three times 16 inches make 4 feet, or the standard length of a plasterer's lath, and one lath will therefore nail on four studs and cover three 16-inch lengths.

Openings for windows are obtained in the manner represented on the left in the front of Fig. 1. For extra strength, and by reason of the weakening caused by introducing the openings, it is the custom to double up the studding on each side of them, and this is done as follows: a single stud, as G, is first inserted and nailed in on each

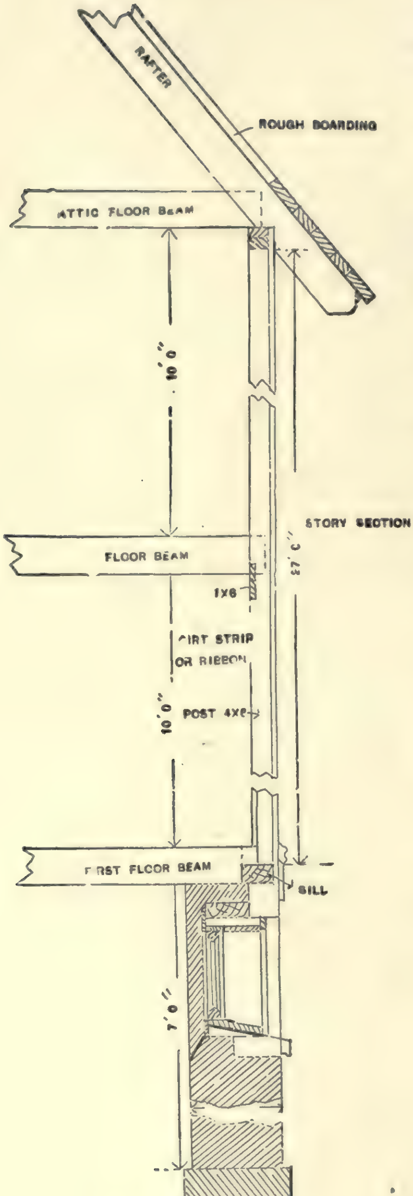

Fig. 6. Section of Wall.

side of the opening. Then the top and bottom headers, as M and N, are cut to the necessary length and placed in, bevelled and nailed. The top or upper header is generally doubled, but the bottom one need not necessarily be so, though I have drawn it doubled here as it is often done in good work. When these are in, a short stud is cut in to form the double thickness. In the better class of framed houses the doubled studs are put in full length from sill to plate, as shown on the left side of the opening, Fig. 1. This method is shown in Fig. 7, which is an inside view of the stud wall standing upright, with the girt strip or ribbon gained in and nailed with a brace cut in to stay the building. The second floor joists are spaced out the same distance between centers as those forming the first floor below — that is, 16 inches between centers. J, J shows them in position on the ribbon, Fig. 1. Door openings likewise have the studding doubled both on outside and inside walls, and when the openings are over four feet wide the headers have a trussing arrangement placed over them to sustain the weight above. See Fig. 12.

I, I, I, I are the four wall plates, which, being supported by the upright studding forming the framework of the walls, carry the rafters which make up the framing of the roof. L, L are the " hip " or angle rafters. Outside angle rafters are termed " hips." Inside angle rafters " valleys." As this building has four outside angles, it has, therefore, four hip rafters. K denotes the " jack " rafters or those which are cut and nailed to the hip rafters. Fig. 8 represents an ordinary peak or ridge roof on a common oblong plan. A, A are the plates as before; B, B, the common rafters; C, the ridge. In order to prevent the plates from being thrust out by the lateral pressure of the rafters, a collar beam or tie beam is inserted, see Fig. 16, thus making the roof a stable, solid construction.

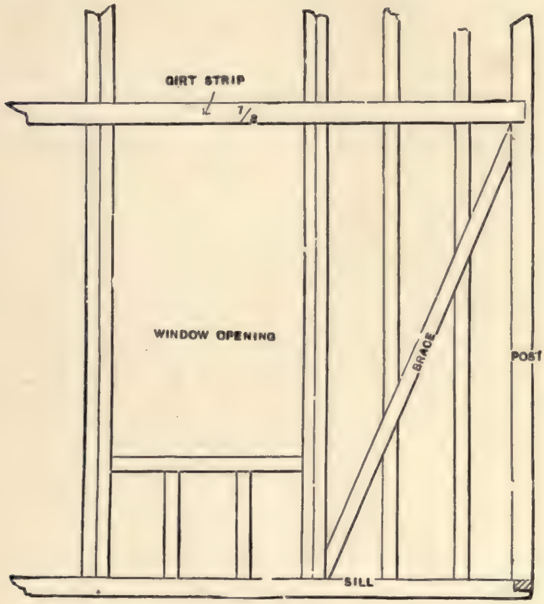

Fig. 7. Elevation of a Stud Wall with a Brace.

Fig. 9 will convey to the reader or student how the side of a balloon frame is put together. The first floor beams are 2x8 timbers, gained out and set on the ribbon which is let into the studding its full thickness, and nailed fast to each stud; on the upper ends the wall plate rests, and is nailed thereto, being made of two thicknesses of 2x4 joist. The other top or attic floor beams, which are also tie beams, 2x6, are set and spaced off on this, also the roof timbers or rafters of 2x4 scantling. From this drawing the construction of the section, Fig. 6, will be readily understood. As the timbers of balloon frames are held together entirely by nails, I would ask readers to note the nailing shown in these sketches, for it represents how the timbers are fastened together in order to form a complete frame.

3. LAYING OUT AND WORKING BALLOON FRAMES, GIRDERS, SILLS, POSTS AND STUDDING.

In the first and second articles I have endeavored to explain to the student the principal timbers forming the balloon frame of a simple house, built on a square plan, or on a square foundation. In this article the student or beginner will be shown the proper mechanical way to proceed in laying out and framing the individual pieces so

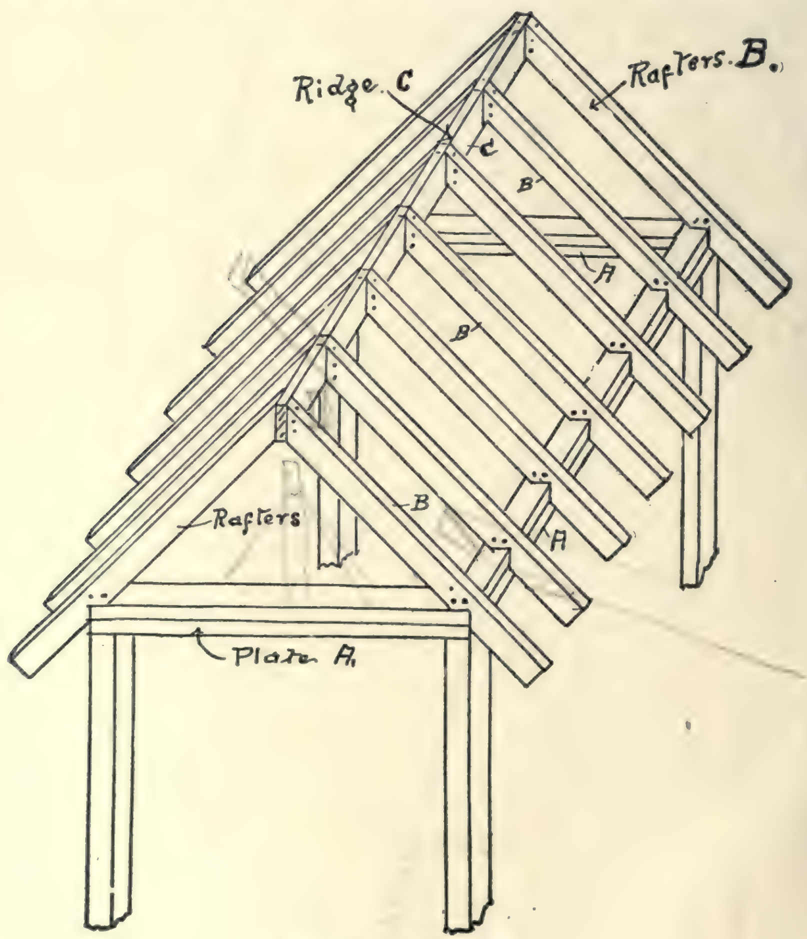

Fig. 8. Roof Timbers Set Up.

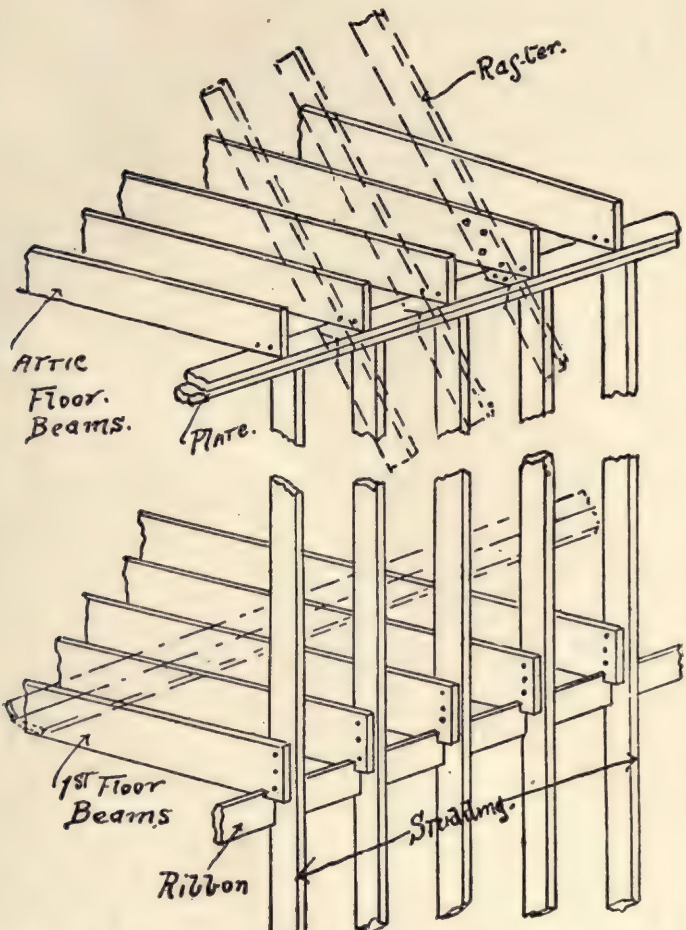

Fig. 9. Floor Joists, Studs and Rafters Framed Together for a Balloon Frame.

that they will fit when "raised," or are placed in their permanent position.

Girders. Cellar girders to support first floor beams should be laid out to the neat length of the walls, between which they will rest, and have not less than 6 inches of bearing added on to each end to go into the wall. If the girder be so long that it must be made up of two sticks or timbers, then they must be separately laid out and squared at the abutting ends, and they must be accurately measured with the ten-foot pole, so that the joint will come exactly in the center of the pier or post, according as the plans and specifications state. It is not usual to halve cellar girders together. But should the specification call for this, then they must be carefully measured to allow for the halving, and still retain the required length from end to end. See Fig. 10. To lay them out they should be placed on saw-horses at full length and accurately marked and squared with the steel square and lead pencil, and afterwards sawn to the lay-out marks. See Fig. 14.

Laying Out Sills. Sills of balloon frames can be laid out by placing each piece singly on horses, and after determining the neat length to lay out the corners for halving and the spacing of the floor posts and wall studding. The whole length is measured with the ten-foot pole, which should always be used in measuring distances over ten feet long. The steel square or two-foot rule is applied in laying off the joists or studding, and the corners are marked for

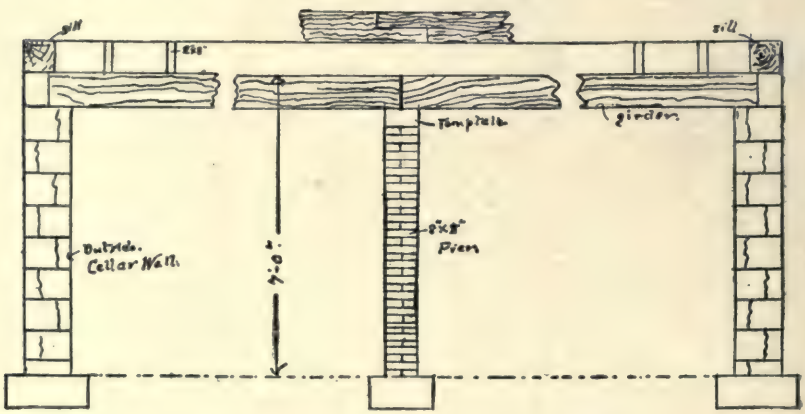

Fig. 10. Cellar Walls, Pier Girder and Sills.

halving with the steel square across the grain, and the gauge with it. I would impress upon all carpenters the necessity for placing the two sticks end to end, with the length of the halve overlapping when they are laying out long sills 30 to 50 feet long and to use the ten-foot pole in measuring. This lessens the possibility of mistakes occurring. They might be laid either on the horses or directly on the cellar wall, and I think the latter is preferable, because, if the foundation wall be correctly built to the size called for, the sill must come right; besides, the sills *must* suit the wall.

Supposing, for example, that the side wall of a building is 39 feet, then two 20-foot sticks should be procured and placed side by side on the horses or wall, one overlapping the other 8 inches to form the halved joint, which can be laid out by squaring across the top edges

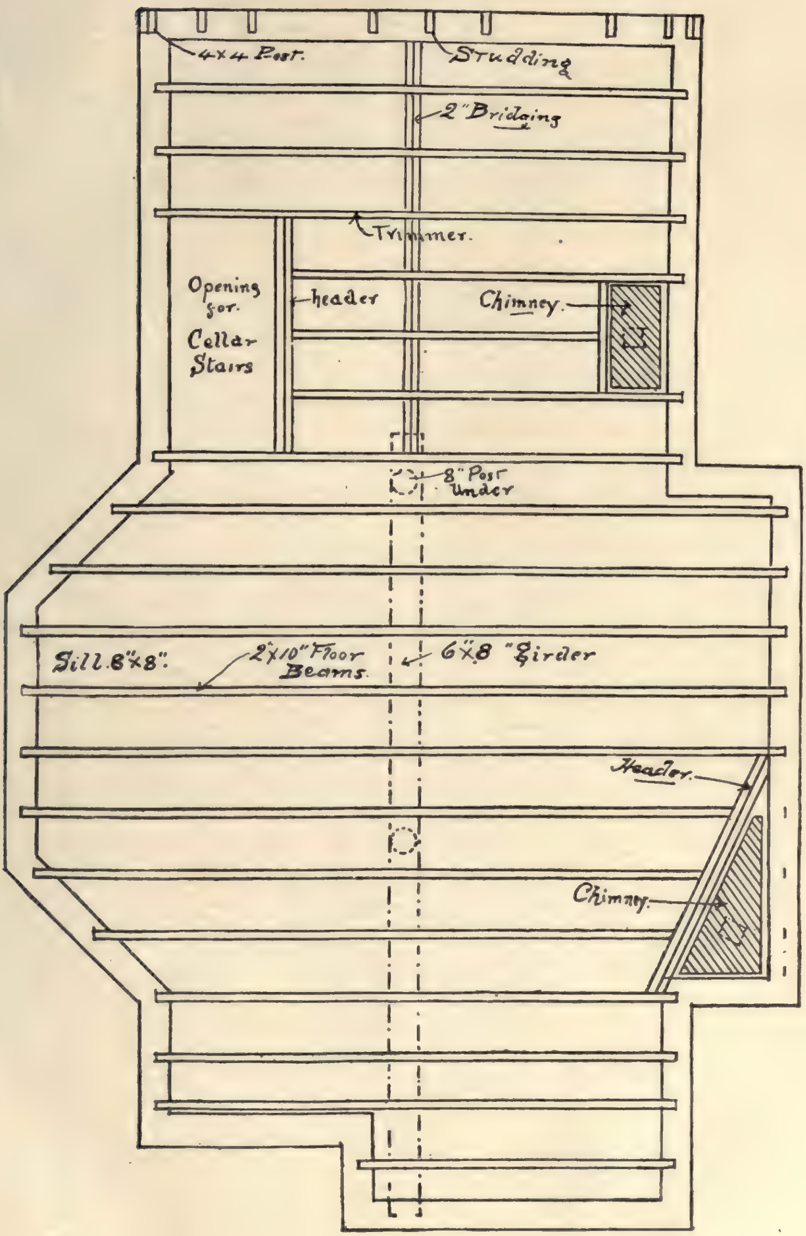

Fig. 11. Floor Plan of First Story Timbers.

of both at once. This will allow 2 clear inches on each end for squaring.

Carpenters should take care not to have a straight joint come over a cellar window, as there is always the liability of its coming apart, or sagging down under the weight of the studding above. All sills will invariably require to be placed *rounding edge up*.

Sills of hexagonal or octagonal plan are to be laid down according to the plan on the template made for the cellar wall and be halved at the corners.

At Fig. 11 is shown the first floor framing plan of a small house with a bay window, which has sills of 6x8 timbers, the floor beams being gained into them. If sills are made in two thicknesses of 2-inch plank as is done in some parts of the country, each thickness should overlap, both at the corners and turning points.

Posts and Studding. Some carpenters and builders form their corner posts in balloon frames of two 2x4 joists spiked together to make 4x4 sticks, as it were. Some use 4x4 scantling, and others make them of one stick of 4x6. The posts and studding can be laid out from one pattern, which should be first framed just as the studs and posts will be. This can either be made out of a piece of ⅞-inch pine or a 2x4 stud, and it must be laid out for the gain for the girt strip or ribbon and squared at the top and bottom ends. The pattern should be perfectly straight on edge and be without wind.

When a good pattern is made the posts are first placed on the saw horses and laid out. The ends are also sawed off square and the gain is sawed and chiseled out for the strip. Next the wall studs are placed on their edges on the saw horses in quantities of 6, 8 or 10 at a time and the edges squared over from the pattern. Careful carpenters use two patterns, placing one each side of a number of joists, when laid on the horses, and then squared across from end to end, or from gain to gain, thus making sure that they will be exactly right. Studding should be laid out on the rounding edge, so that the hollow edge will come on the outside or *face* side of the wall. When the edges are marked the faces are squared over. Some prefer to lay the pattern on each piece singly, and mark the face of stud at once, thus avoiding the necessity of squaring over the edge. This practice undoubtedly saves time, but the sawing must be done by good workmen or the joints won't be square. The reason I say this is, that though it may seem very easy to saw a piece of stuff, 2 inches thick, square, without a guide line, I find few who can do it exactly. The ribbon or girt strip is a strip of 1x6 stuff; so the gain or notch must measure this size.

Should the second floor joists be notched down on the upper edge

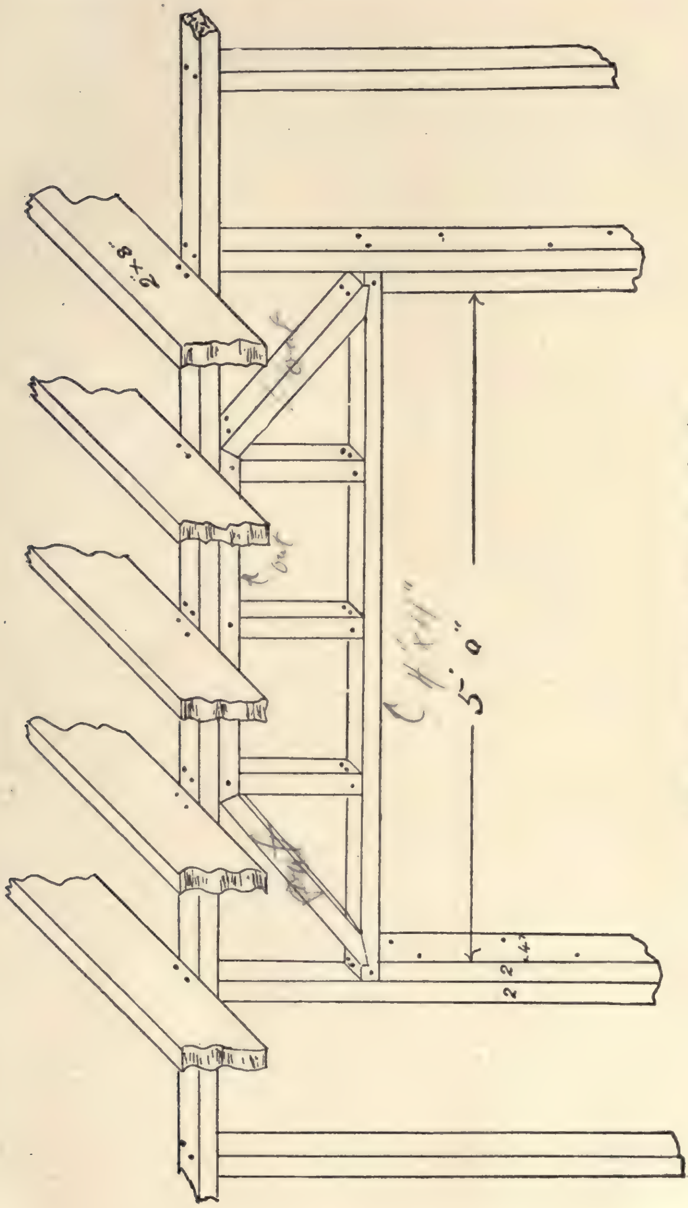

Fig. 12. Trussing Over a Wide Door Opening.

of the ribbon, then the top edge of the ribbon must be kept up higher, the depth of the notch, to get the proper height of ceiling. I notice that it is becoming a common practice to omit notching the floor beams, and I cannot condemn such omission too strongly, even though the joists are nailed to each stud, because the notch prevents the bottom edges of the beams from slipping on the ribbon and ties the opposite walls together. Only the two side walls or those at right angles to the front will require to be gained for the ribbon, as the floor joists run across the front and rear walls. Studding at window openings *should invariably be doubled* and carefully placed so that the casings and siding can be nailed solidly on them, at the same time giving room enough in the opening to allow for ample pocket room for the sash weights; 2½ inches will be room enough. If 4x6 timbers are used for the corner posts, then they must be laid out in pairs, notching them 2 inches from the edge, and the width of the ribbon; I might say here, that it is the best practice to place 4x6 timbers with the 6-inch face to the side wall, thus giving the 2-inch difference of material to nail on the ribbon, and afterwards the plasterer's lath.

If the wall plates be the same height all round the building, then the outside wall studding may all be cut to the same length or one pattern; but should the plans and elevations call for several different heights of wall plates, carpenters should note them carefully, lay out and saw the studding to the exact length required for each height.

Cross studding or "headers" under window sills may be single pieces of wall studding, but those on top, both over window and door frames, are better doubled. Some double the side studding of the openings, the whole way from sill to plate, but a more economical method which might be advantageously followed, is as described in article 1.

Door or window openings of 4 feet or over in width should always have two thicknesses of studding and scantling, forming the head, to resist the pressure from above. Openings of 5-foot span or over *must* be trussed, something after the manner shown in Fig. 12, to prevent the beams above bending the upper plates downwards.

4. FIRST AND SECOND FLOOR JOISTS OR BEAMS, CEILING JOISTS AND BEAMS AND WALL PLATES.

First Floor Joists or Beams. The laying out and framing of floor-beams is a comparatively simple task, yet, like all other mechanical operations, it requires system and exactness.

A pattern is first made by which all the others are marked, so the student or carpenter should take the width between the sills across

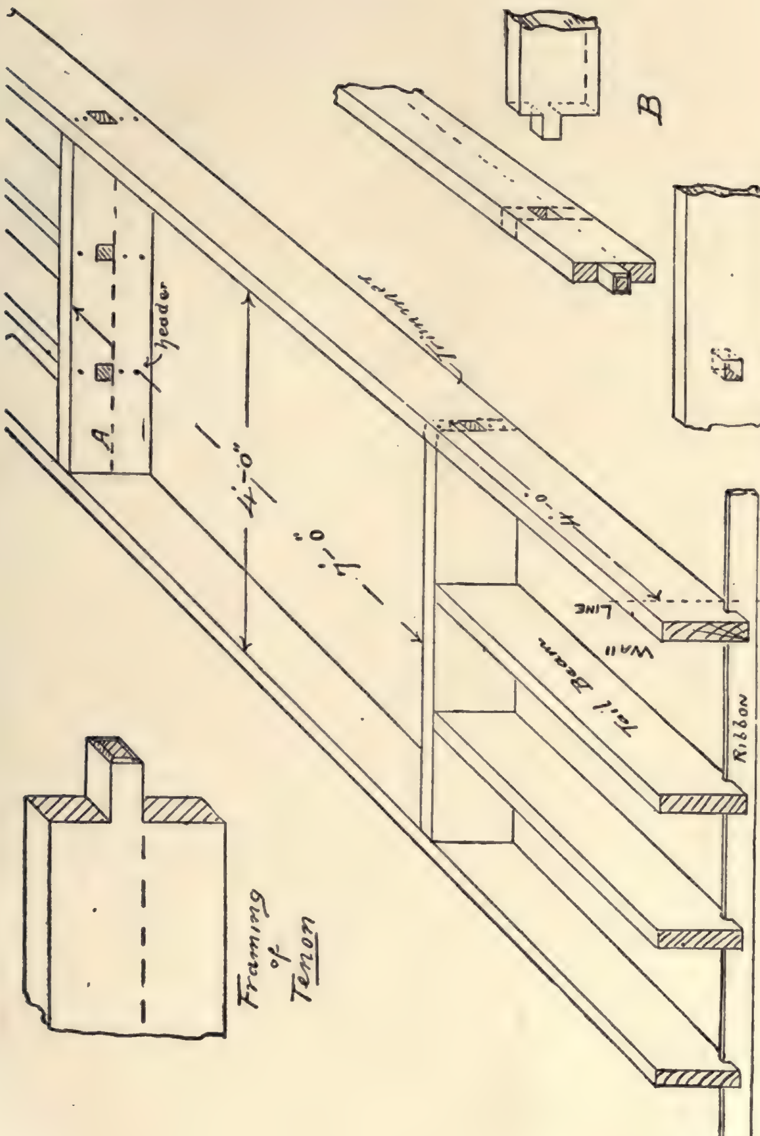

Fig. 13. Framing of a Well Hole.

the house with the ten-foot pole, and add on the width of the sill, thus: supposing the house to be 20 feet wide, then allowing 1 inch on each side for the rough boarding, the outside width would be 19 feet 10 inches. Now, if we deduct the width of the sills, say 12 inches, or 6 inches for each side, then the width between the sills will be 18 feet 10 inches. The pattern is then laid out on the bottom edge 18 feet 10 inches and 5 inches is allowed on each end over the dimension to rest on the sill. The pattern is next sawn, on each end 4 inches x 5½ inches, measuring from the bottom. If a 10-inch joist is used this will give 6 inches above the sill and the 4 inches below it will make the bottom edge of the joist come level with the bottom face of the sill, so that like the sill itself it will rest on the cellar foundation wall. The rounding or cambered edge of each beam *must be kept to the top* in order that the floor may have a slightly curved surface or crown, and allow it to settle straight. The reader will, of course, readily perceive that were the hollow edges kept up, the floor would be also hollow, and when it settled it would become much more so and render it both unsightly and unsafe.

In Fig. 13 I have drawn a view of a second floor stair-opening framed with "headers," "trimmers," and "tail beams."

This opening, technically called a "well hole," measures 4 feet wide by 7 feet long. The face of the header comes 4 feet from the inside line of the wall, so that in laying out mortises in the trimmer-beams for this header 4 feet must be measured off from the face of the wall, allowing for the bearing on the sill or ribbon. (I show this framing as for the second story, because the same rule is applicable for the first story.)

From the squared line 7 feet must be measured off and another line squared over for the face of the opposite header. Back of these lines the mortises must be laid out in the manner represented at B, Fig. 13. A is the neutral axis line or breaking line of the timber. *Every mortise must be made above the line* as represented on the stick marked "header," likewise *every tenon,* as drawn on the tenon framing to the left. The reason that the framing must be done in this way is, that the *neutral axis,* or more practically the breaking line of every beam, is in the center of its width, as shown by the dotted line on the face of the far header; therefore all mortises or holes made in beams must be above the line so as to avoid lessening its strength.

At B the student will perceive how the tenon is framed out to fit into the mortise. The tenon is usually the square of the thickness of the stuff or 2x2. Here also will be seen how the end of a tail beam is framed, in a similar way as the header. There is nothing very difficult in this work, the most important thing being care and accuracy in laying out the measurements and framing. The 2-inch blade of a steel square, and in fact the whole square, is most handy in laying out these beams. The method of spiking the joists together is shown by the nail heads.

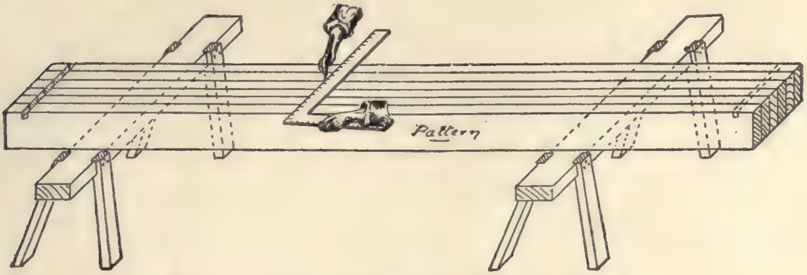

Fig. 14. Laying out Beams with the Steel Square.

Second Floor Beams or Joists. The laying out and framing of the second tier of beams is different from the first, for the reason that they rest on the ribbon or girt strip let into the inside edges of the side wall studding, as I described in "Posts and Studding," article 3. Their full length will be equal to the full width of the house as below, less ½ inch. The ends are kept short at each end to keep them back from the outside edges of the studding. The bottom edges are notched on the line of the inside edges of the studding, 1 inch wide and 1 inch deep to fit over the upper edges of the ribbon. These beams can also be laid out from a pattern. Fig. 14 shows one gain cut out, also how the steel square is applied and held, when laying out timbers.

One special point which must be noted in connection with laying out floor joists or beams, is to always place the pattern fair with the top or rounding edge of the timber and to mark the notches and gains at an equal distance from this top edge. This is done to make the top edges all level so that the floor may have a level surface when the beams are placed, and the flooring laid. It would be a safer method to nail a fence on the top edge of the pattern.

Ceiling Joists and Beams. These simply rest on the wall plates and will only require to be cut the same length as the floor beams except when the corners on the ends are likely to stick up above the top edges of rafters. Then the corners must be sawn off to leave the rafters clear for boarding.

Wall Plates. Except in structures of very large dimensions the wall plates of nearly all balloon frame houses built now are formed of 2x4 or 2x6 scantling in two thicknesses or doubled.

They are solidly joined at all inside and outside corners by being overlapped, and where there is a long side on the building, the joints are well broken to give extra strength. The 4-inch or 6-inch underside is laid out or spaced across for each stud to correspond with the sill at the bottom so that when the top ends of the whole number of studs are nailed to the spaced marks they will stand *plumb* and *straight*. Some carpenters prefer to lay out the plate from a rod after it is raised. Either of these ways is good, but there are some who would space them out with a two-foot rule as they are being nailed in, a method which I think is very liable to cause an error or get them crooked.

When gables occur on the ends, it is proper to return the plates across them, as in Fig. 8. This is largely done for economy, as it saves the over length of studding which would be cut off each gable from the plate to the ridge were the pieces put in from the sill to the rafter. Those wall plates on the gable ends should therefore be laid out, cut and framed before raising, as this tends to hold the walls together.

When the plates are level all round, or rather the walls all the same height, then they will all be set on studding of equal length, but as plans frequently call for plates of different levels and lengths, they must be very carefully studied and measured and clearly understood before the carpenter can lay out a stick of timber.

5. LAYING OUT AND FRAMING ROOF.

The Roof. The best constructional authorities have written and published, both in books and technical journals, very clear and accurate information, showing the proper methods for obtaining the lengths of hip and valley rafters, jacks, etc., and as all carpenters should be familiar with some of them they should study the articles on roof framing further on. In the meantime I will try to show the reader some points hitherto untouched in regard to laying them out.

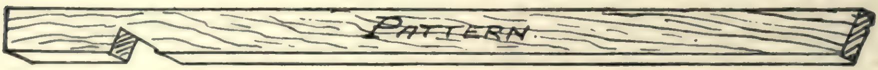

Fig. 15. A Pattern Rafter.

Rafters should in all cases be marked off by a pattern (see Fig. 15), laid out by a good method, to the pitch which the plan and section denote. The pattern can either be a piece of rafter scantling, or a piece of ⅞-inch stuff, but it must be framed *square*, that is, the cuts at the peak and bottom must be sawn perfectly square to the sides. This will give a reversible pattern or one that can be marked from either side or face. It must also have its top edge perfectly straight.

The rule regarding floor beams, about *keeping their rounding or crowning edges uppermost,* also applies to rafters.

There should never be less than 2 or 3 inches bearing on the wall plate on the bottom or level cut, in order to permit of a solid nailing into the plate, and thus do away with the liability of its slipping off the plate. Fig. 16 is an elevation of rafters with a collar beam, which is inserted to prevent long rafters from bending. This will require to be framed on the ground, and is sometimes halved out to fit under the bottom edges of the rafters or nailed on flat. The measurements should be carefully taken from the plans so as to give the attic head room called for.

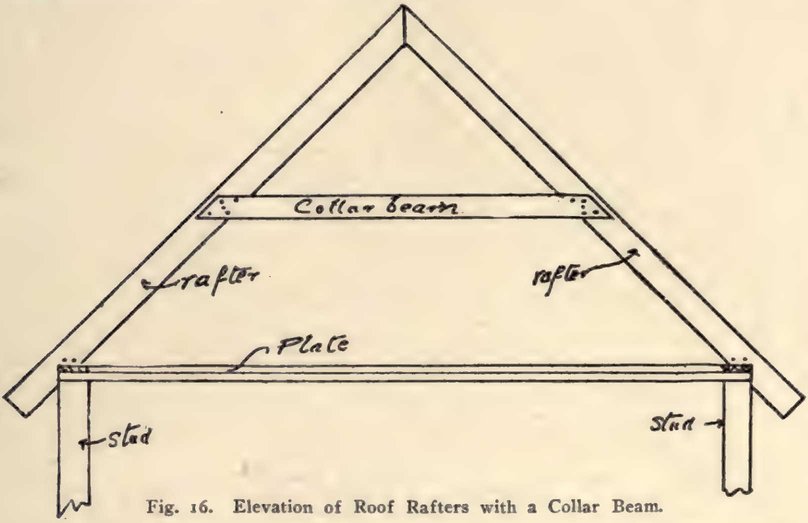

Fig. 16. Elevation of Roof Rafters with a Collar Beam.

Hip and valley rafters will likewise need to be as above; in fact, the student should make it a rule to always lay out frame, and put in position all bearing timbers, *rounding edge up.*

Hip rafters should be backed. I am aware that it is not now customary to do this, still it can be very cheaply done by nailing a beveled strip planed to the angle necessary on the top edge of the hip. This would be a better practice than simply nailing the roof boards on the " arises " of the hips, as is now done. I would now draw the attention of those carpenters who one day contemplate being builders to a point in roof framing generally unnoticed. It is usual in ordering hip and valley rafters to have them the same width or, more properly, the same depth as the common and jack rafters, and the thickest 3 inches or 1 inch thicker than the others. This might not exactly be called an error, but it is scarcely right, which readers will understand on reading the following. Hip and valley rafters are those that form the intersections of the roof planes and they usually have their seats on an angle contained within a right angle. For this reason, then, the top cuts on all jack rafters which fit against, and nail to, the sides of the hip or valley will be longer or rather deeper than the depth of those they are placed against, and this difference will increase according as the pitch of the roof is increased. It is therefore the duty of every roof framer to see that the hips and valleys are obtained wide enough to receive the whole width of the top cut on the jack rafters and give a solid nailing. To my mind it denotes very poor calculation to see one-third of the cut of the jacks hanging below the bottom edge of the hip rafter, and I have known architects who have compelled builders to remove the insufficient timbers and to replace them with others of adequate proportions.

I know there are some who will argue that the hip will be sufficiently strong supported by two sets of jacks without being particular about the joints. To these I would answer that the hip supports two planes and that half or two-thirds of a joint is only half or two-thirds as good as a whole joint. For roofs over one-third pitch the angle rafter should therefore be deepened; this matter must also be attended to in regard to ridges, which should, in all cases, be at least equal in width to the top cut of the common rafters which abut against it. They should be perfectly straight or slightly crowning on the top edge, but never hollow. They should also be laid out on one side with the spacing of the rafters. Fig. 17 will give the student a clearer understanding of what is written above, as it shows a projected view of the hips, ridge jacks, rafters and plates. When very long ridges are inserted, necessitating two pieces, end to end, to make up the whole length, the joint should be placed in the space between two rafters to allow a cleat or tie piece to be screwed or nailed across it to hold the pieces strongly together. Another important point is to lay out the ridge so that the rafters will abut against each other, and not at one side or other which would tend to bend the ridge after the rafters are placed in position. They may be either 1-inch or 2-inch stuff, as desired, but on light frame dwellings 1-inch stuff will be suitable.

6. RAISING.

There is no part of the construction of a frame building which requires more care or accuracy than the raising of the frame. I therefore trust that my remarks on this subject will be carefully read, as they will be found very applicable in practice.

Placing Cellar Girders. These will require to be lifted into the place on top of the piers built for them in the cellar, and set perfectly level and straight from end to end. Some prefer to give their girders a slight crown of say 1 inch in the entire length, and it is a wise plan, because the piers generally settle more than the outside walls.

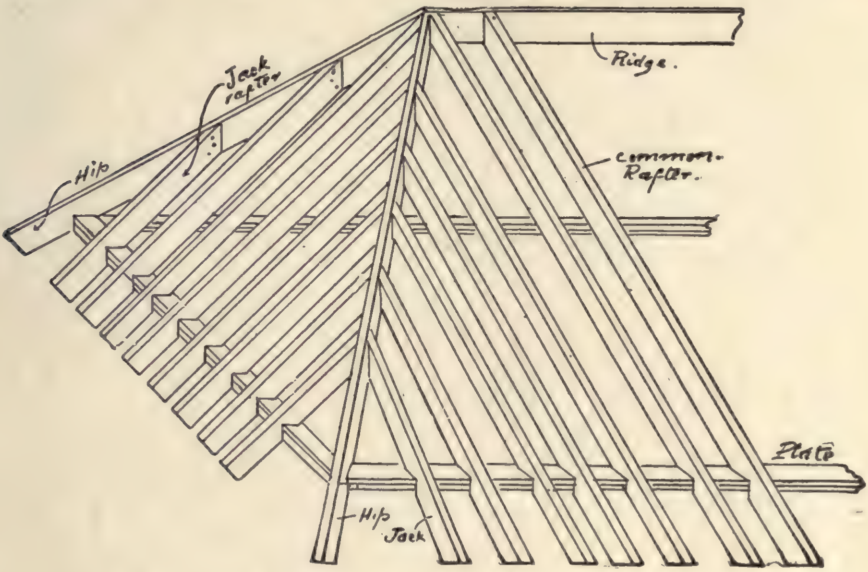

Fig. 17. Wall Plates, Hips, Jacks and Common Rafters in Position.

When there are posts instead of brick piers used to support the girder, the best method is to temporarily sustain the girder by uprights made of pieces of 2x4 joists resting on blocks on the ground below. When the superstructure is raised these can be knocked out and the permanent posts placed, resting their bottom ends on a broad flat stone, to form a base or foundation footing.

If the supporting posts and piers be not placed or built until after the building is erected, then carpenters should exercise good judgment when jacking the girders up, to place them under it and not raise them so much as to strain the building, and it is always desirable to obtain the crown mentioned before. The practice of temporarily shoring the girders, and not placing the permanent supports until after the superstructure is finished, is favored by good builders, and it would be well for carpenters to know just how it should be done.

Setting the Sill. After the girder is in position, the sills are placed on top of the cellar walls, rounding side up and hollow side down, and are very carefully fitted together at the joints and leveled throughout. The last operation can either be done by a sight level or by following the simple method I am now about to describe.

Place ⅞-inch blocks at short intervening distances on the length of each side, also one at either end, and set a long parallel straight-edge on them, also set a true level on the upper jointed edge of the straight-edge. The sill must be wedged up, or lowered down until the air bubble in the level tube is exactly in the centre, and each piece must also be wedged up or lowered till the blocks all touch the bottom edge of the straight-edge. In all cases the whole length of the sill should bear solidly on the stonework, and it should either be bedded in mortar or made solid with chip pieces of slate, stone wedges or furrings, and these should not be inserted less than 2 feet apart.

Sills are generally kept back ⅞ or 1 inch from the face of the stonework, to make the sheathing come flush with it, and allow the water table to project the thickness of itself (usually 1⅛ or 1⅜ inch) to keep the water off the stone.

Sills must be taken out of wind, that is to say, they must be level all around, so that when the carpenter sights them across with his eye (the other being closed), the surfaces will show as one line.

All sill joists will require to be toenailed or spiked to draw them closer together, and the running joints should be nailed dovetail fashion. When sills are made up of two thicknesses of plank, as they sometimes are, they will need to be solidly spiked together, to form one, with " dovetailed " nails.

As some of my readers may not clearly understand what is meant by " dovetailing " nails, I will here state that a carpenter dovetails nails when he drives two with the points inclining to or from each other, so that they form, as it were, a dovetail.

Setting First Floor Beams. This important job is done by experienced carpenters in the following manner:

The stairs and chimneys being conductors, or rather passing up from one floor to the next one above, and having timbers framed to form the openings, or, as they are technically called, " wells," the header and trimmer beams around them must be placed first. The proper method to follow then is, to place and nail one trimmer beam first, exactly in position on the sill, and then to insert its fellow opposite it, loose. When this is done the framed header may have its tenons placed in the mortises in the pair of trimmers, and the loose trimmer made parallel to the one that is nailed, that is, it must be the same distance apart at the sill end as the length of the header. When two headers are framed in, then it will only be necessary to straighten the trimmers from end to end. The trimmers will likewise require to be set square to the sills. After the headers are set, they and the trimmers should be solidly spiked together, keeping the headers square with the trimmers.

The tail beams or joists are next placed, the framed ends, with the tenons, being slipped into the mortises in the header, and there solidly spiked to keep them in place.

This practice of first placing all trimmer and header beams for stairs, chimneys, hearths, or other openings which are framed around, should always be adhered to, because the openings are then sure to be in their proper position as denoted on the first floor plan.

Having these set, the remaining single joists are carried in and placed on the sills, spacing them out at 12 or 16 inches between centers, as called for. The quickest way to space them is either to use a two-foot rule and (when 2-inch joists are inserted) to allow 10 inches between for 12-inch centers, and 14 inches between for 16-inch centres.

The student will, I trust, understand that when 2 inches more is added on, that is, 1 inch on each side, the centers of the timbers will be just 12 or 16 inches, as the case may be. When all the floor timbers are in and toenailed to the sills, a strip is nailed across the top edges to keep them from being overturned. This strip should be kept back at least 12 inches from the end, in order that it may not interfere with the wall posts or studding when raising.

A temporary floor must now be laid on the beams, by placing sheathing board across them, and they should be so placed that there may be no traps in the floor. By traps, is meant the ends of the boards which project over one beam and do not rest on the next, so that when a man stands on the end it is a trap which, being pressed downwards by his weight, lets him fall between the beams. In every case the end of each board should rest on a joist or beam to prevent this occurring. Fig. 18 represents a section of a balloon frame floor with the bridging, which is put in for the purpose of bracing the floor, in position, also the lath and flooring.

Raising the Outside Walls. This, the next operation, is performed very simply. If the wall be not too long, or not more than 25 feet, proceed to spike the wall plates on the top ends of the corner posts, also nail the ends of the girt strip, or ribbon, square in the jambs in the posts. Next place and nail one or two intervening studs on the plate and ribbon, to the marks on them which have been

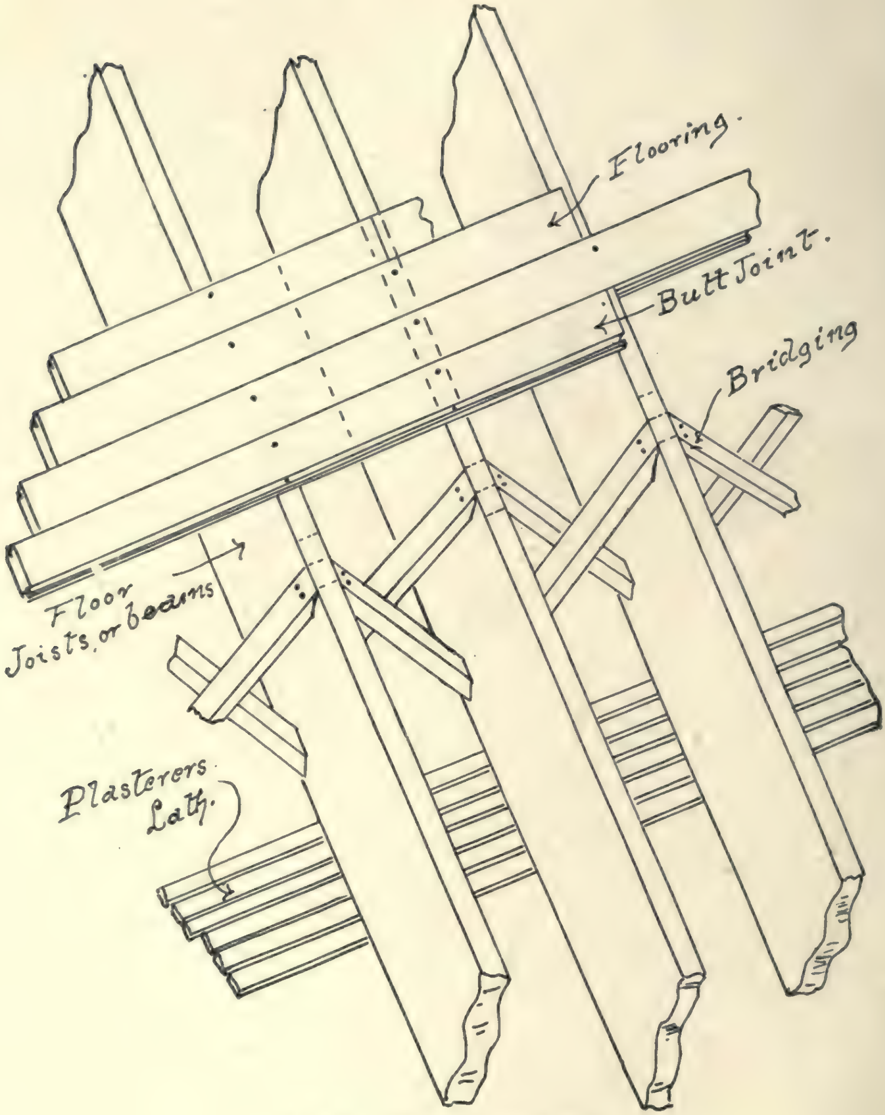

Fig. 18. A Balloon Frame Floor.

previously laid out. This can be done on the temporary floor laid on the first floor beams.

A man is now stationed at each stud and post, and the construction raised, and braces are nailed on each stud and post to prevent falling. These are nailed as high up as a man can reach, in order that they may hold it firmly.

The next thing is to plumb and brace the wall, which is done by one man holding a plumb rule against the surface of a post or stud and watching the bob, while another stands ready to nail the bottom end of the brace into the sill or beam, whenever the bob indicates that it is exactly perpendicular. The rule must be applied to both sides of the posts, to insure their being plumb both ways, and two braces will be needed, or one on each of the sills which form a corner.

If the wall plate be laid out the same length as the sill, then plumbing one post will plumb both, that is for one wall, but both posts must be plumbed separately for the end walls.

Supposing the side walls to be raised, the intervening studding may be inserted, but where window and door openings occur the studding on each side of them must be doubled. This may be done either by putting them in full length reaching from sill to plate, or by placing single studs full length, and after nailing in the cross headers to cut in cripple studs the length of the window opening. For the sake of economy the last method is most popular. The side studs, forming openings, must likewise be plumbed.

Where there are stretches of wall between windows and doors over 4 feet in length, the studding will need to be spaced 16 inches between centers, or 16 inches from the inside of one stud to the outside of the next, which, it will readily be understood, is the same thing. Carpenters call this spacing from " in to out," and follow it for joists, studding and rafters.

If the intended house will be situated in a locality where it may be exposed to much strain, through heavy wind pressure, it would be well to cut in an angular brace, abutting against the corner post, under the ribbon, and fitted down on the sill abutting against a window stud. This will stiffen the frame, and is a practice largely followed along the Atlantic coast, where the dwellings are frequently subject to the pressure of heavy gales. See Fig. 7.

Another thing, always essential, is to properly truss over window and door openings, which can either be spanned by a 4x6 timber, or the weight above can be carried over to the studs by angle braces. In any case, where four or five studs, supporting a plate and timbers, occur over a window, precaution should be taken to resist the downward pressure in the above way.

When the sidewalls are raised and braced, the second floor or tier of beams or joists are raised and fixed in position, resting on the ribbon, and holding the walls together by the notch which I described

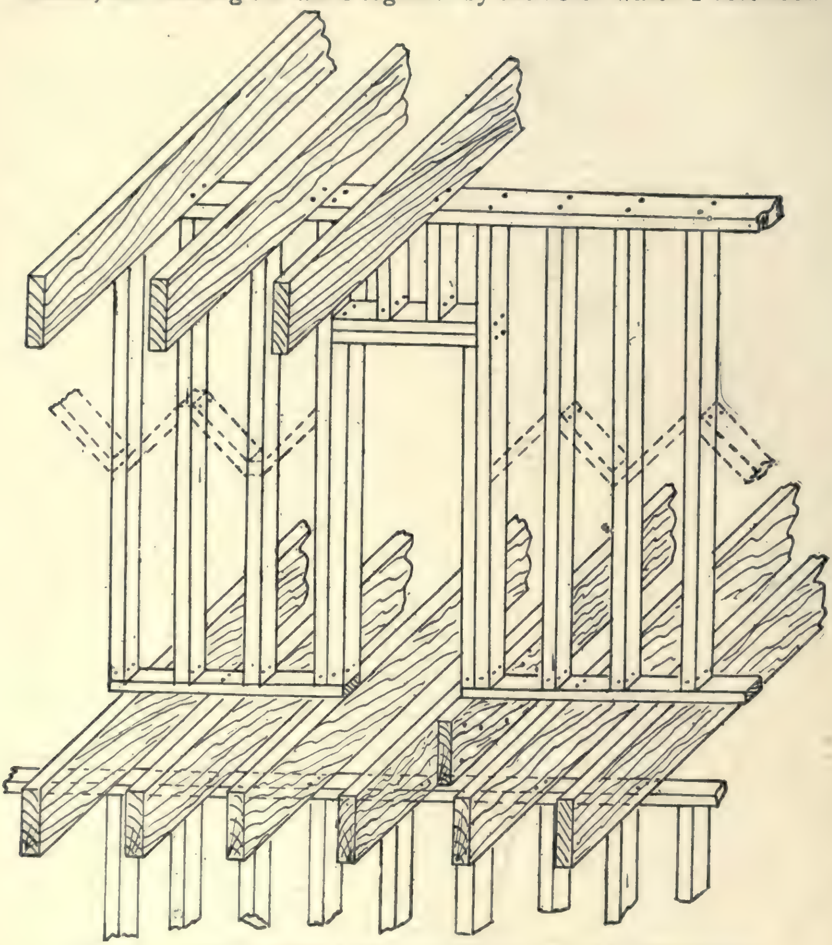

Fig. 19. A Framed Inside Partition Crossing the Beams at Right Angles.

in article 3. It is best to nail each joist against each wall stud when possible, as it enables the carpenter to make the construction more solid by nailing them to each stud as they occur.

The second floor beams are placed on the ribbon in a similar manner, being set so that the notch or gain in their bottom edges drops on the edge of the ribbon. All those beams which come against studs should be spiked solidly thereto. A temporary floor is laid as below to enable the men to walk about and work on.

The third floor or attic timbers must rest upon the wall plate, and can be set either before the walls are sheathed or after, but it is usual to set them before commencing to board the sides.

Bridging should always be inserted and the top ends nailed solidly into the floor beams before the floors are laid. The bottom ends can

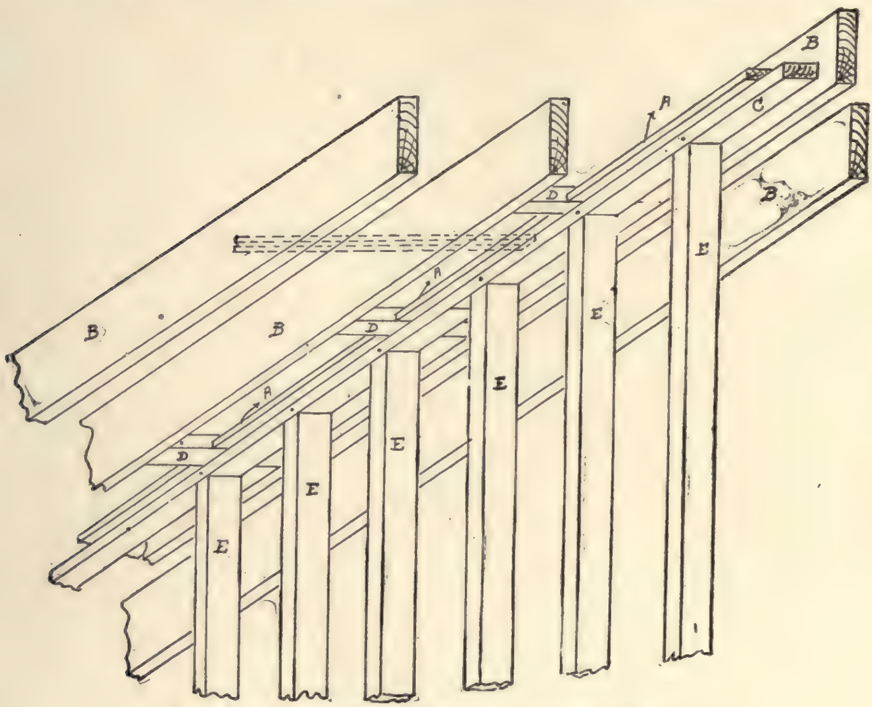

Fig. 20. Framing of a Partition Between Beams.

be nailed after they are laid, thus stiffening and raising up the floor. The writer prefers to nail the bridging top and bottom before laying the flooring, thus preventing sagging under the super-added weight of the floor, and he condemns the practice of laying the floor before the partitions are set. Herewith are presented two sketches showing the proper way to construct and bridge inside partitions. Fig. 19 is where the partition crosses the beams at right angles and Fig. 20 where it runs in the same direction as the beams. It will be noticed in the latter that blocks have to be set up to receive the top piece and that a strip is nailed on the top of the plate to which the ends of the laths are nailed for plastering.

The heights between the floors are usually taken with two rods, sliding them apart till the ends meet floor and ceiling. Not more than ¼-inch over length should be allowed, and measurements for partition studding should be taken with the top plate on the bottom plate, measuring with the rods up. Partition lines should be laid down with a chalk line.

Raising the Roof. When the top floor attic beams are placed, the temporary floor described above must be laid across them. This can be made up of the boards to be used in covering the roof, usually of spruce or hemlock. A peak scaffold must next be constructed, formed out of two uprights, 2x4 studding, and bearers and braces of strips or boards. The height can be taken with a ten-foot pole, by measuring off the height from the floor to the ridge, and then deducting the height of a man who will stand on it; thus, if the height to the peak be twelve feet, then the scaffold should be about 6 feet high. It need not be more than 3 feet wide, or two boards in width, so that one man may stand and walk on it, and it should be well braced. When the scaffold is ready the rafters may be raised in the following manner:

Commencing at the gable end, a pair of rafters one on each side of the ridge are set up, with their top cuts abutting, and the bottoms on the plates may be nailed solidly to each plate. Another pair are set up similarly on the other gable, or near the valley if there be one on the roof. The ridge is next lifted up and set in between the peak cuts, and there solidly nailed. These can now be braced by nailing on a board reaching from the rafter on the gable to the plate. This will be enough at first. The intervening rafters, spaced 16 inches or 12 inches on centres, as desired, are set up in place, care being taken to keep the ridge straight in nailing. Hips, valleys and jacks are next set up and the whole roof well braced diagonally with several boards to prevent it being overturned by the wind.

Collar beams may be inserted either before or after the roof is covered, but the safest method is to cut and nail them in before the roof boards are nailed on.

The projecting ends of the attic floor beams are now sawed off and the roof is ready for cornice and covering.

Some builders set inside partitions at the same time as the outside walls, before covering in, but this hinders free movement on the floor when working, handling timbers, etc. Inside partitions should always be set first on the first floor, and then on the second floor, and so on up, thus maintaining the levelness of each. Great care must be

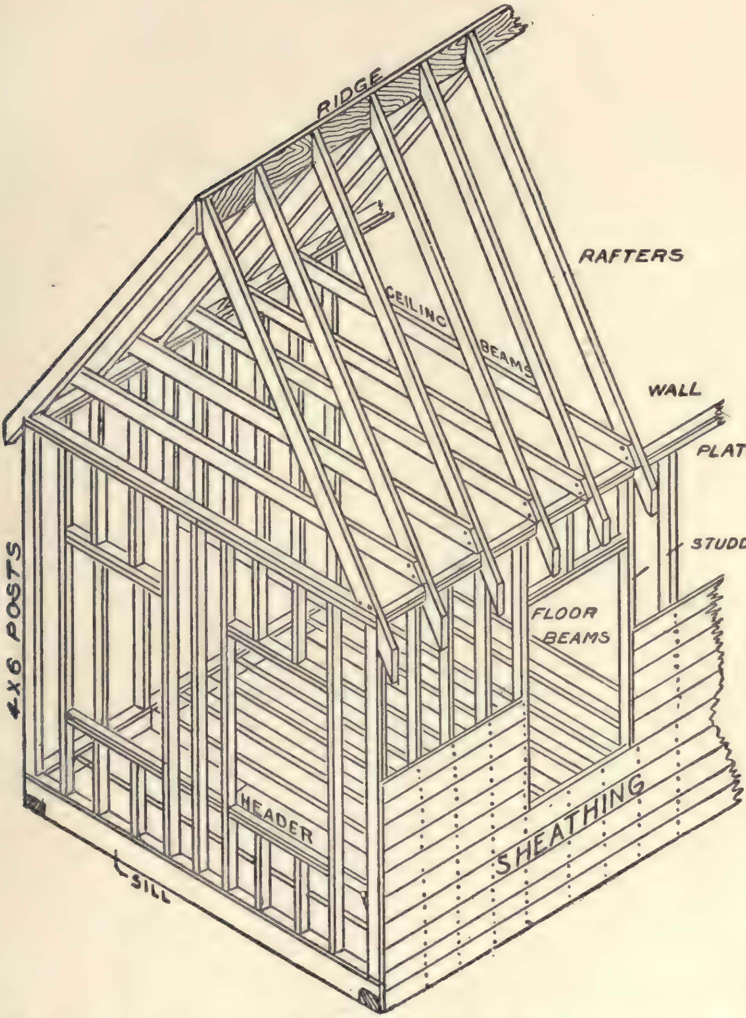

Fig. 21. The Frame of a Small Framed Cottage, of One Story, with the Ceiling Beams and Rafters Raised, and one Side Partly Sheeted or Rough Boarded. Upper Headers are Doubled in the Windows.

exercised to have all door and window studs perfectly plumb, and headers perfectly level.

All nailing should be done without splitting the timber, nor should the hammer head be driven into the wood any more than necessary. This should be especially guarded against in toenailing, as too often the end of the rafter, stud, etc., is broken off and the nails have no hold whatever.

Long beams, hips and valley rafters must be kept straight from end to end by sighting them through with the eye, likewise all long studding. This is essential for the reason that the spacing must be accurate for the plasterer's lath, flooring, boarding, etc.

Balloon framed houses are a better job when sheathed or boarded diagonally. It is a little more expensive in the labor, but stiffens the whole construction.

Thirty- and twenty-penny spikes, and ten-penny cut nails or wire nails are the best for nailing together the timbers of balloon framed houses.

A ladder for climbing floors can be readily made up of two sound 2x4 joists and ⅞x2 cleats or strips nailed on the edges of the joists with eight-penny nails. Steps should be spaced 12 inches apart.

Nails for Flooring and Roofing. The following table will give carpenters the proper size of nails to order for any job. The table is for ordinary widths from 3-inch to 7-inch boards:

TABLE.

Thickness of floor.	Size.	Length.	No. to pound.
⅞ inch	8-penny	2½ inches	92
1⅛ inches	10-penny	3 inches	60
1⅜ inches	12-penny	3¼ inches	44
1¾ inches	16-penny	3½ inches	32
2 inches	16-penny	3½ inches	32
2¼ inches	20-penny	4 inches	24
2½ inches	20-penny	4 inches	24
2¾ inches	20-penny	4 inches	24

7. BRACED FRAME HOUSES, HOW TO LAY OUT, FRAME AND CONSTRUCT THEM.

Framed houses constructed on the braced system differ from those of the balloon type in the fact that the timbers with which the whole frame is made up are framed or mortised and tenoned together so as to be solidly and securely fastened.

In this respect houses constructed in this manner differ from those constructed on the balloon principle as in the latter the pieces are simply held together by nails while in the former they are mortised, tenoned and pinned. Braced frames are the best construction for frame houses. By reason of its great expense this system is not so popular as the balloon principle, yet as it is sometimes adopted in good or large work every carpenter should have a knowledge of it.

Fig. 22 is a skeleton or perspective view of the side walls of a braced frame house and the parts are of the following sizes and thus framed: the sill, generally a 4x6 or 6x8 timber, is halved together at the corners and mortised out for the foot of the posts where they occur, whether at the corners or other places on the sill. Intermediate posts are often draw pinned as shown in the figure, but this is scarcely necessary as the weight of the post is in itself sufficient to keep the tenon in the mortise. Fig. 23 will give a clear conception

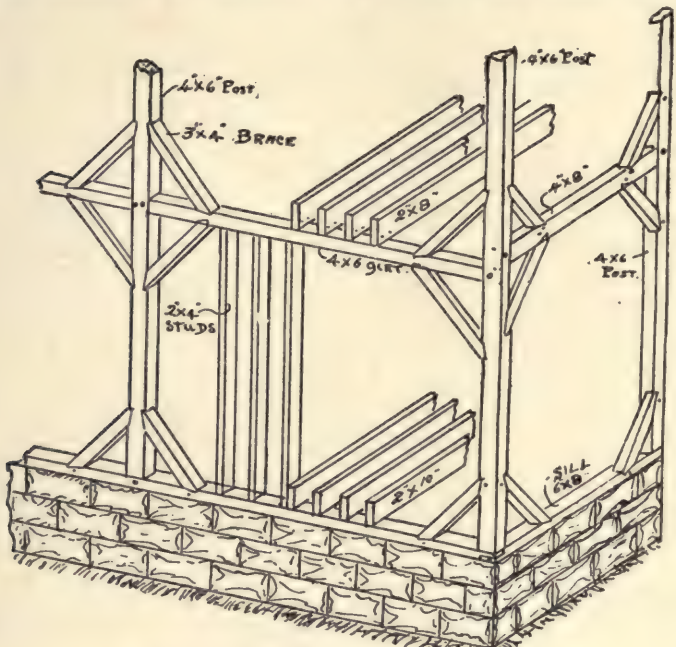

Fig. 22. Construction of a Braced Frame.

of the method of framing the foot of a post into the sill. The tenon is about 2 inches square and 2 inches deep and the mortise is the same square size, 2½ inches deep. The principal object of the tenon is to prevent the post slipping off the sill.

Referring again to Fig. 22 it will be seen that the first floor beams rest on the sill, being supported in the center of the width of the house by a girder or heavy timber 6x10 or 8x12, according to the width. These first floor beams are usually 2x10 or 2x8 timbers and either rest directly on the sill or are halved out to rest on both sill and stonework of foundation. Here I have for simplicity drawn them resting entirely on the sill.

The second floor beams are supported by a timber termed a " girt " or inter-tie, which is mortised and tenoned into the post in the manner shown in Fig. 24, on the top of the engraving. Here also will be seen the method of framing the end of the braces into the posts, sills, girts, wall plates, etc., in order to obtain a rigid construction. The mortise is cut in square but by reason of the brace being on the angle it is necessary that one side be on the angle, as shown, and the gain to receive the thrust of the brace will require to be set on in the way represented above the dotted line of the framed end of the brace in the enlarged portion of Fig. 24.

All posts, girts and braces and plates are draw-bored after being framed to receive the pins. An inch auger bit is generally used.

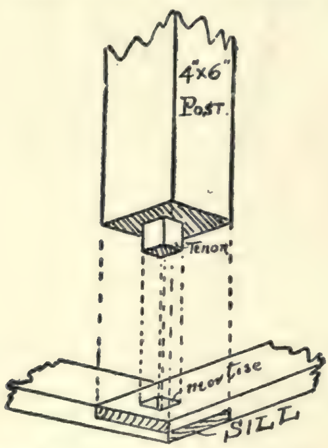

Fig. 23. Framing of Post and Sill.

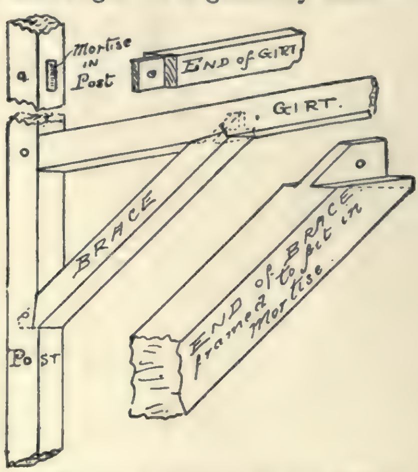

Fig. 24. Framing of Girt and Brace.

By " draw-boring " is meant that the hole in the tenon is generally nearer to the shoulder of the piece tenoned than the hole in the mortise, in order that the taper pin may draw the shoulder closely up against the piece which has the mortise. Pins should be 1 inch diameter and made of oak for a spruce or yellow pine frame.

Studding in braced frames is sometimes tenoned into mortises in sill plates, girts, etc., but the time it costs to pursue this method is fast doing away with it and they are nowadays mostly cut in " barefoot " or without tenons, having only a squared butt end.

In Fig. 25 will be seen a side view of a braced frame showing the main parts as in Fig. 22, also the studding set at the frame round a door and window, the plates set on, and part of the roof raised.

The plates are 4x4 stuff halved together at the corners and mortised on the under side to receive the top ends of the posts. The positions of the timbers will be readily comprehended from a study of Figs. 25 and 26, as they are very clear, and by a comparison with Fig. 22 will be easily reproduced in actual work.

When laying out braced frames care should be taken to lay out and frame all the sills, posts, girts, braces, studs, plates, etc., the exact length; they should also be very carefully mortised, tenoned and fitted together before the pairing. When framing the post the mortises for the girts must be placed one underneath the other. Fig. 26, being an enlarged view of the framing, will illustrate how this is done, and it will be seen in some of the preceding figures. It will also be noticed that the shoulder of the girt is gained into the post. This is often done in high-class work, though it is scarcely necessary, because the square shoulder with the braces and studding under any girt is sufficiently strong without gaining it in.

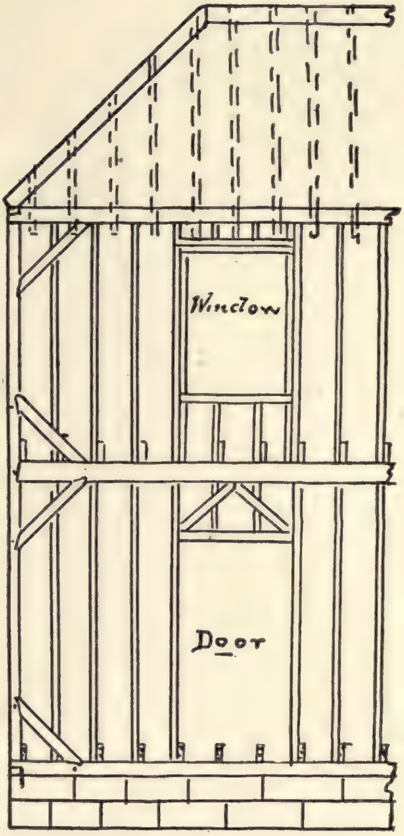

Fig. 25. Side View of a Braced Frame.

I cannot lay too much stress on the necessity for very carefully measuring all the pieces, especially the braces, which may either be laid down to scale, or full size, or laid out with the steel square.

When raising, the cellar girders and sills are first set on the stone foundation, then the sides are set up, the posts being first placed and braced with boards, then the side girts are inserted in the mortises and pinned; the end girts come next and after this the studding on first story (if cut in bare-foot). If not, the whole side framing, sill, girt, and all may be put together, pinned and raised as one " bent " or piece of framing. The wall plates and second story studding may be set up after the second floor beams are set and a temporary floor laid on them to walk on.

Fig. 27 will show the method to be followed in framing round a chimney breast, with a header, tail beams and trimmers.

In Fig. 28 readers will obtain full information in regard to the manner of placing a framing together, posts and girts in barn or other heavy framing, so as to obtain great strength.

8. HOW TO FRAME OUT BAY WINDOWS AND PROJECTING STORIES.

Bay Windows. This is a problem in the construction of frame dwellings which sometimes occurs and taxes the ingenuity of many carpenters, so I am pleased to offer some explanation of the methods of doing it.

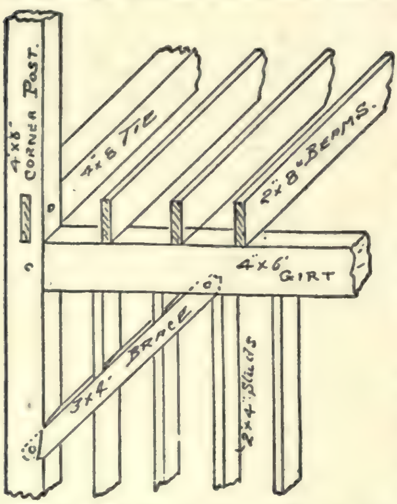

Fig. 26. Details of Braced Frame Construction.

Usually, bay windows, either of square or octagonal plan, are on the first story, built with the rest of the frame, and having the sill resting on a stone or brick foundation, the sill being on a level with the main sill of the house, as shown by Fig. 11.

Sometimes this does not occur and the architect may either frame out a bay window on the first story or place it on the second story. Often two windows are introduced, as will be seen by referring to the illustration Fig. 29.

As to the methods of framing out these windows I have shown two in Fig. 29. On the front or right side the bay window demands special framing; because it cannot be supported on the floor beams or joists in the way by which the side window is obtained. On the side the floor timbers are simply allowed to project out beyond the face of the wall, the projection necessary to support the octagonal form shown, and the plate upon which rests the window studs necessary for the bay is

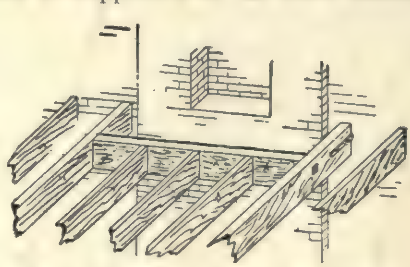
Fig. 27. Framing Around a Chimney Breast.

nailed on top of them. The plan, Fig. 29, will give the readers a clear conception of this construction.

For the window on the front a very different form of framing prevails. Here the fact that the bay must be supported by floor beams at right angles to the regular floor beams of the house compels the carpenter to use his ingenuity in supporting the window safely, and I therefore put forward the method illustrated at the right of the plan, Fig. 29 and in the elevation, Fig. 30. The principle adopted is that of a cantilever, and is simple in construction and quickly framed.

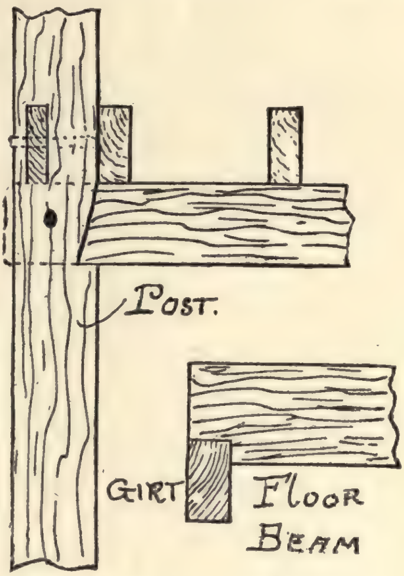

Fig. 28. Details of Braced Frame Construction.

It will be noticed, then, that the two central supporting beams rest on a plate placed under them, which is in turn directly carried by the first story wall studding, and that they are mortised and tenoned into one of the floor beams (the third from the wall), thus making the floor beams *balance,* as it were, the weight of the bay window timbers resting on it outside the face of the wall. In a similar manner the two outside projecting and supporting beams are mortised and tenoned into the second beam from the wall, and it will be seen that the second beam is mortised and tenoned into the central beam on each opposite side, by this means forming a perfect counterpoise. Short pieces of beam stuff are cut in between the supporting beams, on which to nail the flooring; also on the angles of the bay. The mitre cuts of the octagon may be found by using the figures 7 and 17 on the steel square or by any of the simple methods in everyday use.

Some framers prefer to double up the third or fourth floor timbers and frame all the supporting timbers into them, but I am opposed to this plan, as so much mortising weakens the beam and does not distribute the strains.

The figures on the following page are used in order to find mitres on the steel square for laying out bay windows:

12	and	12	=Square	Mitre,	or	45°		
7	"	4	=Triangle	"	"	equilateral		
13¾	"	10	=Pentagon	"	"	5-sided fig.		
4	"	7	=Hexagon	"	"	6	"	"
12½	"	6	=Heptagon	"	"	7	"	"
18	"	7½	=Octagon	"	"	8	"	"
22½	"	9	=Nonagon	"	"	9	"	"
9½	"	3	=Decagon	"	"	10	"	"

Projecting Stories. Referring to Fig. 32, readers will comprehend what is meant by a projecting story, and will see that it is the pushing out of the front of the second story beyond the front of the first story below; also by setting out the third story or gable beyond the second story, thus getting a very effective front. This construction should be done carefully and with a close attention to the strains which will be permanently placed upon the timbers, so that there may be no overstraining of the timbers and consequent

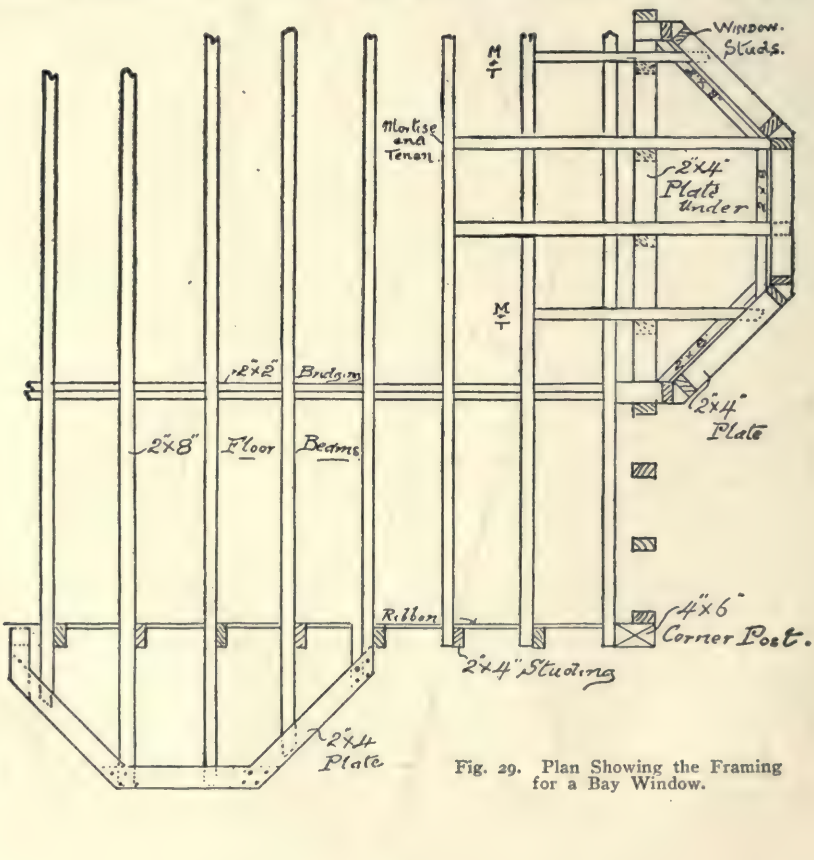

Fig. 29. Plan Showing the Framing for a Bay Window.

cracking of the plaster. Fig. 32 is a section of the three stories of the house from the sill to the ridge showing the constructive timbers, and it will be seen that as the greatest strain comes on the first story, the timbers of that story must be of increased strength in order to safely support the superstructure above. This will include the posts, studding, floor, beams and plates. For an ordinary two-story framed cottage the posts will do at 4x6, the studding at 4x4 for the first story, and 3x4 for the second story; the second story floor

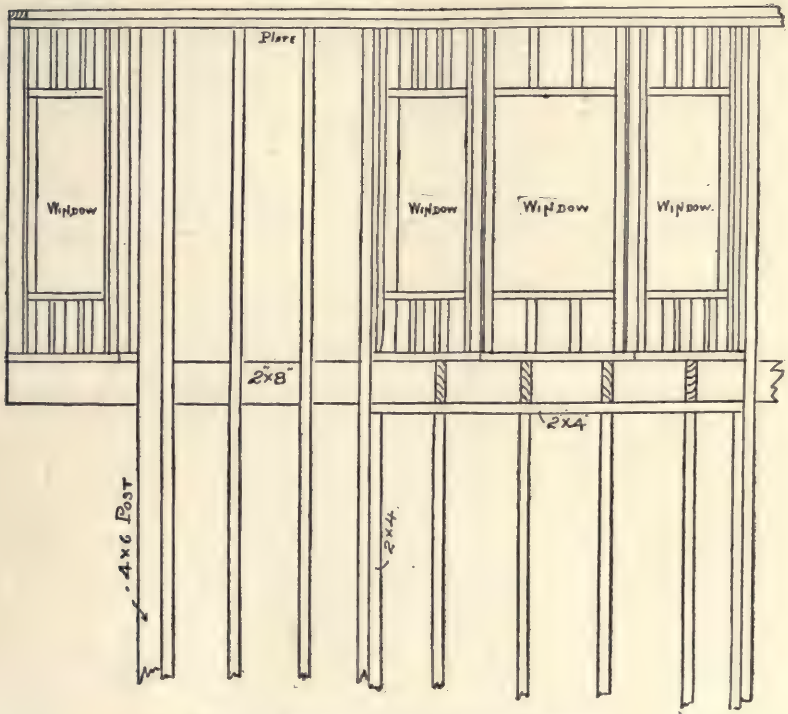

Fig. 30. Elevation of Bay Window Framing.

beams will do at 3x10 and the roof at 2x8. All these timbers will require to be carefully and accurately framed and *braced* to make sure that all support the framing above, and prevent that lateral movement which is only too common in modern balloon frames, so that the lower stories must be braced at angles to stiffen it thoroughly if possible. It is best to frame the angles with a mortise and tenon brace; but should the expense prevent this the balloon framing and braces which I illustrate in Fig. 31 will be sufficient; when the studs

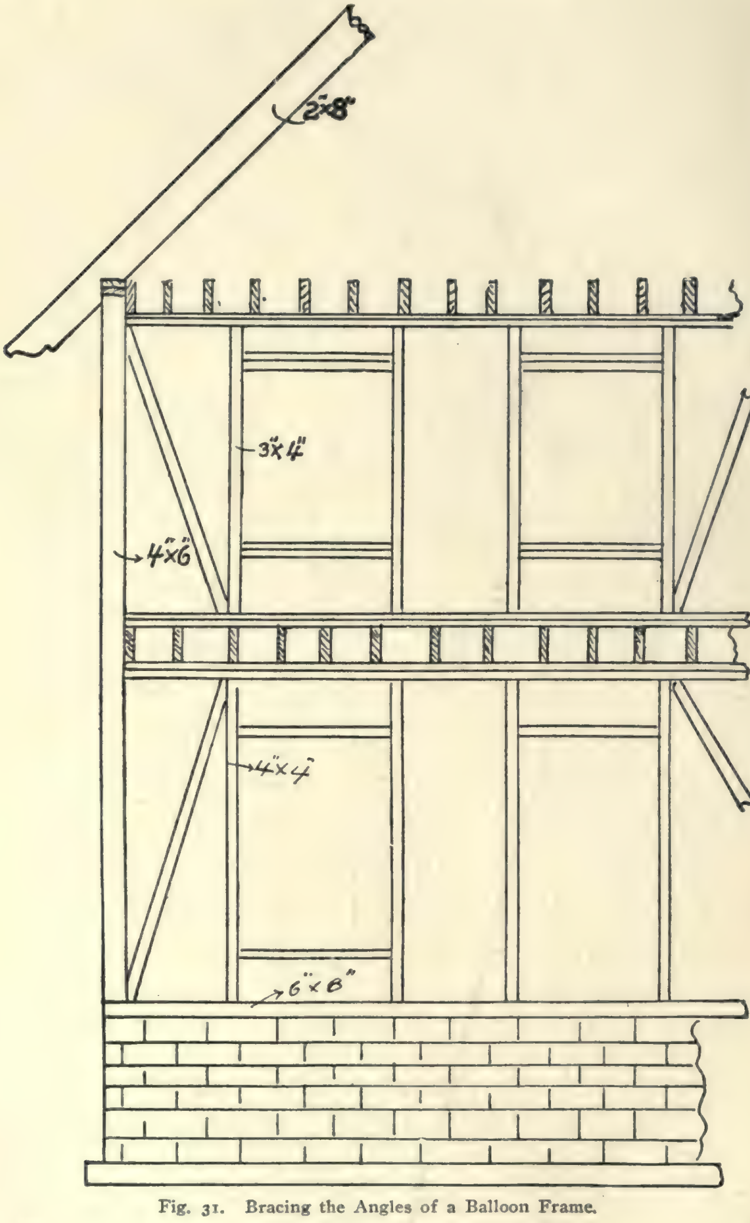

Fig. 31. Bracing the Angles of a Balloon Frame.

are thick as 4x4 or 4x6 it will not be necessary to double them at doors and windows nor need the headers be doubled.

When framing over openings it is essential that the plates supporting the first and second story floor beams *must be trussed,* and the strain carried directly over to the upright studs without resting on the cripples or headers. This trussing must be inserted over large door openings, and should a bay window occur, a lattice girder truss from 12 to 18 inches deep must be placed under the floor beams to prevent any subsidence of the plates.

Regarding the use of a ribbon, which some favor in projecting out second stories, I would say that it can be used with perfect safety if of not less than 10 inches in depth, but it is not an economical method of construction, for the reason of too much cutting of the timber and consequent waste. The method illustrated in Figs. 31 and 32 having a separate plate carrying each tier of floor beams is the simplest and easiest raised. It will be noticed in these figures that the corner posts and studding of the sidewalls are carried up so as to leave the top of the plate of the sidewalls level with the top edge of the ceiling beams.

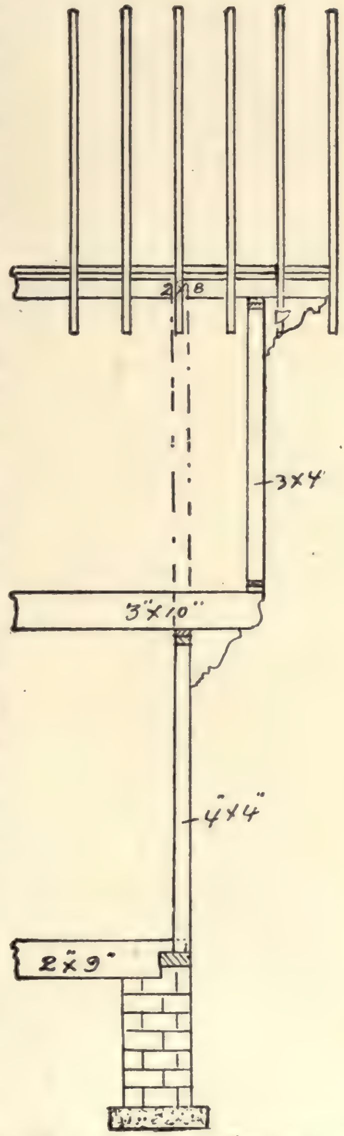

Fig. 32. Framing an Overhanging Story.

9. SHEATHING, SHINGLING AND CLAPBOARDING.

Sheathing. As soon as the exterior studs are in position, the building should be sheathed with inch boards nailed diagonally so as to give additional bracing to the studs.

The roof should be sheathed with 1¼-inch boards to allow a better hold for the shingle or slate nails.

Shingling. When the cornice is set and the gutters on, the roof is sheathed, the valleys should be tinned and the flashings put around the chimneys, the tin being first carefully painted on both sides. The roof, with the exception of the valleys, is also often covered with felt or tarred paper, and the shingles are then put on, commencing at the eaves. Each shingle should be laid with three laps, according to the weather, 5, 6 or 7 inches as may be required, and each should be nailed with two galvanized iron nails, one on each edge.

Clapboarding. When the roof is completed the window and door frames are inserted, and the casings or architraves nailed on. The building is then covered with prepared paper and is ready for clapboarding.

Before commencing to put on the clapboards, the water table is put in place, and it should lap 1½ inches over the foundation wall on its lower edge, and be cut on its upper edge so as to allow the clapboards to form a tight joint.

The clapboards are usually ½ inch thick, the width varying from 5 to 6 inches. The clapboards should lap 1 inch.

Care must be taken to have a tight joint between the clapboards and the door and window casings. Strips of zinc are sometimes laid at the junction of the clapboards and casings, and this is particularly desirable at the top of a casing.

10. DIFFERENT METHODS OF BRACING PARTITIONS.

After careful observations of many partitions, I am satisfied that the average carpenter and builder is not really aware of their true structural value. Most mechanics regard a partition simply as a wood and plaster wall, for separating rooms and supporting the floor beams above, and though these are their principal objects, they should always be used and built as a part of the structure of the house to increase its statical strength. To this end I have deemed it advisable to set before my readers a few suggestions regarding these important details of building construction.

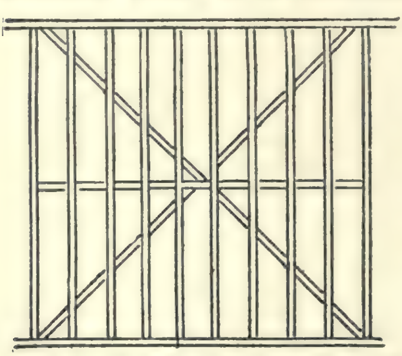

Fig. 33. Partition with Horizontal and Diagonal Bridging.

As I have stated in previous articles, the usual method of erecting partitions is to set the studs 12 or 19 inches apart from center to center, setting all studs plumb, then to cut in horizontal bridging as illustrated in Fig. 33. Bridging is sometimes pitched, as also shown by the dotted lines in Fig. 19, so that it may tighten in case there should be any settlement, but this method is very little better than the straight horizontal bridging. In frame houses I would recommend that cross partitions in the center of the house be "braced" and not " bridged " in order to stiffen the side wall and prevent the building straining, or any liability of its being strained by any outside forces such as wind pressure, etc. This bracing can be very economically done by the method also illustrated in Fig. 33; as will be seen, it consists of simply cutting in a line of bridging from corner to corner diagonally, each piece being driven down until it tightens.

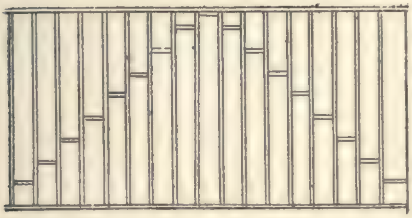

Fig. 34. Bracing a Long Partition.

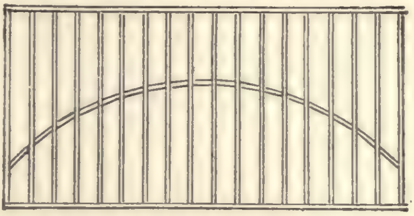

Fig. 35. Arched or Curved Bridging.

Fig. 34 represents a method which the writer has successfully followed in bracing a very long partition, and it will be noticed here that the bridging is cut in between the studs, each piece being nailed in horizontally. The method is, however, somewhat faulty, as the studs are liable to be bucked or sprung when nailing in the bridging; for this reason I would suggest that the curved or arched bridging shown in Fig. 35 be adopted for long partitions, especially if it supports floor beams in the center of a span or be a " fore and aft " partition. This method of introducing the arch formed of small pieces of studding is, as far as I know, not usual and has been followed by the writer in many jobs, with the result that each partition was not alone self-sustaining on each story, but was also rigid.

When partitions are built of studs set on their flat, they should have more bridging than those set the 4-inch way.

Partitions should, if possible, be filled in with some incombustible material to render them both sound and fireproof.

11. FRAMING WOODEN WALLS FOR WINDOW OPENINGS.

Herewith I illustrate by three sketches the methods to be followed in framing wooden walls for window openings. Fig. 36 is the plan and on it will be seen the different details of construction of the window frame, including the weight pocket, which should ordinarily be 2½ inches from the back of the pulley stile to the face of the stud to permit the weights to pass freely up and down. The top header is usually doubled and the construction is the same as shown in Fig. 37. Fig. 38 is the bottom header with the sill stool and apron, and the construction is clearly shown and easily understood by a close study of the pieces. About 1 inch is allowed to permit the frame to slide into its place.

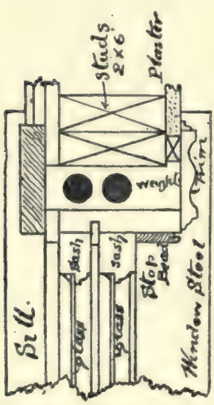

Fig. 36. Plan of Window Frame.

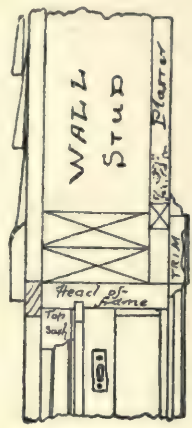

Fig. 37. Section of Top Headers.

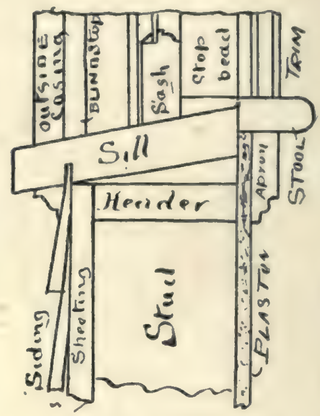

Fig. 38. Section of Sill.

12. FRAMING, SHEETING AND SLATING AN EYEBROW ROOF WINDOW.

The proper method to be followed in making this form of attic window is not always clearly understood and as it is becoming more popular every year, replacing the old fashioned dormer in low pitched roofs, the method may be of value to many.

In Fig. 39, assume AB to be the length of the window, in this case 6 feet at ½ inch scale, and the height 3 feet. Draw the center line DC, and the end lines from A and B at right angles to AB, the sill line. Now the outline of the window is AEB, and the sash and frame of the *eyebrow* outline are as shown in the figure; at a 4-foot radius.

Next proceed to Fig. 40 the section, and note the pitch of the house rafter, and at the proper distance up from the eave of the roof the sill and the height of the window, which is 3 feet.

Assuming the eyebrow window rafters to be *concave,* or hollow, they should be at an 8-foot radius and should locate the point *c,* Fig.

40, where the covering of the window roof intersects the main roof. Now divide the curve of the eyebrow into equal parts, as in Fig. 39, and transfer these over to Fig. 40, as shown, and with the 8-foot center and patterns, lay out the curves of the rafters according to the number desired, that is, if the roof is boarded across or horizontally—3, 4, 5, 6, 7, 8, etc., will be the curve and length of each rafter, and be set up as they are shown on the right side of Fig. 39.

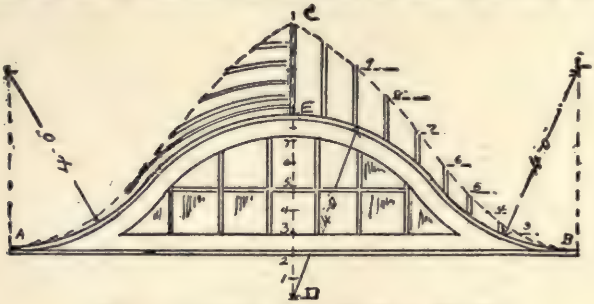

Fig. 39. Elevation of an Eye-Brow Window.

Now lay off from Fig. 40 back again to the elevation, Fig. 39, the points where the curved rafters die into the main roof and mark up square to the sill from division points on the curve. The intersecting of these lines will give the curve C B, Fig. 39, which will be the shape of the valley on the roof. If desired, the vertical rafters can be sheeted with ½-inch pine strips, bent round in two thicknesses, and well nailed to each rafter and breaking joint in each thickness. Another way to frame this roof is to use horizontal, instead of vertical, curved rafters, in the way shown to the left of Fig. 39, each rafter following the outline of the front elevation of the window and dying into the roof as it curves upward. In this case also the sheeting board must be bent. Three thicknesses of ⅜x2-inch pine strips, laid breaking joint, make a reliable sheeting, and one slating nails can be nailed to.

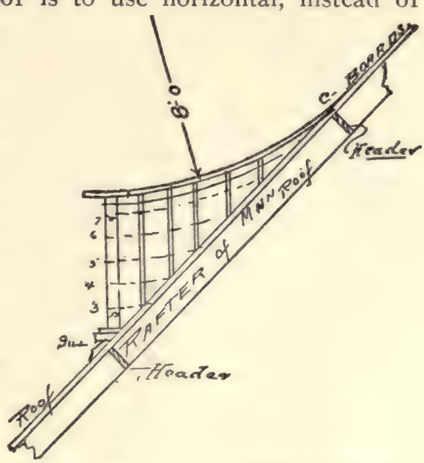

Fig. 40. Section of an Eye-Brow Window.

Regarding slating or shingling the roofs of these windows, I would state that the first course should follow the curvature, and project over the front of the window and continue horizontally up. The slates should be very narrow and may radiate from the valleys.

13. PORCHES AND PIAZZAS.

Much the same rule will apply to the framing of porches and piazzas with their roofs; that is, the plate is nailed on first, then the beams, the floor is next laid and the posts and roof are then set up.

Porch and piazza floor beams should be laid parallel to the front of the house and pitched down and out about ½ inch in every 12 inches,

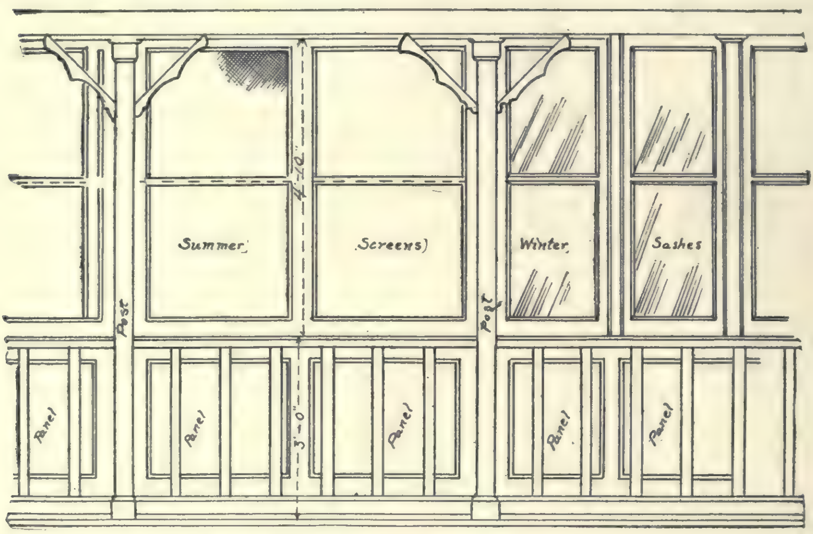

Fig. 41. Method of Enclosing Porch.

in order that the joints of the flooring may be in the line of the water running off the house. This will give 3 inches pitch in a 6-foot porch, enough to keep it always dry and prevent rot. Porch floor beams should either rest on brick piers or good posts, and have sufficient footing to prevent settlement.

Enclosed Porches. It is often a requirement to enclose porches, either with screens for summer or with sash for winter use. This may easily be done without disturbing existing work in the following way. The new work should be fastened to existing work with screws so as to be adjustable and movable in accordance with the elevation shown in Fig. 41. The enclosure should consist of white pine framed paneling, two or three panels in width, with mullions and sashes above as seen at the right of the figure. This should be 1½ inches in thickness and should be fastened between the existing columns or posts of the porch and should be fastened thereto by screws so as to be readily removable. On top of the paneling above the existing balustrade or railing a series of sashes and screens of two or three pairs each should be hung to mullions with 3-inch loose pin brass hinges. Screens may be placed in summer weather and glass sash in winter, glazed portions being made weather tight and set with double thick glass. All sashes or screens should be fastened on the inside with bolts and catches. A door should be provided to conform with the paneling and sashes shown on the drawing, and may be placed where desired. Either double or triple screens or sashes may be employed, according to the requirements. Both styles are shown in Fig. 41.

14. GENERAL HINTS.

If wooden posts are used to support a girder in a cellar, they should rest on a stone at least 8 inches above the cellar floor, otherwise the lower end is liable to rot. Cast iron columns are better than wooden posts; brick piers are best.

The sill being near the ground, and usually resting on a wall of masonry which attracts moisture, is liable to rot. Care should therefore be taken to have the top of the foundation wall at least 18 inches above the surface of the ground, not only to insure a dry wall for the sill to rest upon, but to prevent water from working under it during a rain. Decaying sills are a fruitful source of trouble and expense in wooden buildings.

After placing the sill, lay out upon it with a pencil the position of all doors and windows, and then of each stud.

For spans of not more than 16 feet, 2x10, or 3x9-inch joists are sufficient. A wider span in the first floor can generally be reduced by a girder in the cellar.

One of the most prevalent omissions which is to be found in new work is that of omitting to set the water table before commencing to clapboard and simply putting on the bottom course and continuing up. This is a very deleterious practice and should never be permitted by good mechanics. In every case the water table should be set and levelled all around the house the very first thing, and if possible, well painted; then the corner boards nailed together and set up; and finally the clapboards put on, with the bottom course well beveled and fitted close to the pitch of the water table, so as to form a water-tight joint.

When the floor beams carry a partition, it is customary to put in a girder, or two beams are laid together. Another plan is to place two beams 6 inches from centers; this arrangement gives not only a bearing for the studs, but an opportunity for solid nailing of the flooring.

No beam should be placed within 8 inches of a flue. A space of 2 inches should also be left between a girder and the chimney breast.

The main partitions upon which the beams rest in a house when the beams do not extend in one length across the building, should be set at the same time as the exterior studding.

Such partitions should rest on a wall of brick or stone, or upon a girder.

Stud partitions should never be used in a cellar. The studs are liable to rot and to harbor vermin.

No beams should be placed on a partition which has not direct support from the foundation, unless the partition itself is trussed.

In all partitions carrying beams, or wherever it is possible, the studs should rest on 2x4 plates, and not on the beams. The object of this is to avoid settlement caused by shrinkage. Timber shrinks crosswise, not lengthwise. The shrinkage of a 2-inch plate would be but one-fourth of the shrinkage of a beam 8 inches deep. In a building of several stories this becomes a serious difference and would cause the doors to settle and the plaster to crack.

Besides the main partitions there are cross partitions which of necessity rest on the floor beams, as the rooms in the upper stories are usually of different dimensions from those below. It is sometimes possible to truss these partitions so as to bring the strain on the exterior studs and the main partitions.

Chapter II

How to Frame the Timbers for a Brick House

15. GENERAL DESCRIPTION, FIRST STORY FIRE-PROOF FLOORS, WOOD FLOOR BEAMS AND STUDDING.

In writing this chapter I have endeavored to follow, as closely as possible, the methods of construction laid down by the building laws of the City of New York, as they embody the best forms of construction existant, and are both semi-fireproof and economical.

By referring to Fig. 42 of the illustrations, readers will be enabled to obtain a very clear idea of the floors of a city house or flat in course of construction. There are four stories, supposed to be partially erected, namely—basement, first story, second story and third story. The brick party wall, on the left, is carried up to above the third floor beams, and right frontage is built to the level of the second floor beams. The first floor is fireproof; that is to say, it is constructed of steel beams, filled in with brick arches; the thrust of the arch between the beams being resisted by the wrought iron tie rods seen in the figure, which is an isometric section of a corner house, placed on the northeast corner, showing the south gable front. Fig. 43 is the projection of the framing of the first story fireproof floor, showing how the I-beams are bolted together by knees. It also shows the tie rods, anchors and templets under the beams on the brick foundation wall. Figs. 44 and 45 show two details of different constructions for filling in between the beams.

In Fig. 46, a very inexpensive system of setting centers for turning the brick or terra-cotta arches between I-beams will be seen. It consists of 2x4 or 2x6 spruce joists laid lengthways on the top and bottom flanges of each I-beam; the bottom joist being hung to that on the top by means of 1x3 or 1½x4 spruce cleats or strips. The curved bearers are set on the bottom strips and nailed thereon and the battens are laid on loose edge to edge, thus making the centers easily removed from the arch to the next opening, when the cement has set sufficiently hard to allow it, by simply wedging off the strips from the upper joist. The writer has seen many arches turned on this simple and cheap form of center and it works admirably, carrying both men and material safely. The cleats should be nailed

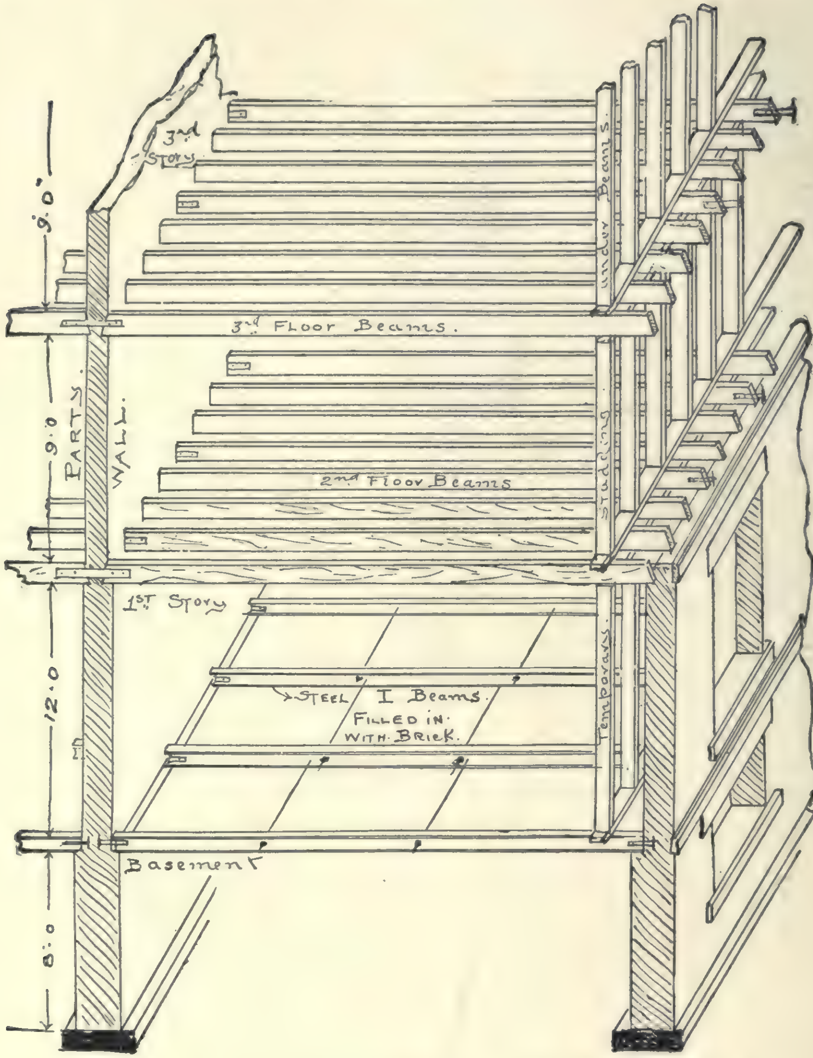

Fig. 42. Framing the Timbers of a Brick House.

opposite each other on different sides of each beam, and be spaced about 6 feet apart. Wire nails are the most reliable for this job.

Fig. 47 shows a view of a completed concrete arch with the centering in. This centering is supported by another method, the bottom joists being supported by hooks which are fastened to the I-beams by clips. See Fig. 48. When the arch has set the wooden centering may be loosened by the removal of the hooks.

Fig. 47 also shows the method of laying sleepers or bearers in concrete laid on top of brick or terra-cotta arches in fireproof floors. Strips 4x4 or 3x3 are set in the concrete above the level of the I-beams. These must be set level and fair with the line and straight edge so the finished floor will be level. The writer is much opposed to this method, however, because even if the strips be *dovetailed* and set in the wet cement concrete, as they dry, they will invariably

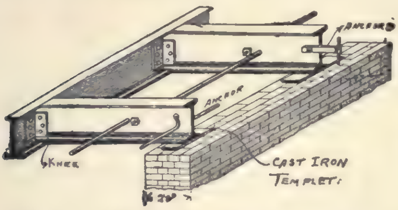

Fig. 43. Method of I-Beam Construction. with Tie Rods, Knees, and Two Different Styles of Anchors.

Fig. 44. A Floor with Brick Arches, Leveled up with Concrete and Wood Strips, Imbedded for Flooring.

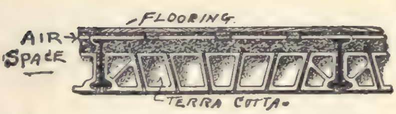

Fig. 45. Hollow Terra-Cotta Arch Floor, with Concrete and Wood Strips Imbedded to Receive Flooring Nails.

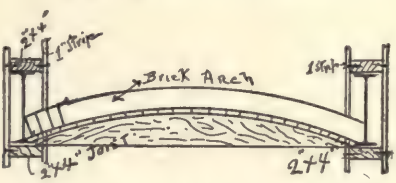

Fig. 46. Method of Setting Centers for a Brick Arch Floor.

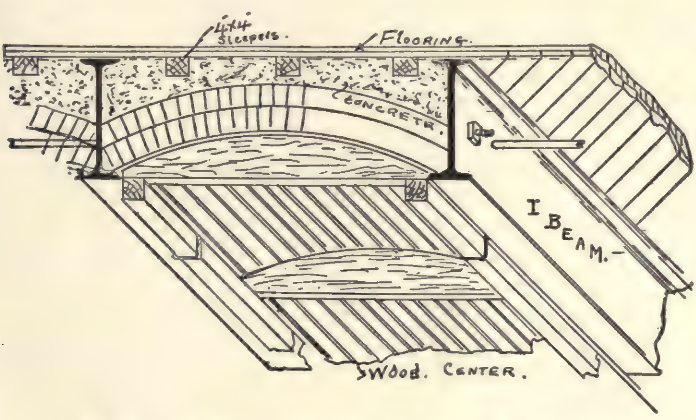

Fig. 47. Section of Brick Arch Floor in its Construction.

shrink and become loose. To this is added their liability to rot from absorbing the dampness in the concrete. For placing these sleepers

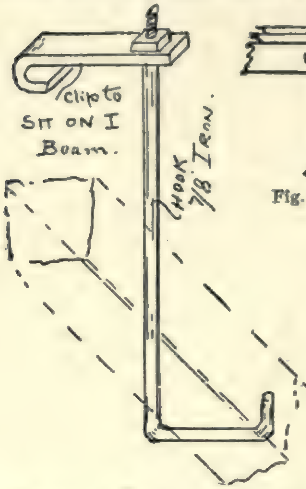

Fig. 48. Hook Support for Centering.

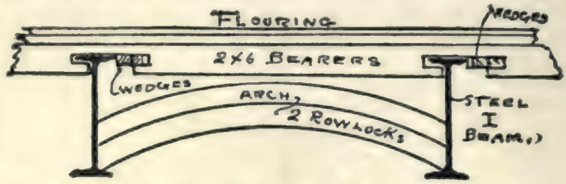

Fig. 49. Section Showing Method of Wedging Bearers.

or bearers the writer has adopted the method represented at Fig, 49, where they are wedged fast and, being above the concrete, cannot rot or be affected by shrinkage. This form of construction can be clearly understood by studying the figure.

In Fig. 42 it will be noticed that there is a temporary line of stud partition placed back of the front wall at each story. These are inserted for the purpose of supporting the several tiers of beams on each floor, till the front is built up to them; as the practice usually is to build the side, rear and party walls first, and then build the fronts up to them. The reason of this is that the front stone-setters or front bricklayers, work much slower than the rough wall men, and, in consequence, the temporary partitions are placed by the framer, or carpenter, so that no time may be lost, or men delayed. There is no waste timber in using this expedient, as the studding and plates, shown on the illustration, are used in the inside partitions when the roof is on and they are being set; but great care must be used in setting the beams level. For this end the measurements must be carefully made and the studding cut the exact length. The New York building law, however, calls for *not more* than two stories of any wall to be built in advance of any other wall, so *that not more than two rows of temporary partition should be needed.* These rows of studding should be kept back at least 3 feet from the face of the wall.

When the beams are being framed their ends must be beveled. They are usually 3 inches thick, and *must* be beveled to not less than 3 inches, or the square of their thickness. This is also shown in Fig. 42, together with the method of anchoring the beams to the brick walls. It will be noticed here that in the party wall *strap* anchors are used, and in the gable T anchors. If there be two gables, or side walls, or if the beams on opposite sides of the party wall be on different levels, then T anchors must be inserted, and all anchors should have the T at least 8 inches, or the thickness of two courses of brick in the wall, as in Fig. 50.

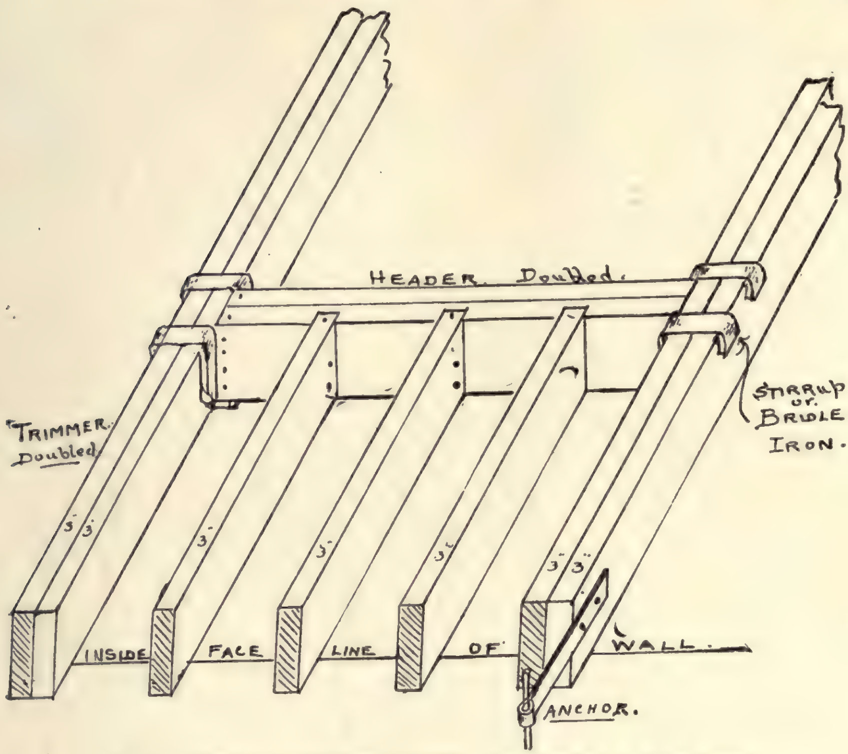

Fig. 50. Headers and Trimmers Doubled, also Framing of Floor Beams.

Where well-holes for stairs, trap-doors, hatchways or skylights occur, according to the exigency of the plan, they have the header and side beams doubled, the headers and tail beams being mortised, tenoned and joggled together and hung in a bridle or stirrup iron as seen in Fig. 51. This useful appliance in framing is a wrought iron strap so constructed that it hangs or hooks over the trimmer or headers and sustains the headers or tail beams so as to add additional strength to the beam. The writer prefers not to mortise the tail or header beams, but to simply abut them against the face of the beam and spike it solidly thereto, believing that the stirrup is sufficiently strong to support the beam without weakening the header to which it is attached.

All wooden *trimmers* and *headers* should not be less than 1 inch thicker than the floor or roof beams of the same tier, when the header is 4 feet or less in length; and when the header is more than 4 feet and not over 15 feet in length or *span* the trimmer and header beams shall be at least double the thickness of the floor or roof beams, or be made up of two beams spiked together. This is illustrated in Fig. 50 also.

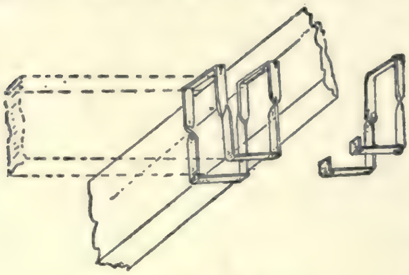

Fig. 51. Stirrup Irons.

The following list of manufactured stirrup irons either for doubled beams or single girders will materially assist the architect or builder in designing or estimating from plans and specifications.

BUILDERS' STIRRUPS.

Standard or Stock Sizes.

Size of Stirrups.	Size Iron 5/16 x 1¾	Size Iron ¼ x 2	Size Iron ⅜ x 2	Size Iron ⅜ x 2½	Size Iron ⅜ x 3	Size Iron ⅜ x 3½	Size Iron ½ x 4
4x10x2	.16	.23	…	…	…	…	…
4x12x2	.18	.26	…	…	…	…	…
4x14x2	.20	.29	…	…	…	…	…
4x10x4	.20	.27	.32	.40	…	…	…
4x12x4	.22	.30	.36	.45	…	…	…
4x14x4	.24	.33	.40	.50	…	…	…
6x12x3	…	.33	.40	.50	.58	.66	…
6x14x3	…	.35	.50	.55	.63	.72	…
6x10x6	…	…	.38	.48	.58	.66	…
6x12x6	…	…	.41	.52	.63	.72	…
6x14x6	…	…	.45	.56	.68	.78	…
6x16x6	…	…	.50	.60	.73	.84	…
8x10x8	…	…	.43	.54	.65	.76	1.25
8x12x8	…	…	.48	.58	.70	.82	1.35
8x14x8	…	…	.53	.63	.75	.88	1.45
8x16x8	…	…	.58	.68	.80	.94	1.55
10x12x6	…	…	…	.60	.73	.84	1.40
10x14x6	…	…	…	.64	.78	.90	1.50
10x16x6	…	…	…	.68	.83	.96	1.60
10x12x8	…	…	…	.63	.75	.88	1.45
10x14x8	…	…	…	.68	.80	.94	1.55
10x16x8	…	…	…	73	.85	1.00	1.65

I would state here that it is scarcely necessary to bevel the roof beams, as the decrease of 4 inches, from a 12-inch to an 8-inch wall, leaves it unnecessary. All wooden beams must be trimmed away from all flues, not less than 8 inches from the flue. Fireplaces must have trimmed arches to support the hearths, 24 inches wide, measured from the face of the chimney breast. The several tiers of beams must, of course, be anchored, as before described, and the anchors should not be less than 6 feet apart, or nailed on every fourth or fifth beam, as represented in Fig. 42. Anchors should be of wrought iron, ⅜-inch thick and 1½ inches wide, nailed with ¼-inch nails. Beams resting on girders may either be overlapped the width of the girder, or abutted, end to end, and tied together with a double strap.

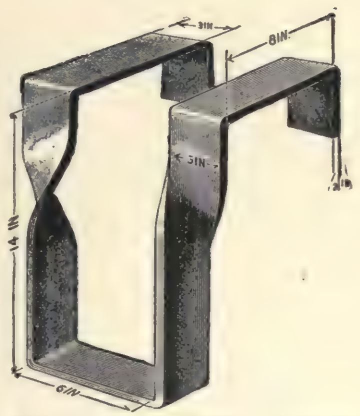

Fig. 52. A Joist Hanger, or Stirrup.

The method of anchoring the front wall is shown in Figs. 53 and 54. The plan of the roof, Fig. 54, shows that every tier of beams front and rear must have, opposite each pier, hard wood or hard pine anchor strips dovetailed into the beams diagonally, which must be inserted in at least four beams and nailed to each, but they *must not* be let in, within 4 feet of the center line of the span of the beams between the walls. The wrought-iron anchors are then placed as I have drawn them in the illustration. The section of the front, Fig. 53, will show better how the anchors hold.

Fig. 53. Section of Store Front Seen in Fig. 69. Anchor and Strips, Tying Beams to Wall.

In regard to stud partitions, I would say that, when they run across the house they are built in the usual way with a top and bottom plate. When longitudinally, or *fore and aft* partitions, as they are usually termed, or run directly over each other, they have the top plate only and the bottom ends of the studding passing through, or between the floor beams and resting on the top plate of the story below, in the manner represented in Fig. 55, which is a projected section of an upper story floor, showing the floor beams and plates and studding of a *fore and aft* partition. When the spacing of the studding compels that one or more studs should rest on a beam or trimmer as the engraving shows, then, of course, it is not possible to pass them through, but they should invariably rest on the plate below and the space between filled in with old or broken brick so as to make the partition semi-fireproof. As I have previously

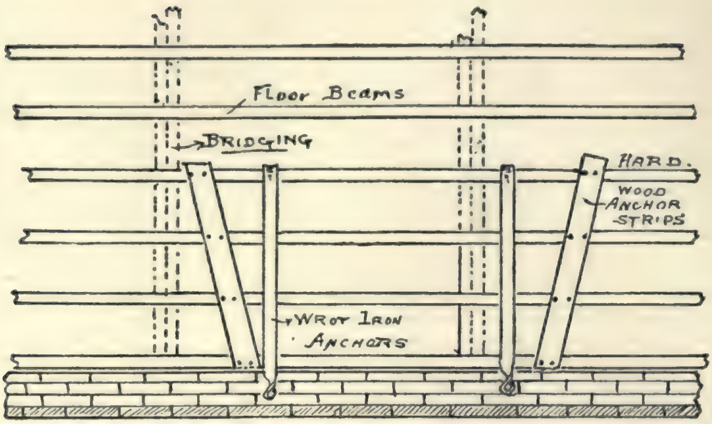

Fig. 54. Plan of Floors, Showing Method of Anchoring Front and Rear Walls to Beams.

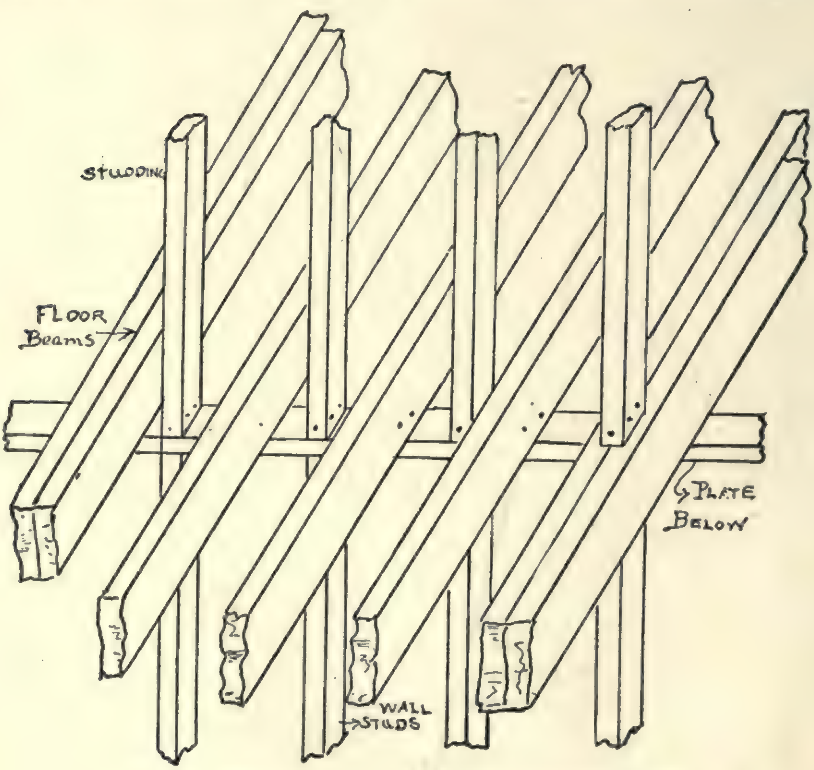

Fig. 55. Section of a Fore and Aft Stud Partition at Floors.

described the methods of centering for the arches between the first story steel beams and other details, I will close this article by advising all readers to study the actual construction when in progress, as it is in this way only mechanical information is acquired.

16. SECOND AND UPPER STORY BEAMS, PARTITIONS AND BRIDGING.

Continuing the consideration of the methods to be followed in framing the timbers for a brick house, I show readers at Fig. 56 the second floor plan of the floor timbers for a house with a splayed or sloping plan on the front of the house, thus necessitating shortening each floor beam as they are spaced out to the acute angle. This peculiar plan is caused by an avenue not running square or at right angles to the street.

In this case the front anchor strips let into the beams would not be necessary and could be omitted, provided the end T-anchors were

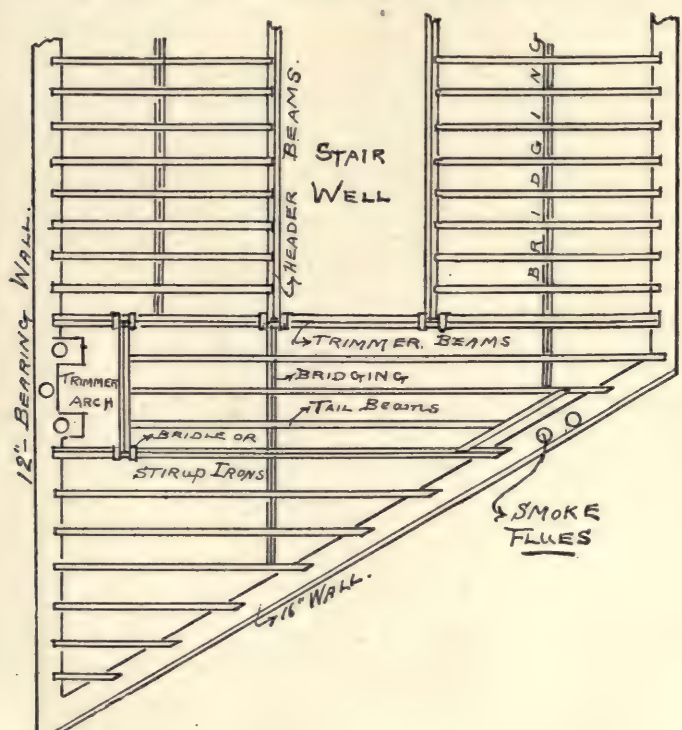

Fig. 56. Framing Plan of a Brick House with a Sloping Front.

placed on every beam and well nailed thereto, thus tying the walls together.

In this figure I also give a very clear conception of the proper way to proceed in framing around openings, by doubling up the *trimmers* and *headers* and hanging the headers in *stirrup* or *bridle* irons and framing of the tail beams. All trimmer beams should be thoroughly anchored, and the *tail* beams should also have some anchors. Some framers claim they are useless on *tail* beams, but I maintain that if tail beams are well nailed to the *headers* they ought to hold and help to tie the sidewalls together. To the left of this figure a trimmer arch will be seen to be turned with one skewback abutting against a

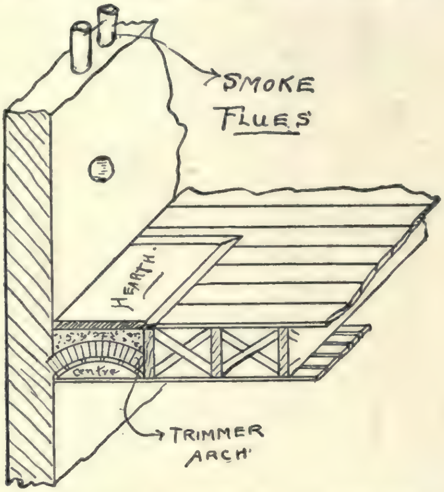

Fig. 57. Section Through a Floor at the Hearth.

beveled strip nailed to the face of the header in the manner represented at Fig. 57, which is a section taken through the floor at the hearth, showing the floor beams, *trimmer arch,* bridging, lathing and flooring, also the flue, and the flue linings, which are now inserted in almost all smoke flues. A center is set for each trimmer arch in the usual way, but is not usually removed or *broken out,* as the material thus saved is not worth the expense of removing it. The object of the *trimmer* arch is to make the hearth incombustible, and consequently the beams are not liable to catch fire, being so far removed from the smoke flues.

Bridging should be set about every 6 feet between bearings, and if possible, for greater stability, should start from the end of a header or against a wall. This is also shown in Fig. 56.

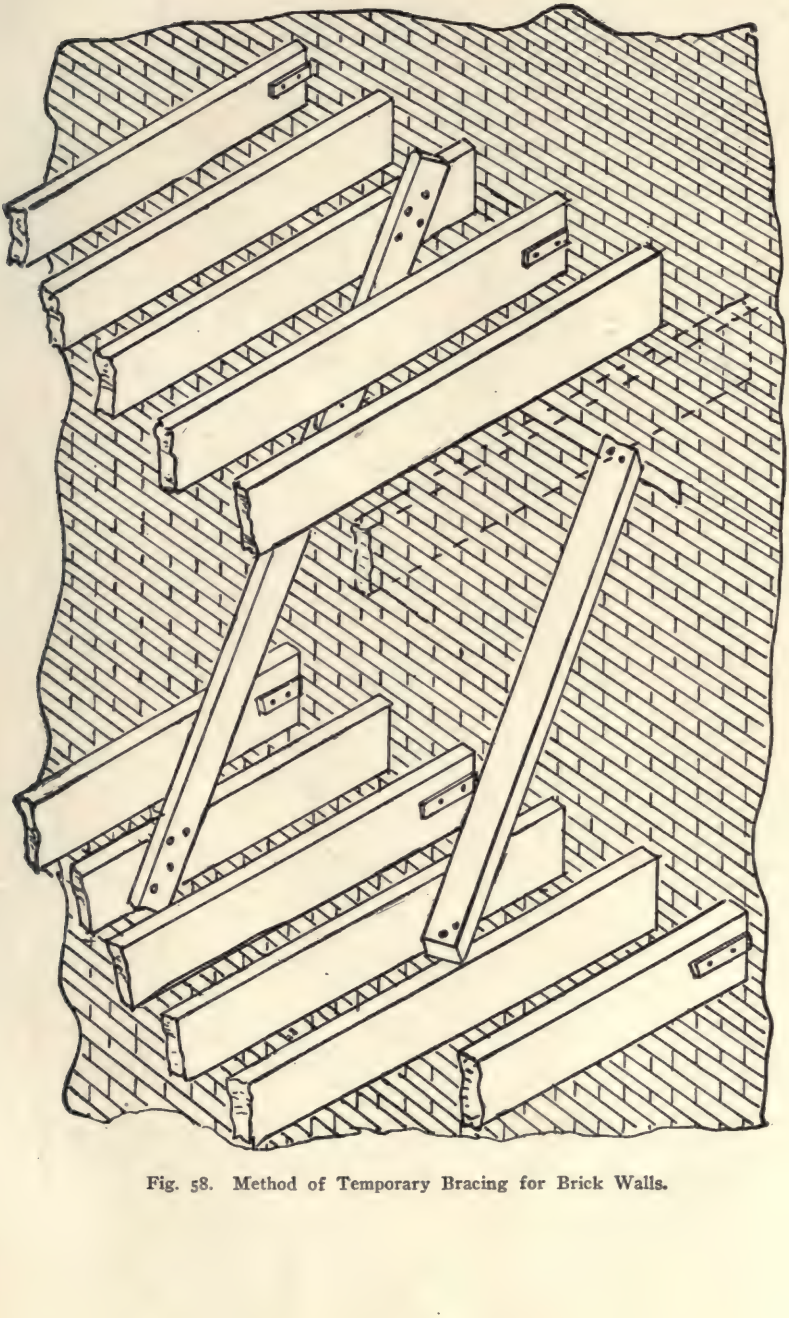

Fig. 58. Method of Temporary Bracing for Brick Walls.

Concerning the bracing of the walls during construction, I would state that the usual method is to build in a piece of 2x4 joist or studding into the inside face of the wall, about two feet below the bottom edge of the tier of beams above, and then nail a 2x4 stud from this built-in piece, to the beam on the floor below. I am opposed to this plan, however, and would recommend that the walls be braced from story to story in the way I also illustrate in Fig. 58.

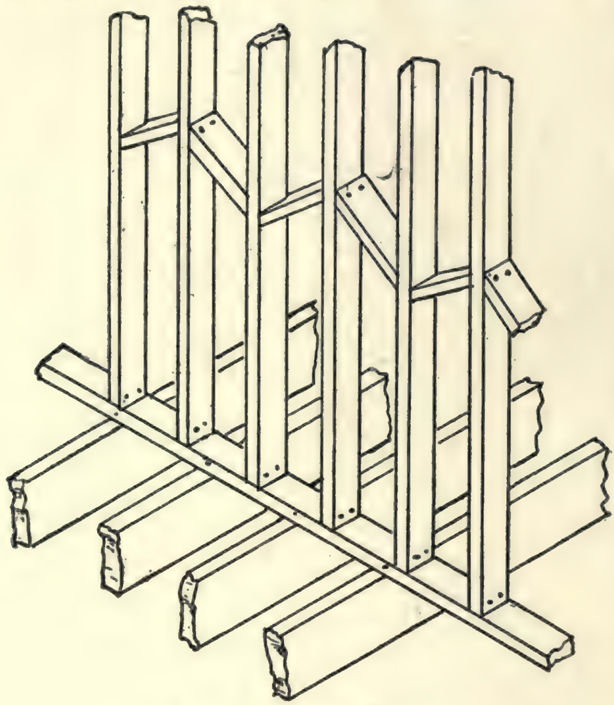

Fig. 59. A Trussed Partition.

I know it is scarcely safe for a framer to walk on, or set beams on a *green wall,* or one with the brick freshly laid, and some bracing is necessary, but strips of wood built in a wall rot out. However, framers and carpenters when setting beams on walls should be very careful so as not to jar the wall and to break the bond, or strain it in any way.

Another important matter I wish noted is to make up under the ends of all floor and roof timbers solid so as to avoid a spring in the floors, also to do all nailing thoroughly either in partitions or other timber structures.

Fig. 59 shows the best method of *trussing* or stiffening a partition so as to resist weight above or prevent buckling. If the partition be very high, two or three rows should be cut in so as to increase its rigidity and also act as a fire stop. If the partitions are to be filled in with brick they should have the *bridging* or trussing pieces set level, and the bricks laid on these pieces.

I would now ask the reader to refer to Fig. 60, which is a projected view of bridging seen from the floor below. In the floor plans shown in the foregoing figures, the bridging is denoted by three parallel lines. Here it is represented placed and nailed to the floor beams.

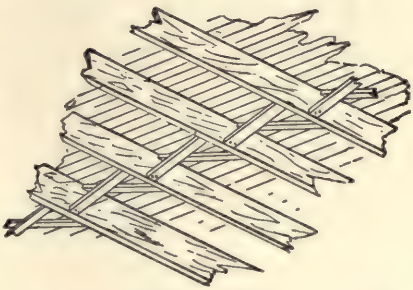

Fig. 60. Bridging for Floors and Roofs.

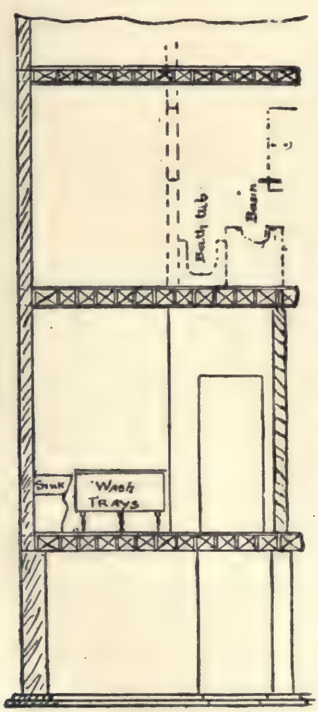

Fig. 61. A Cross Section of House Showing Bridging.

Much difference of opinion exists amongst mechanics as to the proper way to lay out each piece of bridging so as to get it the proper length and bevels on the edges. Some prefer to have one man hold the long piece up while another saws each piece to the bevel required. This, I think, is a tedious and inaccurate method and not satisfactory, as the pieces are often sawn too short or too long, and not to the exact bevel. I would recommend to all carpenters to try the German way, that is, to strike two parallel lines with the chalk line across the top edges of the floor beams at a distance apart equal to the depth of the beams; if they be 8-inch beams, 8 inches apart; if 12-inch beams, 12 inches apart, and so on. Now, if the bridging be laid across from beam to beam diagonally the exact length and bevels will be given and the pieces must fit, even if the beams be not equally spaced out, and it frequently happens they are not. This method I illustrate at Fig. 54, by

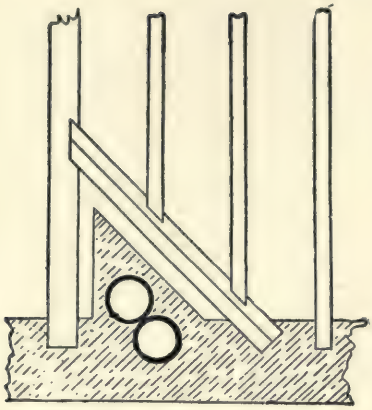

Fig. 62. Framing with an Angular Header.

the dotted lines and the cross section Fig. 61, where the bridging is shown placed on each tier.

At Fig. 62 I show the proper method to follow in framing trimmer and tail beams connected with an angular header. In this case the header is on an angle of 45 degrees. It will be noticed the header and trimmer are doubled and the header mortised into the trimmer on one end, the other end resting on a brick wall. Great care is necessary in framing headers of this kind, and they should never be set in bridle or stirrup iron with a butt joint, as they are liable to slip and the floor to sag as a natural consequence. They should also be framed as represented in Fig. 63, a method which I believe to be the safest and most economical existant. The ends are simply mortised and gained together, the mortise and gain being above the center breaking line or neutral axis of the beam, thus forming a strong joint without weakening the header.

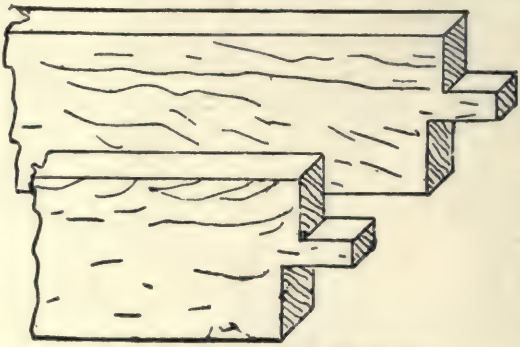

Fig. 63. Framing Cuts for Headers.

17. FIRE-RESISTANT WOOD FLOORS, PARTITIONS AND DOORS.

In connection with floors I would here draw attention to the method of *semi-fireproofing,* or deafening floors, shown at Fig. 64. It consists of a series of wood cleats or strips nailed about 4 inches down on each side of the floor beams. On these strips ⅞-inch or 1-inch boards are placed and nailed, so as to form a shelf or pocket between the floor and ceiling below. These pockets are afterwards filled in with a concrete made of ashes and cement, thus rendering the floor both fire-resistant and soundproof. The writer believes, however, that the water in the concrete is absorbed by the pores of the wood, and after a time a dry rot ensues which is sure to injure the wood, so as to impair its strength and render it unsafe. Care, then, should be taken not to put in the concrete slimy or very wet.

Fig. 65 illustrates the simplest modern method in use for preventing fire from traveling up from one line of lath and plaster partition to that directly over it, above the tier of beams. The scheme is to

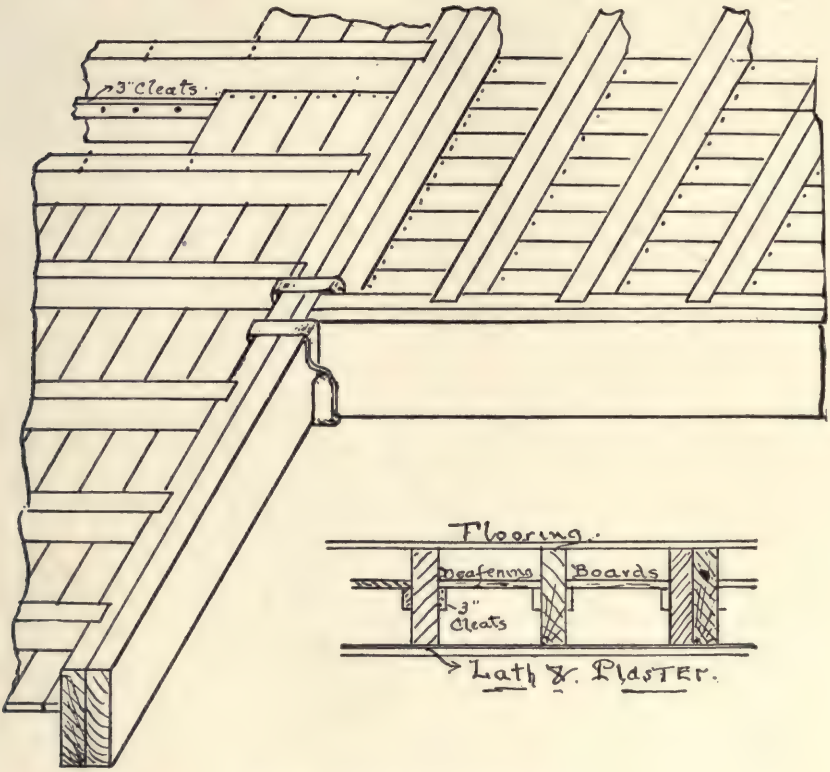

Fig. 64. Method of Deafening Floor.

fill in the spaces between the beams with brick and mortar, in the way represented in the engraving, the brick being laid on the top plate of the partition below. When it is necessary to make a partition entirely fireproof, horizontal pieces of bridging are inserted, about two or three rows in the entire height, and on these pieces the bricks are laid, breaking joint in the bond, so as to stiffen the whole partition. When the partition is constructed of studding set

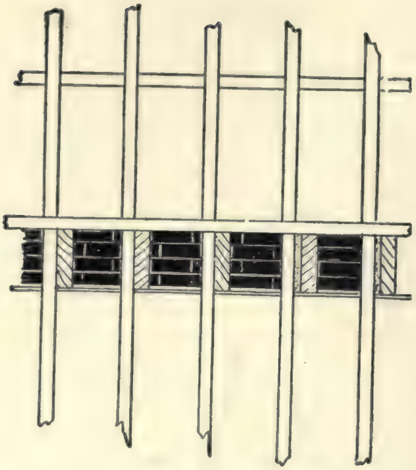

Fig. 65. Common Method of Fireproof Frame Partitions.

on flat or only 2½ inches thick, the bricks are laid on the top of each other, edge to edge. The horizontal bridging pieces should not be more than 3 feet apart in the height: that is, in a 12-foot partition there should be three or four spaces, in a 9-foot partition two pieces or three spaces, and all the spaces should be a tight fit and well toe-nailed into the studding. If there be partitions in the cellar, and the bottom does not rest on a brick wall, or is not carried on stone footings, then a sleeper or plate of *locust*, or other hard wood, should be set into the cellar floor, as locust will not rot. A better plan, however, is to first concrete the cellar, and then set the bottom plate of the partition directly on the concrete and cut the studs in tight. The exact length of any stud may be found by setting the top plate on top of the bottom plate, and then measuring up to the ceiling with two rods, sliding them apart till they touch the ceiling and plates; ⅛-inch or ¼-inch should be allowed for tightening. Spruce studding is best for cellar or basement partitions, as hemlock is too subject to absorb the existing dampness in the cellar and generate early rottenness and vermin. The same rule applies to flooring, yellow or North Carolina pine being the best for use in cellars.

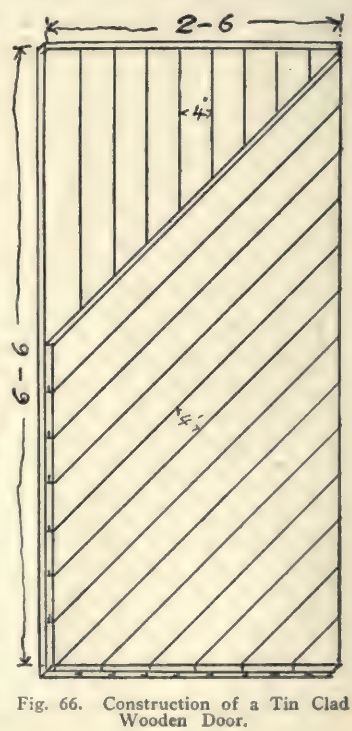

Fig. 66. Construction of a Tin Clad Wooden Door.

Concerning the usual cheap method of laying the bearers and flooring on top of the iron I-beams, forming the first story fireproof floor, I would here state that the common practice is first to cover the brick arches between the beams with a common concrete up level with the top flanges of the I-beams, and then to lay 2x4 spruce or hemlock diagonally across them, either on flat or edge, tying the ends together with cleats or over lengths of joists, and making sure that all the ends are made up solid so as to prevent their springing. These joists are usually spaced 16 inches apart and on them the flooring is nailed in the usual way.

Fig. 66 represents the simplest method of constructing a cheap fireproof door. It is made of ⅞-inch tongued and grooved boards in two thicknesses, one thickness running diagonally. The whole completed door is covered with tin, or sheet iron on both sides and edges, so as to render it incombustible.

Furring is a term applied to wood strips, nailed or spiked to outside brick walls, for the purpose of nailing the plasterer's lath and thus preventing the plaster from absorbing the inherent dampness of the wall. These strips are generally 1x2 or 1⅛x2½, and are nailed on vertically and spaced out 12 inches or 16 inches as desired. The nails are driven into the joints of the brickwork so as to hold the furring tightly against the face of the wall, by this means leaving an air space between the wall and the plaster. Carpenters should be sure in nailing on furring that the nails draw the furring tight to the brick work and that they hold it firmly. The bottom edges of the floor beams are also often furred, and it is a very judicious practice, as it allows the air to circulate round the beams and prevents them generating a dry rot. The frequent discoloration of paper on walls is caused by the plaster being laid on the brick wall and the heat of the room drawing the damp through stains the paper.

Furring, therefore, should be nailed on all outside brick walls of 12 inches thick or less, so as to prevent dampness coming into the rooms and making them unhealthy. If hollow bricks be used on outside walls it will not be necessary to put on furring, as the plaster is spread directly on the hollow brick, and this kind of brick makes a very dry inside surface.

18. ROOFS, BULKHEADS AND FRONTS.

Concerning the construction of the roof, I might state that the roof timbers are usually placed as the floor timbers below, across the house from gable to gable, with the exception that they pitch so as to form a gutter or gutters in the center or rear of the building in order to carry off the water, snow, etc., to proper leaders. This, of course, must be done by pitching the beams as they are spaced out, and the best method is to set one at the front and one at the rear, and stretch a line through so as to get a straight roof surface. Flat roofs of the kind used in cities and covered with tin will drain dry, with a pitch of 1 or 1½ inches to the foot. The roof beams are generally bridged and kept up sufficiently high to give a level ceiling on the top story under them. For example, if the top story is 10 feet in the clear of the ceiling, then the roof beams are kept 1 foot 6 inches, or 2 feet high, so as to permit the ceiling to be *furred down* level. The way builders generally do this is to hang 2x2, or 2x4 joists from the rafters with 1x2 furring strips or scrap scantling, spaced 16 inches on centers to accommodate the plasterer's lath.

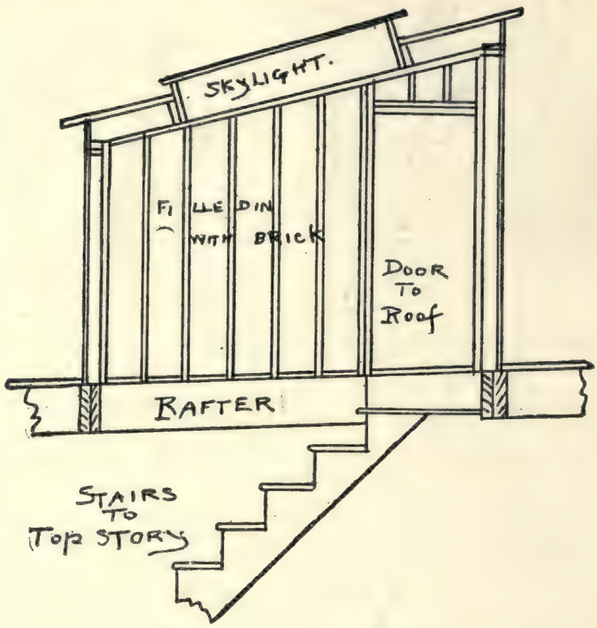

Fig. 67. Section of a Bulkhead.

Of course, all openings for scuttles, which are square openings framed for in the roof, must be allowed for, and constructed according to the methods I have described for floor openings in the preceding sections of this article, and the headers, etc., properly hung in bridle irons.

Similarly, if there be, and there usually are, any fore and aft partitions on the top story, the top or upper-plate of these partitions must be against the under edges of the rafters to support them in the middle of the span and prevent their *sagging* or deflecting.

Regarding next the construction of bulkheads. I would say that these are a sort of box or small, framed structure placed on the roof over the stairs which lead from the top story to the roof. I show a section of a bulkhead at Fig. 67. It is formed by framing an opening in the roof equal to the area required for the stairs and required head-room, the framing being done as in the case of floors, namely, the trimmers and headers being doubled and the headers hung in bridle irons. On these around the opening or well-hole studs are framed and raised with the necessary wall-plates for the roof of the bulkhead. The roof has generally plenty of pitch and is framed for a skylight to light the entire stairs from the roof. There is also a door opening allowed on one side, generally the southwest side, to permit egress to the roof. This method is much better in city houses than the usual scuttle and iron ladder, because it gives easy access to the roof and permits of its use for drying clothes, etc.; but it must be remembered that the friction of the feet in walking is ruinous to a tar and gravel or tin roof, and proper gratings should be placed over the roof covering to preserve it from injury. Bulkhead studding is filled in with brick and covered with boards and metal to make it fireproof, and the door is made in the way illustrated in the last chapter.

I have now led this subject up from the first floor to the roof, so I will here give some general instructions about miscellaneous details to be attended to. The carpenter or framer may be called upon to set the window frames, and as this is a comparatively simple matter, I will not comment upon it except to urge the absolute necessity of getting all frames perfectly plumb, square and out of wind, and to have them all well braced back to the beams so that the mason or bricklayer may not jar them out of position. The carpenter will also be obliged to furnish the mason with all the wood lintels to be placed at the back of the stone lintels he may require.

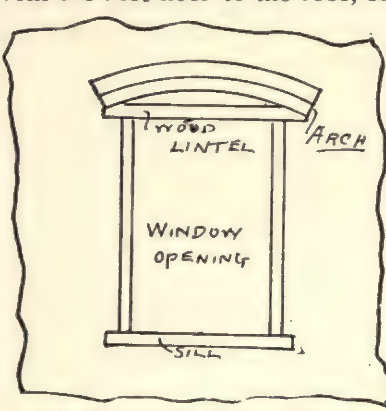

Fig. 68. Wooden Window Lintels.

These are used to span the width of the door or window opening and to form a center for the arch which is turned over them. They are made of 3x10 or 3x12 plank, and are beveled on the ends as shown in Fig. 68, with 4 inches of bearing on each jam. Where the front is of iron columns and girders as seen in Fig. 69, it will be necessary for the carpenter to see that screw holes are drilled and tapped in the iron work for the purpose of fastening the iron work thereto. The plan and elevation shown in the engraving are self-explanatory, so that any carpenter can understand how necessary it is to be familiar with the modern methods of constructing city

Fig. 69. Elevation and Plan of a Store Front.

houses in order to be up with the times. Another thing I would call attention to before concluding, and that is the methods of semi-fireproof floor construction given in the foregoing illustrations in order that all may be thoroughly posted.

19. WOOD AND IRON CONSTRUCTION.

In the beginning I would state that wrought and cast iron and steel have almost entirely displaced timber as posts and columns, and in some cases floor beams, especially in cities and the large towns, where there are stringent fire laws for office or warehouse buildings, but they are still used in dwelling houses and flats and, in conjunction with iron, in warehouse and factory construction. With a view therefore of giving the carpenter and framer an insight into this work, the following will be found of value even if working from plans.

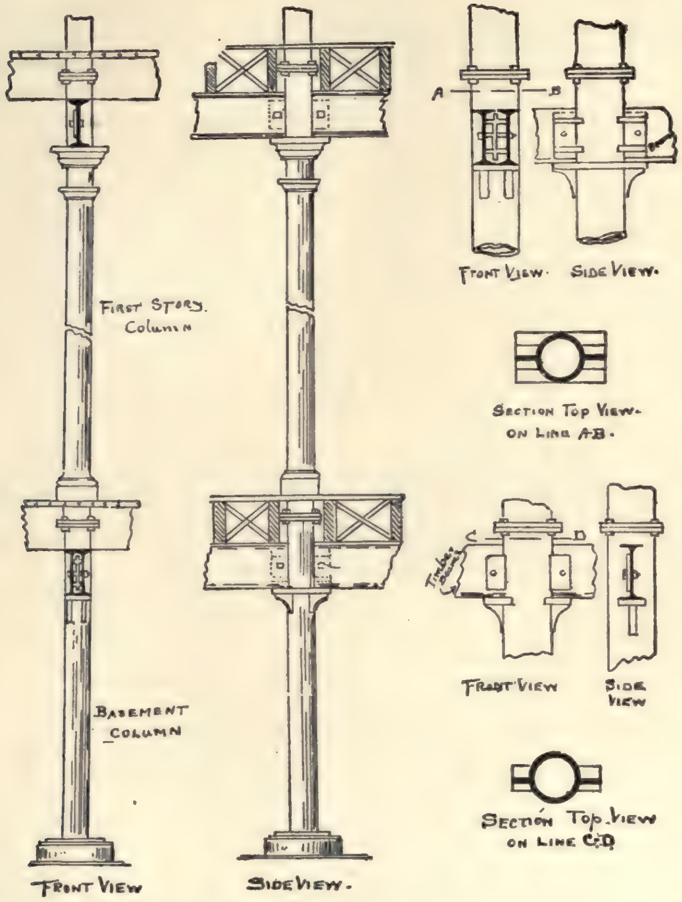

Fig. 70. Elevations and Details, Wood and Iron Construction.

In Fig. 70 will be seen a very fair example of composite construction, which consists of cylindrical cast iron columns, cast with bases and brackets, the latter being used as supports or rests to carry on the basement columns, two 12-inch steel I-beams bolted together and kept together (to act as one) by cast iron separators. The ends of these I-beams are bolted to lugs cast on the columns in the manner seen in the side view in Fig. 70. The first story columns, not having so much weight to sustain as those below, are generally made lighter in the metal and of better design, and have in this case but one I-beam bolted to them. The sectional end of the I-beam is shown on the front view, and the side as bolted to the column in the end view; timber floor beams may be placed on these, crossing them at right angles and spread out at 12 or 16-inch centers, as desired, according to the weight placed upon the floor. For ordinary stores or warehouses sustaining a weight from 150 to 250 pounds per square foot, the construction here given, with the columns spaced 10 feet between centers will be sufficient; but care should be taken to design or lay out the work, not less than three times as strong as is really necessary. The old rule of making every construction—"A little stronger than strong enough,"—is now obsolete and every structure must be carefully and accurately calculated, and put together so as to be in perfect equilibrium and free from liability of collapse. From the above description and a close study of Fig. 70, any intelligent mechanic will be able to grasp the details of this form of wood and iron construction.

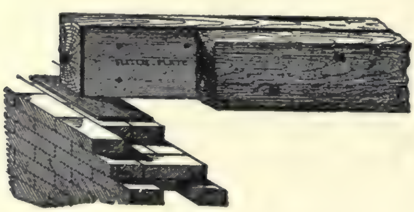

Fig. 71. Flitch Plate Girders.

Fig. 71 is the Flitch plate girder made up of two or more timber beams, having a plate of rolled iron or steel sandwiched between them, the whole being solidly bolted together. This construction is not so economical as a steel or rolled iron I-beam, but can be employed in some cases.

Figs. 72 and 73 illustrate the longitudinal and transverse sections of a floor made up of timber beams, resting on the bottom plate of a girder made up of two steel I-beams with a plate under to give a full bearing to the timbers. This will be clearly seen by a study of Fig. 73, also the method of tying them together by ½-inch by 2-inch wrought iron straps, one of which passes over the top of the girder on one beam and under it on the next one, or on every second beam, thus tying the timbers together on each side of the girder, by being thoroughly spiked to each beam. The beams are fully fitted so as to have a good bearing on both ends, and bridged with double rows of bridging in each span.

20. HEAVY WOODEN BEAMS AND GIRDERS.

As the framing details of heavy modern construction have never yet been properly considered, I will in this chapter convey to carpenters and builders some information which they will find of the greatest value in their practice. We will assume that the construction shown in Figs. 72 and 73 is requisite for a large five-story stable or warehouse to be capable of sustaining a safe bearing load of from 200 to 250 pounds to the square foot. It will be necessary that the timbers be large and of superior timber, presumably of yellow pine, which is the best and most easily obtained in the modern market.

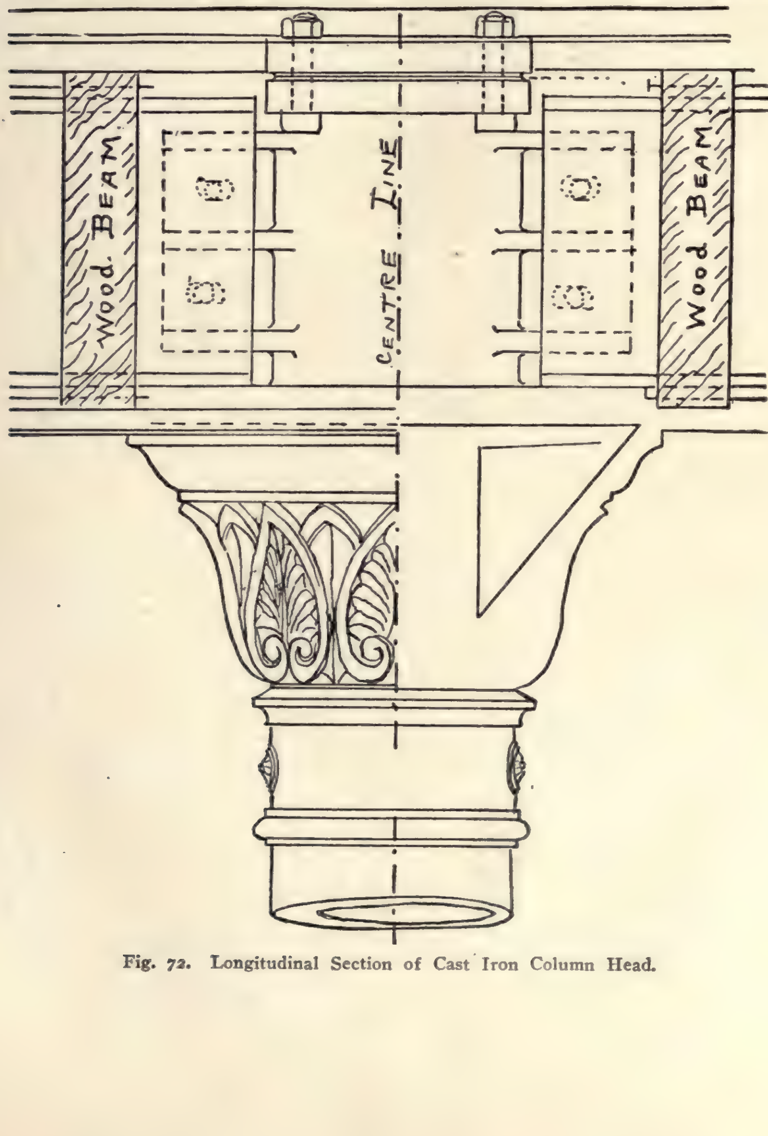

Fig. 72. Longitudinal Section of Cast Iron Column Head.

The timber bill will also be large and should be very carefully compiled from the plans and specifications so as to get all the pieces on the job. To this end a list should be made out, each item being under a separate heading with the quantities required for each length, etc., as

Girders ....
Posts ....
Floor Beams..
Roof ....
Braces ....
Studding ....

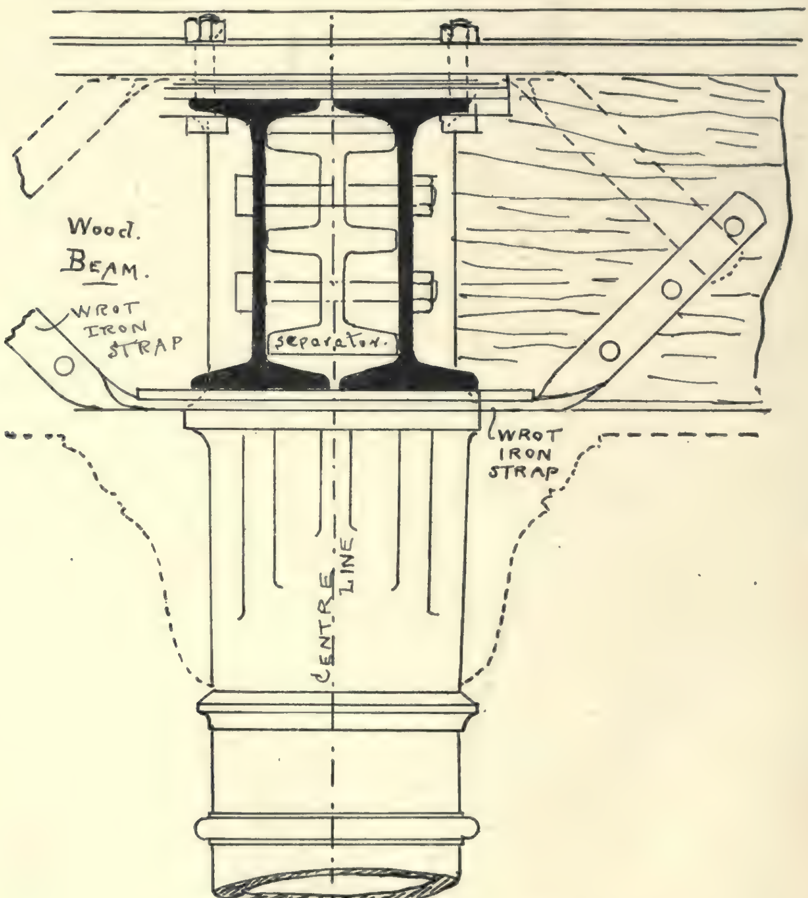

Fig. 73. Transverse Section of Cast Iron Column Head.

With a proper specification list and a framing plan any skilled carpenter or framer may lay out, frame or raise the timbers for a heavy job. I would state here that the framing plan should be furnished by the architect, and it usually is a plan of each story with the girders and floor beams, the headers, trimmers, etc., shown on it so that it is a map or diagram of each timber required and an invaluable guide to the foreman mechanic. In regard to the actual framing of the timbers there is little to be said which I have not already described, with the exception that the form of construction should be stronger than those previously mentioned, and for the instruction of readers I now show them why. Fig. 74 will give an idea of a stronger form of tenon and mortise for 3x10, 3x12, or 3x14 or 16 floor, tail and header beams where bridle irons are not used,

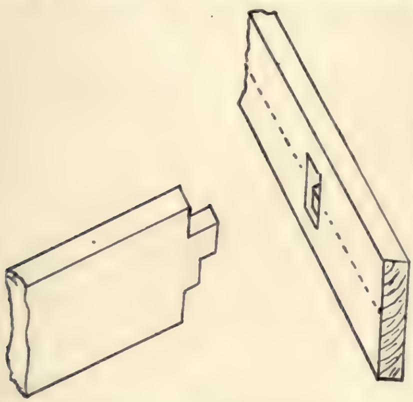

Fig. 74. A Tusk Tenon.

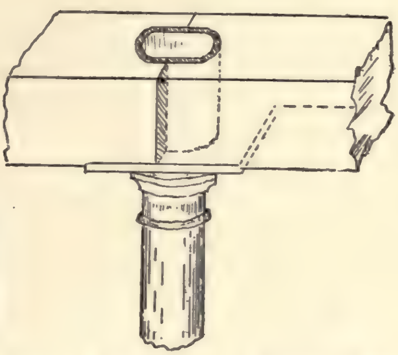

Fig. 75. Framing of a Wooden Girder Around an Iron Column.

and care should be taken to have the tenon and mortise above the neutral axis of the timber as shown in the sketch by the dotted line. This " tusk " tenon gives great strength and may be used with advantage on 3-, 4- or 6-inch floor or roof timbers, where there is a short header as that framed around a chimney; but if the header be over 6 feet long, I would recommend that the tenon be omitted entirely, and each tail or header beam hung in bridle irons, as I have described previously.

Recent experience has shown me that the best way to join main supporting girders over columns is to simply abut them together, end to end, and insert double end T anchors to tie them together; or, if the bearing surface be not large, to halve them with a simple half, as in the case of a sill or plate. The form of construction, which I illustrate in Fig. 75, will explain my preference, as it will be seen there that the girder has the ends of the two lengths mortised out to fit over the sleeves of the iron columns, thereby weakening it where its strength is most needed. A halved horizontal joint with cast-iron or oak dowels inserted in its inside face is, where possible, the best for girders.

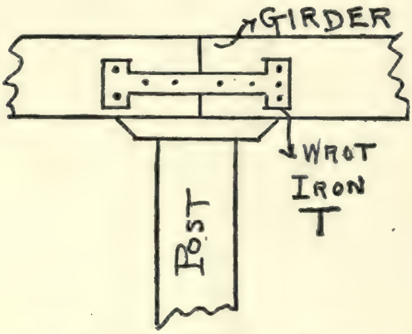

Fig. 76. A Double T-Strap Anchor.

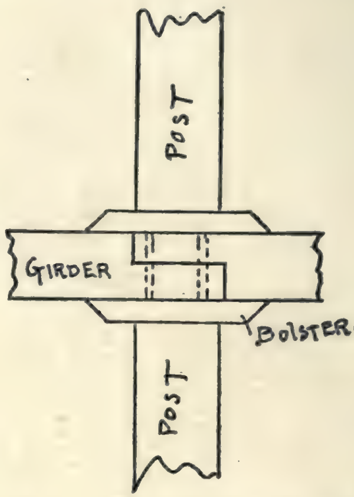

Fig. 77. A Halved and Dowelled Joint.

Similarly with wooden posts or columns of any dimensions, of more than 24 square inches of area on top and bottom ends, the mechanic will invariably find that the best construction is to cut them square (bare foot) and insert two or three dowels to keep them from slipping sideways. I may here say that architects are realizing that the mortise and tenon system sacrifices the strength of the piece mortised to that of the piece tenoned in constructive framing, and are equalizing the loss by the adoption of the dowel which the mediæval and ancient framers used with the greatest success.

The next illustration, Fig. 76, is a very excellent and economical way to join two abutting girders end to end so as to form a continuous girder. It is a "strap anchor," as some mechanics term it, made of heavy metal, usually ½ inch thick by 2 inches wide with a T end, as shown. It is, for greater strength and in order to get the full retaining power of the T ends, let into the face of the beam flush and there nailed, thus making, if one be inserted on each side of the joint, an excellent anchor and a very cheap method of construction as there is no framing called for, the ends being simply sawn square and the strap anchor inserted and nailed.

In Fig. 77 is shown another economical manner of joining girders. It consists of the old-fashioned half or scarf with two *dowels* of iron placed in holes bored to receive them so as to prevent the timbers forming the girders from pulling apart. Under and over the girder a *bolster* of hard wood is placed to receive the thrusts of the posts. This makes a very good form of *tie* at the joint, though the writer prefers the strap T anchors, as there is no liability of the joint splitting should the walls bulge. I might state, the very heavy wooden girder in a store or warehouse building should have *star* anchors to pass entirely through the wall and there be tightened with a nut.

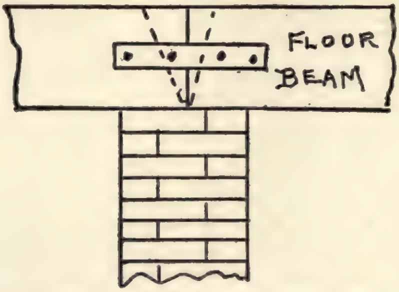

Fig. 78. A Strap Anchor Nailed On.

Fig. 78 illustrates the proper method of tying floor beams end to end where they rest on a party or intermediate wall. It simply consists of a ¼-inch by 1½-inch wrought iron strap *tie* with holes for inserting nails. This is usually nailed on every fourth or fifth pair of beams, thus tying the houses together on every tier and increasing the strength of the brick walls which would naturally fall under lateral pressure such as wind or strain were each not *anchored* or tied to that opposite. In some cases the ends of the floor beams are beveled, as seen by the dotted lines in the illustration. This is done so that in case a fire occurs and the beam falls, it will fall clear, without acting as a lever to overturn the wall above it.

21. METHODS OF RAISING HEAVY BEAMS AND GIRDERS.

Regarding the raising of heavy beams and girders, I would state that this operation demands apparatus, and also skill on the part of the framer. The apparatus or appliances can be readily made of wood, and are indispensable for the safe handling of timbers too unwieldy to be lifted by hand. The first and most important are the ordinary rollers which, being placed on inclined planes of planks

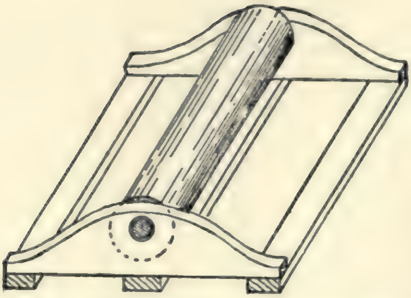

Fig. 79. Roller for Use in Moving Floor Beams.

or beams, enable the mechanics to roll up heavy beams or girders on the first floors from which they are hoisted to the upper floors. These rollers should not be less than from 4 to 6 inches in diameter, and be of oak, maple or some other hard timber not liable to crush, bruise or splinter. They may be of any handy length, say from 2 to 4 feet long, so as to be easily handled. A very excellent roller for use on the floor beams is that shown in the engraving Fig. 79. As will be seen, it is simply a roller set in a frame, so that the frame spans three or four floor beams, and heavy timbers can be rolled on it with greater ease than with a common roller on planks. The use of rollers is, as the reader will understand, of the greatest necessity where timbers weighing from 600 to 2,500 pounds have to be moved on floor beams freshly set in green brick walls.

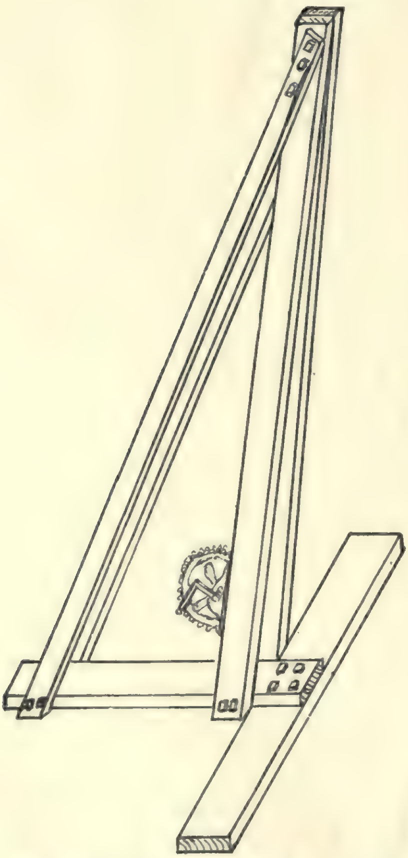

Fig. 80. An Improvised Timber Derrick.

When the timbers are on the floor they will next be raised or hoisted into position, and this may be very conveniently done with the aid of the improvised derrick represented at Fig. 80. It is made up of a T sole or base formed of two 3x8 or 3x10 timbers bolted together, and on these are raised two uprights or standards of 2x4 or 2x6 spruce joists slightly pitched forward. To these, two braces are bolted from the shank of the T to the top. On the uprights a windlass with a pawl and ratchet is bolted. With the usual block and tackle lashed to the top end of this derrick and the addition of guy ropes, almost any heavy timber girder may be safely raised. If the mechanic is afraid his uprights might buckle under the strain of the weight, he can nail horizontal cleats across their edges for bracing, spacing out the cleats 12 or 14 inches apart, so as to form a ladder to get up and make fast the guys or blocks and tackle.

A very important matter which the framer should guard against in raising and placing heavy timbers on a new building is, to avoid jarring the green walls by handling the timbers too roughly. This must be especially guarded against on the upper stories, and the girders and wooden or iron columns or posts must be securely braced, both transversely and longitudinally, before commencing to place the floor timbers. When there is a wide unsupported span of timber, say over 20 feet, a temporary top and bottom plate and a few good studs should be placed under the center of the span, to prevent their springing when weighted and thus avoid jarring the walls. I am very much opposed to the practice of omitting timbers or series of timbers, leaving them out for the purpose of leaving wells for hod-hoisters or such like purpose, as I believe such omissions leave weak spots in the brick walls, as they need to be thoroughly tied when freshly laid or green. All straps, irons and ties, and anchors should be put in as soon as the timbers are placed, and be very carefully fitted and thoroughly nailed in order to avoid the possibility of a high wind or any other strain pulling them apart. If the anchors should not be on the job then temporary hardwood straps may be nailed on, but they are only a makeshift and their use should be avoided by ordering the irons early. To omit putting the strap anchors on the longitudinal girders is a criminal proceeding, especially on a high building or when the girders have a square butt joint. I can't say too much to carpenters, about taking the greatest care in the details of their heavy framing, so as to avoid all danger of collapses or accidents, which are full of menace to the lives of mechanics and mean loss of reputation and money to all interested.

Let us here, in connection with raising heavy timbers, impress on every carpenter the importance of being familiar with the proper knots for tying and fastening his ropes to the timbers when lifting them up. As I have seen in many journals some unusual knots which, to my mind, are not reliable unless made by a sailor, rigger, or some one thoroughly accustomed to ropes, I would recommend carpenters to stick to the simple timber hitch, which is made by passing the rope once around the timber, taking one turn on the rope and twisting it as seen in Fig. 81. If it be necessary to lengthen a rope or join two ends the simple flat, square or reef knot shown at Fig. 82 may be used, but all knots should be absolutely certain and sure to hold to avoid accidents. I have seen several men killed by poor knots, and if one is not sure he should turn the job over to some man who can make a reliable knot.

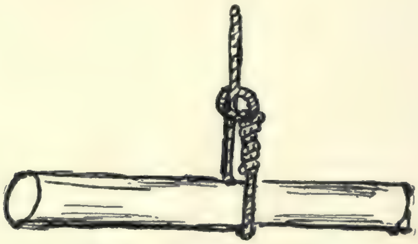

Fig. 81. The Timber Hitch.

Fig. 82. A Square Knot.

I have been noticing lately the difference between the ways by which various builders and foremen take care of their stuff as it comes to the job, and have been seriously impressed with the results thereof. I find that the usual method is to dump sawn timber carelessly in any place close to the job, letting the timbers lie as they fall, in any position, without properly stacking them, and the result is very injurious to the material. Sawn framing timbers should be put into piles at once, for, being green or unseasoned, if they are piled with one timber bearing unevenly on its fellow, the one underneath will become twisted, will crack and warp so as to be unfit for bearing purposes. In stacking, if timber is to lie long on the ground strips should be placed between the ranges so as to allow the air to circulate through them and help seasoning.

Chapter III

Framing Roofs

22. LAYING AND FRAMING A SIMPLE ROOF.

In commencing this chapter on the framing of roofs, I do so with the assurance that readers will find it valuable, in being able to apply the example practically in their work and to any of the intricate roof problems which may be brought before them. I have endeavored to make them as clear and comprehensible as is possible with the subject, so that any roof timbers may be laid out by referring to one or another of the roofs described. No ordinary roofs will be dealt with in order that the chapters may cover a field hitherto untouched by previous writers. Though the descriptions are original, it will be necessary for me to embrace in them the fundamental principles of geometry which invariably control all mechanical operations.

Let A B C D, Fig. 83, be the plan of the wall plates; A D a gabled end, and B C a hipped end of the building, which is to be framed and raised as represented at Fig. 17, for the hipped end, and Fig. 21 for the gabled end. The roof is 12 feet wide to the outside faces of the wall, and the rise or *pitch* 4 feet or one-third the span. The dotted lines denote center lines.

To lay out the gable end produce the center line of the ridge EF, 4 feet in this case, to G. Join GA and GD. Now set off on each side of the dotted line shown, the width of the rafter, 2 inches on each side for a 4-inch rafter, and 3 inches on each side for a 6-inch rafter as shown in Fig. 84, deduct half the thickness of the ridge, half inch, from each rafter peak, cut also notch out for the cut on the plate. All the rafters from F to E will be framed thus.

For the hip rafters, take the distance BC, and transfer it to JK, Fig. 84, divide it into two parts of 6 feet at L, and square up as LM, equal to 6 feet. Join MJ and MK. Produce JM, 4 feet, to N (at dotted line), and join NK. NK will be the center line length of the hip, and the width may now be set off on each side of it in the manner shown in the diagram.

With K as center and KN as radius, strike the arc NO, cutting LM extended in O. On LK lay off the jack rafters as QP, SR,

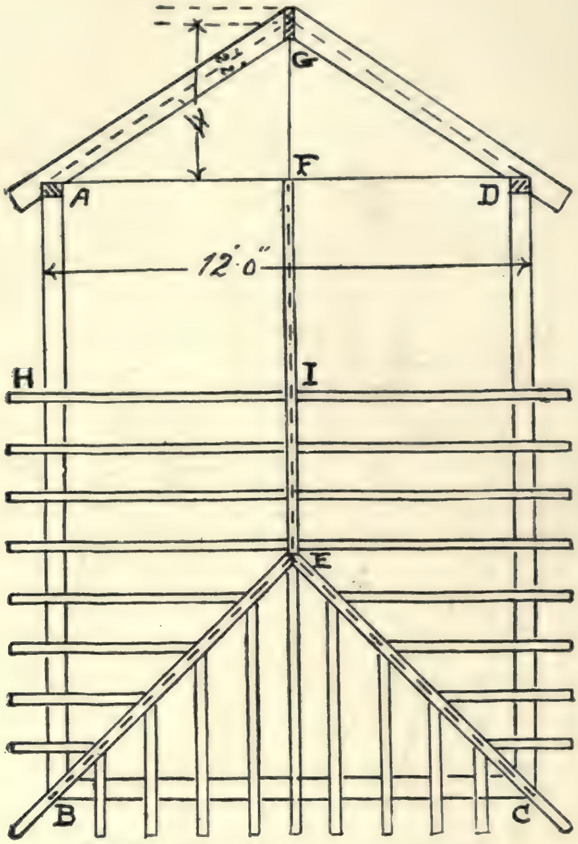

Fig. 83. Plan and Layout of a Simple Roof.

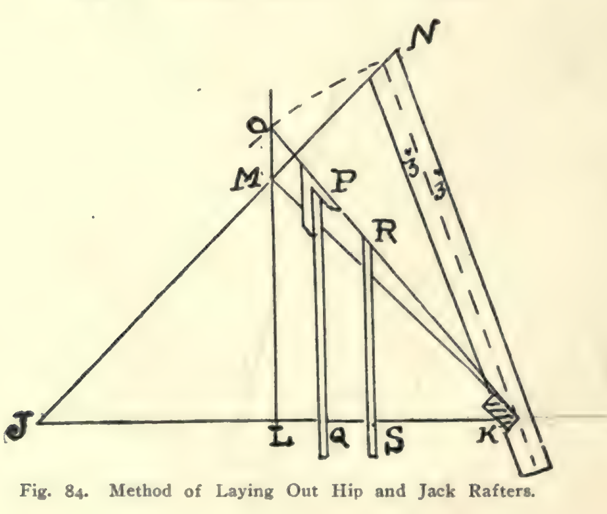

Fig. 84. Method of Laying Out Hip and Jack Rafters.

etc.; equally spaced and square to the wall plate. The exact lengths of the jacks will be to the line OK, and their side level will be as at P. The bottom notch will, of course, be as at A or D, Fig. 83; K shows the bottom notch for the hip rafters and N the peak cut.

23. HIP AND VALLEY ROOFS.

The first roof which I produce is one of the hip and valley class, on a rectangular main building with an L or addition. ABCFDE, Fig. 85, is the plan of the building and the outside line of the wall plates. The roof is of half pitch or square pitch, as some mechanics call it, which means the height of the roof is equal to half the width of the house. The house has two gables, one on each end of the main part with a hip on the L, and the intersection of the L roof with the main roof produces two valleys. EID is the plan of the hip, and EID, Fig. 86, is the elevation of it, where the general view of the constructed roof is shown. QJ and JF are the valleys on the plan.

In framing this roof, the simplest way is as follows:

To obtain lengths and bevels of the common rafter, produce the ridge line GH, a distance equal to half the width of the house which

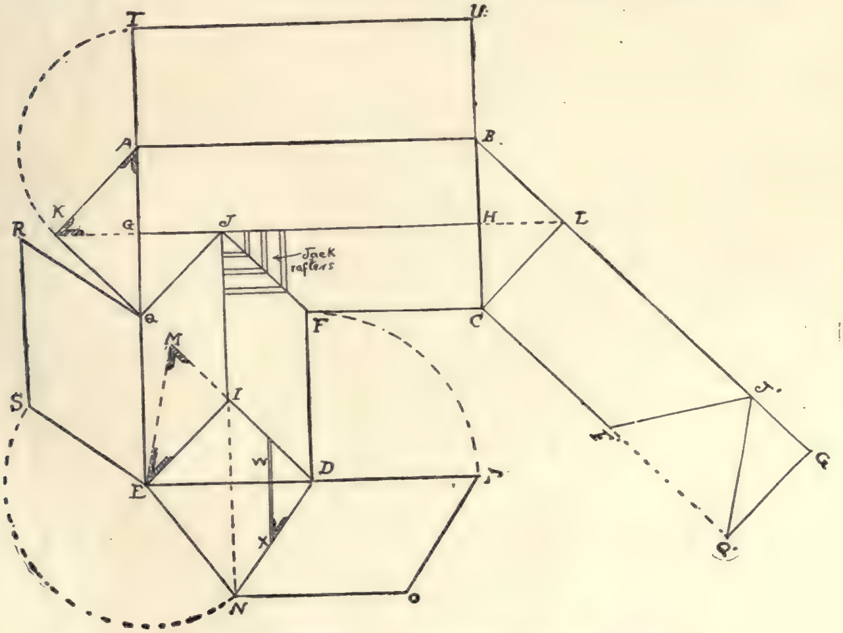

Fig. 85. Diagram of a Roof with Hips and Valleys.

is the height of the pitch, to L and K. Join AK and KQ; also BL and LC. AK will be the neat length of the common rafter, if no ridge board is inserted, but if there be a ridge board, half its thickness must be sawn off the length on the bevel for the cut on the plate. Any ordinary mind will see the simplicity of this method.

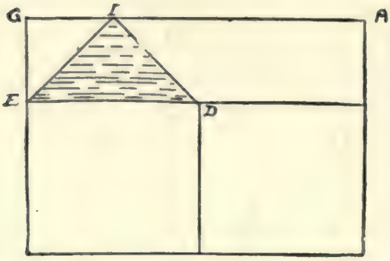

Fig. 86. Elevation of Roof Shown in Fig. 85.

For the hip rafters, which will stand over the seats EI, and DI, produce the line DI and set off on it the height of the pitch, IM, equal to KG. Join ME. ME will be the exact length of the hip rafter required, and the bevel at M, will fit the top cut. The same method applies for the valleys. In regard to the cuts for the jack rafters, which run up the hips and valleys, it might be said that the top cuts against the ridges for the rafters which run up the valleys, have the *top cut* the same as the common rafter top cut. The bottom one which nails against the valley hips can be readily determined by the following simple method: Produce the ridge line JI to N, making DN and NE equal to ME, the length of the hip. W, is the jack on its seat or as it will appear in position. X, is the exact length of it from the plate line to the hip, and the bevel at X, will be the exact bevel for all jacks both on hips and valleys, being reversed for different sides, right and left hand.

The plumb cut of the jacks will be half pitch, or on the steel square, 12 and 12.

In order to prove the exactness of this method of laying out such a roof, we will proceed to develop its planes or sides.

For the rectangular plane ABGH take a pair of compasses with a pencil point, and with A, as a center, and with AK radius, describe the arc KI′; draw I′U parallel to AB, produce GA to I′ and HB to U. This will give ABUI′ the exact covering of AGHB on the pitch AK; AK being the length of the common rafter with its necessary bevels.

For the plane JHCF produce BL to G′ and draw CFQ, parallel to BG′. Make LJ′G′, equal to HJG; CF′ equal to CF also F′Q′ equal to QF. Make J′F′ and J′O′ equal to ME, which will complete the plane or surface to cover GJHCFQ on the plan.

For the plane JFDI take D as a center, with DF radius, and describe the quarter circle FP. Produce ED to P and through P draw

PO parallel to DN; also through N draw NO parallel to DP. DNOP will be the developed covering, and QRSE is similarly found.

BLC and AKQ are the gables.

Now if this roof be laid out on a piece of thin wood or stiff bristol board the roof can be folded over by cutting entirely through the

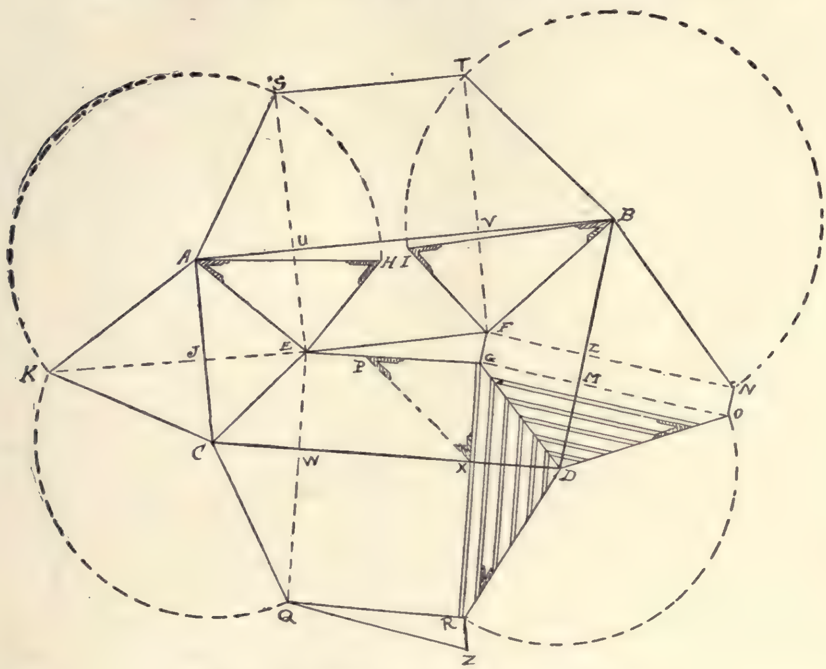

Fig. 87. Diagram of a Roof of Irregular Plan.

following lines: Cut from K to A, A to I′, I′ to U, U to B, B to L, L to G′, Q′ to J′, J′ to F′, F′ to C, C to F, F to D, D to P, P to O, O to N, N to E, E to S, S to R, and R to Q. Also make a slit half way through the thickness of the board, from Q to A, A to B, B to C, C to L, D to N, D to E, and E to Q. By folding the sides or planes over, the exact roof will be seen, thereby proving the exactitude of the methods used. The plan will be the base or plates.

24. ROOFS OF IRREGULAR PLAN.

This roof is of another and rather uncommon plan, and one which will be interesting to work out. It is a form of roof which sometimes occurs and will prove useful.

ABCD is the plan, Fig. 87, and it will be noticed that the side walls are not parallel, or at equal distance apart from end to end, but spread or widen out from A to B, and from C to D, or BD is longer than AC. Similarly AB is longer than CD and not parallel to CD. For this reason coupled with the necessity of keeping the ridge level on both sides a deck is formed on the top, or, more properly, two ridges are needed one for each side, and parallel to each wall plate; these are shown as EF and EG.

The seats of the hips as AE, CE, BF, and DG, are found by bisecting each of the separate angles on the plan, which can be done by taking any two points equidistant from the apex of the angle as A, and striking intersecting arcs. (As every carpenter knows how to do this, I will not illustrate it here.) This process will give the seats of the hips as shown and lettered, with the addition of a short piece of ridge FG.

To find the lengths and bevels of the rafters, proceed as follows: For the common rafters to range from UE to VF on the one side, and from EW to GX on the other side, raise up the pitch GP. Square out from G to X, and join PX, which joining line will be the exact length of the common rafter from outer edge of the plate to the center line of the ridge. To obtain the length of hip rafters square up from each point at the peaks, as EH and FI on one side. Make EH and FI each equal to GP; AH and BI will be the lengths of the hip rafters, which will rise over AE and BF. The hip rafters, which will be set up over the seats CE and DG, are determined in a similar manner. The top and bottom bevels delineated at the peaks and bottoms are the top and bottom cuts of each, and it will be noticed that no two bevels are alike, so that each rafter must be carefully laid out and marked for each particular corner. There will be four hips of different lengths and with different bevels, so they must be properly framed. In regard to the jack rafters, they are shown on the right side spaced out on the wall plate from X to D, against the hip GD. Their top down bevel or plumb cut will be the side bevel. Similarly with those from D to M, the plumb cut will be the same as P, but the bevel will be that at O.

In order to develop the planes of this roof, commence by drawing EUS from E, through U at right angles to EF or AB; also draw FVT parallel to EUS. Make AS equal to AH by taking A as center with radius AH, and striking the arc HS. Through S draw ST parallel to AB. If a center be taken at B and an arc struck as ITN it will be found that the arc will pass through T, or FV produced at T. The surface ASTB will cover the plan AEFB on the pitch EH.

Draw EJ square to AC and produce to K. Sweep HS to K, and join AK and KC. AKC will be the covering plane which will cover over AEC on plan. For the plane of AEGD draw EW square to EG and produce to Q. With C as center and CK as radius, strike the arc KQ; draw QR parallel to CD. Join CQ, which will be the center of the hip rafter on this side. Draw GX square to CD and produce to R; join RD. CQRD will be the covering plane which will cover over CEGD on the pitch GP.

Now draw GM and FL square to BD and produce them to N and O. With D as center and DR as radius, describe the arc RO, also describe the arc TN. Join NO. BNOD will be the covering of the plan BFGD on the pitch GP. QRZ will be the covering or deck, being the same size or area as EFG.

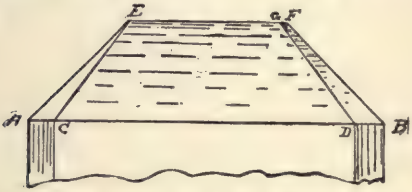

Fig. 88. Elevation of Roof Shown in Fig. 87.

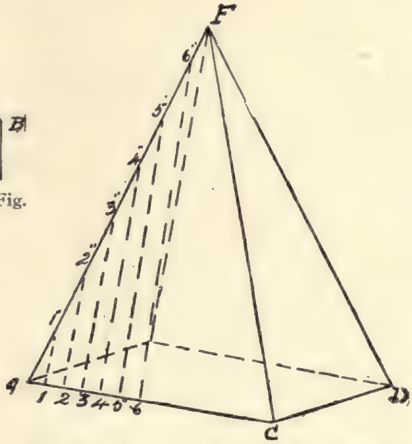

Fig. 89. A Tower Roof of Square Plan.

Fig. 88 shows the elevation, or as it will appear when framed, raised and covered.

A model can be made of this roof by cutting out the entire outside outline of the covering and making a slit from A to B, from B to D, from D to C, from C to A, also from Q to R, which being folded up will show the completed roof with the rafters, cuts and bevels in position.

25. PYRAMIDAL ROOFS.

Roof framing is a study well worth the attention of every carpenter. The roof illustrated and described in this article is one which occurs on many houses and cottages now-a-days. It is one of a kind of tower roof on a square plan, or as they are sometimes termed "pyramidal roofs." ACDF, Fig. 89, is the projection of the roof completed. ACDB, Fig. 90, is the plan of the roof on the plates; AE, CE, DE and BE, being the hips which form the shape of the roof or seats over AF, CF, DF, on Fig. 89. The fourth hip over BE, cannot be seen on the projection, Fig. 89.

In order to find the length of the hips, produce the line EB, Fig. 90, indefinitely. Now set off measuring from E, the height of the peak to F, Fig. 89. Join AF, which will be the exact length of either of the four hips. In framing this roof it is best to let two opposite hips, as BE, and EC, on the same line abut against each other at the peak, and to cut off their thickness from the other two top or peak

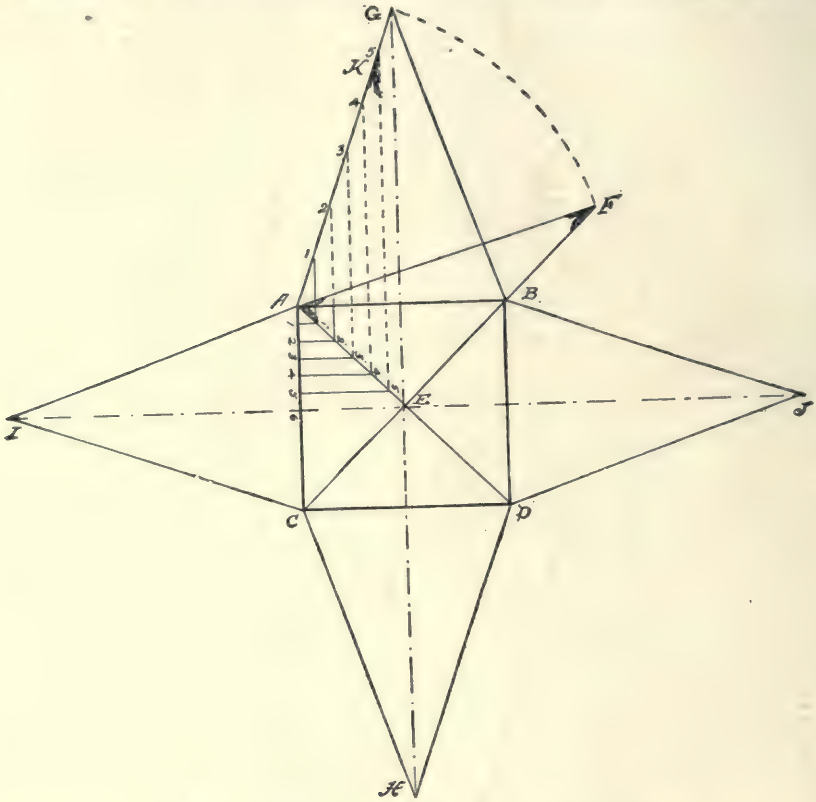

Fig. 90. Diagram of a Pyramidal Roof of Square Plan.

cuts, thus: If BE and EC be each 2 inches thick, then 1 inch will be cut off the peak cuts of AE and DE, which rest against them at E. This is done in the same manner, as every top cut of a rafter resting against a ridge must have half the thickness of the ridge cut from each rafter. The bevel at F, Fig. 90, is the bevel of all four top cuts and that at A, the bevel for the cuts on the plate. Concerning the jack rafters, the best way to determine their length is to set them off the plate as from A to C, Fig. 90, then to draw a line as HG, through E, parallel to AC, or BD. With A as center and AF as radius describe the arc FG, cutting HG at G. Join GA and GB. The triangle, or more properly speaking, the triangular surface GAB, will be the exact covering surface of the roof plane AEB.

From where the jack rafters come against the hip AE, draw lines parallel to EG and square to AB, cutting AG as shown. The lines reaching from the plan line AB to AG will be the exact jack rafters and the bevel at K will be the side cut against the hip, with the bevel at F, as the vertical cut, and that at K the bottom or plate cut.

The development of the covering for the remaining three planes of the roof is found by drawing the line IJ through E parallel to AB or CD, then with B as center and BG as radius, intersecting EJ at J and joining JB and JD; a similar process can be gone through to determine the points H and I, thus obtaining the four convexing planes. To prove the accuracy of this and the two previous roof problems before described, or in fact any roof problem, the plan should invariably be laid out to a scale, say 1½ inches to 1 foot (on a sheet of cardboard ½ inch scale will do if the roof be very large) then to make a cardboard model. Here this can be done, and when the lines have been laid down as just described, the entire model may be made as follows: With a sharp pocket-knife cut clean through the cardboard from A to G, from G to B, from B to J, from J to D, from D to H, from H to C, from C to I, and from I to A. Next make a slit halfway through the cardboard from A to B, from B to D, from D to C, and from C to A. Proceed to fold the planes over the seats till

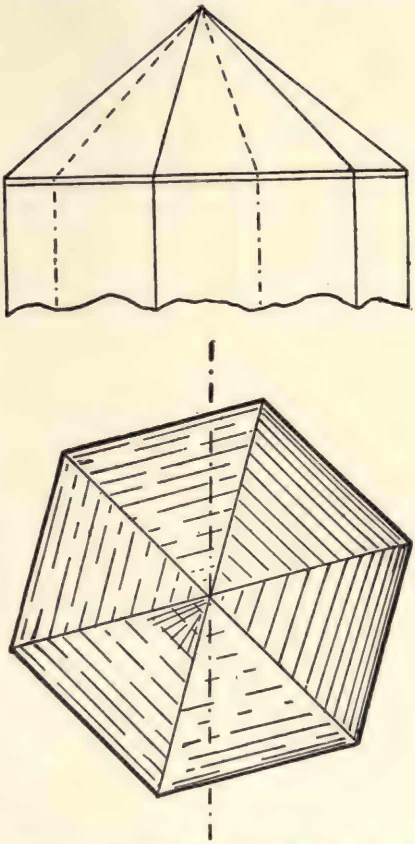

Fig. 91. Plan and Elevation of a Hexagonal Roof.

they all join at the edges, thereby making a completed cardboard roof resembling Fig. 89, with the jacks and bevels in position, and with all the cuts fitting as they ought to.

26. HEXAGONAL ROOFS.

Carpenters will see in Fig. 91 the top and side views of a hexagonal or six-sided tower roof, or one which has a wall plate running round on six walls as shown, the dotted lines representing the angle lines of the hexagonal figure. The completed roof with the tin or shingle on, will appear as shown in the lower sketch.

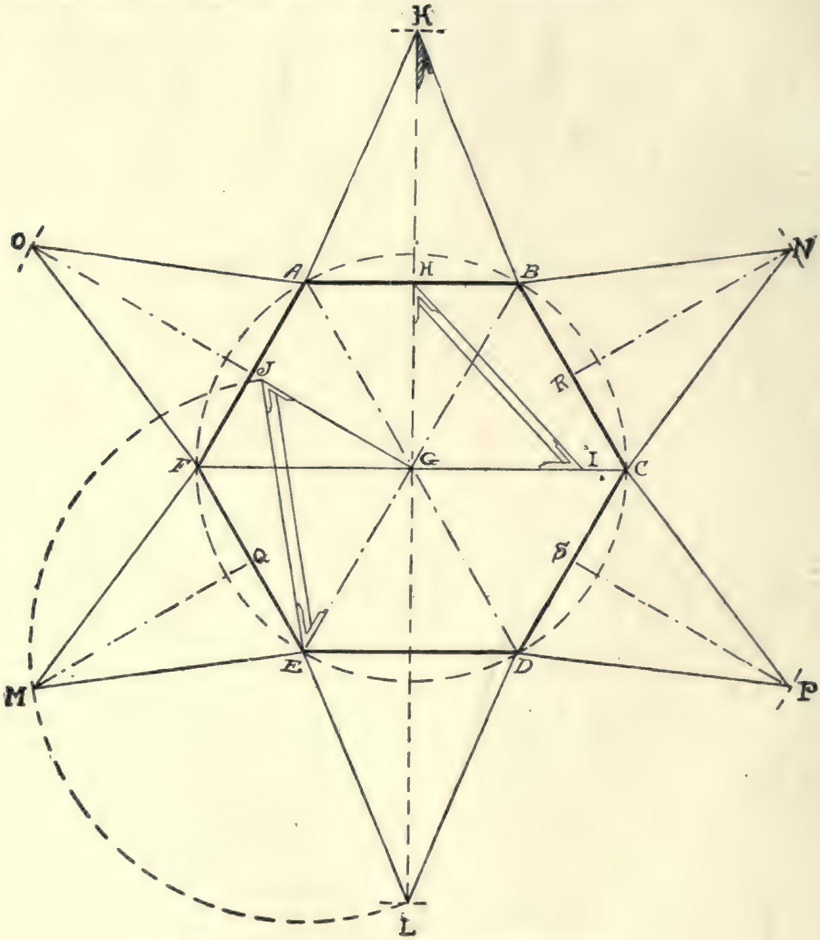

Fig. 92. Diagram of a Roof of Hexagonal Plan.

In order to frame this roof the following system should be used:

For Fig. 92 proceed to lay out on a board to a scale of 1½ or 3 inches to the foot, the plan of the wall plates (on the outside line) ABCDEF; and join the intersections of the sides, as AD, BE, and CF; passing through the center G. This gives the seats of the hip rafters AG, BG, CG, DG, EG, and FG, six in all. To find their exact length, square up from EG. Lay off also to the same scale the exact height in feet of the pitch or rise of the roof from G to J and join JE, which line will be the exact length of the hip rafter as seen in the diagram with the top and bottom bevels necessary for the cuts, these being given at once without any uncertainty.

To find the length of the common rafter to stand over HG, set off the pitch GI on GC equal to GJ, and join HI for the length. This rafter is rarely used on roofs of this class, except when they are of large area, as only the jacks are requisite, especially on modern frame houses where they seldom exceed eight feet in width, thus requiring short rafters.

To develop this roof take a pair of compasses, and with E as center and radius EJ, describe the arc JML, cutting HG produced in L. Join EL and DL which will give the triangle ELD, the covering over the plane EGD, on the pitch or rise GJ. Bisect or rather divide EF into two parts at Q. Square up from Q, cutting the arc JML at M. Join ME and MF. The triangle EMF will lie over EGF. The remaining four triangular developments or coverings can be laid out from the foregoing by making JO, HK, RN, and SP, equal in length to QM, or a simpler method would be to take G as center with GM as radius and describe short arcs cutting O, K, N, and P, thus giving the exact lengths at one sweep, and insuring their being alike so as to meet at the center G, when folded.

The side bevel at K will make the top cuts on the jack rafters fitting against the hips, the bottom cuts fitting on the plates being the bevel at H.

Almost every mechanic knows how a hexagon or six-sided figure is struck out, still in case there should be even one student who is at sea in regard to it, I repeat the method of doing so here. The diameter or length from angle to angle is usually given, or, if not, is easily found by joining the angles as before described. Now, to lay out any hexagon, draw any line as FC, and divide it into two equal parts at G. With G center and radius GF, strike the circle ABCDEF. Now take a pair of dividers (sharp points on both legs) and from C, with one point on C, space out the six distances CB, BA, AF, FE, ED, and DC. Draw the lines as shown for the outline of the hexagon.

In regard to framing an octagonal or eight-sided roof, the same methods as have been described above can be safely followed with the exception of laying out the octagon itself, which can be done in any of the numerous ways now in use.

When the plan of the plate has been laid down, the angles are joined and the pitches raised up in the same manner as for a hexagonal roof. Likewise with the development of the planes. They can be similarly found.

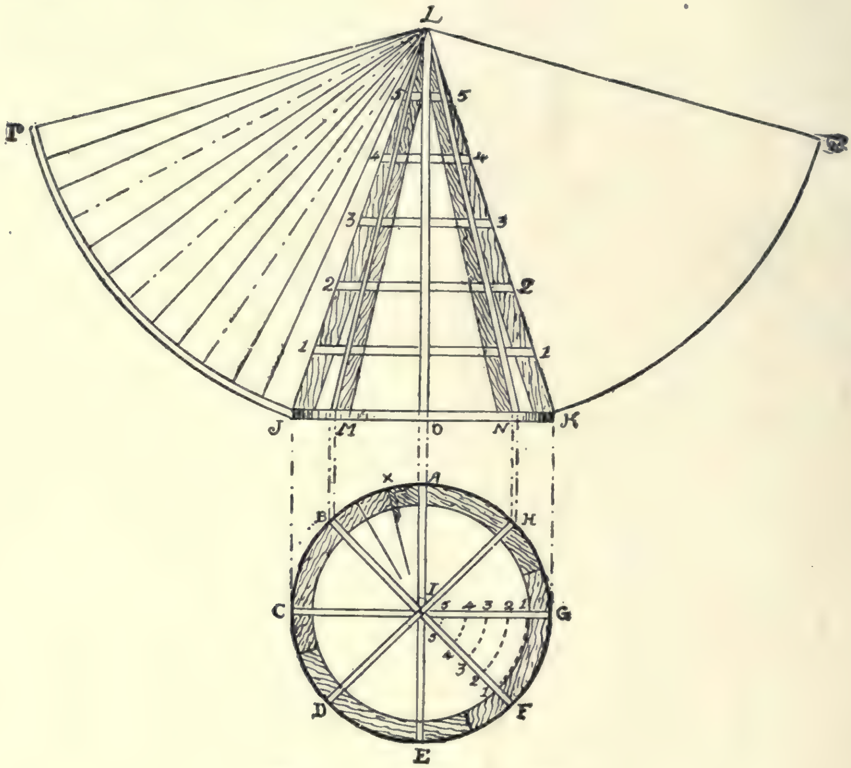

Fig. 93. A Conical Tower Roof.

When cutting out the model of these roofs (after laying the lines out on a sheet of cardboard, should any reader care to do so) the model can be made in this way:

With a sharp penknife or chisel cut entirely through the sheet from A to K, K to B, and so on around each outside line until the piece drops out in the form of a six-pointed star. Next make a slit through the plan lines as AB, BC, etc., and proceed to fold the sides up until the points O, K, N, P, L, and M, all meet over G, and each hip as EL, etc., will be in its exact place, exactly over its seat and the cuts will all fit as contemplated, thus proving the accuracy of the system.

27. CONICAL OR CIRCULAR ROOFS.

Having treated the usual forms of roofs embracing the hip valley principles, I will now draw the attention of my readers to the proper laying out and framing of a roof on a circular tower, as this form occurs very often in modern houses, barns, etc. The methods to be followed are very simple, so that an ordinary mechanic can easily understand them if he only studies the diagram and text a little.

Supposing ABCDEFGH, on Fig. 93, to be the plan or plate line of the roof, and OL, the pitch or rise, it can be laid out as follows: To be more explicit I will take it for granted that a carpenter has a roof to frame with a plan AB, etc., 6 feet diameter, or 6 feet from C to G and 9 feet rise, or from O to L is nine feet. Proceed to strike the plan AB, etc., either to full size or to scale. It is always better to lay out full size if a floor or drawing board can be found large enough to do it, but if not, half size or a scale of 3 inches or 1½ inches to the foot may be used. The reason these are the best working scales is because the three-inch scale works as follows:

3	inches	=1	foot.
1½	inches	=6	inches.
1	inch	=4	inches.
½	inch	=2	inches.
¼	inch	=1	inch.
⅛	inch	= ½	inch.
1/16	inch	= ¼	inch.
1/32	inch	= ⅛	inch.

The one and a half-inch scale is similar, but the divisions are not so handy. For instance:

1½	inches	=1	foot.
¾	inch	=6	inches.
½	inch	=4	inches.
¼	inch	=2	inches.
⅛	inch	=1	inch.
1/16	inch	= ½	inch.
1/32	inch	= ¼	inch.

The above two scales are the best working scales, with the exception of the half size proportion, which is very simple and easily applied, thus:

6	inches =	1	foot.
5	inches =	10	inches.
4	inches =	8	inches.
3	inches =	6	inches.
2	inches =	4	inches.
1	inch =	2	inches.
½	inch =	1	inch.
¼	inch =	½	inch.
⅛	inch =	¼	inch.
1/16	inch =	⅛	inch.
1/32	inch =	1/16	inch.

The foregoing scales are the best for carpenters, either foremen or at the bench, but, as I said above, the full size laying out is the best. Whether the work is laid out to scale or full size, the exact measurements should always be marked in plain figures on every piece.

Having struck the circle, draw center lines for the rafters AE, BF, CG, and DH, and set off the thickness of the rafters as they show on the plan. Next draw any straight line as JK, the same length as CG; raise up the center line OL, the height of the pitch, and join LK, which will be the length of the rafters to stand over AI, BI, CI, DI, EI, FI, GI, and HI, and the top and bottom cuts will be directly given as at L and J: LM and LN are the rafters ID and IE placed in position and LO is the rafter EI in position. By referring to Fig. 94, the rafters BI, AI and HI will be seen at the rear of the figure.

If the roof is to be boarded vertically, horizontal strips or *sweeps* will be required to be sawn out and nailed in the manner represented in both Figs. 93 and 94. To do this properly, divide the height from O to L in Fig. 94, and draw the lines representing the sweeps as 1 1, 2 2, 3 3, 4 4, 5 5. Their neat length, and the cuts to fit against the sides of the rafters, may be determined by striking out the sweeps shown on the plan, 1 1, 2 2, 3 3, 4 4, 5 5. It will be noticed that this roof will require 8 circular pieces for each row, or 40 sweeps in all. One pattern will do for each sweep and the remaining eight needed can be marked from each pattern.

Fig. 94 will convey a better idea of the constructed roof, as this illustration represents each stud plate, rafter and sweep in its fixed position, with the covering boards nailed on half way around.

In order to find the exact shape and bevels for the covering boards,

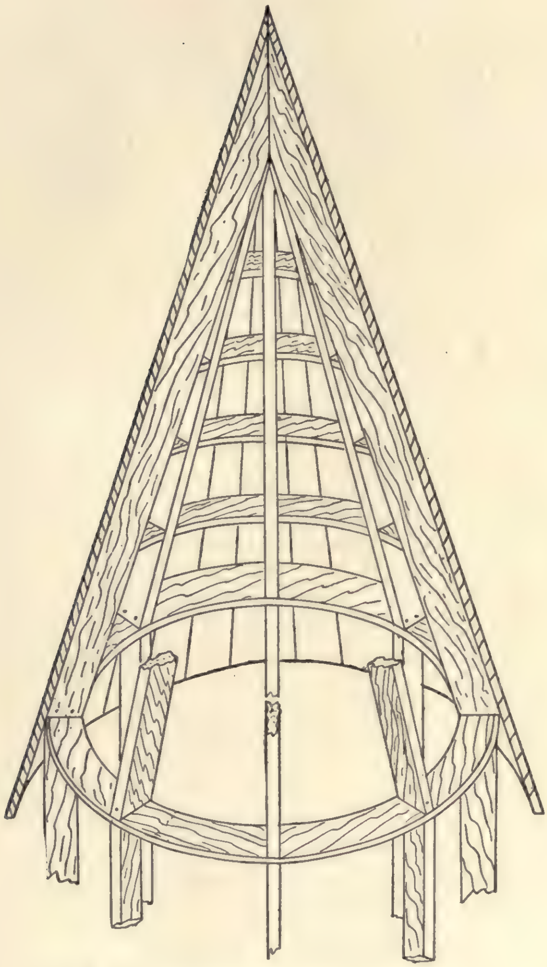

Fig. 94. Framing of a Conical Tower Roof.

a very simple method is used, thus: Take a pair of compasses, or a trammel rod, and with L as center, and LJ as radius, describe the arcs JP and KQ each half the length of the circumference. Join LP and LQ. Now divide the half circle ACE into 12 equal spaces on JP with a pair of compasses, and join the division marks on JP with L. This will give 12 tapering boards and the bevel at X on the plan will be the bevel of the jointed edges. As twelve boards will be needed for half the plan, twenty-four will have to be cut out in all, so it will be seen that if the sweep or arch JP goes round from ACE, the sweep KQ will go round AGE. The diminishing lines from the point L to the line JP are the inside lines of the joints of the boards shown also in Fig. 94.

In order to prove the rectitude of the foregoing, a model can be made by drawing the roof to scale on cardboard, and then cutting out the figures from L to J, from J to K, and from K to L. Also cut out the figures LPJ, and LQK. Now if LJK be stood up over AE, BF, etc., it will be seen to fit over each one.

In a similar way the figure LJP will bend round ABCDE with the peak L over the point I and the line JP around ABCDE. In a like manner KQ will bend round AHGFE, and L will lie over I, thus proving the correctness of the methods followed. Care must be taken to allow for the intervening rafters, when framing the peak cuts of the rafters.

All my roof diagrams are laid out to a scale, as all plans are and usually must be so that if any carpenter finds, for example, that any rafter or number of rafters rises, say ten feet on the plan and has a run of 15, 18, or 20 feet as the case may be, all he has to do is to assume every inch on the steel square to be equal to 1 foot or 1 inch scale, and take 10 inches on the tongue and 20 inches on the blade; the blade angle will give the bottom cut, and the tongue the top or peak cuts. I have followed this simple method in working from plans and it has never failed yet.

The following figures on the steel square give common rafter cuts for different roof pitches; also hips and valleys.

1/8 pitch take	3	in. rise 12 in. level or plate
1/6 pitch take	4	in. rise 12 in. level or plate
1/5 pitch take	4 8/10	in. rise 12 in. level or plate
1/4 pitch take	6	in. rise 12 in. level or plate
1/3 pitch take	8	in. rise 12 in. level or plate
1/2 pitch take	12	in. rise 12 in. level or plate
2/3 pitch take	16	in. rise 12 in. level or plate
Gothic pitch take	21	in. rise 12 in. level or plate

For hips and valleys substitute 17 inches on level or plate for 12 inches.

CHAPTER IV

Rustic Carpentry and Joinery

28. CONSTRUCTING A SLAB OR HALF-LOG CABIN.

So many unusual and interesting items come within the province of the carpenter in his every day practice that it is to be regretted more of them are not recorded and made a matter of reference, and it is to be sincerely hoped that the suggestions which follow may be useful. In this article will be presented some methods of properly putting together circular or elliptical timbers.

At the outset it may be asserted by some that it is of a nature to be rarely executed and may perhaps never come within the scope of a carpenter's or builder's requirements, but in refutation of this I would draw attention to the growing popularity and recent erection of multitudes of bungalows or cozy cottages in all parts of the country, built wholly of logs or tree timbers; so that a knowledge of the manner in which the pieces are put together cannot fail to prove useful. In the natural tree the horizontal section is never circular nor square. It usually varies from an irregular circular to an elliptical form according to the natures of the woods, so that in this class of carpentry and joinery we must consider their specific sections as modifications of these geometrical forms.

Take, for example, the construction of a small slab or half-log cabin such as that illustrated in Fig. 95 and built ostensibly of trees sawn vertically in half through their axis or the pith. How should it be built? The task is not difficult when one knows how, but as seen, the slabs must average a near size of diameter of trees and must be sawn with square, straight edges, say of 1½-inch width as represented in Fig. 96. It is not essential that all the trees be of the same width provided each tier is uniform, but their irregularity however will produce a handsome design if the work is properly executed and an average degree of judgment and taste used in the disposition of the slabs of which the cabin is constructed.

When all the timbers have been sawn to parallel widths, the corners must be halved and mitered together after the manner indicated in Fig. 96. This can be readily done by halving the top edge of the piece marked "A" half way down the width of the slab and

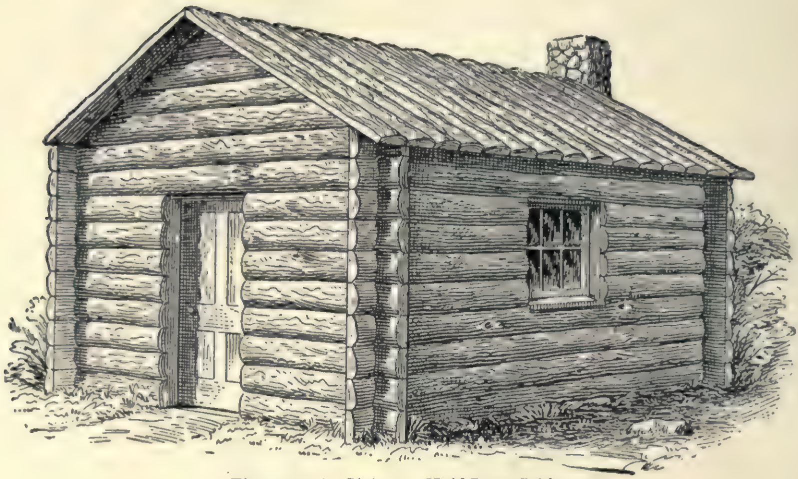

Fig. 95. A Slab or Half-Log Cabin.

mitering it for the curved surface of the log similarly with the bottom edge of "B." The miters may be laid out with 45-degree bevels from the inside flat surfaces, but these will only be approximate on account of the irregularity of the curved outer surfaces, hence the necessity for obtaining for each tier as nearly as possible the same diameter of horizontal section.

Again if the wood has the bark on, it must not be marred but preserved. The judicious use of good, keen, well set saws and

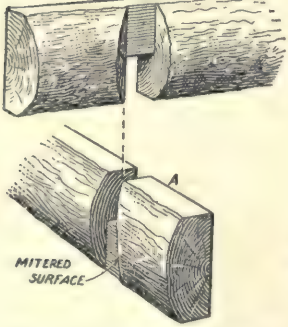

Fig. 96. Method of Joining the Slabs at the Corners.

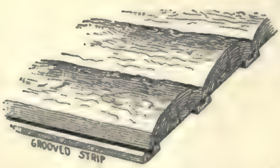

Fig. 97. Roof Slabs with Grooved Strips Under the Joints.

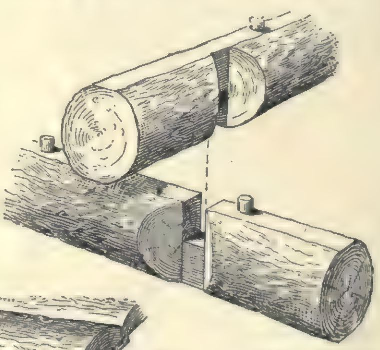

Fig. 98. Framing Whole Logs Together by Halving.

broad chisels combined with taste and tact will render this job comparatively easy to any carpenter of skill even though unaccustomed to it.

The joints are stripped to make them air- and weather-tight, as are likewise the roof slabs as indicated in Fig. 97 and which for drainage purposes have the strips grooved or guttered to carry off the snow or rain water which otherwise would be likely to percolate through the joints.

A careful study of Fig. 98 will clearly indicate the methods of halving and mitering full-log or tree timbers when it is desired to maintain the rustic character in-doors. A similar mechanical operation is performed at each end of each piece at each corner and the joints may be held together by long 2-inch or 3-inch hardwood dowels fitted tightly into holes bored about 16 or 24 inches apart on the jointed edges. With this lateral preventative and the gravity of weight of the trees themselves the slabs or logs will never move, but all the same the corner joints and halves should be fitted snugly.

29. RUSTIC FURNITURE AND THE TOOLS REQUIRED.

As it is perhaps in its joinery value that this art will be found most useful, we will here take up the matter of constructing useful articles, such as window flower boxes, flower pots, pieces of furniture, etc., and show how one must proceed in order to accomplish with entire satisfaction the end sought.

For small work few tools are necessary and, apart from the broad axe or large cross-cut saw used in separating the branches from the trunks, no fine tools are needed. A work bench and good sharp rip saw, fine and coarse toothed hand cross-cut saw, a compass saw, a hand plane, a ½-inch and a 1½-inch chisel with handles sufficiently strong to withstand the necessary pounding and hammering; brace and set of bits, an oil stone, files, spoke-shave, nail-set, chalk line, steel and hand squares, straight-edge with of course a 2-foot rule, are all that will be required outside of the usual hammer and hand or shingling hatchet.

White or red cedar is for obvious reasons the best wood for this kind of work if it be available. It is lasting, offsets and repels insect life, has a pungent, agreeable odor and in addition to giving workable timber nature has also given it the most delicate curvature in its branches. It comes short and curved in these, but straight and long in the trunks. If it be not available then cherry, ash, cypress, butternut, maple or sycamore will do, although the latter is likely to warp and twist. Boughs, branches and twigs are better sawn than hewn apart, as this gives more effective and ornamental knots which with the economy of the timber will justify judicious cutting.

Except for bridges, locust is too hard in texture and difficult to obtain; maple and oak are the same and rough in bark, so the softer woods are preferable under the circumstances. All woods, however, should be weather seasoned and dry. It is preferable to use wire brads in nailing the parts together and these should be greased to prevent rusting while at the same time giving ease in driving.

Commencing with the making of the window flower box, this is simply an oblong open box with bottom, sides and ends made of ⅞-inch spruce or pine wood nailed together and lagged and coated or sheathed with ⅝- or ⅞-inch natural tree branches cut to straight lengths, jointed neatly to close joints and nailed on. This facing may be set either plumb or diagonal on a miter of 45 degrees by cutting the ends of the pieces in an ordinary miter box, or they may be reversed half the length of the box, or have the corners accentuated by nailing on thicker pieces of 1½ inches and mitering between. The rustic work should project ½ inch beyond the edges to conceal the flat wood which is first painted to suit the color of the bark or skin of the tree.

To mark the rusticity, the exercise of a little artistic taste will be found to add much to the appearance of the design. For instance, colors should be varied, knots, wens and cup shakes should be staggered and scattered; and the grains distributed and assorted, in such a way as to balance and emphasize the effect. Too much mechanical accuracy is not well, provided the construction be strong and staple, and the carpenter's own judgment should be the best guide.

"Side" or blind nailing is best and the ends should be chamfered or trimmed off with chisels before varnish is applied, although cedar wood, with its old golden tinge or hue, is better left unfinished; likewise with rough barks.

All boxes and pots can be stripped with 1- or 2-inch bark or bent boughs at the margins of say 1 or 2 inches from the top or bottom edges or ends, thus increasing the decorative effects. The stripping may be done either diagonally or horizontally, as desired.

Coming now to the construction of lawn or garden chairs we find it very interesting and useful work. The backs may be put together first by sawing the legs from 2 feet 6 inches to 3 feet long and bracing diagonally. Occurring branches may be used to tie the two legs together without sawing them off, but they must balance in order to have the work satisfactory. Natural forks may constitute the front legs braced diagonally. The seat lagging averages round stuff about 1½ inches in diameter.

All structural parts must be of sufficient thickness to withstand the strain likely to be put upon them, as for example in chairs and settees the uprights or bearing pieces must be strong enough not to bend. The braces must be sufficiently rigid to prevent springing, and all must be so placed and nailed as to constitute a solid construction. On account of handling and moving the work must not be fragile. All projecting thorns, sharp knots and other parts liable to injure the clothing or person must be hewn or sawn off. The lagging slats or the lattice of seats should be slightly hollow to render them comfortable. The backs should be slightly pitched with the top rails of a height to cross the shoulders of a person of average stature. Seats average 16 to 18 inches in height and tables 2 feet 8 inches to the tops. Finally the workmanship should be clean and so executed as to show as little as possible of the mechanical means necessary to complete it. Like a good picture it should look, as an architect once expressed it, as if it had "grown together," which constitutes, as far as man can devise, "perfect skill."

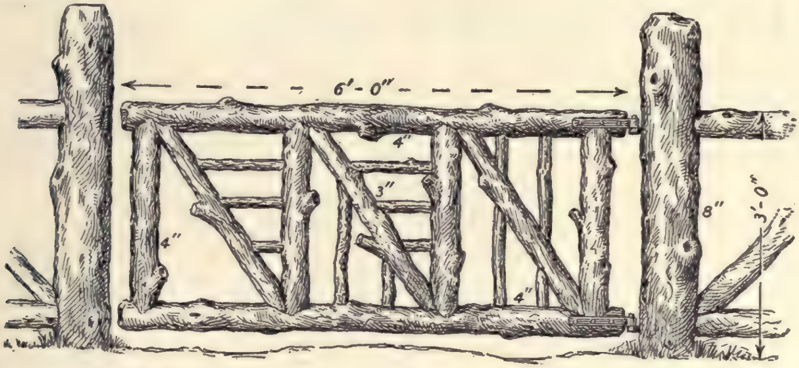

Fig. 99. A Rustic Gate.

30. BRIDGES AND LARGER RUSTIC WORK.

The application of this method of construction to bridges, gateways and fences depends as in the foregoing upon the diagonal system of bracing combined with accurate carpentry and joinery, which is in bearing structures of paramount importance. A rustic bridge may be built of locust tree, which produces artistic effects by reason of the unusual curvative of some of the pieces. The wood is almost everlasting in its constituency and the pieces are easily framed and nailed. For a bridge measuring 12 feet in span and 8 feet in width in the clear of the guard rails the bearing timbers should be heavy pieces 8 inches and 12 inches in diameter, hewn to a nearly square section with rounded edges. The coping and fitting should be well executed and the presence of bent nails and open joints indicates that the work has been done by mechanics inefficient in this class of carpentry.

Fig. 99 shows how rustic work can be applied as fences or for gates. For small cottages and bungalows a fence with gates similar to that shown in Fig. 99 is appropriate. Any one handy with tools should be able to build this in his back yard.

This form of construction has been utilized on a large scale not only for band stands, rustic out-door arbors, auditoriums, shelters, etc., but also for theaters in public parks and for places of assemblage, especially in wooded localities where its adaptability and suitability to the surroundings make it most appropriate. Here, not

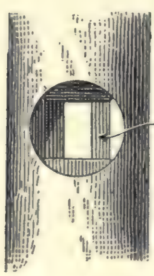

Fig. 100. Front Post Ready for the Rail or Tie.

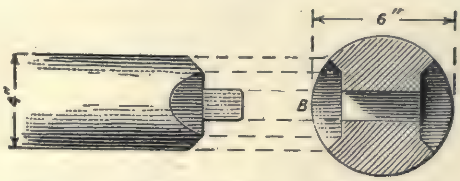

Fig. 101. Horizontal Section of Mitered Joint.

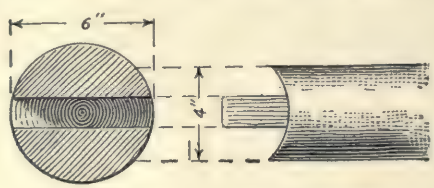

Fig. 103. A Coped Joint.

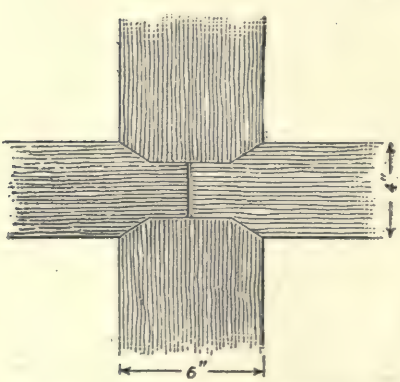

Fig. 102. Vertical Section of Mitered Logs.

Fig. 104. An Oblique Joint.

alone is the timber available, but when the whole structure is rustically completed it lends itself naturally to the situation to form as it were a part of it. The lightness of open framing obviates the necessity for any heavy stone or concrete foundations or footings as on good clay, usual in wooded land, crib or grillage footings of locust or chestnut logs in two or three layers will be found sufficient for the purpose. I call to mind an open-air theater built in the heart of the Maine woods out of fallen tree timbers which is both artistic and useful either for an amusement place or for public functions. It is cool and shaded in hot weather and delightfully sylvan in its character. It seems unwise to build to growing trees, even to those of slow growth, as structures become awry and distorted, though it has been done. It is, however, much better to build clear around them.

An interesting example of a rustic arbor is found at the entrance to Central Park in New York City at 72d Street and Eighth Avenue. The construction is of locust.

In order to explain the practical carpentry of the cope and miter I would ask the reader to consider Fig. 100 which represents the front view of the post or upright as prepared for receiving the rail or tie. Comparing this sketch with Fig. 101 we find the circular incision " B " in both cases to be a miter of four sides mortised and tenoned. The mortise goes entirely through the upright and the tenons enter from both sides and are toe nailed. Fig. 102, which represents a vertical section of miter curved work, gives a clearer idea of the joint, but it is not so strong constructively as that shown in Fig. 103 where the joint is coped. These two joints with that of the oblique example, Fig. 104, consitute the joint-principle necessary in this work, but the fitting must be accurately done to obtain perfect strength.

The mortising and tenoning are not essential in small details, as furniture and fittings, but in building bridges and fences or in connection with any detail subject to jar, strain or stress they are essential to maintain the construction, apart from nailing; in other words, they should be framed by carpenters.

Should the structural pieces be curved to elliptic, parabolic or hyperbolic outlines then the mechanic's own judgment must be his best guide, as no system of geometrical lines will be of assistance to him.

In the way of general remarks it may be stated that the wood must be durable and well seasoned, also free from rot or decay. Cedar is not liable to be attacked by insects but in it as in cherry the carpenter will perhaps find sometimes evidence of boring worms. This destructive agent seems to germinate in the pith or center of the trunk or branch and bore lengthwise at times to the bark surface. Their action and presence may be detected by small holes. They honeycomb the wood and of course impair its strength. Decayed branches should never be used and the soundness of the wood may readily be determined by striking it with a hammer. Its soundness will be indicated by the clear ringing reverberation. Thin cedar or any hardwood should be bored for nails especially toward the ends, as it will split if this is not done. All nails ought to be greased as this will greatly reduce the labor of driving them and the liability of their bending under impact of the blows of the hammer. At the same time the coating prevents early corrosion.

31. RUSTIC ARCHES IN CENTRAL PARK.

Central Park, in New York City, has some exceedingly fine carpentry work of a rustic character, a description of which may be found of interest and value not alone to mechanics, but to those carpenters living in the country, where there is usually plenty of small timber which can be used to advantage either in the garden or the home. That which is here illustrated was designed by the late Calvert Vaux, landscape architect to the Department of Public Parks

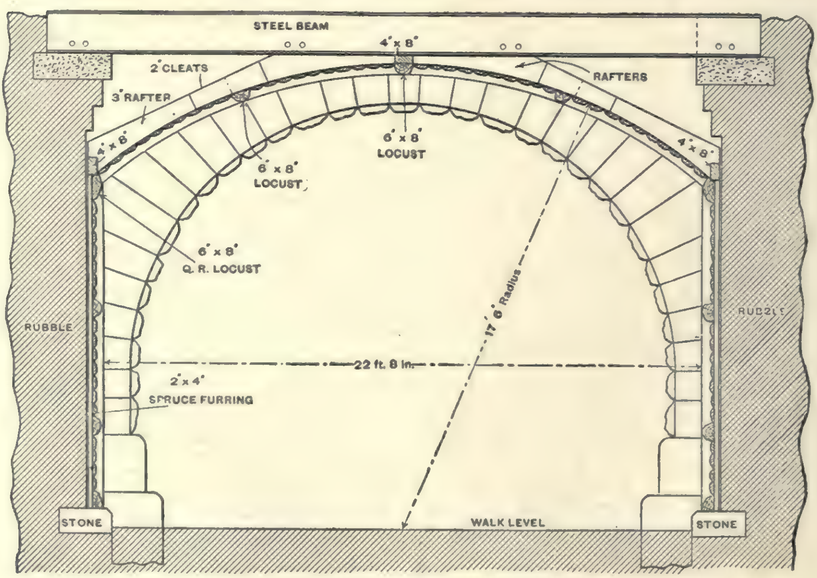

Fig. 105. Cross Section of Archway Built at 110th Street, New York City.

in the City of New York, and was carried out under his direction by the author of this book. In Fig. 105 is represented a cross section of the interior of the rustic bridge at 110th street and Central Park West. The work consists of two stone arches and wing walls, one at each end of the bridge. The sides are carried up in coursed rubble stone work laid in cement. On top of the rubble walls and resting on granite templates are set 20-inch steel I-beams, ten in number, distributed through the space of 45 feet between the walls. These span the archway in the manner shown and are secured laterally by 1¼-inch tie rods, shown in Fig. 106, which represents a portion of a longitudinal section of the

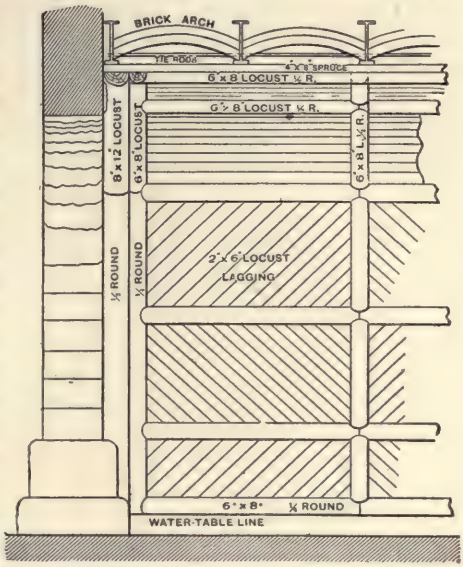

Fig. 106. Partial Longitudinal Section.

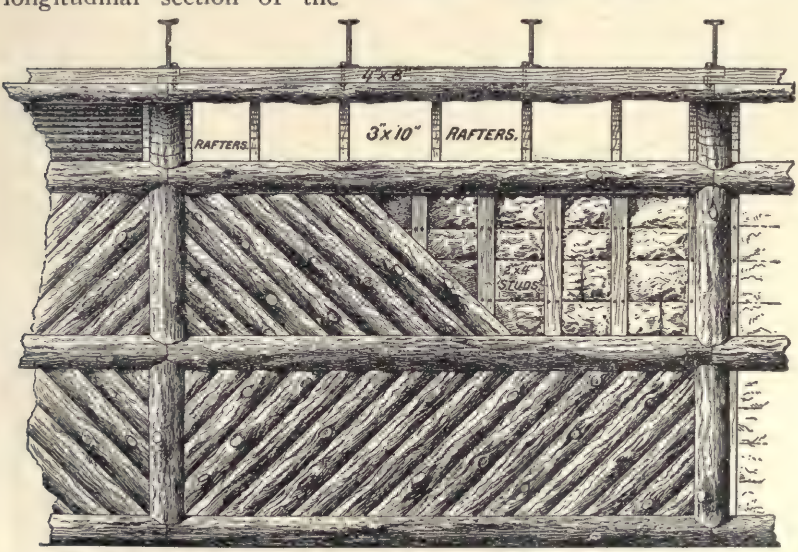

Fig. 107. General Appearance of Locust Finish.

work. Between the beams are brick arches the skewbacks of which rest on the bottom flanges of the beams. Special centers were constructed to permit of these being lowered so as to drop clear of the tie rods. On top of these arches and beams is a 12-inch bed of concrete, above which is the roadway.

The interior of the archway is, with the exception of the stone abutments shown in Figs. 105 and 106, entirely finished in acacia or locust wood work of a rustic character. The wood was sawn and worked to the shapes and dimensions desired in its natural state, the bark being stripped off of the outer surface, exposing only the last annual ring. The round surfaces were of a yellowish color interspersed with brown veins and of a knotty character, some of them being of a peculiar and unusual form. In Figs. 105, 106 and 107 will be seen the method of placing and fixing the rustic work. The first operation consisted of securely spiking to the rubble walls 2x4-inch spruce joists, spaced 16 inches between centers. Where the upright stiles which formed the panels occurred the strips were doubled and kept sufficiently far apart to give a margin outside the stile on which to nail the 2x6-inch lagging. This being done, 4x8-inch spruce timbers were set on top on each side for the purpose of receiving the thrust of the curved rafters, which were notched to fit over them, in the manner shown in Fig. 105. The curved ceiling rafters, 60 in number, measuring 3x12 inches, were of spruce and made in two sections. They were secured in the joint by two cleats, one on each side. The top vertical joints rested against 4x8-inch spruce timbers running the entire length and thoroughly spiked throughout. The ceiling rafters were spaced 2 feet on centers for the purpose of allowing the locust lagging to be securely toe-nailed to them.

The real workmanship, however, was in the manipulation of the locust, for the reason that Mr. Vaux desired to obtain the best and most artistic effects of the wood consistent with the best construction. The way the natural variations of the timber were utilized to gain a rugged and unusual effect is shown in Fig. 107. The yellowish tinge of the wood, intermingling with the brownish veins and dark shadows of the protruding knots and recessed veins or shakes, served to make the archway both quaint and picturesque. The figure under discussion represents a two-panel archway under the bridge at 90th street and Central Park West and gives a very fair conception of the nature of the work. In the 90th street bridge the rustic work is two panels high on the side walls and two panels on the ceiling, while at 110th street the work is three panels high on the side walls and four panels on the ceiling. This archway, however, is small in comparison with the one first mentioned, where the timber bill footed up in accordance with the following list of items.

LIST OF LOCUST TIMBERS.

12 pieces, half round, 6 x 12 inches x 13 feet in length.
16 pieces, half round, 6 x 8 inches x 5 feet in length.
8 pieces, half round, 6 x 8 inches x 3 feet in length.
16 pieces, half round, 6 x 8 inches x 6 feet in length.
20 pieces, quarter round, 6 x 8 inches x 9 feet in length.
8 pieces, quarter round, 6 x 8 inches x 6 feet in length.
4 pieces, quarter round, 6 x 8 inches x 13 feet in length.
210 pieces of 2 x 4 to 2 x 7 inch locust lagging 8 feet long.
280 pieces of 2 x 4 to 2 x 7 inch locust lagging 6 feet long.
100 pieces of 2 x 4 to 2 x 7 inch locust lagging 4 feet long.

SPRUCE TIMBERS.

75 spruce joist, 2 x 4 inches x 13 feet in length.
9 spruce beams, 4 x 8 inches x 16 feet in length.
65 spruce curved rafters, 3 x 12 inches.
130 cleats for the same.

The working of the locust involved much labor, both in the shaping with tools and the fixing in place. In order to have some idea of the trouble in shaping this wood with tools, I would state that its weight per square foot board measure is 3.7 pounds, and as there were 26,000 square feet the total weight handled amounted to over 40 tons. Its hardness, too, caused a continuous sharpening of the tools. The specific gravity is 0.701 and its shearing strength with the grain 700 pounds per square inch. From these figures it will readily be understood how tediously the work progressed and the amount of patience and extra labor entailed in the execution of it. According to Mr. Hartig locust is second only to oak in durability, and it is comparatively impervious to atmospheric changes. Another authority states that it will last 40 years in the ground. The trees rarely exceed 12 inches in diameter and average about 44 feet in height. The strength of locust as compared to oak is as 135 to 100.

The stiles were coped to the rails as indicated in Fig. 107, the cross section outline of the stiles being fitted over the outline of each rail and brought to a close and accurate joint, thus forming the panels. On these panels, and blind nailed to the 2x4-inch spruce wall furring, were inserted diagonal lagging or slabs of locust, averaging 2 inches thick and from 4 to 6 inches wide, these being fitted to a close joint against the edge of the stiles and rails. The direction of the slabs was reversed in each succeeding panel, as represented in the engravings. A still more difficult job was the paneling of the ceiling.

Here the stiles being carried up on the same line as below and following the arc of the ceiling, struck to a radius of 17 feet 6 inches, required that the ceiling stiles should be bent to the arc. This was done in the following manner: The locust pieces were cut to the desired length and then spaced for kerfing, the kerfs being 3 inches apart. The piece was then placed on two bearers which rested on four barrels filled with sand, and kerfs were then made with a hand saw. After being once kerfed the piece of locust was shored down from an I-beam above till the kerfs closed and the piece curved. It was then kerfed again and the second time closed, and this operation continued until the back of each piece was of the same curve as the soffits of the rafters. A clear comprehension of this method will be obtained from an inspection of Fig. 108. The locust sweeps were also shored from the ground when they were placed in position.

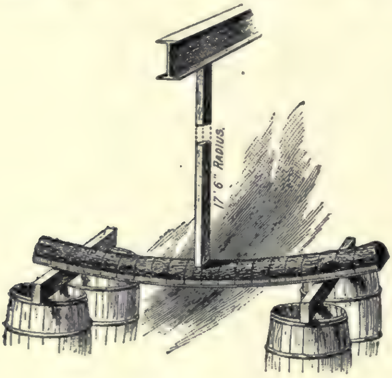

Fig. 108. Bending the Stiles for the Ceiling of the Archway.

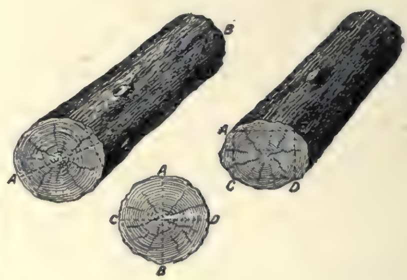

Fig. 109. Method of Cutting the Locust Logs.

The three views presented in Fig. 109 show how the locust logs were sawn by the lumberman in order to obtain the sizes called for in the bill of material. The dotted lines and letters show the direction of the ripping saw. The work of sawing these logs was both tedious and difficult, and like the rest of the undertaking required both time and money. The completion of this unusual and somewhat unique piece of carpentry work was regarded with satisfaction by all concerned.

CHAPTER V

Miscellaneous Framing

32. THE CONSTRUCTION OF FRAMED TENEMENTS AND FACTORIES.

There is no class of constructive carpentry which requires more care, skill and calculation than the houses or edifices in which a number of persons live, work or congregate, as in this class strength and safety are the most important factors to be considered.

This is especially the case with framed houses which are built to accommodate three or more families, or as they are commonly called "tenements," and factories of three, four or more stories in height, usually running from 35 to 60 feet to cornice, and as these high dimensions necessitate doubling and splicing of vertical supporting posts and other bearing timbers, special attention must be given to the framing so as to insure absolute strength and safety.

To illustrate this I have in this article taken as an example for illustration, the practical framing of four four-story timber tenements, to be built on a street with a hill or steep grade. The pitch is 4 feet in 25 feet or 16 feet drop in the whole 100 foot plot covered by the four houses. Each house measures 25 feet front by 75 feet deep, and being each on a lot 100 feet deep, it will be seen there is a 25-foot yard left in the rear which is requisite for light and ventilation. Fig. 110 is a plan of one house showing the interior light shafts, which in the case of framed tenements are better laid out square or at right angles as seen in the figure, in order that the cost be reduced as low as possible, as obtuse and acute angular framing is very costly, not alone in the labor of the framing, but also in the increased cost of the extra material. For this reason it is always most economical to arrange the framing with square corners, as shown in Fig. 110. In building the stone foundations the first house to the left, or that at the bottom, has the side, rear and front walls level, so that the sills will be level all around. House No. 2 has its right-hand foundation party wall 4 feet higher, and house No. 3 has its right party wall 4 feet higher still, and house No. 4 has its wall 4 feet still higher, thus compensating for the pitch of the street, which will be seen by a study of Fig. 113, which is an elevation of the raised and framed principal timbers of the front of the houses. But the pitch of the street will affect the framing, and unless the right-hand stone foundation wall be built up to the level of each house to the right, it will be necessary to change the sill into a girt or tie, and to mortise and tenon this girt into the front, rear and intermediate posts to properly support

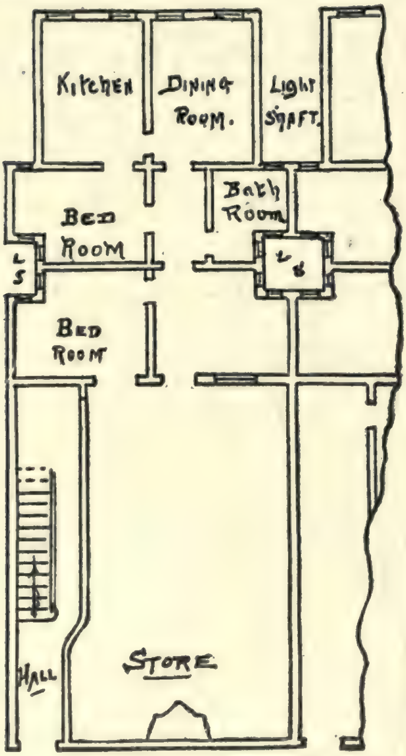

Fig. 110. Plan of Store Floor.

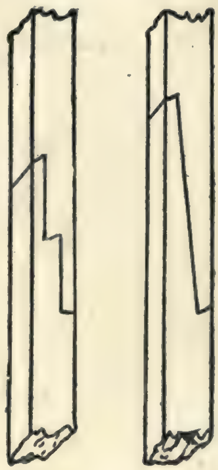

Fig. 111. Splicing Posts.

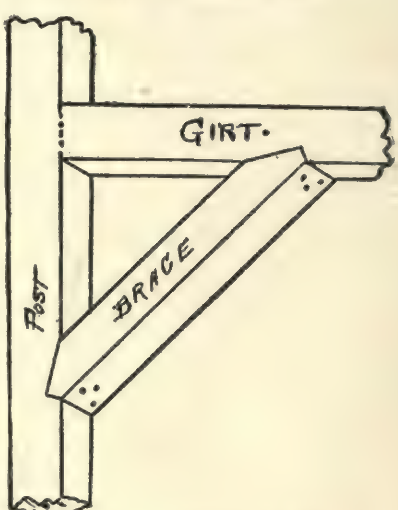

Fig. 112. Framing of Brace.

the first story floor beams which rest on them, as seen in this figure. Similarly the front and rear sills must be framed on the left-hand end with a mortise and tenon, so as to tie the whole framed construction together. From the above it will be seen that much study must be devoted to the proper laying out of this style of buildings by the carpenter in order that the timbers may fit when raised.

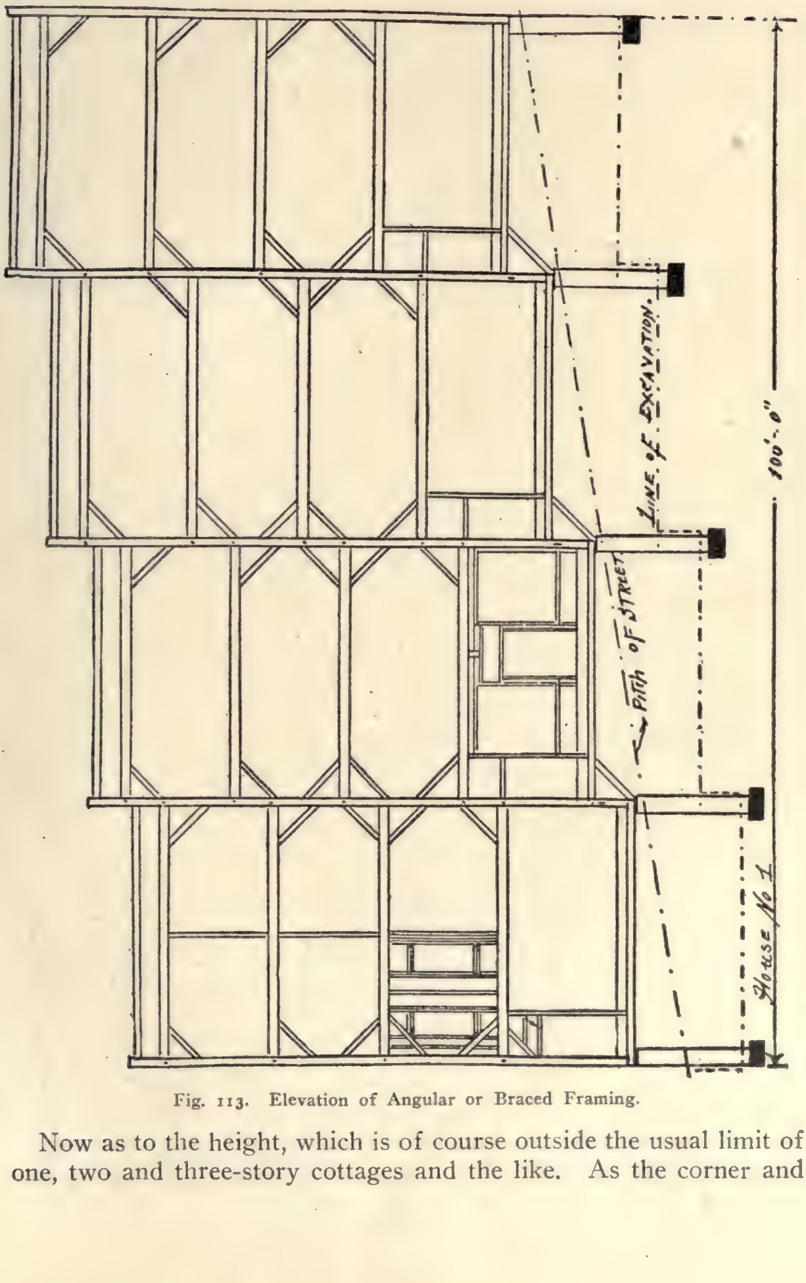

Fig. 113. Elevation of Angular or Braced Framing.

Now as to the height, which is of course outside the usual limit of one, two and three-story cottages and the like. As the corner and inside party and gable wall posts are so high that it would not be possible to obtain single timbers long enough to make up the whole height, it will be necessary to join two or more sticks end to end, and to brace them in such a manner, that there will be no danger of their springing or buckling. For the best form of vertical joint for this I would refer the reader to the sketch shown in Fig. 111. That *splice* on the left is to my mind the most economical and strongest form which can be used in this class of work, for the reason that it consumes only the extra length of the joint on the timber, and is easily ripped down from the end with the saw, and involves no chisel work whatever, if done by a careful hand. This joint is bolted together, and is stronger than that seen on the right, which will require more cutting, and though it has more bearing surface, is not so good or cheap as the other.

As to the proper bracing of long posts, for this the reader would be wise to follow the simple corner method, which is clearly illustrated in Fig. 112, with the tenon omitted. I am entirely opposed to putting tenons and mortises on these braces, and though the method is old, it is nevertheless bad, because the mortising of the girt weakens it and forms a receptacle for dry rot and insects when the timbers shrink away from each other and open the joint. Therefore a simple scarf with a spiked joint is the best, and the braces are so easy to slip in and nail in place, that the frame is held rigid and immovable, and none of the timbers are weakened in the framing.

This form of building may also be framed and raised on the balloon system, but if this be done I would recommend that at least girts and posts be used to carry the floor beams, instead of a ribbon, which is a weak construction; in fact, the frame should be half frame and half balloon, so as to make the building stiff enough to withstand wind pressure, the weight of snow or any ordinary strain.

Fig. 114 is an elevation of a straight gable, showing the braces, and this angular framing should be as far as possible introduced when the absence of windows permits it. If possible, also, these high framed houses should be sheathed diagonally. Sill and girts might also be braced from piers and wall for additional strength.

33. HOW TO CONSTRUCT A FRAMED AUDITORIUM.

In the last article I treated the detailed construction of framed tenement dwellings; in this I propose to explain fully the method of framing large assembly buildings, as adopted in one of the best known timber auditoriums in the United States, the place where many famous pugilistic encounters have taken place. I refer to the building that was called the Coney Island Athletic Club.

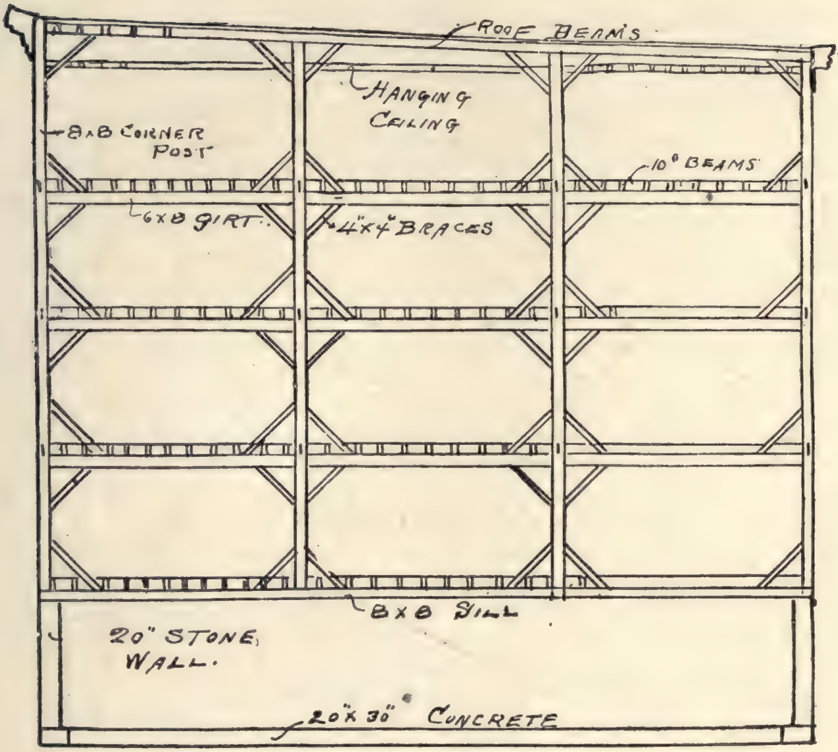

Fig. 114. Side Elevation Showing the Framing of Gables and Party Walls.

This immense framed structure was originally designed and built for a skating rink at the time of the skating craze in 1884, and measured 125 feet in width by 300 feet in length over all. The building consisted of three parts or sections in plan, namely, a main floor or exhibition part 75 feet in width and two aisles or wings, reserved for galleries for spectators, each 25 feet wide.

The construction mainly consisted of a series of brick piers and timber 13-inch posts, spaced 15 feet apart and sunk to rest on concrete bases, as seen in the transverse section of the building, Fig. 115, each capped with an 8-inch blue stone. On these, heavy 12x14 inch yellow pine longitudinal girders were set; the outside lines of girders allowing the ends of the 12x12 inch square vertical columns to rest directly on the centers of the cap stones, the girders being tied together by an inside 3-inch band solidly spiked to the posts and girders as seen in Fig. 115. On these girders the floor beams were placed, overlapping and spiked together, and spaced 16 inches apart.

When the main supporting columns were framed and raised, they were plumbed and strongly braced to the floor beams with 2-inch plank braces, and thus held until the braces and wall plates were framed, raised and set. Here I might state that the raising was all done with gin poles, one being a light 10-inch stick of yellow pine timber, used for the post and timbers, and the other, used to raise the trusses, being an immense round stick of Canadian spruce 60 feet long, 10 inches at the top and 16 inches at the butt. Both were *stayed* with rope guys and rigged with four sheaved blocks and tackles, thus giving great lifting power. The last pole was equipped with a drum and horse gear. When the plates were being framed and set, a special gang of men was engaged in framing and putting together the trusses, the design of which is readily seen in Fig. 116. They were of the Howe class, modified to give a pitch to the roof, and consisted of a lower chord or tie beam 75 feet long, made up of two 40-foot 8x12 inch yellow pine timbers spliced at the center as at Fig. 117 and strengthened by having a 2-inch oak plate bolted on each side to prevent its breaking or springing sideways. Into the upper edge of this beam was framed the principal

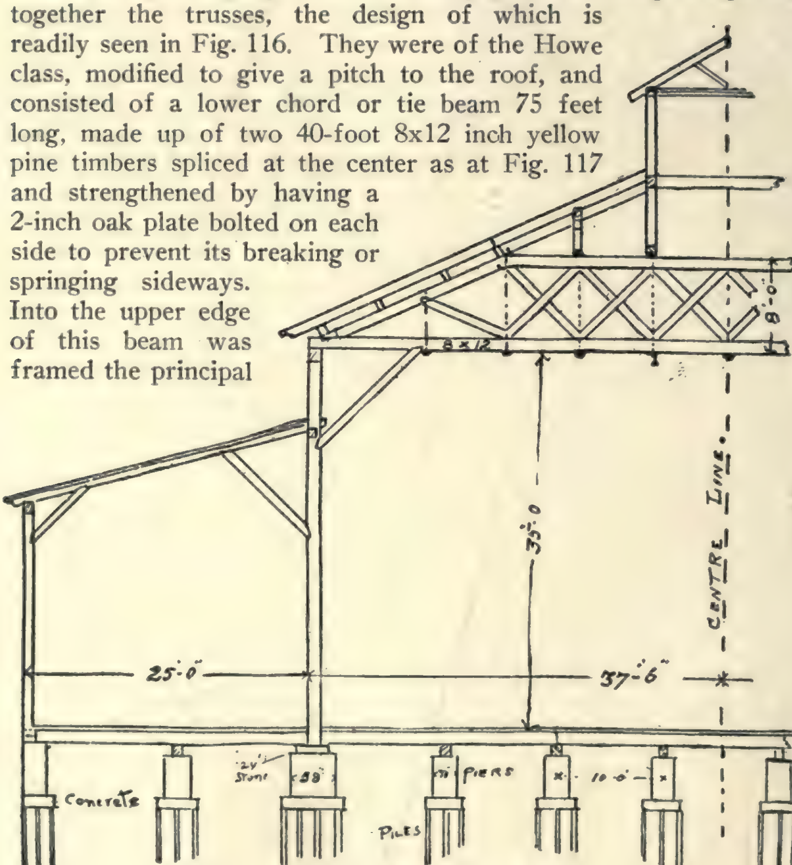

Fig. 115. Section of a Frame Auditorium.

rafter, A, Fig. 116, the diagonal braces and struts all being fitted with tenons and the beams mortised to receive them. Each end of each diagonal brace abutted at the upper and lower chordal beams, and each brace was coped out to fit over the 2-inch wrought iron suspension tie rods, which tightened up the entire truss.

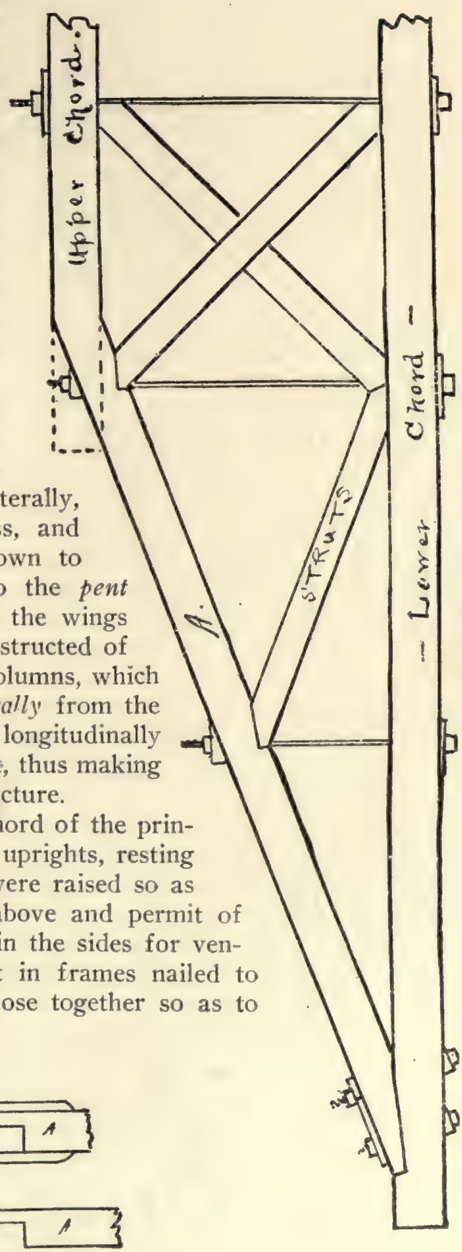

Fig. 116. A House Truss.

The trusses were braced with long diagonal corner braces to the posts, thus stiffening the building laterally, directly under each truss, and carrying the pressure down to each post and thence to the *pent* or *lean-to* shed roofs of the wings or aisles, which were constructed of main posts opposite the columns, which in turn were braced *laterally* from the rafters overhead, and longitudinally from the plate to the post, thus making it a strong and rigid structure.

On top of the upper chord of the principal trusses short 5-foot uprights, resting on a longitudinal plate were raised so as to give the light from above and permit of pivoted sashes being set in the sides for ventilation. These were set in frames nailed to studding and were set close together so as to give plenty of air space.

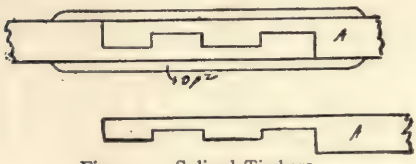

Fig. 117. Spliced Timbers.

34. THE CONSTRUCTION OF REVIEWING STANDS AS USED IN THE DEWEY PARADE IN NEW YORK.

I know of no greater tribute to the skill, care, ability, and trustworthiness of American carpenters than that evinced in the construction of the triumphal arch and tremendous number of reviewing stands erected along Riverside Drive, Seventy-second Street, Eighth Avenue, Fifty-ninth Street, and Fifth Avenue for reviewing the parade in which Admiral Dewey was the central figure. There were over 1,000 reviewing stands and platforms built to accommodate 2,000,000 persons, and these were framed, raised, braced and nailed in such a way by the union carpenters of New York, that not one of them strained, fell, or caused accident.

In order to show the carpenters of the entire country some of the constructive details of the carpenter work done during this celebration, we will commence with the timberwork of the Dewey triumphal arch, erected on Fifth Avenue at Madison Square.

This splendid piece of framed and nailed carpentry was built up of various sizes of timbers, running from 8x8 to ⅞-inch scantling, and was carried up on the diagonal system of bracing as illustrated in Fig. 118, which is a perspective view of the timber framing before the staff was put on. (As this illustration is made from memory,

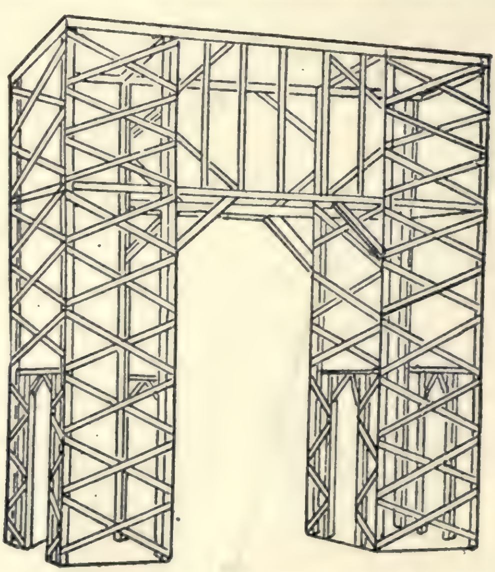

Fig. 118. General View of Framing of the Dewey Arch.

I have purposely omitted many timbers so as not to confuse the drawing.) The abutting joints of each length necessary to make the full height of 60 feet were cleated together, nailed and bolted, afterwards being braced with diagonal braces reversed across on the diagonal on the insides and outsides of the uprights. For the arches intersecting east and west intermediate uprights were inserted, these also being diagonally braced vertically, and horizontal diagonal bracing from corner to corner was used to stiffen the whole construction laterally. This unusual job of extemporized framing was done without accident, and made so strong and rigid that it sustained the weight of the staff of which the covering and modeled work is composed without a sign of strain or fracture. I might state here that the plaster work and staff was spread on plaster boards and wire lath which were solidly nailed to the timber work underneath.

The construction of the pedestals of the single and double columns, forming the approach to the arch, was a comparatively simple matter, as the columns were made up of poles, sunk in the street; and around these platforms of timber were built to the desired height, being of 2-inch plank carried on 3x6 or other uprights and braced diagonally, all bridging, cleats, etc., being cut in and fitted where required by the sculptors and their assistants, thus forming a rigid groundwork for the artistic work, which so embellished the most important part of the demonstration.

Now as to the construction of the reviewing stands, which were erected for the purpose of giving a better opportunity to see the parade, which consisted not only of the hero of Manila and many representative citizens, but also 30,000 troops. As this immense body of men occupied five hours in passing a given point, it necessarily followed that seating accommodation should be provided for hundreds of thousands of persons. To do this required millions of feet of lumber and the united labor of 5,000 carpenters and 10,000 laborers. In order to give some idea of the immense number of seats built, I would state that on Riverside Drive on ten blocks there were 30,000 seats built, which were almost entirely occupied, and the capacity of the stands along the route varied from ten persons to 5,000 persons. From these figures some idea of the vast amount of work may be estimated, especially when it is remembered that the route was over six miles long, and therefore I say great credit is due to those who did the work and built the stands.

As to their construction, as far as possible the diagonal system of bracing was adhered to, the uprights being cut barefoot top and bottom, and butted together at the joints and secured with cleats, well spiked, to prevent their buckling or spreading.

In Figs. 119 and 120 sections of the methods are represented, and here will be noticed the great value of this form of bracing, as by its aid comparatively light uprights may be made capable of sustaining a very heavy weight, provided the possibility of shearing or buckling be reduced to a minimum. Shearing can only be prevented by having a sufficient area of timber and of a nature sufficiently tough to fully resist the compressive force. Buckling is prevented by cross ties, braces, etc., or the tensile strength of the timber itself and the height of the post, and superincumbent weight regulates this.

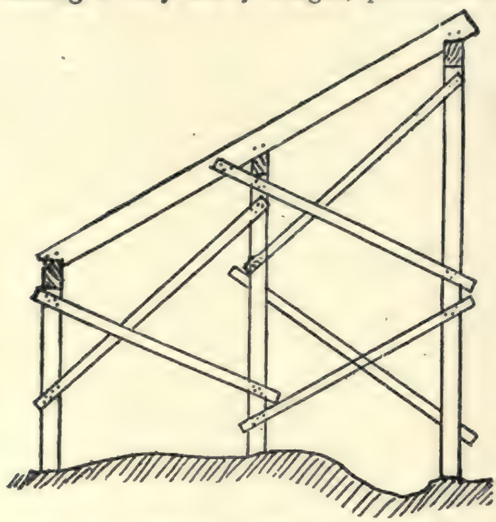

Fig. 119. Section of Framing of a 20-Foot Stand.

The majority of the reviewing stands from 6 to 25 feet in height were built of 4x6 and 6x6 spruce timbers, spaced about 6 feet on centers and braced about 6 feet in the height. The sloping bearers varied from 3x6 to 3x10, also of spruce, and braces from 2x6, 2x4, 2x2, 1x6, 1x7, 1x2 and so on as the timber came, some of it being second-hand timber. Apropos of second-hand timber, I would say that its extreme hardness and brittleness lessens its value as a bearing timber, in addition to its great liability to split when being nailed, which latter peculiarity I noticed existant in much of the hemlock used.

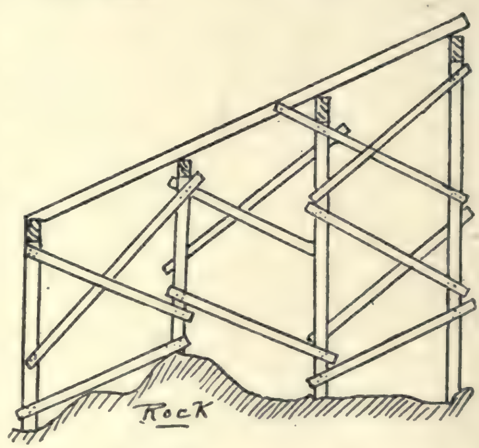

Fig. 120. Section of Framing of a 25-Foot Stand.

The brackets were mostly nailed on the top edges of the sloping bearers, as in Fig. 121, though some, those of 1¼-inch hemlock, were spiked on the sides in the way seen at Fig. 122 and fitted with a small upright. Many of the stands had chairs on the platforms which averaged 4 feet in width, and again many had simple benches

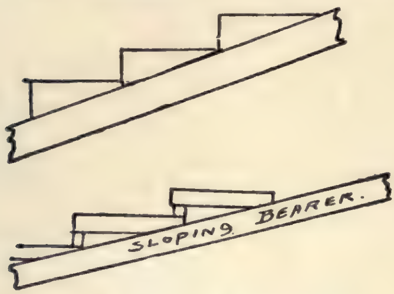

Fig. 121. Brackets to Support Seating.

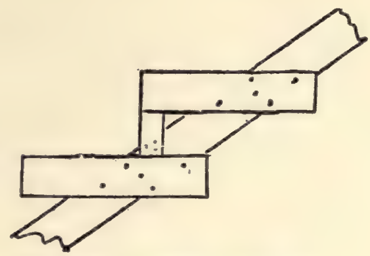

Fig. 122. Brackets Nailed On.

consisting of 9-inch ⅞ boards on 16-inch uprights, well braced, and nailed with *wire nails,* which nails were almost universally used in the stands, the reason for which, I since learned from the builders, was to save the timber as much as possible, as these nails pull out easily with the hammer.

35. HOW TO BUILD A GRAIN ELEVATOR.

Grain elevators are, as far as I know, of a composite construction, namely, of masonry, iron, and wood. The usual method of construction followed is, as in Fig. 123, to make the footings and foundations concrete or stone, the first and second stories of brick, as A, as these are the distributing floors, and the superstructure of timber. For the better elucidation of this I would refer the reader to the sketches which accompany this description, as they are from the actual work as I have seen it built.

As the inquirer will perceive, the second section or story is built of timber, so as to form bins, or boxes, for the purpose of receiving and storing the different kinds of grain; and in order to construct the bins a very unique yet simple form of construction is followed out. Fig. 124 is a cross-section taken through B, the second story, or bins, and fully illustrates the method. It consists of starting the bottom of 2-inch or 3-inch layers of plank timber, 14 or 16 inches wide, on top of the first story masonry and gradually stepping back in 1-inch steps till the thickness of the wall, 6 or 8 inches, is reached, crossing all joints intersecting where possible and scattering all joints so as to obtain the greatest possible strength. All nails are of steel wire and long enough to dovetail into three thicknesses of timber. Corners are overlapped. All this will be clearly understood by a close study of Fig. 125, which is an isometrically projected drawing of one corner of the bin section, showing the laminated, or built-up,

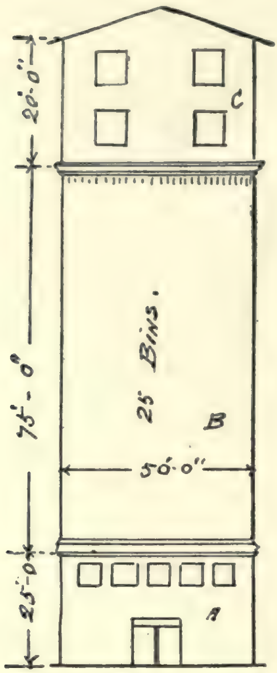

Fig. 123. Elevation of a Grain Elevator.

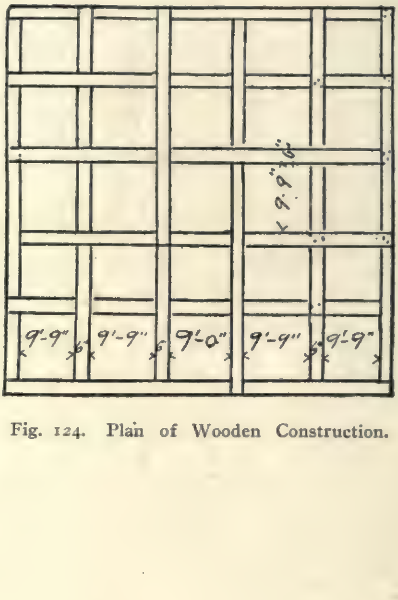

Fig. 124. Plan of Wooden Construction.

method of constructing the bins. On account of the ever-varying grains, breaking of joints, and multitudinous quantity of nails (dove-tailed), this form of building bins is of enormous strength, and can be carried to a great height, and makes a very strong, capable house. The amount of cutting and fitting and nailing involved is tremendous, but the bins are of great strength and content, each of those represented here containing almost 7,000 cubic feet. When the bin section is built up to a height of 75 feet, the upper portion C of Fig. 123 is framed and raised of wood on a braced-framed principle, so as to be light and strong. The whole should be covered with slate, iron, or tin.

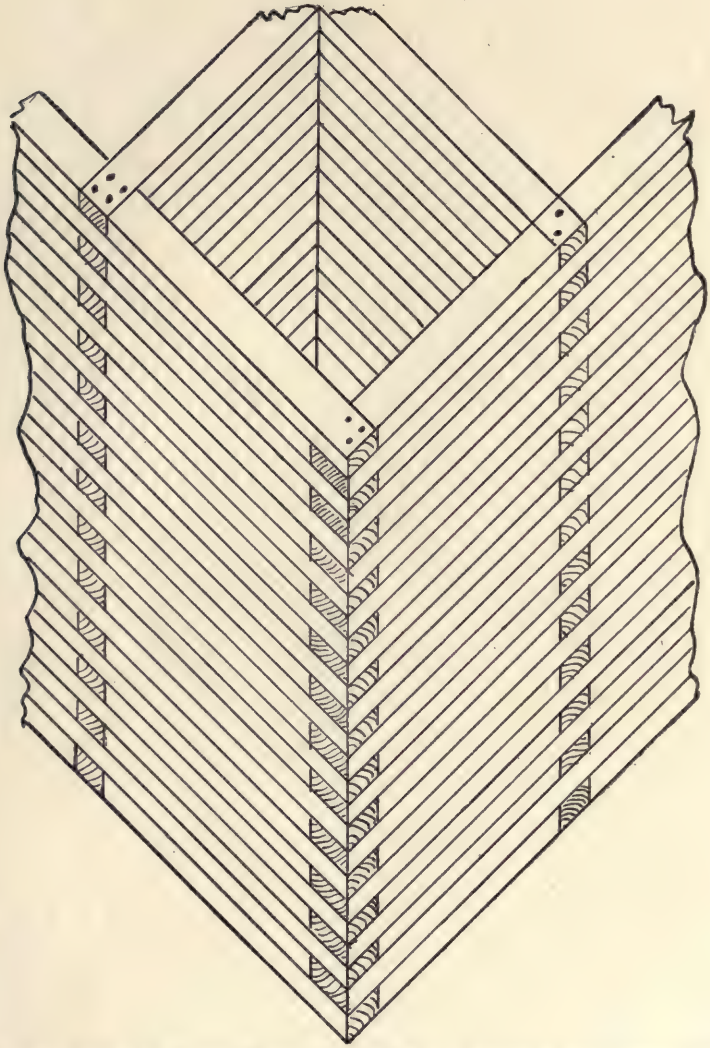

Fig. 125. Method of Building Wooden Grain Bins by Overlapping and Crossing Joints.

36. FRAMING A BATHING PAVILION.

The accompanying illustrations show a bathing pavilion erected on the shores of the Hudson River, at the foot of West 151st street, New York City. The first floor of the structure is devoted to a series of robing rooms for ladies, while the upper floor is intended to be used as an open balcony for those who prefer to watch the bathers. The bath houses for the men are adjacent to the pavilion and extend along the shore. The framing of the pavilion is of a modified balloon style and rests upon rubble stone piers 2 feet square by 5 feet high. The main sills are of 6x12 spruce, set on

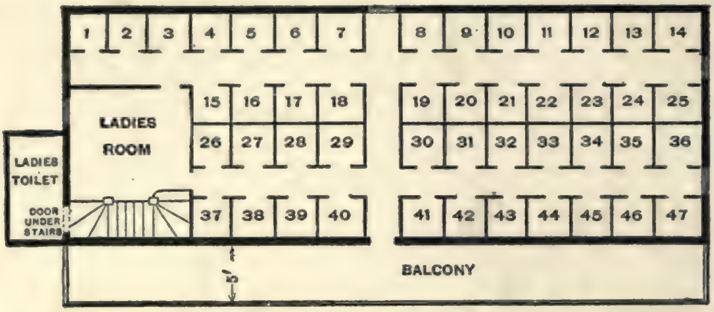

Fig. 126. Main Floor Plan of a Bathing Pavilion.

edge, the corners being halved and all thoroughly spiked. The first floor beams are 3x8 spruce, set on edge, spaced 24 inches on centers and thoroughly spiked to sills and girder. The main posts are of 6x6 spruce, framed in the following manner: At the sill the foot of the post is halved out so as to rest 4 inches on the sill and strongly bolted to it with ¾-inch wrought iron bolts with washers, as indicated in the transverse section, Fig. 128. They are gained out for the stringpieces which support the second story floor beams so as to admit half the thickness of the timber. The stringpieces are of 4x10 spruce let into the inside face of the posts, as indicated in the figures. These occur at the front and rear and are bolted to each post with two ¾-inch bolts, as shown in Fig. 128. The second floor beams are 3x12 spruce, spaced 16 inches on centers and strongly nailed to the stringpieces with tenpenny nails. Supporting the center of the second story floor beams is a longitudinal center beam measuring 4x8 and carried on uprights measuring 4x6 inches. The joints of the beams are halved together, each joint resting on an upright. Similar upright posts of 4x4-inch spruce spaced 5 feet between centers are placed to support the stringpieces on the outside walls. The wall plates are 6x8 spruce, halved together on top of the posts and at the corners. The system of bracing employed is clearly shown in Fig. 127.

The roof trusses are framed as shown in Fig. 128 and carry 2x4-inch spruce purlins spaced 24 inches on centers and nailed in position. The purlins project over the gable ends 2 feet. The first

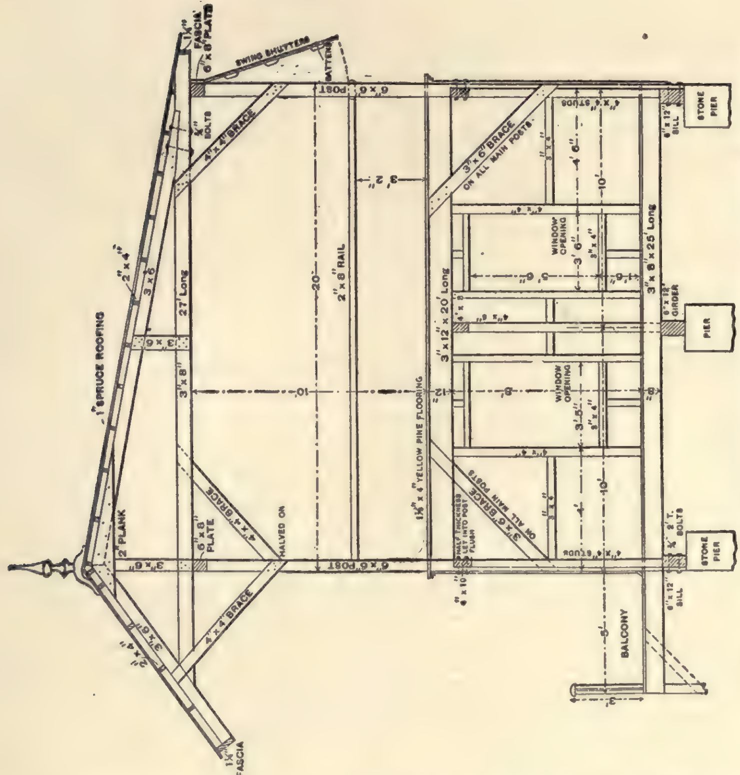

Fig. 128. Transverse Section of the Pavilion, Showing End Framing.

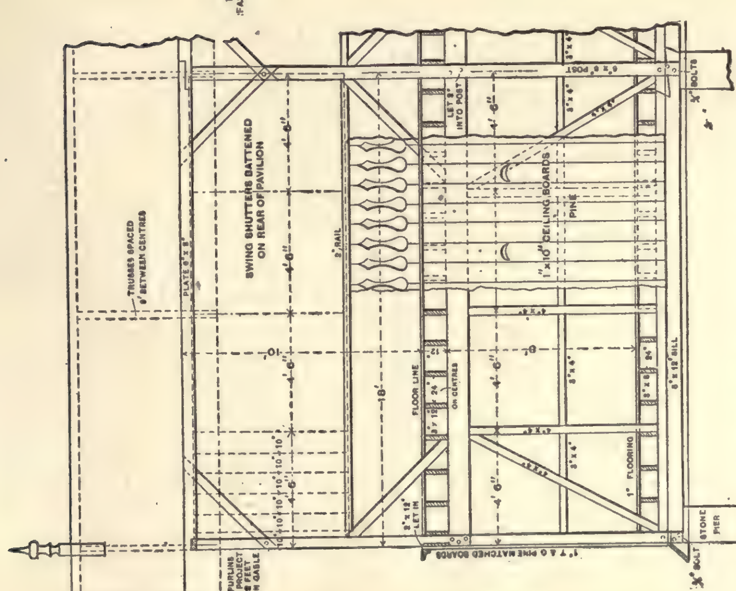

Fig. 127. Framing of the Side Walls of a Bathing Pavilion.

floor and balcony are covered with 1x9-inch tongued and grooved spruce flooring laid with broken joints and nailed on every beam. The second story flooring is of 1x4-inch yellow pine. The entire first story is covered with 1x10-inch matched pine ceiling boards with a crescent shaped opening cut for each dressing room. There are swinging shutters at the rear portion of the pavilion hung with T-hinges. The partitions forming the dressing rooms on the main floor, Fig. 126, are of 1x9-inch double faced pine nailed to 2x2-inch strips spiked to the flooring and ceiling. Two thousand dollars was the cost of the structure, including the painting.

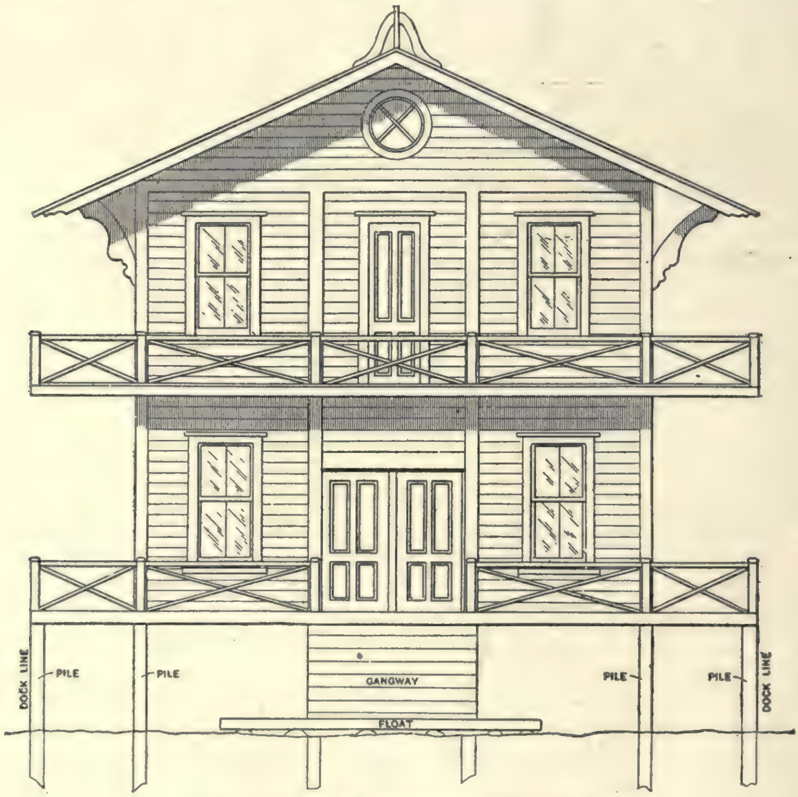

Fig. 129. Front Elevation of a Boat Club House.

37. FRAMING A BOAT CLUB HOUSE.

Figs. 129 and 130 show the section and elevations of a boat club house erected on the Hudson River at the foot of West 152d street, New York City. The house rests on spruce piles driven to a solid foundation, and then sawed off at the height indicated on the elevations. The main corner and intervening posts are of spruce and are framed in the manner indicated. Where floor beams come in contact with the posts they are solidly bolted together in a substantial manner. The two tiers of floor beams are of spruce timber properly framed and overlapped where the lengths are not sufficiently long to span the full width of the building. The longitudinal side girders as well as the end girders at the second story are 4x6-inch spruce timbers, notched 1½ inches into the posts and bolted solidly thereto with

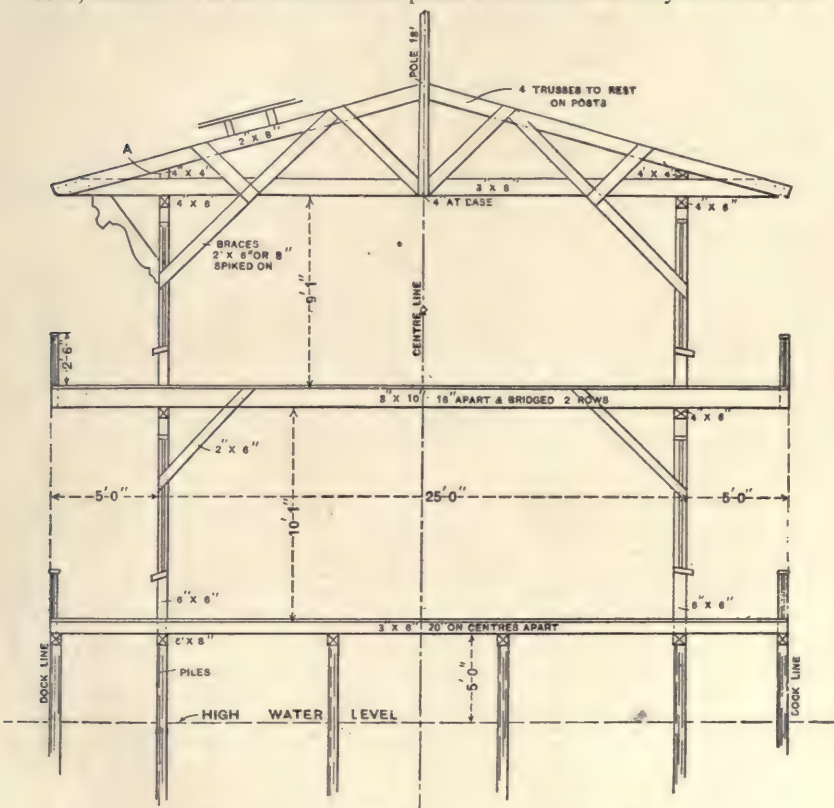

Fig. 130. Transverse Section of a Boat Club House.

⅝-inch bolts and washers. The wall plates, or upper girders, shown in Fig. 130, are of similar material and are tenoned and mortised on the top ends of the posts, being fully braced as indicated. The sides of the house are covered with spruce and cut in tight between the posts to make the construction rigid. Over the sheathing is a layer of building paper and this in turn is covered with white pine novelty siding fitted to a close joint against the window and door frames and the heading joints well broken and staggered. The roof is covered with 1-inch tongue and grooved spruce, planed on one side and laid to a close joint in the soffit edge and thoroughly nailed. The whole is covered with three-ply tar paper, tar and gravel.

The first floor, or boathouse floor, is laid with 2-inch spruce flooring, tongued and grooved and nailed to every beam with 4-inch wire spikes. The second floor is of ⅞-inch yellow pine matched flooring. The tiers of balconies made by the projecting ends of the beams on the north and south sides of the building, are floored with 2-inch yellow pine planed on the upper side, driven to a close joint and thoroughly nailed. Opposite to each post is placed a 4x4-inch baluster solidly nailed to the floor beam below. The top rails and diagonal flooring in between the piers are 2x4-inch pine cut in as shown and firmly nailed, the inner sections being notched together so as to come flush at the edges.

The building here shown was designed by the author.

38. HOW TO FRAME CHEAP TIMBER BRIDGES FOR ROADWAYS, ETC.

The construction of good, cheap bridges for spanning small rivers, valleys, ravines and such, on country roads, necessitates some care and originality; and I have found that this class of work, though not very frequent, still occurs in many localities, also cheap timber roofs. For the purpose therefore of explaining the best and cheapest form I will present in this article several methods of simple trussing which carpenters will find useful. For very short bridge spans of from 4 to 6 feet, the best form is a simple series of 3 or 4 heavy yellow pine or spruce timbers spaced so as to come directly under the wheels, and large enough to sustain a weight of from two to five tons in the center of their bearing. The width of the roadway for two lines of vehicles, allowing room to pass easily, should be from 16 to 18 feet, with 4 feet for sidewalks, so that it will be necessary to lay out a cross section of the prospective bridge, place the stringers or longitudinal bearing timbers in such positions as they will best resist the movable load. According to the best engineering authorities the moving load provided for should be, for spans under 100 feet, 70 to 100 pounds per square foot; for spans from 100 to 200 feet, 50 to 80 pounds per square foot; for spans over 200 feet, 40 to 65 pounds per square foot.

In Fig. 131 readers will see a cross section of a highway bridge spanning a creek about ten feet wide. There are four principal stringers under the roadway which are trussed with the center post and 1-inch wrought iron suspension rod in the manner shown at the

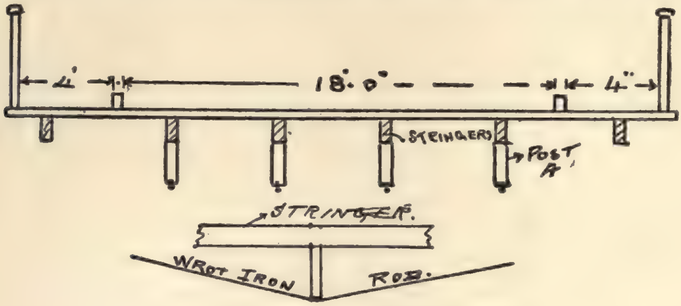

Fig. 131. Section of a Highway Bridge.

bottom of the figure. This suspension rod passes through the ends of the stringer and is tightened with plates, washers and nuts. As will be seen there is four feet allowed on each side for sidewalks. The stringers measure 8x12 inches, the roadway planking 3x8 inches and the guide pieces 5x8 inches; the guard rails for the bridge can be made up of diagonal or some other simple pattern, but they should be well braced from the under side of the bridge. In Figs. 132 and 133 I show longitudinal and transverse sections of a small bridge for spanning any width up to 25 feet. Readers will perceive that this form of bridge is constructed on the Howe truss principle, and

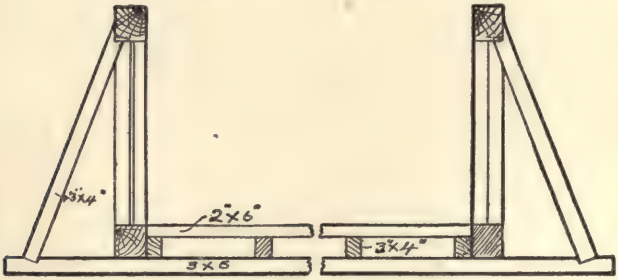

Fig. 132. Cross Section of a Small Bridge.

very strong bridges can be built by increasing the depth or distance between the *upper* and *lower chords*. It will be understood that the sizes of the timbers must be increased in proportion with the increase of each foot of span in order to resist the strain placed thereon.

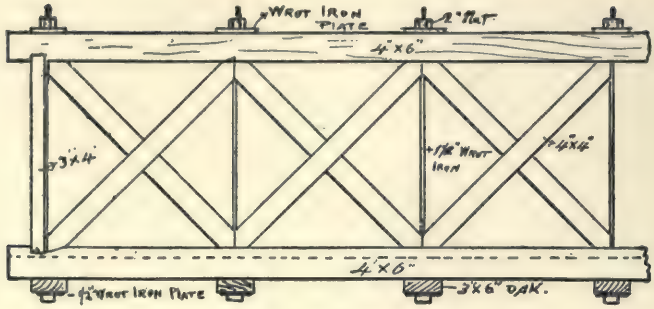

Fig. 133. A Small Bridge Truss.

Fig. 134 shows another form of simple trussing for a span not to exceed 25 feet. Fig. 135 is a simple form for a span not to exceed 15 feet.

Fig. 136 represents a very simple form of diagonal lattice trussing, by means of which a very cheap and serviceable bridge may be built

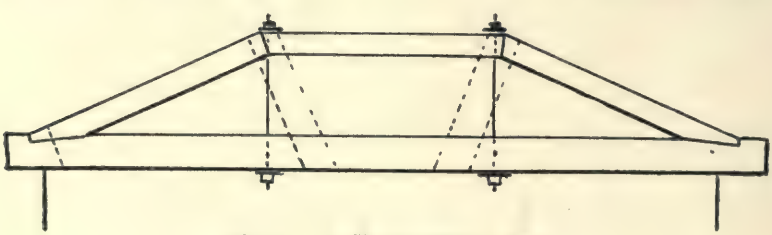

Fig. 134. A Simple Bridge Truss.

for spans of 20 feet, but the writer would not recommend bridges to be built of this kind, as the limits of nailing and the sizes of the timber prevent the adoption of this method.

For flat roofs the diagonal lattice can be used, or on barns or long buildings, bridge girders can be built up by this method, thus

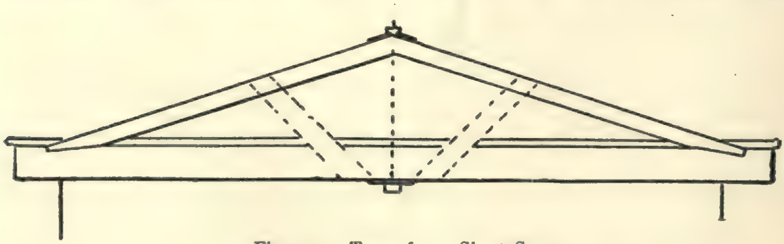

Fig. 135. Truss for a Short Span.

leaving the entire covered space underneath free from columns or supporting posts. For roofs of short span, shingled or slated, the trusses seen in the figures can be readily adapted.

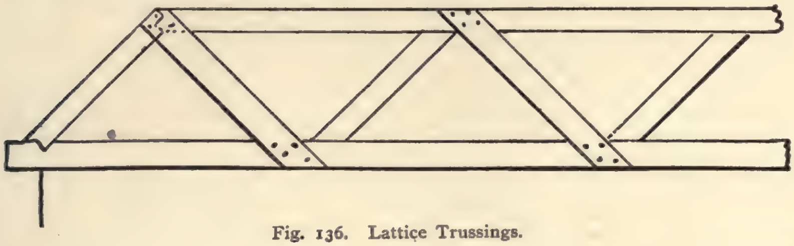

Fig. 136. Lattiçe Trussings.

CHAPTER VI

How to Move a House

39. GENERAL CONDITIONS, TOOLS AND APPLIANCES.

The science of actual practice of house moving is one which is in itself a specialty, being the outcome of the improvements of cities, the widening of streets, the erecting of better houses on occupied lots, transfers of property, etc., and is a familiar incident in connection with most all communities.

Let me state at the outset that successful moving is only accomplished after very careful thought and procedure, as it necessitates not alone a full knowledge of building construction on the part of the house mover, but he must also have a sort of native or acquired knowledge of the elements of civil engineering. This is essential, because not only do statics and dynamics enter into the work, but the forces and mechanical powers as well. Houses being composed of many materials — details so arranged by man's skill that they form a perfect whole — are perfectly safe and secure while at rest and undisturbed; but should any lateral movement occur at their bases, their statical condition is immediately altered and their structure impaired. For this reason, then, it is imperative that the house mover should be a skilled mechanic, preferably a carpenter or mason and experienced in the work — that is to say, he should have worked under an expert or foreman on large and small jobs of brick and frame houses, for nowadays both kinds of structures are frequently moved.

Now as to the tools and appliances necessary. I might state that successful moving depends on accurate and reliable machines, especially constructed for the purpose, and I will describe them in the way in which they are required, although the work embraces both skilled and unskilled labor, ranging from the ordinary laborer who digs, hauls and carries, to the carpenter, electrician and mason who complete the work and make all safe and secure. In addition to the ordinary simple implements of labor, as shovels, pickaxes, hods, wheelbarrows, crowbars, short and long cold chisels, saws, hammers, etc., there are several other tools required, among which are the following of unusual form:

First, there is the "pump," a technical term used to designate the builder's screw or pump screw, illustrated in Fig. 137, and which is used in connection with and at the ends of timbers for the purpose of increasing their length by means of a long bar or lever. This indispensable tool is perhaps the most essential in house moving and raising, being used in great numbers, in lieu of wedges, owing to the fact that it is more powerful and reliable. In itself considered, it is a great revolving power wedge and by reason of its form capable of turning, provided it is properly fitted into the end of the timber, which must, of course, be of sound and solid wood. It is of such a movable nature that it may be applied either in a horizontal or vertical position, thus rendering it of the utmost utility, as will be noted as the article progresses.

The following list of manufactured sizes will be found useful when purchasing apparatus for this class of work. The figures are applicable both to pump and jack screws:

Manufacturers' List of Pump and Jack Screws.

Diameter of screw.	Height of stand. Inches.	Height over all. Inches.	Lifting capacity. Tons.
1½	6	10	12
1½	8	12	12
1½	10	14	12
1½	12	16	12
1½	14	18	12
1½	16	20	12
2	8	12½	20
2	10	14½	20
2	12	16½	20
2	14	18½	20
2	16	20½	20
2	18	22½	20

Another tool of the same kind as that already described, though applied directly, is the locomotive or screw jack, shown in Fig. 138. This is worked like that shown in the previous figure, with an iron bar or lever. By reason of the probability of the ends sliding or slipping on the top plate, or the jack tipping on its base, this tool is never applied to apparatus or shores except at right angles to the axes of the timbers, whether they be placed vertically or horizontally, but the ends must be kept flat against the face of the timber. In Fig. 139 is shown a "cant hook," used by the house mover in turning over the heavy timbers on which he supports and moves the buildings. In

Fig. 140 is shown the builder's roller, of which he generally uses two, three or more for the purpose of transferring by rolling the aforesaid timber from one place to another, as the reader will learn later on. In the meantime he will readily appreciate the fact that the extra

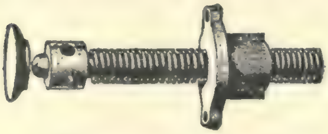

Fig. 137. A Pump Screw.

Fig. 138. Jack Screw.

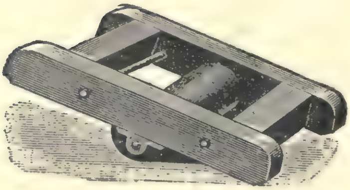

Fig. 140. Truck or Roller.

Fig. 139. Cant Hook.

large size and weight of the timbers would necessitate the employment of a great number of men to carry them about, while the simple appliance here shown obviates any such performance.

Considering now the motive power required, I would state that primarily buildings of the lighter frame class are moved by man

Fig. 141. Method of Moving Light Frame Buildings.

power applied to levers or ropes, in conection with blocks and tackles, acting directly with a pull and haul, or in the manner indicated in Fig. 141, with the assistance of a windlass or roller, either acting direct or with a pawl. Fig 141 shows how a light frame church was moved, and at the same time it clearly explains how the apparatus was applied by man power in turning a fixed drum capstan, revolved by spur gearing and cranks. The whole apparatus is mounted upon a large frame work supported on wooden wheels. The ground being of a soft, clayey nature, it was necessary to place upon it thick planks, to act as the surface over which the rollers upon which the building moved could more readily pass. This method being of an extemporized nature, can be readily adopted by carpenters or building contractors in the smaller communities, more especially as the appliance can be readily made by carpenters themselves.

There is, however, a cheaper and just as available motive power, always obtainable, and that is the direct acting horse-power applied to the windlass, or "crab," as it is technically designated in the

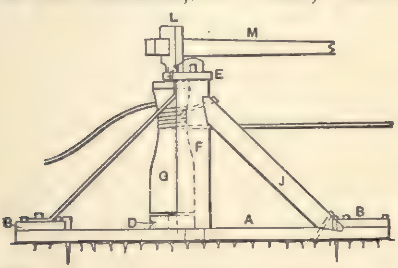

Fig. 142. Side Elevation of Windlass or "Crab."

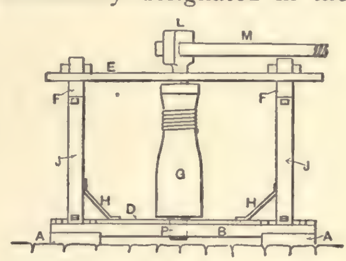

Fig. 143. End Elevation of Windlass.

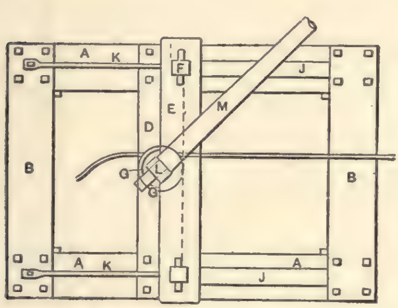

Fig. 144. Plan of Windlass.

United States, and which is illustrated in Figs. 142, 143 and 144 representing respectively side, end and plan views.

This machine, which is generally found in use in the larger cities and towns, is constructed for the most part of timber, and consists of a base or frame, AA and BB, of 3-inch oak or yellow pine timbers bolted together, the transverse end pieces BB being notched down into the side pieces in order to prevent their racking. A third middle piece of oak, D, crosses the center and is placed there to sustain the vertical revolving drum or capstan G, which it receives in a central hole or pocket, P. Two uprights, FF, of 3x8-inch oak, are mortised and tenoned at the bottoms into each of the sides A and A, and kept from jumping out by a wooden taper key driven into slots in the tenons underneath. They are also kept from racking laterally by the short angular braces HH, shown in Fig. 143. These uprights are prevented from overturning by the diagonal compression timber braces JJ, measuring 3x6 inches in cross section, which counteract the pulling strain by being notched and bolted to the uprights FF and sole piece AA. As a further strengthener, 1-inch wrought iron tension diagonal braces, KK, are similarly placed on the pulling side, to maintain the equipoise pressure on the frame and keep the strain as vertical as possible. The upper cross piece E, of oak or hickory, is held in position by being mortised, tenoned and keyed to the side pieces, and in this, at the center, revolves the capstan G. A semi-circular cut is made to receive it and it is kept in place by a wrought iron collar strip, which is hinged at one end and fitted with a slot, staple and pin at the other.

All the foregoing will be readily comprehended by a careful study of the figures, as the details are here presented in a way to show all the salient features. The drum or capstan G, being subjected to great strain, is built up or turned out of a solid piece of hickory, oak or locust, the latter being preferable on account of its density of fiber, which renders it less liable to strip or sliver under the friction of the rope. It is also preferable by reason of its smoothness at the bearings, which, of course, tends to greatly decrease friction. It should be turned or made smooth to about the form shown, but not less than 12 inches in the thickest portion nor 8 inches in the thinnest. A collar must also be turned on the top and bottom, as indicated, to form a flange, and the bottom pin must be left at least 4 inches, or one-third the diameter of the drum. The top pin, where it fits into E, may be of the same diameter, but the top, L, will require to be thicker, if the shaft or capstan bar M is to fit into the mortise as shown. Should its top end be finished square, then 3 or 4 inches will be sufficiently thick for the purpose. The object of turning the drum to this shape is to prevent the rope from slipping down; also to regulate the speed of the "move," which can be done by sliding the rope turns down or up, as required. The bar is made of stout, well seasoned hickory, running from 6 inches in thickness at the inner end to 3 inches at the outer, and is either shaped to fit into a mortise on the drum head, as in the illustration, or made wide and mortised square to fit over it. It is equipped with ⅜x½-inch strips of wrought iron, to prevent its splitting. Its length is 10 to 12 feet, and the outer end is fitted with a ½-inch galvanized wrought iron eye bolt or hook and nut, to which the whiffletree is attached.

The entire machine is fastened down to the street or road by long iron or steel spikes, forged somewhat similar to a railroad spike. These are driven home with a maul into the pavement or ground, depending, of course, upon the location of the moving operation. Of course, longer and broader spikes will be needed for asphalt pavement or clay, but small crowbars will do.

Fig. 145. A Triple Block.

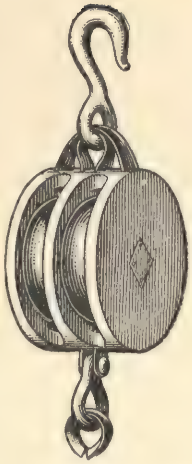

Fig. 146. A Double Block.

The blocks, such as shown in Fig. 145, are manufactured in the best manner and can be obtained in the following sizes and of the stated capacities, the lists being presented so as to enable the practical house mover to properly gauge what will meet his requirements as they occur. The blocks are strong and durable and have smooth and noiseless hardened roller bushings, being adapted to heavy and continuous work. The average for sale are as follows:

	Pounds.
Block for ½-inch rope	3,500
Block for ¾-inch rope	6,500
Block for 1-inch rope	11,000

Table Showing Style and Weight of Block, with Size of Rope.

Style.	For rope diameter. Inches.	Diameter sheaves. Inches.	Length of shell, including becket. Inches.	Weight, each. Pounds
Single sheave	½	2¾	5½	3
Double sheave	½	2¾	5½	4¼
Triple sheave	½	2¾	5½	6
Single sheave	¾	3½	7½	6
Double sheave	¾	3½	7½	8¾
Triple sheave	¾	3½	7½	12
Single sheave	1	5	9½	9¼
Double sheave	1	5	9½	14
Triple sheave	1	5	9½	18

In Fig. 146 is shown a double block, made with lignumvitæ or iron sheaves and loose hooks, which can be obtained in the following sizes:

Inside Iron Strapped Wooden Blocks.

Size sheave.	For Rope, diameter.	Size, Inches.	Size, Mortise.
1¾ x ½ x ⅜	⅜	3	9/16
2¼ x ⅝ x ⅜	½	4	11/16
3 x ¾ x ⅜	⅝	5	⅞
3½ x 1 x ½	¾	6	1
4¼ x 1 x ½	⅞	7	1⅛
4½ x 1⅛ x ⅝	1	8	1¼
5½ x 1⅛ x ⅝	1	9	1¼
6¼ x 1¼ x ¾	1⅛	10	1⅜
7¼ x 1¼ x ¾	1⅛	11	1⅜
8 x 1⅜ x ¾	1¼	12	1½
9 x 1½ x ¾	1¼	13	1½
9½ x 1⅝ x ¾	1¾	14	1¾

These blocks will be found of value in arranging tackle for moving the lighter frame houses, for hoisting shores and needles, hauling out timbers, etc., and should be carefully examined when purchased, in order to make sure of their reliability and safety. Their iron work should be minutely inspected to provide against flaws in the forgings, pins or bushings, as they are liable to fly apart when under strain and might cause serious accidents.

The next important consideration is the rope, which, like all other essentials enumerated, must be of the finest manufacture and absolutely free from all flaws or doubtful attributes. In fact, it might be stated on general principles that every tool or adjunct requisite to safe house moving must be first class. Therefore, the rope should be made out of pure Manila hemp and of the best quality. The following estimates of weight of rope may not be without interest in this connection:

Size in diam...	¼	5/16	⅜	½	⅝	¾	⅞	1
Weight of 100 feet, pounds...	3	4	5½	8	15	17	25	33
Strength of new rope, pounds........	450	750	900	1,700	3,000	4,000	5,800	7,000

From these figures it will be seen that the rope is sold by weight at so much per pound, and in coils of 1000 feet or less, as desired.

40. SHORING TIMBERS, NEEDLES AND WEDGES.

We shall next consider the kind and sizes of the necessary timber. It may be well to state here that there is no golden or fixed rule given in the text books published for this class of work, nor can any be given except that derived from personal practice and experience, as the nature of the work is so varied and the exigencies so unusual that it would be impossible to give any standard list or set of timbers necessary for the needs of the house mover. His plant generally consists of all sorts and conditions of materials, ranging from the cold chisel to the hoisting engine or motor. Generally speaking, it might be said that it requires all and every sort of timber listed, especially of the harder and heavier kinds, for bearing and carrying purposes, such as oak, yellow pine and spruce. These are the most reliable for long shores and needles, the last being most popular on account of its cheapness, toughness and lightness, although yellow pine is more adaptable for very heavy work, such as for brick buildings. All timber must be of the very best quality, straight grained, thoroughly seasoned and free from wens, large knots, heart shakes, cup shakes, dry or wet rot, sap, or any other agents likely to impair its strength. Second-hand building timbers have been found from experience to be the most reliable, as years of exposure or use have tried their qualities and guaranteed their capacities.

Regarding sizes and dimensions, I might state that for spruce they may run from 2x2-inch scantling to the largest sizes, yellow pine from 6 or 8x8 inches, also up to the largest sawn. All may be of lengths increasing in feet, sawn square, smooth and out of wind, as twisted timbers are useless not only by reason of their liability to fracture, but also by their loss of strength through warping or distortion.

In connection with the timbering come the wedges, which are even more reliable than the pump screws heretofore mentioned. These powerful instruments for house moving are sawn out of the hardest and best seasoned oak, being 3 inches wide, 1½ inches thick at the butt and tapering to ¼ inch. Two, as shown at AA, Fig. 147, are always used, and when placed as represented, they constitute the best means of tightening or raising walls, girders, beams, etc., known to scientific builders. The most careful shorers and movers prefer them to the screws, on account of security, but they are not always applicable to horizontal timbers, in corners, or where it is not possible to deliver a blow of the hammer or maul, for it must be remembered that each wedge must be struck with the same, or, rather, an equal, percussive force, or one will be forced past its fellow and the two rendered useless. They must be accurately sawn, else their top and bottom surfaces will not be exactly parallel and at right angles to the

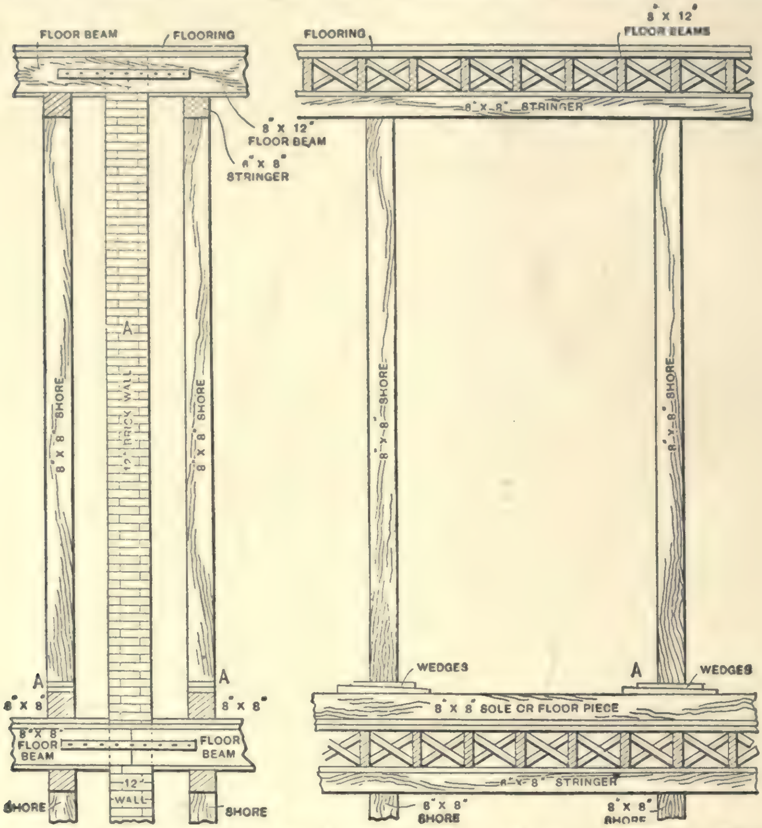

Fig. 147. Showing the Manner of Supporting Floors and the Use of Wooden Wedges.

axes of the thrusting timber which they compress or sustain. For the same reason the abutting and other ends of timbers must be sawn square, not beveled, to guard against any possibility of slipping or buckling.

41. PRELIMINARY PREPARATIONS.

In the preliminary preparations for moving, all gas, steam and water supplies must first be shut off in the street. All plumbing, connecting pipes, either water supply, sink, water closet or other connections, must be cut entirely apart at the first story tier of beams, and the house pipes properly supported from the carrying timbers placed under the sills.

Proceeding now to describe the details of the actual moving operations, we will draw attention to the fact that it will be necessary for the mover to first survey the house to be transferred and ascertain the actual conditions and difficulties of the problem, in order to provide the blocks, labor and tools requisite. The following examinations must be carefully made and details minutely noted, either mentally or on paper, to provide for all eventualities:

1. The dimensions of the house or houses.
2. The weight and construction of the house or houses.
3. Nature of the foundation and bottom.
4. Whether above or below curb level.
5. Whether to be raised or lowered to street grade.
6. Is the house, or houses, perfectly safe to move?
7. The plant necessary for the work.
8. Possible happenings or contingencies during moving.
9. New site or foundation and contemplated possible changes or alterations.
10. Tools, labor, appliances, etc.
11. Estimate of cost.
12. Approximate time which will be required to complete the operation

All this must be gauged and determined before any house mover can give an owner a figure of probable cost, so that the premises will need to be inspected and scrutinized, faults located [illegible] guarded against, and methods of procedure properly arranged. [illegible] moving, raising or lowering are tasks arduous, tedious and [illegible], and demand time and patience, the most critical observati[illegible] forethought, so that haste and negligence are simply impos[illegible] this art, unless one courts failure.

42. MOVING OPERATIONS FOR A FRAM[illegible]E.

It may, then, be assumed that the prospective mov[illegible]ooked over his task and found, say, for a simple first example, [illegible]ork will be to lift a small frame dwelling house, mea[illegible] feet, from its old foundation and transfer it to the new s[illegible]unda-tion situated, say, three blocks or squares west and [illegible] The question naturally arises how is the work to be done [illegible]eason of their weight it is not usual to lift or move foundatio[illegible] will simply raise and move the timber structure with the necessary brick chimneys. To do this, timber or needle holes larger in circumference than the girth of the sticks must be cut through the foundation walls directly under the sills and heavy 12x12-inch timbers passed through from side to side directly under the bridging walls which

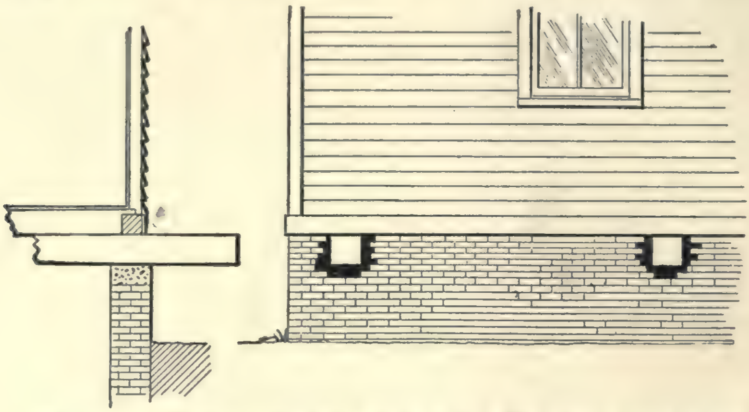

Fig. 148. A Portion of the Under-Pinning of a House Showing Holes in Walls and the Manner in which the Timber is Placed.

support the floor beams on the first and second stories and side wall plates, as shown in Fig. 148. These must be spaced not more than 8 feet apart, with extra timbers placed under the chimney breasts, on which their brick work will be supported and carried and from which they must be blocked up and wedged so tightly as to prevent any possible strain or settlement. The center, fore and aft supporting girder under the first tier of wooden beams must also be blocked and wedged up to obviate the possible settlement and cracking of the stud plaster partitions up through the house before the cellar piers are taken down. Diagonal pieces carried on the main timbers must be placed under all bay windows or projections, and all and every part made to carry free and clear of the foundations before cutting away. Finally the 12x12-inch sliding timbers are set, resting on timber stacks or pyramids of blocks built at intervals of 8 feet or 10 feet, as shown in Fig. 149.

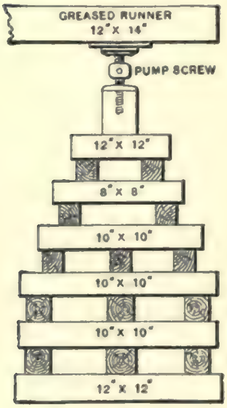

Fig. 149. Manner of Building up the Stacks of Blocking.

The supporting and moving frame must, then, consist of three tiers or thicknesses of

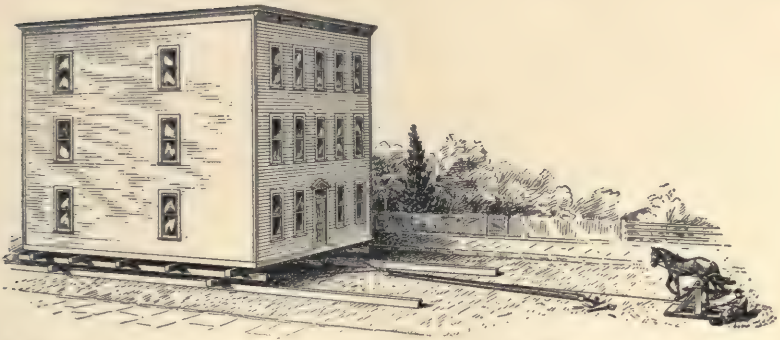

Fig. 150. Showing Manner of Placing the Timbers for a Frame Building Moved by Means of a "Crab" and Horse Power.

timber below the sills, those on the bottom being the slides, resting with their bottom edges on the skids, the edges being heavily smeared with grease or tallow to diminish the friction generated by the weight and motion while moving. The blockings having been all set, the runners may be raised by placing short jacks or pumps under them, so that when the screws are simultaneously turned the entire mass of frame work above will be raised clean and clear from its foundations ready to start. If there be any unusual construction, safes, machinery or heavy loads of any kind, special timbering must be built up for them. It is best, however, to move these separately first and leave the building as empty in its shell as possible.

All having been prepared in the cellar and the frame clear, a heavy 3-inch chain is attached to the rear or last timber as a sling, and to the middle of this, working on a hook, the blocks and tackle are affixed, the only thing remaining being the "crab" and the horse. The mechanical work necessary is very elementary, as the horse simply walks around the crab. The rope is kept tight and coiled down, as shown in Fig. 150, and the building moves, but its motion as it goes off is closely watched in order to prevent its shearing, which it is liable to do should the tackle be unequally adjusted or the friction be greater on one side than on the other. In this case the house will either shear or swerve, or may topple off the skids or runners, unless prevented. This difficulty is obviated by readjusting the bridle or chain already described. Fig. 150 shows the general appearance of a three-story frame structure in the process of being moved through a street. The position of the supporting timbers is clearly indicated, as well as of the chains and tackle connecting with the crab operated by horse-power. As there is never room in the width of an ordinary street to place the crab directly in front of the house, supplementary tackle blocks are set in the street, or to the opposite house, for the purpose of hauling it to the pavement, the main tackle and crab being placed down the street and the rope at right angles, thus giving a more powerful pull.

This process will be necessary for a house on an inside lot; but if a corner, the building may be slewed around as it is dragged off its foundations by a proper adjustment of the tackle and a curved laying down of the skids, which must be kept constantly greased or they will heat and possibly ignite. While the house is, to use a nautical expression, " under way," the street skids or runners must be kept out of wind, because should it strain or warp it will crack the plaster in every room in the building. Should the tackle become so shortened that the house is so close to the crab as to stop its progress, then the crab must be moved further out of the street or around the corner, and the supplementary blocks rigged as before.

When the house has arrived opposite its new site and foundations it will require to be turned, with the front toward the street. This may also be done with the tackle, and when turned the bridle is taken from the rear cross bearer and fastened to the front, so as to pull the house in backward, the main tackle block being attached to a post or house at the rear of the lot, and passing out under the building to the capstan of the crab. A comparison of the foregoing explanation with the accompanying engravings will give the reader a clear conception of the manner in which the operation is carried out, and, if a practical mechanic, he will have no difficulty in comprehending its details as described.

When the building is carried from its new foundations it must be so placed that when lowered it will come exactly as intended, with the sill faces fair with the foundation walls. The screws must not be removed until the building is thoroughly wedged up and made good with slate, brick, stone and cement mortar. Considerable attention, too, must be devoted to the proper blocking in the new cellar, which will sustain the runners on which the house moves in, because on this blocking, with its lowering screws, will depend the proper lowering of the house. It is, therefore, imperative that everything be properly arranged. The blocking in this case would be similar to that shown in Fig. 149 and sufficient in number and so spaced that the stringer and all timbers may be safely lowered, all screws being lowered simultaneously so as not to strain the house, but allow it to descend gradually to its permanent position. All inside piers, fore and aft walls, or girders, must be built and set, and all floor beams wedged up from them before the center moving timbers are taken out.

43. MOVING A BRICK OR STONE BUILDING.

This, the most unusual problem in the whole range of building operations, is one which involves the highest skill and intelligence, as well as many and varied considerations. Nowadays, brick and stone buildings are raised and moved so economically that the information which follows will be found useful not only by house movers, but also by architects and builders who deal with owners and real estate men.

In what condition must a brick or stone building be in order that it may be safely moved or raised? It must be well and thoroughly built, plumb, level, and have its walls free from cracks, bulges, fractures, or strains. Also it must be devoid of serious settlements of floor beams or partitions, etc., and all angles should, if the house is one, say, 40 feet in height, be plumb, free from fissures, well bonded and anchored. Should any house be defective in some of these details it will be difficult to move it, because special provision must be made to tie the weak portions together and guard against possible collapse. From this, then, it will be seen that the survey and examination must be made by a thoroughly experienced and competent brick mason builder, who from a critical inspection will be able to determine as to the feasibility and safety of the proposed operation. Should the conditions prove to be favorable, the work may be undertaken along the following lines:

The first job will necessarily have to do with the "timbering," or, as described in an earlier article, the process of building up a false work consisting of stacks or temporary wooden piers or cribbing or grillage, such as was indicated in Fig. 149, and lifting the entire structure off its foundation, or, rather, to take the weight of the brick or stone superstructure off its base. This is done by first cutting holes in opposite bearing walls of the building, spaced about 4 or 5 feet apart, or close enough to make the brick work of the walls above each hole corbel or arch itself with the next. Into these openings, and running transversely across the house 12x16-inch yellow pine timbers are inserted, sufficiently long to pass 4 or 5 feet outside each wall. The holes must be made in the stone or brick foundation walls directly below the first tier of floor beams and water table, and the timbers kept perfectly level across from wall to wall. Should the wall be not level, then above the top edges of the beams the space must be packed solid and tight with sprawls and oak wedges. Piers and cast iron columns must have double timbers, or, first, two short longitudinal timbers, as shown in Fig. 150, and then cross timbers.

I might state in this connection that where cast iron, steel or other columns occur, which is usually on the corners or in store fronts, it is best to proceed as if the columns were absent and build up tiers of blocks to the second story directly from the main bearing timbers or walls below.

Having properly and securely blocked all columns and girders, the lintels and sills of all first-story door and window openings will need to be sustained with uprights and cross pieces, solidly wedged and braced; also all belt courses, cornices, brackets and other projecting details must be kept from falling by supports of timber or spur shores from the heavy cross timbers below. While all this is being done the men must proceed with the cellar blockings, longitudinal and transverse siding timbers, lifting pumps, jack screws, wedges, etc., in a careful and systematic manner, properly supporting every detail which rested on the foundation or foundation pier, such as chimney breasts, elevator and dumb waiter shafts, smoke stacks, headers, trimmers, fore and aft girders, partitions, etc. In fact, each and every structural part must be supported from below, omitting none and providing for all possible happenings.

The sliding timbers are a very important part of the preparations, as on them the whole mass is to move and they must therefore be unusually well set, absolutely level and straight. Reference to Fig. 149 will illustrate to the reader the general scheme for arranging the timbers on the tiers of blocks and their respective pumps for raising, etc. It is here, also, the reader will realize the full value of these pumps, the most valuable factors in moving operations, as so many will be needed under the slides that the least adjustment or turn of the screws will regulate the levels and keep the building moving in perfect equilibrium, without strain or jar.

At this stage we will take up the matter of the proper treatment of the cellar bottom for the reception of these stacks of blocking, because if the bottom under them should settle or slip disaster may follow, so that another very serious condition confronts the mover. If the bottom be solid rock, good hard clay, shale, gravel or any other reliable substance, the blocking may safely be laid on them, edge to edge; but if it is of soft clay, mud, quicksand or any other compressible, unreliable or insecure substance, then the problem becomes most difficult, and the expense involved in the preparation of the uncertain bottom may possibly preclude the operation altogether. The nature of the earth's crust under the foundation must, therefore, always be ascertained by borings or digging holes at regular intervals along the foundation walls to the full depth of or a little below the depth of the footings. Thus by observation the strata underneath may be definitely determined, for there must be no doubt or uncertainty in house moving. The reader will, of course, understand that it would be simply out of the question to try to move a heavy brick house resting on piles or grillage in a mud bottom, so we will dismiss the idea, as it would be cheaper to pull down and rebuild a house with such footings than risk the increased cost of its moving, for the bearing capacity of the earth under the footings must in every case exceed the weight placed upon it to a factor of safety of at least 4, and no contract for moving should ever be undertaken unless the bottom is fit and all conditions favorable to a safe and satisfactory conclusion of the job.

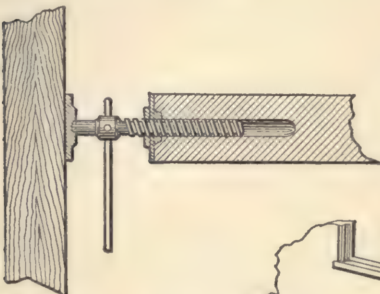

Fig. 151. Section Showing Operation of a Horizontal Screw.

When the longitudinal and transverse timbers are all set, as represented in the illustration, the horizontal pushing braces and screws must be adjusted at fixed distances apart against the front string piece, so as to force it stead-

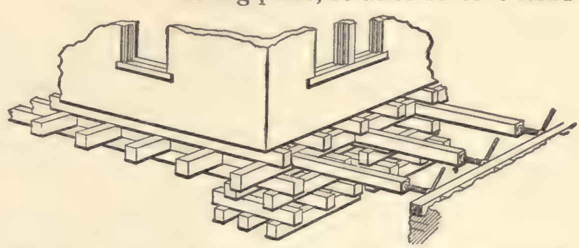

Fig. 152. Manner of Placing Blocking and Horizontal Screws.

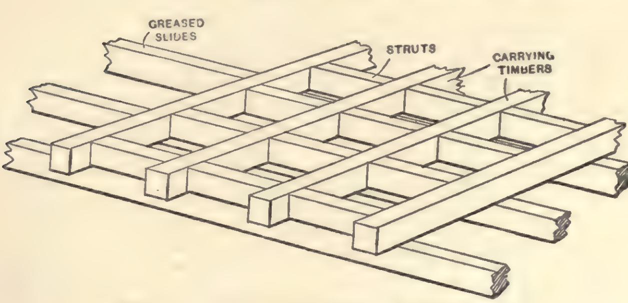

Fig. 153. Method of Bracing the Timbering.

ily and regularly backward as they are uniformly turned with the lever bars. An idea of the construction of one of the horizontal screws may be gathered from an inspection of Fig. 151. These must be placed exactly at right angles to the front "string" or longitudinal timber on the front or end, and perfectly horizontal, as shown in Fig 152, so that by the pressure exerted by the screws the timbers may be pushed slowly and safely along the slides, which are, as before, heavily smeared with heated tallow or axle grease in order to reduce the friction to a minimum. Short struts must be cut, fitted and fastened in between the longitudinal timbers before the screws are turned, all as indicated in Fig. 153. This is necessary for the simple reason that the under platform or series of timbers must move as a whole, without an inch of deviation, and when once started its progress will average from 1 to 2 feet hourly, so that 25 feet will be an excellent day's work. Haste or neglect, however, must be nullified, and the safe progress of the building on any day made the *sine qua non* of the operations. Constant stopping and inspecting will be necessary in order to guard against unforeseen developments, and provisions must be made accordingly, but the careful mover will go all over the house and examine details with a rigid scrutiny before he allows a screw to be turned. Sometimes it may, perchance, happen that a slight bulge or strain crack may be developed, which will necessitate the stopping of the forward movement until a separate brace or spreader is inserted, but this is a simple matter and only emphasizes the need for constant vigilance. Again, a blocking may slightly subside, or a stack be too high, or some such emergency may arise, but they may all be met with care and watchfulness.

44. MOVING A FRAME BUILDING ON PONTOONS.

The actual operation described was carried out on the east bank of the Hudson River, in the City of New York, the building consisting of a large boat house, measuring 50 feet front by 75 feet deep, and having a height of 35 feet. The structure having been sold to a yacht club up the river, it became necessary to provide some means by which it could be transported to the site selected by the purchasers and this requirement necessitated the operations which will now be described.

The house was built of wood on the framed and braced principle of heavy planed yellow pine timber and weighed about 200 tons approximately, so that all that was required was to obtain boats or pontoons of sufficient capacity to carry this load. Two Erie canal boats, each 100 feet long, were chartered and towed to the pile foundation on which the superstructure rested, and provisions were made at once for placing them directly under the main sills, which had to be prepared so the house might be lifted without straining. After a careful examination of the lower timbers it was decided to float the canal boats beneath the house between the rows of piles with the sterns toward the shore, so that the building would be carried longitudinally and the boats be far enough apart to provide against any possible danger of the house capsizing when afloat and in transit on the river.

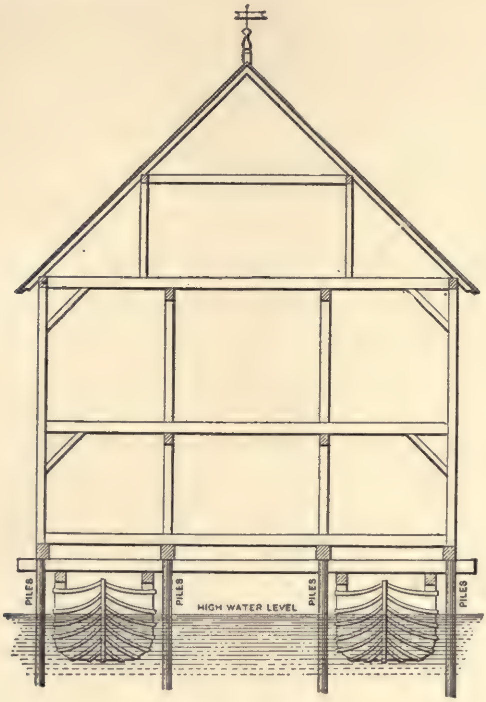

Fig. 154. Showing Method Adopted in Moving a Boat House.

A fuller comprehension of the way in which they were positioned may be obtained by referring to Fig. 154, which gives a transverse section of the boat house, showing the positions of the canal boats and how they acted as hydraulic jacks to raise the mass from its resting place.

When moored beneath the structure, heavy 12x14-inch timbers were passed through from side to side, these being long enough to project outside the north and south gable sills and spaced 6 feet apart in the length of the building. This being done, all the intervening timbers were blocked up from the upper deck with stringers, pump or builders' screws, blocks and wedges. Longitudinal fore and aft string pieces were also laid along the decks, and the deck beams, where deemed weak, were strengthened in the holds with vertical and diagonal timbers and struts to stiffen the vessels and preserve their rigidity.

I might state here that the boats were kept at a stationary level by means of water ballast pumped in or out of the bilges as required, according to the variations of the rise and fall of the tides, during the time preparations were being made for the removal, and no upward pressure was exerted until ready for it.

When the piles to which the main four lines of longitudinal string pieces, or girders, were spiked had been sawn through, the pump screws were applied at the time when the tide had very little further to rise, so that the building was raised sufficiently high to permit the free passage of the cross cut saws through the timber of the piles. As the reader perhaps knows, there is a period of time at high and low water in which the water is comparatively stationary, approximating half an hour, which gave the workmen a chance to complete this operation, though the whole job occupied four days, or the ebb and flow of eight tides.

The spirit level was employed continuously, verifying and regulating the equilibrium of the floor, especially when the raising commenced, in order to insure the house being equally carried by both boats and guard against the possibility of its tipping, nor was the house moved out from its safe position over the piles until this had been made positive.

All work having been safely done and everything in readiness, heavy rope hawsers were fastened to the prows of the boats from a powerful tugboat, which slowly pulled the floated structure into midstream and headed northward. The voyage was commenced and terminated without accident, though the unusual spectacle of a house sailing up the Hudson River in tow of a tug caused much comment among the passengers on the railroads and steamboats at that time. I need hardly add that the same operation was followed when lowering the house to its new foundation, which was previously prepared from measured drawings of the old pile foundation and bottom timbers.

CHAPTER VII

Practical Information for Carpenters

45. THE IMPORTANCE OF ACCURATE MEASUREMENTS.

One of the things which is not sufficiently considered by the majority of mechanics is the value of measurements, and the care and method which should be followed in obtaining them. Let us consider the part they play in mechanical procedure, especially that which pertains to the practice of carpentry, and note the result.

What are measurements? They are the distances between points or the actual sizes of constructions or details of constructions, and being determined either through the system of scale drawings or by other constructions already completed, must of necessity be absolutely correct to ensure success and accuracy in all mechanical operations.

Now as to the best methods of obtaining accurate measurements. In this it has been found that the methods vary with the distances or detail to be measured, and different details will require different methods.

I would say that every distance must be found exactly and by systematic means, and for long distances, the metallic or steel tape-line, as used by engineers and surveyors, is most useful. In laying out and measuring lots and sites for houses it should be employed, or for long distances or materials, but for materials such as timbers not over 30 feet, the writer has found the 10-foot pole the best measuring instrument. This valuable tool should be thoroughly understood by every mechanic. It consists of a simple pole or rod of wood, exactly 10 lineal feet long and from 1 to 1¼ inches square, made of either pine or oak.

It should be well seasoned and laid out absolutely accurate in feet on all four sides, or at least two sides, commencing at opposite ends. The lines should be cut in deeply with a chisel so as to be indelible, and the figures (Roman) thus: I, II, III, IV, V, VI, VII, VIII, IX, X, cut in deeply with a ½-inch or ⅜-inch chisel. By doing this they will be permanent and not liable to be rubbed off as they would be if laid out in ordinary pencil marks. If made in the above way or even out of a 1x2-inch strip, this tool will be found of great value in measuring framing timbers for houses, in laying off windows or doors, setting out partitions, or in fact any work outside the measuring capacity of a carpenter's two-foot pocket rule. Especially will it be found necessary in measuring roof timbers where absolute accuracy is essential; great care should be taken to see that it is not broken nor less than the full 10 feet, as it would make a very serious lessening in the entire length supposing the pole were laid on a long stick.

To measure the distance between two walls or in openings as framing for doors, windows and in recesses, the best method is to use two rods by sliding them along until the ends touch the opposite side, thus obtaining the exact width. If in door openings, as for jambs and windows, the width should be taken at the top, bottom and middle, so as to verify and approximate the average width should there be any variation. Similarly in regard to heights, as heights of doors, windows, ceilings, floor beams, etc., the two rods are safest, as they cannot bend, and if held with both hands and slid apart the exact distance will be ascertained, as it is a very simple matter to measure the length of the rods. Two two-foot rules are also of great utility in inside measuring.

Finally, I would recommend mechanics to be more particular and spend more time on the process of measuring, and note down any peculiarities existant in the construction and make line sketches and remarks about same, especially when measuring up for new work.

46. LAYING OF FLOORING.

Concerning the laying of flooring, I have lately noted that much might be said on this important detail of building construction. First, as to commencing to lay. I would suggest that the first course be laid perfectly straight, being composed of perfectly straight, picked boards, and laid to a line or straightened through from end to end with the eye, and it should be firmly nailed down before commencing to drive up the second course. Second, flooring should go together comparatively easy; that is to say, the tongues and grooves should fit snugly, but not so tight as to necessitate bruising up all the tongues of each succeeding board, or line of boards, by banging it to splinters with a hammer or axe. Third, the running joints should be driven together tight by using a block of hard wood and a heavy mall, so that the flooring board will not recoil or spring out. If it be rounding or hollow one man should drive it to a tight joint and hold it there while the other nails it solidly to the beam below. Fourth, heading joints should be absolutely tight and might be bevelled a little under in the sawing, in order that the face of the board may be tight, and no two joints should be on the same floor beam nor closer together than the spacing of two beams apart, nor should two joints be on any one beam with only one through course between. There should be always two or more between. The heading joints should likewise be well scattered to avoid their being conspicuous, and not, as is often done, all grouped in one, two or more places. All the above suggestions are, however, subject to modification, in order to suit the stuff, so as to use it without waste or loss of time. All head joints rising too high above the surface of the floor must be planed off. Nailing should be done carefully and without splitting the tongues off.

A word as to the ordinary mortise and tenon joints on framing. From close observation the writer has found that it is necessary for a carpenter to study the nature of his stuff closely, in order to construct work of this class so that it will remain a level surface without warping, especially when the framing (as in the case of a framed or panelled door) is suspended or so placed as to be subject to change from not being fixed or nailed in position, as are wainscoting, jambs, soffits, back-linings, etc. If, in laying out, the stuff be not considered and *matched* so as to warp in the proper direction, the result will be a useless job. To exemplify this, I would say that very often the stiles of a door will warp one to the inside and the other to the outside of the door, leaving it hopelessly in wind, and this could be avoided in the laying out, reversing the stiles so that they would both work in the same direction, and thus keep the door comparatively level. This is, of course, entirely unnecessary in the case of veneered doors, as I now refer to pine and whitewood or poplar doors where the varying grains occasion so much trouble as to render some of the timber unfit for use. In fact, so much is this evident, that the writer has often found it more profitable and satisfactory to make pine doors with cores and veneer than out of the solid stuff.

47. HOW TO PUT ON HARDWARE.

Ordinary brass-faced mortise locks need nice fitting and require to be set in flush with the door's edge and not to project if the edge be beveled. Brass door-knobs and escutcheons ought, in all cases, to be covered with linen to prevent rough, sandy hands from scoring the polished surface. Tie the keys to the knob, or, if this be risky, put a marked and numbered tag on each, in order that its lock may be readily found.

Door springs have also printed directions which must be adhered to to insure satisfactory working. Yale and other special locks need special cutting, and therefore a good mechanic to put them on right, but the directions and sketch in the box are a wonderful aid to novices. These locks ought never, under any circumstances, to be taken apart, on account of their intricacy. An error of this kind once cost the writer much expense and delay and a good drenching bringing it to the manufacturer's depot for readjustment.

In regard to sash locks there is little to be said, except that they require to be on so as to really lock the window, namely, bind it close together at the meeting or check-rails, besides preventing the sash from being moved. Fasten on escutcheons perfectly plumb and drawer pulls level, and try to keep the slots of the screws in a line with the work. For instance, in escutcheons, finger plates, hinges and lock faces, keep all the slots plumb, and on drawer pulls, door pulls, or any brass or iron or silver work, keep them level or horizontal. English ship-joiners never put their screws in any way but this, and it really makes the hardware much neater, and is worth following even at the expense of an extra turn of the screw-driver.

The hardware of sliding doors consists of the sheaves or rollers, the track on which they run, the lock and fittings, and the iron door-stop above.

For fitting in the sheaves, the main thing is to get them in the center of the edge, to bring the two doors fair and to have them project equally. The doors ought, of course, to be fitted till the joint comes close, and when the inside wood stop is mortised in and cut, the two can set on the track, which, by the way, comes in two lengths, and the sheaves regulated till the doors close tightly. Allow space enough from the floor for the carpet-saddle. The stop is let flush into the door-head, and the lock put on the usual way. Hardwood sliding doors should never be made without *friction strips,* to save the arises and faces of the door surfaces.

Fanlight levers, bolts, etc., are comparatively simple in their application, and demand little or no attention, but the great thing to watch in putting on all hardware is to make it fit neatly, so that it may look well. All marking should therefore be exact and done with a knife to insure the piece to fit in its place and work freely, without sticking.

48. NAILING OF FRAMING, ETC.

Let me draw attention to the fact that much more care than is usually evinced might be taken by carpenters when nailing parts of framing together, especially at the abutting ends of studding, on the top and bottom cuts of rafters and such like. As a rule I find that many of the pieces are split out by careless or insufficient nailing, which is done so as to split or splinter off the stuff and lessen its holding capacity. This could easily be avoided by entering each nail more carefully. Another thing is to be sure to straighten all studding, flooring, beams and roofing timbers through from end to end, so they will be set rigid and upright, in order to gain their utmost strength. If any timbers be warped they should be straightened up or bridged in some way so they will not twist more. The foregoing I would especially apply to hemlock and spruce, as many pieces are warped and need a little care.

49. HOW TO STACK LUMBER.

All timber, especially that which is to be used in the construction of a frame house, should be properly piled or stacked up adjacent to the building until the building is ready for its use. When the stuff is dumped from the wagon it should immediately be put into piles according to the different sizes of the timbers; for example, all 2x4, 2x6, 2x8, 2x10, and so on should be kept in separate piles according to their lengths, as ordered in the lumber bill, in a manner to allow the air to circulate around each stick and permitting water to fall through, without remaining on the timbers. Piles should in every case have blocks set under them so as to prevent those next the ground absorbing the dampness therefrom. If the pile be very large, as in the case of sheathing boards, it should be pitched slightly from end to end to permit the water to run off. Should flooring be brought to the building before the roof is on, it should be very carefully stacked in layers with strips intervening between each layer, and the top of the pile should be carefully covered with rough boards and over-lapping and breaking joints in such a way as to prevent any rain from wetting the stuff. This is absolutely necessary if the flooring be of white pine and kiln dried; as, on account of the extreme sensibility of the wood to dampness, it will expand if wetted and contract again when laid and subject to the heat of a room. It is always best not to have flooring, wainscoting and trim come to the building until after the roof is entirely completed. The same care must be used in stacking corner boards, clapboards and other outside finish as applied to flooring. The best method, however, is to have all the outside finish primed before sending to the job.

The prevailing method of piling and storing sawn timbers, say 2x4, 2x6, 2x8, 2x10, or 2x12, in lumber yards is illustrated in Fig. 155 of

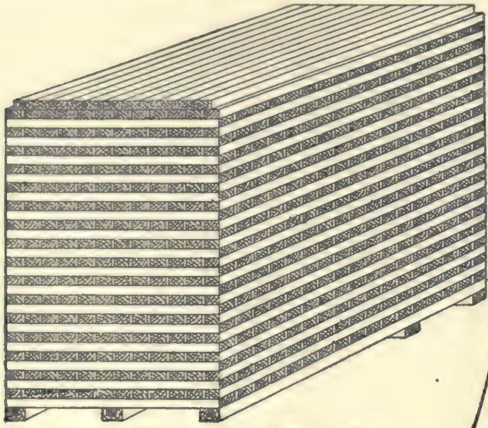

Fig. 155. Method of Piling Sawn Timber.

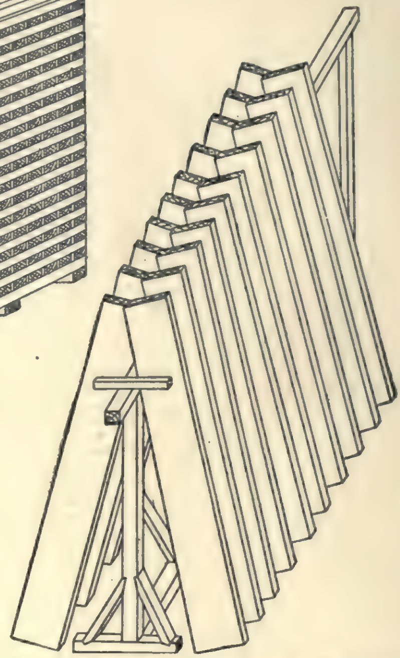

Fig. 156. Vertical Rack for Rapid Drying of Hardwoods.

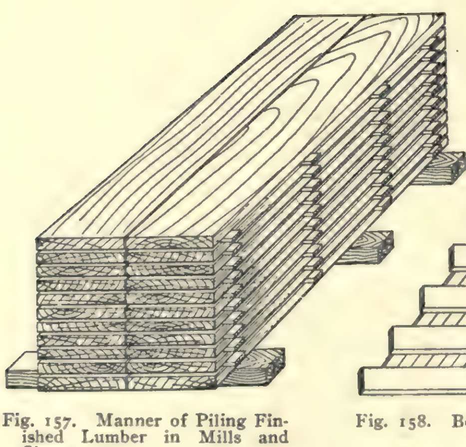

Fig. 157. Manner of Piling Finished Lumber in Mills and Shops.

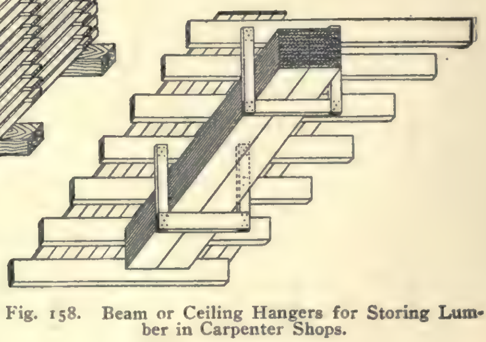

Fig. 158. Beam or Ceiling Hangers for Storing Lumber in Carpenter Shops.

the sketches. The piles should not be higher than the length of the scantlings, so they can be passed down to the man below. For 12-foot timbers the piles should not be more than say 12 feet high and for 16-foot timbers not more than 16 feet high, and so on.

A very convenient ladder for climbing to the top of each pile can be formed by allowing a timber to project 12, 16 or 18 inches on one end and about the same distance apart so as to form, as it were, a series of steps or stairs. In Fig. 156 is a vertical rack used by builders for the rapid drying of hardwoods.

In Fig. 157 is represented the manner in which finished lumber is piled in mills and shops for rapid drying and handling. The strips, especially in the case of the more delicate woods as sycamore, oak, hazel, satin wood or veneers, must never be omitted.

The beam or ceiling hangers shown in Fig. 158 are of the greatest utility in small wood-working shops operated by carpenters and builders and located in basements or elsewhere. They should be placed above the bench so as to be readily accessible when the stuff is required. Brackets of ⅞x4- or 6-inch stuff nailed to side walls in frame structures or to uprights of from 16- to 24-inch projection also serve this purpose. Both of the above should not be more than 6 feet apart, accurately spaced.

Moldings and strips can be stored with much economy of space by building racks or frames of pigeonhole form at the side of the shop or mill as indicated in Fig. 159. Use light stuff 1x2- or 1x3-inch and from 12 to 20 feet in depth, spaced 4 feet apart. All heavy and wide material should be stored on the bottom tier, with the light stuff on top.

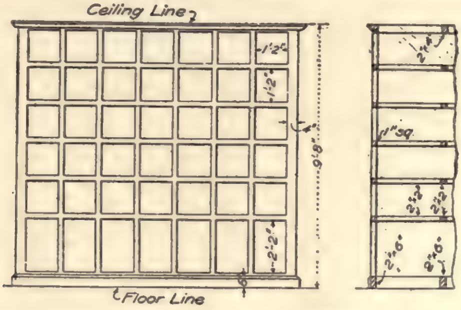

Fig. 159. Economical Method of Storing Moldings in Racks or Bins.

As there are 42 spaces here represented, they will be found sufficient for the needs of any ordinary carpenter, builder or contractor. More or less can be built as required to meet conditions.

INDEX.

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