UNITED STATES ARMY

TRAINING MANUAL No. 10

CARPENTRY

FOR MILITARY SPECIALISTS

Part I. CARPENTER HELPER

PREPARED UNDER THE DIRECTION OF

THE CHIEF OF ENGINEERS, U. S. ARMY

1922

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CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *May 23, 1922.*

Manuals for training the Army are to be prepared and revised from time to time by the branches of the service concerned, and published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Corps of Engineers as a part of this series a group of five pamphlets relating to carpenters. The pamphlets in this series are titled as follows:

Training Manual No. 10.—Carpenter Helper.
Training Manual No. 11.—Basic Carpenter.
Training Manual No. 12.—General Carpenter.
Training Manual No. 13.—Master Carpenter.
Training Manual No. 14.—Instructor's Guide for Carpenters.

This pamphlet is the first of the carpenter series, and is published for the information and guidance of all concerned.

[A. G. 062.11 (5-16-22).]

BY ORDER OF THE SECRETARY OF WAR:

JOHN J. PERSHING,
General of the Armies,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
Acting The Adjutant General.

HOW TO USE THE TRAINING MANUAL.

The Training Manual consists of four essential parts, namely:

1. The *Index* lists the unit operations and information topics and jobs into which the requirements for the vocation have been analyzed for purposes of instruction.

2. *Unit Operations* contain simple, comprehensive, and logically arranged directions, illustrations and questions to guide the student in the rapid acquisition of the correct skills and habits essential to a trained workman. The questions are of such a nature that they can be answered by observation and a little experimenting when doing the work.

3. *Information Topics* contain concise, clear and compact statements of facts, together with the necessary illustrations and significant questions. The questions stimulate the student to discover the relationship among the facts learned and ultimately the general principles involved.

4. *Jobs* which show clearly and concisely a complete course of training in the vocation. For a systematic analysis of each job, it is convenient to use

Job Assignment Sheets, which contain the following:

(*a*) A concise statement of the job.

(*b*) Brief specifications.

(*c*) Drawing.

(*d*) Blank space for unit operations, selected by the student from index and listed in the order of use.

(*e*) Blank space for list of tools and bill of material listed by student.

(*f*) Significant questions with spaces after each for answers. (To be written as the solutions present themselves to the student.)

In using the training manual the student should turn to the assignment sheet of the job that is to be done. The specifications should be read and the drawing studied until the work to be done is thoroughly understood.

The method of performing the work should then be thought out and the titles of the unit operations that are believed essential for performing the job should be listed in the order of performance in the space provided on the Job Assignment Sheet. These unit operations, together with any reference in the information topics, should be read before the student commences the job. While reading he should write out a list of the tools that he believes essential to doing the work. When this list has been studied over and checked it should be written in the space provided on the Job Assignment Sheet. The drawing should be carefully studied and the sizes of the various pieces of wood listed in the space provided on the Job Assignment Sheet, together with the nails, screws, etc., that are required. As the student becomes more experienced he should learn how to figure from the pieces of wood that are required the commercial sizes of lumber and number of each necessary for performing the job.

The student is now prepared to consult with the instructor, who will approve of the work done or give the necessary instruction so that the various lists will be correct and understood prior to commencing the job. The material will then be issued to the student with the special tools that are not contained in the tool chest.

OCCUPATIONAL INDEX.

UNIT OPERATIONS:

Training Manual No. 10. Carpenter Helper—

1. Laying out square cuts.
2. Sawing to a line.
3. Dressing material.
4. Boring holes.
5. Nailing.
6. Fastening with screws.
7. Scraping.
8. Sandpapering.

Training Manual No. 11. Basic Carpenter—

9. Cutting to width and thickness.
10. Making rounded curves.
11. Hewing to a line.
12. Scribing.
13. Reading drawings.
14. Preparing bill of material.
15. Sharpening and setting saws.
16. Sharpening edged tools.
17. Sharpening scrapers.
18. Sharpening auger bits.
19. Laying out special angle cuts.
20. Mortising and tenoning.
21. Grooving.
22. Truing surfaces.
23. Preparation and use of glue.

Training Manual No. 12. General Carpenter—

24. Leveling and plumbing.
25. Making wood foundations and forms for concrete foundations.
26. Laying sills and girders.
27. Cutting and placing joists and bridging.
28. Laying rough flooring.
29. Laying out walls and partitions.
30. Framing and erecting stud walls, partitions, and joists.
31. Framing around window and door openings.
32. Placing ceiling joists.
33. Cutting and framing lookouts.
34. Laying out common rafters.
35. Laying out hip and valley rafters.
36. Laying out jack rafters.

37. Erecting roof frames.
38. Framing dormers.
39. Erecting scaffolds.
40. Putting on sheathing.
41. Waterproofing around exterior openings.
42. Roof sheathing and stripping.
43. Flashing.
44. Putting on siding.
45. Putting on shingles.
46. Placing plaster grounds.
47. Furring.
48. Placing insulation materials.
49. Building straight stairways.

Training Manual No. 13. Master Carpenter—

50. Estimating.
51. Laying out foundations.
52. Setting window and door frames.
53. Framing for concealed gutters.
54. Hanging verge boards.
55. Coping.
56. Making cornices.
57. Bending boards.
58. Putting on interior trim.
59. Fitting doors.
60. Hanging windows.
61. Building winding stairways.
62. Wainscoting and paneling.
63. Hanging sliding doors.
64. Laying finished floors.
65. Fitting standard hardware.
66. Underpinning.
67. Making hopper joints.

INFORMATION TOPICS:

Training Manual No. 10. Carpenter Helper—

1. Tools.
2. Fastenings.

Training Manual No. 11. Basic Carpenter—

3. Definitions of trade terms.
4. Timber.
5. Joints.

Training Manual No. 12. General Carpenter—

6. Foundations.
7. Main frame.
8. Roof frame.
9. Floors.
10. Wall covering.
11. Roof covering.

Training Manual No. 13. Master Carpenter—

12. Estimating.
13. Inside finish.
14. Outside finish.
15. Finish hardware.

TYPICAL TRAINING COURSE:

Training Manual No., 10. Carpenter Helper—

1. Camp sidewalk.
2. Trench board.
3. 9-inch bookcase section and packing box.
4. 12-inch bookcase section and packing box.

Training Manual No. 11. Basic Carpenter—

5. Standard A frame for trench board.
6. Special A frame for trench board.
7. Portable artillery bridge.
8. Low bookcase.
9. High bookcase.
10. Tool tray.

Training Manual No. 12. General Carpenter—

11. Double garage.
12. Lumber shed.
13. Bridge.

Training Manual No. 13. Master Carpenter—

14. Quarters.

FOREWORD.

Training Manual No. 10, Carpenter Helper, teaches the basic tool skills in carpentry that at least 25 per cent of the soldiers of the Army should have. The duration of the course should be sufficient to instruct the student not only in the handling and use of the hammer, saw, plane, brace and bit, screw driver, scraper, and sandpaper, but also in the acquisition of sufficient skill to be of service to his organization on practical work.

This is the first step in training a master carpenter and furnishes a definite objective within the reach of practically all soldiers. At the end of the course a certificate of proficiency as Carpenter Helper is granted to all who have attained the necessary skill. Graduates who are susceptible of further training are eligible to take the course contained in Training Manual No. 11, Basic Carpenter.

These steps need not follow immediately after one another. It may often be an advantage to a man to work at the trade for awhile between each part of the school training.

Some of the men will have difficulty in reading. Others may be able to pronounce the words but will not comprehend what they mean. This need not prevent these men from becoming valuable helpers if the instructor gives them the necessary instruction, telling them in addition what the others may read for themselves.

INDEX TO TRAINING MANUAL NO. 10.

UNIT OPERATIONS: Page.

1. Laying out square cuts ---- 1
2. Sawing to a line ---- 3
3. Dressing material ---- 5
4. Boring holes ---- 7
5. Nailing ---- 9
6. Fastening with screws ---- 11
7. Scraping ---- 13
8. Sandpapering ---- 14

INFORMATION TOPICS:

1. Tools ---- 15
2. Fastenings ---- 26

JOBS:

1. Camp sidewalk ---- 32
2. Trench board ---- 34
3. 9-inch bookcase section and packing box ---- 36
4. 12-inch bookcase section and packing box ---- 38

LAYING OUT SQUARE CUTS.

1. Read Information Topic No. 1 for square, steel and square, try. Lay the steel square on the piece to be cut, with the tongue lying on the face and the blade held firmly along the edge. Mark along the tongue across the face. See Figure 1 at *a*.

2. Hold the blade along the face and the tongue across the edge at the end of the line drawn across the face and mark along the tongue. See Figure 1 at *b*.

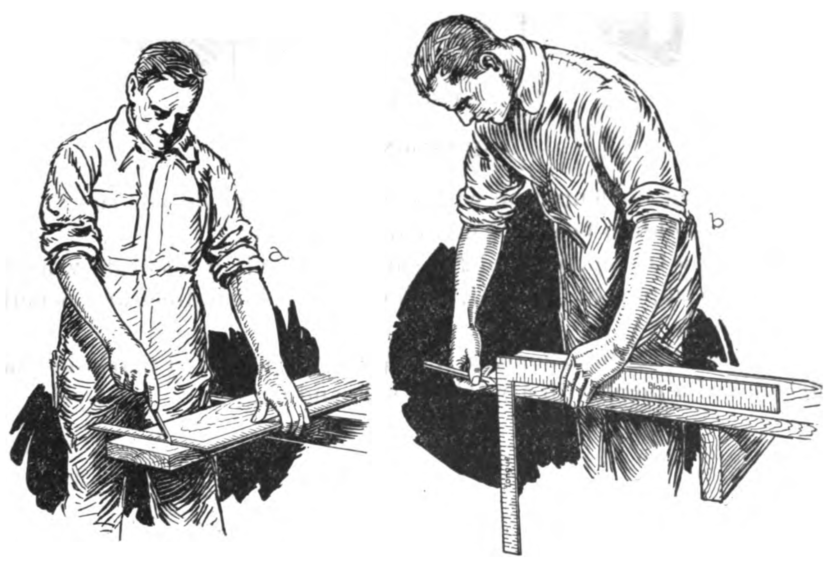


FIG. 1.—Using steel square.

3. For small finished work use a try-square. Hold the beam of the square on the edge of the board with the blade lying across the face. Mark along the blade with a knife or very sharp pencil. See Figure 2. Always keep the beam of the square against the working side or the working edge.

4. Hold the beam on the face with the blade across the edge and at the end of the line on the face. Mark along the blade with a knife or very sharp pencil.

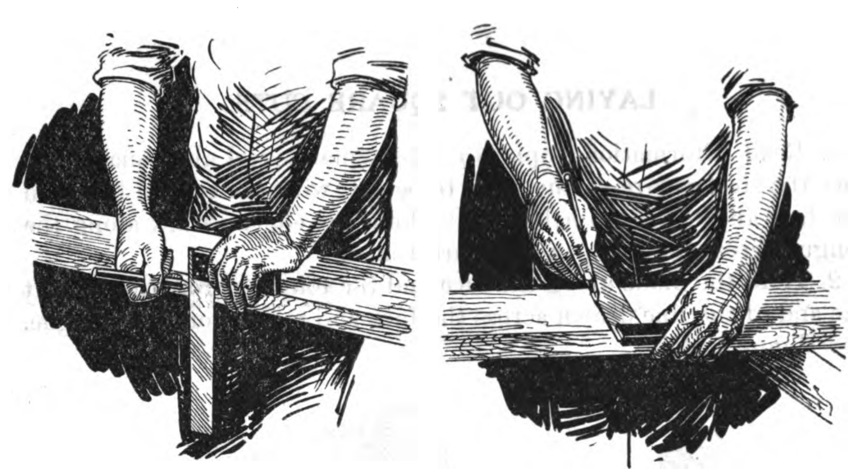


FIG. 2.—Using try-square.

QUESTIONS.

1. In sawing for length on which side of the line do you saw?
2. When should a board be marked all around?
3. Why is a try-square used for small, finished, or accurate work?
4. Give examples of kinds of work on which knife lines and pencil lines are used.
5. In what position should a try-square be placed in marking the four sides of a piece with a working side and edge?

SAWING TO A LINE.

1. Draw a line on the board where the cut is to be made. Draw a second line down the edge of the board, starting at the end of the first line. Read Information Topic No. 1 for saws.

2. If a cut is to be made across the grain, use a crosscut saw.

FIG. 3.—Teeth of crosscut saw.

If the cut is to be made with the grain or lengthwise of the board, use a rip saw.

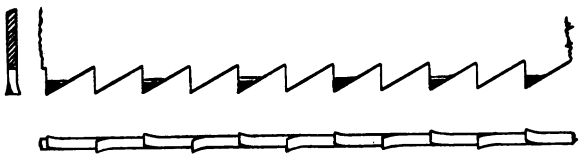


FIG. 4.—Teeth of rip saw.

If the board is of soft wood or two or three inches thick, use a large saw with coarse teeth. If the wood is hard and the board is thin, use a smaller saw with fine teeth. A more accurate, smoother cut can be made with the finer tooth saw.

3. Place the board on a horse or a bench. Grasp the saw firmly by the handle with the right hand, with the forefinger against the side of the handle. Grasp the board firmly by the left hand with the left thumb against the blade of the saw as a guide. Place the heel, or the handle end of the saw on the mark and draw the saw toward you, starting the cut. Push the saw in the direction that your forefinger is pointing but do not bear down on it. If the saw tends to leave the line, force it back by twisting the lower side of the handle to the right or left and take a short stroke with the point of the saw. Use only one hand to run the saw. Stand so that the arm with which you are sawing swings clear of your body and the handle of the saw is at your side rather than in front of you. If the saw binds, you are probably not sawing straight. If the wood is

damp or pitchy, a little oil or paraffin rubbed on the sides of the saw may keep it from binding in the kerf.

FIG. 5.—Sawing to a line.

4. On work requiring accuracy, the marks should be made with a knife or a very sharp pencil.

QUESTIONS.

1. In accurate work, why should you saw to the knife line rather than on it? On which side of the line should you saw? Why?
2. Why are two lines on adjacent faces necessary for sawing a board square?
3. How should a long board be sawed to secure several pieces of exact length?
4. What is meant by set in a saw? Why is set made in a saw?

DRESSING MATERIAL.

1. Lumber is usually furnished S2S or S4S (surfaced two sides or surfaced four sides). On interior trim and in similar work it is usually necessary to plane the material to make smoother surfaces than those made by the machine.

2. Read Information Topic No. 1—Planes.—Set the plane by turning the adjusting nut to the right or left as necessary, looking down

FIG. 6.—Adjusting a plane.

the face of the plane. If the blade projects on one side farther than on the other, shift the blade to the right or left until the plane will cut evenly. Set the blade to the required cut. By looking at the grain you can tell which end to place against the stop, remembering that you are to plane toward the stop, and that the grain should slope upward in the direction you are planing.

3. Lay the material flat on the bench with one end against the bench stop. For an ordinary surface use either the jack or smoothing plane. The longer plane will give a truer surface, but if it is desired merely to smooth the surface use the smoothing plane.

4. To dress the ends of a piece of material, clamp the piece tight in the bench vise, with the end to be dressed up and horizontal. Set the blade of the block plane to cut a thin shaving. Plane from the

edge toward the center of the piece. Reverse the piece in the clamp and plane toward the center from the other edge. Instead of re-

FIG. 7.—Planing a board.

versing the piece, it may be desirable simply to change position to plane from the opposite edge.

QUESTIONS.

1. Why will a long plane give a truer surface than a short one?
2. Why should a plane be laid on its side when not in use?
3. How should moldings be dressed?
4. How is a smooth surface secured where the grain of the wood is not straight and uniform?

BORING HOLES.

1. Read Information Topic No. 1 for bits, braces, and awl, brad.

2. Open the jaws of the brace by holding the knurled round grip on the end in your left hand, and with the right hand crank the

FIG. 8.—Tightening bit in brace.

handle to the left. Insert the tang of the bit between the jaws, allowing it to drop as far as it will go, and tighten into place by cranking the handle to the right. Place the spur of the bit on the center of the place where the hole is to be bored, sight the bit from two sides to make sure that it has the right direction. Hold the head of the brace in your left hand and with the right turn the crank to the right. It will sometimes be necessary to press the bit into the wood with the left hand to make it cut.

3. To prevent splitting of the wood when the bit goes all the way through the board, stop pressing and while turning the brace with the right hand pull back with the left. As soon as the spur comes through the other side the bit will stop cutting and come back. Insert the spur from the other side and make the hole entirely through the board.

4. To bore a hole in a corner where it is impossible to turn the brace around, shift the ratchet in the grip, which will allow the

brace to turn to the left without turning the bit. To withdraw the bit, shift the ratchet in the opposite direction.

5. Read Unit Operation No. 6. Bore small holes with a gimlet bit and brace or gimlet. The gimlet bit is used the same as the auger bit, and the gimlet is turned into the wood and removed by a wood handle.

6. Use a brad awl for boring very small holes. In starting place the cutting edge across the grain, then turn half way around and

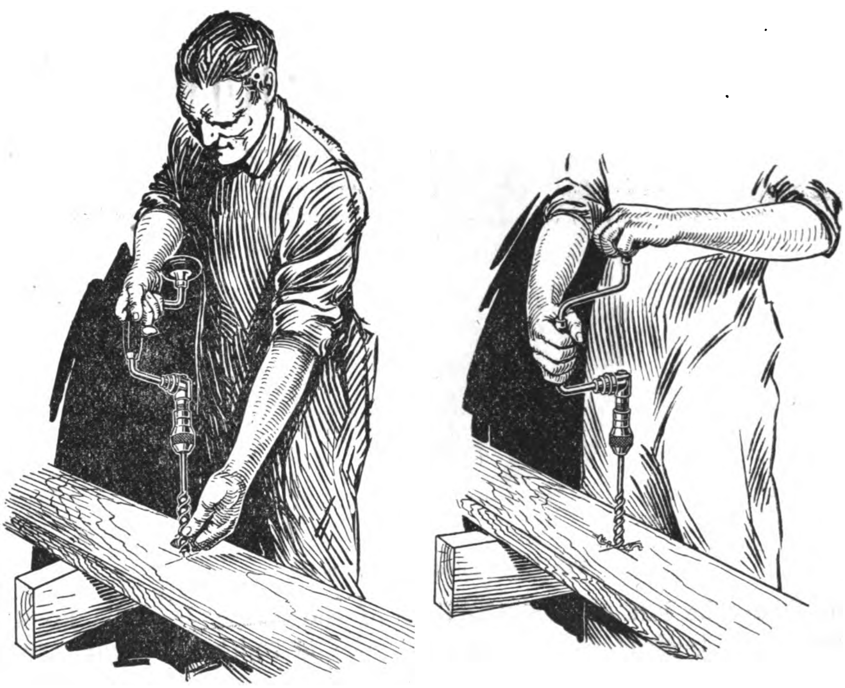


FIG. 9.—Boring holes.

back, bearing down with increasing pressure. Repeat until the necessary depth has been secured. Remove with similar turns while pulling the awl.

QUESTIONS.

1. How should the brace be held in order to steady it?

2. When boring part way through a board, how should the proper depth be determined?

3. When several holes are to be bored part way through a board, what method can be used to secure holes of equal depth?

4. What other tools can be used for boring holes and how are they used?

NAILING.

1. Read Information Topic No. 1 for hammer and hatchet and Information Topic No. 2 for nails. Hold the nail firmly in the left

FIG. 10.—Using nail set.

hand with the point at the place where it is to be driven, pointing in the direction that the nail is to go. Grasp the hammer near the end of the handle. Tap the nail lightly to start it, striking the nail head with the center of the face of the hammer.

2. Small nails should be driven with the arm held rigid and the

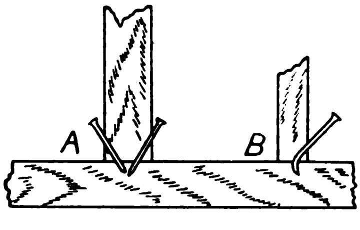


FIG. 11.—Toe nailing.

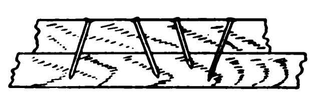


FIG. 12.—Nailing boards together.

wrist acting as a pivot. In driving larger spikes use the whole-arm swing. A good carpenter should be able to start a nail and drive it with eyes closed.

3. When working on casing or other interior work, use a hammer with a rounded face. This will prevent the bruising of the work by the hammer. On interior work, drive the nail head to within one-eighth inch of the wood and use a nail set to drive the head of the nail clear into the wood.

4. Toe nailing consists in driving the nail diagonally through a part of the end of a board into another one. See A, Figure 11.

5. When toe nailing in thin wood, the nail may be bent slightly near the end, causing it to go as indicated in B, Figure 11.

6. When driving several nails in the same boards, drive them in different directions. It is evident that they will hold better than if all were driven in the same direction.

QUESTIONS.

1. Why will nails driven in varying directions hold timbers together to best advantage?

2. How should nails be driven so as to prevent splitting of lumber?

3. How should nails be pulled?

4. What different methods should be used in driving different kinds of nails, such as cut nails, finish nails, shingle nails, etc.?

5. Why are nails set in interior woodwork?

FASTENING WITH SCREWS.

1. Read Information Topic No. 1 for screw driver and gimlet and Information Topic No. 2 for screws. In fastening boards together with screws, select, if possible, a screw whose threads will all be in the second board as shown at C, Figure 14. The threads of the screw should not take hold in the top board.

Fig. 13.—Fastening with screws.

2. If working in soft wood and the screw threads will all come in the lower board, start the screw with a hammer and turn it with a hand screw driver or screw driver bit held in an auger brace.

3. If working in hard wood, bore a gimlet hole through piece A, Figure 14, and started in piece B, Figure 14. Use a gimlet as large as the shank of the screw, and countersink the top of the gimlet hole as shown at E, Figure 14, with a rose countersink held in an auger brace. In B, Figure 14, the hole should be bored of such size as to just fit the core of the screw snugly. Put a little soap on the threads of the screw and drive in with a screw driver bit held in the auger brace.

4. A screw will not hold well in end grain. If necessary to screw one board to the end of another, bore a hole near the end of the piece, insert a plug and apply the screw as shown in Figure 15.

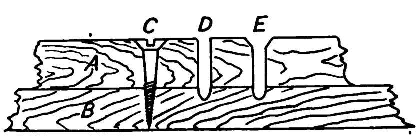


Fig. 14.—Holes for screws.

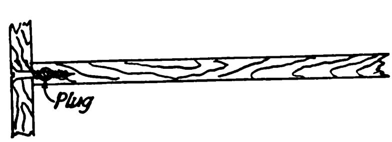


Fig. 15.—Screwing in end wood.

5. In fastening hardware to woodwork, it is not necessary to bore holes in soft wood, but if the wood is hard, holes should be bored

the depth of the shank of the screw. Ordinary soap applied to the threads will make the screw drive much easier than if dry.

QUESTIONS.

1. In fastening boards together with screws, why should the threads not take hold in the top board?
2. In fastening two pieces of soft wood, should screws of large or small gauge be selected?

SCRAPING.

1. Read Information Topic No. 1 for scraper, floor, and scraper, cabinet, and Information Topic No. 17.

2. Hold the scraper in the hands as shown and draw it along the grain of the wood toward you. The scraper should be slightly inclined from the vertical, the amount of inclination being adapted to the condition of the floor so as to secure fine, uniform shavings. Commence at one side and proceed gradually across the floor space, working each part down to the same degree of smoothness or finish. Care should be taken not to produce ridges or hollows in the floor surface.

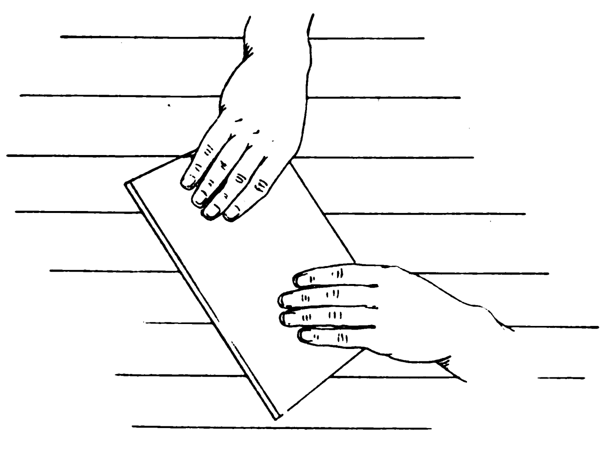


FIG. 16.—Scraping a floor.

QUESTIONS.

1. Why should scraping commence at one side of a room?
2. Should the floor be scraped before the base molding is placed?
3. Why is the scraper drawn along the surface parallel to the grain of the wood?

SANDPAPERING.

DIRECTIONS.

1. Read Information Topic No. 1 for sandpaper.

2. Tear the sheet of sandpaper into four pieces. In sandpapering a flat or convex surface, take a block of wood or cork, turn the edges of the paper over it far enough to grasp with the fingers and thumb, and rub the surface with the grain. Be careful not to take off the edge of the board unless the edge is to be rounded. Begin with coarse sandpaper No. 1½ or No. 2 and finish with No. ½ or No. 1. For convex surfaces use the sandpaper without a block. For concave surfaces use a convex block.

3. Sandpaper should not be used until all tool work has been done. Particles of sand will become embedded in the wood and dull an edged tool used on it.

QUESTIONS.

1. Why should the surface be rubbed parallel with the grain in sandpapering?

2. How should corners and edges be sandpapered?

3. What grades of sandpaper should be used for interior trim and for exterior trim?

CARPENTER INFORMATION.

DESCRIPTION OF TOOLS.

Awl, brad.—The brad awl is a short steel shaft with a wedge-shaped point and provided with a wooden handle. This tool is used for boring very small holes. See Unit Operation No. 4.

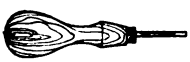


FIG. 17.—Brad awl.

Bevel.—The sliding T-bevel differs from a try-square in having movable blade. This blade has a slot and can be moved about in any direction along the end of the beam and set in any position by means of a thumbscrew. The beam may be made of either wood or steel. The adjustment of the blade of the square to any angle is described in Unit Operation No. 19.

Bit, auger.—The auger bit is used for all ordinary boring in wood. It is a steel shaft having a length of about 8½ inches and is composed of six parts—the cutting section, the twist, the jaws, the lips, the cylindrical shank, and the tang, which fits into the grip or chuck end of the brace. Bits are numbered on the tang or shank according to the diameter of the cutting section in sixteenths of an inch, thus a No. 13 will bore a hole $\frac{13}{16}$ inch in diameter. The use of the auger bit is described in Unit Operation No. 4.

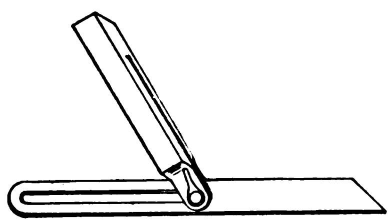


FIG. 18.—T bevel.

Bit, twist drill.—The twist drill bit is similar to the auger bit in being made up of the following sections: the cutting section, the twist, the shank, and the tang. However, this type of bit is generally made of hard steel and is used for boring in thin sheet metal as well as in wood. The use of the drill bit is similar to that of the auger bit as described in Unit Operation No. 4, with the exception of boring hardwood or metal. A center punch is first used to make a "seat" for the point of the drill. As the drill is easily broken, care must be taken in boring not to bend the bit by a sudden change in direction.

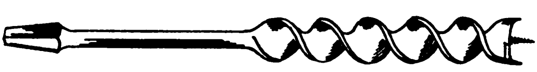


FIG. 19.—Auger bit.

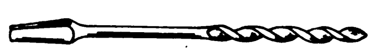


FIG. 20.—Twist drill bit.

Bit, screw driver.—The screw-driver bit is not a boring tool, but is used in connection with the brace to insert screws in hardwood and

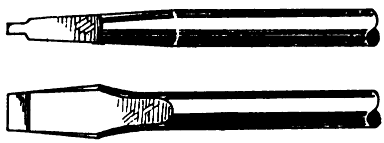


FIG. 21.—Screw-driver bit.

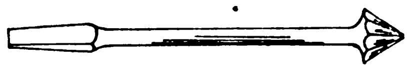


FIG. 22.—Countersink bit.

in corners where the use of the ordinary screw driver is not practicable.

Bit, countersink.—The countersink bit has a rose-head point and is used for enlarging screw holes made with the brad awl and gimlet, so that the heads of the screws will be sunk into the wood even with or below the surface.

Brace, auger.—The auger brace is a tool for holding the various kinds of bits which are used in boring, reaming, and screwing. This tool is composed of three sections—the head, the crank, and the grip or chuck. The latter is provided with jaws for gripping the tang end of the bit. A ratchet brace is provided with an attachment at the head of the grip, which permits the motion of the crank in one direction only. This provision is necessary when the crank can not make an entire revolution as in boring or screwing in a corner. See Unit Operation No. 4.

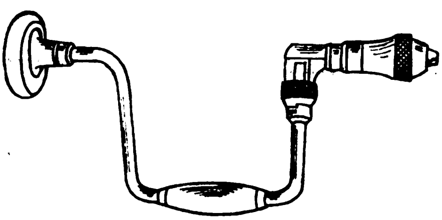


FIG. 23.—Ratchet brace.

Chisels, cold.—The cold chisel is a blade of hard steel provided with a cutting edge and is used for cutting metals.

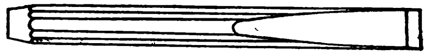


FIG. 24.—Cold chisel.

Chisel, firmer.—The firmer chisel is a blade of steel provided with a cutting edge and a wooden handle which is usually fitted upon a tang or into a socket. The size of the chisel is denoted by the width of the cutting edge, and varies from $\frac{1}{8}$ inch to 2 inches. See Unit Operation No. 20.

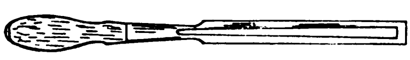


FIG. 25.—Firmer chisel.

Chisel, framing.—A framing chisel is similar to the firmer chisel with the exception that it is larger and heavier in construction, as it is used on heavy work, such as on framing of buildings. Its handle is usually fitted into a socket, and the top is tipped with leather or banded with iron to prevent splitting when hit with the mallet. The size of the framing chisel varies from 1 to 2 inches.

Dividers, wing.—Dividers or compasses are composed of two legs which are hinged at the upper end and pointed at the lower ends. The wing dividers have a metal arc which is attached to one leg and moves through the other leg. A thumbscrew is placed on the movable leg so that this leg may be clamped in position. The dividers are used: 1, describing circles; 2, dividing a given space into a stated number of parts; 3, marking a member which is to be fitted to another irregular member. The points of the dividers are often used as a scriber, but this practice is not recommended. See Unit Operation No. 12.

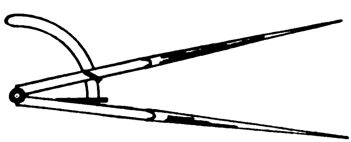


FIG. 26.—Wing dividers.

Drawknife.—The drawknife consists of a steel blade about 1⅝ inches wide and from 6 to 12 inches long. One side of the blade has a knife edge and at each end is a wooden handle at right angles to the length of the blade. See Unit Operation No. 10.

FIG. 27.—Taper saw file.

Fence for a steel square is a piece of wood usually ¾″ x 1½″ x 24″ with a series of holes along the center line of the face for use with two thumbscrews and saw kerfs from each end almost to the center midway between the faces. See Unit Operation No. 13 for drawing and detailed description. It can be fastened to the steel square at any angle or position and is used when a number of pieces of the same shape are to be laid out.

Files, saw, taper.—A saw file is a tapered triangular-shaped piece of steel with closely toothed surface. One end of the file may be provided with a tang which sets into a wooden handle. Double-ended files have come into common use. This tool is used for sharpening the teeth of saws as described in Unit Operation No. 15.

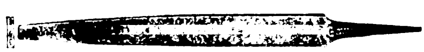


FIG. 28.—Flat file.

File, flat.—A flat file has a thin blade of steel, the surface of which is provided with fine teeth. One end has a tang which fits into a wooden handle. The flat file can be used for the scraping off of wood or metal surfaces, the wood file having larger and more tooth-shaped projections on the surface than the metal file. Flat metal files are used in jointing the teeth of a saw as described in Unit Operation No. 15.

Gauge, marking.—The marking gauge is generally made up of a graduated strip of wood called a beam along which a block of wood called a head moves. This head can be set at any place on the beam by means of a thumbscrew. At one end of the beam is placed a marking point or spur. The graduation on the beam commences at the spur, but it should not be relied upon in settling the gauge for measuring. The accurate setting of the gauge should be done with a rule. See Unit Operation No. 9.

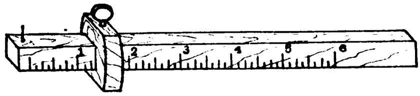


FIG. 29.—Marking gauge.

Gimlet.—The gimlet has a steel shaft of small diameter having a length of about 4 inches. One end of the shaft has a point and twist, while the other end has a small wooden handle.

Gouges.—Firmer gouges and long thin paring gouges are essentiatially chisels with blades, sections of which are circular arcs.

FIG. 30.—Firmer gouge.

Gouges.—Firmer gouges and long thin paring gouges are essentiatially chisels with blades, sections of which are circular arcs. Gouges are ground either on the inside or outside surface and are designated as inside or outside ground gouges. The gouge is used for cutting grooves and hollowing out surfaces. The size of a gouge is determined by measuring the straight distance betwen the corners of the cutting edges. Gouges vary in size from ⅛ inch to 2 inches.

Hammer.—The carpenter's hammer is the well known claw hammer composed of a steel head and wooden handle. The driving face may be either flat or slightly convex; the former is known as a plain

FIG. 31.—Carpenter's hammer.

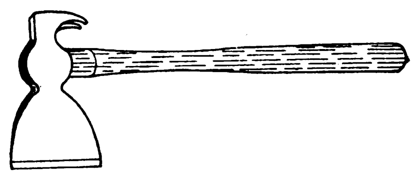


FIG. 32.—Hatchet.

faced hammer and the latter as the bell-faced hammer. The bell-faced hammer is often used in rough work to set the head of the nail below the surface without the use of a nail set. On interior finish, however, all nails should be set below the surface, for puttying, with a nail set. See Unit Operation No. 5.

Hatchet.—The hatchet is similar to the hammer in being composed of two parts, the head and the handle. The claw section of the head of the hammer is, however, replaced in the hatchet by a broad cutting edge parallel to the handle. This cutting edge is useful in the hewing and trimming of lumber. A notch is often made on the lower side of the cutting edge section of the hatchet for use in pulling nails. The hatchet, on account of its weight, is often used for driving large nails or spikes. See Unit Operation No. 11.

Level, carpenter's.—The carpenter's level consists of a piece of hard wood or metal from twelve to thirty inches in length with a true surface on one edge. Bubble tubes are placed in the tool parallel to, and at right angles to, the true surface. The levels are generally made with the edge in which the bubble tubes are placed, also a true surface. This allows the level to be used to level up a board from its under side. Where greater accuracy is required in leveling, long levels are used. These levels are provided with bubble tubes of larger radius, and these bubble tubes are generally graduated so as to indicate the exact position of the bubble. The use of the carpenter's level is described in Unit Operation No. 24.

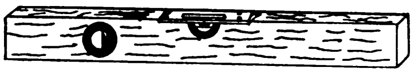


FIG. 33.—Level.

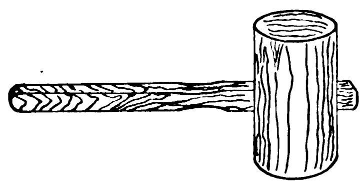


FIG. 34.—Mallet.

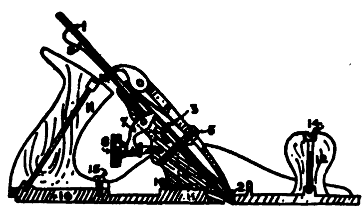
Sometimes the level tubes get shifted so they are not parallel and perpendicular to the true surface. To test the level, place it on a true surface approximately horizontal and note the position of the bubble. Reverse the level end for end and again note position of the bubble. If the two positions are not the same the level needs adjusting. This can be done by turning the screws holding the bubble tube in place so that the bubble will be half way between the two positions previously noted. Do not make the adjustment unless absolutely necessary and then under the supervision of a man experienced in such work.

Mallet.—The mallet is a heavy wooden hammer provided with a large cylindrical shaped head. This tool is used for driving chisels, gouges, wooden pins, etc., and should never be used for driving nails or screws. See Unit Operation No. 20.

Nail set.—A nail set is a round steel shaft about $\frac{5}{16}$ inch diameter and 4 inches in length, with one end tapered to a cupped point of from $\frac{1}{32}$ to $\frac{1}{8}$ inch. See Unit Operation No. 5.

Oilstones.—Oilstones are of two varieties, the fine-grained natural stone, and the coarse-grained artificial stone. The latter is manufactured by placing a powdered metal cutting substance into a rectangular form. The coarse-grained stone gives a rapid cutting surface while the fine-grained stone gives a smooth but slow cutting surface. Oil is used on these stones to clean the pores of the fine particles of metal and to furnish the necessary lubricating medium. See Unit Operation No. 16 for use and for illustration.

Plane, jack.—The jack plane consists of a wooden or iron surface which is pierced with a sharp edged steel blade. The principal parts of a plane are shown below. It should be noted that there are two adjustments for the blade of the plane; the first consists of the thumb screw or adjusting nut which regulates the projection of the plane iron beyond the surface, and the second is the adjustment of the plane iron by the lever to make its cutting edge parallel to the surface. The jack plane is about 14 to 15 inches long. The plane iron has a cutting edge which is ground slightly rounding so as to remove rough or large quantities of wood.



1. Plane-Iron	5. Cap-Screw	9. Lateral Adjustment	13. Handle "Bolt & Nut"
2. Cap-Iron	6. Frog.	10. Frog Screw	14. Knob "Bolt & Nut"
3. Plane-Iron Screw	7. "Y" Adjustment	11. Handle	15. Handle Screw
4. Cap	8. Adjusting Nut	12. Knob	16. Bottom.

FIG. 35.—Jack plane.

Plane, smoothing.—The smoothing plane is similar in construction to the jack plane but is not so long. It is used, as its name implies, for the smoothing of surfaces. The use of a smoothing plane is described in Unit Operation No. 3.

Plane, block.—The block plane is made about 6 inches in length and has an iron frame. It is used for cutting across the ends of wood. The block plane differs from the jack and smoothing planes in that it has no cap iron and the bevel side of the plane iron is placed up instead of down. It should be noted that for large pieces which can easily be placed in a vise, the jack and smoothing planes may be set very shallow and used instead of a block plane. The latter is especially adapted for small pieces and where a vise is not available.

Plane, fore.—The fore plane is similar in construction to the jack plane, but is longer, usually 18 inches. The plane iron is ground with a nearly straight cutting edge. Sometimes the jack plane is used as a fore plane by regrinding the blade iron to a nearly straight edge. The fore plane is used for truing a surface or edge, as described in Unit Operation No. 22.

Pliers, side cutting.—Pliers are composed of two hinged pieces of steel, the shorter ends are provided with inner roughened surfaces for gripping or holding while the longer ends are shaped to serve as handles. Side cutting pliers are equipped with steel cutting edges along one side of the gripping ends. The amount of grip which one is able to secure with a pair of pliers depends upon the length of the handles.

Plumb-bob.—The plumb-bob is a pear-shaped piece of iron, brass or lead, to the larger end of which is fastened a string or plumb

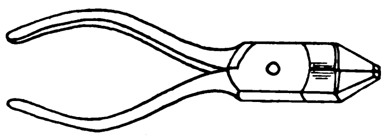


FIG. 36.—Side-cutting pliers.

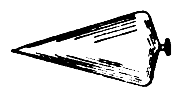


FIG. 37.—Plumb-bob.

line in such a way that the point of the bob, when suspended, will be vertically under the center of the line. The use of the plumb-bob is described in Unit Operation No. 24.

Rule (2 feet, 4 fold).—The ordinary carpenter's rule is made up of four pieces of boxwood or maple which are hinged together so as to fold into a length of about 6 inches. The surface of the rule is subdivided into inches, halves, quarters, and eighths, and on one side into sixteenths. In measuring lines with a rule, the latter should be placed with its edge along the surface to be marked, and the division transcribed with a sharp pointed pencil or knife so that the point touches both the division on the rule and the surface at the same time. See Unit Operation Nos. 1 and 9.

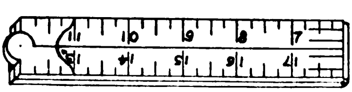


FIG. 38.—Carpenter's rule.

Sandpaper is made by coating one surface of heavy paper with glue and sand. It is cut into sheets 8¾ by 10½ inches and sold by the ream or dozen sheets. Twelve grades of coarseness are manufactured. They are numbered 0000, 000, 00, 0, ½, 1, 1½, 2, 2½, 3, 3½, and 4. No. 0000 is very fine and No. 4 is very coarse. See Unit Operation No. 8.

Saw, crosscut.—The ordinary hand saw is composed of a blade of steel to one end of which is attached a wooden handle. The blade is made narrower at its outer end, or point, than at the handle, or heel end. The cutting edge of a saw is made up of a number of teeth. The number of the saw denotes the number of points to the inch. It should be noted that there is always one more point per inch than there are teeth. The teeth are bent alternately from side to side in order that the thickness of the cuts may be wider than the thickness of the blade of the saw. The amount of side displacement at which the teeth are "set" depends upon the character of lumber to be sawed. Damp, spongy lumber requires greater "set" than well-seasoned material. The sharpening and setting of the saw is described in Unit Operation No. 15. The use of the saw is described in Unit Operation No. 2. The crosscut saw is in principle like two rows of knife points which cut off both ends of the short chips of wood.

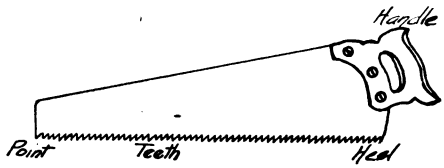


FIG. 39.—Crosscut saw.

Saw, rip.—The rip saw is similar in construction to the crosscut saw, with the exception that the blade is generally larger and thicker

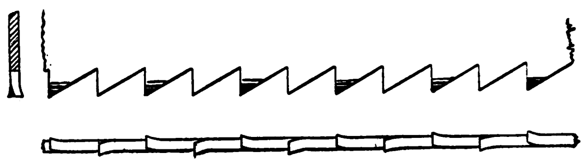


FIG. 40.—Teeth of rip saw.

and the teeth have a different rake or pitch. The latter is the degree of slant which the cutting edges possess with reference to the

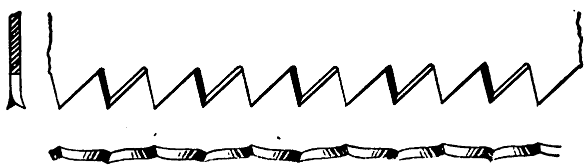


FIG. 40a.—Teeth of crosscut saw.

imaginary line passing through the points of the teeth. In a rip saw, the front or cutting edge of the teeth is usually made at right angles to an imaginary line passing through the point of the teeth, and these teeth are practically little chisels and act as such in ripping out the wood.

Saw, back.—The backsaw has a thin steel blade of uniform width, reinforced on one side by a heavy steel back piece and filed as a crosscut saw. This saw is used for accurate crosscutting and ripping. For the accurate cutting of outside or inside finish or trim, the backsaw is used in connection with a bench stop or miter box.

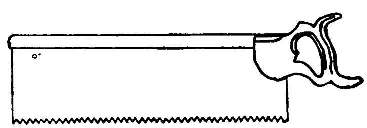


FIG. 41.—Backsaw.

Saw, compass and keyhole.—Compass and keyhole saws have a narrow V-shaped blade which is used for saving along curved lines.

Scraper, cabinet.—Cabinet scrapers are pieces of specially tempered high grade steel either rectangular or irregular in shape. The former are used for plane and convex surface work while the latter are adapted for smoothing concave surfaces. At the cutting edge of a scraper is a burr which is called an arris and turned at nearly a right angle to the surface of the scraper. The method of sharpen-

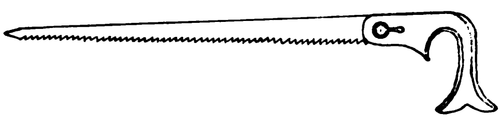


FIG. 42.—Compass saw.

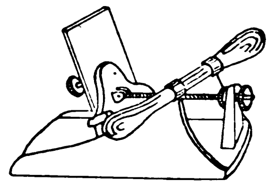


FIG. 43.—Floor scraper.

ing a scraper is described in Instruction No. 17, and the use of a scraper is given in Unit Operation No. 7. For illustrations see Unit Operation No. 17.

Scraper, floor.—The floor scraper may be a rectangular blade of soft steel similar to a cabinet scraper or a special tool which consists principally of a broad iron surface through which a scraper blade projects and is mounted similar to a jack plane. The plane is operated by means of two handles which project from the sides. The plane is generally operated by being drawn toward the worker. See Unit Operations No. 7 and No. 17.

Scriber.—A scriber is a fine steel point with a wooden handle, similar to the brad awl. The principal difference between a scriber and a brad awl is in the point, which is made wedge shaped in the latter for the boring of holes. See Unit Operation No. 12.

Screw driver.—The screw driver has a steel shank with a wedge-shaped point made to fit the slots in the heads of screws and is

FIG. 44.—Screw driver.

provided with a heavy wooden handle. As shown in the drawing, the sides of the handles are often grooved so as to furnish a better grip. The point of the screw driver is made in different thicknesses to take different size screws. Long-handle screw drivers are necessary for the sinking of large screws in order to give sufficient "purchase." The screw-driver bit and brace are used for driving screws into hard wood and in corners where there is insufficient room for the use of an ordinary screw driver. See Unit Operation No. 6.

Square, steel.—The steel or framing square is an L-shaped blade of steel which is graduated on both sides in feet, inches, and their minor subdivisions, commencing with zero at the angle. The long arm of the square is called the blade and the short arm the tongue. In addition to the graduation into inches and fractions of an inch, there is generally on the blade a board-measure table and on the

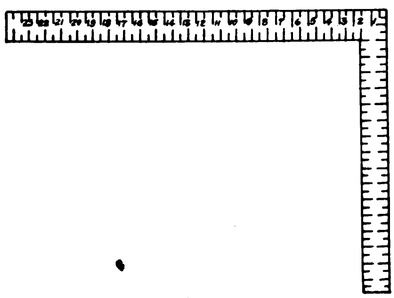


FIG. 45.—Steel square.

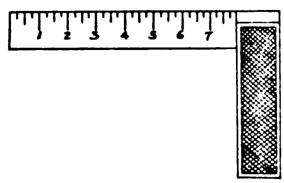


FIG. 46.—Try-square.

tongue a rafter-measure table. Some uses of the steel square are described in Unit Operations Nos. 1, 34, 35, and 49.

Square, try.—The try-square is a blade of steel set into a head or beam of wood or steel. The blade is often graduated into inches and fractions thereof. The angle between the edge of the blade and beam is made exactly 90° or a right angle. The try-square may be used for three purposes: 1. To serve as a guide for the pencil or scriber in marking lines across the grain at right angles to an edge or surface. 2. To test an edge or end to determine whether it is square with an adjoining surface or edge. 3. To test the surface or edge to determine whether it is the same width or thickness throughout its length.

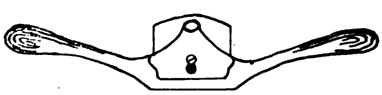


FIG. 47.—Spokeshave.

In making these tests the inside edge of the beam should always be held closely in touch with the surface of contact, and if the beam projects beyond the end of the piece it should be reversed. In scribing, the top of the pencil or scriber should be tilted slightly away from the blade and the mark made with one stroke. The try-square should never be used for scraping the surface of a piece. The use of the try-square is described in Unit Operation No. 1.

Spokeshave.—The spokeshave consists essentially of a wooden or iron wing-shaped handle provided with a small plane blade. The blade may be adjusted by means of a thumbscrew. This tool is used principally for the smoothing of curved surfaces. It may be operated by drawing toward or pushing away from the worker. The use of this tool is described in Unit Operation No. 10.

QUESTIONS.

1. What part of an auger bit cuts the wood? What is the purpose of the twist?

2. Why is a brad awl generally provided with a wedge-shaped point. Under what conditions is a conical point preferable?

3. Why is a firmer chisel with a socket better than one with a tang?

4. Why is a saw file tapered?

5. Why should dividers not be used generally for scribing? Under what conditions should they be used for scribing?

6. Why are the teeth on a wood file coarser than those on a metal file?

7. Under what conditions should inside and outside ground gouges be used?

8. How can the carpenter's level be used to plumb a large surface?

9. What plane should be used in smoothing and truing the surface of heavy planks for a bench top?

10. Why is a plumb bob pear shaped?

11. How should a carpenter's rule be used to lay out accurately a distance greater than the length of the rule?

12. Why is set given to the teeth of a saw? Why are the teeth of a rip saw pitched differently from those of a cross-cut saw?

FASTENINGS.

1. *Nails.*—There are three kinds of nails in common use—plate or cut nails, wire nails, and clinch nails. Wire nails are the type in general use for building construction and according to their use are subdivided into the following classes: Common nails, finishing nails, and casing nails. Common nails are used for all ordinary work, finishing nails for finishing work, and casing nails for hardwood flooring, matched ceiling, and similar tongue and groove boarding.

The length of nails is designated by "pennies" (d's). The weight expressed in "pennies" runs from twopenny to sixtypenny. The size, length, and diameter in inches of common nails and the number to the pound is given in the following table:

Size.	Length.	Diameter.	Steel wire guage No.	Number to the pound.
	Inches.	*Inches.*		
2d.	1	0.072	15	900
3d.	1¼	.08	14	615
4d.	1½	.098	12½	322
5d.	1¾	.098	12½	254
6d.	2	.113	11½	200
7d.	2¼	.113	11½	154
8d.	2½	.131	10¼	106
9d.	2¾	.131	10¼	85
10d.	3	.148	9	74
12d.	3¼	.148	9	57
16d.	3½	.162	8	46
20d.	4	.192	6	29
30d.	4½	.207	5	23
40d.	5	.225	4	17
50d.	5½	.244	3	14
60d.	6½	.262	2	11

It is important to use nails of the proper size for various classes of work. 20d., 40d., and 60d. nails, or spikes should be used, according to the size of the timber. For sheathing and roof boarding, underflooring and cross-bridging, 8d. nails should be used. For upper flooring, such as matched flooring, 8d. flooring nails or casing nails should be used. For inside finish, finishing nails or brads from 2 to 8d. should be used, according to the size and thickness of the trim. Lathing should be put on with 3d. nails and shingles and slatin with 4d. nails. (Fig. 48.)

2. *Screws.*—Trimming or finish hardware of every description is put on with screws. On high-grade building construction, inside paneling, inside finish, etc., screws are used. They give a neater appearance than nails, have a greater holding power, and are less apt to injure the material in case of removal.

The ordinary type of screw has a head, a shank, and gimlet point, by which it can readily be turned into the wood.

Screws are made with a variety of head forms, to suit the different uses to which they are to be put. Screws are ordinarily made of steel, but for special uses are sometimes made of brass or bronze.

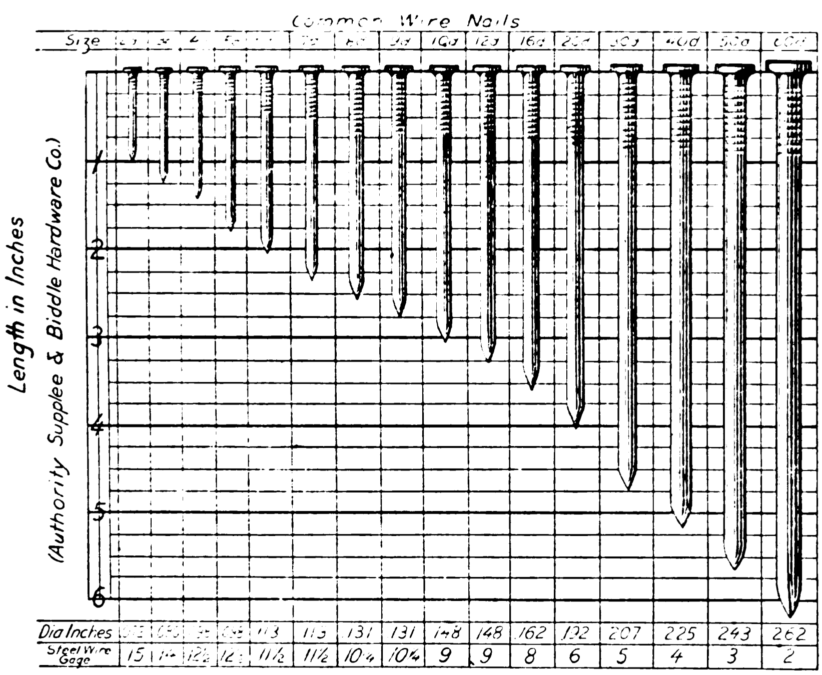


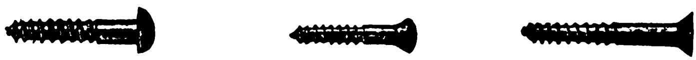
FIG. 48.—Length, diameter, and pennyweight of nails.

They are given a variety of finishes, such as nickeled, bronzed, blued, or galvanized, according to the purpose for which intended. Screws in common use may be classified as follows:

Flat head, bright.
Flat head, blued.
Flat head, brass.
Oval head, blued.
Oval head, brass.
Round head, brass.
Lag or coach screws, brass, galvanized steel, and common finish steel.

Steel screws for wood are made in 20 different lengths, varying from ¼ to 6 inches and from 6 to 18 different diameters for each length of screw. There are 31 different gauges and 250 different sizes of wood screws manufactured.

The size of screws is denoted by the length in inches and the number of the gauge, the gauge denoting the diameter. Thus a 1-inch No. 12 screw has a length of 1 inch and a diameter of 0.2158 inch. The gauge number ranges from 0 to 30 and the length from ¼ inch to 6 inches. Wood or flat head screws are sold by the gross.



Round Head — Oval Head — Flat Head

Iron and Brass Screws for Wood. Stock Size.

(Authority: Supplee & Biddle Hardware Co.)

Inches	Number = Size of Screw																	
¼														0	1	2	3	4
⅜									0	1	2	3	4	5	6	7	8	9
½							1	2	3	4	5	6	7	8	9	10	11	12
⅝					1	2	3	4	5	6	7	8	9	10	11	12	13	14
¾				2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
⅞				2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20
1¼	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
1½	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
1¾		5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
2		5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
2¼		5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
2½		5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
2¾			6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24
3	6	7	8	9	10	11	12	13	14	15	16	17	18	20	22	24	26	
3½			8	9	10	11	12	13	14	15	16	17	18	20	22	24	26	
4					8	9	10	11	12	14	16	18	20	22	24	26	28	
4½								12	14	16	18	20	22	24	26	28	30	
5								12	14	16	18	20	22	24	26	28	30	
6									14	16	18	20	22	24	26	28	30	

No. of Screw	0	1	2	3	4	5	6	7	8	9	10	11	12
Steel Wire Gage	17	15	14	13	12	11	10	9	8	7	6½	6	5
Dec. of Inch	.054	.072	.080	.091	.105	.120	.135	.148	.162	.177	.184	.192	.207

No. of Screw	13	14	15	16	17	18	20	22	24	26	28	30
Steel Wire Gage	4½	4	3	2½	2	1	.0½	.0	.00	.00½	.000	.0000
Dec. of Inch	.216	.225	.243	.253	.262	.283		.306	.331		.362	.393

FIG. 49.—Size, length, and diameter of screws.

Lag or coach screws are used in heavy framing and in fastening metal sections to timber. Coach or lag screws are made in diameters from $\frac{5}{16}$ inch to 1 inch and in lengths from 1½ to 2 inches. As lag or coach screws are sold by the pound, the following table gives the weights of the common sizes.

Weight of lag or coach screws, per hundred.

[Authority: The Barrett Christie Co.]

Length under head.	Diameter in inches.							
	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1½ inches	3.9	5.1	8.7	10.4				
2 inches	4.8	6.7	10.5	13.0	24.0			
2½ inches	5.6	8.4	11.9	15.6	27.2	39		
3 inches	6.5	9.1	13.5	18.2	30.5	45	66	
3½ inches	7.3	10.6	15.1	20.6	33.7	51	72	
4 inches	8.2	12.0	16.7	22.9	37.0	57	78	105
5 inches	9.9	14.0	20.5	27.5	43.5	67	92	127
6 inches	11.7	16.0	24.2	32.0	50.6	77	107	147
7 inches			28.0	36.5	57.8	87	122	167
8 inches				41.0	64.7	97	137	186
9 inches				45.5	72.0	107	152	204
10 inches				50.0	79.2	117	167	221
11 inches				54.5	86.5	127	180	237
12 inches				59.0	94.0	137	191	252

3. *Bolts.*—A large variety of bolts are manufactured and are classified according to their use: machine, carriage, tire, stove, and expansion. The size of a bolt is given by stating its diameter and length in inches. Machine bolts vary in diameter from one-fourth to 1¼ inches and in length from 1½ to 30 inches.

Carriage bolts have a diameter of from one-fourth to five-eighths inches and a length of from 1 to 12 inches. The ordinary bolt used in structural work has either a square or hexagonal head. The carriage bolt has a button head, tire and stove bolts have countersunk heads, and expansion bolts have square heads.

The expansion bolt is made in two styles: a bolt with a nut so constructed that it expands as the bolt is screwed down, and a tapered bolt with a hinged shield or sleeve which expands as the bolt is screwed in.

Drift bolts are used for fastening heavy timbers together in pier, crib, and bridge work. In using the bolts, holes are bored of slightly less diameter than the bolt or pin. The drift bolts are either circular or square, and are headed, generally, at one end and pointed at the other end. The weights and dimensions are given in the following table:

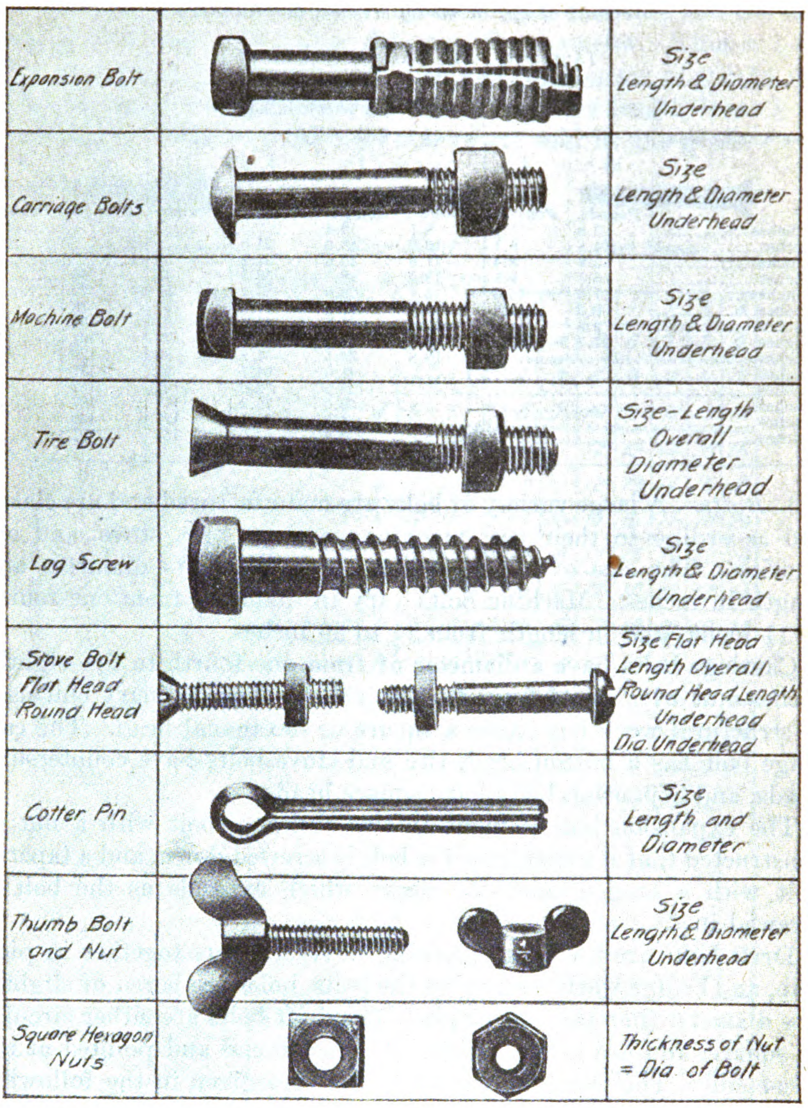


FIG. 50.—Bolts, screws, etc.

Dimensions and weights of drift bolts.

[Authority: Engineer Field Manual.]

Length.	Square section (side).		Round section (diameter).	
	$\frac{3}{4}$ inch.	1 inch.	$\frac{3}{4}$ inch.	1 inch.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
18 inches..........	2.9	5.1	2.3	4.0
20 inches..........	3.2	5.7	2.5	4.4
22 inches..........	3.5	6.2	2.8	4.9
24 inches..........	3.8	6.8	3.0	5.4
26 inches..........	4.1	7.3	3.3	5.8

QUESTIONS.

1. What is the best form of nails for rough work, such as fastening the frame of the building?
2. What nails should be used for erecting the interior trim of a building?
3. When can cut nails be used to advantage?
4. Why should galvanized nails be used for roofing?
5. When are screws used in building construction?
6. When can lag screws be used to better advantage than bolts in building construction? When are washers used?
7. What are the relative advantages of square and hexagonal heads on bolts?
8. When is it desirable to use expansion bolts?
9. Why should toe nailing be used? When?
10. Why is it not good practice to fasten underflooring over a bearing with one surface nail?

JOB NO. 1.

Name ________________________________

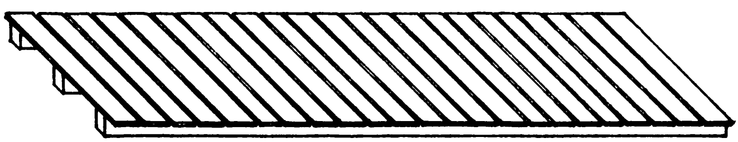
____
(Rank and organization.)

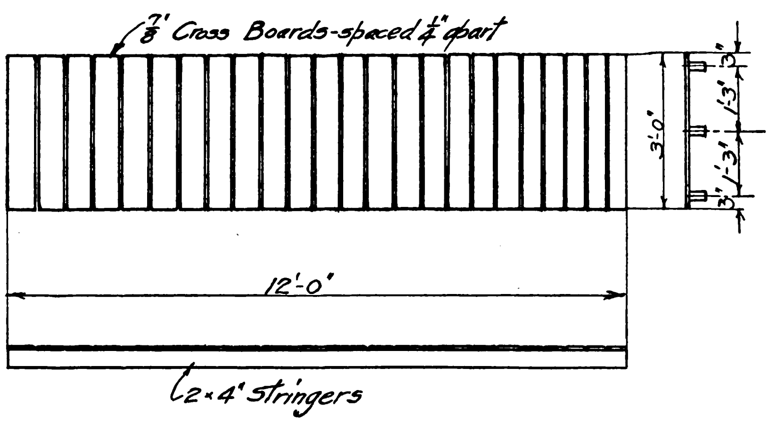
Date ________________________________

1. **Camp sidewalk.**

2. *Specifications.*—The material is to be 2 by 4's for the stringer and ⅞-inch boarding for the cross boards.

3. *Drawing.*





Camp Sidewalk Job No.1.

6. *Unit Operations listed in order of use:*

5. *List of tools and bill of material:*

6. *Questions and answers:*

1. Why are three stringers used?

2. Why are the cross boards spaced ¼ inch apart?

3. Why do the cross boards overhang the stringers?

4. Would it be advisable to fasten the cross boards to the stringers with screws?

5. Would it be advisable to use solid floor for the sidewalks?

6. Would it be practicable to use one nail instead of two for each contact?

JOB NO. 2.

Name ______________________

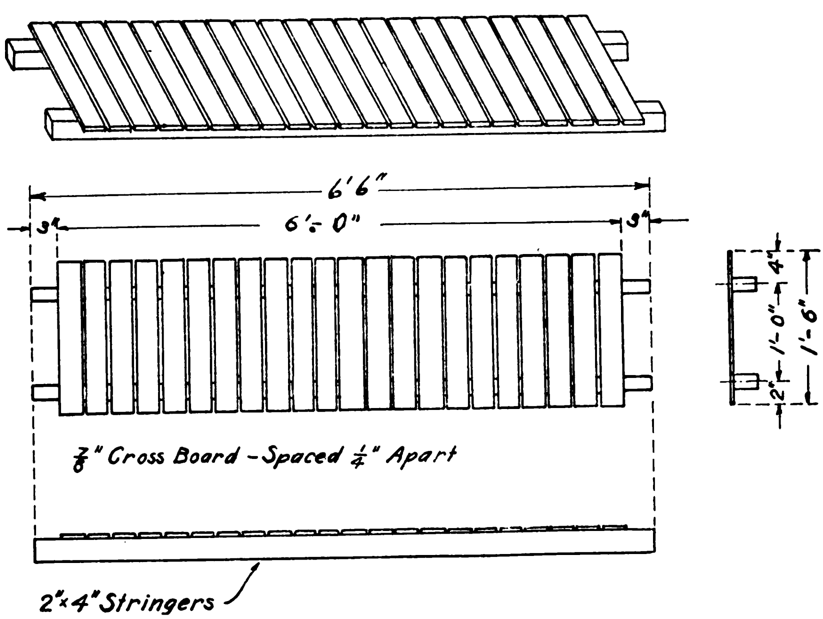
____
(Rank and organization.)

Date ______________________

1. **Trench board.** (See E. F. N. No. 3.)

2. *Specifications.*—The material is to be 2 x 4's for the stringers and ⅞-inch boarding for the cross boards.

3. *Drawing.*



TRENCH BOARD for STANDARD "A" FRAME - JOB No. 2

4. *Unit Operations listed in order of use:*

5. *List of tools and bill of material:*

6. *Questions and answers:*

1. Why are the 2 x 4's extended 3 inches at each end?

2. Why are the 2 x 4 stringers offset from the ends of the cross pieces?

3. Why are the sections made 6′–6″ long?

4. How would adjacent sections be placed with regard to position of stringers?

JOB NO. 3.

Name ______________________________

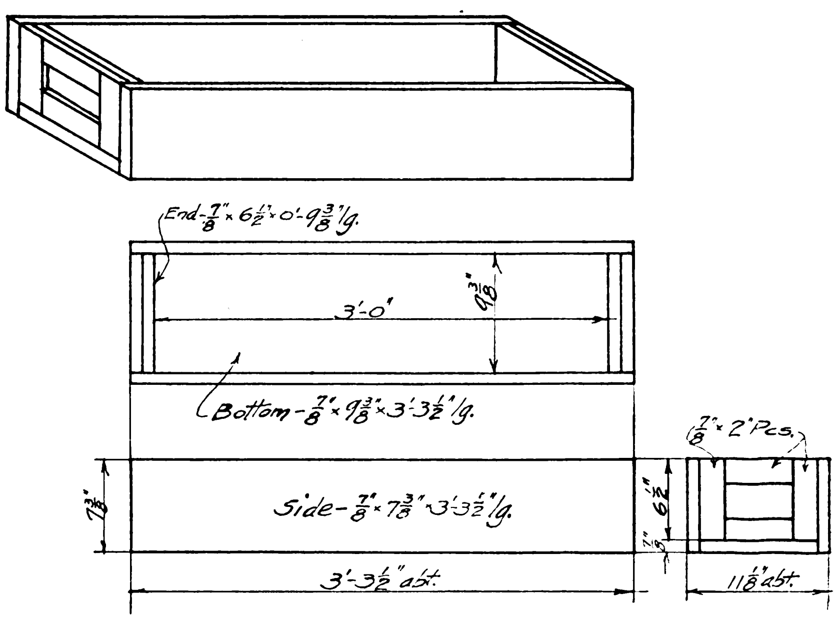
____
(Rank and organization.)

Date ______________________________

1. **9-inch bookcase section and packing box.**

2. *Specifications.*—Net inside dimensions 6½" x 9⅜" x 3' 0". All material to be ⅞" Y. P. or W. P. stock (S4S). The ends to be scraped or sandpapered for varnishing or painting. Each joint to be fastened with three No. 10 screws 1¼ inches long. See sketch below.

3. *Drawing:*



9-Inch Book Case Section-Job No. 3

4. *Unit Operations listed in order of use:*

5. *List of tools and bill of material.*—

6. *Questions and answers.*—

1. Why is the box made of the length shown?

2. Why is the box made 9$\frac{3}{8}$ inches high?

3. Why are the ends built up as shown?

4. How would the section be used as a packing box?

5. Why are only the ends of the section finished?

107821—23——4

JOB NO. 4.

Name_____________________________

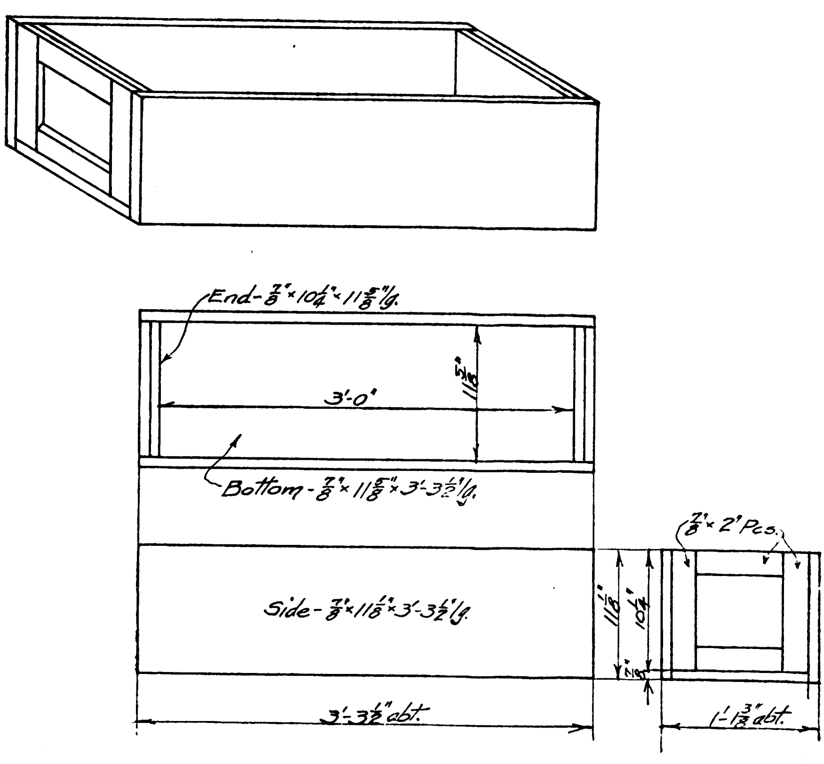
____
(Rank and organization.)

Date_____________________________

1. **12-inch bookcase section and packing box.**

2. *Specifications.*—Net inside dimensions $11\frac{5}{8}''$ x $10\frac{1}{4}''$ x 3′ 0″. All material is to be $\frac{7}{8}''$ Y. P. or W. P. Stock (S4S). The ends are to be scraped or sandpapered for varnishing or painting. Each joint to be fastened with three No. 10 screws $1\frac{1}{4}$ inches long. See sketch below.

3. *Drawing.*—



12-Inch Book Case Section-Job No. 4

4. ***Unit Operations listed in order of use.—***

5. ***List of tools and bill of material.—***

6. ***Questions and answers.—***

1. **Why is the box made $11\frac{5}{8}$ inches high?**

2. **Why are the vertical strips run the full height of the ends?**

3. **In what direction should the grain of the ends of the box run?**

4. **Why are screws used to fasten the sides and bottom to the ends?**

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UNITED STATES ARMY

TRAINING MANUAL No. 11

CARPENTRY

FOR MILITARY SPECIALISTS

Part II. BASIC CARPENTER

PREPARED UNDER THE DIRECTION OF

THE CHIEF OF ENGINEERS, U. S. ARMY

1922

WASHINGTON
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1923

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1923

CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *May 23, 1922.*

Manuals for training the Army are to be prepared and revised from time to time by the branches of the service concerned, and published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Corps of Engineers as a part of this series a group of five pamphlets relating to carpenters. The pamphlets in this series are titled as follows:

Training Manual No. 10.—Carpenter Helper.
Training Manual No. 11.—Basic Carpenter.
Training Manual No. 12.—General Carpenter.
Training Manual No. 13.—Master Carpenter.
Training Manual No. 14.—Instructor's Guide for Carpenters.

This pamphlet is the second of the carpenter series, and is published for the information and guidance of all concerned.

[A. G. 062.11 (5–16–22).]

BY ORDER OF THE SECRETARY OF WAR:

JOHN J. PERSHING,
General of the Armies,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
Acting The Adjutant General.

FOREWORD.

Training Manual No. 11 Basic Carpenter completes the course for teaching the basic tool skills. At least 5 per cent of the soldiers of the Army should have the abilities acquired by satisfactorily completing this course. Graduates receive a certificate of proficiency as Basic Carpenter, which makes them eligible for appointment to this rating.

This is the second convenient step in training a master carpenter. It completes the carpentry bench work, as well as the acquisition of necessary skills and knowledge in the care, sharpening, and use of the common carpenter tools. Graduates who are susceptible of further training are eligible to take the course contained in Training Manual No. 12 General Carpenter.

These steps need not follow immediately after one another. It may often be an advantage to a man to work at the trade for awhile between each part of the school training.

INDEX TO TRAINING MANUAL NO. 11.

Unit operations:

Page.

9. Cutting to width and thickness — 1
10. Making rounded curves — 3
11. Hewing to a line — 4
12. Scribing — 5
13. Reading drawings — 6
14. Preparing bill of material — 11
15. Sharpening and setting saws — 13
16. Sharpening edged tools — 15
17. Sharpening scrapers — 17
18. Sharpening auger bits — 19
19. Laying out special angle cuts — 20
20. Mortising and tenoning — 23
21. Grooving — 26
22. Truing surfaces — 28
23. Preparation and use of glue — 29

Information topics:

3. Definitions of trade terms — 30
4. Timber — 41
5. Joints — 49

Jobs:

5. Standard A frame, for trench board — 56
6. Special A frame, for trench board — 58
7. Portable artillery bridge — 60
8. Low bookcase — 62
9. High bookcase — 64
10. Tool tray — 66

CUTTING TO WIDTH AND THICKNESS.

1. If the material has one straight edge, use it as a base line from which to measure the desired width. If it has no straight edge, plane one edge straight and square with the face. Read Information Topic No. 1 for gauge, marking.

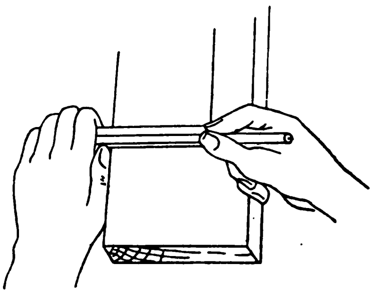


FIG. 51.—Marking for width with rule and pencil.

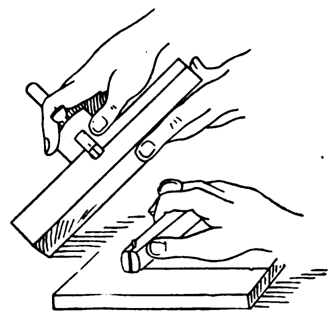


FIG. 52.—Use of marking gauge.

2. The most common method of marking for width is to lay the rule across the material with the figure showing the width on the working edge. Hold the rule in the left hand with the forefinger against the working edge of the material. Place the point of a pencil on the material at the end of the rule and slide both hands with the pencil and rule along the material.

3. A more accurate method is to use the marking gauge.

4. To draw a line ¾ inch or less from an edge, hold the pencil with one finger against the edge and move the hand along the edge of the board.

5. If more than ⅜ inch is to be cut from the side, use a rip saw, cutting to the outside of the line, and if a smooth edge is needed, finish with a plane. If ⅛ inch or less is to be cut off, use a plane.

6. Test the edge with a square, holding one side of it against the working face and the other across the edge. If no light shows through, the edge is at right angles to the face.

7. Having cut the material to the required length and width, set a marking gauge so that the required thickness is shown between the head and the spur. Do not depend upon the scale shown on the gauge, but measure the distance with a rule.

8. Holding the head of the gauge on the working face of the material so that the spur will mark on the edge, draw a line on the edges and ends.

9. Lay the material face side down on the bench, with the end against the benchstop, and plane the entire surface down to the

gauge line. Approaching the line on all four edges, test the surface by turning the plane on edge and looking under it toward the light. If any light shows through, mark the places where the plane touches the wood and plane only on those places.

10. Having planed to the line on all four edges and no light shows under the edge of the plane when held on the board both lengthwise and crosswise of the board, the surface is true and the material the desired thickness.

QUESTIONS.

1. Why is the board cut to length and width before it is cut to thickness?
2. Why is the scale on the wooden marking gauge unreliable?
3. How can one determine toward which end to plane a board?
4. Why plane to a line rather than through it?

MAKING ROUNDED CURVES.

1. Read Information Topic No. 1 for drawknife and spokeshave.
2. Examine the piece to see the direction in which the grain runs.

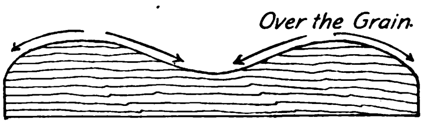


FIG. 53.—Cutting over the grain.

3. Hold the drawknife at an angle of about 75° with the direction of the cut to be made and with the bevel of the knife up.

4. Pull the knife toward you, taking shavings which may be as heavy as it is possible to cut, until you come near the line. When near the line, make the shavings thin.

5. Be careful to cut over the grain so as to avoid splitting. Change the direction of the cutting as often as necessary to cut over the grain.

6. If the spokeshave is used to finish the cut, set the blade to cut thin shavings and hold the spokeshave so that the bottom surface lies firmly against the surface of the piece being cut. Hold the thumbs near the center of the tool and work in either direction as the nature of the work or the direction of the grain requires.

FIG. 54.—Use of drawknife.

QUESTIONS.

1. Why should the drawknife be held at an angle to the direction of the cut?

2. Why is it best to hold the thumbs near the center of a spokeshave?

3. How is a spokeshave adjusted?

HEWING TO A LINE.

1. Draw a line with rule and pencil, gauge, or chalk line to show depth of cut.

2. For cutting use sharp hand ax, hatchet, or adz, depending upon shape, size, and position of material to be cut.

FIG. 55.—Hewing to a line.

3. Begin close to the end and make a series of cuts across the grain and slightly inclined toward the line.

4. If the grain is irregular, chop lightly and make the crosscuts very close together.

5. If the grain is very irregular, cut from both directions. At best, hewing is a rough job and should not be done where a smooth finished surface is desired.

QUESTION.

1. When should wood be hewed rather than sawed?

SCRIBING.

1. Read Information Topic No. 1 for scriber and for dividers.

2. To mark a fine line across a board, place the scriber or knife point at the beginning of the desired line, slide the square or T-bevel along it until it touches the scriber or knife blade; then, holding the head of the square firmly against the edge, draw the scriber or knife blade along, pressing it lightly against the blade.

3. To fit a piece of wood against an uneven or irregular surface, as a casing against a sided wall, place the piece in a vertical position, using a level if necessary and resting as far as possible against the projecting edges of the surface.

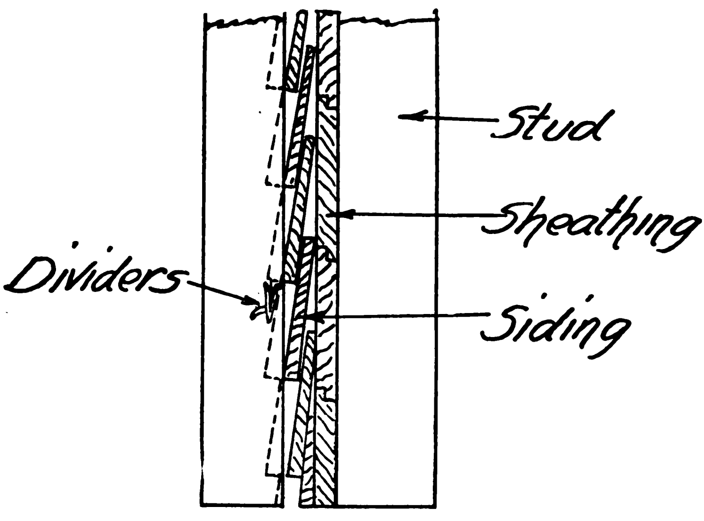


FIG. 56.—Scribing a casing against a sided wall.

4. Holding the wing dividers so that the points are level or square with the surface, set the dividers with the thumb screw so that the points will be separated a space equal to the greatest distance between the edge of the piece and the wall surface. Holding the dividers level, commence at the top of the wall and mark or scratch a line on the surface of the piece parallel to the wall surface.

QUESTIONS.

1. Why is the board to be fitted in the above example placed in a vertical position against the wall?

2. Why are the dividers set at the greatest distance from the edge of the board to the wall surface?

3. Why are the dividers held level in setting them and in scribing for the casing in the above example?

READING DRAWINGS.

1. Read Information Topic No. 1 for fence for steel square.

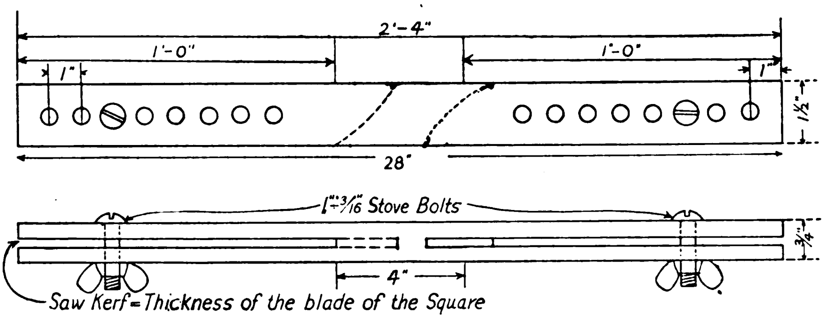


Fig. 57.—Wooden fence for square, with dimensions.

2. The size of the fence shown above is ¾" x 1½" x 2'–4", read three-quarters inch by one and one-half inches by two feet four inches, the marks (") being used for inches and (') for feet. If the wide surface of the fence is placed in contact with a sheet of paper and a mark made around it with a pencil, a rectangle the same size as the board will result. If it is now turned up without slipping, so as to rest on its front edge, and again marked around, a second rectangle, the same size as the edge of the board, and a complete sketch is obtained like this:

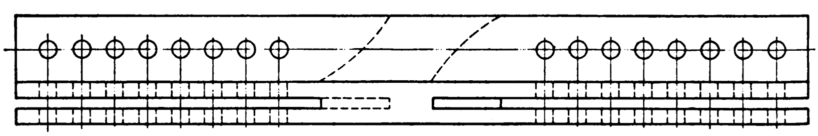


Fig. 58.—Adjacent views of wooden fence for square.

5. These two rectangles, for convenience and clearness, are separated, which gives a drawing like this:

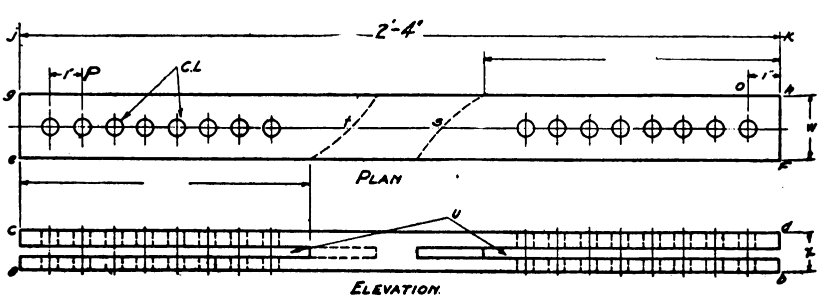


Fig. 59.—Plan and elevation of wooden fence for square.

4. The view at the bottom of the sheet is commonly spoken of as the elevation or front view, and the one directly above it is called the plan or top view. Since the views are the same length and the elevation is placed directly under the plan, the lines *ef* and *gh* will lie in the same straight line as will *ab* and *cd*. The length of the piece is determined by the dimension 2′–4″, as shown by the line ending in the arrow points at *j* and *k*.

5. Notice that the arrow heads on the line *jk* stop on the lines *ja* and *kb*. (These lines are known as the extension lines.) At *o* and *h* it will be seen that the arrow points point out with the dimension

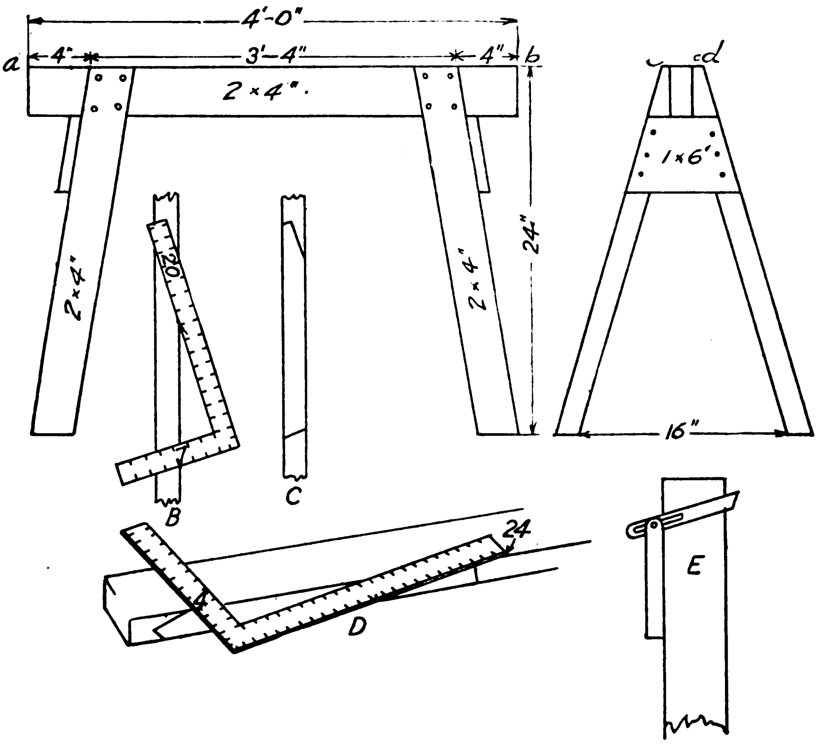


FIG. 60.—Sawhorse.

placed between them. 1″ is the distance from the end of the piece to the center of the first hole *o*. The distance at *p* is the distance between centers of the holes which are bored for the wing nuts.

6. The dotted lines at *t* and *s* represent the limits of the cutting of the saw that forms the kerf *u*, through which the tongue and blade of the square pass. The lines running through the center of the circles representing the holes for the wing bolts in the plan and through the dotted view of these holes in the elevation are called center lines or C. L.

7. The width of the piece is found at w and the thickness at x. From this it will be seen that it takes at least two views to give the three dimensions necessary to make an object.

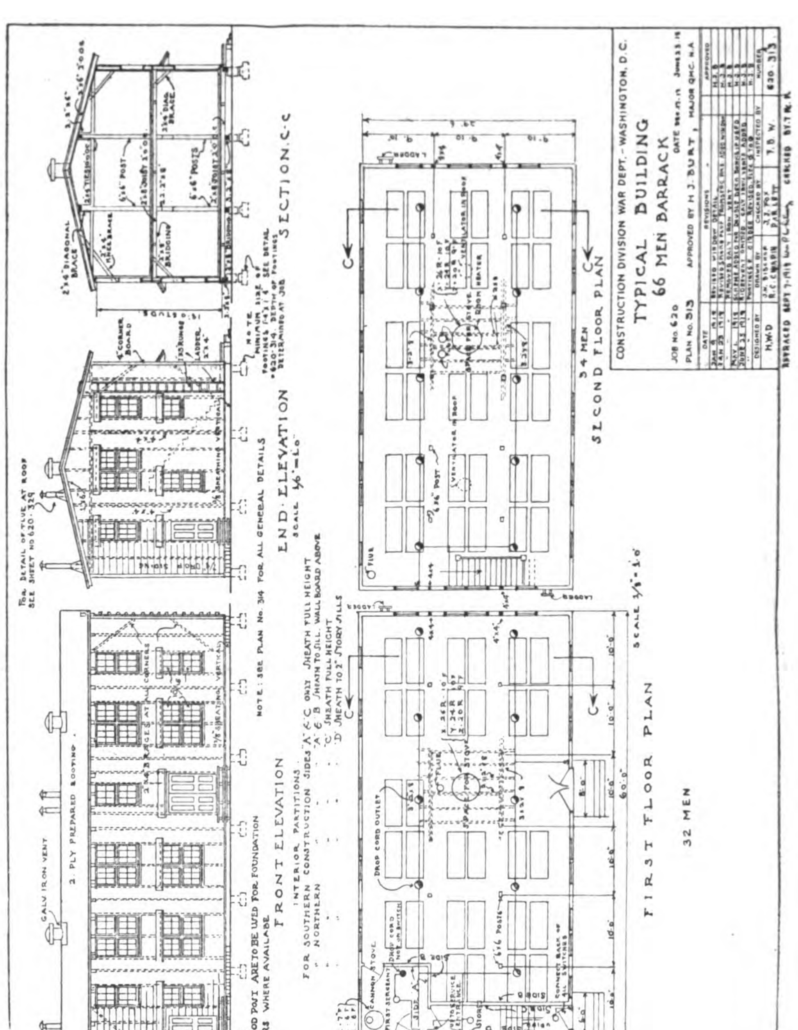


FIG. 61.

8. In the drawing of the sawhorse the front view shows its length, height, and distance that the legs are set in from the end of the top. Since the front and end views are the same height the line ab, if continued, would pass through c and d, and the top of the top piece of the front view will line up with the top of the end view.

In the same way the bottom of the top piece in the front view and the brace board may be carried over to the end view.

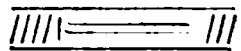
9. In the front view the dimensions of length and height, 4′–0″ and 24″, respectively, are given. The spread of the bottom of the legs, 16″, is found in the end view. The height might be given in this view. The numbers 2 x 4 indicate that the top and legs are cut from a scantling 2″ thick and 4″ wide.

10. At some place in the drawing should be found every dimension necessary for the making of the complete object. If the draftsman has omitted some dimension it may be found by noting the scale to which the drawing has been made and then measuring the drawing. If the scale is ¼″ equals 1′ (one-fourth inch equals one foot), the actual dimension will be 48 times the dimension of the drawing.

11. Read the title at the lower right-hand corner of the sheet. Determine the name and the character of the work of the job shown on the sheet, the date the drawing was made, and any revisions and their respective dates and the scale of the various parts of the drawing, Figure 61, which shows the design for the standard 66-men barrack built in the National Army cantonments in the Fall of 1917.

12. Determine the overall or outside dimensions of the structure from the plan. The building in Figure 61 is 60′–0″ long and 29′–6″ wide. Note that the figures are always read from the left to the right, and from the bottom of the sheet up. Notice the shape of the building, the size, shape, and arrangement of the rooms, and the position of stairways.

13. The first plan shows a room for the first sergeant, a storeroom, and an inclosed stairway to the second floor. The posts which support the second floor and roof are located by dimensions, being 10′–0″ apart lengthwise of the building and 9′–10″ apart crosswise.

14. Note the location of windows shown by this symbol: 

and doors shown thus: 

Dimensions are often given showing the location and sizes of the doors and windows.

15. Study the plan to determine the location of stoves, radiator, lighting fixtures, and furniture. In Figure 61, the plans show the location of the stoves near the center of the room, the incandescent light drops by the symbol ◒, and the cots for the soldiers by the large rectangles.

16. Look above the plans for the elevations or views of the outside of the structure. These views will show the height of the wall, the height and slope of the roof, and location and size of doors,

windows, chimneys, ventilators, and outside stairs. Note in Figure 61 that the kind of roofing, the location and size of framing, the siding, headers, etc., are shown. Note that as many elevations are given as are necessary to indicate the general appearance of the exterior of the building, the character, size, number, and location of openings, and other details. In the case of Figure 61 only one side and one end elevation are given, as the other side and end are so nearly alike that it is unnecessary to show them.

17. Determine interior framework or construction from a section. Assume the structure cut into parts and look into the interior. The building may be cut at any place, as on line CC. Study the framework to determine the sizes, arrangement, and location of the sills, studs, joists, rafters, posts, braces, and other pieces which form the foundation, floors, walls, roof, and ceilings. The height of stories, slope of roof, width of stairs, dimensions of rooms, etc., are often given on the section. Note the 18-foot height of wall studs in Figure 61 and that the first-floor joists are supported on the inside girders made of three 2 x 8 timbers and on the outside sills made of two 2 x 8 timbers. The first-floor supports are 6 x 6 posts, which carry the second floor and the roof framing. The floor joists are 2 x 8 timbers, spaced 2′–0″ OC (on centers). The walls at their tops are tied together by 2 x 4 timbers, spread 10″–0″ OC (on centers), and are braced to the roof by 2 x 4 knee braces.

QUESTIONS.

1. Where may the details of floor framing be found in Figure 61?
2. Where may the details of wall framing be found other than in section *CC*, Figure 61?
3. Is there any provision made for escape in case of fire in the 66-men barracks?

PREPARING BILL OF MATERIAL.

1. List all the material of like kind, grade, and size together.

2. Read Information Topic No. 4. Specify the kind and grade of lumber. In listing sheathing, rough flooring, or similar lumber of which lengths or widths are not specified, state the number of board feet, thickness, and kind—e. g., 2,000 ft. B. M. 1-inch No. 2 yellow-pine sheathing. In listing matched flooring and siding making 10 per cent allowance for matching.

3. In listing timbers, casing, baseboards, and other lumber which is cut to standard length and width, specify the number of boards, the thickness, width, length, grade, kind, and whether rough, surfaced two sides (S2S) or surfaced four sides (S4S)—e. g., 15—2 x 6—17, No. 1, common yellow pine, S2S.

4. Number of bundles, kind, and grade of shingles.

5. Number of bundles, kind, and grade of lath.

6. Complete specifications for all millwork, such as door frames, window frames, sash, doors, etc.

7. Read Information Topic No. 2. State the number of pounds of different sizes and kinds of nails.

8. Number, size, and kind of screws.

9. Number, size, and kind of builders' hardware, such as locks, butts, hangers, etc.

10. To make out bill of material for the sawhorse shown in Figure 60, Unit Operation No. 13, proceed as follows:

The top and legs are of 2″ x 4″ stock; therefore, set down for the top 1 pc. 2″ x 4″—4′-0″.

Each leg is slightly more than 24″ long, so set down 4 pcs. 2 x 4—2′-1″.

The 1″ x 6″ pieces set under the top are approximately 10″ long, so set down 2 pcs. 1′ x 6″—0′-10″.

To nail each leg at the top will require 4 tenpenny nails and each brace will require six or eight nails, so set down 30 10d. nails.

The bill of material for the sawhorse will therefore be:

Bill of material.

Date________________________
Job. No______________________
Name______________________________ Carpenter Shop Vocational School.

Description.	Number pieces.	Dimensions.	Total B. M. ft.	Unit cost.	Total cost.
Top #2 yellow pine (Y. P.)	1	2″ x 4″ x 4′ – 0″	$2\frac{2}{3}$	......	......
Legs. Do	4	2″ x 4″ x 2′ – 1″	$5\frac{5}{9}$	......	......
Braces. Do	2	1″ x 6″ x 0′ – 10″	$\frac{5}{6}$	......	......
Nails, 10d., common	30	....	....	......	......

The exact lengths required are:

1 pc. 2″ x 4″—12′-4″ #2 Y. P.
1 pc. 1″ x 6″—1′-8″ #2 Y. P.

Lumber is generally bought from the mill in even lengths, such as 8, 10, 12, 14, etc., feet, so, allowing for sawing and wastage due to split or defective board ends, it is generally advisable to specify the even foot length greater than the exact length required when ordering lumber.

QUESTIONS.

1. Why is it necessary to allow for matching in tongued and grooved lumber?
2. How is the weight of window weights shown?
3. What is the advantage of listing together material of the same thickness and kind?

SHARPENING AND SETTING SAWS.

1. Read Information Topic No. 1, saw, cross and rip, and Unit Operation No. 2. Clamp the saw in a saw vise, tooth edge up. Lay a 9-inch file on the teeth lengthwise of the saw. Holding the file level, run it lightly the full length of the saw until all the teeth are the same length. This is called jointing the saw.

2. Take a handsaw set and turn the anvil around until the number on it corresponding to the number of points per inch of the saw is even with the punch. Begin at the heel of the saw and press the punch firmly against alternate teeth the full length of the saw to

FIG. 62.—Jointing a saw.

FIG. 63.—Setting a saw.

bend them over the anvil, pressing them toward the long side of the tooth. Turn the saw in the vise and set the other teeth in the opposite direction. Do not press hard enough to crush or break the teeth. Dress the teeth by running a flat file or oil stone lightly along each side, holding the file flat against the saw.

3. Fasten the saw clamp securely to a bench or board with the top of the clamp about as high as the armpit. A good light is necessary.

4. Place the saw in the clamp with the handle to your left and file from the heel to the toe of the saw. Grasp the handle of the file firmly in your right hand with the forefinger up and at the top of the file. Hold the point of the file with the thumb and forefinger of the left hand, with the thumb on top. The file should fit down in

the groove and cut the front side of one tooth and the back side of the next one. Make the file cut on the forward stroke and pick up to pull it back. Hold your hands so that you make every stroke in the same direction. File just deep enough to make the point of each tooth sharp when you have filed the saw from the other side. Make the distance between points equal. If one tooth is larger than the other, crowd the file against the large tooth until the large tooth is like the others. When you have filed the length of the clamp, move the saw along to the left. Place the file in the last groove. Press it in different directions until it just fits the groove, thus getting the angle the same as before, and go on until you have filed all the teeth on that side. Now place the saw in the clamp with the handle to the right. File the same as before and bring each tooth to a sharp point. Stop in each groove when the point is sharp. To make sure that you have the same pitch and bevel as before look down the tops of the teeth from the end and see if the groove is in the middle. If not, change the pitch and bevel until the groove is in the middle and keep the file in that position across the saw. The teeth on both sides must be of equal length. Now place the saw on its side on a straight board and run the flat file once lightly over each side of the teeth. Try the saw to see how it cuts. If it cuts to one side, dress off the teeth on that side by drawing the flat of the file along the side of the teeth.

Fig. 64.—Sharpening a saw.

QUESTIONS.

1. Why must the file always be held at the same angle?
2. Why should the file be lifted out of the groove at the end of every stroke?
3. Why will dressing the teeth on one side of a saw tend to change the direction of its cut?
4. What is a saw jointer and how should it be used?
5. What is the difference in the angle that the file makes with the blade of the saw when filing a crosscut saw and a rip saw?

SHARPENING EDGED TOOLS.

1. Read Information Topic No. 1 for description of oilstone and tools. The directions for sharpening a plane apply to chisels and all other tools having similar edges.

2. Having removed the plane bit or "iron" from the plane and removed the cap, look to see if the edge has any nicks and is too blunt to be sharpened easily on the oil stone.

3. To grind the edge, use a wet grindstone or a wet or dry emery wheel, depending upon what is available. Stand so that the top of the grindstone is turning toward you. Hold the beveled side of the edge of the stone at an angle of about 25°. This is, of course, estimated with the eye. If the tool is to be used in soft wood, a long bevel is necessary. If possible, rest the end of the tool on a table, board, or other brace, allowing the edge to rest against the wheel. Having found the place for the end of the tool to rest that gives the proper angle, mark it, and always place the end back on that point. Holding the lower end of the tool against the brace, shift the edge back and forth from left to right across the face of the wheel. Hold the edge lightly against the wheel and take it away frequently to prevent excessive heating.

4. Make the bevel uniform and square across the end. A smoothing plane should have the corners rounded slightly.

5. Whet the tool on an oilstone.

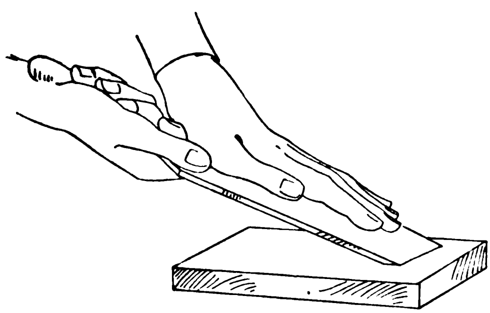


FIG. 65.—Whetting edged tools.

6. To get the proper angle while whetting, lay the bevel edge on the stone and draw toward you. Pushing the tool slowly from you, raise up the back end until the oil is all squeezed from under the cutting edge. Keep this angle and rub the edge back and forth on the stone with a circular motion. Do not rock the handle up and down.

7. If a feather or wire edge is formed, remove it by turning up the bevel side of the tool and whetting slightly, with the straight side held perfectly flat on the oilstone.

8. After removing the feather, strop to a clean sharp edge by drawing the tool backward, alternating from side to side, over a leather strop, or upon the palm of the hand.

9. Sharpen hatchets and other tools having edges beveled on both sides by grinding and whetting on both sides.

QUESTIONS.

1. How is the tool kept cool while grinding?
2. Why should the tool be ground with a short taper for hard wood?
3. Why should plane bits and chisels be beveled on one side only?
4. Why is an oilstone used? When?

SHARPENING SCRAPERS.

1. Read Information Topic No. 1, scraper (cabinet and floor).

2. Place scraper edge up in the vise and draw-file the edges at right angles to the sides as shown at *A*, Figure 66. Oilstone the edge, leaving the corners square and free from all wire edge.

3. Lay the scraper on the edge of the bench and hold it while passing a burnisher back and forth with some pressure and upset the corner as shown in *B*, Figure 66, the burnisher being held in a position at right angles with the edges of the scraper and almost parallel

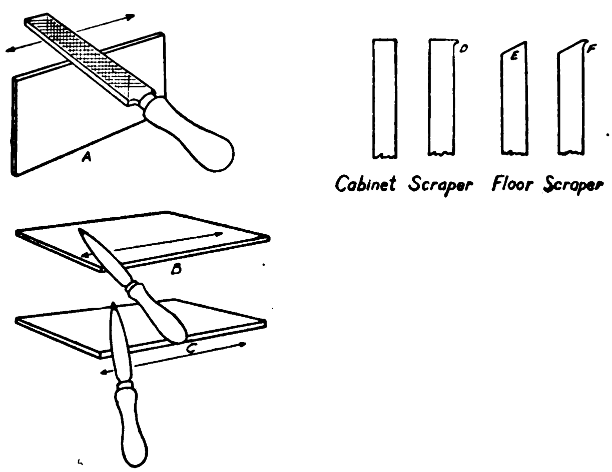


FIG. 66.—Sharpening scrapers.

with the side of the blade. This prepares the corner for turning back to form the cutting edge as shown at *C* and *D*, Figure 66, which is done with the burnisher being held almost at right angles both to the edge and side and is best accomplished by one firm steady stroke.

4. A scraper edge can ordinarily be sharpened a number of times without draw-filing and honing. The second or third sharpening frequently giving the best cutting edge. It is also customary to sharpen two or more edges.

5. The blade of a floor scraper is sharpened in practically the same manner, except that the edge is ground or filed at an angle as shown at *E*, Figure 66, and only one edge turned, as at *F*, Figure 66.

6. Sharpening a scraper is one of those little tricks of the trade which can be learned only by practice, but which only a comparatively few workmen can do well. Attention to each detail, however, is all that is necessary.

QUESTIONS.

1. What tools should be used to sharpen a cabinet scraper and in what order should they be used?
2. What does the oilstone do to the edge?
3. How can the scraper be burnished so that its corners will not scratch the wood?

SHARPENING AUGER BITS.

1. Read Information Topic No. 1, for bits and file, and Unit Operation No. 4.
2. Place the bit against the edge of the bench top, with the screw end or spur up.
3. Take a small flat or narrow bit file and file the inside surfaces of the two projecting ends or "nibs" of the bit.
4. File the under surfaces of the cutting edges between the nibs and the spur, known as the "lips." File the lips on such a bevel as to give sufficient clearance for the advancing cut.

QUESTIONS.

1. Why should the nibs not be sharpened on the outer surfaces?
2. Why should the top edges of the lips not be filed when the spur is up?

LAYING OUT SPECIAL ANGLE CUTS.

With sliding T-bevel.

1. Read Information Topic No. 7 for bevel, sliding **T**, and Information Topic No. 3 for rise and run.

2. For any given angle note the rise opposite the angle in the diagram below is for a run of 12″.

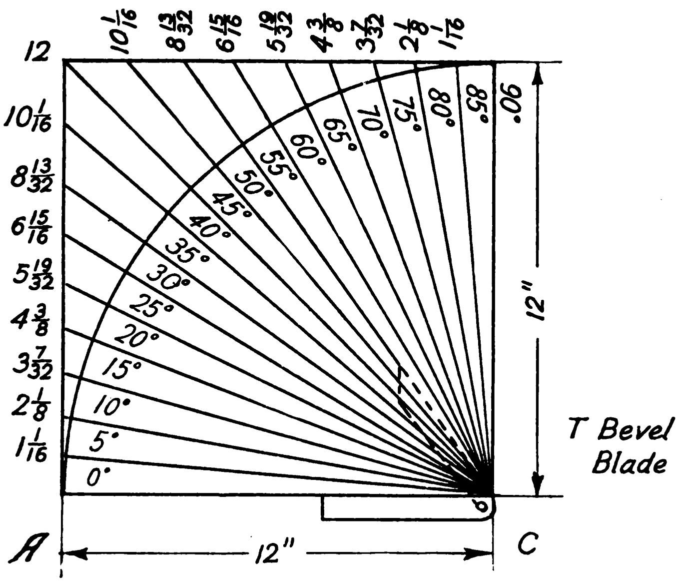


FIG. 67.—Diagram showing rise of various angles for 12-inch run.

3. Make two marks as *A* and *C*, Figure 68, 12 inches apart on the edge of a board, and square a line across the board at *A*. Measure from the edge *AB* equal to the distance indicated in the table. For a 10° angle *AB* is 2⅛″.

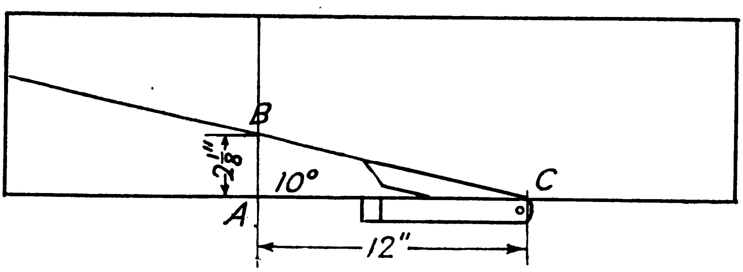


FIG. 68.—Laying out special angle.

4. Draw a line from *B* to *C*. Hold the beam of the **T**-bevel on the edge of the board and make the blade lie along the line *BC*. Set the

thumbscrew of the bevel. Lay out the required angle where necessary by marking along the blade.

5. If the line needed is not shown on the table, draw a square figure 12 inches to the side, similar to Figure 67. Draw with a compass the arc with a 12-inch radius and lay out the two angle lines of the table which lie on each side of the angle line desired. For example, if $26\frac{1}{2}°$ is desired, lay out on the figure the 25° and the 30° lines.

6. The desired line will cross the arc $1\frac{1}{2}°$ higher up than the 25° line, or three-tenths of the arc between the 25° line and the 30°

Fig. 69.—Using sliding T-bevel.

line. With a pair of dividers step over the arc between 25° and 30° until it can be divided into 10 equal parts, and mark off the third point from 25°.

7. Through the three-tenths mark draw a line from C to the side of the square. From that point where this line touches the side of the square figure measure down to the point where the 25° line touches the side of the square figure.

8. Then to lay off $26\frac{1}{2}°$ as in Figure 68, make AB $5\frac{19}{32}$ inches plus the distance found in paragraph 7.

With steel square:

9. To lay out a special angle cut with a steel square, use the length of the sides or projections which determine the angle as units of measure on the tongue and blade of the square. For ex-

ample, to lay out the angle cuts for the legs of the carpenter's saw-horse shown in Figure 60, Unit Operation No. 13.

10. Lay the square on the edge of the 2 x 4 with the 7 inch mark of the tongue and the 20-inch mark of the blade against the same edge as shown in Figure 60, *B*. Mark along the tongue and around the end of the blade. The mark will show as at *C*, Figure 60.

11. Turn the 2 x 4 on its side and lay the square with the 4-inch mark of the tongue at the end of one of the marks already made, as shown at *D* and the 24-inch mark of the blade against the edge of the 2 x 4 and mark across the tongue.

12. Hold the handle of the bevel square against the side of the 2 x 4; place the blade on the line just drawn and clamp the thumbnut tight, setting the bevel at that angle. Using the bevel, draw all the lines across the face of the 2 x 4.

13. A brace is to be cut whose run is 35 inches and rise is 42 inches. Since neither figure can be found on the steel square, take half of both, which is 17½ and 21. Clamp the fence diagonally across the square at these two figures. Place the fence against the edge of the timber and the square diagonal to the face. Mark across timber on both outer edges of square. Move the square so that its other block is on the intersection of one of these lines with outer edge of brace. Mark as before. The two lines farthest apart mark the cut. If it be necessary to divide the dimensions by 3, repeat the operation three times.

QUESTIONS.

1. How is an angle of 45° laid out without using the table?
2. How many degrees are there in each angle formed by laying a straightedge across a square when the straightedge is on 12″ on the blade and on 6″ on the tongue?
3. How is an arc divided into two equal parts?
4. How is an arc divided into three equal parts?

MORTISING AND TENONING.

Open end mortise.

1. Locate the position of the line 1 2 (see Fig. 70), and with the try-square and knife cut the line and carry it to the corner and across the face side *F* and draw 1′ 2′ as shown in the figure 2*a* *b*2′. Do not disfigure the surface if working with a knife by cutting the line the full breadth of the material but just mark the corners and the part to be cut out.

2. Set the gauge to the dimension from 5 to 3 and gauge from face side *F* the line from 1 3 3′ 1′. The distance from 1 to 2 should be exactly equal to the breadth of the mortise chisel and the line gauged 2 4 4′ 2′ from the same side *F*.

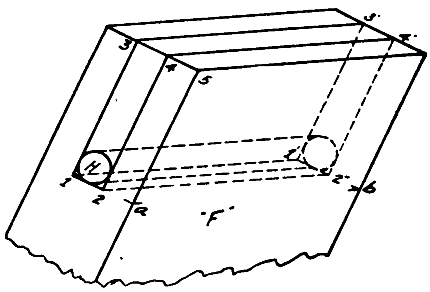


FIG. 70.—Method of laying out open end mortise.

3. Place the piece in a bench vise with the edges toward the front, and in a vertical position saw along the inside of the line 3 3′ and carry the kerf down to the line 1 1′. In a similar manner, saw along the inside of line 4 4′ and down to the line 2 2′.

4. With mortise chisel, the width of the mortise, cut out the material between the kerfs to the plane 1 1′ 2 2′.

5. When the mortise is being cut in hard wood, or is large, it is sometimes best to bore a hole as at *H*, Figure 70. Bore the hole about halfway through from each edge of the piece with a bit slightly less in diameter than the width of the mortise.

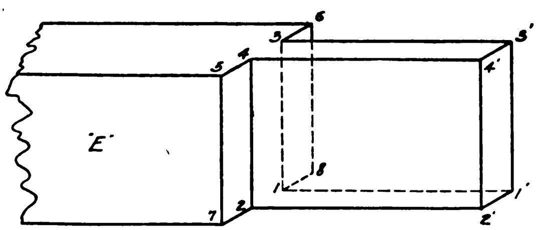


FIG. 71.—Method of laying out tenon.

Tenon.

6. Locate the position of the shoulders in a group as shown in Figure 71 with a square and knife, scribe the lines 5 6, 6 8, 8 7, and 7 5. (Note how the numbers 1, 2, 3, 4, and 5 correspond with those in Figure 70.)

7. Using the gauge, as set for 5 to 3, Figure 70, gauge lines 3 3′, 1 1′, and 3′ 1′, from face side *E*, Figure 71. In the same way,

using the distance from 5 to 4 gauge the lines 4 4′, 2 2′, and 4′ 2′. The layout of the mortise and tenon should be performed as one operation and the use of the mortise gauge set to 5 to 3 and 5 to 4 in Figures 70 and 71 assures uniformity of sizes in both mortise and tenon.

8. To cut the tenon, place the material in the vise and saw the cheeks of the tenon by sawing carefully along the outside of the lines 2′ 4′ and 1′ 3′, carrying the kerfs to 2 4 and 1 3, respectively.

9. After sawing the cheek lines, place the piece in a horizontal position in the vise or on the bench hook and saw the shoulders 5 4 2 7 and 6 8 1 3, Figure 71.

Blind mortise.

10. Locate the position of the mortise. With square and knife mark the ends and with the gauge scribe the side lines of the mortise, the width of which should be the exact size of the mortise chisel.

11. Clamp the piece to the bench top with a hand clamp or mortise grip.

FIG. 72.—Cutting blind mortise.

12. Stand in such position as will enable you to see that the chisel is parallel with the sides, and starting near, but not at the end of the mortise, cut a succession of chips, each cut slightly deeper than the former, until the depth of the mortise is reached. Keep cutting to this depth until near the end of the mortise ($\frac{1}{16}''$ or $\frac{1}{8}''$). Now reverse the chisel, and at about the point where the full depth of the

mortise has been reached work back toward the starting point by cutting through the chips to the proper depth and until near the other end of the mortise. Remove the chips and finish the mortise by making the last cut on the ends.

13. A small amount of material left in either end of the mortise to be cut after the core of chips is removed, avoids bruising the surface of the mortised piece while cleaning out the chips.

Through mortise.

14. Locate the position of the mortise and lay it out on both edges either singly or in groups. Secure the material to the bench top with a clamp or mortise grip and drive the mortise halfway through, as in paragraph 12, except that the end cuts are completed, being sure to plumb the chisel both ways for these cuts. The chips are not removed until the operation is repeated on the opposite edge. If the work has been carefully done, the core of chips can easily be driven out.

15. Make a core driver preferably of hard wood, with a cross-section slightly less than the size of the mortise. Clamp the piece in the vise with the mortise edge up. Place the end of the core driver in the mortise and with a few blows with the mallet drive out the core of loose chips.

QUESTIONS.

1. Why should the same gauge setting be used for cutting the mortise and tenon?
2. In a through mortise why chisel out the core, working from both faces?

GROOVING.

1. Read Information Topic No. 1 for description of the tools and Information Topic No. 3 for grooving.

2. Measure in from the end of the dressed board with a rule. Mark the outer side of the cut. Using try-square and scriber, scribe a sharp line across the piece. From the point just located, measure over a distance equal to the width of the groove. Mark the inner side of the cut. Square the line across the piece with a try-square.

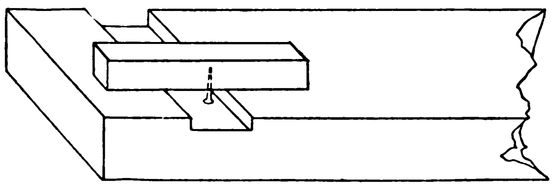


FIG. 73.—Testing depth of groove.

3. Square these two marks across the edges of the piece a distance equal to the approximate depth of the groove.

4. Set the gauge for the required depth of the groove and scribe between the marks on the two edges.

5. Scribe into the face marks with a knife and saw along the inside edges with a backsaw. Be careful to saw down just to the gauge lines, so that the kerfs may be the right depth.

6. Chisel out the waste until the bottom of the groove is true and smooth. Test the bottom surface with a strip into which a common

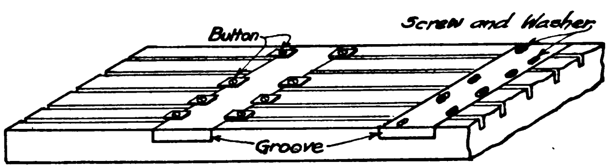


FIG. 74.—Use of battens.

nail has been driven to a projection equal to the required depth of the groove.

7. When it is desired to build up a board of several pieces glued together, use battens with fastening. Glue the pieces together and after drying fit the hardwood batten, in which slots have been cut for screws, into the groove and secure with screws and slotted washers. The batten may also be fastened by means of buttons, pieces of metal screwed to the boards and extending over to hold the batten in place, as in Figure 74.

8. To make a tapering keyway, do the same as above, but lay out the groove with a T-bevel and saw first cuts at the given angles. (See Fig. 75.) No screws are necessary with this device.

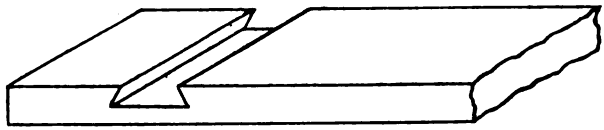


FIG. 75.—Tapering groove or keyway.

9. A router plane is sometimes used to remove the wood between the saw cuts. When the groove is near the end of the piece, a special plane can be used without initial sawing.

10. To make a cut parallel with the grain of the wood, scribe the sides with a gauge from the true edge and cut with a plow plane.

QUESTIONS.

1. How should a series of grooves be laid out along a board?
2. Why should one saw along the inside edges of the marks for the cuts?
3. What tools or appliances may be used in making the kerfs for the grooves to secure true and accurate cuts?

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TRUING SURFACES.

1. Read Information Topic No. 3 for wind.
2. Examine the piece by holding the surface up on a level with the eye. By sighting along the surface, see if there is any "wind."
3. If there is a wind in the piece, place it in the vise or against a bench stop and plane off the high places until the surfaces appear to be level. Plane with the grain.
4. With the plane set so as to take a very light shaving, plane from one end of the piece to the other, working from one edge to the other and making each cut overlap slightly the last cut.
5. When the entire surface has been planed, place a straightedge on it. Move the straightedge in this position along the entire length of the board and observe carefully for high places in the surface.
6. Continue planing and testing until the surface is true with the edge of the straight edge. Sight the board again for wind.

QUESTIONS.

1. How should the warp be planed out of a board?
2. How should a cross-grained board be surfaced?
3. What causes wind in lumber? Warping?

PREPARATION AND USE OF GLUE.

1. Liquid, ready prepared glue may be used directly from its container, unless stiff, when it should be heated in a water bath.

2. Break up the cakes of glue into small pieces and dissolve them in cold water for about 12 hours. Place the dissolved glue in a glue-pot or double boiler and heat to a temperature of about 150° F., 6 to 8 hours, until the glue is of the consistency of cream.

3. Assemble the pieces of wood and see that the parts to be glued fit closely and accurately. Clean abutting surfaces of all foreign matter such as dirt, grease, and wax.

4. Apply the glue with a brush, in a uniform thin coating, to both surfaces that are to be joined; brush the glue well into the pores of the wood. Apply the glue quickly while it is hot. Rub the pieces together, squeezing out the surplus glue. Apply clamps and allow the glue to harden.

5. In assembling pieces, where several parts are to be joined, divide the work into steps, gluing adjacent sections together in a series of operations.

6. Wipe off surplus glue with a warm, damp cloth. If the glue thickens it may be readily peeled off with an edge tool.

7. To fasten end grain, first "size" the wood with a coating of thin glue. After the glue has dried, apply a second coat, assemble the pieces and clamp.

QUESTIONS.

1. Why should glue be applied in a thin layer?
2. Why rub the pieces together and squeeze out the surplus glue?
3. Why is it necessary to size end grain wood before gluing?
4. Why divide a complex job into sections?
5. How should large surfaces be glued?

DEFINITIONS OF TRADE TERMS.

Anchor.—Irons of special form used to fasten together timbers or masonry or both.

Arris.—The edge formed by the intersection of two concave surfaces, such as the edges which separate the flutings of a Doric column.

Backing.—The bevel upon the top edge of a hip rafter which allows the roofing boards to fit the top of the rafter without leaving a triangular space between it and the lower side of the roof covering. (See paragraph 7, Unit Operation No. 35.)

Balcony.—A platform projecting from the side of the house, usually inclosed with a balustrade, and more or less ornamented.

Balloon frame.—The lightest and most economical form of construction, in which the studding and corner posts are set up in continuous lengths from first floor line or sill to the roof plate. (See Information Topic No. 7.)

Baluster.—A small column used to support a rail. (See Information Topic No. 12.)

Balustrade.—A row of balusters with the rails, generally used for porches, balconies, etc.

Band.—A low, flat molding.

Base.—The bottom of a column; the finish of a room at the junction of the walls and floor. (See Information Topic No. 13.)

Batten (*cleat*).—A narrow strip of board used to fasten several pieces together. (See Unit Operation No. 25.)

Batter board.—A temporary framework used to assist in locating the corners when laying out a foundation. (See Unit Operation No. 51.)

Bay window.—A window projecting beyond the wall, sometimes called a bow window.

Bead.—A small round molding.

Beam.—An inclusive term for joists, girders, rafters, and purlins. (See Unit Operation Nos. 26 and 27.)

Bedding.—A filling of mortar, putty, or other substance in order to secure a firm bearing. (See Unit Operation No. 26.)

Belt course.—A horizontal board across or around a building, usually made of flat member and a molding.

Bevel board (*pitch board*).—A board used in framing a roof or stairway to lay out bevels. (See paragraph 9, Unit Operation No. 49.)

Board.—Lumber less than 2 inches thick.

Boarding in.—The process of nailing boards upon the outside studding of a house. (See Unit Operation No. 40.)

Board foot.—The equivalent of a board 1 foot square and 1 inch thick.

Braces.—Pieces fitted and firmly fastened at an angle with two others in order to strengthen the angle thus treated. (See paragraph 6,6, Unit Operation No. 31, and Information Topic No. 7.)

Bracket.—A projecting support for a shelf or other structure.

Break joints.—To arrange joints so that they will not come directly under or over the joints of adjoining pieces, as in shingling, siding, etc. (See paragraph 7, Unit Operation No. 44.)

Bridging.—Pieces fitted in pairs from the bottom of one floor joist to the top of adjacent joists, and crossed to distribute the floor load. Sometimes pieces of width equal to the joist and fitted neatly between them. (See Unit Operation No. 27.)

Building paper.—Cheap, thick paper, used to insulate a building before the siding or roofing is put on and sometimes between double floors. (See Unit Operation No. 48.)

Built-up timber.—A timber made of several pieces fastened together and forming one of larger dimension. (See paragraph 6, Unit Operation No. 5.)

Carriages.—The supports of the steps and risers of a flight of stairs. (See Unit Operation No. 49.)

Casement.—A window in which the sash opens upon hinges.

Casing.—The trimming around a door or window opening, either outside or inside, or the finished lumber around a post or beam, etc. (See Unit Operation No. 58.)

Ceiling.—Narrow, matched boards; sheathing the surfaces which inclose the upper side of a room.

Center-hung sash.—A sash hung on its centers so that it swings on a horizontal axis.

Chamfer.—A beveled surface cut upon the corner of a piece of wood.

Checks.—Splits or cracks in a board, ordinarily caused by seasoning. (See Information Topic No. 4.)

Clamp.—A mechanical device used to hold two or more pieces together. (See Unit Operation No. 20.)

Clapboards.—A special form of outside covering of a house; siding. (See Unit Operation No. 44.)

Columns.—A support, square, rectangular, or cylindrical in section, for roofs, ceilings, etc., composed of base, shaft, and capital.

Combination frame.—A combination of the principal features of the full and balloon frames. (See Information Topic No. 7.)

Concrete.—A combination of sand, broken stone or gravel, and cement used in foundations, building construction for walks, etc.

Conductors.—Pipes for the purpose of conducting water from a roof to the ground or to a receptacle or drain; downspout.

Coping.—The cutting of one molded member to fit the irregular surface of another. The highest or covering course of masonry. Often beveled to carry the water away; also called capping. (See Unit Operation No. 55.)

Cornice.—The molded projection which finishes the top of the wall of a building. (See Unit Operation No. 56.)

Counterflashings.—Strips of metal used to prevent water from entering the top edge of the vertical side of a roof flashing. Also they allow expansion and contraction without danger of breaking the flashing. (See Unit Operation No. 43.)

Dado.—(See Grooving.)

Deadening.—Construction intended to prevent the passage of sound. (See Unit Operation No. 48.)

Drip.—The projection of a window sill or water table to allow the water to drain clear of the side of the house below it.

Fascia.—A flat member of a cornice or other finish, generally the vertical board of the cornice to which the gutter is fastened.

Flashing.—The material used and the process of making the roof intersections and other exposed places upon the outside of the house water-tight. (See Unit Operation No. 43.)

Flue.—The opening in a chimney through which smoke passes. (See Unit Operation No. 47.)

Flush.—When two pieces are perfectly even.

Footing courses.—The bottom and heaviest courses of a piece of masonry. (See Information Topic No. 6.)

Foundation.—That part of a building or wall which supports the superstructure. (See Information Topic No. 6.)

Frame.—The surrounding or inclosing woodwork of windows, doors, etc., and the timber structure of a building. (See Information Topic No. 7.)

Framing.—The rough timber structure of a building, including interior and exterior walls, floor, roof, and ceilings. (See Information Topic No. 7.)

Full Frame.—The old-fashioned, mortised and tenoned frame, in which every joint was mortised and tenoned. Rarely used at the present time.

Furring.—Narrow strips of board nailed upon the walls and ceilings to form a straight surface upon which to lay the laths or other finish. (See Unit Operation No. 47.)

Gable.—The vertical triangular end of a building from the eaves to the apex of the roof. (See Unit Operation No. 33.)

Gain.—A beveled shoulder on the end of a mortised brace to give additional resistance to the shoulder.

Gambrel.—A symmetrical roof with two different pitches or slopes on each side.

Gauge or gage.—A tool used by carpenters; to strike a line parallel to the edge of the board. (See Unit Operation No. 9 and Information Topic No. 1.)

Girder.—A timber used to support wall beams or joists. (See Unit Operation No. 26 and Information Topic No. 7.)

Girt (ribband).—The horizontal member of the walls of a full or combination frame house which supports the floor joists or is flush with the top of the joists.

Grooving.—A groove is a long hollow channel cut by a tool for something to fit into or work in. Carpenters have given special names to certain forms of grooves, such as dadoes and housings. A dado is a rectangular groove cut across the grain the full width of the piece. Dadoes are used in the making of sliding doors and window frames, etc. A housing is a groove cut at any angle with the grain and part way across the piece. Housings are used for framing stair risers and treads into a string (not stringer) and are described in Unit Operation Not. 61. Grooving is used largely in the fastening of boards together or in the prevention of warping and twisting of wide boards or boards glued together. In doing this it is necessary to prevent the warping but to permit the free swelling and shrinking due to changes in the humidity. Various simple devices are used, such as hardwood batten, tapering key, or iron rod. Grooving is required in the first two.

Grounds.—Strips of wood for the purpose of assisting the plasterer in making a straight wall and in giving a place to which the finish of the room may be nailed.

Ground floor.—The floor of a building on a level, or nearly so, with the ground.

Header.—A short joist supporting tail beams and framed between trimmer joists. The piece of stud or finish over an opening. A linted. (See Unit Operation No. 27.)

Headroom.—The clear space between floor line and ceiling, as in a stairway. (See Instruction No. 49 and Information No. 13.)

Heel of a rafter.—The end or foot that rests on the wall plate. (See Unit Operation Nos. 34 and 35.)

Hip rafter.—The timbers placed in an inclined position at the corners or angles of a hip roof. (See Unit Operation No. 35 and Information Topic No. 8.)

Hip roof.—A roof which slopes up toward the center from all sides, necessitating a hip rafter at each corner. (See Information Topic No. 8.).

Hopper cut.—The cut necessary to allow the sides of a hopper to fit together. (See Unit Operation No. 67.)

Housing.—(See Grooving. See Unit Operation Nos. 61 and 49.)

Jack Rafter.—A short rafter framing between the wall plate and a hip rafter. (See Unit Operation No. 36 and Information Topic No. 8.)

Jamb.—The side piece or post of an opening. Sometimes applied to the doorframe. (See Unit Operation No. 52.)

Joints, butt.—Squared ends or ends and edges adjoining each other.

Dovetail.—Made by cutting pins the shape of dovetails in sections which fit between other dovetails upon another piece.

Drawboard.—A mortise and tenon joint with holes so bored that when a pin is driven through, the joint will be made tighter.

Fished.—An end butt joint strengthened by pieces nailed upon the sides.

Halved.—Made by cutting half of the wood away from each piece so as to bring the sides flush.

Housed.—Grooved to receive the piece which is to form the other part of the joint.

Glue.—A joint held together with glue.

Lap.—Two pieces lapping over each other.

Mortised.—Made by cutting a hole or mortise, in one piece, and a tenon, or piece to fit the hole, upon the other.

Rub.—A glue joint made by fitting carefully the edges together, spreading glue between them, and rubbing the pieces back and forth until the pieces are well rubbed together.

Scarfed.—A timber spliced by means of cutting various shapes of shoulders, or jogs, to fit each other. (See Information Topic No. 5.)

Joists.—Timbers supporting the floor boards. (See Unit Operation No. 27 and Information Topic No. 7.)

Kerf.—The cut made by a saw. (See Unit Operation Nos. 2 and 57.)

Laths.—Narrow strips to support plastering. (See Unit Operation No. 47.)

Lattice.—Crossed wood, iron plate, or bars.

Ledger board.—The support of the second floor joists of a balloon frame house, or for similar uses; ribband. (See Information Topic No. 7.)

Level.—A term describing the position of a line or plane when parallel to the surface of still water. An instrument or tool used in testing for horizontal and vertical surfaces, and in determining differences of elevation. (See Unit Operation No. 24 and Information Topic No. 1.)

Light.—A division or space in a sash for a single pane of glass; also the pane of glass.

Lintel (*header*).—The piece of construction or finish, stone, wood, or metal, which is over an opening. A header. (See Unit Operation No. 31.)

Lookout.—The end of a rafter, or the construction which projects beyond the sides of a house to support the eaves; also the projecting timbers at the gables which support the verge boards. (See Unit Operation No. 33.)

Louver.—A kind of window, generally in the peaks of gables and the tops of towers and is provided with horizontal slots which exclude rain and snow and allow for ventilation.

Lumber.—Sawed parts of a log such as boards, planks, scantling, and timber.

Matching, or tonguing and grooving.—The method used in cutting the edges of a board to make a tongue on one edge and a groove on the other. (See Unit Operation No. 64.)

Meeting rail.—The bottom rail of the upper sash, and the top rail of the lower sash of a double-hung window. Sometimes called the check rail. (See Information Topic No. 14.)

Miter.—The joint formed by two abutting pieces meeting at an angle. (See Information Topic No. 5.)

Molding.—*Base.*—The molding upon the top of a base board. (See Information Topic No. 12.)

Bed.—Used to cover the joint between the plancier and frieze; also as a base molding upon heavy work, and sometimes as a member of a cornice. (See Unit Operation No. 56.)

Lip.—Has a lip which overlaps the piece against which the back of the molding rests.

Rake.—The cornice upon the gable edge of a pitch roof, the members of which are made to fit those of the molding of the horizontal eaves.

Picture.—Shaped so as to form a support for picture hooks, often placed some distance from the ceiling upon the wall, to form the lower edge of the frieze.

Mortise.—The hole which is to receive a tenon, or any hole cut into or through a piece by means of a chisel, generally of rectangular shape. (See Unit Operation No. 20.)

Mullion.—The construction between the openings of a window frame made to accommodate two or more windows.

Muntin.—The vertical member between two panels of the same piece of panel work. The vertical sash bars separating the different panes of glass. (See Information Topic No. 14.)

Newel.—The principal post at the foot of a staircase; also the central support of a winding flight of stairs. (See Information Topic No. 13.)

Nosing.—The part of a stair tread which projects over the riser, or any similar projection; a term applied to the rounded edge of a board. (See Information Topic No. 13 and Unit Operation No. 61.)

Notching.—(See Information Topic No. 5.)

Panel.—A rectangular piece set in a frame, as in a door or other structure, either above or below the general surface. (See Unit Operation No. 62.)

Piers.—Masonry supports, set independently of the main foundation.

Pilaster.—A portion of a square column, usually set within or against a wall.

Piles.—Long posts driven into the soil in swampy locations or wherever it is difficult to secure a firm foundation, upon which the footing course of masonry or other timbers are laid. (See Information Topic No. 6.)

Pitch.—Inclination or slope, as of roofs or stairs, or the rise divided by the span. (See Information Topic No. 8.)

Pitch board.—A board sawed to the exact shape formed by the stair tread, riser, and slope of the stairs and used to lay out the carriage and stringers. (See Unit Operation No. 49.)

Plan.—A horizontal geometrical section of a building, showing the walls, doors, windows, stairs, chimneys, columns, etc. (See Unit Operation No. 13.)

Planks—Lumber.–Two or three inches thick and more than 4 inches wide, such as joists, flooring, etc.

Plaster.—A mixture of lime, hair, and sand; or lime, cement, and sand, used to cover outside and inside wall surfaces. (See Information Topic Nos. 10 and 14.)

Plate.—The top horizontal piece of the walls of a frame building upon which the roof rests. (See Information Topic No. 7.)

Plate cut.—The cut in a rafter which rests upon the plate; sometimes called the seat cut. (See Unit Operation Nos. 34, 35, and 36.)

Ply.—A term used to denote the number of layers or thickness of building or roofing paper; two-ply, three-ply., etc.

Porch.—An ornamental entrance way.

Post.—A timber set on end to support a wall, girder, or other member of the structure. See Information Topic No. 7.)

Plow.—To plow or cut a groove running in the same direction as the grain of the wood.

Pulley stile.—The member of a window frame which contains the pulleys, and between which the edges of the sash slides. (See Information Topic No. 13.)

Purlin.—A timber supporting several rafters at one or more points, or the roof sheeting directly.

Rabbet or rebate.—A corner cut out of an edge of a piece of wood.

Rafters—common.—Those which run square with the plate and extend to the ridge.

Cripple.—Those which cut between valley and hip rafters.

Hip.—Those extending from the outside angle of the plates toward the apex of the roof.

Jacks.—Those square with the plate and intersecting with the hip rafter.

Valley.—Those extending from an inside angle of the plates toward the ridge or center line of the house. (See Information Topic No. 8.)

Rail.—The horizontal members of a balustrade or panel work.

Rake.—The trim of a building extending in an oblique line, as rake dado or molding.

Return.—The continuation of a molding or finish of any kind in a different direction.

Ribband.—(See Ledger Board.)

Ridge cut.—(See Plumb cut.)

Ridge.—The top edge or corner formed by the intersection of two roof surfaces. (See Instruction No. 35.)

Rise.—The vertical distance through which anything rises, as the rise of a roof or stair. (See Instruction Nos. 34 and 49.)

Riser.—The vertical board between two treads of a flight of stairs. (See Information Topic No. 13 and Instruction No. 49.)

Roof.—The covering or upper part of a building. (See Information Topic Nos. 8 and 11.)

Roofing.—The material put on a roof to make it wind and water proof. (See Information Topic No. 11.)

Run.—The length of the horizontal projection of a piece such as a rafter when in position.

Saddle Board.—The finish of the ridge of a pitch roof house. Sometimes called comb board.

Sash.—The framework which holds the glass in a window.

Sawing, Plain.—Lumber sawed regardless of the grain, the log simply squared and sawed to the desired thickness; sometimes called slash or bastard sawed.

Scaffold—Staging.—A temporary structure or platform enabling workmen to reach high places.

Scale.—A short measurement used as a proportionate part of a larger dimension. The scale of a drawing is expressed as ¼″=1 foot.

Scantling.—Lumber with a cross-section ranging from 2″ x 4″ to 4″ x 4″.

Scarfing.—A joint between two pieces of wood which allows them to be spliced lengthwise. (See Information Topic No. 5.)

Scotia.—A hollow molding used as a part of a cornice, and often under the nosing of a stair tread.

Scribing.—The marking of a piece of wood to provide for the fitting of one of its surfaces to the irregular surface of another. (See Unit Operation No. 12.)

Seat Cut or Plate Cut.—The cut at the bottom end of a rafter to allow it to fit upon the plate. (See Unit Operation No. 35.)

Seat of Rafter.—The horizontal cut upon the bottom and of a rafter which rests upon the top of the plate. (See Unit Operation No. 35.)

Section.—A drawing showing the kind, arrangement, and proportions of the various parts of a structure. It is assumed that the structure is cut through by a plane and the section is the view given by looking in one direction. (See Unit Operation No. 13.)

Shakes.—Imperfections in timber caused during the growth of the tree by high winds or imperfect conditions of growth. (See Information Topic No. 4.)

Sheathing.—Wall boards, roofing boards, generally applied to narrow boards laid with a space between them, according to the length of shingle exposed to weather. (See Unit Operation Nos. 40 and 42.)

Sheathing Paper.—The paper used under siding or shingles to insulate the house; building papers. (See Unit Operation No. 48.)

Siding.—The outside finish between the casings. (See Instruction No. 44 and Information Topic No. 14.)

Sills.—The horizontal timbers of a house which either rest upon the masonry foundations or in the absence of such, form the foundations. (See Unit Operation No. 26 and Information Topic No. 7.)

Sizing.—Working material to the desired size; a coating of glue, shellac, or other substance applied to a surface to prepare it for painting or other method of finish.

Sleeper.—A timber laid on the ground to support floor joists.

Span.—The distance between the bearings of a timber or arch. (See Information Topic No. 8.)

Specifications.—The written or printed directions regarding the details of a building or other construction.

Square.—A tool used by mechanics to obtain accuracy; a term applied to a surface including 100 square feet.

Stairs, Box.—Those built between walls, and usually without support, except the wall strings. (See Information Topic No. 13.)

Standing finish.—Term applied to all of the finish of the openings, the base, and other finish necessary for the inside of the house. (See Information Topic No. 13.)

Stucco.—A fine plaster used for interior decoration and fine work, also for rough outside wall coverings. (See Information Topic No. 14.)

Studding.—The framework of a partition or the wall of a house; usually referred to as 2 x 4's. (See Information Topic No. 7.)

Threshhold.—The beveled piece over which the .door swings. Sometimes called a carpet strip. (See Information Topic No. 13.)

Timber.—Lumber with cross section over 4″ x 6″, such as posts, sills, and girders.

Tie beam (collar beam).—A beam so situated that it will tie the principal rafters of a roof together, and prevent them from thrusting the plate out of line. (See Information Topic No. 8.)

Tin shingle.—A small piece of tin used in flashing and repairing a shingle roof.

To the weather.—The projection of shingles or siding beyond the course above. (See Unit Operation Nos. 44 and 45.)

Tread.—The horizontal part of a step. (See Information Topic No. 13 and Unit Operation No. 61.)

Trim.—A term sometimes applied to outside or interior finished woodwork and the finish around openings. (See Information Topic No. 13.)

Trimmer.—The beam or floor joist into which a header is framed. (See Unit Operation No. 27.)

Trimming.—Putting the inside and outside finish and hardware upon a building.

Valley.—The internal angle formed by the two slopes of a roof. (See Information Topic No. 8.)

Verge boards.—The boards which serve as the eaves finish on the gable end of a building.

Vestibule.—An entrance to a house; usually inclosed.

Wainscoting.—Matched boarding or panel work covering the lower portion of a wall. (See Unit Operation No. 62.)

Wash.—The slant upon a sill, capping, etc., to allow the water to run off easily. (See Information Topic No. 14.)

Water table.—The finish at the bottom of a house which carries the water way from the foundation. (See Information Topic No. 14.)

Wind (i as in kind).—A term used to describe the surface of a board when twisted (winding) or when it rests upon two diagonally opposite corners, if laid upon a perfectly flat surface. (See Unit Operation No. 22.)

Wooden brick.—Pieces of seasoned wood, made the size of a brick, and laid where it is necessary to provide a nailing space in masonry walls. (See Unit Operation No. 47.)

QUESTIONS.

1. What should be used to tie wooden beams and joists to a masonry wall?
2. If a wooden beam has a section 4 x 6 inches, how should the beam be placed for greatest strength? Why?
3. What is the purpose of a belt course on a building?
4. Assuming a 6 x 8 inch girder is required in a building, would it be better to use a solid 6 x 8 inch timber or three 2 x 8 planks spiked together?
5. Why and where is it necessary to use counterflashing?
6. Why is a nosing used on the tread of a stair?
7. Why is it desirable to drive wooden piles so as to lie entirely under water?
8. Under what conditions is a girder used in a building?
9. What are the advantages of the use of concrete instead of brick or stone for foundation walls?

TIMBER.

Classification of trees.—Trees from which lumber is secured may be divided into two general classes:

(*a*) The deciduous or broad-leaved trees, such as the ash, oaks, poplar, the maples, etc.

(*b*) The coniferous or "needle-leaved" trees, such as the pines, cedars, spruce, cypress, etc.

The *deciduous or broad-leaved trees* listed below supply the hard wood used especially for the interior finish of buildings.

Ash.—Six different species of ash are indigenous to the United States. Only two, however, the white and the black, are used for lumber in the building trades. The white ash is found along the basin of the Ohio River, but also occurs in quantities from Maine to Minnesota. The black ash is found in very much the same localities as the white ash and extends southward to Virginia and Arkansas and other southern States. Ash trees are rapid growers, are small to medium in height, with large trunks, and occur in scattered groups. The wood from ash is heavy, hard, strong, stiff, and quite tough, straight grained, rough on the split surfaces, and coarse in texture. It shrinks moderately, seasons with little injury, stands well, and will take a good polish. It is generally used for interior finish.

Beech.—There is only one variety of beech found in the United States, although this variety is called in different localities red beech, white beech, and ridge beech. It is found intermittently from Nova Scotia to Florida and westward to Wisconsin and Texas. The tree grows to a height of from 60 to 80 feet and from 2 to 8 feet in diameter. However, it is not found in sufficient quantities to furnish an abundant supply. The wood is heavy, hard, strong, works well, and takes a good polish. Its color runs from white to brown and is generally of rather coarse texture. It is not durable in the ground, is liable to the attacks of boring insects, and shrinks and checks in drying.

Butternut.—The trees are of medium size and are found in the eastern States from Maine to Georgia. The wood is very similar to the black walnut, but is light, quite soft, and weak. Its color is generally light brown.

Cherry.—The lumber is generally cut from the wild black cherry trees, which are of medium size and found scattered among the broad-leaved woods along the western slope of the Alleghenies from Maine to Michigan and southward to Alabama. The wood is heavy, hard, strong, and of fine texture. The heartwood is reddish to brown, and the sapwood is yellowish white. The wood shrinks considerably in drying, works and stands well, and takes a good polish.

Chestnut.—The tree grows to a medium size and is found in the eastern section of the country from Maine to Michigan and southward to Alabama. The wood is light, fairly soft, not strong, and coarse in texture. It works easily, stands well, and is very durable, but shrinks and checks in drying. The wood is used in cabinet work and interior finish.

Elm.—This tree occurs in medium to large size trees and is found scattered throughout the eastern section of the United States. The wood is hard and tough, frequently coarse grained, is difficult to split and shape, and warps and checks badly in drying. The wood will take a high polish and is well adapted to staining. The texture varies from coarse to fine and the color from gray brown to red.

Gum.—Lumber is generally taken from the sweet or red gum, which is a large tree abundant in the eastern sections of the United States, especially along river "bottoms." The wood is rather heavy, soft, tough, and strong. It is of fine texture, often coarse grained and takes a good polish. The wood warps and shrinks considerably, works easily, stands well, and is extensively used for interior finish, especially throughout the Middle West.

Maple.—The wood used for building construction comes from the sugar maple, which occurs in medium sized trees from Maine to Minnesota and southward to Florida. The maple grows in trees of medium size and is found in forests of considerable size along the Great Lakes. The wood is heavy, hard, tough, stiff, and of fine texture. It often has a fine wavy grain and gives the effect known as "curly." It is of creamy white color, shrinks moderately, seasons, works and stands well, and takes a good polish. The wood is used for ceiling, flooring, paneling, stairways, and other interior finish.

Oak.—There are 20 or more different varieties of oak native to the United States, but two well-known kinds, white and red, are commonly used in building construction. The trees are of medium size and from a large proportion of the broad-leaved forests. The red oak is generally more porous, less durable, and of a coarser texture than the white oak. The wood is generally very hard and heavy, strong and tough, and somewhat porous. It shrinks and checks badly, but stands well, is durable, and is little subject to the attacks of insects. Oak is always better quartered when it gives a finer and more uniform grain. Oak is used in heavy construction and is especially desirable for flooring and interior finish.

Poplar.—Yellow poplar, commonly known as tulip tree or white wood, occurs throughout the eastern section of the country from New

England to Florida. The tree grows to a large size and is most commonly found in the Ohio River basin. The wood is light, soft, stiff, and of fine texture. It shrinks and warps considerably when seasoning but does not split in nailing. It works and stands well. The wood is used for siding and paneling and is popular in some sections of the country for interior trim.

Sycamore.—The tree grows rapidly and to a large size. It is extensively found throughout the Eastern States, but is especially indigenous to the valleys of the Ohio and Mississippi Rivers. The wood is quite heavy, hard, stiff, strong, tough, and of coarse texture. It is hard to split and work and shrinks and warps and checks badly. When well seasoned it stands well and in recent years has become more popular for interior finish.

Black walnut.—This tree grows to a large size, with a stout trunk. It was formerly found quite abundant throughout the Alleghany region. It is now becoming quite scarce and expensive. The wood is heavy, hard, strong, and of a coarse texture. The heartwood is chocolate brown in color, while the relatively small amount of sapwood is whitish. The wood shrinks slightly in seasoning, works and stands well, and takes a good polish. It was used a generation ago for heavy framing and more recently for interior finish, and has become so scarce and expensive that it is used principally at the present time for cabinetwork and furniture veneer.

The coniferous or evergreens are the "needle-leafed" trees from which is secured the lumber generally used for the framing, sheathing, siding, roofing, and exterior finish of buildings.

Cedars.—There are two species of cedars from which lumber is commonly secured for building construction—the white cedar and the red cedar. There are five different kinds of white cedar and two kinds of red cedar. The white cedars are found in the northern latitudes of the country and especially along the Pacific coast. The ordinary red cedar is native to the Southeastern States, while the redwood is found only in California. The latter grows to an enormous size. The cedar wood is light, soft, stiff, not strong, and of fine texture. The wood seasons rapidly, shrinks and checks but little, and is very durable. It is commonly used for shingling and siding.

Cypress.—This is a large tree commonly found in the swamps and overflow lands of the Southeastern States. The wood is light, soft, close and straight grained, not strong, and easily worked, and very durable when in contact with the earth. The sapwood is nearly white, while the heartwood varies from light to dark brown in color. The principal use of cypress is for shingles, and it has been extensively used for interior trim in houses of moderate cost.

Fir.—Douglas fir grows on the Pacific slopes from New Mexico to central British Columbia. The wood is hard, not very heavy, and fairly durable, and varies in color from reddish to light yellow. It it used for dimension stock, inside finish, and sash and doors.

Hemlock.—There are two species of hemlock commonly found in the United States. In the East hemlock is grown extensively from Canada to Tennessee, and to a size of 80 or more feet in height and 2 to 4 feet in diameter. The western hemlock is prevalent in the western part of the United States, growing to a greater size than the eastern variety. Hemlock is a light, reddish colored wood, which is fairly durable. It shrinks and checks badly, is rough, brittle, and generally coarse grained. The wood is largely used for framing and siding of buildings.

Pines.—There are several varieties of pine, which are generally classified under hard and soft pine. There are four kinds from which lumber is commonly secured—white pine, long-leaved pine, short-leaved pine, and loblolly pine. The white pine is a softwood, while the other three varieties are generally classed as hardwoods.

The *white pine* is found in the north central and northeastern sections of the United States and along the Alleghenies into Florida. In the different localities it is known as Weymouth pine, soft pine, northern pine, spruce pine, and pumpkin pine. The trees grow to be from 75 to 150 feet in height and up to 5 or 6 feet in diameter. The wood is soft, light, not strong, very close and straight grained, easy to work, and takes a good polish. The heartwood is light brown, sometimes tinged with red, and the sapwood is nearly white. It seasons well, shrinks but little, and is fairly durable. White pine is used in cabinet and pattern work and interior finish.

The *long-leafed pine*, also known as hard pine and yellow pine, is a native of the southeastern States. The tree grows to 90 feet in height and from 1 to 3 feet in diameter. The wood is heavy, hard, strong, tough, coarse grained, and durable. It is used for the framing work of buildings and for both exterior and interior finish.

Short-leafed pine is also known as yellow pine and hard pine and occurs throughout the central section of the country from Connecticut to Texas. The tree grows from 50 to 60 feet in height and from 2 to 4 feet in diameter. The wood is very similar to long-leaved pine, except that it is light and not so strong, but its uses are practically the same.

Loblolly pine occurs in practically the same localities as the long-leafed pine and is similar to the latter in growth and characteristics of the wood. However, the tree is found largely on abandoned and cut-over land, and in its isolated position often grows to a large size.

The wood is not so durable as that of the long-leafed pine and is generally used for heavy timber framework.

Redwood.—This tree resembles cedar in appearance, the color being a clear light red. It is light, soft, not strong, brittle, coarse grained, easily worked, and durable in contact with earth. It has been extensively used for interior finish, as it takes a good polish and has an attractive grain.

Spruces.—There are two varieties of spruces the lumber of which is in general use—the white spruce and the black spruce. The two varieties of spruce are very similar in appearance, with the exception that the white spruce generally grows to a greater size and the color of the wood and foliage is lighter. The black spruce is found extensively in the Allegheny Mountains from Pennsylvania to North Carolina, while the white spruce is more prevalent in higher latitudes, as Canada and Alaska. The tree grows to a height of from 40 to 80 feet, and has a diameter of from 1 to 2 feet. The wood is light, soft, not strong, straight grained, and of a satiny texture. The wood varies from a light red to nearly white in color, while the sapwood is nearly white. Spruce is largely used for fence posts, railroad ties, and light timber construction.

Structure and growth of trees.—If the cross-section of a tree is examined, it will be found that there are three principal elements—the center pith, the main portion of concentric rings, and the envelope of bark. The concentric rings of the main portion decrease in thickness from the pith to the bark and are alternately light and dark, one light and one dark ring representing a year's growth. The light wood represents the spring growth and is relatively soft and weak, while the dark wood is summer and autumn growth and is dense and strong. These sections of the annual ring are clearly marked in some woods, such as pine, while in other woods, as oak and chestnut, the spring growth shades into the darker and denser zones of the summer and autumn growths.

The inner and darker portion of the tree is the heartwood, while the outer and lighter portion is the sapwood. The latter forms the newer and growing part of the tree and gradually changes to heartwood with the age of the tree.

An inspection of *A*, Figure 76, shows the annual rings, the heartwood by the shaded section, the sapwood by the outer light section and the " medullary " rays radiating from the pith toward the bark.

Wood is classified as to grain by the terms " fine-grained," " coarse-grained," " straight-grained," and " cross-grained." Wood is said to be fine-grained when the rings are relatively narrow and coarse-grained when they are wide. When the fibers are straight and parallel to the trunk, the wood is called straight-grained, and when twisted or otherwise distorted the wood is termed "cross-grained." Fine and straight-grained woods are stronger and will take a higher polish than coarse and twisted grained woods.

Defects in timber may be due to irregularities in the growth of the trees or to the deterioration of the timber. The former are heart shake *B*, Fig. 76), wind shake (*C*, Fig. 76), wet rot and knots (*E*, Fig. 76). Wet rot is due to a tree becoming saturated with water.

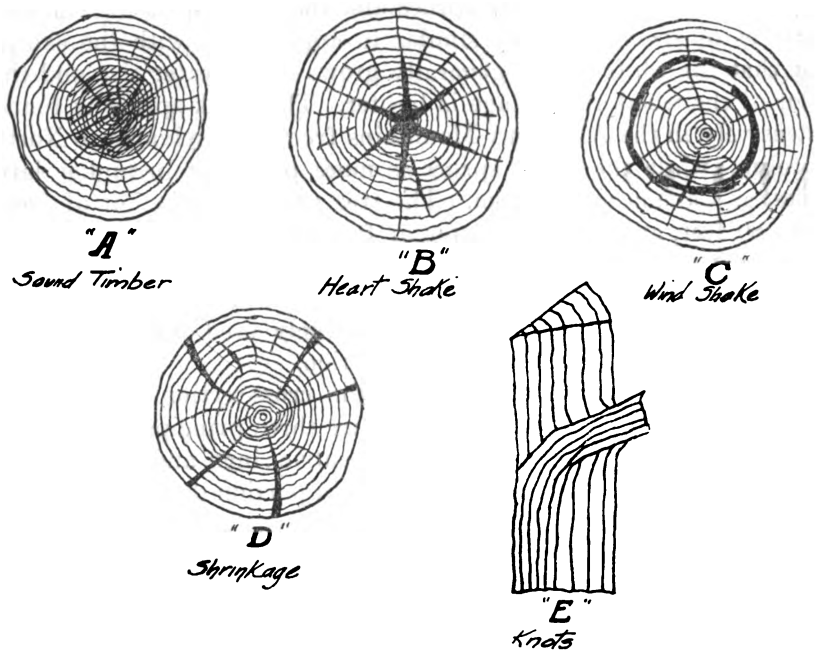


FIG. 76.—Defects of wood.

Timber deteriorates by dry rot, which is caused by a fungus growth, when exposed alternately to wet and dry conditions.

Shrinkage of timber is due to seasoning, which means the drying out of its moisture. If the timber were uniform in structure throughout, the shrinkage would be the same in all parts and there would be no warping. However, timber is made up of layers of different thicknesses, and irregular shrinkage occurs during seasoning. Shrinkage in a log is shown by *D*, Figure 76. The warping of a sawn log is indicated by *I*, Figure 77. Timber should be seasoned in the log so as to secure the least amount of warping in the milled lumber.

Knots occur in all timber and result from the cutting of the log where branches joined the trunk of the tree. Knots are not very objectionable in boarding, sheathing, and in timbers under compression. Pieces subjected to tension and cross bending should be free from knots.

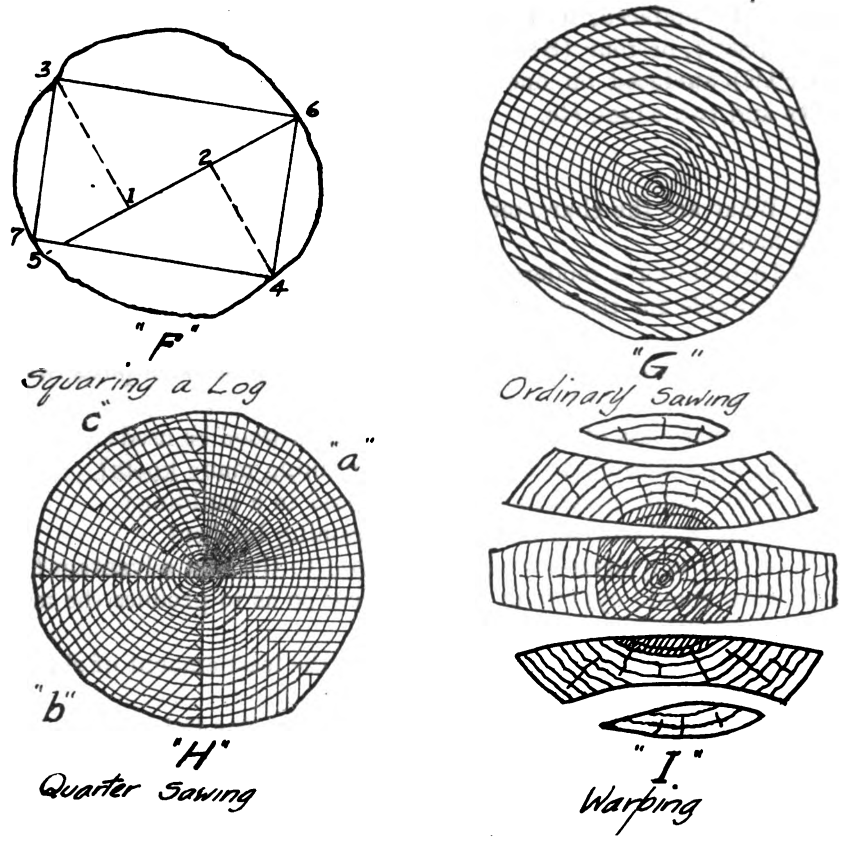


FIG. 77.—Sawing of lumber.

Sawing of lumber.—The simplest method of sawing a log into planks is shown at *G*, Figure 77. This slicing method generally produces boards which will warp on drying out. The best method of sawing up a log is shown at *H*, where several ways of quarter-sawing are shown. The method shown at *a* is true quarter-sawing, the ordinary method is given at *b*, while the style given at *c* is often used and gives fairly good results.

The squaring of a log to cut out the largest timber is done as outlined at *F*, Figure 77. Draw the diameter 5 6, so that it will become the diagonal of the largest rectangle that can be inscribed in the cross-section. Divide 5 6 into three equal parts, 5 1, 1 2, and 2 6. Erect perpendiculars at the points 1 and 2. From the points where these perpendiculars cut the circumference 3 and 4, draw lines 3 6, 3 5, and 6 4, 4 7, so as to form a rectangle.

Surfacing of lumber.—Lumber may be purchased rough or surfaced. If surfaced, it may be planed on one (S1S), two (S2S), three (S3S), or four (S4S) sides. Boards and planks are also sold (S1S1E) surfaced on one side one edge, (S2S2E) surfaced two sides and two edges, etc.

QUESTIONS.

1. What are the characteristics of a wood suitable for the frame of a house?

2. In building a moderately priced house, what woods would be most suitable for the exterior trim, the inside finish, and the upper floors?

If a section of a building is to be supported on wooden posts, what kind of wood should be used for the posts?

4. In what class of work can cross-grained wood be used?

5. Is it permissible to use lumber containing many knots?

6. Why should green lumber not be used in a building?

7. What methods can be used for seasoning lumber?

8. Where is quarter-sawed lumber used to the best advantage?

9. How should cypress or poplar be cut so as to produce the most attractive grain for interior finish?

10. How should the log be cut to secure the least amount of shrinking or cracking in lumber?

11. Is a coarse, brittle wood suitable for interior finish?

12. How should logs be sawed so as to secure wood finish with a curly grain?

JOINTS.

Classification.—A very important feature of carpentry is the making of joints, especially in external and internal finish work. All joints should be made so that the abutting pieces of timber may be tight and all joints be closed and inconspicuous. The making of a true and accurate joint depends upon very careful workmanship. Working sides are generally truer than the other surfaces, and should be used, whenever possible, as abutting surfaces. All measurements should be made from a common starting point, and the distance spaced with a marking gauge or try-square from the true surface. Wherever possible, determine the sides of the joint by laying one piece upon another and transferring the measurements directly. Where several pieces or joints with similar dimensions are to be made these should be laid out at one time so that the measurements will be the same.

Joints in timber may be divided into two general classes—those joining pieces along their lengths and those joining timbers placed at an angle with one another. All joints should be made so as to weaken the connecting pieces of timber as little as possible and to make the connections as strong as the pieces connected. Where one surface abuts another, the abutting surface of the joint should be as nearly as possible at right angles to the pressure which it transmits.

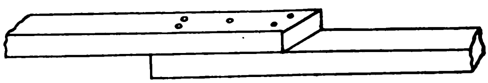


FIG. 78.—Lap joint.

Joints connecting timbers in the direction of their lengths.—The principal joints used in connecting timbers with the direction of their length are as follows:

Lap joint.—The lap joint is made by fastening two pieces together.

Butt or fished joints.—The butt joint as shown in Figure 79 is often called a fished joint from the fish plates which are used to splice the abutting pieces. The fish, or splice plates, may either be of wood or metal and may be simply laid on the face sides of the timbers.

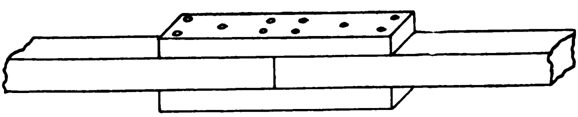


FIG. 79.—Butt or fished joint.

Scarfed joint.—A scarfed joint is one in which the abutting timbers are so cut and fitted as to make the joint uniform in size with the timbers. The scarfed joint may be strengthened by using fish or splice plates.

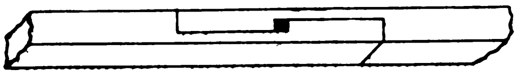


FIG. 80.—Scarfed joint.

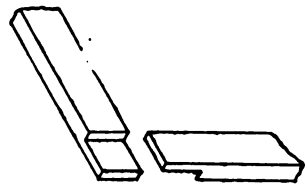


FIG. 81.—Halved joint.

Joint connecting timbers at right angles.—The following are common types of joints used for connecting timbers at right angles:

Halving.—Halving is one of the simplest forms of joints and is frequently used as in joining sills or plates of a building frame at the corners.

Notching.—Notching is commonly used where it is desired to bring the tops of adjacent timbers to the same elevation, as in the case of floor and ceiling joists.

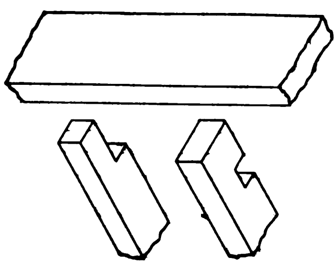


FIG. 82.—Notching.

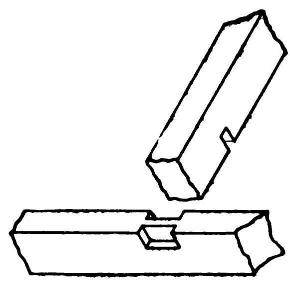


FIG. 83.—Cogging.

Cogging.—Where it is desirable to provide for the maximum strength in the bearing timber, the supporting or lower timber is cut out so that the bearing or upper timber may have its full depth for the support.

Mortised and tenon joints.—A mortise and tenon joint consists of a projection on one timber which fits into an opening in the other timber. This form of joint is generally used to connect a vertical timber with a horizontal timber.

There are several types or kinds of mortise and tenon joints, the more common being the through, stub, double wedged, haunched, and the tusk. These various types are shown above in the order named. The method of making a mortise and tenon joint is described in Unit Operation No. 20. Where two timbers meet each other at an oblique angle, the mortise and tenon joint may be used to advantage. Such a joint is commonly used for connection between the top and bottom chord at the end of a timber roof or truss. A space should be left between the toe of the top chord and the end of the bottom

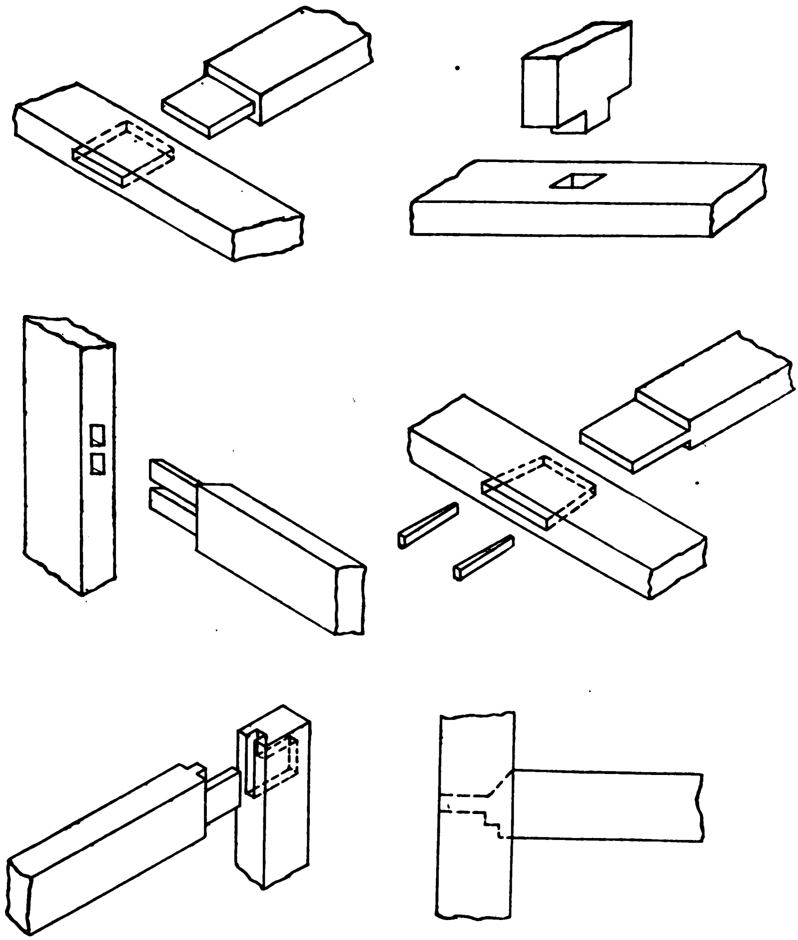


FIG. 84.—Types of mortise and tenon joints.

chord to prevent the shearing out of the bottom chord by the thrust of the top chord.

Miter joints.—Miter joints are generally used to join pieces of exterior or interior finish at right angles to each other. To secure an accurate fit, the pieces wherever possible are cut in a miter box. The abutting surfaces are often spread with a thin coating of glue before they are fastened together. To secure careful and accurate fastening of the joints, it is well to place one piece in a vise and hold the second piece so that the nailing will bring it finally to its proper place.

Dovetail joints.—Dovetail joints are generally used in box construction where it is desirable to secure a tight-fitting joint. It is a

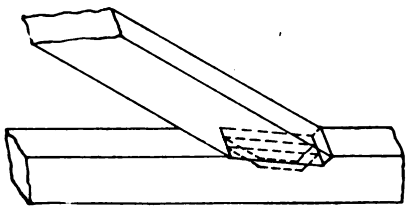


FIG. 85.—Mortise and tenon angle joint.

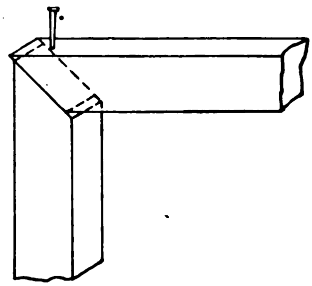


FIG. 86.—Nailing miter joint.

common practice to lay out and cut the tenons without measurement at the end of the piece, and to lay out the mortise on the other piece by scribing directly from the pieces originally cut.

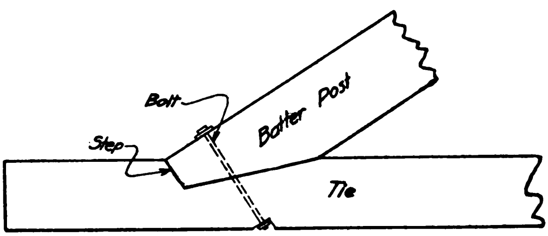


FIG. 87.—Single step joint.

Heavy timber joints.—The following are the common types of heavy timber joints.

Step joints.—Step joints are commonly used in heavy timber framing, where one timber frames into another at an acute angle. Stepping consists of one or more notches with inclined sides or bearings arranged in the form of steps. One or two lag screws or bolts may be used to hold the two timbers together.

A double step joint is generally used to furnish sufficient bearing area for the inclined timber on the tie member. A simple form of double step joint is shown below which is often used in bridge and other outside heavy framing on account of the ease and rapidity with which it can be made.

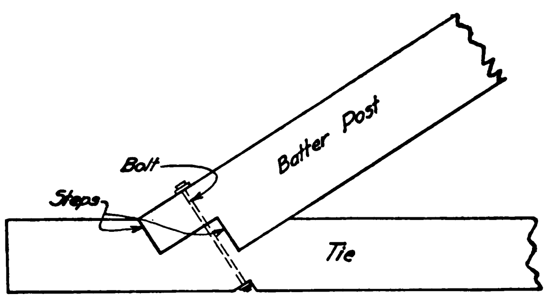


FIG. 88.—Simple double step joint.

Figure 89 shows two types of double step joint which are used as end joints of roof trusses. The fish plates on the bottom of the ties add to the strength of the joint. Note in the double step joint with unequal steps that the step *cd* is deeper than step *ab*. This is done to give a greater bearing surface and to place the two bearing surfaces of the steps at different sections of the tie.

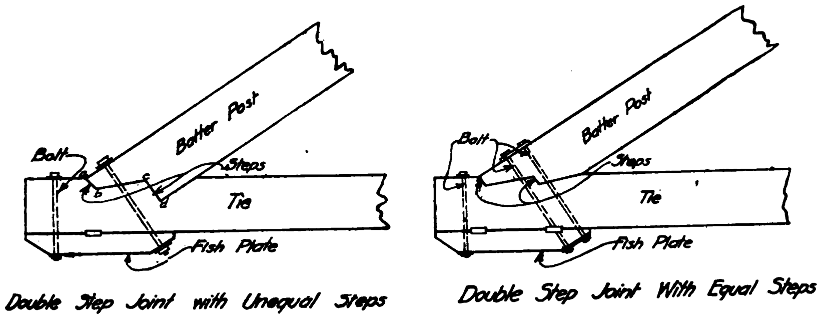


FIG. 89.—Double step joints.

Where timber is scarce and expensive, trusses with members built up of planking obtainable on the job may be used, especially on building construction. Figure 90 shows a typical joint where built-

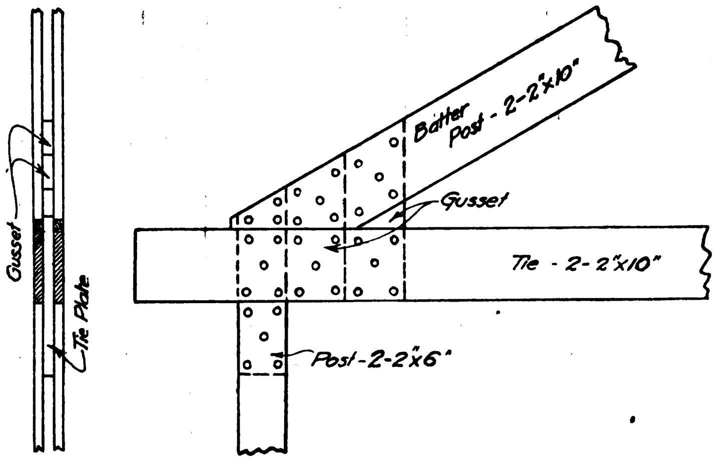


FIG. 90.—Gusset joint with built-up timbers.

up timbers are used in a roof truss. To secure greater strength, joint splice plates or gussets are bolted to the timbers.

Hip joints.—The joints between the batter posts and top chords of roof and bridge trusses are shown in Figure 91. The simple type is preferable to the more complicated form, as it is easier to make and more durable, especially on outside work such as bridge work.

Splice joints.—Three types of splices are the butt joint, the half lap joint, and the oblique scarf. As the butt joint has one bearing surface and the other two joints have two bearing surfaces, the former is the better joint. The simpler a joint is made, the easier it can

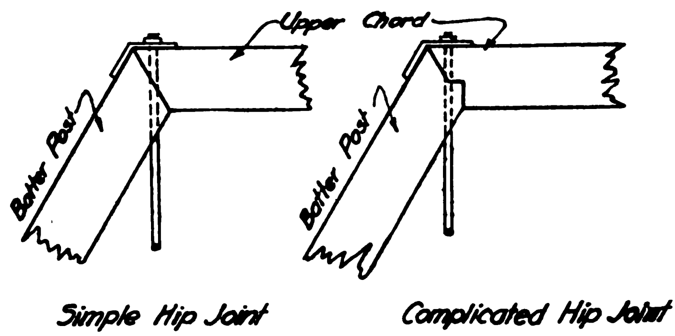


FIG. 91.—Hip joints.

be made and the stronger it will be. The oblique scarf joint is stronger to resist bending than the half lap joint.

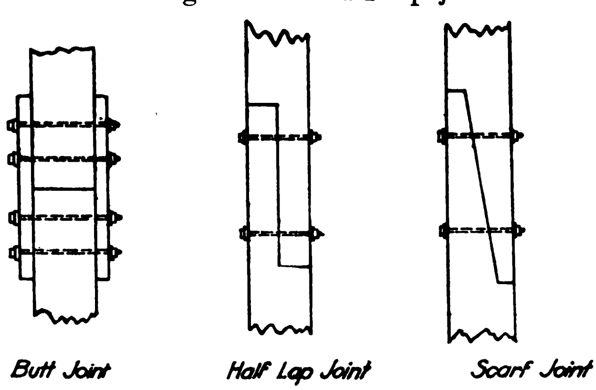


FIG. 92.—Splice joints.

Intermediate joints.—A simple type of intermediate joint for a roof truss is shown below. The end cuts of the strut are normal to the pressure, and large bearing surfaces are provided.

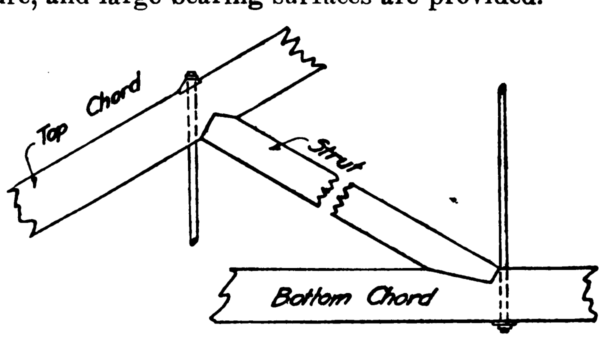


FIG. 93.—Intermediate truss joint.

QUESTIONS.

1. Why should the abutting surfaces in a joint be made as nearly perpendicular as possible to the pressure it has to carry?
2. Is it necessary to make a joint so that the pressure may be distributed uniformly over the abutting surfaces?
3. When are fishplates used in a joint?
4. What is the best form of scarfed joint for resisting tension?
5. In what cases should a stub tenon be used?
6. In what class of work should a double tenon be used? What is the purpose of a tusk tenon?
7. In what class of building construction is an oblique tenon used?
8. What is the strongest method of fastening a lapped joint? A fished joint?
9. When is it desirable to use fishplates with a scarfed joint?
10. Under what conditions should a half joint be beveled.

Name................................

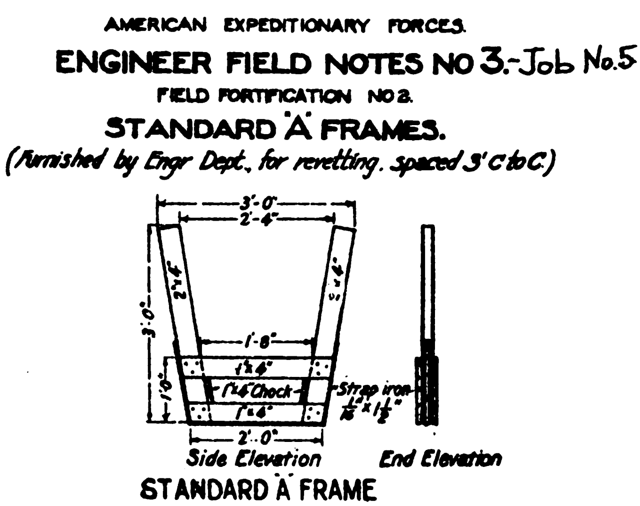
....
(Rank and organization.)

Date................................

1. **Standard "A" Frame, for trench board.** (See E. F. N. No. 3.)

2. *Specifications.*—All material to be 1" x 4" and 2" x 4" rough yellow pine, Spruce or Hemlock. Fasten each joint with three 12d. wire nails.

3. *Drawing.*



4. *Unit Operations listed in order of use:*

5. *List of tools and bill of material:*

6. ***Questions and answers:***

1. In what order should the 1″ x 4″ crosspieces be fastened to the 2″ x 4″ sides?

2. Why are the 1″ x 4″ "chocks" used?

3. Why is the strap iron used?

4. How should the strap iron be fastened to the frame?

Name ______________________________

____
(Rank and organization.)

Date ______________________________

1. **Special A frame for trench board.** (See E. F. N., No. 3.)

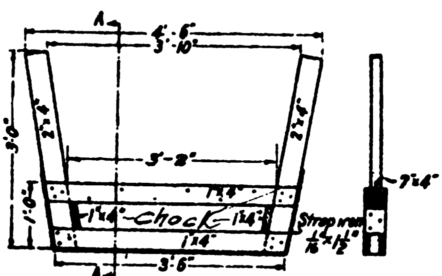
2. *Specifications.*—All material to be 1" x 4" and 2" x 4" rough yellow pine, spruce, or hemlock. Fasten each joint with three 12d. wire nails.

3. *Drawing.*

AMERICAN EXPEDITIONARY FORCES.

ENGINEER FIELD NOTES NO 3.- Job No.6

FIELD FORTIFICATION NO 2.



Side Elevation Section A-A

SPECIAL "A" FRAME
(For use in C.T. Type C)

4. *Unit Operations listed in order of use:*

5. *List of tools and bill of material:*

6. *Questions and answers:*

1. How is the angle or bevel cut for the ends of the 1" x 4" cross pieces determined?

2. Should the steel square or T-bevel be used to lay out the bevel cut for the ends of the 1" x 4" cross pieces?

3. Why use three nails to fasten each joint?

Name ______________________________

____
(Rank and organization.)

Date ______________________________

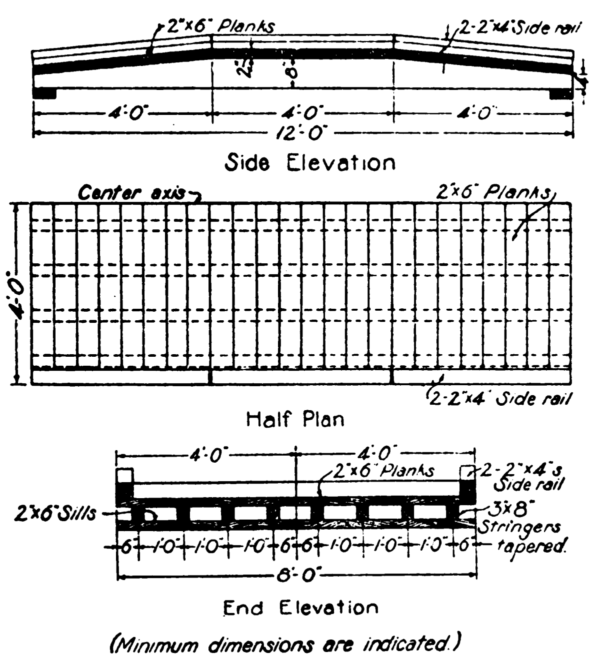
1. **Portable artillery bridge.** (See E. F. N., No. 45.)

2. *Specifications.*—The bridge is built in two equal sections for portability. Used yellow pine or spruce stock. The 3 x 8 inch stringers are tapered to 4 inches at the ends. All connections and joints are to be fastened with 20d. wire nails.

3. *Drawings.*

E. F. N. 45
Bridges 7
Portable Artillery Bridges

PORTABLE ARTILLERY BRIDGE. Job No. 7.
To take 155 mm. Howitzer gun carriages.
Maximum axle load of 3 tons.



(Minimum dimensions are indicated.)

Bill of Material

Pieces	Size	Length	No. Pcs.
Side rails	2"x4"	4'-0"	12
Stringers	3"x8"	12'-0"	8
Flooring Sills	2"x6"	4'-0"	52
25 lbs 20 d wire nails			
432 Board Measure Feet			

Weight in lbs.

1 Section	720
Bridge	1440

4. *Unit Operations listed in order of use:*

5. *List of tools, and bill of material:*

6. *Questions and answers:*

1. Why are the stringers tapered?

2. Why are sills used?

3. What is the purpose of the side rails?

4. How many nails should be used to fasten the planks at each stringer bearing?

5. How should the joint be made between the floor planks at the breaks in slope?

Name ______________________________

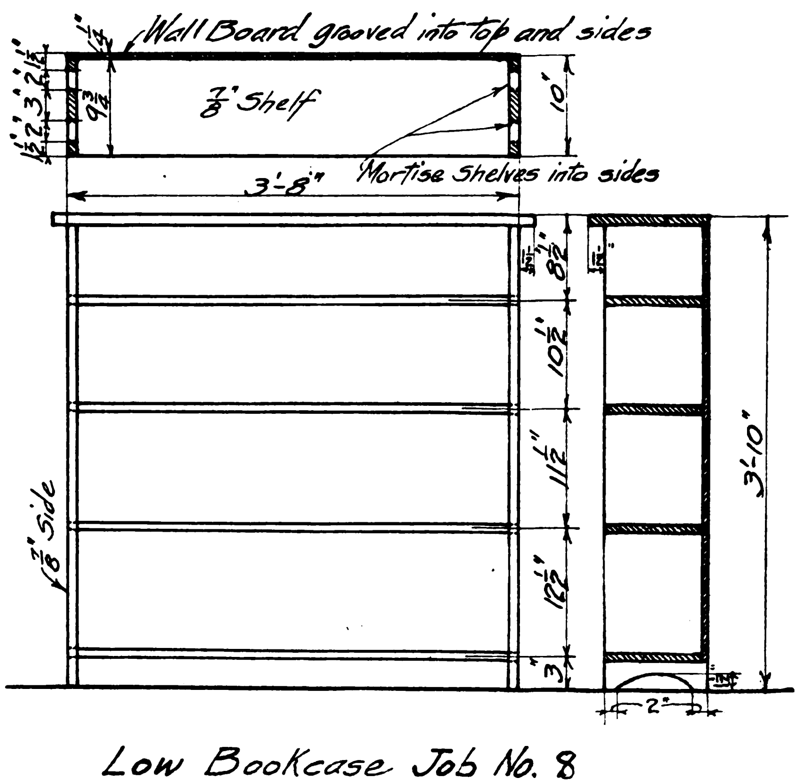
____
(Rank and organization.)

Date ______________________________

1. **Low bookcase.**

2. *Specifications.*—The material is to be 7/8-inch white pine with through mortise joints for the shelf connections. Fasten each joint with five 8d. finish nails. Sandpaper the front and outer edges and faces of the shelves and side pieces for painting.

3. *Drawing.*



Low Bookcase Job No. 8

4. *Unit Operations listed in order of use:*

5. *List of tools and bill of material:*

6. *Questions and answers:*

1. Why are the shelves mortised into the side pieces?

2. Why is the wall board backing grooved into the case?

3. Why are the shelves spaced as shown in the drawing?

4. Why does the top board project over the side pieces?

5. Why should not the case be made 5 feet long instead of 3 feet 6 inches?

6. Why is the bottom shelf placed above the floor?

Name ________________________________

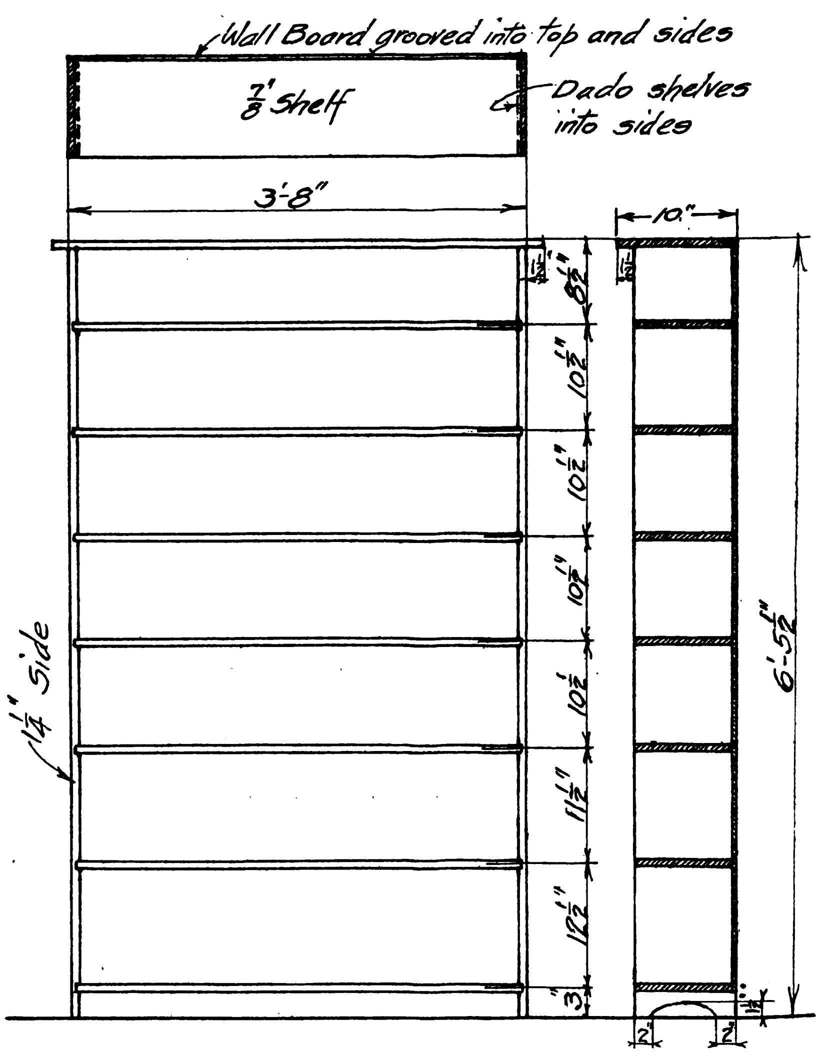
____
(Rank and organization.)

Date________________________________

1. **High bookcase.**

2. *Specifications.*—Use 7/8-inch white pine stock and dado the shelves into the side pieces as shown. Fasten each joint with five 8d. finish nails. Sandpaper the front and outer edges and faces of the shelves and side pieces for painting.

3. *Drawing:*



High Bookcase Job No. 9

4. *Unit Operations listed in order of use:*

5. ***List of tools and bill of material:***

6. *Question and answers:*

1. Why are the shelves dadoed into the side pieces?

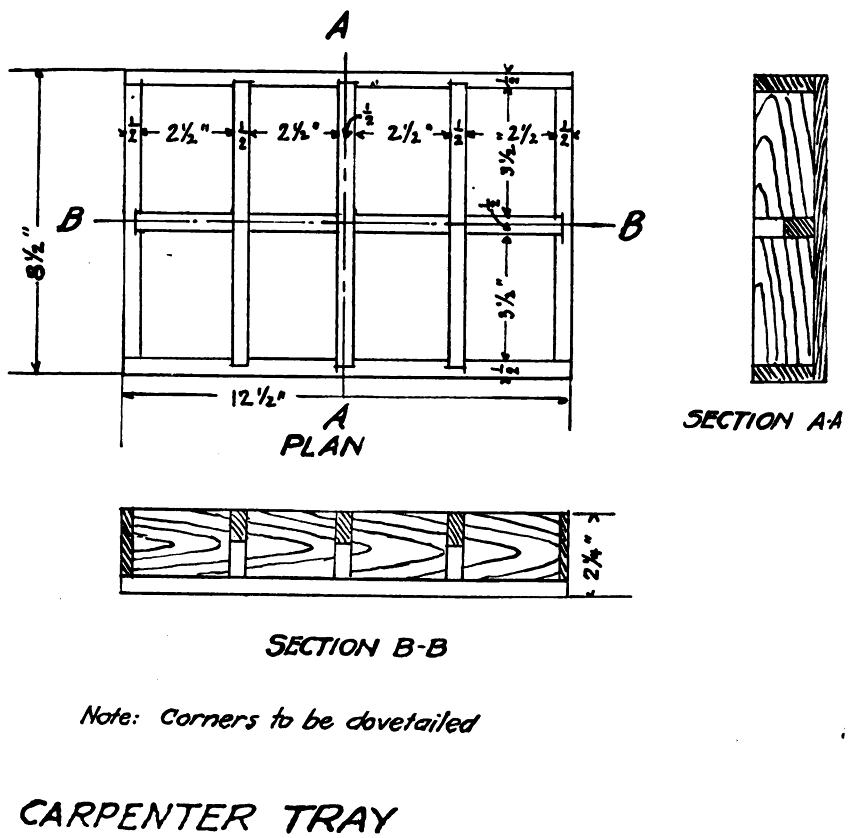
2. What uses does the wall board backing have?

Name ________________________________

____
(Rank and organization.)

Date ________________________________

1. **Tool tray.**
2. *Specifications.*—The tray to be made of yellow pine, surfaced and sandpapered, all joints to be rabbetted and glued. Outside corners fastened with screws. Dimensions and design to conform exactly to the attached drawing.
3. *Drawing.*



4. *Unit Operations listed in order of use:*

5. *List of tools and bill of material:*

6. *Questions and answers:*

1. How is the glue prepared for use? What is the difference in use between cold and hot glue?

2. How can the top of the screw be made flush with the surface of the wood?

3. What other types of joints may be used in making the corners of the box?

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UNITED STATES ARMY

TRAINING MANUAL No. 12

CARPENTRY

FOR MILITARY SPECIALISTS

Part III. GENERAL CARPENTER

PREPARED UNDER THE DIRECTION OF

THE CHIEF OF ENGINEERS, U. S. ARMY

1922

WASHINGTON
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CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *May 23, 1922.*

Manuals for training the Army are to be prepared and revised from time to time by the branches of the service concerned, and published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Corps of Engineers as a part of this series a group of five (5) pamphlets relating to carpenters. The pamphlets in this series will be numbered and titled as follows:

Training Manual No. 10.—Carpenter Helper.
Training Manual No. 11.—Basic Carpenter.
Training Manual No. 12.—General Carpenter.
Training Manual No. 13.—Master Carpenter.
Training Manual No. 14.—Instructors Guide for Carpenters.

This pamphlet is the third of the carpenter series, and is published for the information and guidance of all concerned.

[A. G. 062.11 (5-16-22).]

BY ORDER OF THE SECRETARY OF WAR:

JOHN J. PERSHING,
General of the Armies,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
Acting The Adjutant General.

FOREWORD.

Training Manual No. 12 General Carpenter teaches the more general construction units in carpentry. At least 2 per cent of the soldiers of the Army should have the skill and knowledge acquired by satisfactorily completing this course. Graduates receive a certificate of proficiency as General Carpenter and are eligible for appointment to this rating. Sergeants having this certificate and a similar one in masonry and concrete are qualified for the grade of technical sergeant (construction foreman).

This is the third convenient step in training a master carpenter. These steps need not follow immediately after one another. It may often be an advantage to a man to work at the trade for awhile between each part of the school training. A general carpenter should compete successfully in civil life with journeyman carpenters for his all-round knowledge and skill is more complete.

In this course the student is educated in building and bridge construction. Graduates showing special proficiency and having the native capacity for estimating, laying out difficult work, and doing finish work are eligible to take the course contained in Training Manual No. 13, Master Carpenter.

INDEX TO TRAINING MANUAL NO. 12.

Unit operations: Page.

24. Leveling and plumbing ... 1
25. Making wood foundations and forms for concrete foundations ... 2
26. Laying sills and girders ... 6
27. Cutting and placing joists and bridging ... 8
28. Laying rough flooring ... 10
29. Laying out walls and partitions ... 11
30. Framing and erecting stud walls, partitions, and joists ... 12
31. Framing around window and door openings ... 16
32. Placing ceiling joists ... 18
33. Cutting and framing lookouts ... 19
34. Laying out common rafters ... 21
35. Laying out hip and valley rafters ... 23
36. Laying out jack rafters ... 26
37. Erecting roof frames ... 28
38. Framing dormers ... 30
39. Erecting scaffolds ... 32
40. Putting on sheathing ... 33
41. Waterproofing around exterior openings ... 35
42. Roof sheathing and stripping ... 36
43. Flashing ... 38
44. Putting on siding ... 40
45. Putting on shingles ... 42
46. Placing plaster grounds ... 43
47. Furring ... 44
48. Placing insulation material ... 46
49. Building straight stairways ... 47

Information topics:

6. Foundations ... 50
7. Main frame ... 53
8. Roof frame ... 58
9. Floors ... 61
10. Wall covering ... 63
11. Roof covering ... 67

Jobs:

11. Double garage ... 70
12. Lumber shed ... 73
13. Bridge ... 76

LEVELING AND PLUMBING.

1. To level a piece, place it in its required position and place a spirit level on its top surface with the side of the level exactly parallel with the edge of the piece.

2. Look at the bubble to see whether its center lies under the center mark of the tube. If the bubble is off center, the piece is not level.

3. Notice on which side of the center mark the bubble lies. The bubble will be at the high side of piece, and the piece must be raised at the other end or lowered at the high end until the center of the bubble lies under the center mark of the tube.

4. To plumb short upright pieces, use the level as in the case of leveling, except watch the bubble in the tube, which is set in the circular hole near the end of the level.

5. To plumb corner posts or other long vertical pieces, use a plumb bob and line.

6. Tack a nail in the center of each of two adjoining surfaces of the post near the top.

7. Fasten a line and plumb bob to the nail on one face and let the line extend to the bottom of the post.

8. Stand away from the post and see whether the line runs exactly down the center of the post. If it does not, it can easily be seen, and the post must be moved at the top or bottom until the line lies exactly along the center.

9. After testing one side of the post, test an adjoining side in the same way.

QUESTIONS.

1. Why is it necessary to test two adjoining sides of a post when plumbing?

2. Why should a level be held parallel with an edge of a timber or board to be leveled?

3. How should a spirit level be tested to find whether it is true?

MAKING WOOD FOUNDATIONS AND FORMS FOR CONCRETE FOUNDATIONS.

Pile footings.

1. For pile foundations select straight piles of suitable length, taper the small ends slightly and square the tops.

2. Have the piles driven until the penetration at each blow is less than 1 inch. In hard driving fit an iron ring to the tops to keep the piles from brooming.

3. Saw off the tops of the piles to give proper height for the sills.

Wood post footings.

1. Where specifications call for wooden footings as shown in Figure 94, after the excavation has been completed, cut pieces of material not less than 3″ in thickness to the specified dimensions.

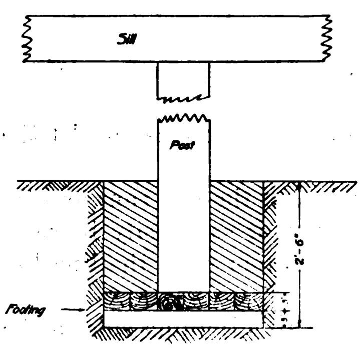


FIG. 94.—Wooden footing.

2. Nail the pieces together as shown in Figure 94, and place in the hole.

3. Level by tamping and pack earth around edges to hold in place.

4. Cut both ends of the post square to the proper length and toenail post on the footing.

5. Plumb and pack earth around it.

Wall forms for concrete foundations.

1. Read Information Topic No. 6 on foundations and note from plan and specifications size and shape of footing courses for the foundation walls. Do not make forms for the footing courses unless an unusual shape is specified.

2. After the excavation has been completed, cut a 2 x 4 to a length of 6 inches greater than the height of the wall. With this piece as a sample saw (several pieces at a time) enough vertical supports or cleats to make the form panel. Determine the number required by assuming a 24 inch spacing of cleats for $\frac{7}{8}$″ boarding and 36 inch spacing for $1\frac{1}{2}$″ boarding (dressed to $1\frac{5}{16}$ inches).

3. Saw out of $\frac{7}{8}$″ or $1\frac{1}{2}$″ T. and G. boarding or shiplap, a board with square ends and of a length of from 6 to 9 feet, depending on the spacing of the cleats. With this board as a templet, saw out enough boards to make the form panel.

4. Place the 2 x 4 cleats for one panel on a bench, floor or other level working surface, parallel to one another, and at the required spacing of 24 or 36 inches. If a number of these forms or wall panels

are to be made, nail blocks or strips to the bench or other surface, along both sides of each cleat, thus forming templets to hold the cleats in making up each form section or panel.

5. Place one board with one edge flush with the ends of the cleats and its ends bearing on about one-half of the 2-inch edge of the cleats. Nail the board to the cleats with two 8d. nails at each bearing. In similar manner, nail on successive boards, taking care to make tight joints by driving each board up snug against the preceding board.

6. Make up every other panel with the end cleats omitted, so that the free end will but against the cleat ends of the panel described in paragraph 4.

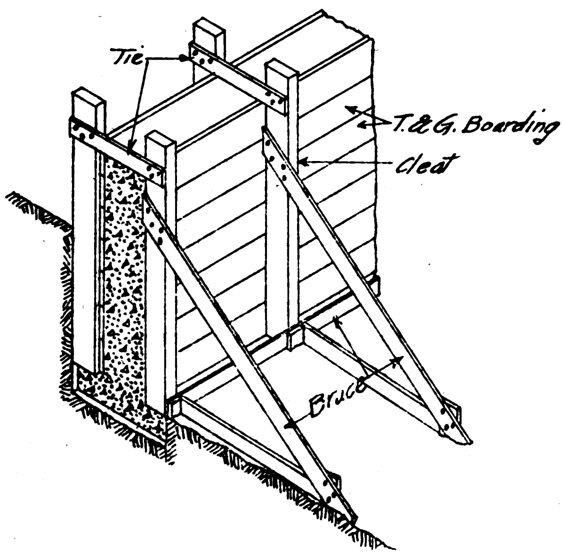


Fig. 95.—Form for wall foundation.

7. After the footing course has been placed, set the wall form or panel in its proper position, with its lower edge resting on the top surface. Place a bottom strip and diagonal braces to hold the form in place. Make, in like manner, enough form panels to furnish one section of wall for the placing of the concrete. In making the panel on the bench, as described above, the length of panel will depend on its height so that it may be easily handled. Nail strips to opposite cleats above the panels to tie the two side panels together.

8. Drive strong stakes firmly in the ground and nail to bottom strip and braces. In case of a deep excavation with only one wall form brace forms from wall to opposite wall.

Post forms for concrete footings.

1. Lay off the length of post, from the top of the footing course to the under surface of the girder or floor, on 1¼″ T. and G. stock and cut to length with square ends. With this piece as a sample, cut as many boards as are necessary to make the required width of side. When necessary, rip and joint one piece to proper width.

2. Cut enough cleats from 2″ x 3″ stock to space 6 inches from each end of the post side and about 24 inches between cleats. Make the cleats 14 inches longer than the width of the form.

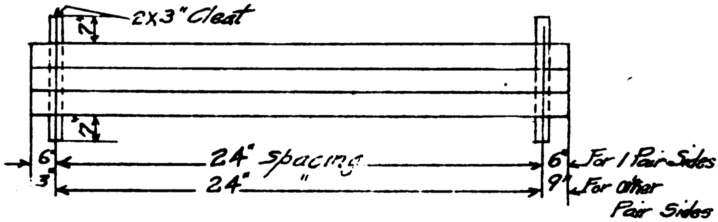


FIG. 96.—Side of form for post.

3. Lay the cleats in position on a bench or other smooth surface and nail strips or blocks on both sides of each cleat to form templets to hold the cleats in place while making up each post side.

4. Nail the boards to the cleats, driving the successive boards together to secure tight joints.

5. Make another side the width of the finished post, and in like manner, two sides of a width equal to the width of the post plus twice the thickness of the stock used. Space the cleats on the second set of sides so as to clear those on the first set. This is done by making the end spacings of the cleats 9 inches and 3 inches instead of 6 inches (as used for the first set of sides).

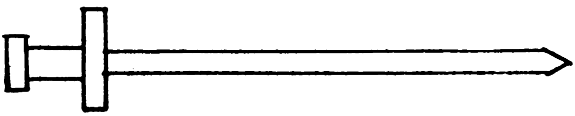
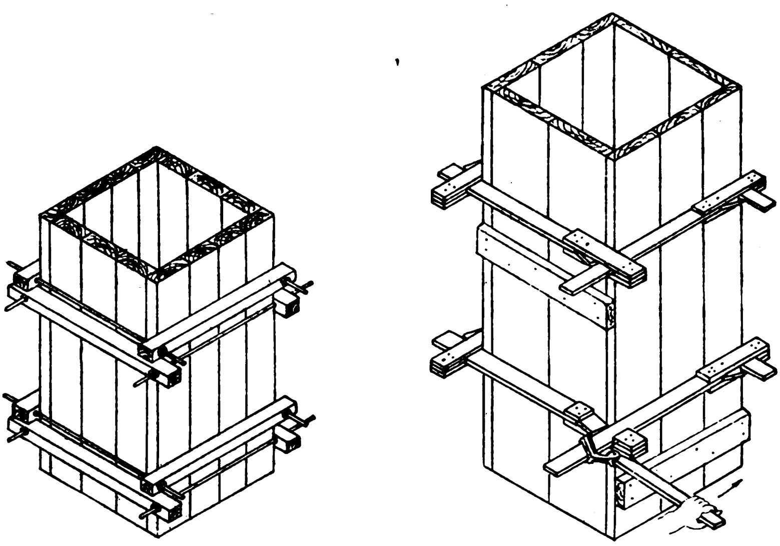


FIG. 97.—Double-headed form nail.

6. Set the post sides in place and nail the corners together, taking care to leave the nails projecting about $\frac{3}{16}$ inch from the surface of the wood, or use double-headed form nails as shown in Figure 97. Nail the ends of the overlapping cleats together, or fasten with special clamps or bolts, as shown in Figure 98.



Methods of Clamping Column Forms

FIG. 98.—Types of clamps for post forms.

QUESTIONS.

1. Why is it necessary to brace wall forms thoroughly at the top and bottom?
2. Why is it desirable to use tongued and grooved boarding with tight joints for form work?
3. How would the spacing of the cleats on wall and post forms vary with the height of the forms?
4. Why should the nails holding the form sections not be driven clear in?
5. What is the purpose of the double-headed form nail?
6. What is the advantage of having the mills furnish lumber of standard width, such as 4¾ inches, 5¾ inches, 6¾ inches, 7¾ inches, etc., for beam and girder sides and bottoms?
7. What other form of cleats or yokes could be usel to hold the sides of post forms together?
8. What kind of lumber is best suitable for concrete forms? Should the lumber be dry or relatively green?

LAYING SILLS AND GIRDERS.

1. Cut solid sills to dimensions, making the corners as shown at *A*, Figure 99, and the cross-wall lap joints as shown at *B*. Plumb the anchor bolts which have been set solidly in the masonry or concrete foundation walls and piers by the masons. Place the sill in proper position on the foundation against the bolts and with the steel square draw lines across the top of the sill opposite the center of the bolts. Measure along the lines from one edge of the sill and locate the position of the center of each of the bolt holes, since some may be out of line in the foundation.

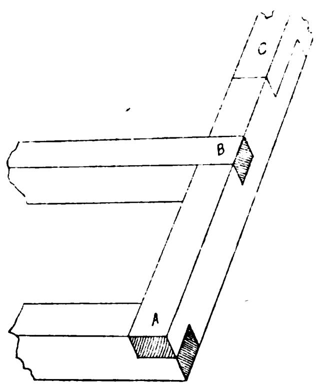


FIG. 99.—Solid sill.

2. Bore holes at the centers located on the top of the sill, using a bit $\frac{1}{8}$ inch larger than the diameter of the bolts.

3. Spread a thin layer of cement mortar on the pier or foundation wall. Lay the sill over the bolts on the layer of mortar and place the spirit level on the sill. With a heavy hammer drive the high places down until the sill is level. Be certain that the sills on the corners make 90° with each other. If it is necessary to splice a piece, make the joint as shown at *C*, Figure 99.

4. Read Information Topic No. 7. for box sills, and examine Figure 150.

5. Select straight lumber for box sills. Spike together as indicated on the working drawing. Make corners as shown at *A*, Figure 100. If necessary to splice, make the joints no nearer the corner than between the third and fourth joists and reinforce by splice plate, as shown at *B*, Figure 100.

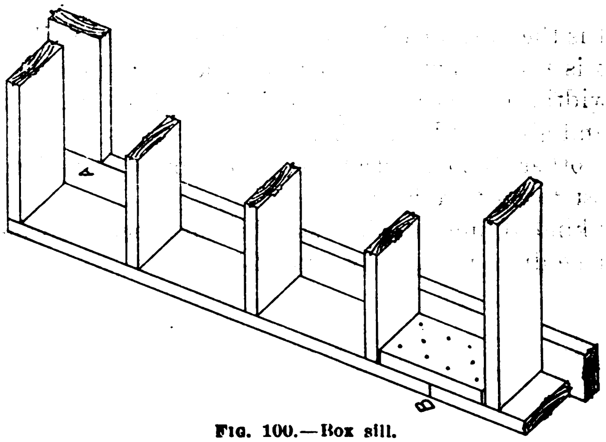


FIG. 100.—Box sill.

6. Spread a thin layer of mortar on the foundation and set the sill in position 1 inch back from the outside of the foundation wall to allow for sheathing. Level the sill by driving the high places down in the mortar with a heavy hammer.

7. To square the corners, make a mark on the outside of the sill on the wall 6 feet from the corner and another mark on the sill of the adjoining wall 8 feet from the corner. The distance between these points should be 10 feet. Any multiples of 3, 4, and 5 may be used for squaring the sills; the larger the numbers the greater will be the accuracy.

8. If there are cross foundation walls, lay sills the shape of an inverted T on them. If piers are used to support partition walls, use solid girders under the partition walls. When timber of the right size is not available build up girders by spiking planks together.

QUESTIONS.

1. Why should a box sill never be spliced less than three joists from the corner?

2. Why is it better to locate the bolt-hole centers by measuring across from the bolts on the sill rather than to transfer measured distances from foundation to sill?

3. What provision is made in the construction of the sill for keeping mice and vermin out of the house?

4. What provision is made in the construction of the sill for preventing the spread of fire?

5. How should sills be framed at the corners?

6. Which is the better type of sill, solid or boxed?

7. Why are bolt holes made $\frac{1}{8}$ inch larger than the diameter of the bolts?

CUTTING AND PLACING JOISTS AND BRIDGING.

1. Read Information Topic No. 7, for joists and bridging.

2. Determine from the specifications or drawing the dimensions of the floor joists and how they are supported on the sills or girders. whether sized or notched, and how they are to be secured to studs. When not specified, lay the joists the shortest way between the supporting walls.

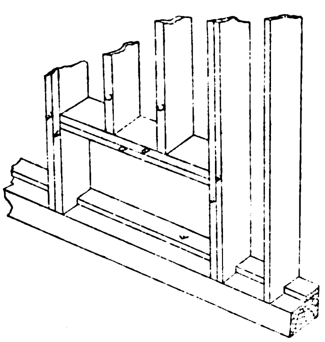


FIG. 101.—Framing around an opening.

3. In order to make the top edges even, make all measurements for notches and sizing from the top edges of the joists.

4. Space joists as specified. "On center" (O. C.) means the distance between the center lines of joists.

5. Place trimmer joists and headers for all openings. In framing the opening, put in the members in the following order: First, trimmer joists A A; second, header B; third, tail joists C C; fourth, D; fifth, E E; spiking firmly as you go.

6. Place rows of herringbone or solid bridging as directed by the architect, or if not specified, every 6 or 8 feet. Herringbone or cross-

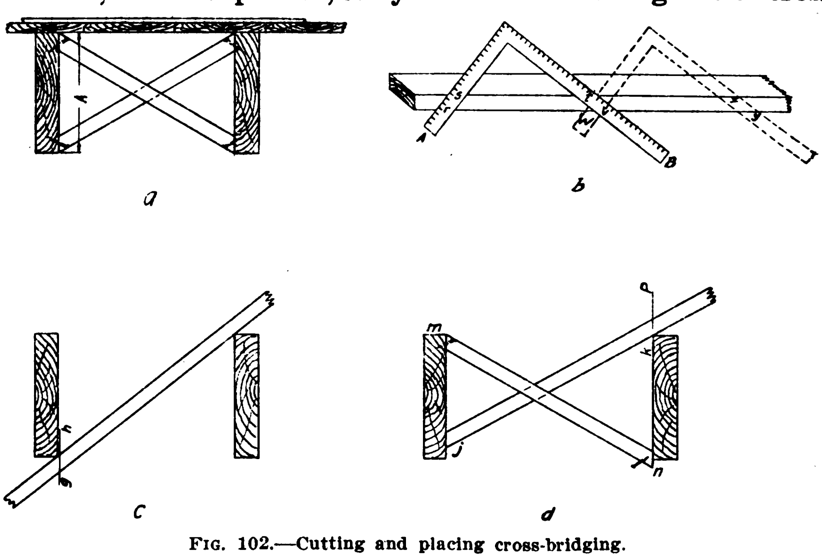


FIG. 102.—Cutting and placing cross-bridging.

bridging is illustrated in Figure 102 and consists, in small or moderate-sized dwellings, of 1″ x 3″ cut and nailed as shown.

7. A section of flooring, joist, and cross-bridging is shown in Figure 102 *a*. To get the exact measurements for cutting the cross-bridging, lay the material with the narrow side up as in Figure 102 *b*. Place the point of the square above the upper edge. On the tongue find the inch mark corresponding to the depth of the joists and hold this inch mark at the lower edge *r*. On the blade find the inch mark equal to the span between centers of joists less the exact thickness of the bridging and hold it at the upper edge of the bridging *t*. Mark along *rs* and *tv*.

8. Slide the square along the material to the position shown by dotted lines in Figure 102 *b*. Hold the inch mark in the same relative position as before so that the edge of the tongue crosses the point marked *t*. Mark along *tw* and *xy*. Saw on the lines *rs* and *tw*. Repeat to secure the required number of cross-bridging.

9. The usual method of cutting bridging is shown in Figure 102 *c* and *d*. Place the material to be cut in the position as shown at Figure 102 *c*. After cutting a bevel, as at *gh*, place the bridging as in Figure 102 *d* at *j*, a distance above the lower edge of the joist slightly more than the thickness of the bridging, and cut on the line *kp*. Nail with two nails on the upper ends, as shown in Figure 102 *d* at *m*. After the rough flooring is laid, complete the bridging by nailing the lower ends at *n*.

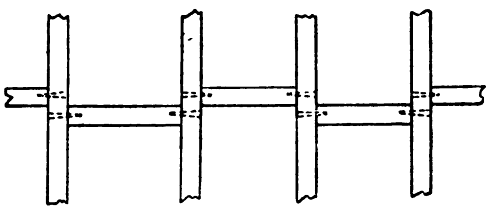


FIG. 103.—Placing solid bridging.

10. To make solid bridging cut plank with the same dimensions as the joists, to fit snug between the joists. Nail as shown.

QUESTIONS.

1. Why is it necessary to frame around a chimney so that no wood will come in contact with it?
2. Why are headers and trimmers made in pairs?
3. Why is bridging nailed at its upper ends before flooring is laid?
4. Why are joists generally laid the shortest way between supporting walls?
5. Is the bearing strip *F* on the girder necessary?
6. Should all joists be notched? How will the notching affect the ceiling?

LAYING ROUGH FLOORING.

1. Read Information Topic No. 9, floors.

2. To lay rough flooring at right angles to the joists, begin at one side and nail each board tight to each joist, using 8d. nails and place a nail within 1 inch of the edge of each board and intervening nails not farther than 3 inches apart.

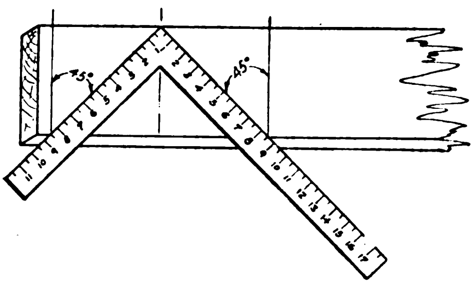


FIG. 104.—Laying out 45° angles.

3. To lay rough flooring diagonally, begin at one corner. Take a board and at one end lay the square as shown in Figure 104, with the point of the angle at one edge of the board and the same figures on the tongue and blade at the other edge. Mark along the outside edges of tongue and blade. Saw on these lines to make the corner piece.

4. Turn the board over and place the longest edge of the corner piece at *AB*, Figure 105. Mark the point *B* on the board *M*. Draw the line *BD*, as shown in Figure 104. Saw on this line to make the second floor piece.

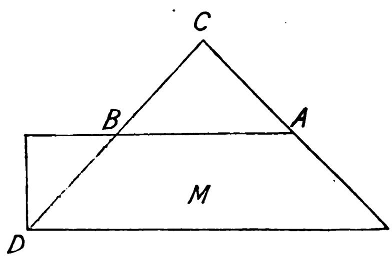


FIG. 105.—Laying out diagonal flooring.

5. Repeat, using the second floor piece to lay out the third floor piece, etc.

6. Where the board is too short to reach the entire length, make a joint on the center line of a joist.

7. The floor pieces should be nailed as soon as used for marking. Use 8d. nails and place a nail within 1 inch of the edge of each board and the intervening nails not farther than 3 inches apart.

8. Fit flooring around wall studding if it passes through the floor.

QUESTIONS.

1. Why should joints of rough flooring always be at the center line of joists?
2. Should the floor be nailed at every joist?
3. How should the material for rough flooring be milled?

LAYING OUT WALLS AND PARTITIONS.

1. Cut, lay, and spike straight 2 x 4s on the floor at the outside edge of the house as directed in the plan or specification.

2. From the floor plan of the first story, lay out and mark on the floor the center lines of all partitions.

3. Mark on this line the location of all doors in partition walls.

4. Cut straight 2 x 4s the length of each partition wall. Where doors occur, leave a space equal to the outside width of jamb plus 1 inch. Spike these pieces to the floor, putting the center of the 2 x 4 on the center line of the wall. These 2 x 4s will be the floor plate or " sole " of the partition walls.

5. If sliding doors are to be installed in any of the walls, double walls with at least 3 inches between them must be laid out.

6. On the floor plate, lay out and mark the position of every stud in all the walls. On both sides of every window and door lay out double studs.

7. When the floor plate is not specified, and the drawings show that the studding passes through the floor and rests on the bedplate or sill, the laying out of walls and partitions will be done on the bedplate or sill.

QUESTIONS.

1. Why is it necessary to locate the position of the studs?

2. How should the stud spacing be kept uniform in walls and partitions having door and window openings? Why is it necessary to keep the stud spacing uniform?

FRAMING AND ERECTING STUD WALLS, PARTITIONS, AND JOISTS.

1. Read Information Topic No. 9, and determine from the plans which walls will bear the ends of the floor joists of the second story. Select enough straight 2 x 4s for the corner posts and the top plate.

2. Measure and cut the lower 2 x 4 of the top plate for the long side from straight material, the full length of the floor plate, or sole, on the same side of the building.

3. Cut the ribband, or ledger boards, from straight 1 x 5 to 1 x 6 stock the same length as the top and floor plates. As one length of

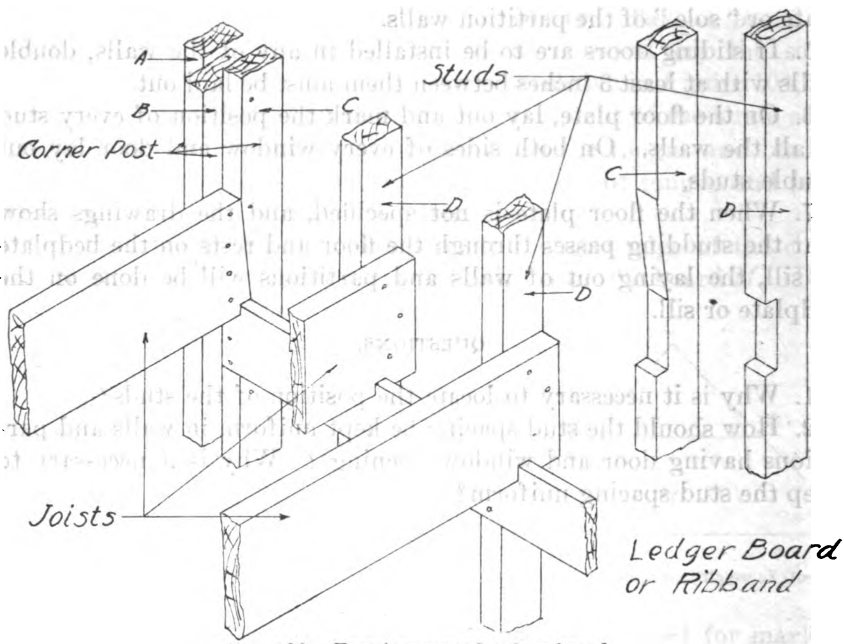


FIG. 106.—Framing around ledger board.

stock will probably not reach the length of the house, make a butt joint at the center of a stud.

4. Lay the top plate and rib band by the side of the floor plate on the side that is to bear the joists, and, with a square, transfer to them from the floor plate the location of each stud.

5. Cut three corner studs the height of the wall, less the thickness of three 2 x 4s laid flat, which allows for the plates at the top and bottom.

6. Lay out the studs and cut the notches for the ledger board, as shown in Figure 106 at *D*, of such depth that their faces will be 3 inches from the outside of the studs. These notches should be

so made that when the ledger board is in place and the sized or notched floor joists are placed upon it, the tops will be in position to receive the flooring. Figure 107 shows a wall stud and first and second floor joists sized and notched, with stops nailed to the edges, so that they may be used as templets or patterns for laying out duplicate timbers. These templets are eventually used in the structure.

7. One member of each of the corner posts should be cut like the studs except that the top shoulders of the notches are beveled away to receive the ends of the wall joist, as shown in Figure 106 at *C*, before the corner posts are assembled.

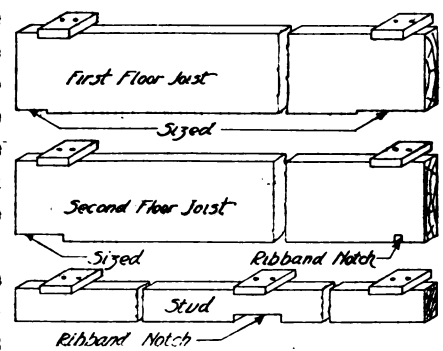


FIG. 107.—Templets for joists and studding.

8. When ready to erect the wall, take the exact measurement of the combined thickness of two members *A* and *B* of the corner posts, Figure 106, and cut this amount from the end of the ledger board which has been made the length of the floor plate. Nail the end of the ledger board to the post in the notch already cut. Nail the other end in place on a stud. Raise the corner post, stud, and ledger board to position, toenail the lower ends to the floor plate in proper places and plumb the corner post and stud and brace them. Repeat this operation on the other end of the wall. Fill in the remaining studs, holding them erect by nailing to the ledger board and floor plate, and use sufficient temporary bracing for alignment.

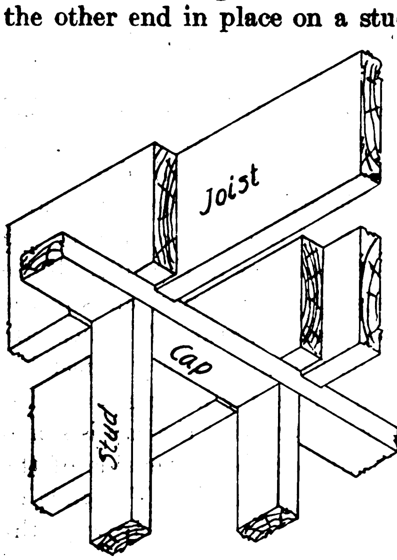


FIG. 108.—Framing top of patrtition.

9. Erect the opposite wall. If there are any partition walls that carry floor joists and extend the entire two stories, erect them in the same manner. Where one-story partitions support the end of joists, as in Figure 108, cut the studs the length from the rough floor to the sized joists above, less the thickness of two 2 x 4s (the sole and the cap or top plate). Frame up a section as large as can be well handled, nail the cap

to the ends of the studs and cut in the headers and form the openings. Set up and toenail to the floor plate and hold in position by temporary stays. Unless the joists are spaced to locate directly over the supporting studs it is better practice to use a double cap. The construction is the same where the partition walls run at right angles to the joists, but are located at some other point than at their ends, and are erected after the joists above are placed.

10. Cut the wall joists, as shown in Figure 106, and from the floor plate lay out the positions of the studs. If this wall joist is necessarily made of more than one piece, make a butt joint on one of the studs. Place the joists in the notches prepared in the corner posts in the member marked *C* and spike it fast, tying the walls together. Place the notched and sized intermediate joists, as shown on the ledger board, and spike to the studs *D*. While the second-floor joists are being spiked in place it is necessary to line up and plumb the walls and corner posts of first story.

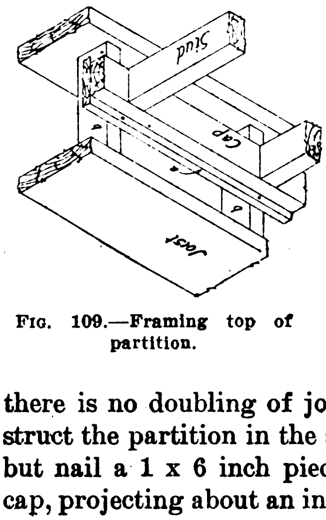


FIG. 109.—Framing top of partition.

11. After the second floor joists are placed, erect the studs of the end walls. Spike them to the wall joists to the lines which have been transcribed to it from the stud layout on the floor plate. Toenail the lower ends to the floor plate.

12. When a partition runs parallel to, and is located between joists and there is no doubling of joists to support a similar wall above, construct the partition in the same way as described for one-story walls, but nail a 1 x 6 inch piece *a* the length of the wall on top of the cap, projecting about an inch on both sides of it as in Fig. 109. Raise the partition to place between the joists. Nail the lower ends to the floor plate and the upper surface to pieces marked *b* which are similar to solid bridging, spaced and nailed about every 3 feet between the joists. The 1-inch projection serves for nailing space for lath or ceiling of any kind. In cheaper construction the cap is sometimes omitted and the studs cut to the line on the lower side of the joists and the piece *a* nailed to the ends of the studs. The ends of partitions are sometimes secured to the walls in a similar way, the nailing strip being secured to the end stud and attached to horizontal bridging between the studding.

13. After the first-story walls are plumbed and braced, proceed with the second story. Spike the double plate to the tops of the wall studs, making butt lap joints at the corners, tying the top walls together.

QUESTIONS.

1. Why are double studs used at the door and window openings?
2. In a two-story house, should the outside wall studs extend the full height of the house?
3. What form of corner posts should be used?

FRAMING AROUND WINDOW AND DOOR OPENINGS.

1. Mark off on a 1 x 2 inch pole about 8 feet long, the heights of the bottom of stools and top of headers above the rough floor or top of joists. Place the pole alongside the studs of the outside walls to be cut and transcribe the marks on them. To determine the height of window openings, add 11 inches to the glass measurement.

2. Saw off the studs where marked, taking care to make the cuts horizontal.

3. Saw the stools and headers, from 2 x 4s piled up so as to cut three or four pieces at one time.

4. Nail the stool and headers in place by toenailing the ends of the studs and vertical nailing the intermediate studs. Always use a double timber for the header.

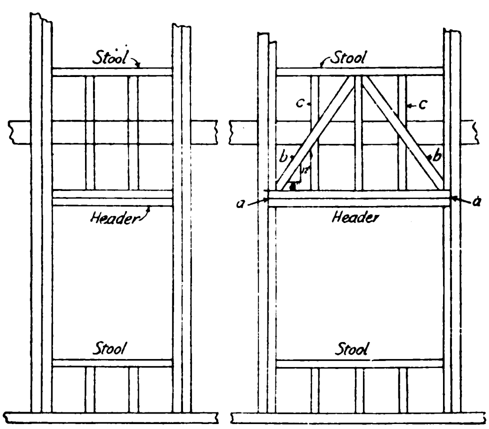


FIG. 110.—Window openings.

5. When the opening is 4 feet and greater in width, truss the head of the opening, as shown at *b*, Figure 110. Set the headpieces into the sidepieces so as to rest on top of the inside studs, as shown at *a*.

6. Measure the rise and run of truss pieces *b* and lay out the plumb and seat cuts as shown in Figure 111. Set the fence on the steel square with the rise laid out on the blade as 1 foot and the corresponding run on the tongue. Place the square on the 2-inch edge of the 2 x 4 and mark the seat cut as shown at *mn*. Move the square along until the edge of the blade intersects the center line of the edge and draw

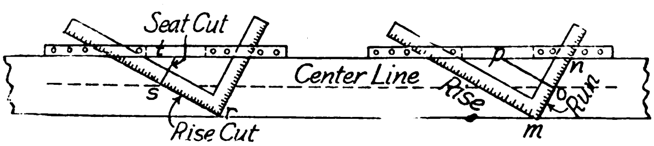


FIG. 111.—Laying out bevel cuts.

the plumb cut, *op*. Move the square from *m* along the edge the number of times the run is contained in the rise. Mark the rise cut, as indicated at *rs*. Move the square until the edge of the tongue intersects the center line of the piece and mark the seat cut *ts*. Saw the cuts as marked. Use the first piece as a pattern.

7. Place the pieces *b*, Figure 110, in their position and mark the intersection cuts on the short studs *c*. Saw the studs *c* at the cuts as marked. Place the diagonal braces *b* in position and mark the inset cuts for the ribband board. Saw and chisel out the insets in the braces *b*. Toenail the braces *b* into the frame and toenail the short studs *c* into the braces *b*.

8. Mark off on the 1 x 2 measuring strip the height of the tops of the headers above the rough floor or top of joints. Place the pole along the studs of the walls to be cut and transcribe the marks to them. To determine the height of the door opening, add 5 inches to the door height.

9. Saw off the studs where marked, taking care to make the cuts horizontal.

10. Nail the double-piece header in place in the door opening as shown at *A* in Figure 112.

11. Place 2 x 4s alongside the jambs of the door opening, and mark out the two sidepieces. Saw these pieces with square cuts.

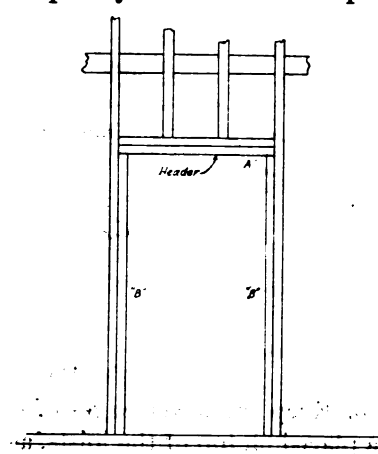


Fig. 112.—Door opening.

12. Nail the sidepieces in place as shown at *B*, Figure 112.

13. Truss the heads of the door openings 4 feet in width and over, as shown for window openings, Figure 110.

QUESTIONS.

1. Why is the header at *a*, Figure 110, set into the sidepieces?

2. Why are the braces *b* in Figure 110 carried through from stool to header?

3. Why are the heads of door and window openings over 4 feet in width trussed?

PLACING CEILING JOISTS.

1. Determine from the drawings and specifications the direction to run the ceiling joists. Study Information Topic No. 7.

2. Cut the joists even with the outside edge of the plate, or to extend beyond, as indicated by the drawings. See Figure 113.

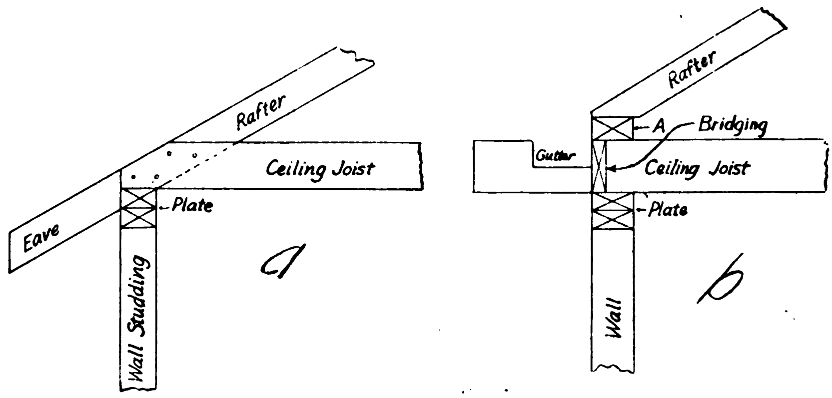


FIG. 113.—Placing ceiling joists.

3. Keep the lower edges of ceiling joists even. If a plate, *A*, is to be placed on top of the joists, as shown in Figure 113*b*, notch the tops to make the plate bearing.

4. When placing joists as shown in Figure 113*b*, put solid bridging above the plate. Place another row of bridging in the middle of the joists.

QUESTIONS.

1. Why should the lower edges of ceiling joists be kept even?
2. How can they be evened up when necessary?
3. What is the purpose of solid bridging above the plate?
4. What is the purpose of the upper plate shown at *A*, Figure 113*b*?

CUTTING AND FRAMING LOOKOUTS.

1. Inspect the plan and note the type of lookouts to be constructed. If the roof has a gable, note that the lookouts in the gable are different from those on the sides.

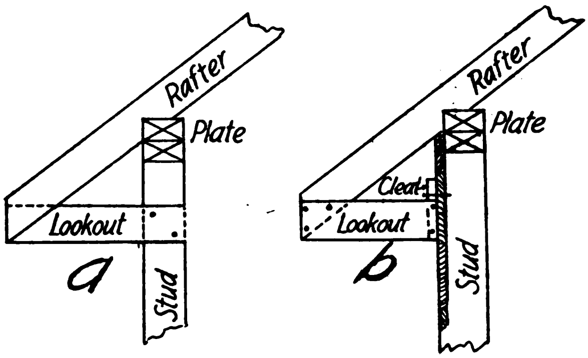


FIG. 114.—Lookouts on side.

2. The lookouts under the gable should be cut and placed before the roof sheathing is put on unless they are built as shown in Figure 115*b*, in which case they are placed after the sheathing is in place.

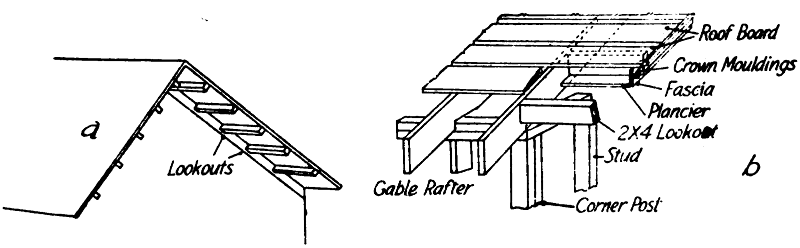


FIG. 115.—Gable lookouts.

3. If the lookout under the gable is of larger timber than the rafters, make the lookout long enough to reach to the inside edge of the second rafter from the end, and notch it as shown in Figure 116.

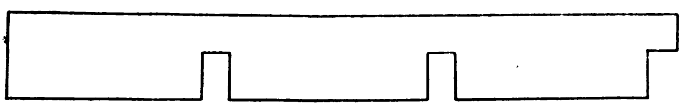


FIG. 116.—Notching gable lookouts.

The width of the notches is the thickness of a rafter, and the depth is the width of a rafter. If the lookout is narrower than the rafter, make it long enough to reach to the outer edge of the second rafter, notch the top of the first rafter half the width of lookout, and notch the lookout one-half its width. Place the lookout over the first rafter and nail it to the second one. Space the lookouts as shown on the plans of the building.

4. For lookouts on the sides of the building use short pieces of 2 x 4 and nail as shown in Figure 114. Make the lower edges even.

QUESTIONS.

1. Under what conditions of construction would the lookouts be framed as shown in Figure 114*a*?

2. Are cleats necessary at the ends of the lookouts as shown in Figure 114*b*?

3. Why are lookouts in the gable different from those on the sides of a roof?

4. What is the purpose of the lookout in its various locations?

LAYING OUT OF COMMON RAFTERS.

1. Read Information Topic No. 8. Base all operations upon the unit rule of 12 inches of run of the common rafter, and make all measurements upon horizontal and plumb lines.

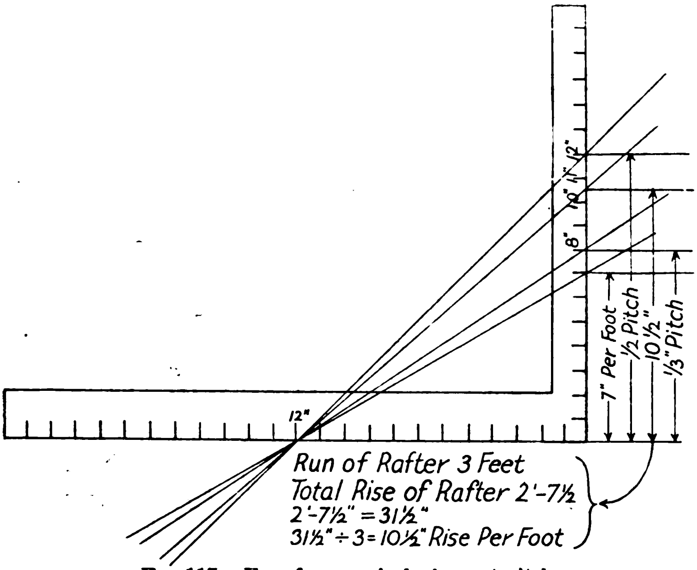


FIG. 117.—Use of square in laying out pitch.

2. Set the roof framer's fence to 12 inches on the blade of the square, and the point indicating the rise per foot of run on the tongue. If the total rise of the rafter is given in feet, change it to inches by multiplying by 12 and dividing by the number of feet in the run of the rafter which will give the rise per foot of run as shown in Figure 117.

3. Place the timber to be laid out with the full or convex edge from you, and place the square with roof framer's fence in position near the end as shown in Figure 118 at *A*, and mark for the end cut or facia line *ab*. Move the square to *B* and draw the plumb line *cd*, then to *C* and draw *ef* or wall line which is 3 inches from *cd* and parallel with it. Place the square at *D* for the seat cut *gh*; the location of this cut may vary according to plans and the size of the rafter stock.

4. From the intersection of the line *ef* with the top or pitch line of the rafter, step along with the square as many times as there are feet and fractions of a foot in the run of the rafter proper, *LL*, *LL*, etc., and draw the center line *jk*.

5. From the center line measure back one-half the thickness of ridge board and mark for the plumb cut.

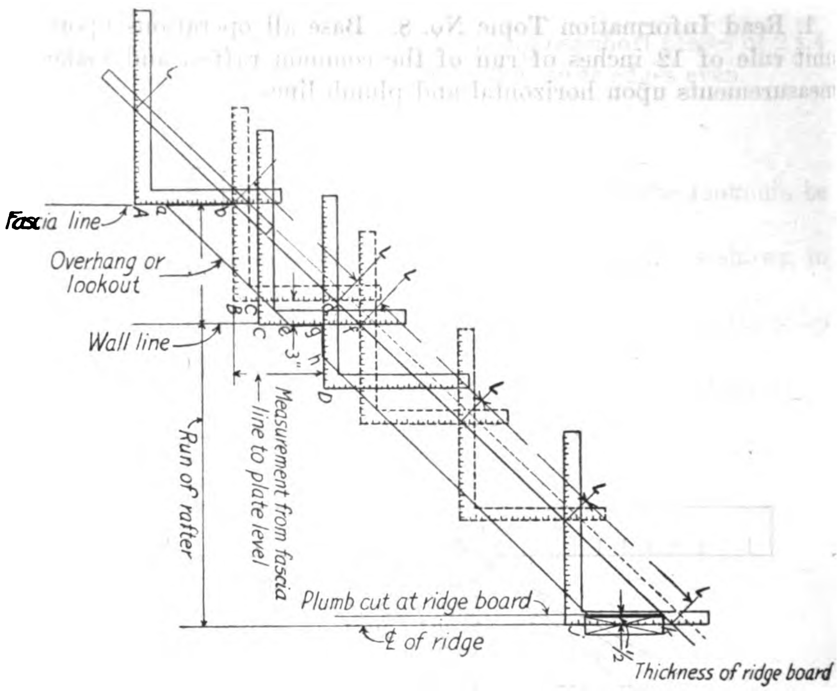


FIG. 118.—Laying out rafter.

QUESTIONS.

1. Why use the unit rule of 12 inches of run in the laying out of rafters?

2. What would be the figures on the blade and the tongue of the square if the run of the rafter was 8 feet and the total rise 6 feet 6½ inches?

3. What is meant by full pitch, one-half pitch, and one-third pitch?

4. What is the purpose of the ridge board? Is it necessary to use it?

5. Why should the rafter be placed with the convex edge up?

LAYING OUT HIP AND VALLEY RAFTERS FOR SQUARE-CORNERED BUILDINGS WITH ROOFS OF EQUAL PITCH.

1. Read Unit Operation No. 34 and Information Topic No. 8.

2. Figure 156, Information Topic No. 8, shows a roof plan in which the run of either the hip or valley rafter is equal to the diagonal of a square having sides equal to the run of the common rafters. For obtaining the length and for the laying out of the hip and valley rafters, use the 17-inch mark (which is length of the diagonal of a 12-inch square) on the blade of the square, and on the tongue the point indicating the rise per foot of run of the common rafter.

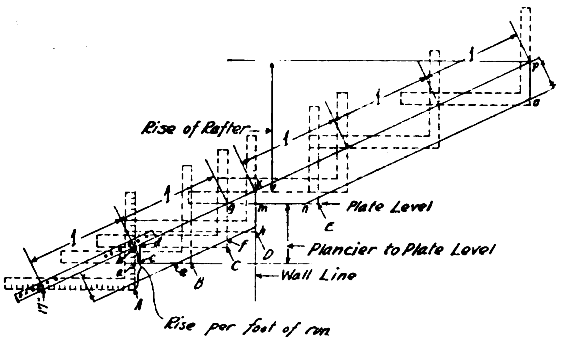


FIG. 119.—Layout of hip and valley rafter.

3. Place the timber to be laid out with full or convex edge from you. With roof framer's fence, set to proper points, place the square near the end as shown in Figure 119 at *A* and mark for the end line *ab*. Square this line over to the center line of the rafter. At a distance from the end line equal to one-half the thickness of the rafter mark for *cd*. Carry this line square across the top edge of the rafter and draw a plumb line on the reverse side. Connect these points as *m g n*, Figure 120, which when cut on these angles and on the plumb lines will produce the end as shown.

4. Move the square to *B*, Figure 119, and draw line for plancier level *ae*. Then move to *C*, 1 foot of run, and draw *fg*, and 3 inches of run to *D*, and mark for the wall line *hk*, which is $4\frac{1}{4}$ inches from *fg* and parallel to it ($\frac{3}{12}$ by 17 inches equals $4\frac{1}{4}$ inches). Place the square at *E* to produce the seat cut *mn;* the location of this cut may vary according to plans and the size of the rafter stock.

5. For the intersection of the line *hk* with the top or pitch line of rafter, step along with the square as many times as there are feet and fractions of a foot in the run of the rafter proper *l*, *l*, *l*, and draw the center line *op*.

6. To lay out the cheek cut, if a ridge is used as shown, Figure 120, measure back from the center line *op* a distance equal to one-half the diagonal thickness *A* of the ridge board and draw the plumb line *qr*. At *r*, square the line over the top edge of the rafter to the center line at *u*, which is the point where the center line of the rafter intersects the ridge. From *qr* measure back a distance equal to one-half the thickness B of the hip rafter and draw the plumb line *st*.

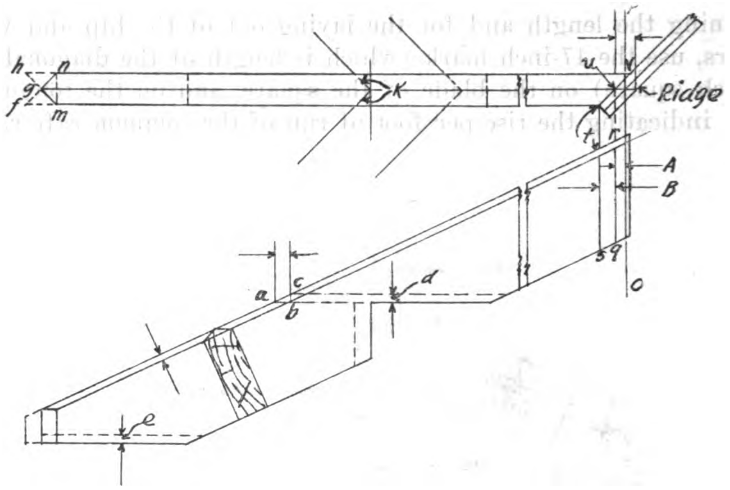


Fig. 120.—Hip rafter.

On the top edge of the rafter from *t*, through *u*, draw the line *tv*, producing the angle of the plumb cut or cheek.

7. In order that the roof sheathing may lie flush with the common rafters it is necessary to either back the hip rafter or drop it. Draw, as in Figure 120, the line *ab* equal to one-half the thickness of the hip rafter. A line drawn through *b* parallel with the top edge of the rafter will give the required amount of backing. If the rafter is to be dropped, draw the plumb line *bc*, and the distance from *b* to *c* will be the amount of drop, and must be taken from the seat cut and plancier level at *d e*.

8. The layouts of the valley and hip rafters are the same, except that no backing or drop is required on the valley rafter, and that the end or fascia cut is reversed, as shown at *fgh*, in Figure 120, and the seat cut is made to clear the plate, as shown at *k*.

9. Second method of finding the angle for the cheek cut of the hip and valley rafters: Take the length of the diagonal of 17 inches and the rise per foot of run, on the blade of the square and 17 inches on the tongue. Lay the square on the top edge of the rafter to these figures and a line drawn along the blade of the square will give the points from which to draw the plumb lines for the cheek cut.

QUESTIONS.

1. Why use 17 inches on the square per foot of run in laying out hip or valley rafters?
2. What is meant by backing the hip? Dropping the hip?
3. Why is it unnecessary to drop or back the valley rafter?
4. Which is the more practical method, to back or drop a hip rafter?
5. What would be the run of a hip rafter in a roof of one-quarter pitch on a building 28 feet wide with an overhang of 18 inches?

LAYING OUT JACK RAFTERS FOR SQUARE-CORNERED BUILDING WITH HIP ROOF OF EQUAL PITCH.

1. Read Unit Operation No. 35.

2. Figure 156, Information Topic No. 8, shows a roof plan of a hip roof of equal pitch for a square-cornered building in which the rafters are spaced 16 inches on centers and the rise of the common rafter is 8 inches per foot of run. Set the roof framer's fence to 12 inches on the blade and 8 inches on the tongue.

3. As the run of the common rafter in the hip roof of equal pitch is equal to the distance from the adjacent wall line to the center line of the rafter, measured at right angles to the run of the rafter, the run of any of the jack rafters is equal to the distance from the wall line to the center line of the jack rafter measured in like manner.

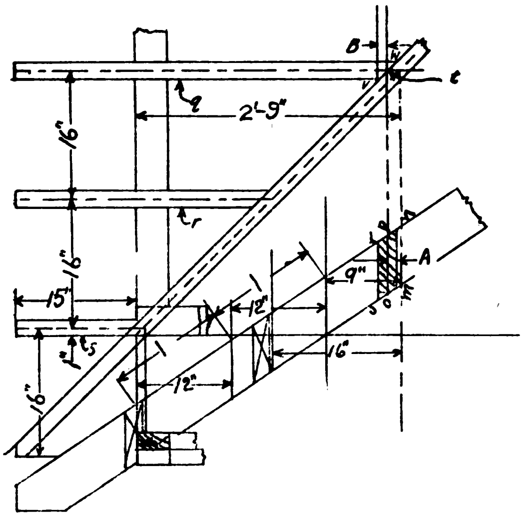


FIG. 121.—Laying out jack rafter.

4. Place the crowning edge of the rafter stock from you, and with the square placed as in Figure 118, Unit Operation No. 34, mark for the end or fascia cut, the plancier cut, wall line and seat cut. Proceed in the same manner as for the layout of the common rafter. Consider the tail or overhang of the rafter as a separate part and that the rafter proper begins at the wall line. In Figure 121, measuring along the plate, we find the center lines for the short jack rafter spaced 1 inch from the adjacent wall line, then regular spacing of 16 inches. Therefore, 1 inch plus 16 inches plus 16 inches, or 2 feet 9 inches, equals the run of the jack rafter *q* to the center of the hip rafter *mn*, Figure 121. To lay out the cheek cut, measure back from the center line *mn* a distance equal to *one-half* the *diagonal* thickness of the hip rafter and draw the plumb line *op*. At *p*, square the line over the top edge of the rafter to the center line at *t*, which is the point where the center line of the jack rafter intersects the ridge. From *op* measure back a distance equal to *one-half* the *thickness* of the jack rafter and draw the plumb line *uv*. On the top edge of the

jack, from *v* through *t*, draw the line *vw*, producing the angle of the plumb cut or cheek. A bevel laid on the top edge of the rafter and set to the angle just found will serve also for the rafters *r* and *s*, after locating the point at which their center line will intersect the hip rafter.

5. The run of the *valley jacks* is obtained from the spacing of the center lines on the ridge. Lay out with the square, set to the unit run and rise. Make the reduction of one-half the thickness of the ridge piece and one-half the diagonal thickness of the valley rafter. Draw the angle and plumb lines for the cheek, and when cut the valley jacks will be found to fit into their proper positions.

6. *Cripple jack.*—The run of the *cripple jack* rafters is the same as the distance between centers of hip and valley rafters. In laying out the cheek cuts which occur on both ends of the cripple rafter reduce the length on the run the equivalent of one-half the diagonal of thickness of both the hip and valley rafters and produce the angle for the cut, as described in paragraph 4. The positions of the cripple rafters must be spaced on hip or valley rafter, as they do not naturally seek their position, as do the jacks and valley jacks.

7. *The steel-square method of getting angle of cheek cut.*—Take the length of the diagonal of the run and rise per foot on the blade of the square and the run of 12 inches on the tongue. Lay the square on the top edge of the rafter to these figures, and a line drawn along the blade through the point at which the center line of the jack rafter intersects the hip or valley rafter will give the points from which to draw the plumb lines of the cheek or side cut.

QUESTIONS.

1. Why is the length of the run of a jack rafter equal to the distance from the wall line to the center of the jack measured at right angles to the run of the rafter?

2. What would be the run of the fourth jack if spacing was 24 inches on centers, overhang of roof being 15 inches?

3. Why is the run of the cripple jack rafter the same as the distance between centers of hip and valley rafters?

4. Would the method of getting length of jack rafters in a roof of equal pitch be the same in one of unequal pitch? Why?

5. How would the angle of the cheek cut of a jack rafter be obtained by the steel-square method? Show by sketch the figures used on the square and position on the rafter of a one-third pitch roof.

6. On a hip roof with open cornice how would the rafters be spaced?

ERECTING ROOF FRAMES.

1. Lay a safe temporary floor upon the upper or attic floor joists and erect a scaffold under the ridge, either by the use of trestles or other scaffolding. The platform of this peak scaffold should be about 4 or 5 feet below the ridge and about 3 feet wide, so that the workmen standing on it may readily reach and nail the rafters at the ridge.

2. Lay off spacing for the rafters on the plate and ridge board. Place the rafters out near the location in which they are to be erected. Have two men on the scaffold and two at the plate. If erecting a gable roof, raise one of the pair of rafters at the end of the gable, these being selected straight rafters. Back nail the ridge board to the rafter and raise it and the ridge to its position, one man at each end holding it while the man at the plate spikes the rafter securely to it. Raise the second rafter of the pair and spike to the plate and ridge, toenailing it securely. The men at the plate then move to the other end, pass up the rafters and repeat the operation. If the ridge is made up of more than one length of material, erect the second pair of rafters where the first length joins the second piece. The joint of such ridge board should be located on the center line of the rafter and this point considered when the ridge board is laid out and cut.

3. Stretch a line across the gable at the seat of the rafters, and when a plumb dropped from the peak intersects the crossline brace temporarily with a diagonal from the ridge board to the end plate or floor beams. After plumbing fill in the intermediate rafters, being careful not to force the ridge out of line in nailing the rafters at the peak.

4. In erecting a hip roof commence by raising the pair of common rafters one space from the end of the ridge. In a roof where there is a hip and valley, as in Figure 156, Information Topic No. 8, the hip and valley, which are cut so that their ridge cuts abut, should be placed after the first common rafters near the other end are set up and stayed. Nail the ridge securely in place and complete the frame by erecting the other hips, valleys, commons, jacks, valley jacks, and cripples. A roof of this character, if the members are carefully laid out and cut, will require very little plumbing, as the various members tend to bring the whole roof structure into proper alignment.

5. Keep in mind the theoretical center lines in the erection of a roof of this type, that the planes or slopes of the roof may meet in proper relation to the plan.

QUESTIONS.

1. The ends of valley jacks must be placed so that the upper edge of the cheek cut at the valley rafter is some amount above it. How much? How would it be found other than by trial?

2. Why is it necessary to locate on either the hip or valley rafter the positions of the cripple jacks?

3. How is the length of the ridge board found?

4. Find the length of the ridge board of a square-cornered building, 24 feet by 32 feet, hip roof of equal pitch. Ridge board to be 1 inch thick and hip rafters to be 2 inches thick.

FRAMING DORMERS.

1. Frame the opening for the dormer as shown in Figure 122. Double the rafters or trimmers at each side and place the doubled

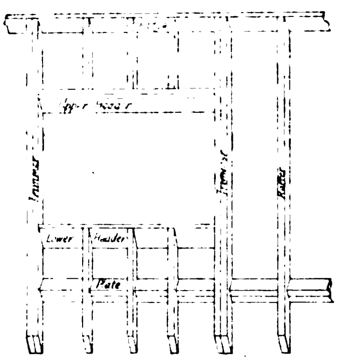


FIG. 122.—Framing opening for dormer.

upper header at the height of the dormer plates. Double the corner posts.

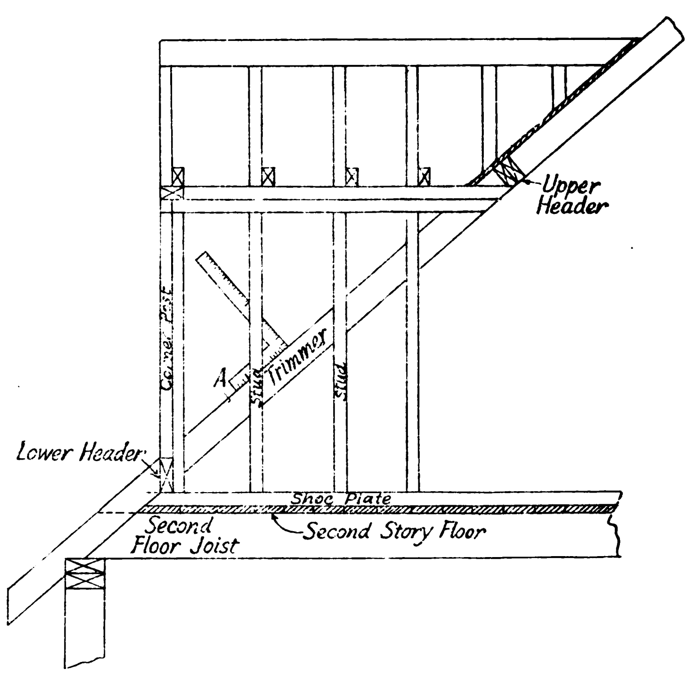


FIG. 123.—Laying out small dormer.

2. Space the studs as shown in Figure 123 on a shoe plate resting on the floor.

3. Cut the plate to fit against the trimmer as shown in Figure 123. Frame in the upper header as shown, to allow nailing space for lath.

4. If the dormer is small, the studs in its side walls may be cut to rest on top of the trimmers. If this is done to cut the lower ends, use the run of the common rafter on the blade and the rise on the tongue as shown at *A*, Figure 123. Mark along the tongue for the cut. In this case the ends of the dormer plate will rest on the trimmers. To make the cut, use the run on the blade of the square and the rise on the tongue. Mark along the blade for the cut.

5. Cut the common rafters, valleys, and jacks as in any gable roof.

QUESTIONS.

1. Why are the upper headers and corner posts of dormers made up of two pieces?

2. Should the spacing of the studs of a dormer be the same as for the walls?

ERECTING SCAFFOLDS.

1. Saw a sufficient number of 2 x 4s to a length slightly greater than the height of the building. The posts should be 6 to 8 feet on centers.

2. Cut twice as many 1 x 6s, 3 feet long, as there are posts.

3. Lay the posts on the ground and nail two 1 x 6s at right angles to each post, with the 6-inch face of the 1 x 6 against the 4-inch face of the 2 x 4. The position of the 1 x 6s will depend on the height of the proposed walk ways.

4. Set the posts upright and nail the horizontal 1 x 6s to the sheathing. Place small blocks, usually of 7/8″ stock, along the vertical

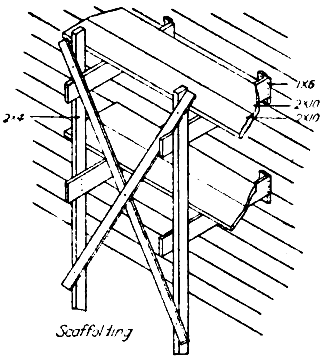


FIG. 124.—Scaffolding.

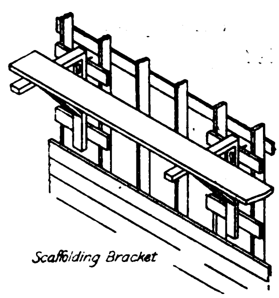


FIG. 125.—Scaffolding bracket.

faces of the 1 x 6s and nail to the sheathing, and then nail the horizontal 1 x 6s to the blocks. See Figure 124.

5. Cut diagonal braces out of 1″ x 3″ stock, and to such length as to cover more than one-half the height of the posts. Nail these cross-braces to the posts as shown in Figure 124.

6. Lay two 2 x 10s on top of the horizontal 1 x 6s to form the walk ways.

7. In laying siding or sheathing, scaffold brackets as shown in Figure 125 are often used. These brackets may be purchased at a hardware store, or can be built out of 2″ x 4″ stock to any convenient size.

QUESTIONS.

1. What is the purpose of the cross-bracing?

2. How many nails should be used at the ends of the horizontal pieces?

3. How many nails should be used to connect the horizontal 1 x 6s to the posts?

4. Why are the blocks used at the ends of the horizontal pieces?

PUTTING ON SHEATHING.

1. Read Information Topic No. 10, wall covering.

2. To lay rough sheathing diagonally, begin at a lower corner. Take a board; at one end lay the square as shown in Figure 126, with the point of the angle at one edge of the board and the same figures on the tongue and blade at the other edge. Mark along the outside edges of tongue and blade. Saw on these lines to make the corner piece.

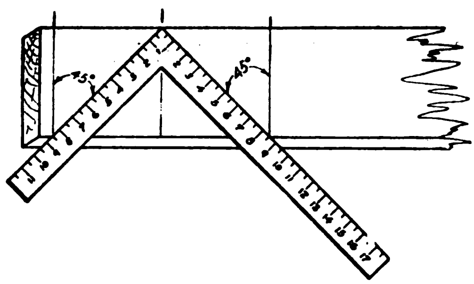


FIG. 126.—Laying out 45° angles.

3. Turn the board over and place the longest edge of the corner piece at *AB*, Figure 127. Mark the point *B* on the board *M*. Draw the line *BD* as shown in Figure 127. Saw on this line to make the second sheathing piece.

4. Repeat, using the second wall piece to lay out the third wall piece, etc.

5. Where the board is too short to reach the entire length, always make the joint on the center line of a stud.

6. The wall piece should be nailed as soon as used for marking. Use 8d. nails, and place a nail within 1 inch of the edge of each board and the intervening nails not farther than 3 inches apart.

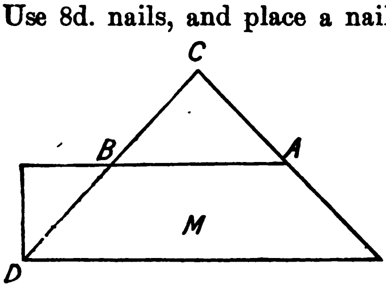


FIG. 127.—Laying out diagonal sheating.

7. Let sheathing project into or across openings when nailing it on, and after the walls are sheathed saw sheathing along the inner face of the openings.

8. To put on sheathing at right angles to the studs, begin at the bottom and nail each board tight to each joist, using 8d. nails, and place a nail within 1 inch of the edge of each board and intervening nails not farther than 3 inches apart.

QUESTIONS.

1. Why should joints of sheathing be along the center line of studs?
2. Which is the better way to lay sheathing, diagonally or at right angles to the studs?
3. Should the sheathing be nailed at every joist?
4. What is the minimum number of nails that should be used at the ends of sheathing boards?

WATERPROOFING AROUND EXTERIOR OPENINGS.

1. For each side of the opening cut one strip of insulation material such as rosin-sized building paper, tar paper, or tar felt, 6 to 8 inches wide and about 8 inches longer than the length of the side.

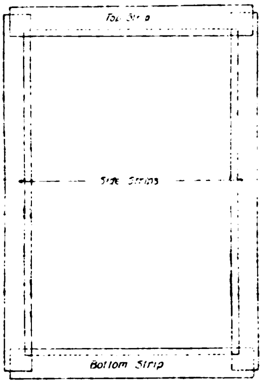


FIG. 128.—Tacking on waterproofing strips.

2. Tack the bottom or sill strips along the bottom of the opening with the top of the strip extending about 1 inch above the bottom of the opening.

3. Tack the side strips along the sides of the opening with the lower ends overlapping the bottom strip about 4 inches and the inside edges folded back 1 inch, as shown in Figure 129.

4. Fasten the top strip along the top of the opening with the ends overlapping the side strips about 4 inches and the lower edge extending about 1 inch below the top of the opening.

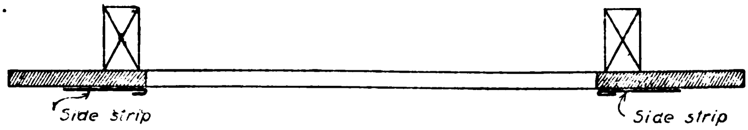


FIG. 129.—Folding back side strips.

QUESTIONS.

1. Why are the top and bottom strips made to extend beyond the edges of the opening?

2. Why are the side strips folded back along the edges of the opening?

ROOF SHEATHING AND STRIPPING.

1. Lay the square on the board as in Figure 130 *A*, using the length of the common rafter on the blade and the run of the common rafter on the tongue. Mark along the tongue. This gives the side cut where the board rests on a hip or valley.

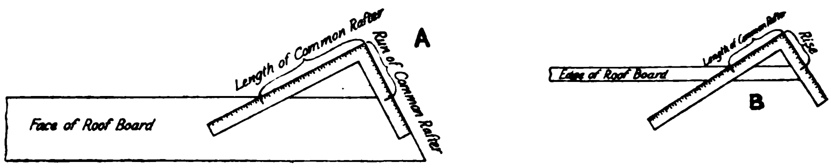


FIG. 130.—Use of square in laying out roof sheathing.

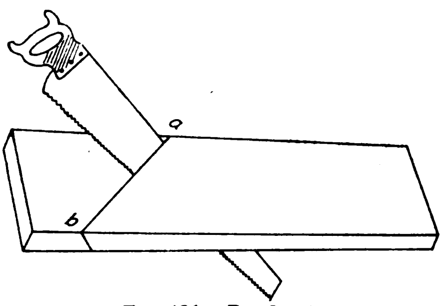


FIG. 131.—Bevel cut.

2. Lay the square on the edge of the board at the side-cut mark, using the length of the common rafter on the blade and the rise of the common rafter on the tongue, as in Figure 130 *B*. Mark along the tongue. This gives the bevel cut of the roof boards. See Figure 131.

3. Lay the board with the face of the bevel cut at the center of the hip or valley as shown in Figure 132.

4. Nail with three or more nails at each rafter and break all joints on a rafter.

5. If very careful fitting of roof boards is not required, lay the board across the hip or valley and mark the lower edges of the boards at the center of the hips, as *A* and *B*, Figure 132. Holding the saw at an angle to the face of the board, saw from *a* to *b* as shown in Figure 131.

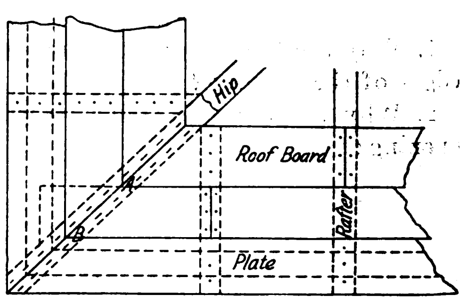


FIG. 132.—Nailing roof sheathing.

6. If roof strips are to be used, they may be cut just as solid sheathing. Use 1″ x 4″ lumber spaced about 2 inches apart.

7. Measure along two rafters about 12 feet apart, marking the position of the lower edge of the strips. Nail on the strip at the lower

end of the rafters and drive down partly a 6d. or 8d. nail at each mark on the two rafters. Make the spacing of the strips conform to the weather exposure of the roofing material.

8. Lay strips against the nails all the way to the ridge and nail down with 8d. common nail.

QUESTIONS.

1. Under what condition should roof sheathing be used solid and as stripping?
2. Why not lay roof sheathing diagonal to the rafters?

FLASHING.

1. To flash over a hip, bend the tin to the angle of the hip. When the first course of flashing shingles is laid, turn the lower corners under the ends of the roof shingles and drive them up snug. Nail the flashing shingles at the upper corners so that the next course of shingles will cover the nails. Repeat this operation as each course of shingles is laid. See Figure 133.

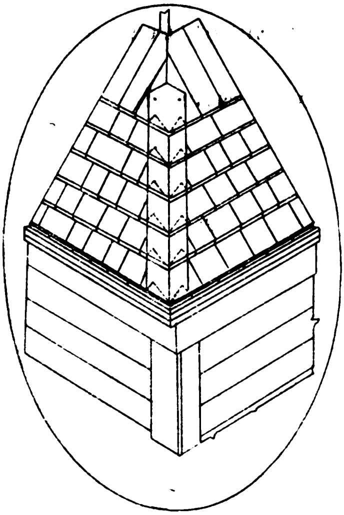


FIG. 133.—Hip flashing.

To flash around a chimney, first flash the upper side. Take a sheet of tin, zinc, or copper about 2 inches wider than the chimney, bend as shown in Figure 134*x*. The mortar between the bricks is scratched out and *B* is put in place and cemented. *C* extends up under the shingles. The lower side is flashed in the same manner, but the sheet is the same width as the chimney and the side *F* is placed on top of the shingles.

3. Flash the sides of chimney as the shingles are laid. Bend a piece of tin. See Figure 134Y. Put *H* between courses of brick and *J* on top of one course of shingles with the upper end under the next course of shingles. Let the next flashing overlap the first. A somewhat simpler method, called counterflash-

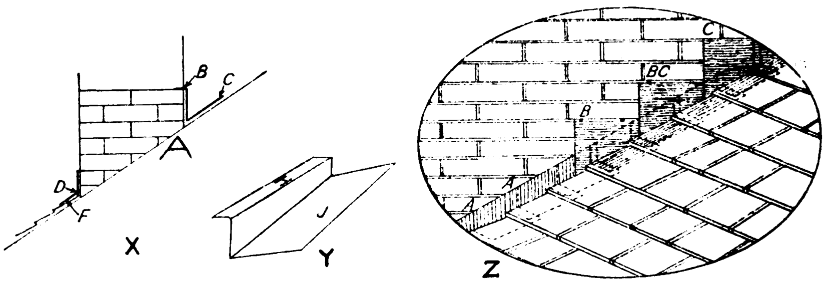


FIG. 134.—Flashing around chimney.

ing, consists of bending pieces of tin at right angles, placing on one side a course of shingles projecting under the next course, with the other side upright against the chimney. See Figure 134Z at *A*. Another tin is then bent at right angles. One side is placed between courses of brick with the other overlapping those on the shingles. See Figure 134Z at *B* and *C*.

4. To flash between a roof and siding, follow either of the above methods, inserting the vertical side of the flashing between the sheathing without bending as at *H*, Figure 134Y.

QUESTIONS.

1. Why is the flashing at *B*, Figure 134X, turned into the joint of the masonry?

2. Why is metal generally used for flashing?

3. What are the forms of flashing shown in Figure 134 called and what purpose do they serve?

PUTTING ON SIDING.

1. To put on bevel siding, measure the distance from the top of the water table cap to the plate line in inches. Divide this number by the required exposure "to the weather" of the siding, which is usually 4 inches or $4\frac{1}{2}$ inches. The number thus found will usually be a whole number and a fraction; for example, if the height of the wall is 143 inches and the siding is to show about $4\frac{1}{2}$ inches to the weather, there will $143 \div 4\frac{1}{2}$ boards showing, or $31\frac{7}{9}$ boards. Seven-ninths of $4\frac{1}{2}$ inches is $3\frac{1}{2}$ inches. This $3\frac{1}{2}$ inches should be distributed over the 31 boards. $3\frac{1}{2}''/31$ is a little more than $\frac{1}{8}$ inch. Then if the boards are exposed $4\frac{5}{8}$ inches instead of $4\frac{1}{2}$ inches, the 31 boards will cover the wall. In determining the exposure, make allowances for door and window open-

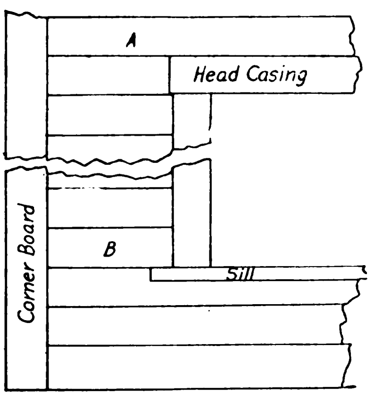


FIG. 135.—Spacing siding for openings.

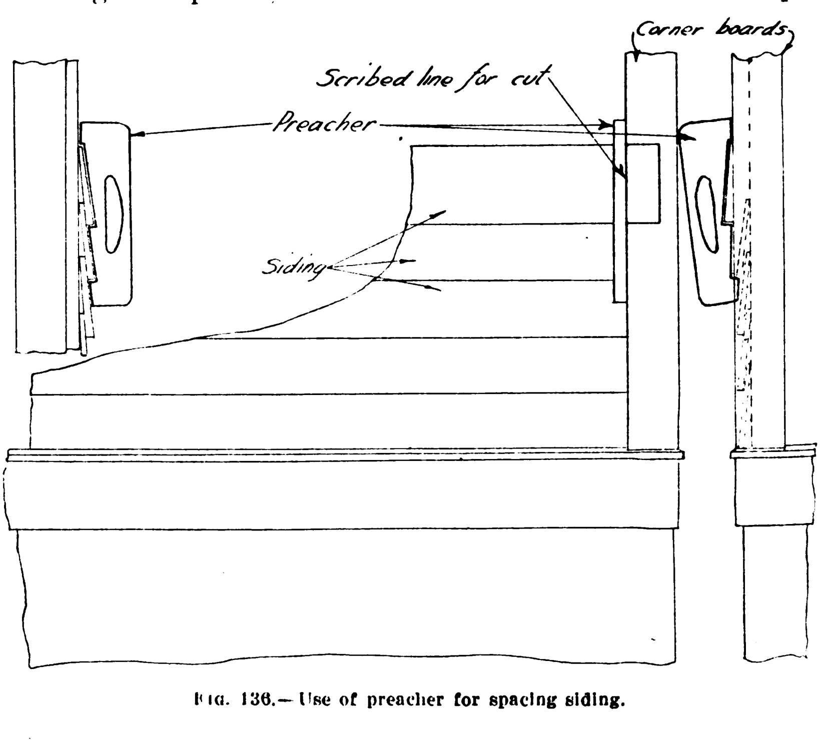


FIG. 136.—Use of preacher for spacing siding.

ings, so as to have the bottom edge of the siding come flush with the top of the sills and head casings, as shown in Figure 135.

2. After finding the proper exposure for each board, make a templet or "preacher," as shown in Figure 136. This may be made from a piece of 1-inch scrap lumber.

3. Cut the ends of siding perfectly square across the face and slightly undercut along the edge. This brings the end tight against the trim or the end of another board. To make a tight joint with the trim scribe the end cut with the preacher, as shown in Figure 136.

4. Nail on the first siding board, which must fit tight on the water table cap. Measure up $4\frac{5}{8}$ inches from the lower edge at each end of this board and at two or three places along its length. Nail on the second board, holding its lower edge on the marks just made, sighting it to make sure it is perfectly straight.

5. For the rest of the boards hold the preacher on the last board nailed and lay the new board on the upper notch of the preacher. Apply the preacher at two or three places along the length of the board and at both ends before nailing down.

6. Every three or four courses sight along the thick edge of the last board nailed to be sure the boards are straight.

7. Break all joints at the center of a stud. Be careful to distribute joints over the wall so that they do not occur together.

8. Nail with casing nails. Place one nail at each stud so as to catch two boards.

9. To fit the siding up around windows hold the board up under the sill and mark at the ends of the sill. With a try-square mark down on the face from these marks the depth of the piece to be cut out. With a straightedge or marking gauge mark from one line to the other at the depth of the cut. Saw on the inside of the two end lines and at several places near one end of the part to be removed saw down several times. Break out the blocks formed and insert a ripsaw. With the ripsaw saw from one end of the cut to the other.

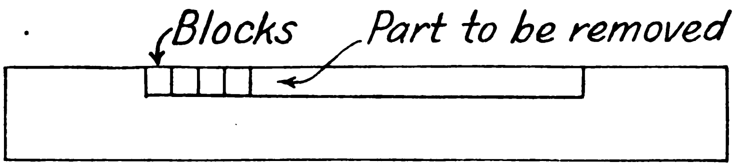


FIG. 137.—Fitting siding around openings.

QUESTIONS.

1. Why should beveled siding line up either with the top or bottom of window sills?

2. Is there any advantage in using beveled siding?

PUTTING ON SHINGLES.

1. Place all metal or composition valleys before shingling begins.

2. Strike a chalk line on the valley to show the line of the shingles at the valley. This should be from 1 to 2 inches each side of the center line of the valley at the top and from 2½ inches to 4 inches back from the center line at the bottom.

3. Nail one shingle at each lower corner of the roof, making it project at least 1 inch beyond the sheathing at the bottom and ½ inch at the ends.

4. Drive a shingle nail in the lower end of each of the shingles just laid and stretch a line between them flush with the butts of the shingles.

5. Lay one course of shingles, using the line as a guide for the lower ends. If the shingles are dry, leave ⅛ inch between shingles to allow for expansion. Lay another course directly on top of the first one, but breaking joints with it. Do not have the spaces between shingles in the second course directly over the spaces in the first course. Place all nails at least 8 inches from the lower end of the shingles. Use two nails for each shingle, putting one within ¾ inch of each side.

6. Use a light hatchet for nailing. At valleys and on hips saw the shingles to fit the angles. Split shingles that are wider than 8 inches.

7. After the first course is nailed use either a chalk line or straightedge for lining the shingles. If a straightedge is used, it should be the width that the shingles are exposed to the weather. If a chalk line is used, snap three lines at a time. Nail the three courses at one time. Begin by putting on two shingles of the first, a half and one of the second and one of the third course, and continue in this manner, keeping the first course one shingle ahead of the second and the second course a shingle ahead of the third.

8. Put metal flashing on the hips and about the chimneys.

9. Directions for the laying of composition shingles usually come with the package. Most of them are laid on the same general plan as wood shingles, but no flashing shingles are necessary on hips, as the shingle can be bent to fit.

QUESTIONS.

1. Why should shingles be laid to break joints?
2. Why is it more efficient to lay three courses of shingles at a time?
3. Why should no nailheads show on the surface of the roof?

PLACING PLASTER GROUNDS.

1. Determine from the specifications the location and necessary thickness of the grounds. If the specifications do not expressly state, make the thickness $\frac{5}{8}$ inch for plaster applied directly to brick or tile walls and for metal lath on wooden stud walls $\frac{3}{4}$ inch for two-coat work on wooden lath and $\frac{7}{8}$ inch for three-coat work on wooden lath.

2. If strips for grounds are not on hand (supplied by the mill), rip out of stock of the required thickness strips of the required width. Ascertain the required width of grounds from the specifications.

3. Measure the height and width of door and window openings and saw a strip for each door and window jamb and head.

4. Set the strips so that their edges adjacent to the openings will be covered at least $\frac{1}{2}$ inch by the casings, and allow spaces of at least 1 inch for lath. Nail to the studs.

5. To secure true surfaces at the sides of door openings, rip out of $\frac{7}{8}$-inch stock pieces about $\frac{1}{2}$ inch wider than the width of finished wall and true both edges to exact width. Measure and cut jamb and headpieces. Nail the pieces to the sides and head of the door openings, taking care to plumb up the sidepieces and have edges in line with finished wall surfaces. See *B*, Figure 138.

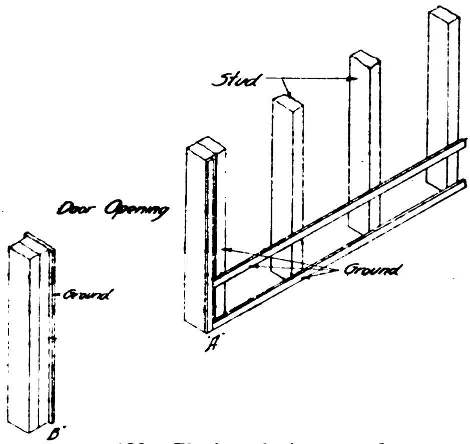


Fig. 138.—Placing plaster grounds.

6. Measure and cut strips for the walls of rooms and halls, making due allowance for openings and for two parallel strips, as shown in Figure 138.

7. Fasten the strips with a 6d. nail at each bearing.

QUESTION.

1. How is the door jamb placed when the type of grounds described in paragraph 5 is used?

2. Why use two grounds at the bottom of the walls?

3. What other method of providing for grounds could be used at the base of a room?

FURRING.

1. Around a chimney set the studs with the 4-inch side parallel to the face of the brickwork and not less than 1 inch therefrom. Toenail the studs at their lower ends to plates set on the rough flooring and

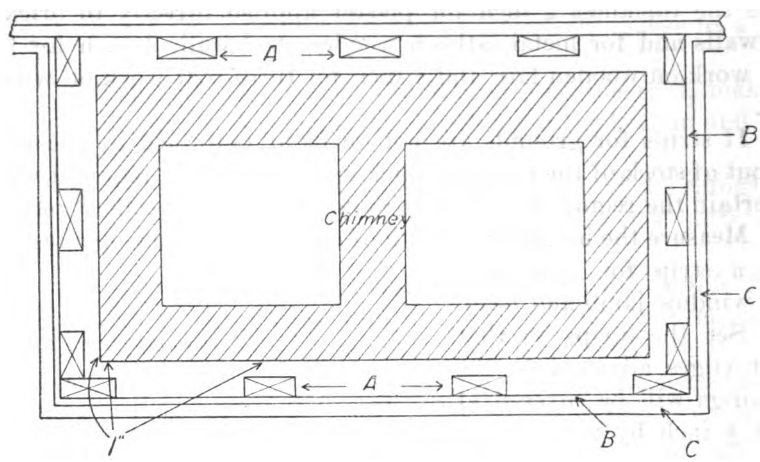


FIG. 139.—Furring around chimney.

at their upper ends into the header and trimmers. At the outside corners use two studs nailed together to form a right angle. The lath *B* and plastering *C* are applied to the studs as shown.

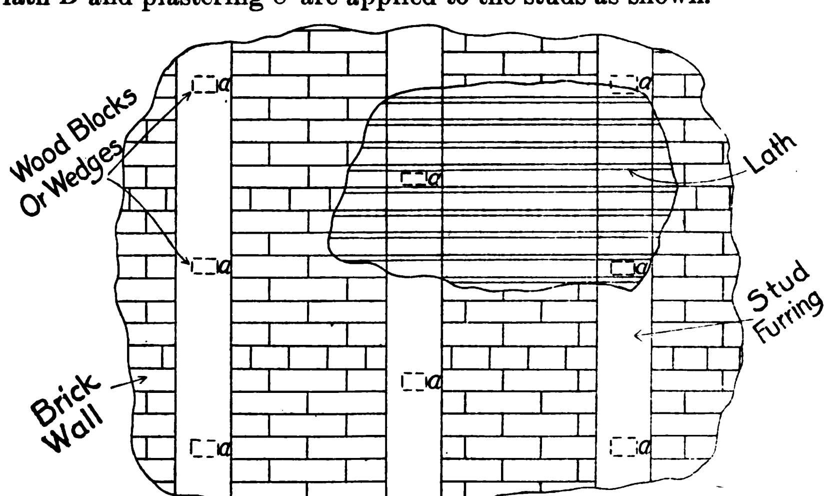


FIG. 140.—Furring on brick walls.

2. In order to plaster on a brick wall set wood blocks or plugs into the wall in vertical rows 16 inches on center. These blocks should be spaced about 3 feet vertically and staggered as shown in Figure 140, *a*, *a*, *a*, *a*.

3. Place the furring strips, 1 x 2 inches, 2 x 3 inches, or 2 x 4 inches, on the lines of blocks, and with the faces against the surface of the wall. Nail the strips to the blocks.

4. Nail laths to furring in the usual manner.

QUESTIONS.

1. Why are the furring strips or studs set flat, or with their faces parallel to the masonry surfaces?

2. Why not nail the furring strips directly to the masonry wall?

3. Why are the furring strips placed at least 1 inch from the surface of chimneys?

4. What is the purpose of furring? Why not plaster directly on the masonry wall?

PLACING INSULATION MATERIAL.

1. After the outside door and window frames are in position, and have been properly waterproofed, apply the building or sheathing paper in accordance with the architect's specifications. Tack the first sheet of paper or insulating material along the bottom of the wall sheathing, cutting out for openings, where the sheet should lap under the waterproofing material at least 2 inches. In like manner, apply succeeding layers of paper, lapping over at lower side and end joints at least 2 inches.

2. If, as required by the specifications, a sheathing felt or quilt has been applied to the walls, nail laths vertically over the studs to provide nailing strips for the siding.

3. Commencing at the eaves or gutter line of the roof, tack a strip of the building paper or insulating material, required by the architect's specifications, on the roof boarding. Cut out for scuttle holes, chimneys, and skylights, and lap the material under the insulation or flashing at least 2 inches. Apply successive layers of paper or insulation material, lapping side and end joints at least 2 inches.

4. After the lower flooring has been laid, tack a strip of paper, felt, or quilt as required by the architect's specifications, on the boarding and along the wall of the longer side of the room. Apply successive strips parallel to the first and lap over side and end joints at least 2 inches.

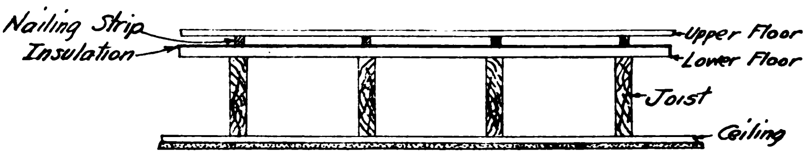


FIG. 141.—Arrangement of nailing strips on felt or quilt.

5. If felt or quilt is used, nail wood strips about 1¾ by 1½ inches over the joists to serve as nailing strips for the upper floor.

QUESTIONS.

1. Why are strips necessary where felt or quilt is used?

2. Why is an insulation material used on walls, roof, and between floors?

3. What are the best kinds of insulation to provide for the following: Fireproofing, waterproofing, vermin and rat repellent, and sound-proofing?

BUILDING STRAIGHT STAIRWAYS.

1. Find the height in inches from the top of one floor to the top of the next floor. Find the length in inches of the allowable space for the stair, which is the run of the stair. The width of one tread plus the height of one riser should equal about 17 inches. The riser

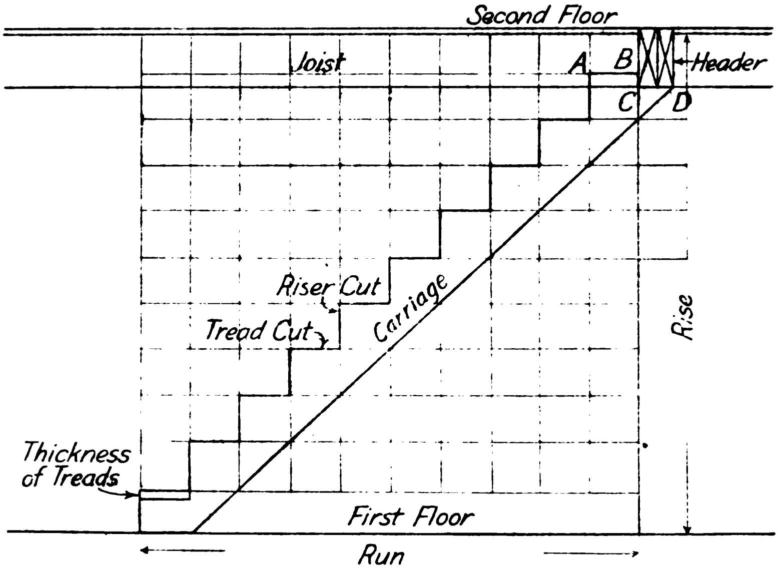


FIG. 142.—Carriage layout.

should not be less than 6 inches nor more than 8 inches for a comfortable stair. Decide on the number of risers desirable and divide this number into the number of inches in the rise of the stair. The number thus found gives the inch mark to use on the tongue of the square for the riser cuts.

2. There will be one more riser than there will be treads. Divide the number of inches in the run of the stair by one less than the

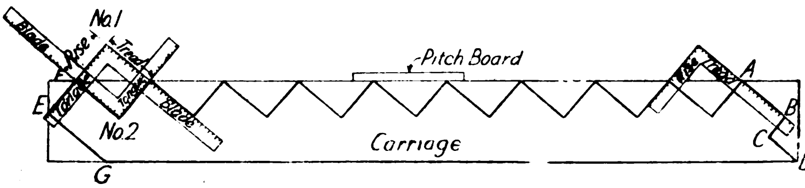


FIG. 143.—Laying out carriage.

number of risers. This gives the inch mark to use on the blade of the square for the tread cuts.

3. At the lower end of the carriage hold the square so that the rise and tread marks are on the upper edge of the carriage. Slide

the square back and forth until the distance from the edge along the square to the end as *EF*, Figure 143, equals the height of a riser less the thickness of a tread. Draw the line *EF*.

4. From *E* with the tongue of the square lying along *EF* lay off *EG* along the blade.

5. With the square held with the riser and tread marks on the upper edge of the carriage as shown at No. 2, Figure 143, mark along the tongue and blade.

6. Using the same marks on the tongue and blade step along the carriage marking off the other risers and treads.

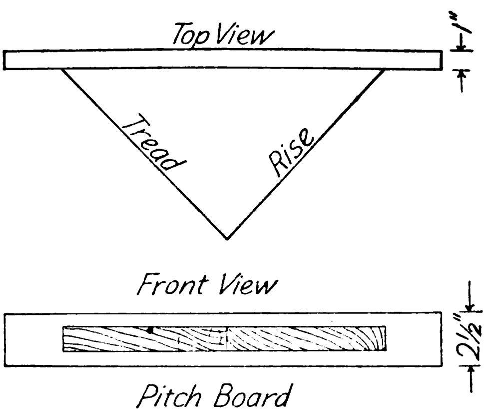


FIG. 144.—Pitch board.

7. At the last position of the square, as at point *A*, Figure 143, turn the square over as shown and lay off *AB* equal to a tread.

8. Lay off *BC* square with *AB* and of sufficient length to reach the bottom of the header. See Figure 143. Lay off *CD* square with *BC*.

9. A pitch board may be made and used in place of the square as indicated in Figure 143. The dimensions of the board are shown in Figure 144.

10. Determine length of treads and risers, allowing ⅜ inch on each end for housing. Lay off this length on stock and make two square end cuts for both tread and riser. With these as samples, cut as many treads and risers as required for stairways. Make width of tread equal to regular run plus width of nosing and ½ inch allowance for rabbet to frame into riser.

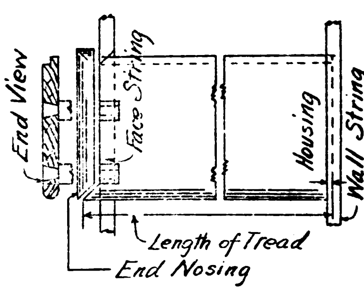


FIG. 145.—Detail of stair tread.

11. Where "open string" type of stairway is used, measure the length of a tread as the distance between faces of wall and face strings plus ⅜ inch for housing in wall string, and an additional allowance equal to the width of nosing. This last is to provide for the overhang. See Figure 145. For the riser, measure the distance between outside surfaces of the wall and the face strings and add ⅜ inch for

housing in the wall string. Cut end of tread to receive end nosing as shown in Figure 145.

12. Rabbet the bottom of the edge on the rear of each tread and plow a corresponding groove in the outer face of each riser.

QUESTIONS.

1. Why will there be one more riser than tread in a stairway?
2. How should provision be made for drainage of treads of porch steps?

FOUNDATIONS.

The building should be located where the subsoil is hard and underdrains readily. Glacial clay or gravel prove satisfactory if well drained. If it is necessary to erect a building on soft soil, such as silt or muck, piles should be driven to serve as a foundation. Piles are round, straight logs of oak, hard pine, or cypress, pointed on the lower ends and having a length of from 10 to 40 feet.

After one corner of the house is located, the foundation lines of the house may be laid out with a tape or with the use of a surveyor's transit. Where great accuracy is required, the transit should be used to measure the angles. The length of the lines should always be measured with a steel tape. The method of laying out a foundation is given in Unit Operation No. 51. Figure 146 shows the general appearance of the batter boards and lines of a building foundation.

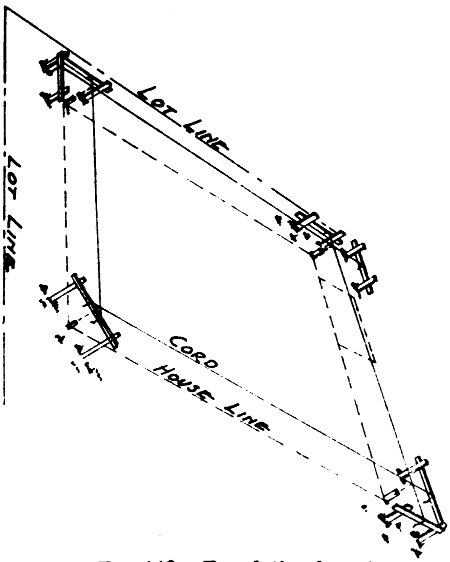


FIG. 146.—Foundation layout.

Excavation.—The excavation for the foundation walls should be made sufficiently large to provide for a footing course, and, in wet soil, for a drain at the bottom of the trench to carry off the water. In soft caving soil the sides of the excavation must be sloped or revetted and braced where necessary. The footing course should be carried down below the surface so as to be at least 6 inches below the lowest frost line.

Footing course.—The foundation wall is spread at the bottom in order to distribute the load from the building upon the supporting subsoil. The width of the footing course will depend upon the load to be supported and the bearing power of the soil. If brick or stone are used for the foundation wall, the footing course may be made by stepping out the wall on both sides until the proper width of wall is obtained.

Foundation walls.—Foundation walls may be constructed of stone, brick, or concrete. The latter has come into general use at the present time, even for small inexpensive dwellings, on account of the ease and cheapness of construction. The carpenter is principally concerned with the forms which are used for the holding of the concrete in place until it is set.

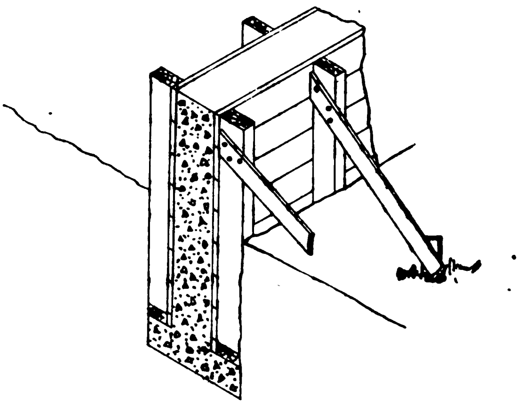


Fig. 147.—Concrete foundation form.

Formwork should be made of partly seasoned stock; and spruce, Norway pine, and white pine are generally used. Formwork is made of tongue-and-grooved sheathing, supported by vertical studs. The forms must be securely braced and tied together in order to take the pressure of the concrete.

The footing course is placed first and sometimes the wall forms are set upon the footing course after the concrete has set. If this method is used, rods or stone should be left projecting from the top of the footing course so as to form a bond for the wall above.

In large houses, where considerable length of wall is to be constructed, the forms are sometimes built in sections or panels. The use of sections or panels permits the construction of the wall in sections and the use of the panels several times. This method gives a maximum and economical use of the lumber in the form work.

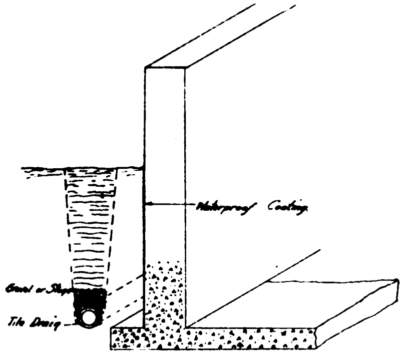


Fig. 148.—Waterproofing foundations.

Waterproofing.—Provision should always be made for the waterproofing of the basement or cellar of a building. Special protection must be provided where foundations are adjacent to running water. The waterproofing of the outside of a foundation wall may be done with a layer of neat cement, tar, asphalt, or alternate layers of tar and tar felt. The latter is called the bituminous-shield method and should be used where the foundation wall would be subjected to water under pressure. Tar or asphalt should be applied hot and in a layer having a thickness of about ½ inch.

A foundation drain should be made of agricultural tile, or sewer tile laid with open joints. The tile should be laid just outside the footing course and given a sufficient slope to carry away the subsoil water quickly. Broken stone or gravel should be placed above the tile to a depth of a foot or so in order to facilitate the water reaching the drain.

QUESTIONS.

1. If it is necessary to locate a house near the foot of a hill, what provision should be made to secure a dry cellar?
2. In order to secure uniform settlement of a building, how should the footing course be designed?
3. Why should the outside, rather than the inside, of a foundation wall be waterproofed?
4. Where should the waterproofing be placed when the bituminous-shield method is used?
5. How does the subsoil water get into a tile drain?
6. What methods should be used in placing concrete to secure dense walls?
7. How can an even and smooth outside wall surface be secured?

MAIN FRAME.

The main frame of a wooden frame building may be of three different types; first, the full or braced; second, balloon type; third, combination frame.

The *full or braced* frame is the type of construction used in this country up to about 1850. Such a frame was composed of heavy timbers which were mortised and tenoned together, and well braced. This method of construction is rarely used in this country at the present time, and will not be discussed further.

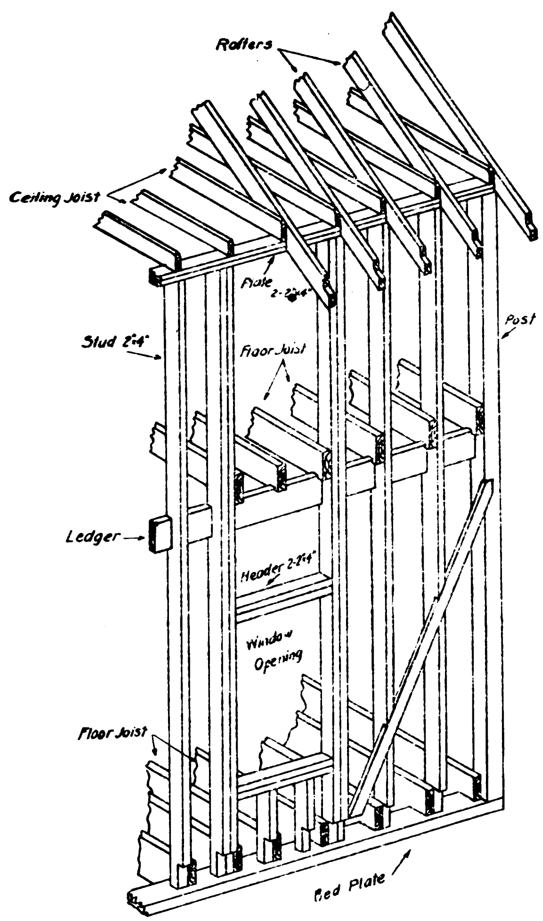


FIG. 149.—Balloon frame.

The *balloon* frame is the most economical type of construction used in wooden-frame houses at the present time. In this type of construction the timbers are spiked or nailed together, and the studs are laid continuous from the sill to the plate on the outside walls of the house.

The *combination* frame is a combination of the full and balloon frames, and is used in the best construction. This form of construction is similar to the full-frame type as far as the girders and braces are concerned, although the latter are often of the balloon type. In the best work of this type the studs are mortised or tenoned at the top, generally nailed at the bottom. Ordinarily the studs are nailed at both ends.

The average practice in the use of the balloon type is as follows:

Sills.—The sills may be of two different types—the solid sill and the box sill. The construction and method of laying these two types

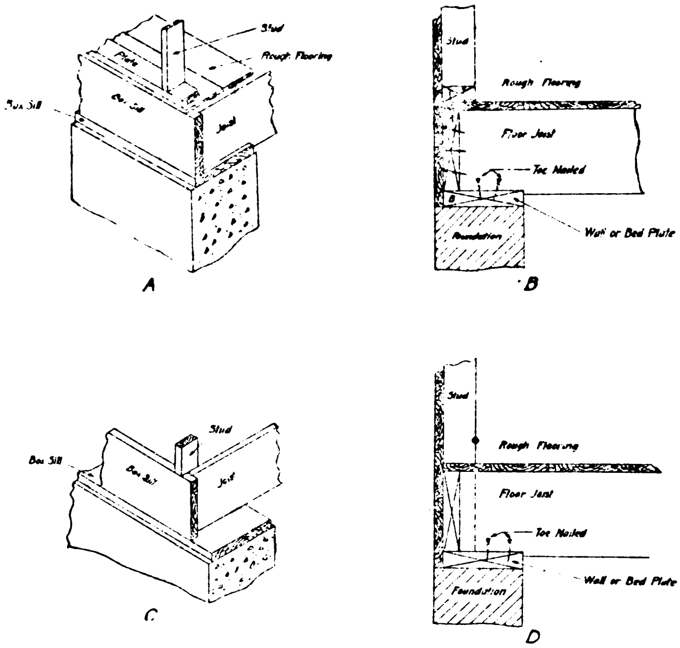


FIG. 150.—Box sills.

of sills are described in Unit Operation No. 26. The solid sill is rarely used, except for the full or combination type of frame, on account of the scarcity and cost of large-sized timbers. The open-box sill is generally used on account of its simplicity and cheapness. In the use of box sills care should be taken to select uniform solid stock for the bed or wall plate.

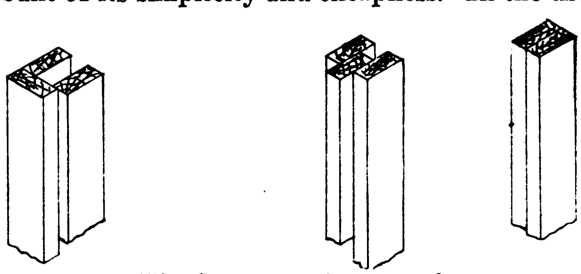


FIG. 151.—Corner posts for balloon frames.

Girders.—The girders which extend across the house to support the floor joists and partitions are built up of several timbers spiked together. The flooring and ceiling joists are usually framed over the girders in the manner similar to that used for the walls.

Corner posts.—The corner posts are usually made by spiking together two or more 2x4s or 2x6s.

Ribband.—The ribband or ledger boards, which support the floor joists above the first floor, are cut into the studs and corner posts. The outside face of the ledger boards must be parallel with the outside of the studs in order that the shoulders of the floor joists may be held in proper line.

Braces.—In the full or combination type of frame the corner braces are framed into the corner posts, sills, and plates. These braces are generally of the same size as the studs and may be mortised and tenoned in the balloon frame. Diagonal braces are usually fastened into the corner posts, studs, walls, and plates at the top and bottom of the walls as shown in Figure 152. In the cheaper class of balloon-frame houses temporary braces are used until the flooring is laid and the partitions set, and the builder relies upon the outside sheathing to strengthen the walls. In some cases this sheathing may be laid diagonally.

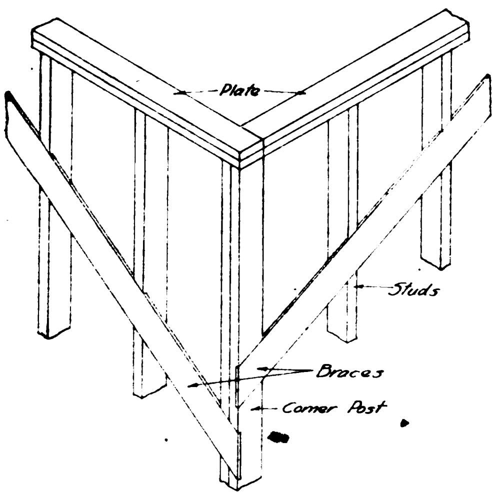


FIG. 152.—Braces for balloon frame.

Studding.—The studs are generally 2 x 4, spaced about 16 inches on centers. This spacing is adapted to the laths, which are 32 inches and 48 inches in length. It is advisable to use for studs material which has been milled to an even width, so that no difficulty will be experienced in securing true surfaces for the outside and partition walls. The laying out of walls and partitions is described in Unit Operation No. 29, the framing and erecting of stud walls and partitions in Unit Operation No. 30, and the methods of framing window and door openings in walls and partitions is given in Unit Operation No. 31. The outside walls and partitions should be protected with short blocks nailed between the studs, in order that these may serve as a fire break and prevent the passage of mice and vermin.

Joists.—Floor and ceiling joists vary in size from 2 x 6 inches to 3 x 12 inches, depending upon the spacing and span of the timbers. The floor and ceiling joists are generally spaced 16 inches on centers, the same as studs in order to provide for the proper nailing of laths, which are 4 feet in length. The methods of supporting joists upon sills and girders are shown in Figure 153. The notching of the joists over the top of the walls and girders is not important in the first-floor framing, but should be done in the second and third floor in order to true up the outside walls. It will be noted that the joists are carried to the outside of the sills and are generally spiked to the side bearings to give strength by tying the wall and floor framing together. The tops of the floor joists of a floor should line up in a plane, and this often requires the notching of the under surfaces, where they rest on sills and girders. This notching, called "sizing," should always be made with reference to the top edge of the joist, which in every case should be the crowning or rounding

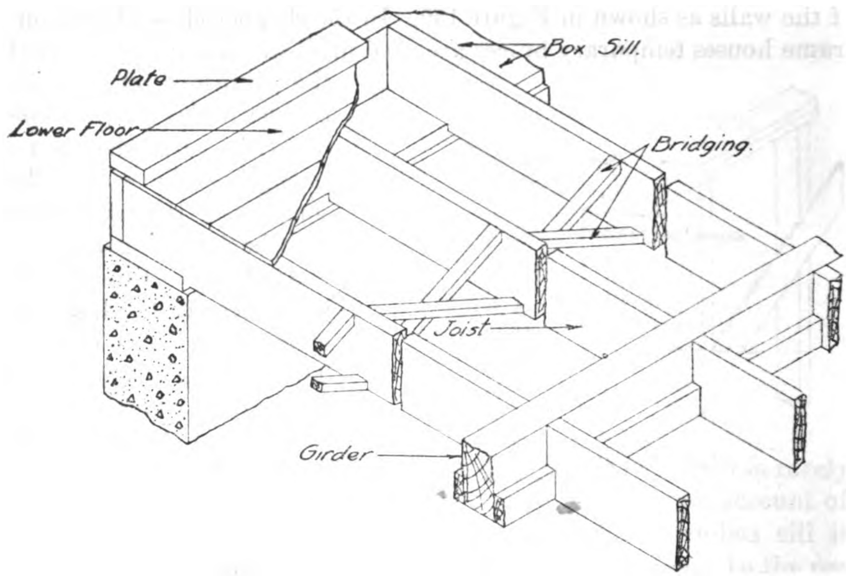


FIG. 153.—Joists and bridging.

edge. Hence where the floor is loaded the deflection of the joists will tend to straighten them. The methods of placing floor and ceiling joist are given in Unit Operations Nos. 27, 30, and 32.

Bridging.—Rows of bridging should not be more than 8 feet apart. For light floor framing the bridging is made up of crosspieces of 1 x 3 inch material, while for heavy floors 2 x 4 inch or 2 x 3 inch material is used. The placing of bridging is described in Unit Operation No. 27. Floor joists should be placed along the outside walls parallel to the regular joists to furnish the support for the floor boards and ceiling laths. Under partitions the floor joists should be doubled to provide for a suitable bearing. Where pipes or conduits may be placed in the partitions the double joist must be spread to allow a space. In some cases the single joists are reinforced with a 2 x 4 nailed along the top edge of each side of a joist under the partition. At the intersection of an inside partition with an outside wall a U-shaped corner is made by abutting a partition stud on two wall studs slightly separated to allow nailing spaces for the lathing.

Trimmers and headers.—Where stairs and chimneys pass through floors and ceilings, it becomes necessary to frame around the openings. This is done by doubling the joist along the sides of the opening and supporting the ends of the joist adjacent to the ends of the opening on headers. The term header is also used to designate

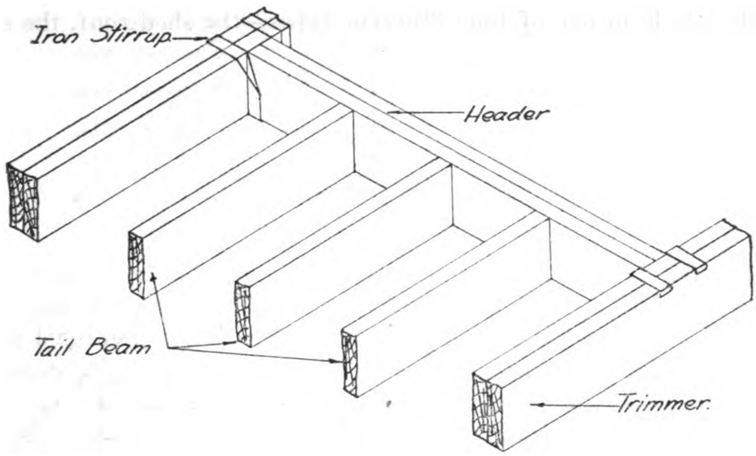


FIG. 154.—Headers and trimmers.

the timber placed horizontally above a door or window opening. Since headers act as girders in carrying the ends of several joists or studs, they should usually be double timbers. The placing of headers and trimmers is described in Unit Operation No. 27. For long spans and large openings it is desirable to support the headers with iron stirrups or joist hangers, and the joists or tail beams are either tenoned into the header or hung in stirrups. This form of construction is shown in Figure 154.

QUESTIONS.

1. Why is the balloon frame the most economical type of construction for buildings?
2. Why is the shrinkage less in a balloon frame than in a full or braced frame type of construction?
3. To what extent should a balloon-framed house be braced?
4. Why are the crowning edges of joists placed up?
5. What is the purpose of bridging?
6. Why is it necessary to spread the floor joists under a partition to provide a space between them?

ROOF FRAME.

Roofs may be classified as "pitch" and "flat" roofs. The latter are generally considered as those roofs which have a slope of less than 4 inches in 12 inches. The roofs of most timber frame buildings have a pitch of 6 inches in 12 inches (one-fourth pitch) or greater, the amount of pitch or the slope of the roof depending upon the desired appearance and the roofing material to be used.

Pitch roofs, as used in ordinary wooden frame buildings, are usually made in one of four different types—the shed roof, the sim-

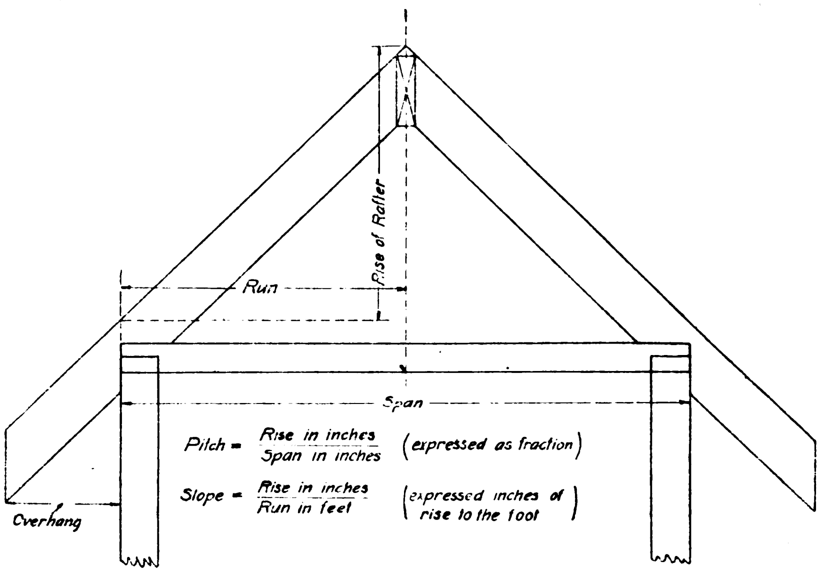


FIG. 155.—Rise, run, pitch, and slope.

ple gable roof, the hipped roof, and the gambrel roof. When the span of the building is 30 feet or less, and the wall plates are securely tied by the top story ceiling beams, the roof can be framed so as to be supported entirely by the outside walls. If the span is more than 30 feet, interior supports will be necessary. It will be noted from Figure 156 that the main timbers of the roof are the ridgepiece and the hip and valley rafters. The intermediate rafters, known as common and jack rafters, are framed between these main pieces and the wall plate. Rafters extending from valley rafter to hip rafter are called *cripple jacks*, those connecting hip rafter and wall plate are *hip jack rafters*, and those extending from ridge to valley rafter are called *valley jacks*. Rafters are spaced 16 inches on centers in the better class of buildings, especially where it is intended to seal the attic. This space provides for the use of roof boards and laths. In the cheaper class of buildings, and where it is not desired to finish the attic, the spacing of rafters may be made 20 to 24 inches on centers. It should be noted that the greater spacing of rafters will require the use of larger timbers.

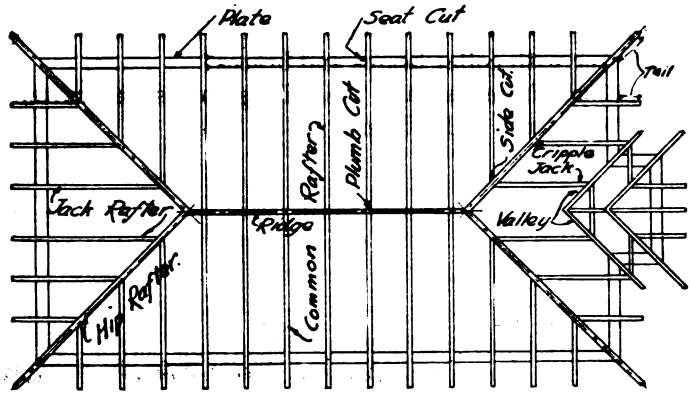


FIG. 156.—Plan of roof frame.

Common rafters should be at least 2 x 6 inches for lengths up to 12 feet, 2 x 8 inches for lengths from 12 to 20 feet, and 2 x 10 inches for lengths over 20 feet. The valley rafter should be made proportionately heavier than the common rafters, as it takes the load from the latter and acts as a girder. The rafters should be securely nailed at their ends to the ridge board and wall plate and should have suitable bearing on the latter. This bearing should be at least 2½ inches for 6-inch rafters and not less than 3 inches for 8-inch or 10-inch rafters. Long span, flat roofs should be reinforced with collar beams and braces, as shown in Figure 157.

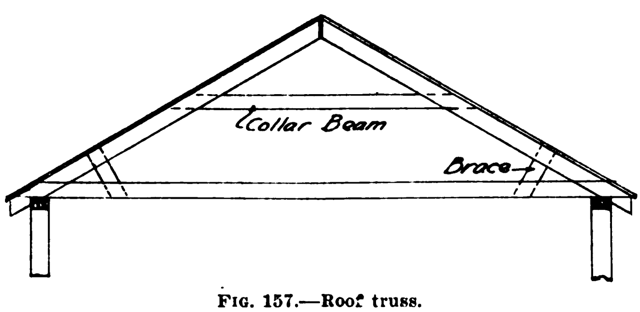


FIG. 157.—Roof truss.

The method of laying out common rafters is described in Unit Operation No. 34; for hip and valley rafters, Unit Operation No. 35; for jack rafters, Unit Operation No. 36; the erection of roof frames, in Unit Operation No. 37; and the framing of dormers, in Unit Operation No. 38.

QUESTIONS.

1. What advantage has the gambrel roof over the ordinary gable roof?
2. What is the purpose of the ridgepiece?
3. Why is it necessary to strengthen roof frames having spans of 30 feet and over with collar beams and braces?
4. In a balloon frame, should the ceiling joints and rafters frame together on top of the wall plates?

FLOORS.

Under floor.—The better classes of wooden frame buildings have rough underfloors. These floors are generally laid in a direction diagonal to the length of the floor joist, so as to strengthen the floor during construction. In the balloon type of building frame the underfloor is generally carried to the outside of the joists, to provide a barrier which would serve as a fire stop and prevent the passage of mice and vermin. Where the studding of the outside wall is carried down to the bed or wall plate the rough floor should be cut around the studs and carried out flush with their faces.

A cheap kind of lumber, generally yellow pine or hemlock, is used for the rough flooring. The lumber should be dressed at least on one side to a uniform thickness, and preferably ship-lap should be used, so as to prevent open joists. The method of laying a rough floor is described in Unit Operation No. 28.

Upper floor.—The upper or finished floor is usually made of hardwood, milled with tongue and groove edges. Oak and maple are generally used for upper floors on account of their hardness, durability, and attractive grains. Finished flooring varies in thickness from $\frac{3}{8}$ to $\frac{7}{8}$ inch and in width from 2 to 4 inches. The upper floor should never be laid parallel to the lower floor, as the shrinkage of the wide boards of the latter will open up cracks in the finished floor. However, when it is necessary to lay the lengths of both floors in the same direction, the upper floor, if of $\frac{7}{8}$-inch material, should be separated from the rough floor by thin furring, such as wooden lath spaced about 16 inches on centers. If the lower floor is laid diagonally, the upper floor may be laid in either direction, and the floor should be laid parallel to the main side of the room. Care must be taken in laying the finished floor to drive the boards tightly together, and a pounding block should be used so as not to destroy the tongue of the board being laid. All upper flooring should be toenailed above the tongue with finish nails. They are spaced about 8 inches on centers. Hard maple flooring is often provided with drilled holes for nailing. In order to facilitate the driving of nails through the hardwood it is customary to dip the points in soap or oil. A special kind of nails, called floor brads, is sometimes used for fastening the finished floor.

In order to provide insulation and deafening, some form of insulating material, such as building paper, tar paper, tar felt, sheeting quilt, and mineral wool is inserted between the floors. The paper, felt, or quilt generally comes in rolls 1 yard wide. The material should be laid on the upper surface of the underfloor, and so lapped as to break joints both along the sides and at the ends of the strips. In the better class of work furring strips or cleats are placed about 16 inches on center on the insulating material and the finished floor is nailed through them. Where a great amount of insulation is desired, the space between the cleats or strips may be filled with asbestos, mineral wool, or a similar substance.

QUESTIONS.

1. Why is a floor laid diagonally better than one laid across the joists?
2. Why is it necessary to use underflooring dressed on one side to a uniform thickness?
3. Should the underflooring of the first floor be laid before the outside stud walls are erected?
4. Why is it desirable to use two nails to fasten each board to a bearing?
5. Why should the upper floor be laid at an angle with the direction of the lower flooring?
6. When should the upper flooring be laid?
7. What precautions should be taken in the breaking of joints in the flooring?
8. Is it preferable to use flooring in short or long lengths?

WALL COVERING.

Outside wall covering.—The three principal outside wall coverings are shingles, siding, and stucco. Brick veneer and cement-block veneer are sometimes used in connection with wooden framing, and proper allowance must be made for the same by the carpenter and mason as directed by the plans. The siding and shingles are generally applied over a layer of sheathing or rough boarding. Stucco may be applied on wood lath, metal lath, patent lath, or patent sheathing.

When siding, shingles, brick veneer, and cement-block veneer are used a layer of sheathing is nailed to the outside of the exterior wall studding. This sheathing is generally of a cheap kind of lumber—

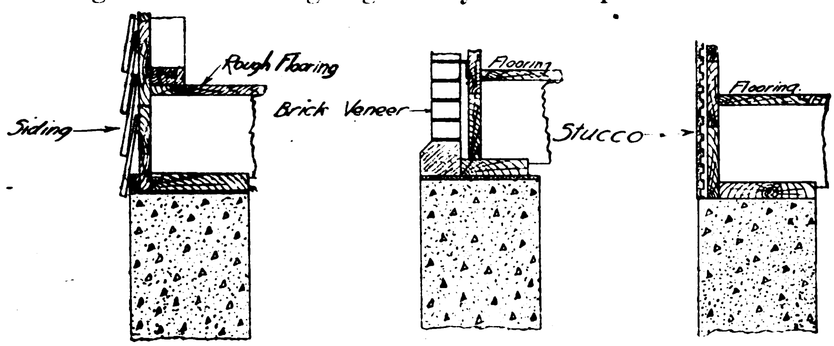


Fig. 158.—Various forms of wall construction.

hemlock, spruce, or hard pine. The boards should be dressed at least on one side to bring them to a uniform thickness. It is preferable to use ship-lap in order to prevent open joints. Builders generally place the boarding diagonally in order to secure more rigidity in the main frame. However, if the frame is properly braced, the sheathing may be laid horizontally. The boards should be nailed on each stud with two 8d. nails. The application of sheathing is described in Unit Operation No. 40.

Shingles have come into proper use in small buildings for wall covering. Shingles are generally laid with from 5 to 6 inches exposed to the weather and are often laid in double rows, to give more attractive appearance to the surface. Occasionally the shingles are cut to an ornamental pattern for architectural effect. Method of laying shingles is given in Unit Operation No. 45.

Clapboards, or siding, are generally used for the outer wall finish. Clapboards are largely used in the New England States and are really a form of bevel siding 6 inches in width. The siding is of two types, bevel and novelty or drop siding. Bevel siding is of similar section as clapboards, but is ordinarily made larger in section and longer in length. Novelty and drop siding are made in various forms, all of which are molded so as to secure a lap or rabbeted joint. This form of siding is usually made of $\frac{7}{8}$-inch material. Cypress, redwood, spruce, and pine are the most used.

Insulating material.—Insulating material, such as building paper or tar felt, is generally tacked over the sheathing or rough boarding before the outer layer of shingles or siding is placed. This insulating material is ordinarily lapped so as to secure two layers, which will furnish a desirable protection against the passage of wind and rain through the wall.

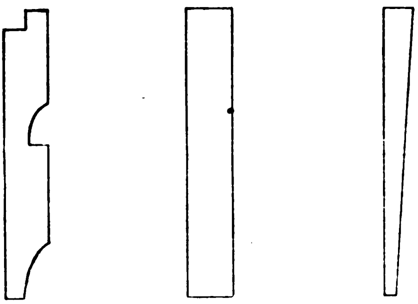


FIG. 159.—Various forms of siding.

Stucco finish.—Stucco finish consists of two or more coats of cement mortar applied to some form of lath. Generally three coats of a mixture of sand and Portland cement are applied successively and form a plaster surface for the thickness of about $\frac{3}{4}$ inch. The outside surface is treated in different ways to give the desired appearance. The finish varies from the smooth trowel to a rough surface formed by the application of small pebbles in the finish coat. The lath used may be of two different types, metal and wood lath. The metal lath comes in two general forms, rectangular mesh and diamond shape mesh, while the wooden lath is usually in some patent form, such as "Bishopric" plaster board.

Inside wall covering.—Inside wall covering may be lath and plastering, composition board, or gypsum board. The common form of inside wall finish is wooden lath and plaster. The lathing is sometimes considered a part of the plasterer's work and is often done by men who make a specialty of this class of work. On small buildings, however, the carpenter is required to do the lathing as a part of the interior finish. Before the laths are applied strips of from $\frac{3}{4}$ x $\frac{7}{8}$ inch to $\frac{13}{16}$ x 1 inch, called "grounds," are nailed upon the studs, around the openings, and at the bottom of partitions for the baseboard. At the corners of rooms metal pieces are often used in order to make a true and durable corner. Laths are made of pine, spruce, poplar, fir, and occasionally of the hardwoods. They are made at the sawmills from the waste and edgings and are of two widths, 1 inch and $1\frac{1}{2}$ inches.

The laths should be laid at least ⅜ inch apart so as to provide a sufficient space for the plaster to go between and form a key on their rear surface. The joints should be broken about every nine laths. The laths should be laid horizontally on the walls. These laths should be nailed to each bearing with one 3d. fine lath nail.

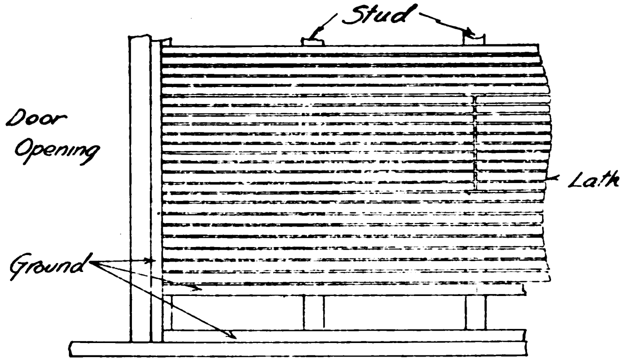


FIG. 160.—Placing plaster grounds and laths.

There are several forms of patent laths on the market, both wood and metal. The wooden types are generally made in the form of thin boarding, with a dovetail section. There are several forms of metal lath in general use, rectangular, triangular mesh, and expanded metal.

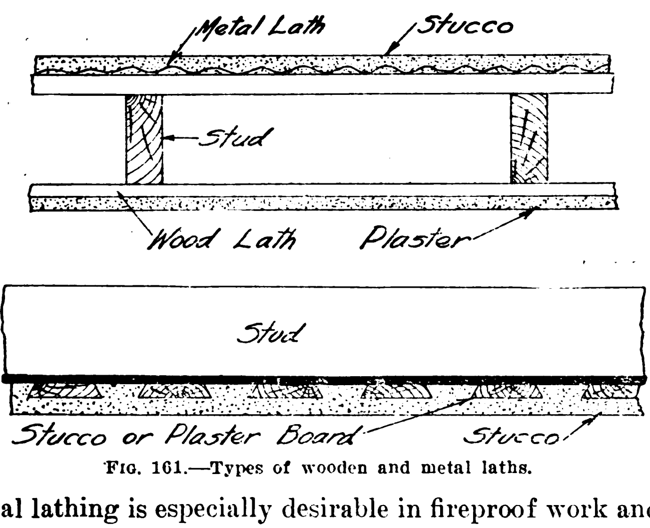


FIG. 161.—Types of wooden and metal laths.

The metal lathing is especially desirable in fireproof work and forms a better bond or key for the plaster than wooden lath. However, the metal lath is about twice as expensive as the wooden lath laid on studs or walls.

In the cheaper classes of buildings, especially cottages and summer homes, the use of a composition board for interior wall surface has become popular. There are two classes of wall boards in general use, the composition or compo board and the gypsum or plaster board. Wall board has the advantage of coming in large-size sheets which can be readily applied in any kind of weather by a carpenter, is clean, and makes an attractive surface where the joints are covered with stripping. The composition board is generally made of a fiber material, which, however, is subject to rapid deterioration from water and fire. The gypsum or plaster board is a heavier material, more difficult to apply than the composition board, but has the advantage of being waterproof and reasonably fireproof. Joints of the gypsum board may be plastered and the surface painted to give a smooth, uniform, and attractive surface finish. The wall board comes in widths of 32 to 48 inches, so that it can be applied directly and economically to the studding, which is generally 16 inches on centers. The lengths vary from 6 to 16 feet.

QUESTIONS.

1. What are the relative advantages of shingles, siding, and stucco as wall coverings? Which is the cheapest?
2. From what portion of the log does the clapboard or beveled siding come?
3. What advantages does siding have over clapboards?
4. What qualities should wall-insulation material possess?
5. Is it preferable to place the insulation material in horizontal or vertical strips?
6. What are the relative advantages and disadvantages of plaster, plaster board, and compo board?
7. What kind of interior wall surface gives the best protection against vermin, mice, and fire?
8. What are the relative advantages and disadvantages of wood and metal lath?

ROOF COVERING.

The under or lower covering of a roof is boarding or sheathing nailed directly to the rafters. In the cheaper class of buildings this boarding may consist of boards nailed to the rafters horizontally and with spaces of 2 or 3 inches between them. This cheaper method has the advantage of furnishing the foundation for the upper surface of shingles, but makes an open roof, which is hot in summer and cold in winter. In the better class of buildings the sheathing consists of dressed boarding similar to that used on the outside wall. Roof boarding or sheathing is generally of 1-inch stock with widths of 2½ to 6 inches. The material used may be hemlock, pine, fir, or spruce. Methods of laying roof sheathing are given in Unit Operation No. 42.

Various kinds of material are used for the upper surface of the roof, the kind of material depending upon the pitch or slope of the roof, the quality of material desired, and the requirements for weather and fireproofing. The materials in general use for wood frame buildings are: Wood shingles, tar paper, slate, tile, metal shingles, sheet metal roofing, asphalt and composition rubber in rolls, asbestos shingles, tar and gravel, tar and felt.

Wood shingles may be made of spruce, cedar, pine, or cypress, listed in the order of the average life of the material. Wooden shingles should not ordinarily be used on a roof which has a slope less than one-fourth pitch. Shingles should be laid with from 4 to 5 inches exposed to the weather, the steeper the pitch the greater the exposure which may be used. Shingles should be fastened with non-corrosive nails, preferably galvanized steel, zinc, or copper. The method of putting on shingles is described in Unit Operation No. 45.

Slate should not be laid on a roof that has a slope of less than 5 inches in 12 inches. Slate varies in size from 8 by 16 inches to 10 by 20 inches and have an average thickness of $\frac{3}{16}$ inch. Slate should be laid with a double lap and each slate fastened to the roof with two tinned or galvanized nails. Slate shingles are used in the Northeastern States of the country on better class of buildings and furnish a very durable but heavy roof covering.

Tile of the interlocking or shingle type is often used on the more expensive buildings, largely for the purpose of appearance. Tile is about as durable as slate.

Asbestos shingles are made in various forms and sizes and are a composition of asbestos and cement. They are about as expensive as slate but are very much more durable and furnish one of the best weatherproof and fireproof roofing materials known.

Asphalt shingles are made of a combination of materials of which asphalt is the principal component. They are made as separate shingles or in a roll with notches cut to represent shingles. The surface of the shingles is sanded and the material may be obtained in different sections. Asphalt shingles furnish a more fireproof roof than wooden shingles and are somewhat more durable.

Metal shingles are made of fine sheet steel, and in various sizes and forms for ornamental purposes. They are not durable unless kept well painted with a metal paint and are generally more difficult and expensive to lay than other forms of shingles.

Sheet-metal roofing is generally used on flat roofs or those having a slope less than one-fourth pitch. Metal roofs are made of two materials, steel and tin. Steel may be used in flat or corrugated sheets of different thickness. On account of its light weight and relatively low cost, steel or iron roofing is used almost exclusively on shops and mills.

Tin comes in sheets varying in size and is laid with either standing seams or flat seams. The flat seam, generally known as the lock joint, is preferable on account of its strength and greater protection against weathering. The tin should be painted on its lower surface before it is laid. It is desirable to use one or more layers of building paper (not tarred paper) between the roof boarding and the tin roofing.

Asphalt and rubber composition roofing is used on shed and barn roofs where the appearance is not an important factor. The material comes in continuous rolls from 32 to 36 inches in width and is laid in strips, which are lapped so as to break joints, both along the sides and ends. The material is nailed to the roofing boards with tin or galvanized large-headed nails, and the joints are mopped with hot tar or asphalt. This material makes a very cheap and serviceable roof, the life of which depends upon the number of layers and quality of material. The cheaper and less durable material is rubberoid, while the most expensive and more durable material is the combination asphalt and asbestos roofing, which is from 2 to 5 ply in thickness.

Tar and gravel roofs are used on flat-roofed buildings. Three to four layers of roofing paper or felt should be laid with proper laps on the roofing, roof boarding or sheathing, and the joints thoroughly mopped with tar or pitch. The last layer should be nailed with 3d. common nails, or roofing nails, driven through tin disks or guards. On top of this foundation a thick coat of hot pitch is spread, over which is strewn clean, well-screened gravel.

Flashing is the process of placing metal strips against the members making a joint to make the joint weather and water proof. In some cases it is necessary to place a double layer of metal so as to insure complete waterproofing, and this operation is termed "counter flashing." Hips and valleys are generally flashed with metal shingles or continuous strips of metal which overlap in the case of hips and underlap in the case of valleys the roofing material. In valleys the metal strip is generally made from 16 to 20 inches in width. Counter flashing is generally used at the intersection of a roof surface with a vertical wall, such as a dormer, chimneys, or parapet wall. The metal should be carried high enough to prevent rain or snow from driving behind it, and wherever possible the upper edges of the flashing should be turned into the joints of the brick or tile wall. The various methods of flashing and counter flashing are described in Unit Operation No. 43.

QUESTIONS.

1. What form of roofing is best for a flat roof? For a roof having a quarter pitch, and for a roof having a half pitch?
2. Why is the exposure for wooden shingles on roofs less than for shingles used on the walls?
3. Give the types of roofing in order of their fireproof quality.
4. If wooden shingles are to be used, what kind of wood should be selected for durability?
5. What methods should be used for constructing a roof that will be warm in winter and cool in the summer?

Name_______________________________

____
(Rank and organization.)

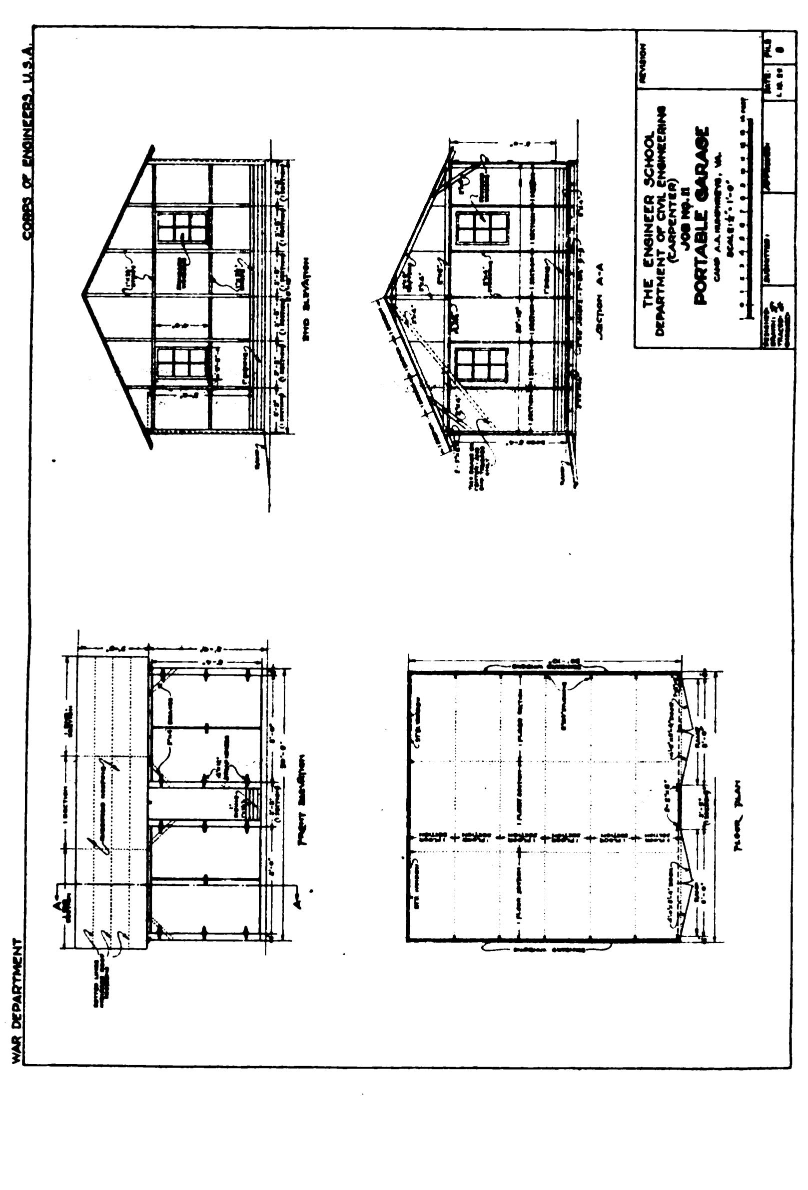
Date_______________________________

1. Double garage.

2. *Specification.*—Use sections of the Burpal portable barrack buildings in accordance with the following drawing. Set the sills on 3 to 4 inches of steam cinders spread and tamped on the ground surface. Use 1-inch novelty siding to sheath in the sides of the building below the sections at the floor level. Lap the sheets of roofing at least 2 inches on both sides and ends and swab all joints with hot tar.

3. *Drawing.*—(See next page.)

4. *Unit Operations listed in order of use:*


WAR DEPARTMENT
CORPS OF ENGINEERS, U.S.A.
SECTION A-A
THE ENGINEER SCHOOL
DEPARTMENT OF CIVIL ENGINEERING
(CARPENTER)
JOB NO. 11
PORTABLE GARAGE
REVISION

5. *Bill of material and list of tools:*

6. *Questions and answers:*

1. How would the roof frame be erected?

2. What is the purpose of the long 2 x 4″ diagonal braces?

3. What is the purpose of the knee braces?

4. Why are the sills set on a cinder bed?

Name_______________________________

____
(Rank and organization.)

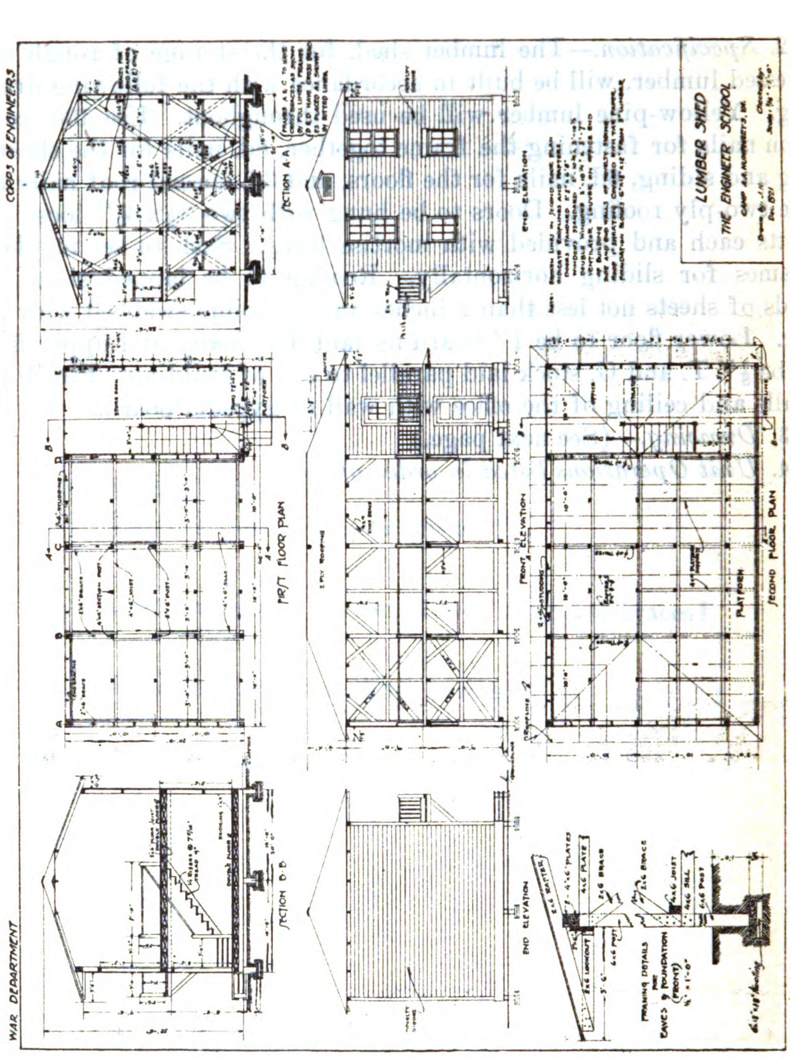
Date _______________________________

1. **Lumber shed.**

2. *Specification.*—The lumber shed, for the storage of rough and dressed lumber, will be built in accordance with the following drawing. Yellow-pine lumber will be used throughout. Use 10d. common nails for fastening the frame together, 8d. nails for the sheathing and siding, 6d. nails for the floors, and 3d. special roof nails for the two-ply roofing. Doors to be hung with two $3\frac{1}{2} \times 3\frac{1}{2}''$ loose pin butts each and provided with mortise locks. Sash to set in plank frames for sliding horizontally. Roofing to be lapped sides and ends of sheets not less than 2 inches and all joints swabbed with hot tar. Lower floor to be 1″ boarding laid diagonally and upper floor to be $\frac{7}{8}''$ T. and G. stock laid parallel to end of building. Finish the walls and ceiling of the office with wall or gypsum board.

3. *Drawing.*—(See next page.)

4. *Unit Operations listed in order of use:*



5. *Bill of material and list of tools:*

6. *Questions and answers:*

1. Why are the building sills placed above the ground and supported on posts?

2. What is the least distance below the ground surface that the footings should be placed?

3. What is the purpose of the knee and cross braces?

4. How would the tops of the posts be leveled prior to setting the sills?

5. Describe in detail the steps that would be taken in erecting the frame of the building.

6. Why is intermediate studding necessary between wall posts?

7. How should the roof frame be erected?

Name ______________________________

____
(Rank and organization.)

Date ______________________________

1. **Frame trestle or wood truss bridge for heavy traffic.**

2. *Specifications.*—Bridge to be of an approved type, designed by a competent officer or noncommissioned officer in accordance with the Manual on Bridges, TR-445, at a site where a bridge is required for military purposes. Prior to the publication of the training regulations on bridges, the bridge should be designed in accordance with the Engineer Field Notes and the Engineer Field Manual.

3. *Drawing.*—(To be inserted with the specifications by the instructor.)

4. *Unit Operations listed in order of use:*

5. *Bill of material and list of tools:*

6. *Questions and answers:*
(To be supplied by the instructor.)

ADDITIONAL COPIES

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V

Adjutant general's office

UNITED STATES ARMY

TRAINING MANUAL No. 13

CARPENTRY

FOR MILITARY SPECIALISTS

Part IV. MASTER CARPENTER

PREPARED UNDER THE DIRECTION OF
THE CHIEF OF ENGINEERS, U. S. ARMY

1922

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

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1923

CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *May 23, 1922.*

Manuals for training the Army are to be prepared and revised from time to time by the branches of the service concerned and published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Corps of Engineers as a part of this series, a group of five pamphlets relating to carpenters. The pamphlets in this series are titled as follows:

Training Manual No. 10—Carpenter Helper.
Training Manual No. 11—Basic Carpenter.
Training Manual No. 12—General Carpenter.
Training Manual No. 13—Master Carpenter.
Training Manual No. 14—Instructor's Guide for Carpenters.

This pamphlet is the fourth of the carpenter series and is published for the information and guidance of all concerned.

[A. G. 062.11 (5-16-22).]

BY ORDER OF THE SECRETARY OF WAR:

JOHN J. PERSHING,
General of the Armies,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
Acting The Adjutant General.

FOREWORD.

Training Manual No. 13, Master Carpenter, teaches the more skilled operations in construction work. Graduates receive a certificate of proficiency as Master Carpenter, which makes them eligible for appointment to this rating. One per cent of the soldiers of the Army should have the skill and knowledge essential to graduate from this course. Technical sergeants having this certificate and a similiar one in concrete and masonry are qualified for the grade of master sergeant (construction foreman).

This course is the fourth and final step in training the master carpenter. Graduates are qualified to work successfully in civil life as master carpenters on wood construction.

INDEX TO TRAINING MANUAL NO. 13.

Unit operations:

Page.

50. Estimating 1
51. Laying out foundations 4
52. Setting window and door frames 6
53. Framing for concealed gutters 9
54. Hanging verge boards 11
55. Coping 12
56. Making cornices 13
57. Bending boards 15
58. Putting on interior trim 17
59. Fitting doors 20
60. Hanging windows 22
61. Building winding stairways 24
62. Wainscoting and paneling 30
63. Hanging sliding doors 32
64. Laying finished floors 33
65. Fitting standard hardware 34
66. Underpinning 37
67. Making hopper joints 39

Information topics:

12. Estimating 40
13. Inside finish 44
14. Outside finish 49
15. Finish hardware 53

Jobs:

14. Quarters 58

ESTIMATING.

1. Read Unit Operation No. 14 and Information Topic No. 12, and remember that estimating is hastier and less accurate than making bills of material.

2. Make suitable allowance for waste, noting that standard lengths are 10 feet, 12 feet, 14 feet, etc. Allow 10 to 15 per cent for waste in machining the stock—dressing, edging, and tonguing and grooving. Estimate lumber in terms of board feet.

3. Count large timbers carefully on account of cost. Take off posts, noting the dimensions given in the detail at the left in Figure 162. Where dimensions are not shown as the projection at the top of the posts, scale the length with a rule or architect's scale.

Outside posts	68 pieces, 2″ x 8″ x 13′-6″ long..
Inside posts	51 pieces, 2″ x 8″ x 19′-9″ long.

4. Take off the timbers of the roof trusses, scaling the lengths where not given by dimensions:

One truss:

Top chord	4 pieces, 2″ x 12″ x 25′-6″ long.
Bottom chord	4 pieces, 2″ x 10″ x 18′-0″ long.
Bottom chord	2 pieces, 2″ x 10″ x 18′-0″ long.
Knee braces	6 pieces, 2″ x 10″ x 14′-6″ long.
Diagonals	6 pieces, 2″ x 10″ x 14′-0″ long.
Diagonals	4 pieces, 2″ x 10″ x 14′-0″ long.

As there are to be 17 trusses, multiply the quantities above by 17 and add the members of the same size together wherever possible.

5. Determine the number of joists and rafters by count or by the following rule: Where spaced 16 inches on centers, the number will be three-quarter times number of feet in length or width of building. Add one timber for joist or rafter placed against the second wall. Similarly for 18″ O. C. use two-thirds, 24″ O. C., one-half, etc.

6. Determine the number of studs for walls and partitions by allowing one for each lineal foot of wall or partition where specified 16 inch on centers. Extra studs are to be used in doubling corners, framing around openings and gables.

7. Allow 25 lineal feet of 2″ x 4″ for each square of flooring for bridging.

8. *Sheathing.*—Calculate the wall surface to be covered and deduct openings. For plain or unmatched boards add $\frac{1}{12}$ for 12″ boards, $\frac{1}{10}$ for 10″ boards, and $\frac{1}{8}$ for 8″ boards. Use 4″ and 6″ boards 2 inches apart for shingling on roofs. For ship-lap, calculate

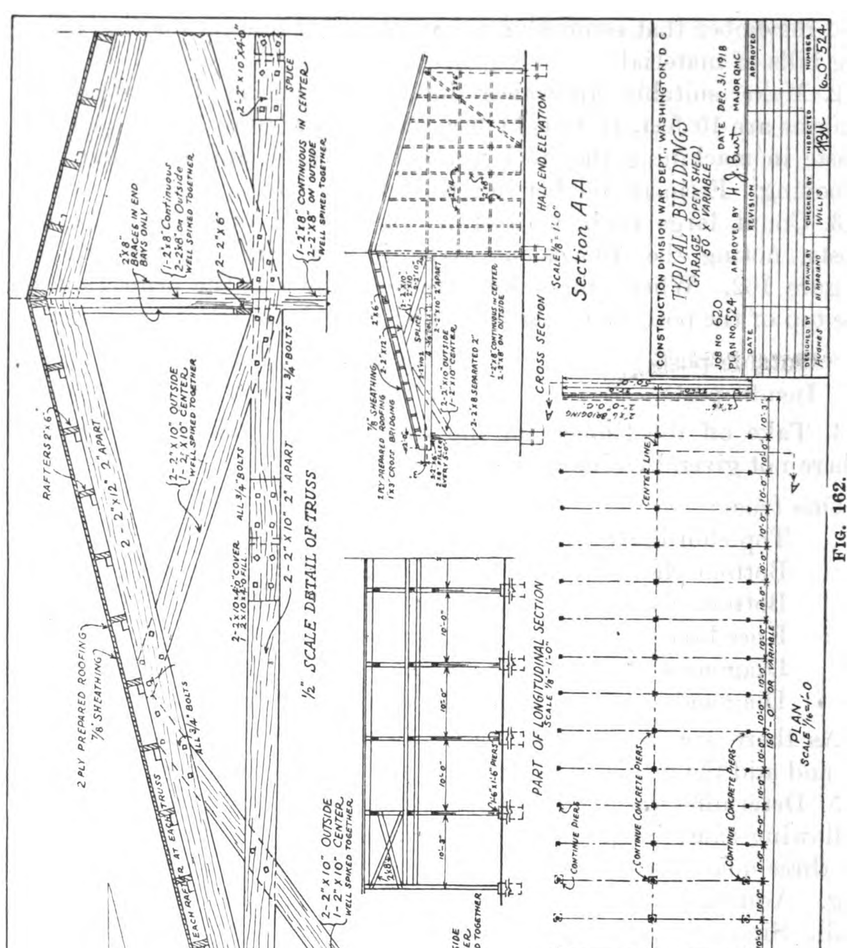


FIG. 162.

the exact surface to be covered, deduct openings, and then add for floors 17 per cent, for side walls 20 per cent, and for roofs 25 per cent. If the sheathing or ship-lap is laid diagonally add 5 per cent for waste.

9. *Bevel siding.*—Calculate the exact surface, deduct openings, and then add for 6″ siding laid 4½″ to the weather, 33 per cent; and for 4″ siding add 50 per cent.

10. *Drop siding, ceiling, waiscoting, and matched flooring.*—Calculate the exact surface to be covered, then add 20 per cent for 5¼″ material, 25 per cent for 3¼″ material, 40 per cent for 1½″ material, and 33 per cent for 2¼″ material. Material less than 1″ thick shall be estimated as 1″ thick.

11. *Shingles.*—Estimate the exact surface of roof. Note that with an exposure of 4½ inches to the weather a 4″ shingle will cover 18 square inches, or an average of 800 shingles to the square. Allow 8 per cent additional for plain roofs and 12 per cent for hips or gabled walls to care for waste.

12. *Laths.*—Calculate the exact interior surface of walls to be plastered, deduct for openings, and allow 1,000 laths for 70 square yards of surface.

13. Determine the number of doors and windows to be used, calculate the amount of moldings, casings, baseboards, window stools, and other finish to the nearest 100 feet of each kind in excess of the exact quantity required. Such material is furnished in random lengths.

14. Compute the quantity of nails required by multiplying the quantities found above by the number of pounds required per thousand or per unit from the table. (Information Topic No. 12.) Set the decimal point over three places when 1,000 is given in the first column except when quantities are stated in M board feet.

15. Estimate the cost of construction, dividing this item into two classes—labor and material. Determine the hours per day and scale of wages per hour for the locality in which the work is to be done. From an estimate of the time required to place frame, floor, bridging, furring, doors, windows, lath, shingles, etc., estimate the labor cost. Determine the material cost by multiplying the various items of lumber, hardware, etc., by the current market prices.

QUESTIONS.

1. Why is the number of joists or rafters three-fourths times the number of feet in length or width of building when 16″ O. C.?

2. In estimating number of studs required, why allow one for each foot of wall or partition?

3. What area is meant by the term "square"?

LAYING OUT FOUNDATIONS.

1. Drive a stake at one corner of the building and lay out a line the required length and direction of one side of the building, as *AB*, Figure 163. Drive a nail in the top of the stakes *A* and *B* at the exact location of the corners.

2. Stretch a line from *A* to *B*. Measure from *A* along *AB* a distance of 8 feet and drive a stake as at *M*, Figure 163. Drive a nail in the top of the stake at the exact point.

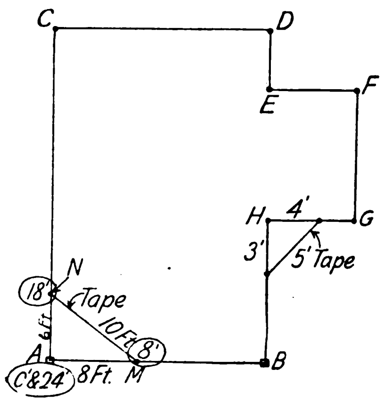


Fig. 163.—Laying out foundation.

3. Fasten a tape at *A* and pull it around the nail at *M*. Hold the 24-foot mark at *A* and have a helper hold the 18-foot mark and pull the tape taut. Where the 18-foot mark rests drive a stake as at *N*. Stretch a line over this stake and measure the line *AC*. In applying this right triangle method of laying out right triangles, any multiple of 3, 4, and 5 may be used.

4. All right-angle corners may be made in this way. If the numbers 8, 24, and 18 are not convenient, use the figures 4, 12, and 9 on the tape.

5. To test the squareness of the layout measure the diagonal distances across the foundation lines as *AD*, *BC*, *EG*, etc. The diagonals of a figure which has square corners are equal and its opposite sides are equal.

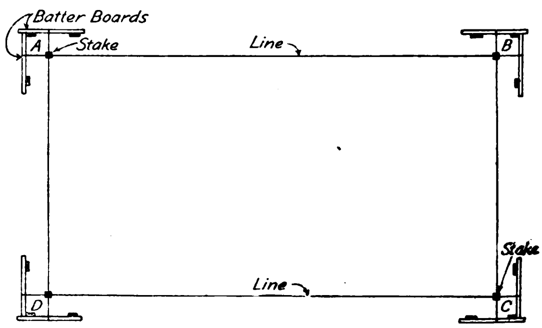


Fig. 164.—Placing batter boards.

6. To set batter boards, sharpen the ends of enough 2 x 4s or 1 x 6s about 3 feet long to have three for each corner.

7. Drive three of these pieces into the ground in the positions shown in the figures so they will stand firmly about 2 feet high. Place them back 3 or 4 feet from the stake at the corner, as shown in Figure 164.

8. Near the tops of these pieces nail boards as shown in Figure 165.

9. Stretch lines over the batter boards so that intersecting lines come exactly over the corner stakes.

10. When the lines are found to be exactly over the stakes, mark the place where they cross the batter boards.

11. At these marks saw down about an inch.

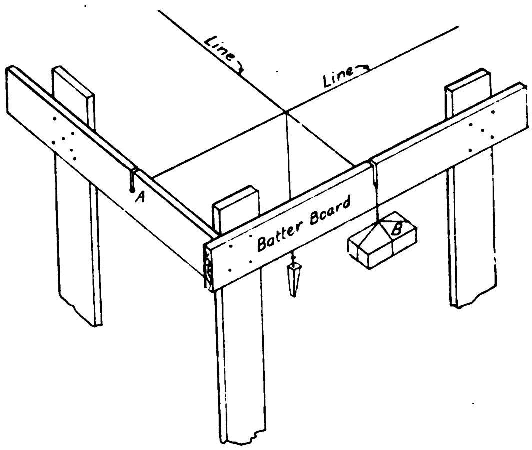


FIG. 165.—Batter boards.

12. The lines can be placed in these saw kerfs when needed and fastened to a nail placed in the back of the board as at *A*, Figure 165, or tied to a weight of some sort as at *B*, Figure 165.

QUESTIONS.

1. How may the squareness of a corner be checked with a steel tape?

2. What precautions should be taken in the use of cloth or metallic tapes?

3. How should a batter board of two posts and one crosspiece be placed?

4. Under what conditions should batter boards be placed more than 2 feet high?

5. How should batter boards 10 feet high be built?

SETTING WINDOW AND DOOR FRAMES.

Window frames.

1. Place the window frame in the framed opening as shown in Figure 166. Allow on each side not less than 2 inches open space between the back side of the pulley stile and the stud frame for window weights. Level the sill with a spirit level and test the pulley stiles with relation to the sill with a square as shown in Figure 166.

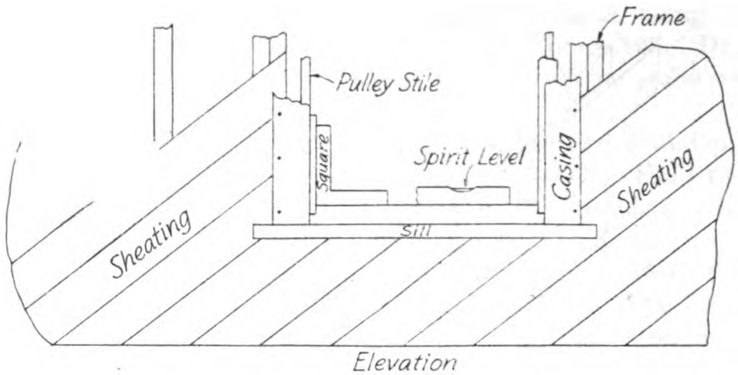


FIG. 166.—Details of window frame.

2. When level and square, tack the casings to the stud frame with casing nails, as explained in Unit Operation 58.

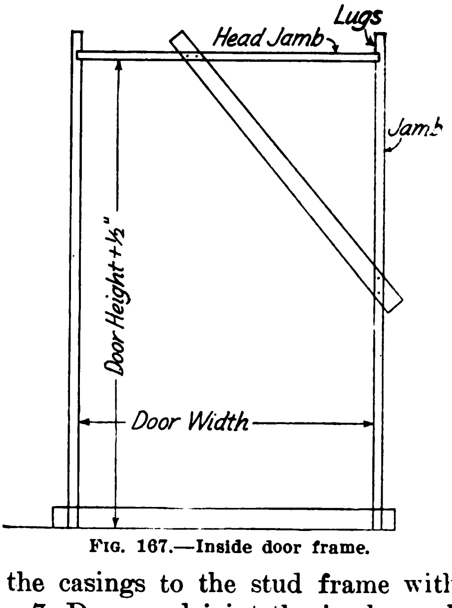


FIG. 167.—Inside door frame.

Door Frames.

3. Cut out the rough floor, sheathing, etc., so as to allow the door sill to be on a level with the finished floor.

4. Set the frame in place and level the sill with a spirit level. Shim with a shingle if necessary.

5. Tack the casing on each side close to the sill.

6. Plumb the jambs with a spirit level and finish nailing the casings to the stud frame with casing nails.

7. Dress and joint the jambs, making them about 3 inches longer than the required height of the opening.

8. Square one end of each jamb, and from these ends lay off the exact height of the door plus ½ inch. At this point square across the piece and cut a dado ⅜ inch deep and as wide as the head jamb is thick.

9. Joint and dress the head jamb to dimensions, making it ¾ inch longer than the required width of the opening.

10. Fit the head jamb in the dadoes and nail with small nails and tack a strip across the bottom ends of the jambs and a diagonal brace across the edges to hold the frame square.

11. Tack a block to the stud frame at the height of the upper hinge and lay a straight edge against it as shown in Figure 168. Plumb the straightedge and place a block at the height of the lower hinge. This block is of such thickness as to just touch the straightedge.

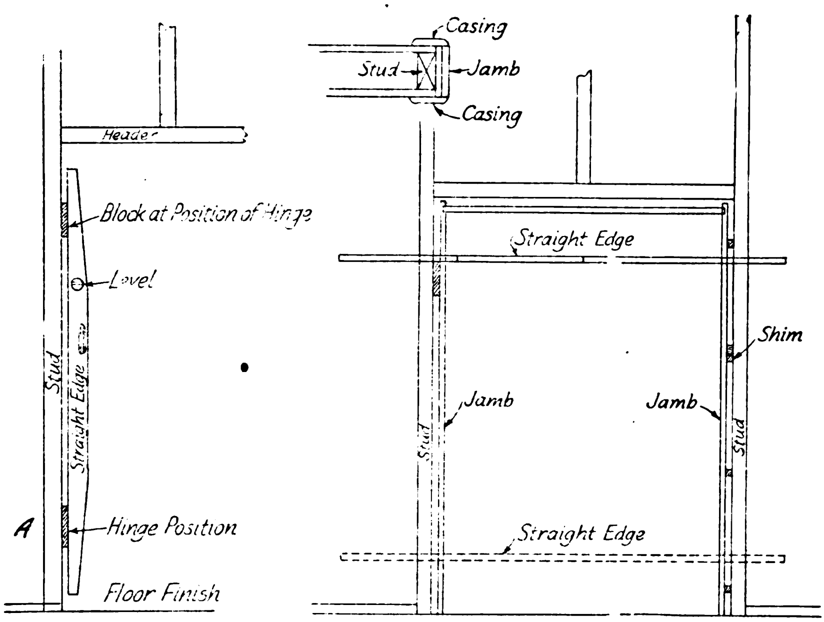


FIG. 168.—Setting doorframes.

12. Tack the second block to the stud, remove the braces from the frame, cut off lugs to permit the frame to go into the opening, and slip the frame into the stud opening with one jamb against the blocks.

13. Place the straightedge across the edges of the jambs and reaching back along the wall. When the jambs are true with the wall surface, nail them to the studs with casing nails. Shim behind the second jamb where necessary to make it plumb and firm.

14. Nail the casings to the edges of the jambs and to the studs, setting back ¼ inch from the face of the jambs as shown in Figure 168.

QUESTIONS.

1. Why are casing nails used in setting window frames?
2. What size nails should be used?
3. Why is it necessary that there be no wind in a doorframe?
4. Why is the distance from finished floor to head jamb ½ inch longer than the door?
5. Is it better to make inside doorframes on the job rather than to have them made at the mill?
6. Why are the door casings set back ¼ inch from the face of the jambs?

FRAMING FOR CONCEALED GUTTERS.

1. Measure the distance that the fascia cuts of the rafters are out from the wall boarding and lay out this distance, less one-fourth inch on ⅞″ x 3″ boards, a sufficient number of times to make the necessary lookouts for the roof. Fasten a cleat to one end of each lookout. Nail the lookouts to the rafters, making the bottom edges level and flush with the bottom or plancier cuts *de*, Figure 169, of the rafters. Nail the cleats and lookout ends to the wall boarding.

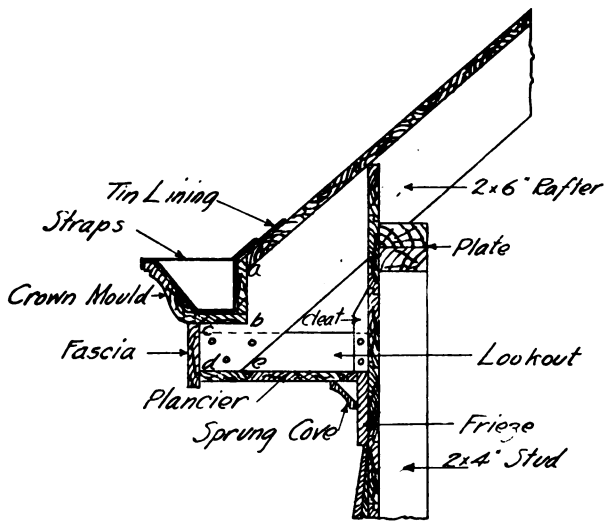


Fig. 169.—Concealed gutters.

2. Measure in from outside or fascia cut of end and one or two intermediate rafters a distance of 4 inches to locate plumb cuts for gutter. Snap a chalk line over the top edge of all the rafters. Set T-bevel for plumb cut and mark plumb cut *ab* on all the rafters.

3. With a try-square lay off on an end rafter from the fascia cut *cd* the bottom cut *bc*.

4. Fasten one end of a chalk line to the point *c* on the end rafter, and allowing for a slope of 1 inch in 20 feet upward from or downward toward the down spout (shown on the architect's plan) snap lines on the outside ends of the rafters. From these lines, with a try-square, square across the sides of the rafters the bottom lines *bc*.

5. With a crosscut saw make the bottom and plumb cuts for the gutter in all the rafters.

6. True one edge of $\frac{7}{8}''$ stock, scribe and rip out bottom boards $4\frac{3}{8}''$ wide. Saw the boards to such lengths as to have a bearing over rafters.

7. True one edge of $\frac{7}{8}''$ stock, measure the heights of the plumb cuts of the rafters (allowing for an overrun for $\frac{7}{8}''$ roof boarding), scribe and rip out the inside boards of the gutter. Lay off the edges of the boards, the slope of the roof, and plane down to the bevel cut for the top edge.

8. Fasten the bottom boards in place with 6d. nails, breaking joints at bearings on rafters. Paint the lower edges and fasten the side boards in place, arranging wherever practicable for joints to stagger with those of bottom boards.

9. Measure fascia cuts *cd* of rafters and lay out and cut fascia boards from $\frac{7}{8}''$ stock. Note that top edges of fascia boards will have the slope of the gutter. Fasten facia boards in place, fitting the top edges against the lower sides of the bottom boards.

10. Complete the gutter by cutting the crown mold to convenient lengths and nailing in place. Paint the lower abutting edge of mold boards before putting in place.

11. Ceil under the lookouts with tongued and grooved boarding of $\frac{1}{2}''$ x $4''$ stock. Paint edges of plancier boards before fastening in place. Close the joint with the frieze with a sprung cove molding.

12. Cut holes for down spouts (as shown on architect's plans), using expansion bit, or $\frac{3}{4}''$ bit and keyhole saw.

13. At the corners of the building carry the gutter framing around the corner with a mitered joint and make a return on the gable end

QUESTIONS.

1. Why is the gutter sloped?
2. How may the accuracy of the chalk lines on the rafter tops and ends be tested?
3. Why is the gutter floor placed before the sides?
4. Why are abutting edges of gutter boards painted before being set in place?
5. Why not carry lookouts through and nail to studs?
6. Why are the straps used along the tops of the gutter?
7. Are the cleats at the wall ends of lookouts necessary?

HANGING VERGE BOARDS.

1. Where verge or barge boards are shown, by the architect's drawing, on the gable of a building, cut and frame up the lookouts. Read Unit Operation No. 33.

2. Select stock of about the specified width and thickness and plane down one edge and one side to the required cross section.

3. Wherever practicable, use one board for each side of a gable. Measure the length of gable side or slope under the roof boarding.

4. Lay off the length of the gable on a true edge of board. Mark the end bevel cuts. Cut ends with crosscut saw.

5. Paint the upper or abutting edge of the verge board and fasten to the ends of the lookouts with finish nails. Nail into the top of the verge board through roof boarding. Set and fasten verge board on other side of the gable in similar manner.

QUESTIONS.

1. How should the verge boards be framed to make a closed or box type of cornice?

2. What methods of construction could be used to secure ornamental effects with verge board?

3. Why are verge boards used?

4. What are the advantages of the open type of cornice described in this operation?

COPING.

1. Place the piece to be coped in a miter box, holding it against the side of the miter box in the same position the piece will have against a wall or other surface on the job, and miter it. Cut the miter as in making a miter joint. This will give on the face of the piece the shape of the cut to be coped, as *B*, Figure 170.

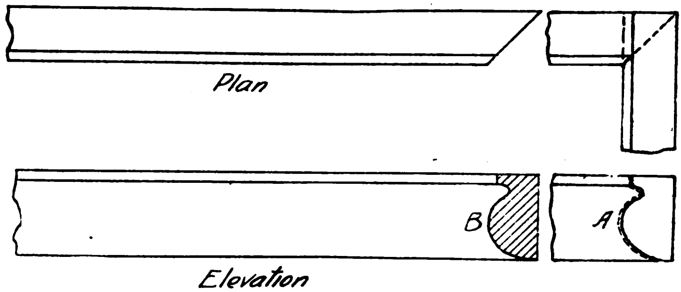


FIG. 170.—Coping.

2. Undercut the end of the piece with a coping saw along the curve *B* on the face, Figure 170.

3. Place the piece coped against the piece it must fit, as in *A*, Figure 170, and see whether it fits exactly. If it does not, it can be easily fitted by trimming with a knife.

QUESTIONS.

1. Why will mitering a piece give the correct line on the face for coping?

2. Does coping make a better molding joint than mitering? If so, why?

MAKING CORNICES.

Open cornice.

1. To make the fascia, rip stock of specified thickness to required width. Joint one edge and make square ends so that boards will break joints on ends of rafters. Nail board in place with 6d. nails. Set boards up tight under roof board. At the corners of the building make miter joints with gable fascia boards.

2. To make the frieze rip out stock of specified thickness to required width. Joint one edge and rabbet edge to receive siding. Tack board in place with upper edge against lower edges of the rafters. With the steel square and dividers project the sides of the rafters down on the face of the board a distance equal to the depth of the rafters measured vertically. Remove the board and with a crosscut saw and chisel cut out the notches for the rafters. Strike a chalk line on the wall boarding at required lower edge of frieze. Fasten frieze boards in place with 6d. nails. At the corners of the building make proper miter joints with the frieze boards of the gable ends.

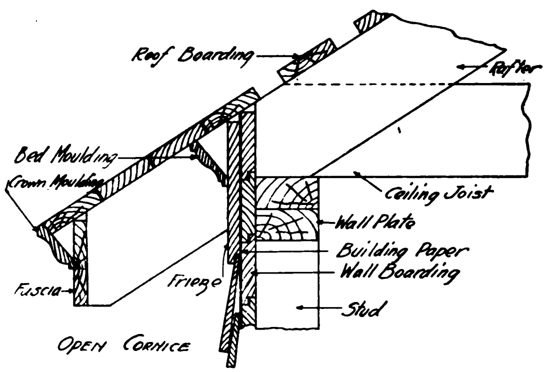


FIG. 171.—Open cornice.

3. For the crown and bed moldings make all joints beveled at 45 degrees by sawing in miter box. At corners of building make miter joint to meet corresponding moldings of gable ends. Nail moldings in place.

Box Cornice.

4. Measure the distance the fascia cuts of the rafters are out from the wall boarding and lay out this distance, less one-fourth inch, on ⅞″ stock, 3 or 4 inches wide. Joint one edge and with the crosscut saw make two square cuts. With this "lookout" as a templet, saw out the number of lookouts required for the entire roof. Nail the lookouts to the rafters, making the bottom edges level and at the required elevation for the plancier, making due allowance for the thickness of the plancier. Toenail the other ends of the lookouts to the wall boarding.

5. To make the fascia, rip stock of specified thickness to the required width. Joint one edge and saw boards with square ends so

that joints will be broken at the ends of rafters. Nail boards in place with 6d. nails. At the corners of the building make proper miter joints with the gable fascia boards.

6. To make the frieze, rip out stock of specified thickness to the required width Joint and rabbet one edge to receive the siding. Set boards up snug against bottom edges of lookouts. At the corners of the building make proper miter joints with the frieze boards of the gable ends.

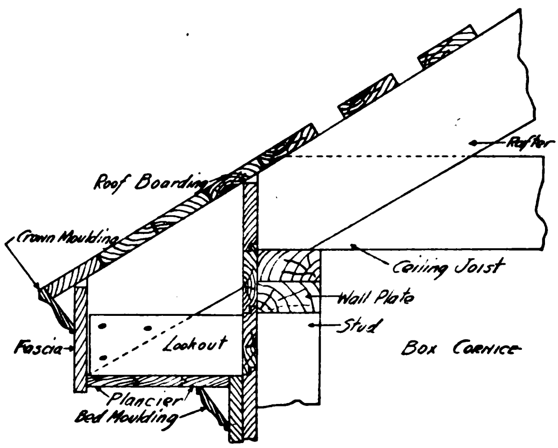


FIG. 172.—Box cornice.

7. Ceil under the lookouts with tongued-and-grooved boarding of ½″ x 4″ stock. Joint edges of boards adjacent to fascia and frieze. Break the end joints at lookouts, as far as practicable, toenailing at the tongued edges. Paint edges of plancier boards, and fasten in place with 6d. finishing nails.

8. From stock required by the architectural drawings or specifications, cut out crown and bed moldings of greatest practicable length. Make the joints beveled at 45 degrees by cutting in a miter box. At corners of the building make proper miter-joints to meet the corresponding moldings of the gable ends. Fasten the moldings in place.

QUESTIONS.

1. Why is the wall boarding carried up to the under side of the roof boarding?

2. What different types of gutters could be used for these two classes of cornice?

3. Why are crown and bed moldings used?

BENDING BOARDS.

Kerfing the Back.

1. If the piece of wood is to be bent in the arc of a circle, measure the length of the chord c and the height of the arc M. Then find the radius of the curve by the formula:

$$\text{Radius} = \frac{\overline{\text{chord}}^2 + \overline{(4 \times \text{height})}^2}{(8 \times \text{height})}.$$

2. Select a piece of the material with straight grain. Scribe a line parallel to and $\frac{3}{16}$ inch from face or front side of piece.

3. Make a saw kerf across the piece near one end. From this cut measure off a length equal to the radius. Hold one end flat on the bench top, and gently raise the other end until the saw kerf is closed tightly. Measure the distance from the bench top to the radius mark shown in Figure 174. This distance will be the desired space between saw kerfs.

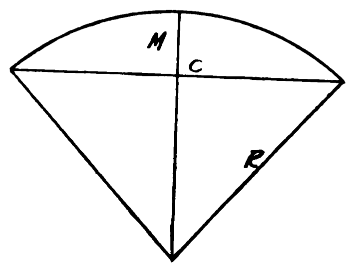


FIG. 173.—Diagram.

4. With the dividers lay off the spacing of the saw kerfs along the length of the piece to be bent. Make the kerfs with a small crosscut or back saw.

5. If the curve is a uniform curve of any kind, lay it off on a flat

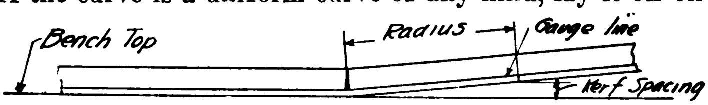


FIG. 174.—Laying out for bending.

surface, scribe a line parallel to and about $\frac{3}{16}$ inch from the face of the piece.

6. Make a kerf near one end of the piece and place the piece at one end of the curve, as shown in Figure 175. Bend the board gently until the kerf closes. The distance AB is the amount the piece moves due to one cut. Make a second cut a distance from the first cut, depending on the amount the piece moved for the first cut, AB, Figure 175. Bend the piece around the curve, and if the surface lies outside the curve, make the kerfs closer; and if the piece lies inside the curve, make the kerf spacing greater. Continue the cuts, at the proper spacing, over the length of piece to be bent.

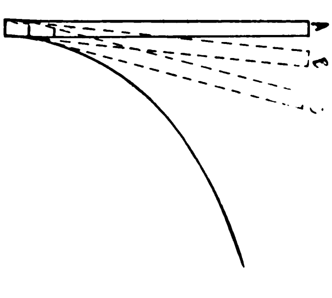


FIG. 175.—Laying out curve.

Steaming.

7. To bend a piece of wood to a slight curvature, soak it in water (hot water if procurable) for about 30 minutes. For curves of short radius (sharp curves) boil the pieces in water for at least six hours, or place in a steam bath. Clamp the pieces to a form of the desired curve and dry out in a warm place.

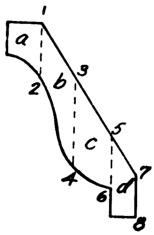


FIG. 176.—Crown molding.

Laminated.

8. To bend a molding which has an irregular surface and is placed at an angle, use the laminated method as follows:

9. Lay off the squared ends of several pieces of the required length, the line 1 2, 3 4, and 5 6, parallel to the rear side 7 8 and about ¼ inch apart.

10. From one piece saw along the line 1 2, to make a full-sized piece *a*, and in like manner saw along the lines 3 4 and 5 6 to make a full-sized piece *c*. The undersized pieces *b* and *d* are wasted. The full-sized pieces *b* and *d* are cut in a similar manner from a second piece of stock molding.

11. To erect the molding, fasten the section 5 6 7 8 (*d*) in place with brads or small finish nails.

12. Spread a thin layer of glue over the surface of the section just applied, and bend the next section 3 4 5 6 (*c*) over it and nail in place. Repeat this operation until the entire molding is assembled.

QUESTIONS.

1. What determines the depth to which the kerfs should be made when bending a board?
2. How may the spacing of the kerfs be determined when starting one at the center of the piece to be bent?
3. Why can a piece of wood be bent after soaking it in water?
4. Why is boiling or steaming the best treatment for wood to be bent?
5. Why is it not practicable to bend a molding by kerfing or steaming?
6. How should the kerfs be made in a beveled board, similar to a molding, in order to bend the board in a horizontal plane.

PUTTING ON INTERIOR TRIM.

General.

1. Read Information Topic No. 13, Inside Finish. Select the inside finish or trim so that all the pieces will be clear, clean, free from splits, cracks, and knots. Sort the light and dark pieces so the trim of each room will be of the same shade or color.

2. All casings and other interior finish, wherever practicable, should be in continuous lengths. Make all end cuts true and square, except for miter joints, which are to be made in a miter box.

Door casing.

3. Cut the base blocks (plinths) to the length shown on the architect's detail drawings. If the finish floor has not been laid, set small

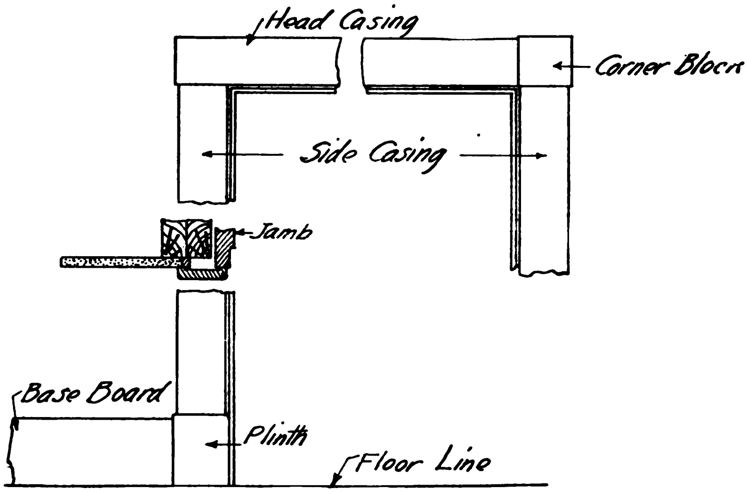


FIG. 177.—Details of door casing.

blocks or fillers the thickness of the upper floor for the plinths to rest on. Nail the plinths in place at the floor level and set back about $\frac{1}{8}$ inch to $\frac{1}{4}$ inch, according to width of plint and casing, from the face of the jamb. If the side casings are carried to the floor line, base blocks (plinths) will not be used.

4. Cut the side casings to the proper length, make due allowance for corner blocks, if used. Nail the side casings in place, making a tight joint with the tops of the plinths or floor surface. Set the inside edges of the casings in $\frac{5}{16}$ to $\frac{3}{8}$ inch from the edges of the jambs.

5. If corner blocks are used, fit and nail them in place, making close joint with the upper edges of the side casings.

6. Cut the head casing to the exact distance between corner blocks, if used or to extend about ¼ inch beyond outside edges of side casings.

Window casing.

7. Lower the sash and fit the stool to the bottom rail, allowing about $\frac{1}{16}$ inch clearance. Measure and cut the stool to the length shown on the architect's detail drawing.

8. With a chisel or a block plane "return" the ends of the stool to match the front or face edge.

9. Fit and nail the stool in place.

10. Measure and cut the apron, as per detail drawings. Cut the ends so as to "return" the face design. Nail the apron under the

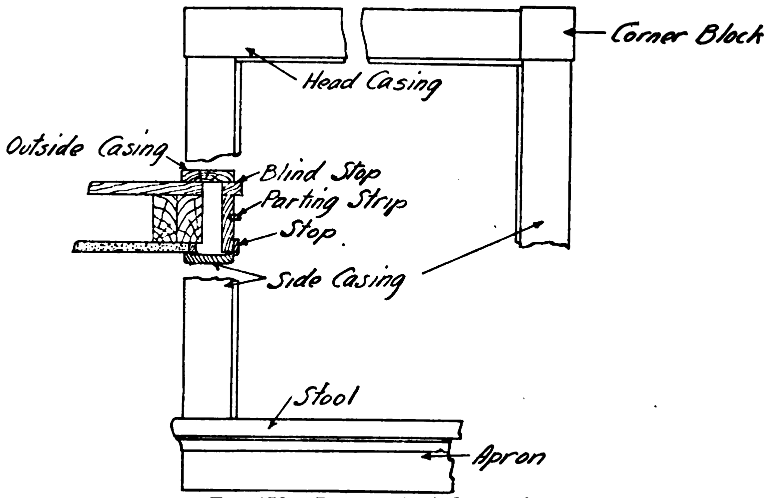


FIG. 178.—Details of window casing.

stool. If a scotia is used, miter proper "returns" on each end and nail under the stool and against the apron.

11. Measure and cut the side casings to the length shown on the detail drawings. Place the inside edges of the casings flush with the face of the jambs and nail in place.

12. Measure and cut the head casing, making due allowance for corner blocks if used. Nail the head casing in place, with the lower edge flush with the face of the head jamb.

13. Measure the length of the under surface of the head jamb. Lay off this length on the material for stops and make two square cuts. Nail the head stop in place, with the outer edge covering the joint between the head casing and the head jamb.

14. Measure the height of one side jamb, from top of stool to under face of head stop. Make a square cut for lower end of side stop and

lay off the required length. Make allowance for the thickness of the head stop and cope the end of the side stop to butt against the head stop. Fit the other side stop in a similar manner.

Base trim.

15. If the finish (upper) floor has not been laid, nail narrow blocks the thickness of the floor at intervals around the walls.

16. Measure the long sides of the room, and lay off these lengths on the baseboard stock. Make square cuts for the ends. Set boards in place and nail to the plaster grounds.

17. Measure the short sides of the room, and lay off these lengths on baseboard stock. Allow for the thickness of the baseboard at each end, and scribe the ends for coping. Cope the ends to fit the boards in place. Nail the two baseboards in place.

18. If base moldings are used in addition to baseboards, measure, cut, and fit them in the same manner as for the baseboards.

19. Cut and fit picture molding in the same manner as for baseboards, wherever required by the architect's plans and specifications.

QUESTIONS.

1. Why not splice casings?
2. How should the grain of end blocks be placed?
3. How should the end cuts of casings be marked to make good joints?
4. Why are stool and aprons of window trim "returned" on their ends?
5. Why are stops, baseboards, base and picture moldings made with coped rather than mitered joints? When are mitered joints used?

FITTING DOORS.

1. Take a straightedge about 2 inches shorter than the height of the door and hold it against each jamb to see whether the jamb is perfectly straight.

2. Hold a framing square on the angles made by the jambs and the head jamb to see whether the frame is square.

3. Measure back from the edge of each jamb the thickness of the door both near the top and near the bottom and drive a casing nail in about one-fourth its length.

4. Lay the door on two trestles which have no nails or anything else which could scratch the door. Saw off the lugs of the door.

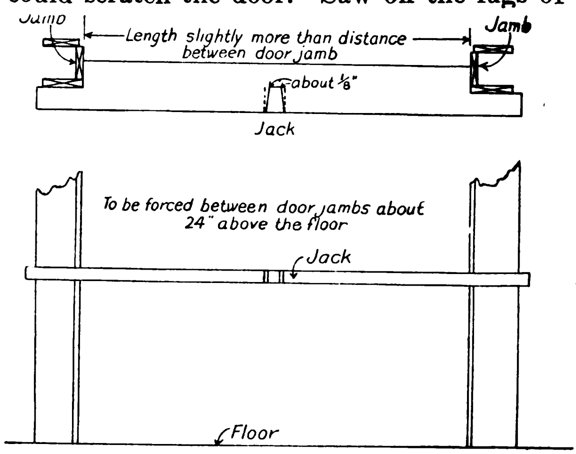


Fig. 179.—" Jack."

5. Place the door on its edge and against a jack, as shown in Figure 179, and plane one edge to fit the door jamb.

6. Place the door in the frame against the nails tacked in the jambs and hold it in place with a brace made of a piece of scrap lumber.

7. Go to the opposite side of the door and mark the second edge with pencil or scriber along the face of the jamb, allowing $\frac{1}{16}$ inch on hardwood doors and $\frac{3}{32}$ inch on softwood doors. Also mark top of door along the head jamb.

8. Place door back against the jack and plane to the scribed line for width. Place the door on the trestles and saw to the scribed lines across the end. Dress the end with jack plane.

9. Set the door in the opening and push a large chisel under it and force it up in place. Place two wedges between the door and

one jamb so as to force it tight against the jamb which carries the hinge.

10. Make on "reveal" of the jamb and the door a small mark at the position of the top of the top hinge and the bottom of the bottom hinge.

11. After the door is hung, close it and scribe along the bottom with a pair of dividers with one point of the dividers sliding on the floor and the other on the bottom rail of the door. If a threshold is not used, set the dividers at about $\frac{1}{2}$ inch.

12. If a threshold is used, first mark off the thickness of the threshold. Then, after sawing along this line, hang the door and, with the dividers held as before and set at $\frac{1}{8}$ inch, scribe along the bottom of the door with one point of the dividers on top of the threshold.

QUESTIONS.

1. Why should the bottom of the door be scribed rather than merely cut square across?
2. Why is $\frac{3}{32}$ inch allowed in the width of a softwood door and about $\frac{1}{16}$ inch in width of hardwood doors.
3. Why is a threshold often used?

HANGING WINDOWS.

Double-hung windows.

1. Remove stops, parting strips, and pocket pieces from the frame.

2. Joint the top and sides of the top sash, allowing about $\frac{1}{16}$-inch clearance on each side, and chamfer the arrises slightly with a plane. Place sash in frame opening and fit a piece of lath between sill and bottom of sash to hold sash in place while fitting bottom sash.

3. Joint the edge of the lower sash, allowing $\frac{1}{16}$-inch clearance on each side.

4. Place the bottom sash in the opening, and set dividers for distance between the tops of meeting rails of the top and bottom sash. Scribe the outside of the bottom rail of the bottom sash with this setting of the dividers, if possible to reach it.

5. Remove bottom sash from frame. With a T bevel lay off the slope of the sill on the edges of the sash. Joint the bottom of the bottom rail to the bevel indicated.

6. Replace the bottom sash in opening, and fit to top sash so that meeting rails will be a uniform distance apart, will have top surfaces flush, and bottom rail set true on top of sill.

7. Remove the top sash. Run the sash cord on each side over the pulley and down into the pocket. Tie the weights to cords, cut cords to length and fasten to the sides of the sash. To determine the proper length of sash cord, place sash on the sill, run weight to top of the pocket, cut the cord to a length of about 4 inches greater than opening in the edge of the sash in which the knotted cord is to be fastened.

8. After the top sash is hung, replace pocket pieces and set parting strips in place.

9. Hang the bottom sash and fasten on the stops, as soon as the stool is in place.

Basement windows.

10. Joint the side edges of the sash so as to allow $\frac{1}{16}$-inch clearance. Place the sash in the opening and mark the top and bottom edges to allow about $\frac{1}{8}$-inch clearance for the width of the sash.

11. Remove the sash and joint the top and bottom edges.

12. Place the sash in the frame and screw the hinges on the top rail and the button on the bottom rail.

QUESTIONS.

1. Why is the top sash fitted first?

2. When fitting the sash of a double-hung window, should the distance between the tops of the meeting rails of the sash be laid off on the inside or outside of the bottom rail of the bottom sash?

3. How much space should be left between the meeting rails?

4. What kind of a knot should be made in attaching the cord to the weight so that it will not work loose?

5. If the weight is placed after the wall is plastered and casing set, should the sash cord be run through the pocket and pulley?

BUILDING WINDING STAIRWAYS.

1. Read Unit Operation No. 49 and Information Topic No. 13 for stairways. Find the height in inches from the top of one floor to the top of the floor above and ascertain the run and rise of stair.

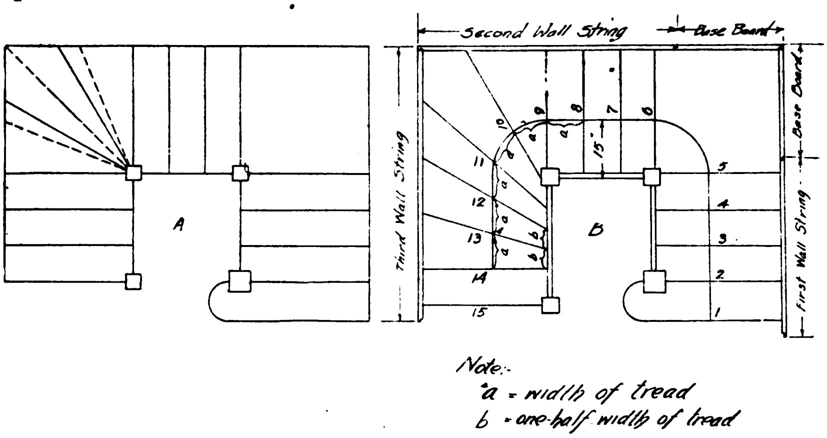


FIG. 180.—Winding stairway.

2. Lay out the plan of the stairway, as shown in Figure 180, on the floor as far as practicable. Note that the architect's drawing will generally give the plan of the stairway, as shown at *A*, Figure 180, while the stairs should be built as shown at *B*, Figure 180. "Winders" of a stairway should never be built as shown by the dotted lines in Figure 180, *A*.

3. Determine the headroom, which should be not less than 6 feet 6 inches over the tread directly under the ceiling of the floor above.

4. To lay out the carriages and the wall and face strings for the open-strings type of stairway, shown in Figures 181, 182, 183, and 184, make a pitch board, a marginal templet, and a housing templet, as shown in Figure 185.

Wall string.

5. Lay out on the wall strings the lines of the upper faces of the treads and outer faces of the risers by the use of the pitch board and marginal templet when the regular run of tread occurs and by measurement from the layout of the winders. Use the housing templet for marking the housing of the treads and risers, as shown at *A* in Figure 181. With the templet placed as shown, lay out with knife lines the housing for treads and risers. Locate the centers of the nosing for treads by a nail point driven through the templet. Make the nosing equal in projection to at least the thick-

ness of the tread. Make the bottom tread about 1 inch wider than the regular runs of the tread. Lay out the breadth of the winders on the wall string from the dimensions shown by full-size layout. Lay out the housing for the corner tread No. 10 on the second and third wall strings. At the landing and the upper floor make the tread about 4 inches wide, and provide for housing in the wall string to this extent.

6. With a bit, the diameter of which is equal to the thickness of the treads, bore out for the housing of the nosing of the treads to a depth of about ⅝ inch. Bore a second hole and chisel out the

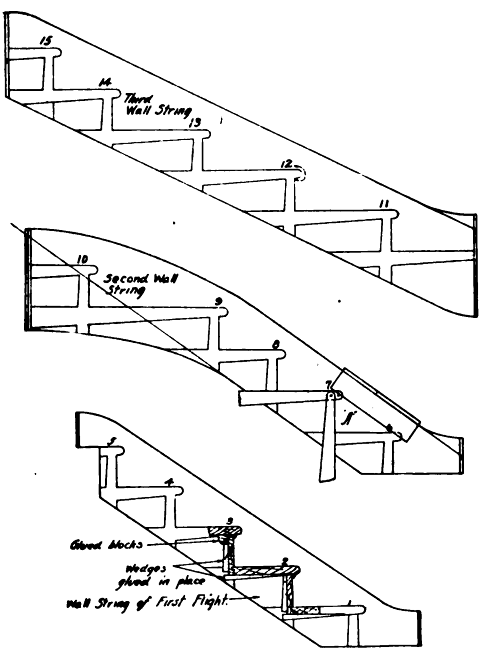


FIG. 181.—Wall strings.

wood between to give clearance for sawing the tread housing. Saw the upper and lower lines of the tread housings to the required depth. Chisel out the core between saw cuts and finish to even depth with router plane.

7. Cut out the riser housings in a manner similar to that described above for tread housing.

8. Cut ends of the strings and baseboards, as shown at *B*, Figure 180.

Face strings.

9. Lay out the lower lines of the treads and the face lines of the risers, using the pitch board described in paragraph 5, making allow-

ance for the miter at the intersection of the ends of the risers with the face string, as shown in Figure 182 *a*, *a*.

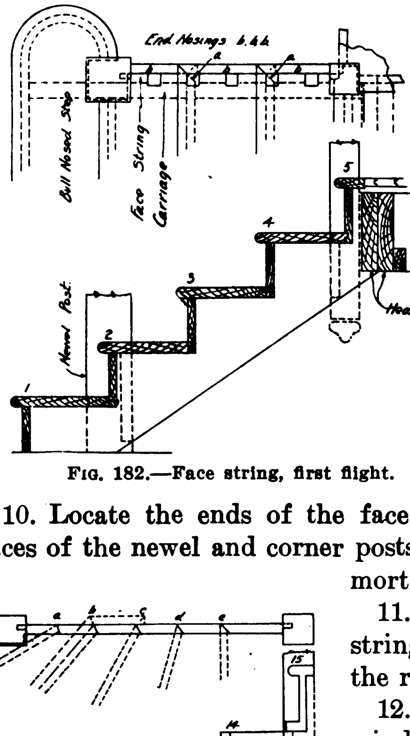


FIG. 182.—Face string, first flight.

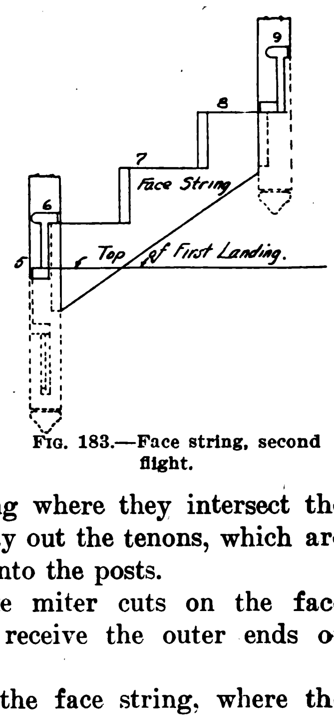


FIG. 183.—Face string, second flight.

10. Locate the ends of the face string where they intersect the faces of the newel and corner posts. Lay out the tenons, which are mortised into the posts.

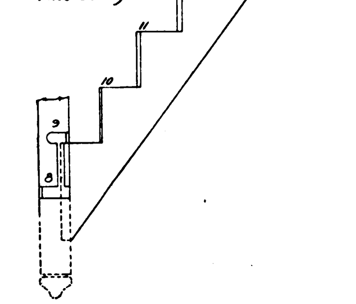


FIG. 184.—Face string, third flight.

11. Make miter cuts on the face string to receive the outer ends of the risers.

12. On the face string, where the winders occur, the run of the treads should be taken from the full-size layout, and are about one-half the regular run of the tread. Determine the miter cuts for the risers from the full-size layout and make these on the face string, as shown in Figure 184, *a*, *b*, *c*, *d*, *e*.

Erection of stairway.

13. Build the platform framework with the joists running in the direction of the first flight and framing into the header, as shown in Figure 182. Place the carriages of the first flight, the wall carriage about 6 inches from the wall, the face carriage at a distance from the wall equal to the width of the stairs, and an intermediate carriage halfway between.

14. Frame in a header at the upper end of the second flight (under the inner edge of tread No. 8, Figure 180 *B*) and support its outer end on a double stud. Place the carriages of the second flight in position, similarly to those of the first flight.

15. Place the wall string of the first flight, framing its lower end with a half-lap joint into the baseboard. Line up the strings and carriages. Place the remainder of the wall strings in a similar manner. Nail all wall strings with 8d. finish nails to grounds set in the wall.

16. Set riser and tread for step No. 2 of the first flight (see Figure 180, *B*), placing the inner ends in the proper housing cut in the wall string. Cut the proper housing and mortise for face string in the newel, as indicated in Figure 182. Set the newel post in position,

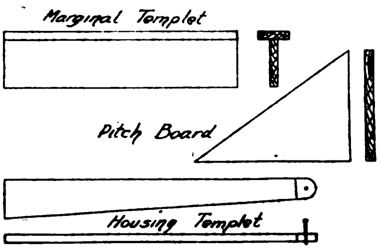


FIG. 185.—Templets.

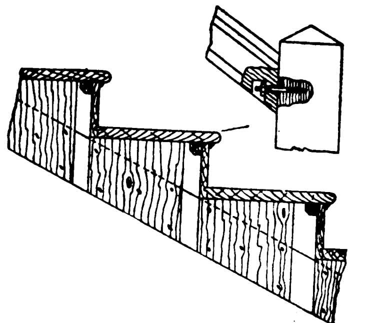


FIG. 186.—Details of tread and riser.

carefully fitting ends of the riser and tread in the housing, and place the assembled step No. 1 with the newel.

17. Set risers and treads for steps Nos. 3, 4, and 5, the tread of No. 5 being the nosing of the landing. (See Figure 180, *B*, and Figure 182.)

18. Lay the floor of the platform or landing, running the finish floor in the direction of the nosing.

19. Assemble the riser and tread of step No. 6, with the corner post and the face string of the first flight.

20. Set in place the risers and treads of steps Nos. 7, 8, 9, and 10.

21. Set in place the face string of the second flight and the second corner post, housing into the latter the outer ends of the risers and treads of steps Nos. 8, 9, and 10 and mortising for the face string.

22. Place the risers and treads of steps Nos. 11, 12, 13, 14, and 15, the tread of No. 15 forming the nosing of the second floor. Set the face string and the corner post of the third flight.

23. Frame in three planks, 2″ x 6″ each, under the third flight for the carriages. Cut and fit blocks under the treads, as shown in Figure 186.

24. Measure and cut handrails between the newel and the corner posts. Fasten the handrails in place with finish nails or handrail screws, as shown in Figure 186. Set the handrails at the height shown on the architect's drawing.

25. Set the balusters in place, cutting bottom to fit dovetail mortise in ends of the treads and the tops to fit under the surface of the handrail. If the tops of the balusters are tenoned into the handrail, set the balusters in position and then place the handrail.

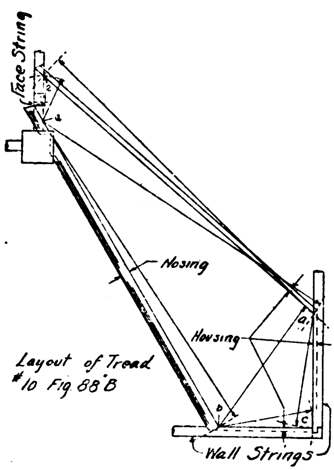


FIG. 187.—Laying out winders.

26. Place the nosings on the ends of the treads to cover the dovetail joints of the balusters and return the nosings of the treads on the face string. Cut and fit cove mouldings under the front end nosings of the treads, making miter joints at corners and "returns" on the face strings.

27. For the "winders" lay out the treads full size of the stock, determining first the net outline, as shown at *a*, *b*, *c*, *d*, *e* in Figure 187. Then add $\frac{3}{8}$ inch wherever necessary for the housing, and make proper allowance for the nosing on the front end of the tread. Make miter cut for each tread from the layout. Lay out the risers in a similar manner, beveling the ends to the angles shown in the layout for the open-string type of stairway.

QUESTIONS.

1. Why is the first step of a stairway often made wider than the regular run?
2. What is a "bull-nosed" step and why is it used?
3. Why should the rise and run of a stairway not be varied?
4. Why not build winders of a stairway as shown by the dotted lines at *A*, Figure 180? Why are the "balanced" stairs, shown at *B*, Figure 180, the best form of winders?
5. What distance apart should the carriages supporting a stairway be placed?

6. What is a "closed string" type of stairway and how would the carriages be placed?

7. What is meant by "headroom" for a stairway? What is the usual minimum headroom?

8. Describe three different methods of applying balusters to a stairway.

9. Why is it desirable to house the treads and risers into the wall strings?

WAINSCOTING AND PANELING.

Wainscoting.

1. Smooth one face of the matched boarding or ceiling of selected stock. Saw off one end square. Lay off the required height of the wainscoting from this end, mark for other end, and cut with cross-cut saw. With this piece as a sample, cut out as many pieces as are necessary to make the complete wainscoting.

2. Start at one corner of the room and fasten one piece of the matched boarding in place tight against the corner studs. Blind-nail the piece through the tongue to the grounds. Fasten on successive boards, being sure to drive the pieces together to make tight joints.

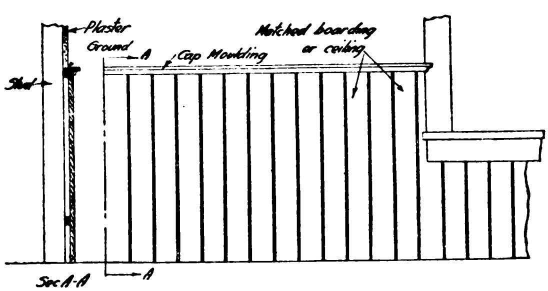


FIG. 188.—Wainscoting.

3. At the door and window cases, scribe, cut, and joint the boards to make tight joints.

4. Measure the length of the room, or the distance from one side to outer edge of door or window casing. Lay off this length on the wainscoting cap and make two square cuts. Nail the cap in place on the top edges of the boarding. Measure, lay off, and cut the rest of the sections of the cap in similar manner. At the corners of the room make coped joints.

Paneling.

5. Measure the length of the room or the distance between the side and outer edge of door casing. Lay off this distance on selected stock for the lower rail of the paneling and make two square cuts. Scribe and fit end against the door casing. Smooth one face and joint two edges of piece. Rabbet upper edge to receive panels.

6. Measure, lay out, cut, and finish the piece for the upper rail in the same manner as noted above for the lower rail.

7. Measure the required height of paneling and subtract the width of the top and bottom rails to determine the net length of stiles between the rails. Lay off this length on selected stock, one side of which has been smoothed and two edges jointed. Scribe a mark around the piece at each end of the line, allowing about 1½ inches beyond each line for the length of the tenon. With a back saw and chisel cut the tenon as described in Unit Operation No. 20.

8. Lay out the position of the stiles on the top and bottom rails. Cut mortises to fit the tenons of the stiles. See Figure 189.

9. Lay out and cut the panels to the size given by the distances between the rabbeted edges of the stiles and rails. Bevel the edges of the panels to fit the grooves cut in the edges of the stiles and rails.

10. Erect the paneling in place in sections and fit where necessary around door and window trim. Nail the paneling in place, blind-

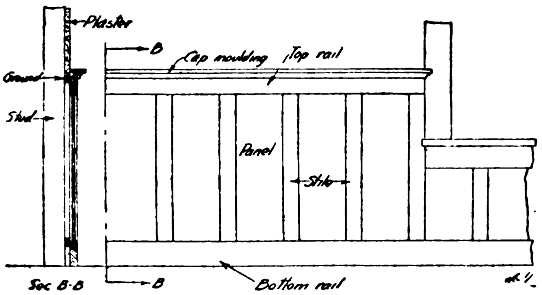


FIG. 189.—Paneling.

nailing wherever practicable, to grounds near the top and bottom of the section.

11. If moldings are used to frame the panels against the rails and stiles, measure, lay out, and cut the moldings with miter joints. (See Figure 189.)

12. Measure, lay out, and cut the molding for the panel sections, making miter joints at the corners of the room. At door and window casings "return" the cap molding against the face of the casing.

QUESTIONS.

1. Why is it preferable to lay the matched boards vertical instead of horizontal?

2. Should a base or base molding be used with wainscoting?

3. Would it be better to use nails or screws in fastening the paneling to the wall? If screws are used, where should they be placed?

4. How should panels be held in place to prevent splitting or cracking?

5. Should the moldings in paneling be nailed to the panels?

6. Under what conditions would the end or corner stiles be carried through and the top and bottom rails housed into them?

HANGING SLIDING DOORS.

1. Saw off the lugs of the doors.
2. Joint both edges of each door, and if double doors are used fasten the meeting strip or molding to the "meeting" edge of one door.
3. Measure the distance from the finished floor to the lower side of the trolley hanger along both door jambs.
4. Square up the top ends of the doors. Lay the doors together on horses, lay off the measured heights along the respective edges of the doors, and scribe a mark for the bottom edge. Saw and joint the bottom edges of the doors.
5. Screw the hanger plates to the top edges of the door in the locations given in the manufacturer's instructions.

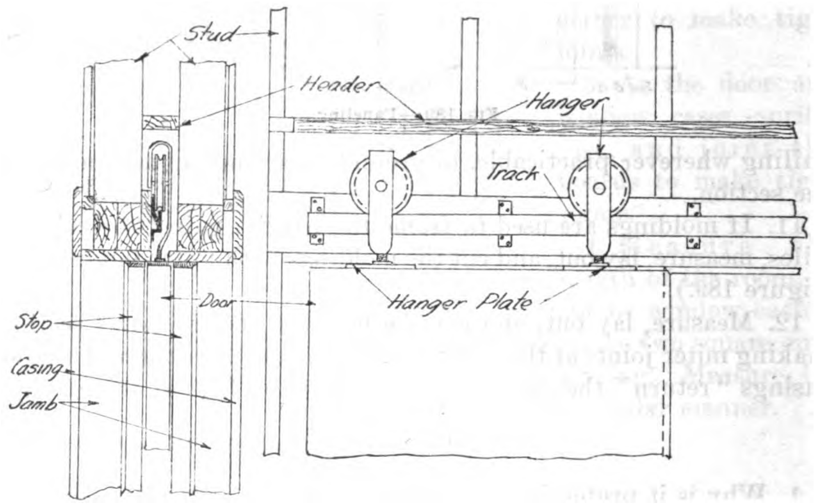


FIG. 190.—Details of hanger and track.

6. Hang the doors to the trolleys and locate the stops by moving the doors to the closed position and measuring back to the abutting edges of the hanger plates. Screw the two stops in position.
7. Fasten the jamb and head stops in position, with the doors closed, allowing about $\frac{1}{16}$ inch clearance between the edges of the stops and the door surfaces.

QUESTIONS.

1. What kind of stud partition is necessary for sliding doors?
2. How should the top of the sliding door opening be framed?
3. What method is used to guide the bottoms of sliding doors?
4. What is the best form of track to use for sliding doors?

LAYING FINISH FLOORS.

Select clear, clean flooring of the width and thickness required by the specifications. Reject stock which is cracked, split, or has damaged edges.

2. Lay the first line of boards, making an angle with the direction of the lower flooring and leaving a space of about $\frac{1}{4}$ inch between the strip and the adjacent wall. Be careful to lay the first line of boards parallel with the side of the room.

3. If the flooring is $\frac{13}{16}$ inch thick, nail every 16 inches with an 8d. cut flooring brad; if $\frac{7}{16}$ inch thick, use a 4d. finishing nail; and for $\frac{3}{8}$ inch thick, use a 3d finishing nail. Always drive each nail through the tongue at the angle shown below. When the nail has been driven nearly the entire length, set it in place with a final blow of the hammer, taking care not to bruise the face or edge of the board.

4. Where hard-maple flooring is used, holes for the nails should be drilled. For hardwoods in general dip the point of the nail in soap or oil before driving it into the board.

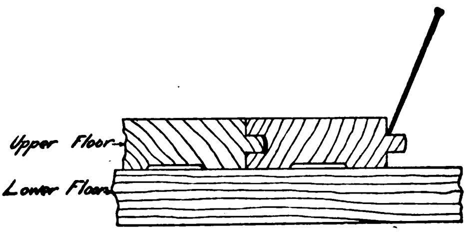


FIG. 191.—Nailing finish floors.

5. After the first line of boards across a room has been nailed in place, set the groove of the second board on the tongue of the first and drive tightly into place, using a short driving block to prevent damaging the tongue and edge of the second board. Drive up each line of boards tight against the preceding line before nailing.

6. After the floor is laid, sweep it free of all shavings, dust, and dirt. With a cabinet or, preferably, a floor scraper, smooth the floor to a uniform surface. (See Unit Operation No. 7.)

QUESTIONS.

1. Why is it necessary to leave a space between the first line of floor boards and the wall?
2. Why is it necessary to drive the nails at an angle of about 50 degrees with the floor?
3. What benefit is derived from greasing or oiling the ends of the nails?
4. How should a board which is sprung or bent be nailed?
5. What care should be taken in the selection of the floor boards for surface finish and grain?
6. Is it necessary to nail the upper floor at joists?

FITTING STANDARD HARDWARE.

Door hinges.

1. Read Information Topic No. 15, Finish Hardware.

2. Place the door in position with the top and hinge side tight against the frame.

3. Measure from the top and bottom of the door to locate the top of the upper hinge and the bottom of the lower hinge. If these distances are not given in the architect's specifications, place the top of the upper hinge nearly opposite the bottom of the top rail of the door and the bottom of the lower hinge nearly opposite the top of the bottom rail. Mark these locations simultaneously on the door and frame jamb with a knife or chisel.

4. Take the door out of the frame, place it on edge, and scribe the outside boundaries of the hinges. In a similar manner mark the outlines of the hinges on the jamb.

5. Set a marking on butt gauge for the depth the hinges are to be sunk and for the breadth of the hinge, and scribe the door and jamb.

6. Chisel out "gains" as shown by marks on edge of door and jamb of frame.

7. If loose pin butts are used separate the parts. Place one part of the butt in place on the jamb and drill holes for the screws. In a similar manner fasten the same part of the other hinge or butt on the jamb and the remaining sections of both hinges on the door. If plain or fixed pin butts are used, fasten the hinges to the door, and then wedge the door in place while fastening the hinges to the frame. Set the screws in toward the rear of the gain so as to force the hinge against its rear edge.

Door locks.

8. To attach a rim lock, place the lock against the side of the door with the center of the knob at the height from the floor given in the architect's specifications, generally 2 feet 10 inches. Mark through keyhole and knob-spindle hole of the lock with an awl or dividers' point.

9. Bore holes of proper size through the door for knob and keyhole, using marks given in paragraph 7 as centers.

10. Screw the lock in place and fasten on the knob spindle and knobs.

11. Place the latch or strike plate in position on the edge of the jamb opposite the lock and fasten with screws.

12. To attach a mortise lock, place the lock against the side of the door at the required height from the floor and with selvage

back about $\frac{1}{16}$ inch from the edge of the door mark through the keyhole and knob-spindle hole of the lock with an awl or dividers' point. Mark the upper and lower edges of the box on the edges of the stile.

13. Bore the proper size holes for the knob spindle and key, using the marks given above as centers.

14. With a try-square mark across the edge of the stile the upper and lower edges of the box. Mark the center line along the edge of the stile between these marks. With a bit of a diameter slightly larger than the thickness of the box bore a series of holes between the marks and to a depth slightly greater than the width of the box. Chisel out the mortise until the box slides in easily.

15. Mark along the outside of the selvage with a knife. Remove the lock and "gain in" the edge of the stile to a depth slightly greater than the thickness of the selvage.

16. Fasten the lock in place by screwing through the selvage.

17. Attach the knob spindle, roses or escutcheons, and knobs.

18. Close the door and mark the vertical position of the latch upon the jamb. Open the door, place the latch or strike plate in position, locating it vertically by the latch mark on the jamb and horizontally by setting it in from the face of the jamb a distance equal to the offset of the latch from the face of the door. With a knife or scriber outline the plate on the jamb.

19. Gain out the jamb with a chisel and fit the latch plate in place.

20. Screw the latch plate into the jamb and chisel out the holes for latch and bolt.

Window fittings.

21. Close the upper and lower sash of double-hung windows so that the meeting rails are flush and the surfaces level. Place the sash lock on the upper surface in proper position near the center of the window and set so that the sash will be tightly closed when the catch is set. With an awl mark the centers of the screw holes.

22. Remove the lock and drill holes for the screws.

23. Replace the parts of the lock and screw in place.

24. If flush sash lifts are used, place in position on the bottom rail, scribe the outline of the lift and mark the centers of the screw holes.

25. Remove the lifts, chisel out holes in the rails for insets, and bore holes for the screws.

26. Replace the lifts and screw in position.

27. If hook lifts are used, place in position on the bottom rail and mark the screw holes.

28. Remove the lifts and drill the holes.
29. Fasten the lifts in position with screws.

QUESTIONS.

1. Can a mistake be made in fastening a butt wrong side up on a door? Are there right and left hand butts or hinges?

2. If the door hangs away from the frame on the hinge side, how may the hinge be reset to straighten the door?

3. If the door strikes the jamb at the hinge and will not close, "hinge bound," how may the hinge be reset to straighten the door?

4. Why is the selvage of the lock set back from the face of the stile?

5. If the door fails to latch, what should be reset and how?

6. How would you make a templet for use in fitting a number of locks of the same size?

UNDERPINNING.

1. To underpin a house to support the superstructure, in order to move the house or raise or lower the foundation, cut holes through the side walls of the foundation just below the sills. Make these holes of sufficient size to insert cross timbers, spaced from 6 to 8 feet apart, to support the building.

2. If the building is to be raised or lowered or the foundation rebuilt, use short beams, called needle beams or "needles"; but if the building is to be moved, use continuous timbers, extending from

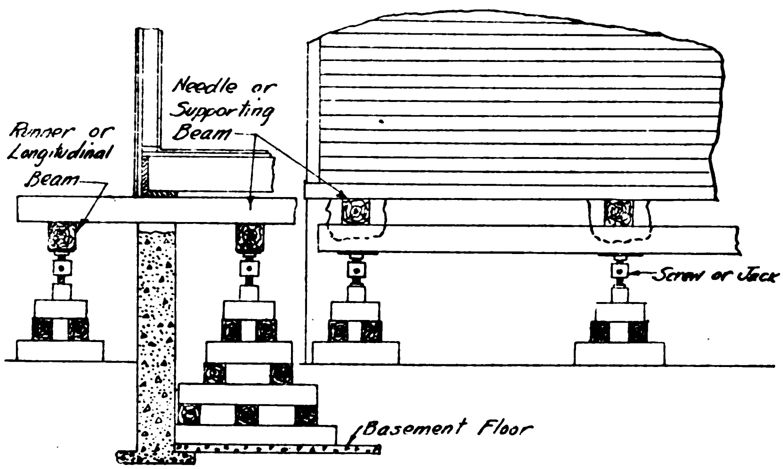


FIG. 192.—Underpinning.

the support on one side of the building to the corresponding support on the other side.

3. Build a timber support under each end of the needle or supporting beam. If the building is to be raised or moved, make the supports of timber blocks. If the foundation is to be lowered, the outside supports must be carried to a depth as low as the elevation of the bottom of the proposed foundation. (See Figure 193.) Under the ends of the needles or supporting beams place longitudinal timbers, which rest upon screws or jacks set on top of the supports.

4. Place supporting timbers under chimneys, hearths, and floor girders. Block up under girders, where necessary, to remove the load from basement piers or columns.

5. To raise the building from its original foundation, turn the screws or operate the jacks equally and simultaneously. Raise the

building to the proper height for the new foundation or clear of the foundation if it is to be moved.

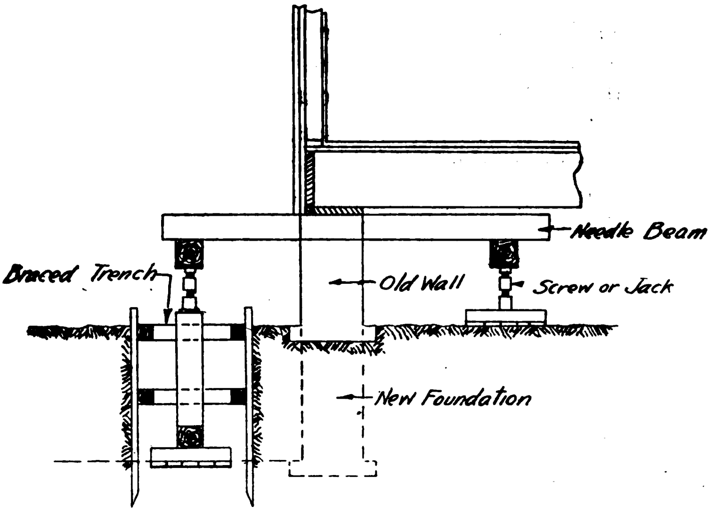


FIG. 193.—Underpinning for new foundation.

QUESTIONS.

1. Where should the needle or supporting beams be placed in order to best carry the weight of the building?

2. What size cross timbers should be used for the needle or supporting beams?

3. What is the purpose of the "runners" or longitudinal timbers?

4. What size of timbers should be used for the "runners"?

5. Why is it necessary to support the main floor girders?

6. Why is it necessary to carry the timber supports to the depth of the new foundation?

MAKING HOPPER JOINTS.

1. Select stock of the required thickness and rip out the side boards of the required width *w*.

2. Set the T-bevel to the required slope of the sides of the hopper (in this case 6 inches in 12 inches) and lay off this bevel on the top and bottom edges of the board, as shown at *d* and *m*. Plane the edges of the board to the bevel as marked.

3. Lay off the lengths of the upper and lower edges on the board as *AD* and *IM*.

4. With a try-square, square across the bevel edges, marking the lines *AB*, *DE*, *GI*, and *KM*. Scribe the lines *AI*, *BG*, *DM*, and *EK*, and cut the bevel edges *ABGI* and *DEKM*, which will give the true hopper joints for simple butt joints.

5. Lay out and cut the other three sides of the hopper in a similar manner.

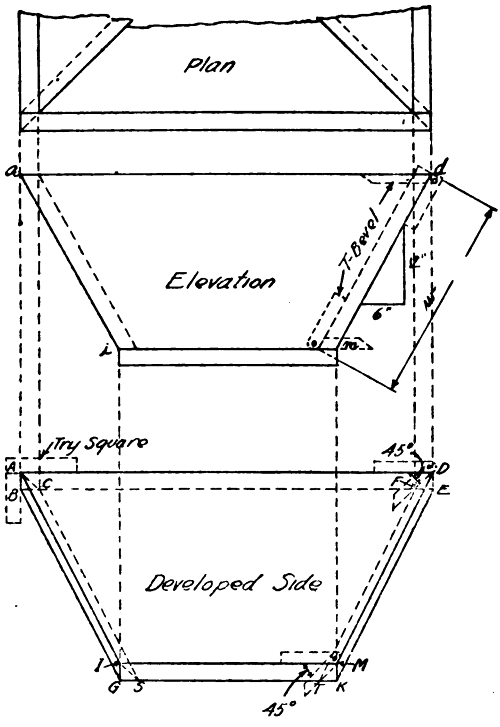


Fig. 194.—Details of hopper.

6. For a miter joint, plane the upper and lower edges as in the butt joint and bisect the angle that the adjacent sides make with one another. Lay this angle, which will be 45 degrees for a square hopper, off on the T-bevel and mark the lines *AC*, *DF*, *SI*, and *TM* on the top and bottom edges of the side, placing one leg of the T-bevel against one side of the beveled edge. Draw the lines *CS* and *FT*.

7. With a crosscut saw make the bevel cuts *ACIS* and *DFTM*, which will be the miter cuts for the hopper joints.

QUESTIONS.

1. For a square hopper, would the sides be the same size if butt joints were used? If miter joints were used?

2. Why does squaring the lines *BC*, *EF*, etc., on the top and bottom edges give the lines for the side bevel cuts for butt joints?

ESTIMATING.

Methods.—The cost of a building may be determined by either approximate or accurate methods. Architects and builders, in order to determine the approximate cost of a building use the "cubage" or "square" methods. The former consists in the determination of the cubic contents of a building and multiplying this by a unit price based upon the type of building. The square method comprises the determination of the total floor area of a building and the multiplication of this figure by a unit price based upon the class of building considered. Both of these methods of estimating should be used only by the experienced estimator to gain a general idea of the approximate cost of a building.

The most accurate way to estimate the cost of a building is to take off in detail the actual quantities of materials required and carry out the price with the cost of labor, allowance for profit, overhead, and contingent expenses. This method requires accurate working drawings, from which schedules of material may be prepared and the amount of labor estimated. It should be noted that the cost of a building consists of two main divisions—material and labor.

Board measure.—All lumber or timber is estimated or determined by board measure. The unit of board measure is a square foot of a board 1 inch thick. All lumber is rated by the thousand feet, so the expression "$50 a thousand" (M) means $50 for a thousand square feet of stock 1 inch thick. When stock is less than 1 inch thick it is figured as 1 inch, and when it is greater than 1 inch in thickness the board measure may be easily and quickly determined by reducing the area to an equivalent area having a thickness of 1 inch. For example, suppose it is desired to find out the board measure of a girder 6″ x 12″ and 20 feet in length. The area of the girder would be 6″ x 12″ or 72 square inches. The equivalent cross section of a board 1 inch thick would be 72 times 1 inch, or an area 1 inch thick and 6 feet wide. The board measure (B. M.) would then be 6′ x 20′ or 120 feet (B. M.). Therefore, as a general rule to determine board measure (B. M.) divide the product of the width and thickness in inches by 12 and multiply by the length in feet. This may be expressed as a formula:

$$\frac{\textit{Width (in inches)} \times \textit{thickness (in inches)} \times \textit{length (in feet)}.}{12}$$

The following table will be useful in giving the board measure per linear foot for different sizes of timber:

End size.	Board measure.	End size.	Board measure.	End size.	Board measure.	End size.	Board measure.
Inches.	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*
1 x 2	0.17=⅙	1¼ x 3	0.31=5/16	1½ x 10	1.25=1¼	3 x 14	3.50=3½
1 x 3	.25=¼	1¼ x 4	.42=5/12	1½ x 12	1.50=1½	4 x 4	31.33=1⅓
1 x 4	.33=⅓	1¼ x 5	.52=25/48	2 x 4	.67=⅔	4 x 6	2.00=2
1 x 5	.42=5/12	1¼ x 6	.62=⅝	2 x 6	1.00=1	6 x 6	3.00=3
1 x 6	.50=½	1¼ x 8	.83=⅚	2 x 8	1.33=1⅓	6 x 8	4.00=4
1 x 8	.67=⅔	1¼ x 10	1.04=1 1/24	2 x 10	1.67=1⅔	8 x 8	5.33=5⅓
1 x 10	.83=⅚	1¼ x 12	1.25=1¼	2 x 12	2.00=2	8 x 10	6.66=6⅔
1 x 12	1.00=1	1½ x 2	.25=¼	2 x 14	2.33=2⅓	8 x 12	8.00=8
1 x 14	1.17=1⅙	1½ x 3	.37=⅜	3 x 4	1.00=1	10 x 10	8.33=8⅓
1 x 16	1.33=1⅓	1½ x 4	.50=½	3 x 6	1.50=1½	10 x 12	10.00=10
1 x 18	1.50=1½	1½ x 5	.62=⅝	3 x 8	2.00=2	12 x 12	12.00=12
1 x 20	1.67=1⅔	1½ x 6	.75=¾	3 x 10	2.50=2½	14 x 14	16.33=16⅓
1¼ x 2	.21=5/24	1½ x 8	1.00=1	3 x 12	3.00=3	16 x 16	21.33=21⅓

Measuring quantities.—In estimating the quantity of the various kinds of lumber used in a building suitable allowance must be made for waste. This waste is incurred in cutting timber to the required lengths and also in measuring stock.

Architects and builders ordinarily design a building so as to use standard lengths of lumber—10 feet, 12 feet, 14 feet, 16 feet, etc.

Heavy timbers.—Sills, plates, girders, posts, etc., are determined by count.

Joists.—The number of joists, if spaced 16 inches on center, is determined by taking three-fourths of the length or width of a room, in the direction of the joists, and adding one which is placed against the second wall. If the joists are placed 12 inches on centers, the number will be equal to the number in feet of the length or width of the room plus one joist.

Studding.—Allow one stud for each linear foot of wall or partition, where the spacing is 16 inches on centers. The extra studs are for an allowance for doubling at corners, doors, and windows.

Bridging.—An allowance of 25 linear feet of 1½″ x 3″ or 2″ x 4″ for each 100 square feet of flooring.

Rafters.—On a simple roof, count the actual number and add one, as for joists. In a broken roof an actual count of the different size material for valleys, hips, jacks, and cripples should be made.

Sheathing.—Sheathing for walls and roofs should be estimated on the basis of the exact surface to be covered, deducting for openings. When plain boarding is used make the following allowances for shrinkage and for waste in cutting: $\frac{1}{12}$ for 12″ boards, $\frac{1}{10}$ for 10″ boards, $\frac{1}{8}$ for 8″ boards.

When ship-lap is used add 17 per cent for floors, 20 per cent for side walls, 25 per cent for roofs. When matched sheathing is used, add the following percentages for waste for 6″ stock: 15 per cent for floors, 17 per cent for side walls, 20 per cent for roofs.

Siding.—Where bevel siding is to be used, calculate the exact surface, deduct for openings, and add the following percentages for waste and lap for 6″ siding: 33 per cent when laid 4½ inches to the weather, 50 per cent when laid 4 inches to the weather.

Drop siding and wainscoting are estimated the same as matched flooring.

Flooring.—Calculate the exact surface to be covered, making allowance for openings and for matched stock, add 20 per cent for 5¼″ flooring, 25 per cent for 3¼″ flooring, 33 per cent for 2¼″ flooring, and 40 per cent for 1½″ flooring.

Shingles.—A bundle of shingles is assumed to contain the equivalent of 250 shingles of 4 inches in width. With an exposure of 4½ inches to the weather, a 4″ shingle will cover 18 square inches, making 800 shingles to the 100 square feet or square.

In order to make allowance for doubling, matching, and waste, the following figures should be used: 4-inch exposure, 1,000 shingles per square; 4½-inch exposure, 900 shingles per square; 5-inch exposure, 800 shingles per square.

Laths.—Laths for interior plastering work are ⅜″ x 1⅜″ x 4′ in length. Laths come in bundles of 50 and are generally laid so that 14 laths cover 1 square yard, or 1,000 laths (20 bundles) will cover about 70 square yards of surface and require 8 pounds of 3d. fine lath nails.

Millwork.—Door frames, window frames, doors, and window sash are determined by actual count. Outside and inside casings or trim, baseboards, moldings, etc., are estimated to the nearest 100 linear feet or multiples thereof. This material comes in random lengths, and an allowance of about 20 per cent should be made for waste in cutting. On contract work the mills will supply the finish in lengths sufficient to square up for each opening.

Labor costs.—Labor costs vary in different parts of the country, and to some extent are based on the union rates. The amount of time necessary for doing a definite amount of any class of work depends upon the workmen and the efficiency of the organization. The following is given as an approximate statement of the average amount of work which should be done by the ordinary journeyman carpenter on the various kinds of carpenter work in building construction during an average 8-hour day.

Set about 500 board feet of joists, studs, or common rafters.

Put on about 400 feet of dressed and matched or ship-lap sheathing.

Put on about 500 feet of common sheathing on roofs or floors.

Put on about 350 feet of common 6″ siding.

Lay about 350 feet of 4″ to 6″ siding.

Cut and lay 1,500 shingles on a hip roof and 2,000 on a gable roof.

Cut and lay 250 feet of clapboards.

Fit and hang 8 two-sash windows.

Put on about 1,000 feet of rough barn boards.

Set and fit about 8 window frames.

Fit and hang 8 ordinary doors.

Case about 8 ordinary doors, one side only.

Nails.—The quantity of nails of various kinds which are necessary for the carpenter work of an ordinary building is given in the following table:

Table for estimating quantity of nails.

Material.	Size of nail.	Pounds required.
1,000 shingles	4d. common	5
1,000 laths	3d. common	8
1,000 square feet beveled siding	6d. common	18
1,000 square feet sheathing	8d. common	20
1,000 square feet sheathing	10d. common	25
1,000 square feet flooring	8d. common	30
1,000 square feet flooring	10d. common	40
1,000 square feet studding	10d. common	15
1,000 square feet studding	20d. common	5
1,000 square feet furring, 1″ x 2″	10d. common	10
1,000 square feet finished flooring, $\frac{7}{8}$″	10d. finishing	20
1,000 square feet finished flooring, $1\frac{1}{8}$″	10d. finishing	30
1,000 feet B. M. joists and sills	20d. common	25
1,000 feet B. M. rafters	20d. common	15
1,000 linear feet cornice	8d. common	18
1,000 feet B. M. ceiling and wainscoting	6d. finishing	20
1 window, trim, 1 side	8d. finishing	$\frac{1}{4}$
1 door, trim, 1 side	8d. finishing	$\frac{1}{2}$

QUESTIONS.

1. Why are the "cubage" and "square" methods of estimating inaccurate?

2. When is it advisable to use the "cubage" and "square" methods of estimating?

3. Is it necessary for the contractor to take account of allowances other than material and labor in making a bid for the construction of a building?

4. How many feet board measure in a plank 2″ x 12″ x 16′ in length?

5. How many feet board measure in a girder made up of three 2 x 8s, 20′ in length?

6. Why should an allowance of 25 linear feet be made for bridging for each 100 square feet of flooring?

INSIDE FINISH.

The inside finish of a building comprises the finished woodwork which is put in after the plastering or other wall finish has been done. This finish, or trim, is used primarily to cover up the rough work and make a finish where the plaster joins the door and window frames and floor. In addition to the trim or "standing" finish, doors, stair work, wainscoting, and other ornamental finish are generally included as the inside finish of a building. All of this work actually comprises the last work which is done on a building after the structure is inclosed and the plastering thoroughly dried out.

Materials.—As one of the principal requirements of inside finish is an attractive appearance, the material used should be free from knots, sap, or other defects and of thoroughly seasoned stock. The character and quality of material to be used depends upon the finish and the requirements as to the class of wood—hard or soft wood. Poplar, redwood, and cypress are the soft woods generally used, while hard pine, white pine, oak, black walnut, and mahogany are the hardwoods. The soft woods and hard pine are generally used for the cheaper class of buildings, while such material as black walnut and mahogany are only used for the finest and most expensive work. It should be noted that white pine, poplar, redwood, and cypress are soft woods and dent easily, while the hardwoods, such as oak, ash, and walnut, are more durable and stand up better under hard usuage. Specifications generally require that the stock for inside finish shall be kiln dried.

Preparation of material.—Inside finish or trim, as it is usually made up at the mill, is delivered at the building site clean, true, and ready for immediate use. However, the carpenter should always go over each piece of stock and with sandpaper remove rough edges and smooth down irregular surfaces. All material should be cleaned, trued, and smoothed up before being cut and set in place.

Inside trim.—Inside trim, or standing finish as it is often called, consists of the door and window casings, baseboards, picture moldings, wainscoting, paneling, etc. The interior finish is generally made in accordance with detailed drawings furnished by the architect. In the cheaper class of buildings it is customary to use simple trim and moldings which are carried in stock by the mills and lumber yards.

The first step in the placing of the standing finish is the setting of door jambs. As the rough framework may vary slightly from the plans, it is always necessary to cut and fit the door frames as well as all other inside finish. Special care should be taken in this operation to secure jambs which are plumb and the edges of which are out of wind. Useless the door frame is set true and plumb, it will be difficult to fit the door, and the latter will never operate satisfactorily. The method of setting a door frame is described in Unit Operation No. 52.

The window sash is sometimes fitted before the building is plastered, but generally the window openings are covered with building paper or cheesecloth during the plastering and the window sash is set after the plastering is dry. This latter method is preferable in order to keep the sash clean and dry.

See Unit Operation No. 60 for hanging windows.

The next step in the inside finish of a building is the placing of the door and window casings. Various styles of casings are used, depending upon the character and quality of the work required by the specifications. In the more elaborate and expensive work the casings are heavily molded and base and head or plinth blocks are used. In the cheaper and simpler work a simple form of casing with plain surfaces and without head and base blocks is customary. Door and window casings are generally the same in character, except that the window trim stops at the sill, while the door casings are carried to the finished floor. In putting up door trim the base block or plinth, is first placed, and serves as a base upon which the side trim is set. The head blocks and casings are placed last. In the case of windows the stools are set first and serve as a base for the side casings. The latter are generally set in first and serve as a base for the side casings. The latter are generally set in from the face of the jamb about $\frac{1}{8}$ of an inch. The head is set last. All baseboards and base moldings are now set, care being taken to place the latter on blocks the thickness of the finished floor, if the latter has not been laid. The shoe mold is set after the finished floor is laid. See Unit Operation No. 58 for window and door casings and base boards.

Paneling and paneled wainscoting is often used for ornamental purposes in living and dining rooms of the more expensive class of buildings. The material is ordinarily prepared in the mill and set up in the building. In order to have the finished work smooth and true, it is customary to set it out from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch from the studding or plastering and fasten with finish nails or screws to the stripping. In halls, closets, kitchens, etc., the walls are often wainscoted or sealed with matched boarding. This boarding is generally made of stock 3″ or 4″ wide, tongued and grooved, and toenailed in place. The wainscoting is usually carried from the floor to a height of about 40 inches and capped with molding. The wainscoting should be fastened to grounds or strips which are nailed to the studding before the walls are plastered. Wainscoting and paneling are described in Unit Operation No. 62.

Stairs.—The stairway or stairs furnish a passageway from one story of a building to another. The stairs consist of a series of steps, each of which has a vertical face called the "riser" and a horizontal member known as the "tread." The risers and treads are proportioned so that the ascending of the stairs may be easily and comfortably made. A simple rule for determining the relative widths of risers and treads is: Twice the riser plus the tread is equal to 24 inches. A good average stair for a house should have a rise per step of 7 inches and a run of tread of 10 inches. Figure 195 shows the various parts of a simple stair.

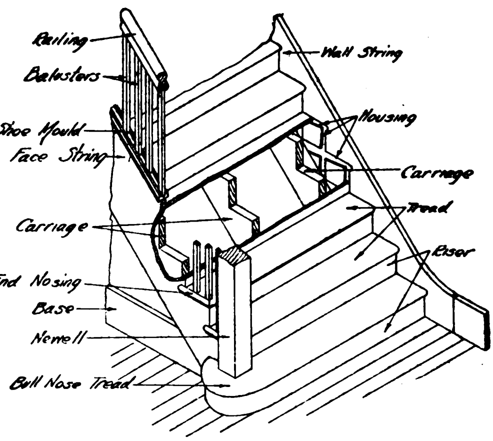


FIG. 195.—Details of stairway.

The general plan of a stairway is made so as to provide easy access from one floor to another, sufficient width of stairs in case of fire and for the transmission of goods, and proper headroom between the stairs and adjacent floors or ceilings. Landings are generally introduced in a stairway, especially at changes of direction, and serve to provide a stop or resting place. Stairs are usually made 3 feet in width in order that boxes and trunks may be easily moved over them. A minimum space of 6 feet 6 inches should be allowed between a stair tread or platform and the ceiling above.

A series of stringers so notched as to receive the treads and risers, called carriages, are first erected as a part of the main frame of the building. Rough boards are laid on these carriages and serve as a temporary stairway until the inside finish of the building is commenced. A part of the inside finish consists of the finished treads and risers, wall stringers, etc., that are necessary to cover in the carriages to form the finished stairs.

The stair stringers are first set in position. On semiclosed or inclosed stairs and stairs adjacent to one or two walls the stair stringer serves also as a wall board or continuation of the baseboard of the hall or room out of which the stair rises. The outer or open side of a stair should have a fascia or finished board fastened to the outer carriage.

The treads and risers are generally tongued and grooved and framed into one another so as to form tight joints. The risers are first nailed to the carriages, commencing at the bottom, and the treads are fitted into them and nailed in place.

Stairways are generally built of the same material as is used for the rest of the interior trim. The treads, however, should always be made of hardwood, as they are subject to considerable wear. Oak is in common use for the treads of all classes of buildings.

In a great many localities, especially the large cities, stair building is done by special concerns which manufacture the stairs complete from the architect's detailed drawings and later set them up in the building. The method of housing stairs, cutting stair risers and treads, and erecting a stairway is given in Unit Operation Nos. 49 and 61.

Doors.—Doors may be classified as to design—stock doors and specially made doors; and as to construction—solid doors and veneer doors. In the cheaper class of building construction standard doors, which may be secured from the stock of a mill or lumber yard, are ordinarily used. Specially made or custom-made doors are used in the more expensive work and for the front doors of a house.

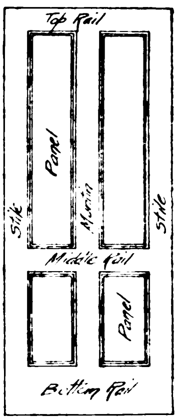


FIG. 196.—Detail of door.

Until recently the majority of doors were made solid and vary in thickness from $1\frac{1}{8}''$ to $1\frac{3}{4}''$. Figure 196 shows the various parts of a door, which may be divided into four or more panels. Outside doors, for the sake of appearance, may have larger panels or glass introduced to transmit light. The top and bottom rails of a door should be framed with haunched tenons for strength.

In the better class of construction, where it is desired to use more expensive hardwood, veneer doors have come into common use. This type of door consists of hard pine which is covered with thin sheets or strips of the surface hardwood. The panels may be of solid hardwood, but if wide are generally veneer.

The fitting and hanging of a door is a particular operation and should be carefully done. An allowance of $\frac{1}{16}$ inch should be made at the top and each side of the door to provide for proper clearance. It is customary to bevel the edge of the door, so as to give greater clearance in closing. Thresholds or carpet strips are used on the outside doors and where rough upper floors with carpets are to be used in the house. Where hardwood upper floors are used the threshold for interior doors is omitted. The method of hanging doors is described in Unit Operation Nos. 52 and 59.

QUESTIONS.

1. Why is it necessary to place the interior finish after the interior wall surface has been completed?
2. Why must stock for interior finish be kiln dried?
3. Why should the carpenter wait until the wall plaster is thoroughly dry before placing the interior finish?
4. Why are window openings covered with building paper or cheesecloth during the plastering?
5. Why not place the window sash before the interior wall surface is applied?
6. Why is it necessary to have the door jambs vertical?
7. Why are the head casings for door and window openings generally placed last?
8. Why does the carpenter often place the shoe mold several weeks after the finished floor has been laid?
9. Why are the treads and risers generally housed into the wall string?
10. Why is it desirable to commence placing the treads and risers at the bottom rather than at the top of the stairs?
11. Why are the treads and risers tongued and grooved into one another?
12. What is the advantage of built-up or veneer doors? Is it advisable to use this type of door on the outside of buildings?

OUTSIDE FINISH.

Materials.—The material for outside finish should be white pine, cypress, or spruce. Redwood is generally used in the States west of the Rocky Mountains. The material should be of clear well-seasoned stock and free from knots.

Flooring, roofing, ceiling, etc., should be tongued and grooved material, and the tongue should be painted with white lead and oil before the pieces are joined. Care should be taken to make the joints close and tight so as to be weatherproof. Where several pieces are fastened together, toenailing should be used wherever possible. Where surface nailing is used, all nail heads should be sunk below the surface of the finish and the holes filled with putty.

Application of finish.—The outside finish of a frame building is applied after the sheathing is in place. Corner boards, water tables, belt course, door and window frames should be placed before shingles or siding are put on. Cornices and gable ends should be applied before the roofing material is applied.

The principal parts of the outside finish are corner boards, door and window frames, belt courses, cornice, gable finish, brick and miscellaneous construction. The method of applying exterior trim is given in Unit Operation Nos. 52, 53, 54, and 56.

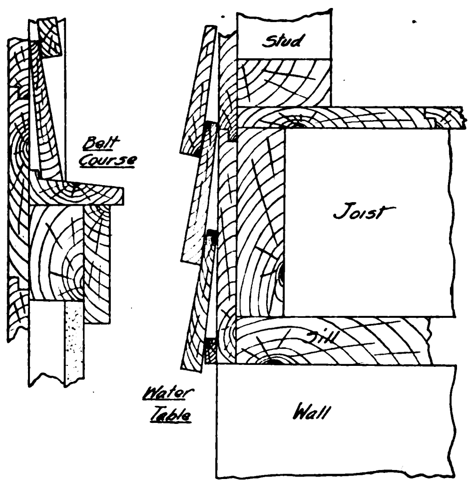


FIG. 197.—Cross section of belt course and water table.

Corner boards.—The corners of a wooden frame building, the walls of which are to be covered with siding or shingles, are generally finished with vertical boards called "corner boards." These boards are usually from 4″ to 5″ wide on the external angles and 2″ to 3″ wide on the internal angles. On colonial houses the corner boards are frequently made in the shape of wide pilasters for the purpose of ornament. The siding and shingles are butted against the inside edges of the corner boards, which serve as a finish or stop.

Belt courses.—Wide belt courses are often placed on the sides or across the gable ends of wooden frame buildings. They may be constructed in any shape, but are generally formed of a wide vertical surface surmounted by a group of moldings, the top of which has a pitch or slope to carry off the water. The belt course along the bottom of a wall is known as the water table, and should be constructed so as to drain the water away from the foundation wall below it.

Door and window frames.—Door and window frames which are made up by the carpenter or in the shop or at the mill are placed in their proper openings in the walls before the outer wall surface is built.

Door frames should be made of clear well-seasoned material with a thickness of 1⅛ inches to 1¾ inches. The sides and the top of the frame should be rabbeted at the inner edge for the door. The

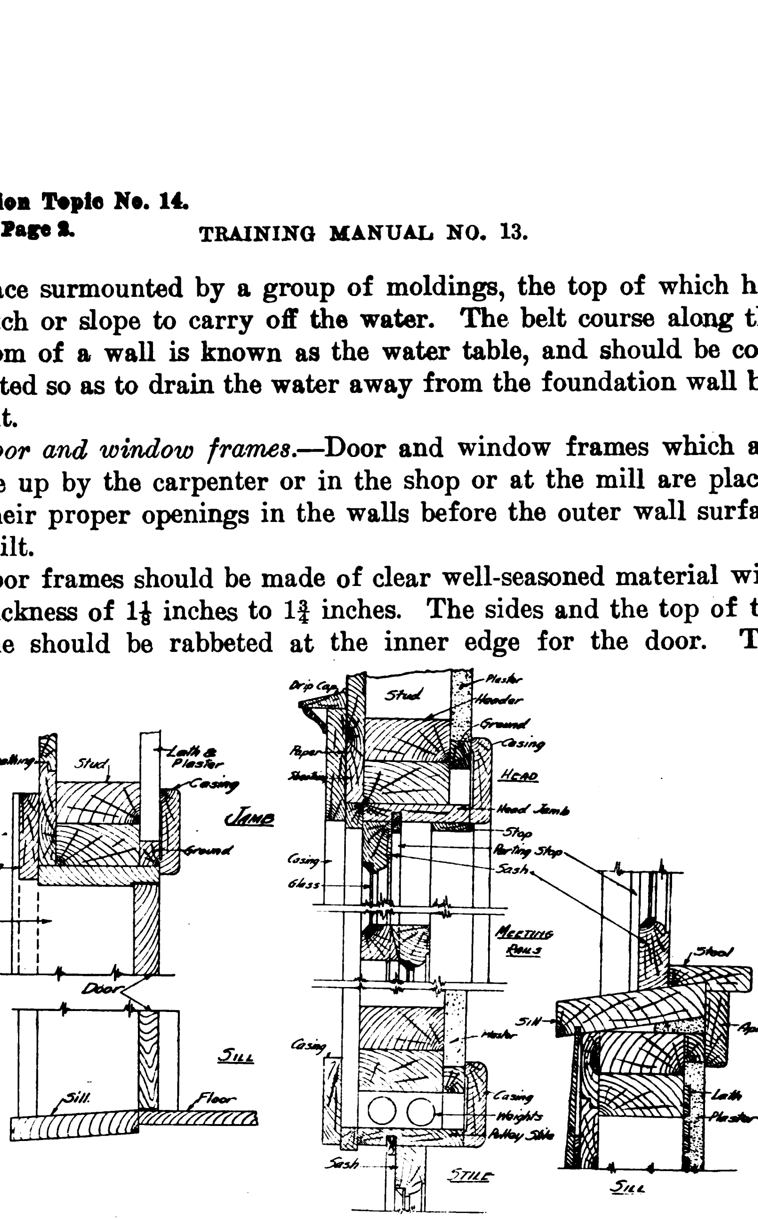


FIG. 198.—Details of outside door and window frame.

inner edge of the frame should be set flush with the plaster. Provision should generally be made for using a screen door on the outside of a frame. This may be done by rabbeting the outer edge of the frame or by building a stop against the outer edges of the frame. The sill should be of 1½ inch to 1¾ inch stock and given a slope of 1 inch in 12 inches toward the outside in order to drain off the water.

Window frames are provided for double-hung windows, casement windows, single sash, basement or cellar windows. Window frames are of three types—plank frames, skeleton frames, and box frames. Plank frames are used for fixed sash and hinged sash. Skeleton frames are necessary to furnish space required for the sash weights for double-hung windows, and in masonry buildings the box frame is used. The sides and finish of a window frame are commonly made of $\frac{7}{8}$-inch stock. The yoke or head jamb is made of $\frac{7}{8}$ inch to $1\frac{3}{4}$ inch and the sill or stool is generally made of $1\frac{1}{8}$-inch material. In order to provide sufficient space for the weights the depth of the weight box should be made not less than 2 inches for $1\frac{3}{8}$-inch sash. For windows of large size a depth of $2\frac{1}{4}$ inches is generally used.

Sheathing paper should be applied to the boarding before the door and window frames are set. The method of applying this insulation is described in Unit Operation No. 48. The method of setting a door and window frame is given in Unit Operation No. 52.

The tops of window and door frames are generally flashed with tin, lead, or copper. This flashing is carried over the top or drip mold of the frame and fastened along the outside edge of the same.

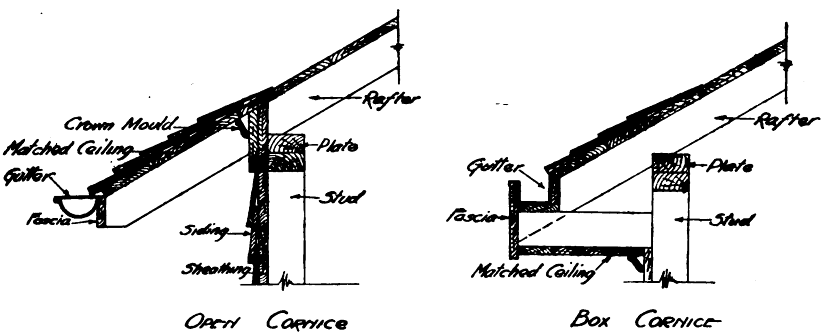


Fig. 199.—Open and box cornices with gutters.

The bottom of the sills of all window frames should be rabbeted for the insertion of shingles and clapboards, so as to prevent wind and rain from passing underneath.

Cornices.—Cornices are of two different classes—the open cornice and the box cornice. The open cornice is less expensive than the box cornice, but it does not make so warm a house. The box cornice is more complicated and is subject to leaks and the necessity for frequent repairs.

In wooden framed dwellings various forms of eaves construction are in use. It will be noticed that these forms differ largely as to the type of material used. The gutter may be of wood or metal and built in as a part of the eaves or attached to the outside edge of the roof.

All the joints of a cornice should be thoroughly covered with white lead or thick paint so as to prevent the decay of the wood. All joints in the moldings should be mitered. The exterior finish of a gable should correspond with that of the sides of the house in all details.

Often the box cornice is carried around on the end or gable walls and returned. Methods of building cornices are given in Unit Operation No. 56.

QUESTIONS.

1. Why should white lead and oil be used on the edges of tongued and grooved flooring for the outside porch?
2. Should outside finish be as thoroughly seasoned or dried as inside finish?
3. Is it necessary to take as much care in fitting and placing outside finish as for inside finish?
4. Why should the corner boards, belt course, and water table be placed before the shingles or siding are applied?
5. Why should the cornice and gable ends be set before the roofing is applied?
6. Why are corner boards used on a building?
7. Why are the jambs or pulley stiles grooved for the parting strip?
8. How much space should be allowed between the jambs and studs for window weights?
9. Is it more desirable to house the head and sill of a window frame into the pulley stiles or the pulley stiles into the head and sill?
10. Why are the jambs of a door frame rabbeted?
11. Why are the ends of a doorsill housed into the jambs?
12. Why does a box cornice make a house warmer than an open cornice?
13. Why are the tops of window and outside door frames flashed?

FINISH HARDWARE.

The finish hardware of an ordinary building consists of the hardware which is necessary for the operation of doors, windows, drawers, and other movable parts of the building. This hardware may be made of different material, style, and finish, depending upon the quantity or grade necessary to trim the building. Steel, wrought iron, brass, bronze, and copper are materials which are used for the various kinds and grades of finished hardware. Steel, wrought iron, and cast iron are materials generally used in ordinary building construction. Brass, bronze, and copper are used largely for exterior hardware which would be subjected to corrosion or oxidation from climatic conditions. Surface finish of hardware depends, to some

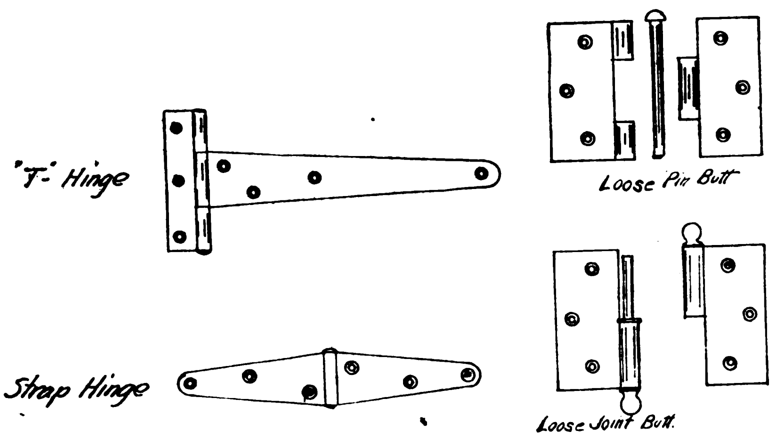


FIG. 200.—Hinges.

extent, upon the interior finish required by the specifications. Much of the ordinary hardware is japanned or painted to correspond with the interior finish of the building. Special finishes, such as bronzed, oxidized, nickel, etc., are finished in standard hardware by different manufacturers.

Door trimmings.—The hardware for a single door usually consists of hinges, lock, knobs, and escutcheon plates. Outside doors are often provided with plates and overhead checks. Sliding doors are usually hung on hangers and fitted with locks, flush pulls, and escutcheon plates. Swinging doors are provided with push and kick plates instead of the customary escutcheon plates.

Hinges.—Hinges may be divided into two general classes—the strap hinge and the butt hinge. The strap hinge is fastened to the face of the door, while the butt hinge is screwed to the edge of the door and frame. The former are used for hinging batten doors for closets, sheds, stable, trap doors, etc. The latter are used for outside and inside doors in finished buildings, etc.

Hinges are sometimes equipped with springs, so that the door or cover to which the hinges are attached will swing back to its original position when released.

The strap hinges are mostly wrought iron or steel and in two shapes—the strap hinge and the T-hinge. These two types are shown in Figure 200.

Butt hinges.—The butt hinges are generally made in two types—the loose-pin butt and the loose-joint butt. Some cheaper makes of hinges are so made that they can not be taken apart. The former is made in two sections with a loose pin which forms the jointed connections. The latter is made in two sections with the pin forming a part of the lower section. Figure 200 shows these two types. The loose pin has the following advantages: The bearing surfaces are maximum, and the butt can be used interchangeable for either a right or left hand door. The loose-joint butt has the advantage of hinging a door which it is impossible to open without being unlocked first. A special form of butts are those provided with simple or ball-bearing washers so as to take the load from heavy doors.

Butts may be made of cast iron, malleable iron, wrought steel, brass, and bronze. For outside work, solid brass or bronze butts should be used. The cheaper grades are made of cast iron, either in the plain iron, japanned, lacquered, or plated. Butts are made in sizes varying in inches from 2″ x 2″ to 5½″ x 5½″ and above that size, varying by inches up to 8″ x 10″; 3½″ x 3½″ butts are generally used for 1⅜″ doors, 4″ x 4″ butts for 1¾″ doors, and 5″ x 5″ butts for doors of greater thickness.

Spring hinges may be single and double action. Single-action hinges are used on closet and cupboard doors, box and open covers, etc. Double-action hinges or butts are used on pantry and kitchen doors where it is desired that the door shall swing freely in both directions.

Sliding doors are suspended from a track with hangers. The latter consists of a frame which is fastened to the top of the door and carries two small wheels which run along the wooden or metal track.

Locks.—Locks may be classified in accordance with their construction as tumbler locks and cylinder locks. Tumbler locks are of two types—rim lock and mortise lock. The rim lock is used on light and inner doors and in the cheapest grades of work. Mortise locks are ordinarily used on doors having a thickness of 1⅜ inches and more. The ordinary tumbler lock consists of a metal case which houses the operating mechanism.

The cylinder lock consists of two barrels or cylinders, one rotating within the other and eccentric. The inner and smaller cylinder is held in place by a series of small pistons operated by springs. When the proper key is inserted in the lock, all the pins are raised to the joint between the cylinders so that the inner cylinder can be rotated. A cam on the back of the rotary cylinder works the bolt in the lock.

Door knobs and escutcheon plates are used in connection with both the tumbler and cylinder locks to serve as a handle and a finish for the sides of the door. Rim locks require escutcheon plates only on one side of the door, while mortise locks require escutcheon or key plates on both sides.

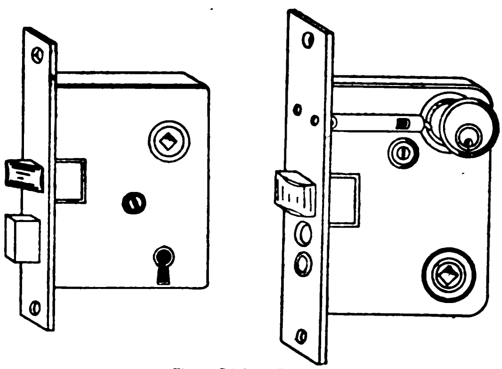


FIG. 201.—Locks.

Door knobs and escutcheon plates are made in a great variety of styles, and of various material. The knob and escutcheon plates are often ornamental in character.

Bolts.—Bolts are used to hold doors in place or to fasten two sections of a single door together. Bolts may be classified according to their construction—barrel bolts, flush bolts, and chain bolts. The barrel bolt may be made with a round or square face and is fastended to the outside of the door. Flush or mortise bolts are set into the door so that the surface of the bolt is flush with the outside surface of the door. Chain bolts are provided with a chain having a dog at the end, which slides in the slot of the plate, and thus allows the door to be partially opened.

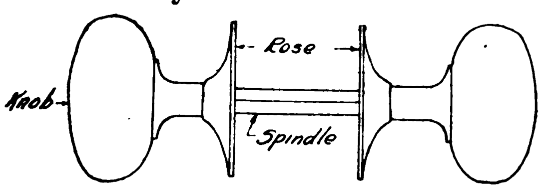


FIG. 202.—Parts of a door knob.

Door checks.—Door checks are mechanisms used to prevent the slamming of doors which are provided with spring hinges and also to insure the automatic closing of the doors. The former type ordinarily consists of a cylinder in which a tight-fitting piston moves. As the spring-hung door closes, the air in the end of the cylinder, back of the piston, acts as a cushion and insures the slow and gradual closing of the door. The latter type of check combines the self-closing and checking features in one appliance.

Window trimmings.—Window trimmings consist of pulleys, weights or balances, fastenings, hinges, and adjusters.

Pulleys: All double-hung windows are counterbalanced with weights so that the windows and sash will remain in position. The weights are attached to chains or cords which pass over the pulley wheel into the sides or at the top of the pulley stiles of the window frames and are attached to the sides of the sash. All pulleys are made in two styles—side pulleys and overhead pulleys. The former is the style of pulley generally used, and consists of a cast-iron wheel working on an axle in a cast or wrought iron frame.

The common stock size of such pulleys are $1\frac{3}{4}''$, $2''$, $2\frac{1}{2}''$, and $3''$, the size referring to the diameter of the wheel. Overhead pulleys are made to be placed above the pulley stile, and their advantages are the setting of the pulley and the giving of 8 inches more play for the wheels than is afforded by the slide.

Sash cord: Sash cord consists of linen or cotton cord from $\frac{7}{32}$ to $\frac{3}{8}$ inch in diameter. Where wooden-frame windows of large size or metal sash are used a sash chain or metal ribbon is used. These chains are made of a bronze mixture, which is tough, strong, and nonrusting.

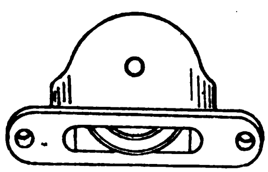


FIG. 203.—Axle pulley.

Sash weights: The weights ordinarily used for balancing windows are made of cast iron, in the form of a cylinder, from $1\frac{1}{2}''$ to $2''$ in diameter. The upper end of a weight has an eye through which the sash cord is attached. For special shaped windows, such as those which are wide and low, square lead weights are used. As lead is 80 per cent heavier than cast iron, weights made up of this material can be considerably smaller in size than those of cast iron. In hanging sashes, the weights of the upper sash are $\frac{1}{2}$ pound heavier than the sash, and for the lower sash $\frac{1}{2}$ pound lighter than the sash, in order to hold the sash in place.

Sash fastenings: Sash fastenings are metal devices placed on the surface formed by the top of the bottom rail of the top sash and the top of the top rail of the bottom sash, for the purpose of holding the two sashes together when closed. There are various forms of sash fasts in use at the present day. The simplest fast consists of a joint pivoted to the plate on the lower sash, and so operated as to catch the inner lock with a hook-shaped pin, which forms a part of the plate fastened to the upper sash.

Sash lifts: There are two forms of sash lifts used on double-hung windows—the hook lift and the flush lift.

Casement windows.—Casement windows are generally hinged on one side and swing in or out of the building.

The windows are held in place by some form of bolt or adjusters. The simplest form of the latter consists of a rod, one end of which is pivoted to the sash and slides through a small metal stand attached to the sill. This stand is provided with a plate or clamp so that the window may be held in any desired position.

Special Hardware.—Closets, cupboards, etc., require special hardware, such as catches, latches, turns, drawer pulls, hat and coat

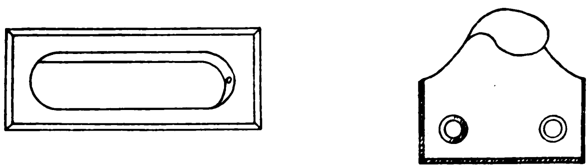


FIG. 204.—Sash lift.

hooks, etc. The catches, latches, and turns are attached to the inside or outside of cupboard doors and are used to hold them in place. Drawer pulls are made in a variety of forms and sizes.

QUESTIONS.

1. Why is it desirable to use brass, bronze, or copper for exterior hardware?
2. What is the advantage of the T form of strap hinge?
3. Why is a strap hinge made of wrought iron more durable than one made of steel?
4. Why are butt hinges often made with several bearing surfaces?
5. What kind of locks are used on thin doors?
6. What is the most important advantage of the cylinder lock?
7. What is the purpose of the escutcheon plate?
8. Is it preferable to swing a casement window in or out of the building?

Quarters for Army camps.

1. Two-story and basement house. Seven rooms, including four bedrooms.

2. *Specifications.*—General conditions: The building is to be constructed on the site approved by the commanding officer of the post by the various classes of the post school as an actual job in the course of regular instructional work. The director of the post school shall exercise general supervision. All millwork, comprising door and window frames, outside and inside casings, stairs, etc., can be constructed to advantage in the shop. The rough framing, including the main and roof frames, should be laid out, cut, and erected upon the site. However, considerable rough framing can be laid out and cut in the shop when weather conditions preclude outside work. The working plans accompanying these specifications shall be used as the basis for all detail sketches.

Masonry.—(1) Excavation: The top soil to a depth of 6 inches should be removed and stacked for use in grading. The excavation for basement foundations shall be made as shown and noted on the plan and cross sections. These excavations shall be maintained in good order, necessary barriers provided, and, where required, sides of the excavation shall be braced. The excavation should be kept free from water during the placing of the concrete. Foundations and trenches should be back-filled with clean earth after the foundation walls are stripped and completed.

(2) Foundations: The concrete for foundations shall consist of 1 part Portland cement, 2 parts sand, and 4 parts of gravel or crushed stone. The sand, gravel, and broken stone shall be clean, sharp, and well graded, with not more than 5 per cent of any foreign material, such as clay or silt. It shall be thoroughly mixed with clean water to "quaking" consistency. All concrete should be placed in layers not exceeding 8 inches in thickness, and each layer should be thoroughly tamped immediately after being placed. Whenever practicable, the concrete should be placed continuously until the entire foundation wall is completed. If this is impracticable, the work should be divided into sections and the incompleted surface of the section left rough and on a slope. Before the next section is placed, the unfinished surface should be thoroughly washed and covered with a layer of cement mortar. Concrete placed during hot weather should be protected from the direct rays of the sun with tar paper or tarpaulin and should be wetted daily until thoroughly set. When it is necessary to place the concrete in freezing weather, the materials should be heated and the concrete kept above

the freezing point until thoroughly set. The form-work should be built of clean, well-seasoned, good quality of lumber. Forms should be rigid, true, and plumb; made sufficiently tight to prevent leakage, and well braced. The form work should remain in place long enough to allow the concrete to set thoroughly.

(3) Brickwork: The chimney and fireplace shall be built of good quality, hard, well-burned brick, from which the pale or soft brick, including the bats, in excess of 5 per cent shall be removed. Select brick shall be used for facing the hearth and fireplace. The brick-work shall be built plumb and true on both sides and laid in cement mortar with struck joints. Each course shall be completely flushed with mortar and every ninth course a full header course. Exposed joints shall be cut off flush within the building and shall be neatly struck where exposed to the weather. The fireplace shall be fitted with cast-iron throat and damper and set with cast-iron clean-out doors and frame and smoke-pipe thimbles for flues. All smoke flues shall be lined with vitrified flue lining the full height of the flues. The hearth shall be of brick laid flat upon a bed of sand 2 inches thick, placed over a layer of gypsum board. The tops of the bricks shall be flush with the finished floor and grouted with cement mortar. The chimney above the roof shall be topped off with a 4-inch cement cap, built up.

Carpenter work.—(1) Walls and partitions: All studs shall be 2″ x 4″, spaced 16 inches on centers and erected plumb, straight, and true. The posts shall be built up at angles and doubled and trussed over wide openings. Stub sills and partitions shall be braced as required. Sills shall be set level and bedded in fresh mortar spread over the foundation walls. Fire stops of the same material as the studs shall be placed between the studding directly over the ledger board or ribband. The studs should be securely spiked to the sills and floor beams spiked to studs. The partitions shall be of stud construction and bearing partitions shall be provided with single sills and double top plates. All corner studs shall be well spiked together. Use material from concrete forms for sheathing and studding.

(2) Floor and roof construction: Floors shall be of joist construction with timbers of size and spacing noted on the plans. All partitions running same direction as joists shall have double joist under them, but these must be spread sufficiently for pipes to pass through without cutting. Floor beams shall be sized for bearings and set with crowning edges up. Care should be taken to frame properly around flues, chimney, hearth, and stairs. Frame 2″ x 4″

timbers between the ends of the beams for nailing the lower or rough floor if it is laid diagonally.

Roof rafters shall be of sizes and spacing shown on the plans. Frame carefully for the chimney and at hip and valley junctions. Frame rafters on plates and against hip and valley rafters with tight joints.

Each section of beams having a span greater than 8 feet shall have one row of cross-bridging of 1″ x 3″ strips accurately cut and fitted between the beams. Each strip shall be nailed at each end with two 8d. nails, and the lower ends shall not be nailed until the floor is laid.

(3) Sheathing: The exterior walls and roof surfaces shall be covered with sheathing laid with close joints and face nailed with two 8d. nails at each bearing. Where available, shiplap shall be used. On roofs the boards should be closely fitted at the hips, valleys, and crickets. Break all joints on bearings.

(4) Rough flooring: The first and second floors (with the exception of the porches) shall have lower or rough floors of shiplap or square-edged (surfaced one side) lumber. This floor should be laid diagonally, if practicable, breaking joints in every course and over the center of bearings. All joints should be close, the flooring brought up tight against the walls and partitions, and each board nailed to each bearing with two 8d. nails.

(5) Finish flooring: Finish flooring throughout the building, should be tongued and grooved hard pine, laid with tight joints and blind nailed at each bearing with 8d. nails. Porch floors should be laid with 1⅛″ tongued and grooved cypress or fir, laid in continuous lengths, without butt joints. The edges should be painted with white lead. The outer edges of the floor should be sawed to a line and rounded to form a nosing.

(6) Building paper: The sheathing of exterior walls and roof should be covered with one thickness of building or tar paper, laid with not less than 3″ lap. The under surface of the corner boards and the exterior finish should be lined with strips of similar material.

(7) Scuttles and ladders: The construction of scuttle in the ceiling of the second story should be as shown on the second-story floor plan and a removable ladder built to reach the same.

(8) Coal partitions: Partitions of coal bins shall be constructed of 2″ x 4″ supporting frame, boarded up with ⅞″ tongued and grooved or ship-lap lumber to height shown. Openings with removable sliding boards shall be provided, as shown on the basement plan.

(9) Porch framing: Front and rear porches are to be constructed as shown on the plans. Cross beams or girders shall be framed into the main sills and supported on bearings at their outer ends. Joists should be well supported and spiked to the girders, as shown on the cross-section. The floor shall have a pitch away from the building of 1½ inches in 8 feet. Cornices shall be framed as shown on the cross-section plan.

(10) Siding: The building shall be sided above the foundation wall with clear beveled siding of cypress, pine, or other clear stock, ¾″ x 12″, laid 10 inches to the weather, as shown on the detailed drawing. The siding should be laid with close joints against door and window casings and with beveled joints at the corners. The siding shall be laid with straight lines and spaced with top and bottom of windows. Siding should be securely nailed with 8d. nails.

(11) Roofing: The roof is to be covered with a good grade of cedar or cypress shingles, laid 4½ inches to the weather, joints broken not less than 1½ inches, and all nailed with 3d. galvanized nails, two nails to the shingle. Where composition roofing is available, it is recommended that asphalt shingles or roofing of a similar character be used.

(12) Trim: The exterior woodwork shall be of well-seasoned cypress, fire, or white pine and free from shakes, knots, wanes, and other defects. The exterior woodwork, especially around the eaves and cornices, should be set up or backed with white lead before being nailed in place. Posts, rails, cornices, latticework, and other finish shall be cut and placed, as shown on plans. The ceilings of cornices shall be finished with matched lumber or ceiling, blind nailed to each bearing, and with joints broken. Exterior steps should be built with 2″ rough strings or carriages, ⅞″ risers, and 1⅛″ treads with proper nosing. Steps shall be made with 12-inch tread or run, and 6-inch rise.

(13) Window frames: Window frames shall be made in accordance with the detailed drawings. Plank window frames shall be used for basement and attic windows. Frames for the double-hung windows shall be made with outside casings of the same material as the exterior finish. Weight pockets, at least 12 inches long, shall be cut so as to be easily accessible and fastened with screws. The detailed drawing calls for the housing of the pulley stiles into the head and sill. This method of construction can be reversed and the head and sill housed into the pulley stiles whenever considered advisable.

(14) Sash: The drawings specify, for the dougle-hung windows, sash with six 10″ x 15″ panes. This is the standard sash used in

cantonment construction, and it is assumed that it will be available for this work. All sash 1⅜″ thick. Basement and attic sashes will have to be especially constructed or purchased in the market. If available material is on hand, cut down old sash.

(15) Doors: The two exterior doors should probably be purchased from mill stock in the open market. The interior doors are of standard size used in cantonment construction, and it is assumed that they will be secured from surplus or salvaged stock.

(16) Interior woodwork: The interior woodwork, door and window casings or trim, baseboards, etc., should be made of well-seasoned pine, fir, or cypress. The character of the interior trim is shown on the detailed drawing.

(17) Doorframes: The interior doorframes shall have jambs of 1⅛″ stock, of full width equal to the thickness of the wall from face to face of grounds, and shall be rabbetted for the doors to swing as shown on the accompanying plans. All frames shall be set plumb with the walls, squared, and the jambs straight and true. The frame shall be fastened with casing nails.

(18) Casings: The door and window openings will be cased both sides, and all inside casings shall be mitered. The windows shall have proper casings, stool, and molded apron with scotia. The door casing shall be carried to the finished floor without plinth.

(19) Base: The finished rooms and halls shall have solid base, as detailed. At interior angles the base shall be coped and at exterior angles mitered.

(20) Picture molding: All rooms, with the exception of the bathrooms and kitchen, should be provided with picture molding ⅞″ x 2″. This molding shall be located at the height directed, and the angles and corners shall be carefully made, as noted above for the base.

(21) Wood stairs: Interior stairs shall be constructed of 2″ x 12″ yellow pine or fir carriages, one carriage 4 inches from each side wall, and a center carriage. Treads shall be 1⅛″ oak or yellow pine and risers of ⅞″ pine or fir. Treads and risers shall be tongued and grooved together and both housed into the wall strings with wedges driven in grooves. Treads shall be finished at the front and outer end with a nosing, where the open-string style is shown, and a molding placed underneath. Risers shall be mitered to face string.

Cellar stairs shall be constructed of yellow pine 2″ x 12″ cut out for the bearing of treads and risers, aill nailed together. All treads shall be 1⅛″ clear yellow pine boards.

(22) Railings: The first-story stairway shall have a newel post 4½″ square, handrailing 2¼″ x 3½″, and balusters of 1⅛″ square stock, as shown on the drawings.

Cellar stairs shall have a newel 4½″ square and simple hand-rails of 1⅛″ material. All porch railing should have top and bottom rails 1¼″ x 3″ and 1⅜″ square balusters spaced 4 inches on centers.

(23) Shelving: Each clothes closet shall have two shelves 12 inches wide on rabbetted cleats. Around three sides of each closet a cloak rail ⅞″ x 4″ shall be placed 5 feet 6 inches from the floor for clothes hooks.

(24) Linen closet: The linen closet, on the second floor, shall have a series of eight shelves 14 inches wide and 12 inches apart, and divided into pigeonholes 18 inches wide.

Sheet-metal work.—(1) Flashing: Flashing shall be laid water-tight. Valley flashing shall be of tin sheets 20 inches wide, with joints well soldered and painted both sides. The base of the chimney will be counterflashed with galvanized iron overlapping the base flashing 4 inches and extended into the masonry joints 1 inch and calked with elastic cement. Heads of all openings shall be flashed with bent metal strips, well nailed. Proper pans shall be placed on upper side of chimneys and these pans counterflashed after roofing material is on.

(2) Gutters: All gutters shall be of the trough type of 24-inch gauge galvanized iron, with outer edge beaded and provided with slip joints well graded, and hung on adjustable galvanized wrought-iron hangers set about 20 inches on centers. All gutters shall be 4 inches.

(3) Conductors: The outside conductors shall be of No. 26 galvanized iron, corrugated, and are to be 3 inches in diameter. They should be properly connected with the gutters, using gooseneck connections where offsets are necessary. The conductors shall stand free from the walls and be erected straight and plumb with approved galvanized conductor fastenings and connected into the cast-iron conductors through a tight-fitting flange of galvanized iron soldered to the conductor.

(4) Strainers: Galvanized-wire basket strainers shall be set in all conductor openings.

Interior wall surface.—The interior wall and ceiling surfaces shall be covered with wall or plaster board, free from blisters, cracks, splits, or other imperfections. The surface shall be smooth and capable of receiving coatings of paint. All wall boards shall be nailed to the studs and joists with large-headed nails spaced about 8 inches on centers. All joints shall be made as tight as possible and shall not exceed ½ inch in width. If fiber or compo board is used, all joints shall be stripped with $\frac{3}{16}$″ x 1⅜″ smooth strips securely nailed.

not over 12 inches on centers. If gypsum or plaster board is used, all joints shall be filled with gypsum plaster, pointed flush.

Painting.—(1) General: The number of coats of paint herein specified shall be in addition to the priming coats and shellacing of knots, etc. All paint shall be evenly spread and well brushed. After the completion of the work, all spots of paint or varnish should be cleaned from glass, walls, floors, hardware, etc., and the painters must see that all sash and doors are free to move and all parts of the work left clean and smooth.

(2) Exterior woodwork: The exterior woodwork shall be primed as soon as erected, and the siding shall have two coats of white lead and boiled linseed-oil paint, with colors to be selected by the commanding officer of the post. Exterior doors and frames shall be painted three coats, as specified above.

(3) Porch woodwork: Porch ceilings shall have two coats of exterior varnish. Porch floors and steps shall have three coats of an approved exterior floor paint. All glazing to be double-strength glass, well sprigged, bedded, and puttied up.

(4) Roofing: If wooden shingles are used, they will be given a brush coat of a stain, the color to be selected by the commanding officer of the post.

(5) Interior woodwork: All interior woodwork, except in the basement and attic, shall have two coats of white lead and oil paint, with colors to be selected by the commanding officer of the post. Where painting is not desired, in order to preserve the grain, the interior finish can be stained with an approved oil stain. Cypress or white pine should have a filler before the stain is applied.

(6) Interior floors: Interior floors can be finished as desired, either two or three coats of floor paint, two coats of shellac, or two to three coats of floor varnish.

Hardware.—(1) Rough hardware: The necessary hardware, consisting of sash pulleys, sash cord, sash weights, sash hinges, and sliding-door hangers, shall be provided, using such sizes and types as may be easily procured in the open market or from surplus available stock.

(2) Finished hardware: Finished hardware shall be of such finish, style, and make as may be available from surplus stock, salvaged, or easily procurable in the open market.

Exterior and vestibule doors shall have brass-plated steel butts 4½″ x 4½″ in size, with three butts to each door. Interior doors shall have loose-pin, ball-tipped steel butts 4″ x 4″ in size, with two butts to each door.

All locks shall be of an approved type of tumbler or cylinder mortise lock and shall be fitted with proper keys, escutcheon or key plates. The sliding doors to the living room shall have a mortised sliding door lock and latch combined and provided with folding latch handles, keys, and flush cup escutcheon.

All double-hung windows shall be provided with approved form of sash fasts and lifts.

Outside blinds or shutters shall have hinges and fasts of wrought steel of an approved pattern.

The medicine cabinets in the bathrooms shall be equipped with mirror, hinges, and catches.

(3) Miscellaneous hardware: Clothes hooks shall be provided in all closets and other miscellaneous hardware, as shown and noted on the accompanying plans.

Plumbing.—(1) Scope of work: This work comprises the installation of a water supply and drainage system, with the fixtures for the first and second story bathrooms, kitchen, and water connections for heating the plant. The accompanying plans show the location of the fixtures in the kitchen and bathrooms, but do not show the detail arrangement of soil, waste, vent, water, and drain piping in the building. The following detailed specifications are intended to indicate important details covering the material, workmanship, etc.

(2) Excavation: Trenches for water and sewer pipes shall be of uniform width sufficient to accommodate the various sizes of pipe. The bottom of all trenches should be tamped and graded in order to provide the necessary foundation for the pipes. The bottom of sewer-pipe trenches should be cut out under each hub, to give a solid bed for the pipe. Soil pipes should be laid with a grade of not less than ¼ inch to the foot. Soil and water pipes are to be laid in separate trenches.

(3) Cast-iron pipe: All soil, waste, vent, and drain piping in the building, 2 inches in diameter and larger, and the main sewer connection to 5 feet outside the building shall be extra heavy or medium cast-iron pipe and fittings. Sewer-pipe connections shall be 4 inches in diameter.

(4) Soil, waste, vent, and drain piping: Horizontal soil and waste pipes shall be given a grade of 1 inch per foot. The vertical soil and waste stacks shall be extended full size above the roof line as vents. Several vent pipes shall be combined into one larger pipe wherever practicable. Horizontal waste lines receiving the drainage from two or more fixtures shall be provided with end vents. Such connections will not require separate venting for each fixture. Openings in the roofs for vent pipes are to be provided with roof flanges or to be flashed and watertight.

(5) Branch connections: The following sizes will be used for soil and waste pipe branches to various fixtures: Water closet, 4-inch; kitchen sink, 2-inch; laundry tubs, 2-inch; bath tubs, 1½-inch.

(6) Water-supply system: Underground water-supply pipes shall be heavy galvanized wrought iron, mild-steel pipe or lead and equipped with curb box. The fittings on the water pipes shall be galvanized cast-iron or malleable-iron standard leaded type. The main water-supply pipe should be provided with a ¾-inch globe valve and hose nipple for drainage, just inside the basement wall. This supply pipe shall be run up to and along the basement ceiling and branches of the size required taken therefrom. Branch water-supply pipes shall be run to the front and rear of the house and sill cocks be provided for outside hose connections. These branches shall be provided with shut-offs for drainage. The hot and cold water pipes to bathrooms shall be ½ inch in diameter. The hot-water circulation pipe shall be provided with a gate valve and check valve and a union between the gate valve and the boiler. Branch water-supply pipes to sink and laundry tubs shall be ¾ inch and to all other fixtures ½ inch in diameter. Branch pipes to the fixtures on the first floor shall be run underneath the floor. Branch connections to the second-story bathroom will be run concealed in partitions and second floor. The main water-supply pipes to each bathroom, and to the kitchen fixtures shall be provided with a gate or globe valve placed in an accessible position with drips. These valves shall be arranged so as to control all of the fixtures in each bathroom or in the kitchen.

(7) Hangers: Horizontal runs of pipe shall be hung with heavy adjustable wrought-iron or malleable-iron hangers, spaced not over 4 feet apart. Vertical pipe shall be held in position with heavy wrought-iron clamps or collars, not less than one to each story. Chain or wire hangers should not be used. Pipe sleeves, floor, wall, and ceiling plates shall be used wherever necessary.

(8) Painting: After the complete piping system has been installed and tested, all exposed pipe hangers, etc. (except brass and nickel piping), shall be painted. The colors used shall conform to those used on the adjacent walls.

(9) Cellar drain: A sump pit shall be built in the corner of the cellar nearest the outside drain and an automatic cellar drainer installed.

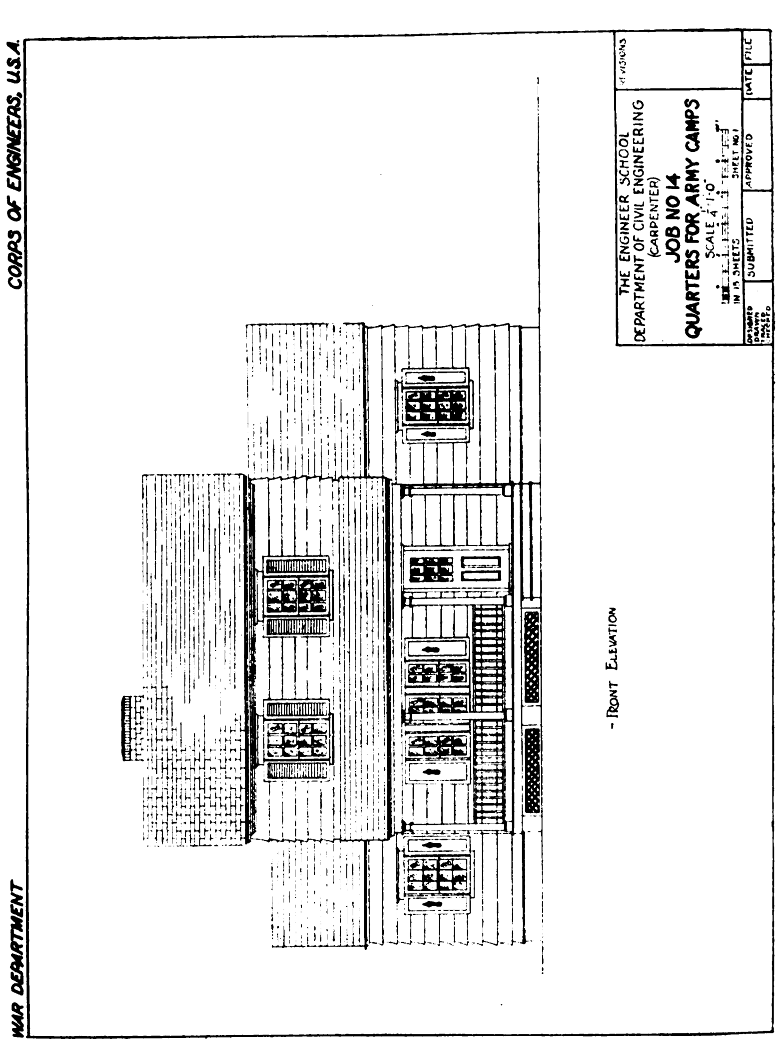
(10) Pipe covering: Where it is necessary to put water pipes in the unexcavated portion of the building, as for example, to provide water supply for the first-story bathroom, all such piping should

be covered with a suitable insulation. This covering should not be applied until after the piping system has been tested.

(11) Tests: A thorough test of the piping and distribution systems shall be made after the systems are installed and before connections are made to sewer, piping covered, and fixtures connected. Tests may be made either with air or water. The water-supply system should be tested to a hydrostatic pressure of 100 pounds to the square inch.

Steam heating.—The requirements for the installation of a steam-heating system of the low-pressure, gravity return type are indicated in a general way. The accompanying plans show the location of the heater in the basement and give the location and size of the radiators in all the rooms of the building. Suitable changes should be made depending on the type of heating installed. Detailed specifications shall be drawn up by the instructor in steam fitting.

Lighting.—The lighting system for the building will consist of a complete installation of the electric wiring, cabinet, panels, outlet boxes, switches, meter, fixtures, etc. The plans indicate the character and location of the lights, switches, etc. A complete and detailed wiring layout for the building to be used for instructional purposes and for the assignment of jobs to the students shall be drawn up by the instructor of interior wiring.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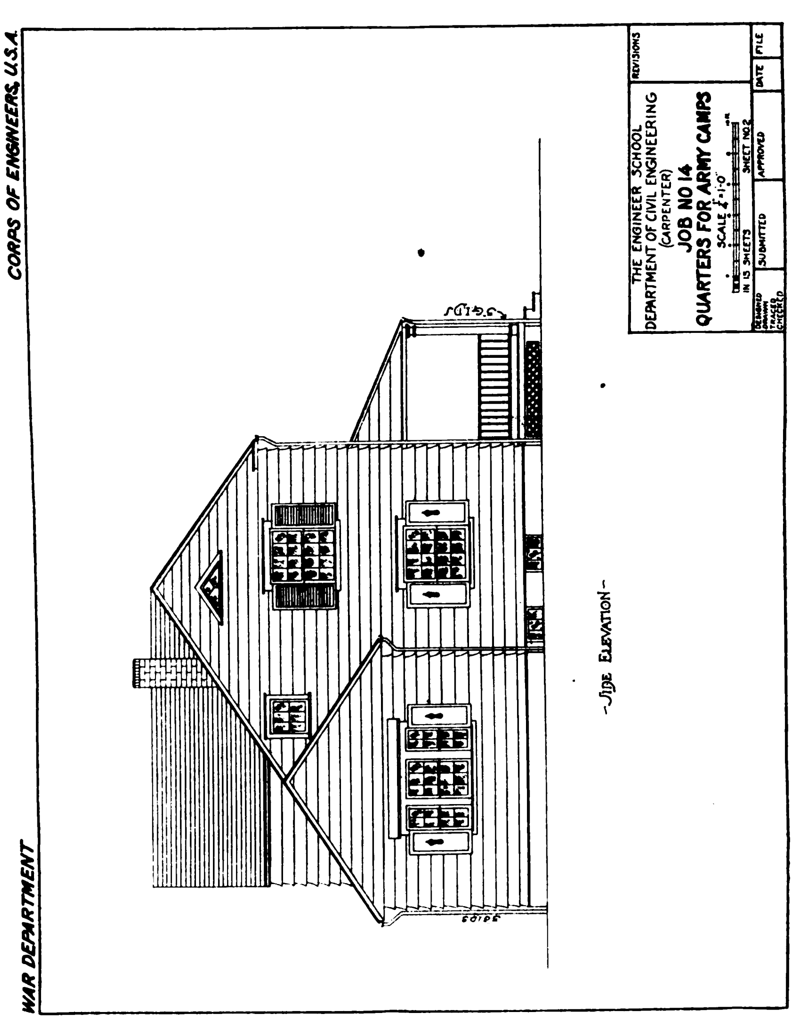
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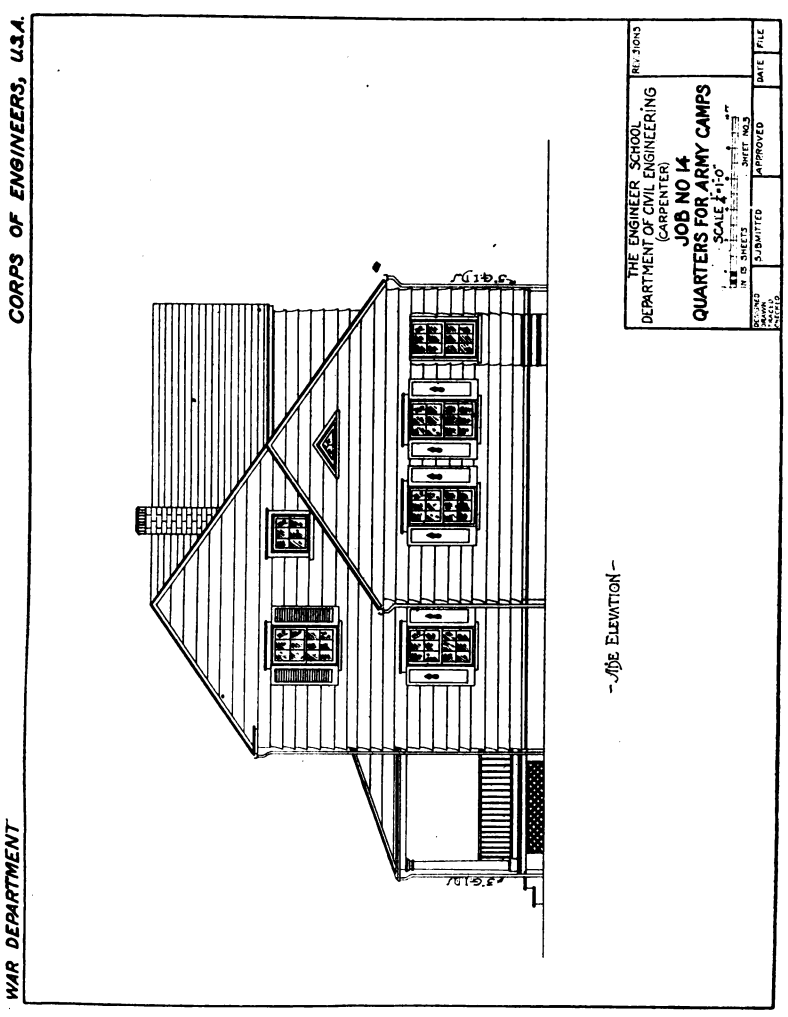
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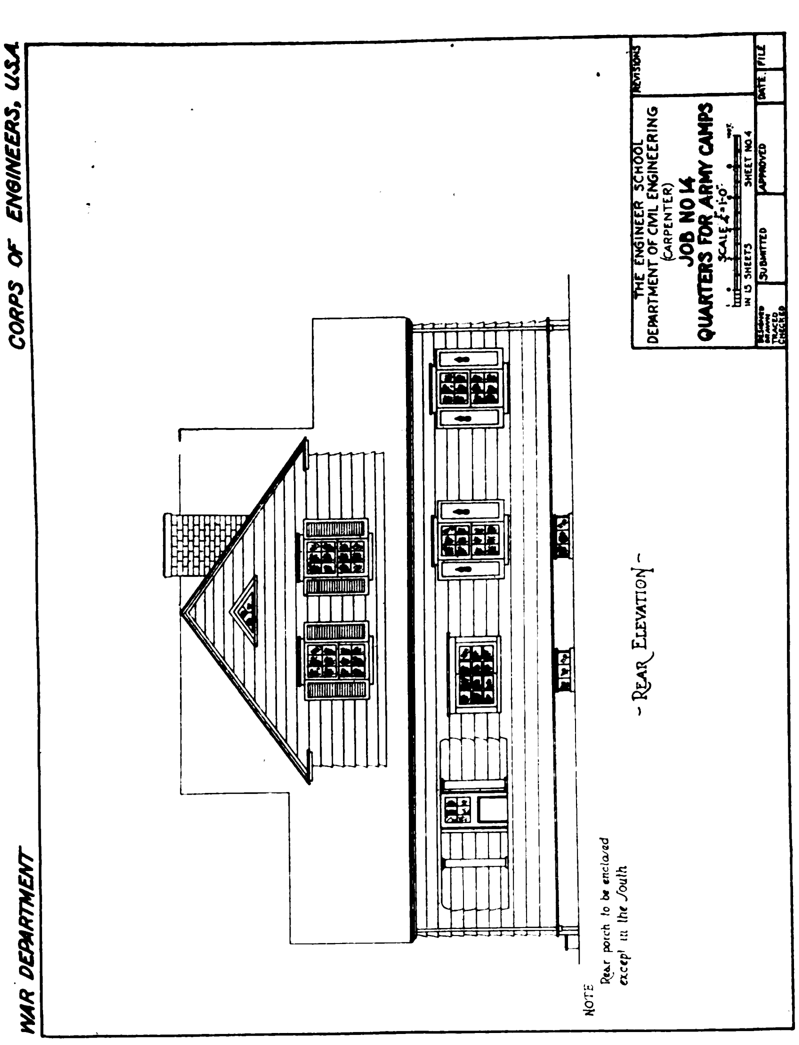
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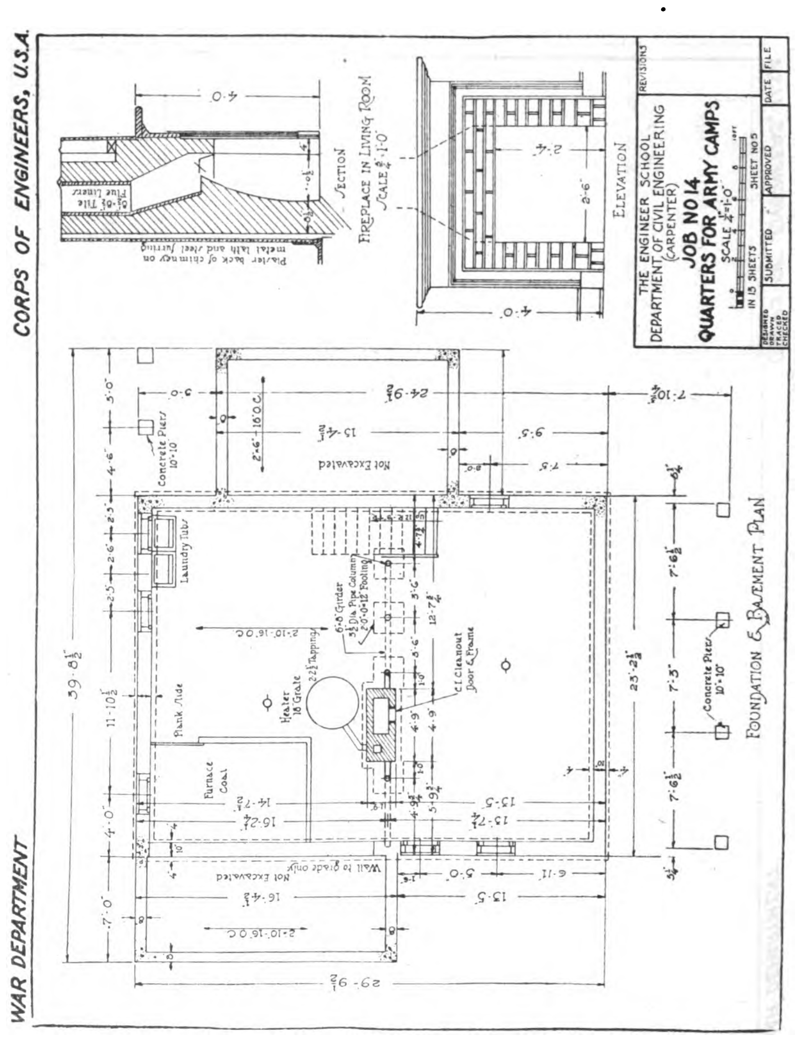
NOTE
Rear porch to be enclosed
except in the South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Not Excavated
Laundry Tubs
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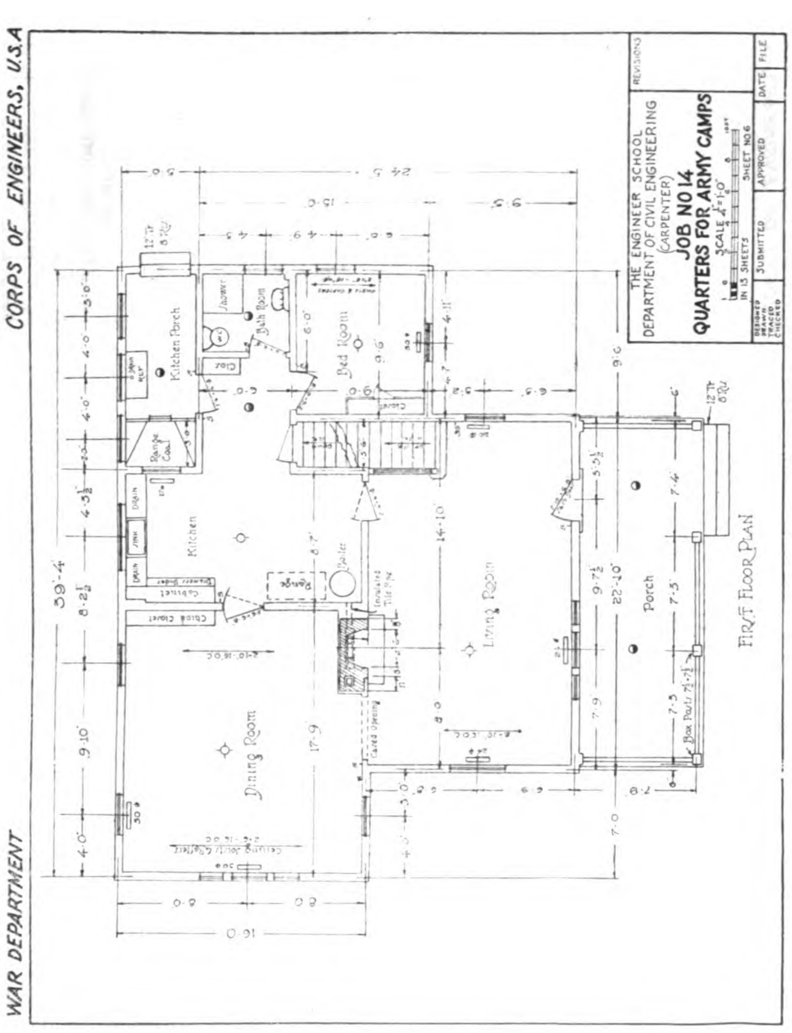
Concrete Piers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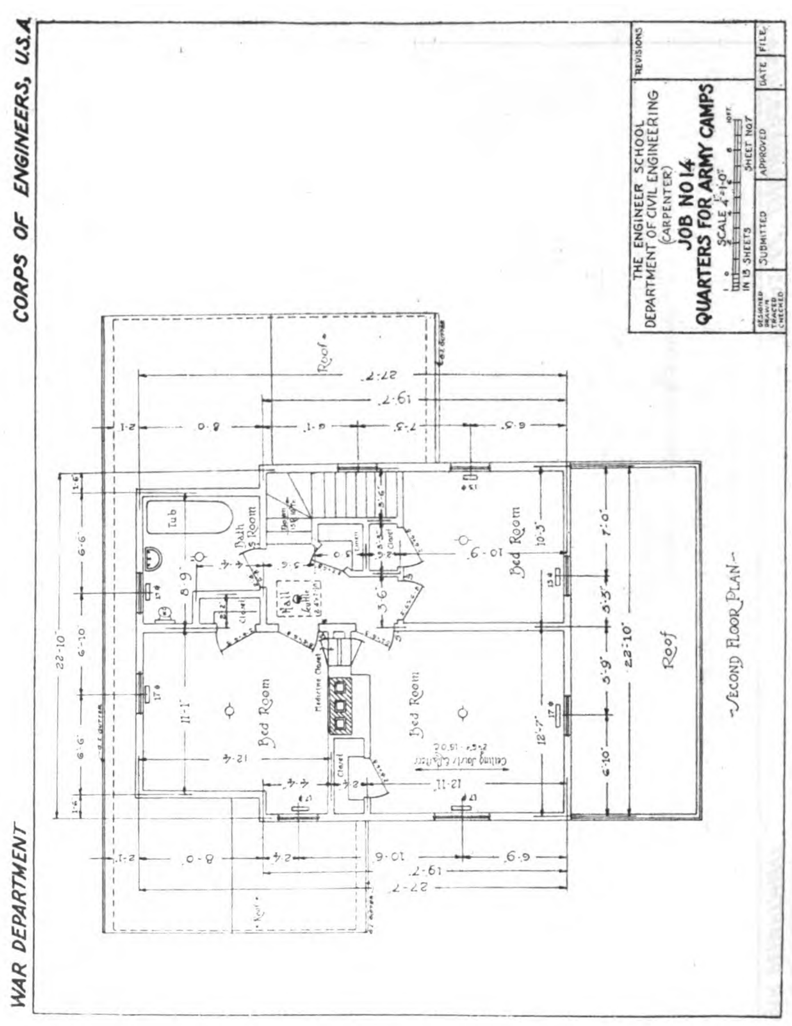
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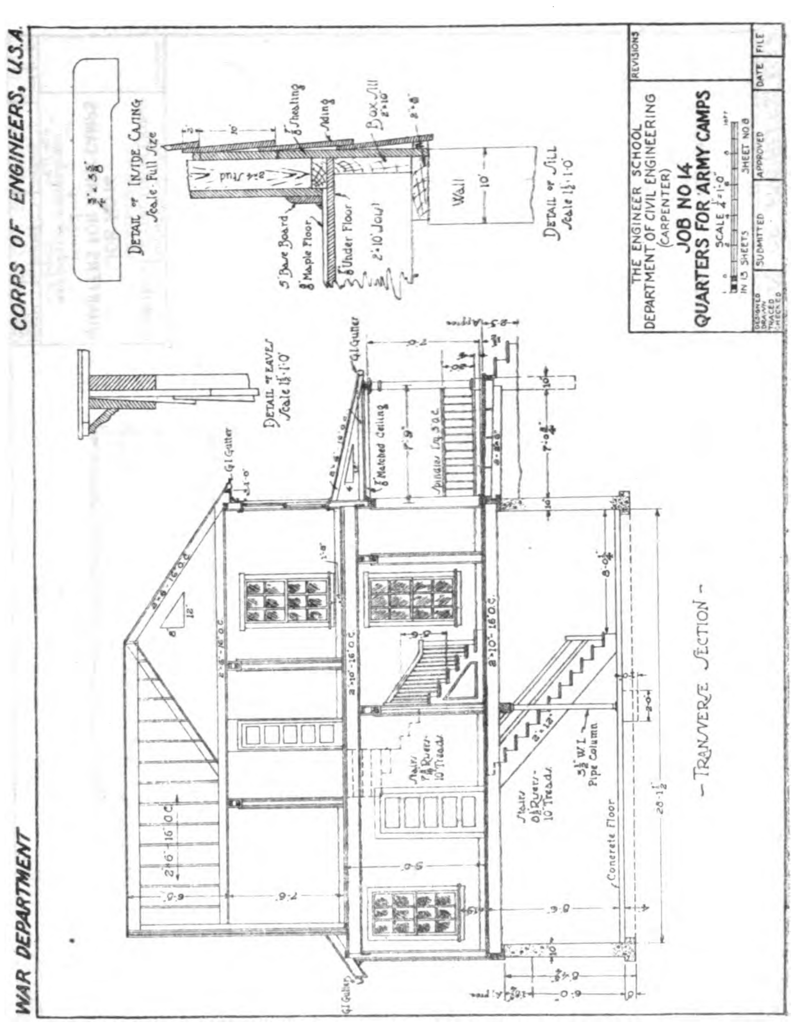
Bed Room
Bed Room
Bed Room
Bath Room
Hall
Roof
Roof
Tub
SECOND FLOOR PLAN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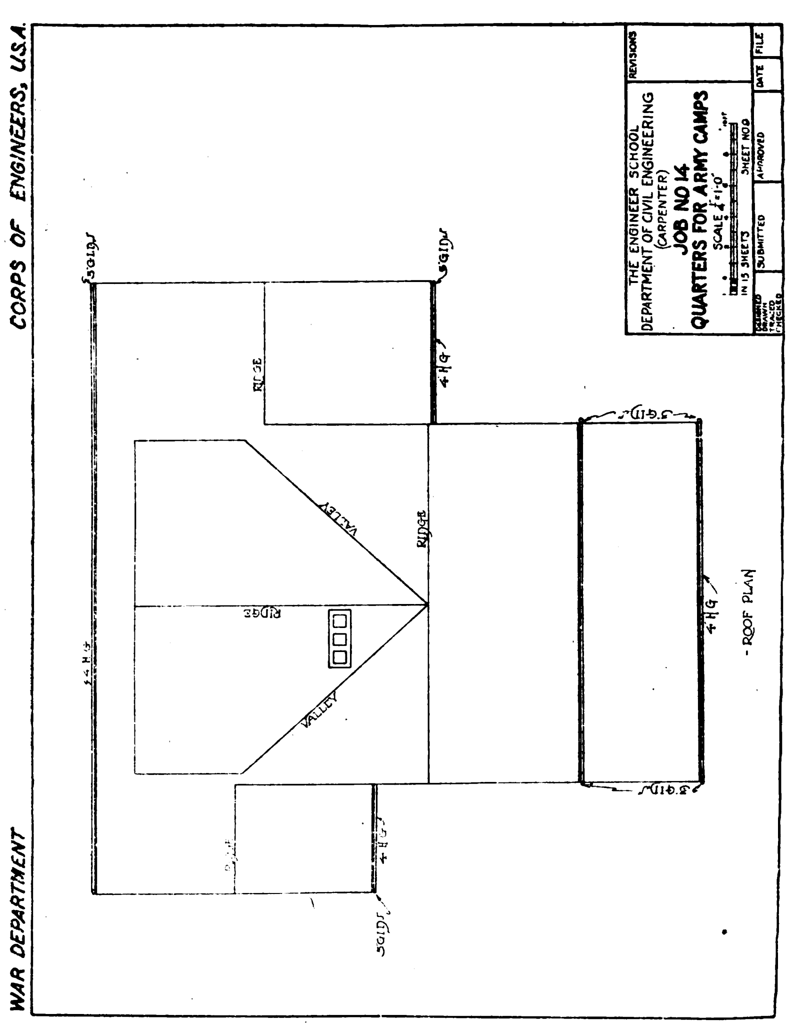
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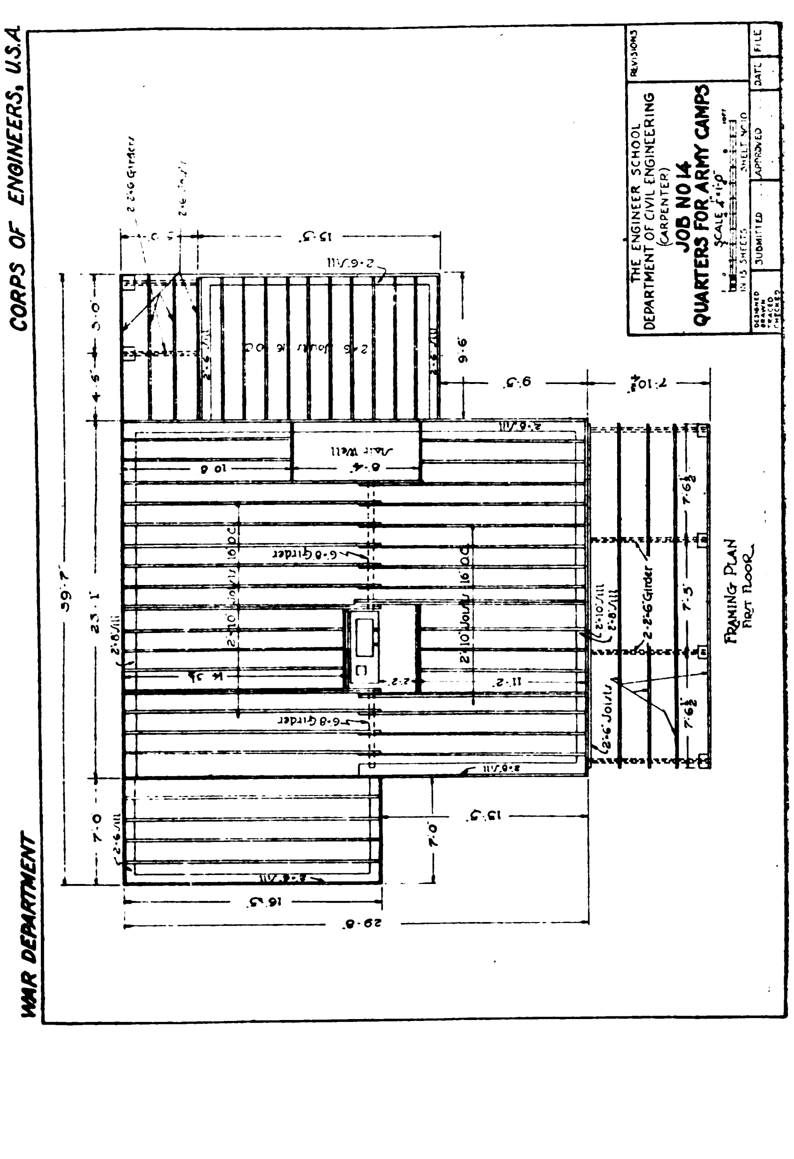
- ROOF PLAN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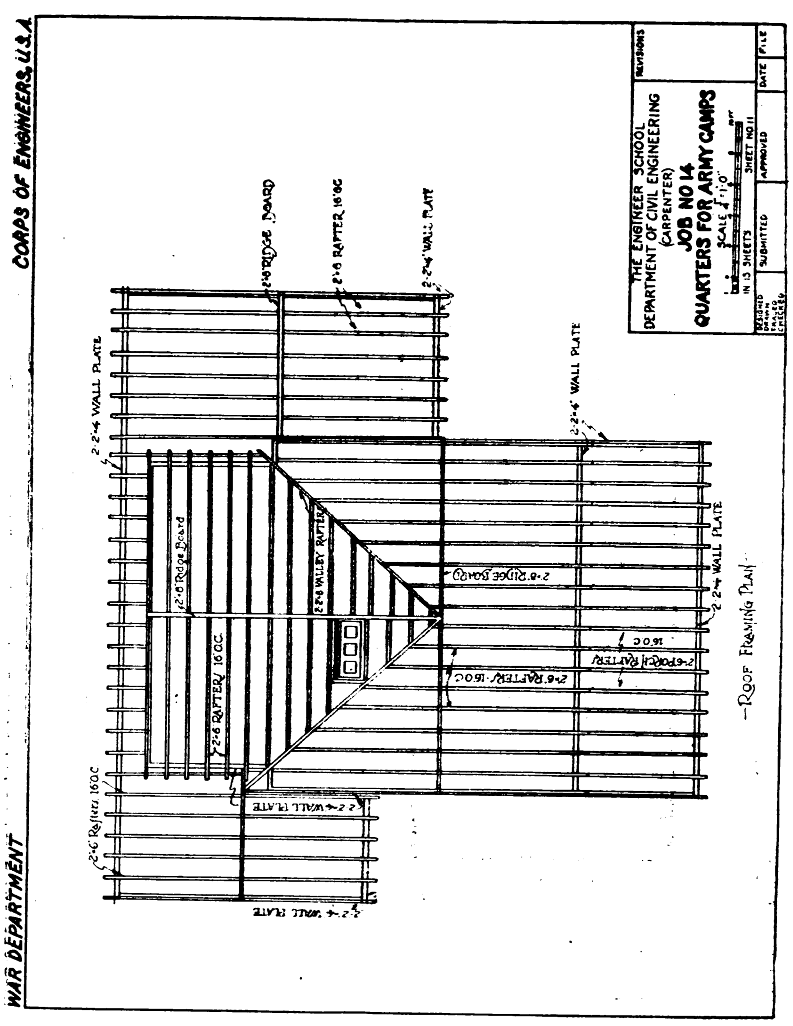
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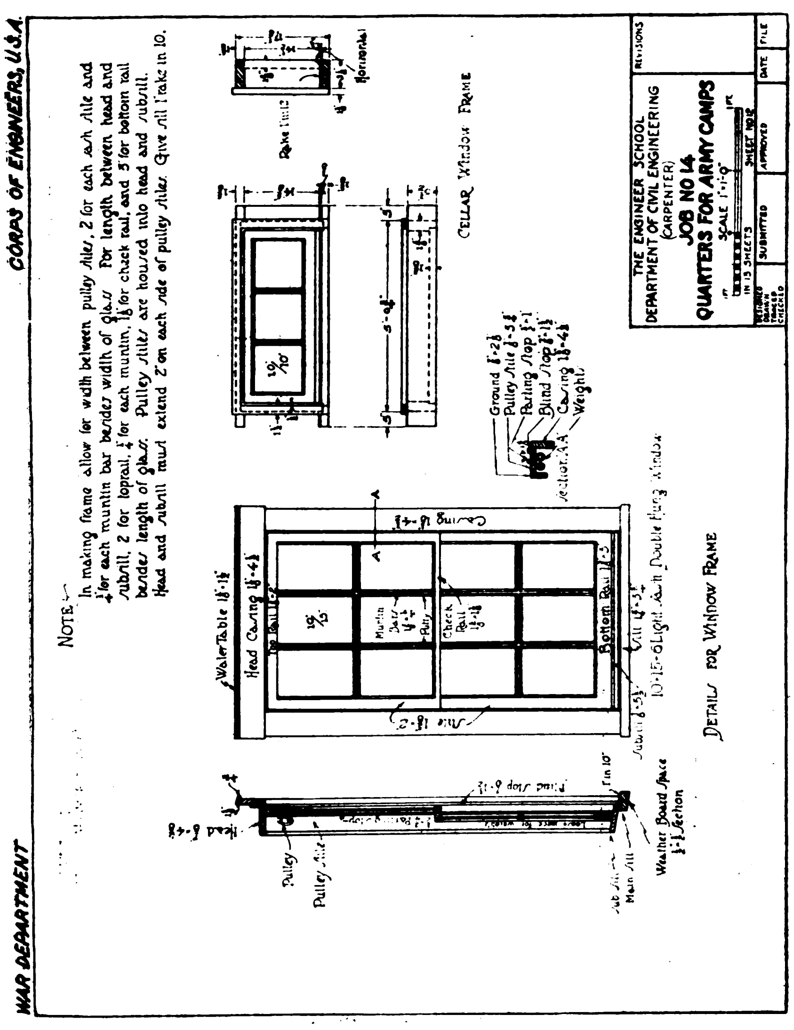
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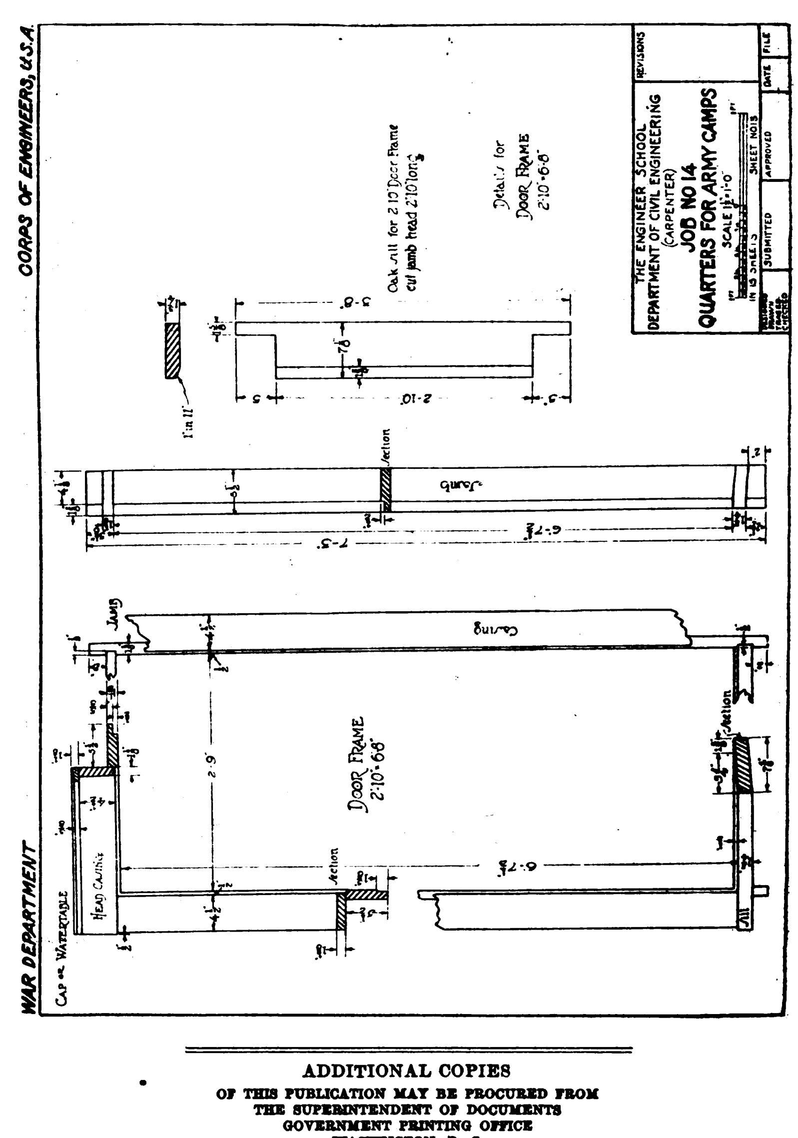

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FOR MILITARY SPECIALISTS

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PREPARED UNDER THE DIRECTION OF

THE CHIEF OF ENGINEERS, U. S. ARMY

1922

WASHINGTON
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FOR MILITARY SPECIALISTS

Part V. INSTRUCTOR'S GUIDE

PREPARED UNDER THE DIRECTION OF
THE CHIEF OF ENGINEERS, U. S. ARMY

1922

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *May 23, 1922.*

Manuals for training the Army are to be prepared and revised from time to time by the branches of the service concerned and published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Corps of Engineers as a part of this series a group of five pamphlets relating to the carpenter. The pamphlets in this series are titled as follows:

Training Manual No. 10—Carpenter Helper.
Training Manual No. 11—Basic Carpenter.
Training Manual No. 12—General Carpenter.
Training Manual No. 13—Master Carpenter.
Training Manual No. 14—Instructor's Guide for Carpenters.

This pamphlet is the fifth of the carpenter series, and is published for the information and guidance of all concerned.

[A. G. 062.11 (5-16-22).]

BY ORDER OF THE SECRETARY OF WAR:

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FUNDAMENTAL PRINCIPLES.

INDEX.

	Page.
Development of the technique of Army training	1
Applicatory system of training	4
Organizing the training course	6
Variability of Army personnel	7
The "step up" method	9
How to teach from the Training Manual	11
Organizing the class	13
Shop and class room set-up	14
Preparing the lesson and meeting the class	16
Grading students	18
Trade bibliography	20
Selected references for teachers and supervisors	21
Occupational index	22

FUNDAMENTAL PRINCIPLES.

THE DEVELOPMENT OF THE TECHNIQUE OF ARMY TRAINING.

The Army for many years has been evolving a method of educating or training its personnel. Practical and successful courses were in effect before the war at the School of the Line, Fort Leavenworth; the Engineer School, Washington Barracks (now at Camp A. A. Humphreys, Va.); the Coast Artillery School, Fort Monroe, and other service schools. The Army is now committed to certain principles of training known as the applicatory system which may be defined as "learning to do by doing."

During the war the Army was confronted with the task of training 4,000,000 soldiers. No means had been developed for assigning these men to positions commensurate with their abilities and experience. As a result, many men having special abilities were assigned to positions where these abilities were only partially used. When new units were organized, no means were available for transferring these men from the organizations to which they had been assigned. Nor were there adequate means to determine whether all the skilled men retained by industry would function best for the common good in industry or in the new units of the Army. Consequently it was found necessary to organize the "National Army Training Detachments," later known as the "Students' Army Training Corps" to furnish an additional supply of vocationally trained men.

Many schools and colleges were used with their trained instructor personnel for this vocational training. The problem was not essentially teacher training as the term is commonly understood in educational circles, but that of furnishing teachers with text material adapted to Army work. The Committee on Education and Special Training produced a series of manuals based on the applicatory system using as a vehicle a series of job sheets. These indicate in general terms the job to be performed, supply an itemized list of the required equipment and then ask questions to assist the student in thinking out the entire situation when performing the job. This method of teaching is adapted to a high grade, reasoning type of student.

A revised edition was printed and used in the various Army camps during the school year 1919–20. It was found that this form was not suitable for Army requirements and a new set of manuals was written at Camp Grant during 1920, using a technique suggested by R. W. Selvidge, now professor of industrial education, University of Missouri. The basic idea was the analysis of the occupation into operations or trade units requiring automatic skill such as have been developed in large, well-organized factories. Directions were then written for performing these unit operations in the best manner. Information sheets supplementing the directions contained in the operation sheets with information relating directly to the vocation, and instructions for the solution of problems in science, mathematics, and drawing related to the trade were inserted.

Instruction was given by jobs, which the student had to analyze into unit operations. He had also to plan the work and decide on the sequence of operations, thus bringing the student's initiative into play, although he was told how to perform the manipulative processes. Like practically all previously written texts this technique contemplated training for the entire vocation which, as a rule, set up too ambitious an objective for the majority of learners. The introductions to all such books made frequent use of such expressions as "the well-trained mechanic," "the high-grade mechanic," "the all-around mechanic," etc., placing emphasis upon the necessity for completing the entire course of instruction. Many students of such courses after making some progress become discouraged and unhappy by the consciousness of impending failure, because they realize that the goal is too high for the abilities they possess.

The Camp Grant manuals were used in the Army schools during the year 1920–21, and, as a result of this experience, the following statement appears in Circular No. 211, August 9, 1921, War Department:

> The following school activities, which have been partially developed by the general staff, are hereby assigned to the chiefs of branches.
>
> (*a*) Methods of instruction.
> (*b*) Manuals and other aids for students.
> (*c*) Manuals and other aids for instructors.
> (*d*) Training of senior instructors, instructors, and assistant instructors.
>
> In addition to the vocational and educational specialties pertaining to a branch of the service (such as Infantry, Cavalry, Artillery, Engineers, etc.), all subjects common to two or more branches are tentatively assigned to a single branch for the purpose stated above.

Of 72 subjects common to two or more branches, 21 were assigned to the Corps of Engineers.

Before detailing various officers to prepare manuals on these subjects, the Chief of Engineers ordered the preparation of a complete manual and instructor's guide, embodying the latest developments in educational practice. The preparation of Training Manuals and an Instructor's Guide for Carpenters was undertaken first.

The incomplete manual written at Camp Grant in 1920, and as further developed at Camp Dix in 1921, was used as the basis for the new work. Its good and bad features were considered in the light of one year's use in Army schools. The analysis of the vocation or trade into unit operations and information topics was retained as a basic feature of the new manual after being revised and reorganized.

While the applicatory system or the project method had been accepted in theory for the Camp Grant manuals, no means were provided for its application to the material furnished in the manuals. The task of selecting the jobs and outlining the instruction was left for the individual instructor.

A series of jobs is now incorporated in the training manual comprising a typical training course to be used as a minimum standard and objective by instructors when preparing definite courses of their own based on local requirements and the interest of the students. When the instructor has neither the time nor the ability to develop a course, the typical training course contained in the manual may be used, which will insure the required experience and proficiency on the part of the students.

The manual gives concrete expression to the "step up" principle of vocational education within a vocation, as conceived and applied at the Engineer School. A near objective is provided which renews the effort of the student by giving recognition to each step in achievement. The student, who is limited to short periods for training, can find a higher grade of work in his vocation after each step. When the practical limit of his training is reached the student goes to work at this level in his vocation with little loss of time and with no sense of failure and the instructor is relieved from carrying along those who can not profitably continue. During each step not only are new skills or abilities developed but also higher degrees of the skills acquired in previous steps. Consequently it appears that in general the steps are of increasing duration as well as of increasing difficulty.

THE APPLICATORY SYSTEM OF TRAINING.

The old conception of a soldier as a nonthinking automaton is well described by the quotation "Theirs not to reason why, theirs but to do and die." The new conception is that each soldier is a member of a team, trained for certain duties so as to coordinate with the other members, each and all ready to grasp the opportunity that leads to victory.

Since the Army is committed to the applicatory system no attempt is made here to discuss other educational methods. The applicatory system of training is the purposeful solution of jobs or problems in their natural or usual environment. For instance, learning to build a bridge by the applicatory system involves its construction across a stream where it is required and its test under traffic conditions. Building a bridge under assumed conditions such as a foot or two above solid ground or through lectures in the classroom is like learning to swim on the piano stool or by means of a correspondence course. The mere memorizing of rules and theories often leads to their mechanical application, but if these are learned by means of a carefully graded course of jobs or problems the student acquires in the natural manner the faculty of giving a proper response or solution to each situation as it arises.

While men can be forced to learn, the results are not commensurate with the energy expended. Experience proves that the amount and rapidity of learning vary directly with the interest of the student. Inherent interest is an inner urge which sets an aim for the action, guides its purposes, and furnishes the drive toward accomplishment.

Four different types of experience are especially valuable for learning:

First. The embodiment of an idea or aspiration in material form, such as making a bookcase.

Second. The purposeful enjoyment of an experience, such as witnessing a trained regiment on parade, or living imaginatively through a great battle by visiting the field of action.

Third. The solution of a problem as a means to achieving a desire, such as estimating the situation in a military map problem or determining the stresses in a bridge truss.

Fourth. The acquisition of some idea or degree of knowledge or skill through drill as a means to an end, such as learning the multiplication table or the manual of arms.

The secret of successful teaching is to have the student seek to learn. The exceptional teacher can accomplish this with almost any kind of text material, but even he could secure better results with less effort by employing the applicatory system. On one hand is the experience of the race, our only source of instruction material; and on the other is the individual, a partially trained bundle of impulses and potentialities. For efficient learning, the portion of race experience to be taught should be so organized that not only will the individual seek to learn but all jobs or problems will be graded to come within the learning power of the student, and will supplement one another in the development of various desired abilities. When this has been done the stage is set for efficient teaching.

When a man is learning to build a sidewalk, he is also learning something about dawdling or not dawdling. The way he works and the way he studies fixes or tends to fix him somewhere on the "lazy-energetic manner of learning" scale and his position on this scale is as important as the particular thing or things he is learning.

The secret of successful teaching is to motivate the student or to imbue him with purposeful activity—to crank him up and make him run on his own power. Purposeful activity has three aspects or phases: (1) The presence of a purpose; (2) the activity itself; (3) the results of the activity. The first and third phases are largely within the control of the instructor and to a great extent determine the character and scope of learning which occurs during the second phase.

The old conception of a soldier as a nonthinking automaton has given to industry the word "soldiering," meaning loafing on the job or shirking work. The applicatory system of training is developing a new type of soldier—one that comes to the Army from civil life because of the lack of facilities for development, becomes an efficient soldier, and later leaves the Army because he is trained for wider fields of employment.

ORGANIZING THE TRAINING COURSE.

The experience of the race in any trade or occupation can be expressed and organized to a considerable extent in a textbook or training manual, which will be of considerable service to the instructor in teaching the trade or occupation and to the student who comes to school with the desire to learn. Equipped with the training manual, the primary function of the instructor is to arouse and sustain the interest of the student into purposeful activity. Such a result can best be attained by using the applicatory system of training.

The instructor should find real jobs in the vicinity of the school involving the necessary elements that are required for teaching the vocation. Select those jobs in which the student is or can be interested and arrange these in order of increasing difficulty. Compare these jobs with the typical course in the training manual. Discard those which duplicate each other unless additional practice is necessary. Select jobs from the typical training course, if none can be found in the locality of interest to the student which give the necessary practice in the instruction and information units. Make sure that the jobs as finally organized in the course of training can be performed in the time allotted and that there is a sufficient variety so that the student's interest in the work will be sustained.

The jobs presented in the training manual comprise a complete course for the training of the average student in the essential skills and knowledge to the required degree. They are set up as a minimum standard for the instructor when organizing a course based on local conditions. The jobs in the manual that fit local needs may be used without hesitation and the entire course may be used if lack of time prevents the instructor from organizing a course of his own.

VARIABILITY OF ARMY PERSONNEL.

Those interested in training or education find it of value to consider the wide diversity in degree of human talents. The variety of abilities possessed by the human race is almost infinite. However, if these abilities could be measured it would be found that each human being possesses each ability in some degree ranging from zero to 100 per cent.

It is comparatively simple to measure the athletic abilities of the individual, such as running or hurling objects. It is still easier to measure a man's physique, such as height and weight. Scientists are now endeavoring to provide means for measuring intelligence, knowledge and skills. Success has already been achieved in measuring abilities such as handwriting and reading, and it is expected that means for measuring higher abilities will be developed in the near future.

The problem of training in the Army is far more complex than in the public-school systems. Practically all children enter the public schools at about six years of age. If the system is efficient, the children are promoted when they have achieved a certain degree of knowledge. Therefore the second grade has a more uniform group than the first grade. This selective process occurs year after year. When high school is reached the children that remain are those especially adapted by nature to the training of the public schools. This selective process continues through the high school and college.

Consequently the college graduates represent the small portion of the entire population who have the means as well as the natural abilities for the long period of unproductive training demanded by our schools and colleges. On the other hand, the Army accepts not only the products of our school system but also the discards, providing they are not morons (people having a mental age of 10 years or under). In addition to this, the Army specifies age limits and certain physical requirements.

The Army has soldiers of all nationalities, races, environments, and experience, varying from the mountain cabin or the city slum to the home of luxury; from the man who has never been away from home to the one who has been everywhere; from the unskilled laborer to the trained mechanic; from the sluggish in thought to the most brilliant; from the physical plodders to the best athletes of the Nation; from the unsophisticated to the man of the world; from the barely literate to the most brilliant university graduate.

Thus it may be seen that the training problem of the Army is far more complex than that of other schools, since the Army follows the democratic principle of offering an opportunity for every man to develop himself to his capacity.

There are three means now at the command of the Army for selecting students: First, the desire of the student; second, the judgment of superiors; third, psychological tests. These methods are all employed and gradually a system based on all three is being evolved to achieve the best results not only for the soldier who is to be benefited but also for the taxpayer who " foots " the bill. The " step-up " principle provides convenient steps or grading platforms which enable men to engage in suitable work when the abilities with which they are endowed at birth are developed to the point where it is no longer profitable to the Nation to train them further or when military exigencies permit only short training periods.

Confronted with this unique problem of training, the Army has further evolved its technique of teaching and has developed a new type of text material, which has proven effective not only in the Army but it is believed will meet the needs of many civilian situations.

THE "STEP UP" METHOD.

Schools and colleges have established goals which are not only difficult to reach but which require training periods of several years before graduation. On the other hand, industry adapts itself to the abilities of the men who do its work, by requiring a small percentage of the master or highly skilled type and increasing percentages of lower grades down to the "helper" type who do heavy, semiskilled labor under close supervision.

In frank recognition of the requirements of the more complex vocations, the "step up" method of training has been evolved. By this means the men of high native abilities can be advanced from one step or grade in the vocation to the next. Depending upon circumstances and the natural qualifications of the man, the stepping up process may be continuous or occur between periods of actual work at the trade. These steps also serve as grading platforms for those who have gone as far as their abilities warrant.

To provide for men of limited capacity who are incapable of sustained application, the first step or "helper" course is composed of simple jobs involving elementary tool skills and requiring low standards of performance. For example, the first job is a camp sidewalk, requiring the use of the square, saw, and hammer, and the succeeding jobs require additional abilities and higher degrees of performance in the skills previously acquired. The average student will finish this course in 30 hours of shopwork. The slow thinking, methodical student may require 60 hours to achieve the proficiency required of a "helper." Salvage lumber is used, as it produces satisfactory results at a low cost.

There is a definite place, both in civilian and military occupations, for men of this "helper" type. They are usually men of low mentality who can perform simple hand tool operations under close supervision with a fair degree of accuracy. They reach the saturation point in their training at about this level and can be sent from the school to do useful work with a feeling of achievement at having gained a certificate. They will undertake the new work without any feeling of personal stigma at leaving school in this way. As a result their attitude toward education will be friendly instead of antagonistic, as is now generally the case when they are unable to complete the course as laid out. This type of man matures slowly and in favorable environment may develop dormant capacities. As he feels the need for further training, he will be disposed to return to the school for the additional instruction.

The second step in training completes the acquisition of tool skills so that employment in the vocation will develop these into correct manipulative automatisms. The duration of this course is from six to eight weeks. It requires higher intelligence and physical coordination than is required of the "helper" in his everyday employment. Those achieving proficiency in this step of training have acquired sufficient skills to be eligible for additional pay in military and civil life. This is another convenient point for the elimination of men whose further training is unwarranted.

The third step in training teaches construction skills on actual building and bridge work. The student has now achieved sufficient tool skills to use efficiently commercial grades of lumber. Tool skills consist of such items as sawing to a line and dressing material, while construction skills consist of such items as leveling and plumbing, and laying out rafters. Three or four months are required to enable the student of this course to achieve the necessary proficiency in the wide range of abilities required in the construction of buildings and bridges. The graduate of this course is a high grade journeyman carpenter and can receive extra pay either in military or civil life. The completion of this course again calls for the elimination of the students who have been developed to their capacities.

The fourth step in training completes the acquisition of skill and knowledge in the construction of wooden buildings. Very high abilities are required, such as those possessed by a master craftsman, including the power of visualization, the anticipation of difficulties, initiative, and resourcefulness. Only those students should be admitted to the course who have attained high rank in the preceding courses and who have demonstrated reasoning power. A complete school year of six or seven months is desirable in this step of the training of a master carpenter, since these men, in addition to acquiring certain new skills and higher proficiency in the skills previously acquired must have experience in handling men and in following building construction through from inception to final completion. From test data at hand, only 10 to 20 per cent of the selected men beginning the helper course are sufficiently endowed by nature to secure a certificate of proficiency for this fourth and final step in training.

In addition to the continuous training of students to the highest level of their ability, the "step up" method is also readily adapted to the needs of the students who wish to engage in practical work for wages between each step in his training. Each step has given him a marketable asset of skill from which he can realize a profit.

HOW TO TEACH FROM THE TRAINING MANUAL.

The instructor should thoroughly appreciate that the group of men in the class even though especially selected for training to become carpenters will possess a very wide range of natural abilities and experience. Some of the men will be "natural mechanics," while others will learn with difficulty and probably will fail in analyzing the job. It is the instructor's duty to stimulate the interest of the men, not only by selecting the right kind of jobs but by all his powers of leadership. A sympathetic understanding of the men who do not seem capable, accompanied with kindly assistance, will frequently develop unforeseen powers in the student. The instruction should vary with the student so that each will be developed as far as it is practicable to train him. To educate an unskilled laborer to become a carpenter helper in a month may be just as profitable to the Army and the Nation as the training of a "natural mechanic" to become a master workman in two years.

While students should be encouraged from the start to fill out the job assignment sheet, it is desirable for the instructor to make group demonstrations to all who require it. Men should be eliminated from the demonstration group as rapidly as they are able to analyze the job for themselves. This is one of the best opportunities that the instructor has for coming in close contact with the individual student and for demonstrating his teaching ability.

The instructor should impress upon the student the advantages of the training manual. Its special form and arrangement will arouse comment just as everything does to which the student is unaccustomed. The advantage of having clear, explicit directions for doing the work is apparent but the ordinary textbooks have accustomed people to looking through masses of information to find possible directions. It is well for the instructor in this connection to keep the following definitions in mind:

A unit operation is a group of manipulative processes which occurs in substantially the same form, either alone or in combination with other unit operations in practical work. In general two classes of unit operations are considered; the tool unit, such as "sawing to a line," and the construction unit, such as "building stairways."

An information topic is a group of related facts, the mastery of which is essential to proficiency in the trade.

A job is a piece of work done, or to be done, as a whole. These are to be selected and arranged so that the unit operations and information topics will be practiced and studied in order of difficulty.

The instructor should establish in the students correct habits of workmanship. This can be done only by insisting that each tool be handled properly from the start. Breaking up a had habit is much more difficult than teaching a correct one. Establishing correct habits is made easier if the beginner understands why he handles the tool or does the work in a particular way. Tell the student why he lays a plane on its side, and then have him do it until he gets the habit.

The point to be emphasized in teaching all operations is forming the habit of doing them properly. After some skill in handling tools has been acquired, the student is ready to acquire construction skills. During the entire period of training special emphasis should be placed on the acquisition of correct methods which, with practice, will develop into habits or automatisms.

It should be kept in mind that the student knows little or nothing about the skills and knowledge that he is to acquire in the course. The instructor should remember that it took several years for him to learn to be a master carpenter and that he should not expect the beginner to learn faster than he did. The student, however, will learn rapidly if taught one or two things at a time, making sure that those one or two things are understood before proceeding further.

Be patient with the slow or awkward student and repeatedly show him proper methods of handling tools and doing various operations.

ORGANIZING THE CLASS.

Since 30 to 50 per cent of the students commencing the "helper" course will either drop out or reach the limit of their training in the first month or two it will frequently be found desirable to plan two "helper" courses, with 12 to 16 students each—one following the other. These classes will be so reduced in number that they can be combined into one class by the time that the learning of construction skills is commenced, if not before.

Students should be allowed to develop as fast as their abilities permit. Consequently, in a short time the class will be working on several jobs. Some of the students will be found capable of learning tool skills while engaged on construction work. Actual building and bridge projects should be commenced as soon as possible providing that the various unit operations can be taught. Building and bridge construction is the real objective of training and other jobs are simply a means to this end.

A practical organization on construction can be commenced when a number of students have reached the master carpenter course. The students can then be organized and given work in the same manner as though employed by contractors. For further details see Job 14 in this guide.

SHOP AND CLASS-ROOM SET-UP.

The carpentry shop should be located on the ground or first floor of a building with good light and ventilation. As heavy loads, such as piles of lumber, chests of tools, and machine tools are ordinarily placed in the shop, the floor should be inspected and strengthened, if necessary, to carry these loads. A classroom should be provided adjacent to the shop. This classroom should contain seats with facilities for writing for students, a desk for the teacher, and blackboards. Opening out of the shop should be tool and supply rooms of sufficient size to hold on shelves, in racks, and in bins all the necessary tools and hardware. Bins should be provided in the supply room for different sizes and kinds of nails, screws, bolts, etc. The instructor should arrange the tools in the tool room so that they will be readily accessible for distribution and all tools of a like kind grouped or stacked together. The instructor or an assistant should have charge of the tool room, which should be freely accessible to but not entered by the men. Sufficient tool boxes with locks and sets of tools should be at hand for issue to each student. Special tools should be issued as required from the tool room. The lumber shed or room should be adjacent to the shop and have suitable racks for storing lumber of the same kind and size in such a way as to be available for issue. Lumber should never be arranged in large, unassorted piles, which require repiling each time that a piece of the stated size is desired.

The instructor should give considerable study to the arrangement of the shop. Special attention must be given to the placing of the benches, so that the student will have the best light on his work at all times. If possible, the work benches should be placed with their long sides at right angles to the wall and between windows. Sufficient space should be left between or near the benches for the use of sawhorses and the performance of the simpler operations of sawing, assembling, and so forth. The machine tools should be placed in a separate section of the shop and so arranged as to utilize to the best advantage the available power. Ordinarily woodworking machinery is belt connected to a line shaft, but provision must be made for countershafts where machinery of different speeds is used. All woodworking machinery should be set on solid foundations, concrete where possible.

The instructor should utilize, as far as practicable, illustrated materials such as photographs, charts, diagrams, models, sample tools, etc. Tool and machinery manufacturers often have available for advertising large wall charts, diagrams, and sample tools mounted on boards. Such illustrated material should be hung about the walls of the shop and classroom, and can be used to advantage to show the students the make-up and operation of the various tools and machinery.

A place should be provided in the classroom for reference books; not only for the use of the instructor, but also for the general use of the students. The latter should be encouraged to extend their knowledge of the trade as far as possible by the reading of standard text and reference books outside of the regular shop periods.

In order to stimulate the interest of the student it is suggested that the instructor prepare a large wall record chart, which will give a graphic record of the proficiency of each student in the various unit operations. The instructor should keep this chart up to date from the student's rating card and encourage the men to study it daily in order to note their progress.

All woodworking machinery should be provided with suitable safety devices, in accordance with the recommendations of the National Safety Council, or similar organizations. Warning signs should also be posted adjacent to the machinery, cautioning students regarding its improper use. The shop should always be kept neat, clean, and in first-class working order. The student should clean off his bench and sweep the adjacent floor before leaving the shop at the end of the instruction period. Each student should check over his personal tools with the instructor and check in all special tools at the tool room before leaving the shop. The machinery shall be kept in good operating condition, the instructor inspecting it daily to see that it is properly cleaned, oiled, and adjusted. If the instructor expects clean, orderly, and systematic work from his students he should set a good example and maintain the shop and classroom in a clean, orderly, and businesslike condition.

PREPARING THE LESSON AND MEETING THE CLASS.

Before beginning the first day's work, the instructor should have studied the four training manuals in conjunction with this instructor's guide so that he can plan ahead and coordinate the jobs comprising the training course.

The instructor should always review the work which is to be done by the class before the beginning of the class period. This should at least consist of a careful thinking over of the work to be done by the instructor and by each member of the class. However, it is generally better to make a written plan which should be studied to see that everything is arranged for the efficient use of the time of the instructor and students. A written plan is of value not only in scheduling the work of the instructor but as a guide during the teaching period. The preparation for the lesson should include the laying out of the necessary special tools, supplies, equipment, machinery, etc., so that there will be no delay during the class period when securing equipment. The instructor should plan ahead so that all necessary equipment and supplies will be available when required.

The instructor must realize that he should know exactly how to do a given job before he attempts to teach his class how to analyze it. He should solve all the problems connected with any job and know the various ways of handling the work. If a student suggests a method of performing a job different from that given in the Training Manual the instructor should tell the student whether his method is reasonable and when it can properly be used. The way to learn to do a job is by doing it. Men should teach themselves when their initiative and ability permit. Lectures, demonstrations and personal instruction should be given only when the students are unable to gain the information by and for themselves within a reasonable period and to prevent the formation of bad habits of thinking out problems, of handling tools and of doing things.

At the beginning of the class or shop period the men may be assembled in the classroom to receive the general and specific directions for the work to be done during that period. Demonstration in the use of some tool or the performance of some operation may be given as cautions or suggestions as to the most efficient handling of a job. The instructor should utilize this as well as every other opportunity for stimulating and encouraging the men to progress in their vocation and ambitions.

Men should work individually in order to progress as fast as their abilities permit. However, on the larger jobs, it is often necessary for several men to work together as a group. In such cases, the instructor should study his men and assign them so as to develop those who have ability as group leaders. Competitive spirit should be encouraged whenever possible, by having several men or groups do similar work simultaneously. The man or group that does the best work should be encouraged by making the fact known either formally before the assembled class or informally to the students while they are at work.

The men should be kept comfortably busy, never permitting idling. Loafing will soon break up the morale of the class, while on the other hand "speeding up," except in the spirit of competition either with another or against a past performance, will arouse a spirit of resentment at being exploited.

When opportunity presents, for example, when a man or group of men are "stalled" or up against a problem they are unable to solve, the instructor should hold a conference in order to discuss the matter with the man or men interested. If the problem is of sufficient importance, the work of the whole class may be stopped to have a general discussion. At such times the instructor can give instruction and drill in related facts and mathematics which lead to the solution of the problem. Never talk or lecture to the students more than 20 minutes. Lead them to solve their problems by asking them questions and directing their attention to those facts which will solve the difficulties. During the "problem periods" the instructor can refer the students to the information topics and reference books which may be of assistance.

The instructor should carefully supervise the work of each student and make such mental and written notes as may be necessary for him to keep his class records continually up to date. A careful study of these records will guide the instructor in assisting the weaker men and in stimulating those having ability and capacity.

A successful instructor must be fair and just with all men at all times. He must treat his class with entire impartiality, regardless of personal likes or dislikes. Carelessness, laziness, and shiftlessness should be censured, while industry, conscientiousness, and skill should be commended and rewarded. The instructor should not be distant, aloof, or arrogant with his students, but should be a man among his men, always arousing their interest, holding their attention, and inspiring them whenever possible to greater efforts and higher achievement.

The instructor must thoroughly like his job of teaching the trade before he can hope to become a successful teacher. No person can become successful for any length of time in any given work if it is irksome or burdensome. Hence, if the teacher does not like the carpentry trade, or develops a dislike for teaching, he should take steps to be assigned to other work.

GRADING STUDENTS.

The keeping of accurate records of the performance of work by the students is essential. The instructor immediately in charge of a section is the best qualified judge of the progress of the student in his course. Standard forms should be used to enter the marks showing the student's progress. These are designed for a twofold purpose: They first let the student know what progress he is making and serve as an incentive for better work. Secondly, they let the instructor know wherein his instruction has been good or poor. Unless the instructor makes this record up daily or weekly, it will be impossible for him to know whether the students are receiving and understanding the information he is giving them.

Two sets of forms should be kept. The first one gives the student's skill in the unit operations covered by the instruction units. Form 758 A. G. O., "Proficiency rating in vocational training," is made with the unit operations listed on the left and a series of 10 vertical blank columns on the right. When a student has completed an operation, the instructor draws a horizontal line opposite the operation, and of such length as to indicate the student's proficiency. The horizontal lines are gradually lengthened as practice increases proficiency. At the end of the course the rating cards show graphically which operations have been done and what degree of proficiency has been obtained in each. In entering these marks, consideration should be given to speed, accuracy, and skill in performing the operation.

On completion of a course, the instructor may draw a line in his class record connecting the ends of the horizontal lines representing the proficiency of the student in the unit operations represented in that course. The same page of the record may then be continued for the same man in the succeeding course. At the completion of the second course a longer vertical line to the right of the former one will represent his proficiency and so on until the entire series of courses for carpenter is completed. Such a card in the hands of the soldier will be of value upon his release from the service in enabling him to get a desired position.

The second record is designed primarily for the use of the school. The first form makes no reference to the man's rate of progress, his attention to instruction, or his attitude while in the school. The latter factor is of value to the instructor in knowing how he must teach each student. This record should be in the form of a weekly report, based on 100 per cent marking maximum progress, attention to instruction and general attitude.

The instructor should not allow his personal feeling toward the student to affect his grading in any way. When grading the student's proficiency the only element to be considered is his workmanship regardless of how hard the student tries. However, credit for effort made will be given in the second record mentioned above.

TRADE BIBLIOGRAPHY.

Building Construction and Superintendence, Kidder and Nolan. The William T. Comstock Co., New York City.

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Essentials of Woodworking, Griffith. The Manual Arts Press, Peoria, Ill.

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Carpentry, Townsend. American Technical Institute, Chicago, Ill.

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Cyclopedia of Building Construction, Radford Architectural Co., Chicago, Ill.

Price Book and Specifications for Lumber and Millwork, Chicago Millwork Supply Co., Chicago, Ill.

Price Book and Specifications for Lumber and Millwork, Gordon-VanTine Co., Davenport, Iowa.

Rules for Measurement and Inspection of Hardwood Lumber, The National Hardwood Lumber Association, Chicago, Ill.

While the four Training Manuals and this Instructor's Guide have been written as a complete unit, instructors and the more able students should read other books. Instructors should mark the portions of the above books that they consider of interest and give them to students who show ability.

SELECTED REFERENCES FOR TEACHERS AND SUPERVISORS.

Vocational Education, Snedden. Macmillan.
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Symposium on the Project Method, T. C. Record. No. IV, Vol. 22, 1921.
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How to Measure in Education, McCall. Macmillan.
How to Experiment in Education, McCall. Macmillan.
History of Education in the United States, Monroe. Macmillan.
History of Education, Cubberley. Houghton, Mifflin & Co.
Theory of Human Society, Giddings. Macmillan.
Mind in the Making, Robinson. Harpers.
Principles of Scientific Management, Taylor. Harpers.
Educational Sociology, Snedden. Century.

Instructors who have been chosen for their occupational skill will find it well worth their time to study the history, theory, and practice of their new vocation.

Supervisors of instructors should make every effort to increase their knowledge of teaching.

OCCUPATIONAL INDEX.

UNIT OPERATIONS:

Training Manual No. 10. Carpenter Helper—

1. Laying out square cuts.
2. Sawing to a line.
3. Dressing material.
4. Boring holes.
5. Nailing.
6. Fastening with screws.
7. Scraping.
8. Sandpapering.

Training Manual No. 11. Basic Carpenter—

9. Cutting to width and thickness.
10. Making rounded curves.
11. Hewing to a line.
12. Scribing.
13. Reading drawings.
14. Preparing bill of material.
15. Sharpening and setting saws.
16. Sharpening edged tools.
17. Sharpening scrapers.
18. Sharpening auger bits.
19. Laying out special angle cuts.
20. Mortising and tenoning.
21. Grooving.
22. Truing surfaces.
23. Preparation and use of glue.

Training Manual No. 12. General Carpenter—

24. Leveling and plumbing.
25. Making wood foundations and forms for concrete foundation.
26. Laying sills and girders.
27. Cutting and placing joists and bridging.
28. Laying rough flooring.
29. Laying out walls and partitions.
30. Framing and erecting stud walls, partitions, and joists.
31. Framing around window and door openings.
32. Placing ceiling joists.
33. Cutting and framing lookouts.
34. Laying out common rafters.
35. Laying out hip and valley rafters.
36. Laying out jack rafters.
37. Erecting roof frames.

Training Manual No. 12. General Carpenter—Continued.

38. Framing dormers.
39. Erecting scaffolds.
40. Putting on sheathing.
41. Waterproofing around exterior openings.
42. Roof sheathing and stripping.
43. Flashing.
44. Putting on siding.
45. Putting on shingles.
46. Placing plaster grounds.
47. Furring.
48. Placing insulation materials.
49. Building straight stairways.

Training Manual No. 13. Master Carpenter—

50. Estimating.
51. Laying out foundations.
52. Setting window and door frames.
53 Framing for concealed gutters.
54. Hanging verge boards.
55. Coping.
56. Making cornices.
57. Bending boards.
58. Putting on interior trim.
59. Fitting doors.
60. Hanging windows.
61. Building winding stairways.
62. Wainscoting and paneling.
63. Hanging sliding doors.
64. Laying finish floors.
65. Fitting standard hardware.
66. Underpinning.
67. Making hopper joints.

INFORMATION TOPICS:

Training Manual No. 10: Carpenter Helper—

1. Tools.
2. Fastenings.

Training Manual No. 11. Basic Carpenter—

3. Definitions of trade terms.
4. Timber.
5. Joints.

Training Manual No. 12. General Carpenter—

6. Foundations.
7. Main frame.
8. Roof frame.
9. Floors.
10. Wall covering.
11. Roof covering.

Training Manual No. 13. Master Carpenter—

12. Estimating.
13. Inside finish.
14. Outside finish.
15. Finish hardware.

TYPICAL TRAINING COURSE:

Training Manual No. 10. Carpenter Helper—

1. Camp sidewalk.
2. Trench board.
3. 9-inch bookcase section and packing box.
4. 12-inch bookcase section and packing box.

Training Manual No. 11. Basic Carpenter—

5. Standard A frame for trench board.
6. Special A frame for trench board.
7. Portable artillery bridge.
8. Low bookcase.
9. High bookcase.
10. Tool tray.

Training Manual No. 12. General Carpenter—

11. Double garage.
12. Lumber shed.
13. Bridge.

Training Manual No. 13. Master Carpenter—

14. Quarters.

INSTRUCTOR'S GUIDE FOR CARPENTERS

TRAINING MANUAL No. 10.

CARPENTER HELPER

INDEX.

	Page.
Foreword	26
Unit Operations:	
1. Laying out square cuts	27
2. Sawing to a line	29
3. Dressing material	30
4. Boring holes	32
5. Nailing	34
6. Fastening with screws	36
7. Scraping	37
8. Sandpapering	38
Information Topics:	
1. Tools	39
2. Fastenings	41
Jobs:	
1. Camp sidewalk	44
2. Trench board	47
3. 9-inch bookcase section and packing box	48
4. 12-inch bookcase section and packing box	49

FOREWORD.

Training Manual No. 10, Carpenter Helper, teaches the basic tool skills in carpentry that at least 25 per cent of the soldiers in the Army should have. The duration of the course should be sufficient to instruct the student not only in the proper handling and use of the hammer, saw, plane, brace and bit, square, screwdriver, scraper, and sandpaper, but also in the acquisition of sufficient skill to be of service to his organization on practical work.

The instructor, in this course, will find it necessary to outline the work clearly and completely and to make demonstrations of the tool operations and perform such work as cutting to width and thickness and truing surfaces, which are not generally done by Carpenter Helper. He will demonstrate how to analyze and plan the jobs and how to fill out the Job Assignment Sheets properly before starting the job. The brighter men will, as the course proceeds, work faster than the others, and the instructor will direct these men to fill out the Job Assignment Sheet before he demonstrates to the class. Job No. 4 should be analyzed by the entire class and the results graded by the instructor before the demonstration. These marks should be one of the tests for entering the course outlined in Training Manual No. 11, Basic Carpenter. Students not capable of job analysis should not be permitted to take the advanced course though they may receive certificates as Carpenter Helpers.

The "Helper" course is a fundamental and convenient step in training a master carpenter and furnishes a near and definite objective within the reach of most soldiers. At the end of the course a certificate of proficiency as Carpenter Helper will be granted to all who have attained the necessary skill. Special mention will be made of those students who have attained the grades of "Superior" and "Above average." These men and the "Average" graduates, who are susceptible of further training, are eligible to take the course contained in Training Manual No. 11, Basic Carpenter.

These steps need not follow immediately after one another. It may often be an advantage to a man to work at the trade for a while between each part of the school training.

Some of the men will have difficulty in reading. Others may be able to pronounce the words but will not comprehend what they mean. This need not prevent these men from becoming valuable helpers if the instructor gives them the necessary instruction, telling them in addition what the others may read for themselves.

LAYING OUT SQUARE CUTS.

Explain to the student that unit operations Nos. 1, 2, and 3 are the various steps in the shaping up of a board. In order to measure and lay out for a square cut it is necessary for accurate work to have a face and an edge, which are both plane surfaces and meet at a right angle, from which to measure. Lumber usually comes from the mill with one side and one edge planed but if this has not been done, it is necessary to do some additional planing on it for finish work. There are six steps in shaping a board accurately, and it is economical to do them in the following order:

(1) Working face.
(2) Working edge.
(3) Square end.
(4) Length.
(5) Width.
(6) Thickness.

It is necessary to have a working face before the edge can be squared as the face serves as a plane against which to place the square when testing the edge. This face and edge are then available for squaring the end. It is economy to cut the piece to length at this time in order that the labor of planing the part that is not needed may be saved. As planing a face is more labor than planing an edge it is now economy to cut to width before planing to thickness. Show that the handle of the square must always be placed against the working face or edge and that an edge squared from any other than a working face or edge will not be true. For the same reason length should be measured from a square end.

The student should have it thoroughly impressed upon him that these six steps are necessary for accurate work, but that when lumber comes from the mill it may have all of its faces planed and need only cutting to length. He should also understand that in rough work, such as the camp sidewalk, it is good practice to square an end from a side or an edge that is approximately straight, but that this degree of accuracy is not acceptable on other than rough work.

In marking a line with a knife, the knife should be drawn toward the student and the knife handle inclined slightly away from the square. In marking with a pencil it should be laid at the same angle throughout the stroke.

When working near the end of the piece hold the square so that the blade will have bearing along its entire length.

QUESTIONS AND ANSWERS.

1. In sawing for length, on which side of the line do you saw?

The saw cut should be made on the side opposite from the direction the measurement was made. If the cut is made along the line, the measured board will be short about one-half the width of the saw kerf.

2. When should a board be marked all around?

For very accurate work, such as cutting a tenon when it is necessary to have the shoulders lie in one plane.

3. Why is a try-square used for small, finished, or accurate work?

The try-square is smaller, easier to handle, and better adapted for finished and more accurate work than the steel square.

4. Give examples of kinds of work on which knife lines and pencil lines are used.

Knife lines would be used in laying out cuts on the interior and exterior finish or trim of a building. Pencil lines would be used in marking cuts for the rougher types of work such as framing, stair carriages, rafters, and boarding.

5. In what position should a try square be placed in marking the four sides of a piece with a working side and edge?

Draw a line across the face side with the blade of the square against the working edge. From the end of the line just drawn, draw a line across the working edge with the blade of the square against the working side. Repeat this on the opposite edge with the blade of the square against the working side. Finally, with the blade of the square against the working edge draw the closing line across the fourth face or side opposite the working side. If the work has been carefully and accurately done, this line will intersect the line on the opposite edge, making a square around the piece.

SAWING TO A LINE.

Have the student note the difference in the shape of the teeth of the crosscut and ripsaws, so that he can recognize each saw after a brief inspection. Have him saw a board across the grain and along the grain with each type of saw. Direct the student's attention to the chisel-shaped teeth of the ripsaw and the bevel-faced teeth of the crosscut saw. Demonstrate that the action of a ripsaw in ripping along the fibers or grain of the wood is like a series of chisel cuts. In like manner show the action of the crosscut saw in scoring, cutting, and tearing the wood across the fibers similar to the combined action of a knife and a chisel.

Watch the student carefully not only to insure that he holds the saw properly, but especially that he allows the saw to move freely without exerting pressure to force the saw into the wood.

Impress upon the student the necessity of never attempting to saw without first drawing a guide line. Demonstrate the value of keeping the saw kerf in the waste-wood side of the line by laying out two pieces exactly the same length and sawing one on one side of the line and the other on the opposite side; then show him that these two pieces vary in length at least one-eighth of an inch.

Have the student test the sawed end of several pieces with the try square and inspect the cut to determine how closely he has followed the scribed lines.

QUESTIONS AND ANSWERS.

1. In accurate work, why should you saw to the knife line rather than on it? On which side of the line should you saw? Why?

In making the cut or kerf, the saw removes a strip of wood of from one-sixteenth to one-eighth inch in width. Hence, in sawing to length, the saw cut should be made so as to leave the line as the boundary of the measured length. Thus, the cut should always be made on the side of the line away from the measured length.

2. Why are two lines on adjacent faces necessary for sawing a board square.

The saw in making its cut works through two adjacent surfaces or faces of the board. and the two lines on these faces furnish a guide for the making of a square cut.

3. How should a long board be sawed to secure several pieces of exact length?

Lay out the measured lengths successively after each cut is made.

4. What is meant by "set" in a saw? Why is "set" made in a saw?

"Set" in a saw is the offsetting of the teeth alternately from side to side. This "set" gives clearance and prevents the side of the saw blade from binding in the cut.

DRESSING MATERIAL.

Assemble the class and take a plane apart explaining the purpose of each part. Be certain that each student knows how to put a plane together properly and especially show him how the chip breaker or cap iron is adjusted on the plane bit. Explain the use of the chip breaker emphasizing that in fine work on hard wood the chip breaker is nearer the edge than in coarse work on soft wood. Impress the value of holding the plane properly, of standing at the bench in a workmanlike manner and of habitually laying the plane on its side when through working. Show that the wedge can be used as a screw driver in removing the cap iron from the bit.

Have the student read carefully the description of the four kinds of planes in Information Topic No. 1. Show samples of these various kinds of planes, both iron and wood planes, if available. Turn up the bevel and point out the convex edge of the jack plane knife. Call attention to the similarity of the plane iron to the chisel, and demonstrate the reason for turning the bevel edge down in cutting with the grain and up in cutting across the grain.

Have the student first set the plane iron for a thin shaving, and then gradually increase the depth of cut by turning the brass adjusting nut as required.

Give the student a rough board and have him use the jack plane for the preliminary dressing, and the smoothing plane for the later smoothing up of the surface.

QUESTIONS AND ANSWERS.

1. Why will a long plane give a truer surface than a short one?

The long bottom surface of a plane such as the fore plane or jointer will carry the plane iron across the low points of a surface and only remove the high places.

2. Why should a plane be laid on its side when not in use?

The cutting edge of the projecting plane iron might be nicked or dulled by striking a nail head or other obstruction on the bench top, if the plane was rested on its cutting surface. Also the plane might cut into the bench top by being shifted around while resting on its cutting surface.

3. How should mouldings be dressed?

Mouldings are roughly dressed by special planes equipped with curved plane irons. The final dressing or smoothing of mouldings is done with sandpaper.

4. How is a smooth surface secured where the grain of the wood is not straight and uniform?

Where there is a "break" in the grain, the planing of the surface must be done in sections; in each case planing with the grain up to the "break." This will require reversing the piece on the bench in order to plane in the same direction. Sometimes a piece with an irregular grain may be planed at an angle across the board if care is taken to make a very thin cut.

BORING HOLES.

Have the students study the auger bit to comprehend the cutting parts and action; the spur draws the end of the bit into the wood, the nibs score the surface, and the lips chisel out the wood as the bit revolves. Show the accurate method of starting to bore a hole, by first carefully guiding the point of the spur to the center mark of the hole with the left hand, while the brace is being held in the right hand.

When a student first picks up a brace teach him to keep the chuck in his left hand turning the handle with his right. When he has learned to put the bit in the stock properly have him learn to keep his right hand on the handle and guide the brace with his left.

Bore a hole through a piece of wood, bearing down on the bit until it goes entirely through, showing how the wood splits when the hole is bored in this manner, then show the proper way of releasing the pressure when the bit is almost through, withdrawing it and completing the hole from the opposite side. Make certain that the student knows how and why everything is done and then insist that he does it properly.

QUESTIONS AND ANSWERS.

1. How should the brace be held in order to steady it?

The left hand which holds the head of the brace can be rested against some adjacent part of the body. In boring in very hard wood, it may be desirable to press down on the handle of the brace with the chest in order to secure a greater force.

2. When boring part way through a board, how should the proper depth be determined?

Determine the depth of the hole below the surface, and substract this distance from the length of the auger bit from its spur to the bottom of the grip of the brace. The result will be the length of the auger bit, below the bottom of the grip of the brace, which will project from the surface of the wood when the hole is bored to the required depth. A 2-foot rule can be used to measure the length of the auger bit from time to time so as to determine when the boring should cease. Another method of determining the proper depth of the hole is to saw out a block the length of the auger bit as determined above, and turn the bit into the wood until the bottom of the grip of the brace strikes the top surface of the block which is placed alongside of the bit.

3. When several holes are to be bored part way through a board, what method can be used to secure holes of equal depth?

Determine the depth of the hole, subtract this from the length of the bit from lips to chuck, and cut a block this length. Bore a hole through this block and leave it on the shank of the bit.

A metal depth gauge which may be attached to the shank of the bit may be purchased.

4. What other tools can be used for boring holes and how are they used?

Holes having a diameter of less than one-fourth inch can be effectively bored by using a gimlet or a special form of drilling tool such as the automatic drill.

NAILING.

Take two boards and nail them together, driving at least three nails in the same direction into the wood. Show that these boards can be pulled apart easily. Take two other boards and drive three nails in different directions. Show that it is much more difficult to separate these boards. Drive nails so that they will split the wood and then drive them so that they will not, explaining why this occurs. Blunt the point of a nail and show that this will not split the wood as readily as a wedge-shaped point. Explain and show why and how in driving a small nail a wrist motion is used. In like manner show that on a larger nail the forearm is used pivoting at the elbow and that on spikes the full arm swing is used.

Endeavor to arouse pride in driving nails in a workmanlike manner, showing that when the nail has once been found with the hammer head it can be driven with the eyes shut. The difficulties in teaching will be largely overcome when a pride in doing work in a thoroughly workmanlike manner has been aroused.

In nailing through one piece into the edge of another piece, the student should stand so as to look along the length of the second piece in order to direct properly the driving of the nail.

Start the nail in the top piece so that the joint just projects below the lower side. Then place the board in the proper position and drive the nail into the second or lower piece. Caution the student not to drive the nail into the bench top.

A nail driven crooked or bent in driving should be withdrawn. It should not be straightened in place and driven, as it will generally "come out."

QUESTIONS AND ANSWERS.

1. Why will nails driven in varying directions hold timbers together to best advantage?

Nails driven in different directions will resist better the pull in any one direction than if driven in the same direction.

2. How should nails be driven so as to prevent splitting of lumber?

Dull or blunt the points of wire nails when driving in timber that is likely to split.

3. How should nails be pulled?

Place a block of scrap wood under the head of the hammer to prevent marring the surface of the wood and if the nail is big add blocks of different thickness as the nail is withdrawn.

4. What different methods should be used in driving different kinds of nails, such as cut nails, finish nails, shingle nails, etc.?

Cut nails are made with wedge-shaped points and should be driven with the wedge across the grain to prevent splitting the wood. Finish nails should be driven so that the head projects above the finished surface and then driven in with a nail set.

5. Why are nails set in interior woodwork?

The nail head is driven below the surface of the wood so that the hole may be filled with putty and a smooth surface obtained which will not show the nail head.

FASTENING WITH SCREWS.

Demonstrate to the class that it is practically impossible to screw two pieces tightly together if the threads are holding in both boards. Show that the shank of the screw should turn in the top board the threads holding in the bottom one, and that the top board is wedged between the head of the screw and the threads. Show also that a wedged-shaped screw driver will pull out of the head of the screw. Also show that a little soap rubbed on the threads of a screw will make it drive into hardwood much more easily than if not lubricated.

Caution the student to hold the screw driver firmly in the slot of the screw. If the driver is allowed to jump out of the slot it will spread the slot and mar the head of the screw.

Have the student try screw drivers of different length in handling a large screw. Also direct him to use a brace and screw driver to realize the greater purchase or power obtained from this type of driver.

In order to drive a screw straight the student should be taught to sight his driver and screw from two directions at right angles to each other, from time to time.

QUESTIONS AND ANSWERS.

1. In fastening boards together with screws, why should the thread not take hold in the top board?

The thread of the screw grips the wood, and if entirely in the lower board the shank will slide in the upper board so that the head will bind the two boards tighter and tighter as the screw is turned.

2. In fastening two pieces of soft wood, should screws of large or small gauge be selected?

Screws of large gauge can be used in soft wood, as the larger thread surfaces of the screw give greater bond in the wood.

SCRAPING.

Explain to the student that scraping is a method of finishing a surface and is often done before sandpapering in order to remove the greater roughness or irregularities of the surface. These irregularities are often left on hardwood surfaces after planing.

For small areas, such as sections of trim or cabinet work, pieces of glass with slightly convex edges can be efficiently used for scraping.

QUESTIONS AND ANSWERS.

1. Why should scraping commence at one side of a room?

After the scraping is done there should be as little walking and working on it as possible. Scraping should commence at one side, and the workman should keep his feet and the tools with which he is working on the part that has not been scraped.

2. Should the floor be scraped before the base molding is placed?

The wide molding should be in place but not the quarter round. It is impossible to scrape into the corners and the quarter round will cover the part that is not well scraped.

3. Why is the scraper drawn along the surface parallel to the grain of the wood?

If drawn across the grain, the scraper will roughen the surface instead of smoothing it.

SANDPAPERING.

The student should be cautioned not to use sandpaper for the rough dressing or even the smoothing of surfaces. The former should be done with the jack plane and the latter with the smoothing plane. It will be found that many men will be tempted to use coarse sandpaper to do the work which should be done with planes, especially when the latter are not sharp and are not in good working condition.

Demonstrate that it is exceedingly difficult to remove scratches made by sandpapering across the grain.

Take various kinds of woods with surfaces of different degrees of smoothness and explain to the student the need of carefully selecting the proper grade of sandpaper, the coarser grades for the rougher surfaces and harder woods and the finer grades for the more finished work and softer woods.

The student should realize that sandpapering is the final operation in the finishing of surfaces in general carpenter work and should only be done after the preliminary planing and scraping. Show that small particles of the sand will remain in the wood and dull any edged tool that may be used upon it and emphasize the necessity of sandpapering only after all other tool work is done on the wood.

QUESTIONS AND ANSWERS.

1. Why should the surface be rubbed parallel with the grain in sandpapering?

Sandpapering across the grain will produce streaks and scratches which will mar the surface.

2. How should corners and edges be sandpapered?

Corners and edges should be lightly rubbed with a piece of sandpaper which is bent over the edge or corner and run lightly over the adjacent surfaces.

3. What grade of sandpaper should be used for interior trim and for exterior trim?

Coarser sandpaper should generally be used for the exterior trim rather than for the interior trim. Nos. 1 and 1½ are often used for exterior trim, while No. 0 and No. ½ are used for interior finish.

DESCRIPTION OF TOOLS.

This information unit on tools should be supplemented by one or more class periods during which the instructor should discuss each tool with the students. By questions lead the students to describe the construction and use of each tool and add such supplementary information as may be necessary from time to time.

This information topic does not include some general tools and equipment, which should be kept available in the tool room and with which the student should be familiar. Such tools and equipment are the drawknife, automatic drills, clamps, miter box, gluepot, etc. The instructor should discuss the construction and use of this general equipment with the class as opportunity offers.

QUESTIONS AND ANSWERS.

1. What part of an auger bit cuts the wood? What is the purpose of the twist?

The nibs make the initial cut or scoring of the wood on the surface. Then the cutting or chiseling out is done by the chisel-like edges of the lips. The twist serves as a spiral channel through which the chips of wood pass to the surface.

2. Why is a brad awl generally provided with a wedge-shaped point? Under what conditions is a conical point preferable?

The wedge-shaped point makes a hole larger than the shank of the awl and allows easier and more effective boring. A conical point is desirable for an awl which is to be used as a scribe.

3. Why is a firmer chisel with a socket better than one with a tang?

The socket furnishes a better seat for the handle than the tang. In driving the chisel with a mallet the tang is apt to split the handle.

4. Why is a saw file tapered?

A saw file is three cornered and tapered in order to fit the teeth of the saw. The taper gives it a downward pressure when the file is pushed forward.

5. Why should dividers not be used generally for scribing? Under what conditions should they be used for scribing?

The general use of the points of the dividers for scribing will dull and injure them. Dividers should only be used for marking or scribing curved lines or arcs of circles.

6. Why are the teeth on a wood file coarser than those on a metal file?

The teeth of a wood file should be very coarse in order to cut the fibers of the wood and not become clogged with the particles of wood.

7. Under what conditions should inside and outside ground gouges be used?

Outside ground gouges are best adapted to the cutting of grooves in plane surfaces. Inside ground gouges are used for cutting curves, edges, or making rounded surfaces.

8. How can the carpenter's level be used to plumb a large surface?

Use the level with a long straightedge.

9. What plane should be used in smoothing or truing the surface of heavy planks for a bench top?

Use a jointer.

10. Why is a plumb bob pear shaped?

The plumb bob serves to project a point vertically, and hence needs to be pointed at its lower end. The upper part is made large to secure the necessary weight.

11. How should a carpenter's rule be used to lay out accurately a distance greater than the length of the rule?

Measure a foot and then 2 feet at a time. Measure the line in the opposite direction as a check on the first measurement.

12. Why is set given to the teeth of a saw? Why are the teeth of a ripsaw pitched differently from those of a crosscut saw?

"Set" offsets the teeth alternately from side to side and prevents the binding of the saw blade in the cut. The teeth of a ripsaw are pitched at right angles to the cutting edge of the saw so as to secure a chiseling action. The teeth of the crosscut saw are pitched at an acute angle, so as to alternately cut the fiber at each side of the kerf and then chisel out the wood.

FASTENINGS.

The instructor should show the class a wire gauge and demonstrate its use in determining the gauge number and diameter of wire nails.

Discuss the difference in materials of which the cut and wire nails are made. Lead the students to understand the reason for the use of cut nails for shingles and other work especially subject to weather conditions.

Explain the use of the screw gauge and the purpose of the great variety of form and sizes of screws. Discuss the use of the flat-head steel screw in rough work and of the finished types with flat, round, and oval heads for the fastening of finish and finish hardware. Show the use of the lag screw in timber framing and discuss its field of use as compared with the spike and the driftbolt.

Discuss with the class the use of the various types of bolts, noting especially the function of the expansion bolt as an anchor and the great holding power of the driftbolt.

QUESTIONS AND ANSWERS.

1. What is the best form of nails for rough work, such as the fastening of the frame of the building?

Common wire nails.

2. What nails should be used for erecting the interior trim of a building?

Finishing nails.

3. When can cut nails be used to advantage?

For exposed work, such as roofing.

4. Why should galvanized nails be used for roofing?

To prevent corrosion due to weathering.

5. When are screws used in building construction?

To fasten trim, finish hardware, and in some cases of rough work where great strength and holding power is required.

6. When can lag screws be used to better advantage than bolts in building construction? When are washers used?

Lag screws are especially adapted to the fastening of the heavy metal members to the timber members of a framework and of adjacent timbers together, where it is impossible or undesirable to pass bolts through the members. Washers should generally be used to distribute the pressure from the head of the screw or bolt over a greater area of the timber surface.

7. What are the relative advantages of square and hexagonal heads on bolts?

Generally the wrench can get a better grip on a square head, while the hexagonal head can be used to advantage in limited spaces.

8. When is it desirable to use expansion bolts?

Expansion bolts are used to anchor timbers to masonry.

9. Why should toenailing be used? When?

Toenailing is used in fastening vertical timbers to horizontal timbers and matched boarding, such as flooring, ceiling, etc.

10. Why is it not good practice to fasten under flooring over a bearing with one surface nail?

The flooring is apt to be green and may warp or twist and should be strongly fastened with more than one nail at each bearing.

TYPICAL TRAINING COURSE.

The jobs have been prepared to serve as a productive method of training the students in the elementary steps of the carpentry trade contained in this part of the Training Manual. Hence the instructor should emphasize the educational and not the productive phases of the work.

The instructor should see that each student fills out by himself the paragraphs 4, 5, and 6 of each Job Assignment Sheet. Review each student's work on the Job Assignment Sheet before allowing him to begin actual shopwork. Go over carefully the answers to the questions in paragraph 6 and quiz the student to make certain of his detail understanding of the job.

CAMP SIDEWALK.

The teaching of the first job will influence the attitude of the students toward the entire course. It is therefore highly important that the instructor know exactly what he is going to do and give clear-cut directions for all the work that is to be done.

Assuming that the first job is the camp sidewalk, it is desirable to demonstrate in great detail how to use the Job Analysis Sheet and then build the sidewalk in front of the class, showing how to perform each unit operation and demonstrating the correct handling of tools. A great deal of the work can be done in advance to avoid tedious repetition. While demonstrating have the student study the working drawing of the sidewalk and ask such questions as: How long must the 2 x 4s be? How long are the cross pieces? How far are they spaced apart, and how far do they project over the 2 x 4? Have the student find out from the drawing.

Show that the lumber is furnished in long lengths and ask what the first operation is. Obviously it is laying out square cuts. The answer to the question will probably be that it is necessary to cut up the lumber, and this is the place to emphasize that lines must be measured and drawn before attempting to cut any material. Then demonstrate the use of the square in laying out square cuts. The next operation is sawing to a line. Demonstrate the correct use of the saw. The top edge of the stringers and the top surface of the boards will be dressed to demonstrate the use of the plane and to give practice to the student. Explain that this operation may not be done in practical work. The last operation will be nailing, which will be carefully demonstrated.

Have these unit operations listed under paragraph 4 of the Job Assignment Sheet and then the tools and the bill of material under paragraph 5. Answers to the questions will be brought out in the demonstration. Next turn to the Unit Operations Nos. 1, 2, 3, and 5 and explain carefully these operations with the related information topics. Instruct the student when at work to have the manual at hand for reference when he does not know what to do. Give the opportunity to ask questions about anything which is not understood. If these points have been impressed, the student will have been given all that should be included in one lesson.

Explain that this is a rough job and that in the following jobs he will be required to work more accurately, but do not give him the impression that inaccurate work will be accepted even in making a sidewalk. When the students are at work, the instructor should devote his time to training them in the acquiring of proper methods in laying out the work and in forming proper habits in handling tools.

In nailing the walk together teach the proper steps in the set-up and fastening together of the members. Have the student set the three stringers on a level surface (preferably two sawhorses) and fasten their ends together temporarily with small strips of wood. Caution him to square the frame and keep it square with a temporary diagonal brace as the cross boards are being nailed on. Suggest the use of a templet, such as a strip of board, for the spacing of the cross boards. Discuss the use of the simplest and best method of lining up the ends of the cross boards by the use of a string, a piece of stripping, or a templet.

When the job is completed give each man a grade in your class-record book, by drawing a line to the dot which, in your opinion represents his proficiency in Operations 1, 2, 3, and 5. This mark is your estimate of his proficiency compared with an expert and will probably average about 2. This mark has no relation to a passing grade of 70 but represents his present proficiency. If he has had previous experience and handles his tools like an expert grade him 8 or 9 and give him more advanced work. If he gets a mark of 2 and does much better on the next job his line can be lengthened to 3 or 4, etc.

QUESTIONS AND ANSWERS.

1. Why are three stringers used?

Three stringers are necessary to make a rigid frame and to furnish uniform bearing for the walk on the ground.

2. Why are the cross boards spaced one-fourth inch apart?

A small space must be left between the board to allow water and dirt to pass through, but if the space is greater than about one-fourth inch a person using the walk is likely to stub his toe.

3. Why do the cross boards overhang the stringers?

A slight overhang of the cross boards brings the stringers close and thereby decreases the span of the boards and increases the strength of the frame.

4. Would it be advisable to fasten the cross boards to the stringers with screws?

No. Fastening with screws would be much more expensive than nailing and is unnecessary to secure the desired strength.

5. Would it be advisable to use a solid floor for the sidewalk?

No. An open walk should be used to allow the passage of dirt and water. A walk with closed joints would also cause dry-rot and decay in the joints.

6. Would it be practicable to use one nail instead of two for each contact?

No. One nail does not make a good fastening for plain boards. Two or three nails should be used, depending on the width of the board.

TRENCH BOARD.

This job involves the same instruction units as the camp sidewalk, but the operation of putting the pieces together and nailing is more difficult. All the students should endeavor to complete the Job Assignment Sheet. The instructor should glance through their work as each student submits it to him and give such help as may be necessary. After all of the students have submitted their Job Assignment Sheets for comment, the instructor should call the students together and make another job demonstration as described under Job No. 1 The abler students can now be determined and should be permitted to progress as fast as they can.

As each man completes the job, again record his grade for each unit operation in the class record book by extending a line to the dot which represents his proficiency in the instruction units performed. The instructor should exercise care in not giving too high a grade since many jobs will be performed before the student becomes a master carpenter and progress will be continually made even in such simple operations as sawing to a line and nailing.

QUESTIONS AND ANSWERS.

1. Why are the 2 x 4's extended 3 inches at each end?

The extension is necessary to secure a suitable bearing on the cross-pieces of the **A** frame which are the supports of the sections.

2. Why are the 2 x 4 stringers offset from the ends of the cross-pieces?

The ends are offset so as to allow the stringers of the adjacent sections to pass by and lie against one another.

3. Why are the sections made 6′ 6″ long?

The **A** frames are spaced 6′ 0″ on centers and a 3-inch projection is necessary at each end to give full bearing on the **A** frames.

4. How would adjacent sections be placed as regards position of stringers?

The sections must be placed end for end in order that the projecting ends of the stringers will lap by.

9-INCH BOOKCASE SECTION AND PACKING BOX.

More accurate workmanship should be required on this work than was accepted in the preceding projects. While a variation of one-eighth inch in the lengths of two boards in the sidewalk would be permissible, such a variation in the length of the sides of the box will not be allowed. Emphasize the fact that good workmanship depends upon attention to details and that one error in measurement or one inaccuracy in workmanship may be carried through and eventually ruin an entire job.

Call attention to the basic or accurate figure to use in getting the length of the box. The inside figure 3′—0″ is the basic figure, while the outside figure, 3′—3½″, will vary with the thickness of the stock used. For example, the figure 3′—3½″ would be correct only for ⅞-inch material, while if ¾-inch stock was used this figure would become 3′—3″.

Caution the student about screwing into end grain when fastening the sides and bottoms to the ends.

Check up the job to insure square corners before fastening with the screws. Show the student how to tack the pieces together temporarily with 8d. wire nails driven part way in before beginning to put in the screws.

QUESTIONS AND ANSWERS.

1. Why is the box made of the length shown?

The length is made so that the box will fit crosswise into an Army wagon box.

2. Why is the box made 9⅝ inches high?

This box is designed to hold books of octavo or 8mo size, which are 9 inches high.

3. Why are the ends built up as shown?

The ends are reinforced to furnish greater strength and handholes.

4. How would the section be used as a packing box?

To use the case as a box for the transportation of books, a cover could be made and fastened on with screws.

5. Why are only the ends of the section finished?

The ends are the only exposed parts of the case when the sections are stacked up.

12-INCH BOOKCASE SECTION AND PACKING BOX.

The 12″ bookcase section and packing box is very similar to the previous job and has been inserted so that the student may give his full attention to acquiring tool skills without the mental difficulties which would occur in the untrained man when attempting a new type of work.

When marking the operations the instructor should be careful not to overmark, weighing carefully the skill of the student against that of a master carpenter whose marks would probably range from 8–10.

QUESTIONS AND ANSWERS.

1. Why is the box made 11⅝″ high?

This box is made to contain one of the standard sizes of books, which is 11½″ x 9″.

2. Why are the vertical strips run the full height of the ends?

This is the correct design for taking up the weight of the books in the box.

3. In what direction should the grain of the ends of the box run?

The grain of the ends of the box should run crosswise, so that the vertical strips mentioned in question 2 will prevent the ends from splitting.

4. Why are screws used to fasten the sides and bottom to the ends?

To give the strength required for book-packing boxes that will be shipped and reshipped a great many times.

INSTRUCTOR'S GUIDE FOR CARPENTERS

TRAINING MANUAL No. 11.

BASIC CARPENTER

INDEX.

	Page.
Foreword	52
Unit Operations:	
9. Cutting to width and thickness	53
10. Making rounded curves	54
11. Hewing to a line	55
12. Scribing	56
13. Reading drawings	57
14. Preparing bill of material	59
15. Sharpening and setting saws	60
16. Sharpening edged tools	62
17. Sharpening scrapers	63
18. Sharpening auger bits	64
19. Laying out special angle cuts	65
20. Mortising and tenoning	67
21. Grooving	68
22. Truing surfaces	69
23. Preparation and use of glue	70
Information Topics:	
3. Definitions of trade terms	71
4. Timber	73
5. Joints	75
Jobs:	
5. Standard A frame for trench board	77
6. Special A frame for trench board	79
7. Portable artillery bridge	80
8. Low bookcase	81
9. High bookcase	83
10. Tool tray	84

FOREWORD.

Training Manual No. 11, Basic Carpenter, completes the course for teaching the basic tool skills, which at least 5 per cent of the soldiers of the Army should have. This course completes the carpentry bench work and provides for the acquisition of the necessary skills and knowledge in the care, sharpening, and use of carpenter tools.

The students should be required to analyze and plan each job and properly fill out the Job Assignment Sheets before starting the job. The instructor should review the job assignment with each student as soon as the student fills it out and insure himself that the student understands the instruction and information units required to do the job.

The basic carpenter course is an important step in the training of students who demonstrated high ability during the helper course. At the end of the course a certificate of proficiency as Basic Carpenter will be granted to all who have qualified. Special mention will be made of those students who have attained the grade of "Superior" and "Above average." These men and the "Average" graduates are eligible to take the course contained in Training Manual No. 12, General Carpenter.

These steps need not follow immediately after one another. It may often be of advantage for the student to work at the trade for a while between each step.

CUTTING TO WIDTH AND THICKNESS.

Review the six steps necessary for cutting a board to accurate dimensions, mentioned in the discussion of Unit Operation No. 1. Call attention to the necessity of gauging all the way around the board and of always working with the block of the gauge against either a working face or a working edge.

Have the student lay out a stated width on a board by the two methods, with rule and pencil and with marking gauge, so as to realize the relative accuracy of the two methods. Call attention to the advantages of the use of the thumb along the edge of the board in marking with rule and pencil (see Fig. 51) over the method used by many carpenters of running the side of the index finger along the edge of the board.

Instruct the student to check up his gauge with his rule to determine the accuracy of the scale on the guage and the need for setting the gauge each time with the rule.

In testing the surface of dressed material, the student should learn to use the edge of the plane diagonally across the surface as well as crosswise.

QUESTIONS AND ANSWERS.

1. Why is the board cut to length and width before it is cut to thickness?

Planing to thickness is a slow and laborsome process, and it is advisable to cut away all material that is not needed before planing the board to thickness.

2. Why is the scale on the wooden marking gauge unreliable?

The scale is frequently not accurate, also the bending of the spur in the use of the gauge will render the scale inaccurate.

3. How can one determine toward which end to plane a board?

Examine the side or edge of the board at right angles to the surface to be planed, and set the board so as to plane along or over the grain, and not into or against it.

4. Why plane to a line rather than through it?

By planing just to a line the required width or thickness will be secured. When the line has been planed away, one has no way of knowing when to stop planing.

MAKING ROUNDED CURVES.

Discuss the comparative uses of the drawknife and spokeshave; the former for larger and rougher work and the latter for smaller and more finished work.

Direct attention to the direction of grain and the necessity for cutting over the grain in order to avoid splitting the material. A few trials with material of irregular grain will give the necessary experience.

The beginner generally makes too deep a cut and must be taught to take thin shavings. This applies especially to the spokeshave.

QUESTIONS AND ANSWERS.

1. Why should the drawknife be held at an angle to the direction of the cut?

This position of the drawknife will permit the better control of the cutting edge, especially in adjusting it to variations in the grain.

2. Why is it best to hold the thumbs near the center of a spokeshave?

To give better control of the tool.

3. How is a spokeshave adjusted?

The bit or knife is generally adjusted by a screw which must be loosened with a screw driver before the knife can be reset.

HEWING TO A LINE.

Hewing is rough work which requires considerable skill and experience to do well. The tools must be sharp and the strokes in cutting made under close control of the arm.

The cuts should be made sufficiently close together so that it will be easy to strip the wood, with a single stroke of the tool, parallel to the mark.

QUESTION AND ANSWER.

1. When should wood be hewed rather than sawed?

Hewing is especially adapted to the trimming of short lengths of boarding or planking in the field where power machinery is not available.

SCRIBING.

Instruct the student in the proper methods of scribing with a scriber or knife point so that a light, uniform scratch will be made on the surface of the board. Emphasize the necessity of holding the blade of the square or T bevel firmly against the edge or side and of drawing the scriber uniformly and lightly along the edge of the tongue of the square or T bevel.

In the use of wing dividers point out the importance of setting the wing nut of the dividers tight, so that the spacing of the points will not change during the scribing of an irregular surface.

QUESTIONS AND ANSWERS.

1. Why is the board to be fitted on the above example placed in a vertical position against the wall?

The board must be placed in a position similar or parallel to the position in which it is to be placed.

2. Why are the dividers set the greatest distance the edge of the board is from the wall surface?

In order that the board may properly fit the wall surface it is necessary to scribe a line on the board parallel to the wall surface and a distance from it equal to the greatest distance the edge of the board is from the wall surface.

3. Why are the dividers held level in setting them and in scribing for the casing in the above example?

It is necessary to hold the dividers level in setting and scribing in order that the proper distance the edge of the board is from the wall surface may be truly determined and maintained in scribing the board.

READING DRAWINGS.

Impress upon the students the fact that there is nothing mysterious about a working drawing—that a drawing is merely directions for constructing an object. If the drawing is complete, all the necessary directions for the construction may be found in it.

Each member of the class should take a simple rectangular object and draw outlines to represent plans and elevations as described in paragraphs 2 and 3 of the Training Manual. Make it clear that the plan of an object is the view looking down upon it and that the elevation is the view one would have standing off and looking at the side of it.

Call attention to the difference in weight of the principal lines of the figure and the axis lines, the center lines, and the dimension lines; the latter being made lighter than the former. Be sure that the reason for the use of the arrows at the ends of the dimension lines is understood.

Ask the student whether an end view is necessary to fully show the fence shown in Figure 59. Have him point out that it is necessary in the case of the sawhorse shown in Figure 60, in order to clearly show the 1 x 6″ end bracing.

Discuss the function and importance of the detail sketches in Figure 60, showing the layout of the special angle cuts with the steel square and the T bevel. Direct attention to the use of dimensions which give the lengths of the various parts of an object together with the total length, which is the sum of these component parts. This is illustrated in the two sets of dimensions shown above the elevation of the sawhorse in Figure 60. Direct attention also to the custom of placing the size of a timber directly on its representation in the drawing.

In studying the drawing of the 66-men barrack, the men should carefully inspect such a building if one exists in the camp or post with the instructor. If the barrack building is not available, it may be possible to visit a building of a similar type, such as a mess hall, bachelor officers' quarters, or hospital building. The method of framing, door and window details, etc., were made the same in all buildings of this temporary character. Have the students compare the drawing with the building and study the methods of representation of windows, doors, stairways, ventilator, electric lights, etc.

Ask why it is necessary to show the section C–C in Figure 61. Questions should be asked as to whether, in simple construction of this character it would be necessary to show large scale details of the frame. Make it clear to the student that such details should always be given where it would be desirable or necessary to show clearly the connections, methods of bracing, and fastening, etc., for the use of the carpenter.

The building shown in Figure 61 furnishes the instructor with a splendid opportunity to discuss with the class the various structural elements of a simple building and their size, arrangement, methods of fastening, and purposes. Assume that there is a heavy load of snow on the roof or a large number of men on the second floor of the building and point out how the load is transmitted from the roofing and flooring to the joists and then to the walls, which carry the loads down to the footings, which in turn pass it on to the soil on which they rest.

Call attention to the purposes of the many braces shown in section C—C in maintaining the proper relations of roof and floors with the walls in case of a heavy wind blowing on either side of the building. Note the importance of the footings which must be designed to transmit the loads, both of dead weight of the building and the live loads of wind, snow, men, and stored goods, from the roof and floors to the earth below. Point out that these loads must be transmitted uniformly in order that the building, as it gradually settles into the earth, may do so without changing its original shape, which would result in damage to the building.

QUESTIONS AND ANSWERS.

1. Where may the details of floor framing be found in Figure 61?

The details of the floor framing are shown in dotted lines near the middle of the first and second floor plans and also in section C–C.

2. Where may the details of wall framing be found other than in section C—C, Figure 61?

The details of wall framing are shown by the dotted lines on the front and end elevations.

3. Is there any provision made for escape in case of fire in the 66-men barracks?

The ladder shown on the end elevation serves as a fire escape.

PREPARING BILL OF MATERIAL.

The instructor should familiarize the student as fast as possible with the method of listing various kinds of material by insisting that a complete and accurate bill of material should be prepared by each student independently. After the student has prepared the bill of material for a job the instructor should review it carefully and point out errors or discrepancies. Make sure that each student understands what "board measure" means. Call attention to the fact that lumber may come from the mill faced one side and one edge as well as the two methods noted in paragraph 3 of the training manual.

Direct attention to the difference in specifying lumber as shown in paragraph 10, where the exact lengths of material are noted, from the approximate method of ordering from the mill when even foot lengths greater than the exact length required are specified.

QUESTIONS AND ANSWERS.

1. Why is it necessary to allow for matching in tongued and grooved lumber?

Dimensions of tongued and grooved material are given from the outside of the tongue. As the tongue fits into the groove some allowance must be made for the tonguing and grooving of the material.

2. How is the weight of window weights shown?

The weight of a window weight is marked on the side or the top, the figure being cast as a part of the weight.

3. What is the advantage of listing together material of the same thickness and kind?

It facilitates the securing of material from the supply room or stockyard. Also if material is to be ordered from the mill it will greatly assist the mill in furnishing the required material.

SHARPENING AND SETTING SAWS.

The sharpening and setting of a saw requires considerable knack and skill and should be undertaken by the beginner only after a careful study of the directions, working on an old saw under the supervision of the instructor.

The sharpening and setting of a saw should be demonstrated carefully to the class. The student may often learn much more from watching a carefully executed demonstration than from any amount of directions or descriptions.

In setting a saw, the student should be cautioned not to use too much force or strength, which would result in crushing or breaking the teeth. It is necessary to press the anvil of the set uniformly and carefully until the teeth are uniformly offset the required amount, which should be no more than is necessary to prevent binding of the saw.

In sharpening a saw, direct attention to the setting of the saw blade with the teeth projecting only a short distance above the top edge of the clamp. In filing the teeth it is important to keep the file in the same relative position as he proceeds from tooth to tooth in order that the sharpened faces of the teeth may be parallel to one another. Caution against filing too much. The tooth should be filed only enough to bring it to a sharp edge. The student should watch the teeth as he sharpens them to be sure that the cuts are being made parallel and to the same depth.

Emphasize the proper sequence of steps in sharpening and setting a saw: First, setting the saw; second, jointing the saw; third, sharpening the saw.

QUESTIONS AND ANSWERS.

1. Why must the file always be held at the same angle?

In order that the faces of the teeth may be parallel to one another.

2. Why should the file be lifted out of the groove at the end of every stroke?

This should be done in order that the filing may always be done in one direction, thus insuring a smoother and truer edge to the tool.

3. Why will dressing the teeth on one side of the saw tend to change the direction of its cut?

If one set of faces of the teeth of a crosscut saw are dressed and the other set left untouched the saw would cut ununiformly and move out of a straight line. The undressed faces would extend farther out of line and would tend to throw the direction of cutting out of line.

4. What is a saw jointer and how should it be used?

A saw jointer is a simple frame made to hold the flat file and provided with guides which serve to hold the jointer in place as it is moved along the teeth of the saw.

5. What is the difference in the angle that the file makes with the blade of the saw when filing a crosscut saw and a rip saw?

In filing a crosscut saw the file is alternately held at an angle of less than 90° with the plane of the blade, thus producing a series of beveled edges in the faces of the teeth. In filing the teeth of a rip saw, however, the file is held at a right angle with the plane of the blade, as the planes of the faces of the teeth are always at right angles to the plane of the blade.

SHARPENING EDGED TOOLS.

The sharpening of edged tools should be demonstrated by the instructor before the class, especially with regard to the use of the grindstone or dry emery wheel. Point out the importance of always holding the blade in the same position on the stone so that the bevel will lie in a plane surface. Also caution against excessive grinding of the blade and especially excessive heating, due to long continued grinding.

In whetting the edged tool, a student should be cautioned not to bear down heavily and cut too much on the cutting edge, as this will produce a long feather and a waste of material. The circular motion used in rubbing the edge of the stone should be a slight one, and special care must be taken not to change the angle which the tool makes with the stone.

Caution against cutting the hand in stropping a newly sharpened tool on the palm of the hand.

QUESTIONS AND ANSWERS.

1. How is the tool kept cool while grinding?

In using a grindstone it is customary to provide for the dripping of water over the surface of the stone. Emery and carborundum wheels are used dry. Whetting on an oilstone is generally done with a film of oil over the surface of the stone.

2. Why should the tool be ground with a short taper for hard wood?

A long tapering edge would be broken off in the hard wood and the short taper will provide for the making of lighter cuts, which are generally desired in the dressing or planing of hard material.

3. Why should plane bits and chisels be beveled on one side only?

Plane bits and chisels are beveled on one side only so as to force the tool in the direction of the bevel.

4. Why is an oil stone used? When?

An oilstone is used to whet or put the finishing edge on an edged tool. An oilstone is a stone of very fine texture and grinds the edge very slowly.

SHARPENING SCRAPERS.

Direct attention to the fact that the edge of the scraper is turned over toward the face of the blade so as to produce a projecting edge, which produces the shaving when the scraper is passed over the surface of the wood.

The sharpening of the scraper should be demonstrated to the class by the instructor, directing the special attention to the methods of burnishing with one firm steady stroke. Direct attention to the fact that the file and burnisher should be pushed across the edge in one direction, by a uniform stroke, and not drawn back and forth across the edge.

QUESTIONS AND ANSWERS.

1. What tools should be used to sharpen a cabinet scraper and in what order should they be used?

The edge of the scraper should first be draw-filed with a large flat metal file and then burnished with a metal burnisher.

2. What does the oilstone do to the edge?

The oilstone removes any ridges left by the file and gives a finer and more uniform feather or wire edge.

3. How can the scraper be burnished so that its corners will not scratch the wood?

The ends of the edge toward the corner should be slowly ground down with the file.

SHARPENING AUGER BITS.

The sharpening of auger bits is one of the most difficult processes of sharpening edged tools and must be done with great care if satisfactory results are to be obtained. The instructor should give a thorough demonstration to the class and also carefully supervise the work of the students. Direct attention to the importance of filing the inside surface of the nibs and the under surface of the lips when the spur is up so that the cutting action will be downward and toward the outward surface of the hole. It might be well to file the nibs on the outer surface and show the students that this method of filing will cause the bit to make a hole, the diameter of which is less than that of the twist, and thus gradually produce a wedging action.

It is important in filing the under surface of the lips to provide sufficient clearance in order that the lips may cut properly.

QUESTIONS AND ANSWERS.

1. Why should the nibs not be sharpened on the outer surfaces?

The sharpening of the nibs on the outer surface will cause the wedging or the jamming of the bit in the wood.

2. Why should the top edges of the lips not be filed (when the spur is up)?

The sharpening of the top edges of the lips would prevent the proper downward cutting action of the bit.

LAYING OUT SPECIAL ANGLE CUTS.

This unit operation provides excellent opportunity for class exercise, devoted to giving an understanding of the significance of angles, slopes, and pitch. Point out that a complete arc or circle contains 360 degrees; a semicircle, 180 degrees; and a quarter circle or quadrant, 90 degrees.

Draw right triangles and illustrate to the class the functions of right triangles with equal legs and of the special case where the acute angles of the triangles are 30 and 60 degrees and the shorter leg is one-half of the hypothenuse.

Familiarize the student with the rise or run method of determining slopes in which the horizontal distance is taken as 12″ and the rise is a distance less or greater than 12″, depending on whether the angle is less or greater than 45 degrees. When the rise is equal to the run, the angle is, of course, 45 degrees.

Point out that the use of the steel square, in laying out special angle cuts or bevels, is a simple application of the rise and run method of determining the layout of angles. The run of 12″ is generally taken on the blade of the square and the corresponding rise on the tongue to lay out the special angle cut. Indicate the use of this method in laying out stair stringers, roof rafters, etc.

QUESTIONS AND ANSWERS.

1. How is an angle of 45 degrees laid out without using the table?

Lay off the run of 12″ and an equal rise of 12″ or take 12″ on the blade and 12″ on the tongue of the steel square.

2. How many degrees are there in each angle formed by laying a straight edge across a square when the straight edge is on the figure 12 on the blade and 6 on the tongue?

26° 34′ and 63° 26′.

3. How is an arc divided into two equal parts?

There are two methods; the approximate and the exact methods. The approximate method is to assume one-half the length of the arc, set the dividers and test the arc. If the spacing is too large, reset the dividers and try again. Keep resetting and trying until the correct spacing is secured. By the exact method, the dividers are set to a space somewhat greater than one-half the length of the arc and with one point of the dividers on one end of the arc, scribe an arc, above and below the original arc. With the same setting of the dividers and with one point of the dividers set on the other end of the original arc, again draw an arc above and below the original arc, intersecting the first arcs drawn. Lay a straight edge across the two sets of intersecting arcs, drawn above and below the original arc, and scribe a short line cutting the original arc along this line. The point of intersection of the line with the arc will give the center of the arc.

4. How is an arc divided into three equal parts?

Assuming the subdivision of the arc, set the dividers to this length and step off along the arc. If the subdivision assumed is too large or too small, shorten or lengthen the spacing of the dividers and try again until the right setting of the dividers is found.

MORTISING AND TENONING.

The methods of making the various kinds of mortise joints should be discussed with the class. Emphasize the importance of making accurate layouts of the mortise and tenon and of careful workmanship in cutting both parts of the joints. Even in rough work, such as making mortise and tenon joints for the framing of a stud into a plate or sill, the student should be required to do as accurate work as is within the limits of his skill.

Direct attention to the need of making the tenon very slightly larger than is required by the layout in order that a tight fit may be secured. The tendency is to make the mortise too large and the tenon too small, in other words, to cut beyond the lines in every case. It is always possible to enlarge the mortise or cut down the size of the tenon while it is impossible to decrease the size of the mortise or increase the size of the tenon if they have been overcut.

The average beginner makes a great deal of hard work out of cutting mortises. It is probably advisable to demonstrate how simply and quickly a mortise may be cut by carefully following the instructions. This is especially true with relation to the cutting of the blind and through mortises. Make the series of parallel cuts with single direct blows of a mallet on the head of the chisel, and take care not to cut too close to the ends of the mortise in starting the work. The end should always be finished off after the core has been removed. When the core driver is used the end should be cut fairly close, and in rough work it is generally customary to cut them accurately so that the core driver will leave the finished mortise.

QUESTIONS AND ANSWERS.

1. Why should the same gauge settings be used for cutting the mortise and tenon?

The same gauge settings should be used for cutting both mortise and tenon so as to insure the same layout for equivalent dimensions.

2. In a through mortise why chisel out the core working from both faces?

If the cutting is carried through the material from one face it will be difficult to follow a definite direction accurately. It will be much easier to work from both faces and have the cuts meet near the middle of the piece.

GROOVING.

The making of grooves requires accurate laying out and cutting to secure good results, and as in the case of making mortise joints, the student should be urged to use all possible care so as to acquire a reasonable amount of skill in this operation.

In laying out kerfs, caution the student to lay out or set off his measurements, always from the same edge or side, in order that the parallel cuts will be made truly parallel. Also direct attention to the fact that it is not necessary to scribe lines entirely across an edge or surface, if the ends of the lines are marked on the edges, as this will furnish a sufficient guide for the cutting.

The chiseling out of the core of the groove requires considerable care in the handling of the chisel to prevent cutting into the material below the bottom of the groove. Direct the student to hold the back of the chisel parallel to the bottom of the groove, with the beveled cutting edge up. The chiseling out of a core or waste should be done in thin slices to prevent splitting the piece and cutting below the bottom of the groove. The leveling of the bottom of the groove should be done with long uniform strokes of the chisel in order to secure as uniform and smooth a surface as possible.

In using battens, direct the student to make the battens slightly wider than the width of the groove in order that they have a tight fit. Caution must be exercised, especially in the tapering of the groove or keyway, not to drive the batten too hard, as this would cause the end of the material to become sheared out.

QUESTIONS AND ANSWERS.

1. How should a series of grooves be laid out along a board?

The groove should be laid out from the end, using the total or over-all dimensions from the end of the bottom of each groove.

2. Why should one saw along the inside edges of the marks for the cuts?

This method insures a groove which is very slightly less in width than the required dimensions, and thus gives a better fit for the batten or other piece which is to be fitted into the groove.

3. What tools or appliances may be used in making the kerfs for the grooves to secure true and accurate cuts?

Narrow pieces of wood may be inserted in a miter box and wider pieces may be held on a bench hook, to secure accurate cutting with a back saw. The saw may also be guided by tacking a straight piece of wood along the mark.

TRUING SURFACES.

Truing a surface is a careful, particular operation and one which requires good judgment. It will help the student to place two straightedges of equal thickness, one at each end of the board, and sight along the top surfaces to determine whether they are in the same plane. This method is more accurate for the untrained eye than simply sighting along the surface of the board.

Show how the edge of the plane may be used as a straightedge, testing the surface of the board diagonally as well as transversely. Indicate how the straightedge may fit a warped surface diagonally in some one position and the board still not have a true surface.

Caution the student to cut down carefully the high places with fine or thin shavings and not to cut more than is necessary.

QUESTIONS AND ANSWERS.

1. How should the warp be planed out of a board?

Test the surface with a straightedge, note the high places, and dress them down evenly with a smoothing plane.

2. How should a cross-grained board be surfaced?

Dress with the grain, using short strokes and turning the board so as to work always with the grain.

3. What causes "wind" in lumber? Warping?

"Wind" is caused in lumber by unequal or ununiform seasoning and shrinkage. Warping, like "wind," is generally due to ununiform or unequal shrinkage of the lumber after it is milled.

PREPARATION AND USE OF GLUE.

Gluing may seem to be a very simple and easy operation, but it is one which is generally improperly performed. The inexperienced man will ordinarily use too much glue and neglect to rub the adjacent surfaces together properly. The glue in all cases should be rubbed thoroughly into the wood, and in the case of end grain a thin coating of glue should be first applied to serve as "sizing." After this sizing coat has dried, the second coat should be applied in as thin a layer as possible. Direct the student to squeeze out and wipe off all surplus glue.

QUESTIONS AND ANSWERS.

1. Why should glue be applied in a thin layer?

The glue should be applied in a thin layer so as to bring the adjacent surfaces as closely together as possible with the use of the least amount of adhesive material. The strongest joint will be secured when just enough glue is used to produce a thin, continuous film between the abutting surfaces.

2. Why rub the pieces together and squeeze out the surplus glue?

Rubbing the pieces together forces the glue into the grain of the wood and at the same time forces out the surplus glue, which must be removed to secure a strong joint. When glue is applied it forms a thin film on the surface, which is broken by the rubbing.

3. Why is it necessary to "size" end grain wood before gluing?

If the end grain wood is not "sized," the applied glue will penetrate into the pores of the wood and not leave a sufficient amount to bond the abutting surfaces. The "sizing" coat serves as a somewhat impervious surface upon which to place the glue to tie the pieces together.

4. Why divide a complex job into sections?

In order to secure proper results, each pair of abutting surfaces should be glued independently.

5. How should large surfaces be glued?

The glue for large surfaces should be applied with a large brush, while the glue is hot. In some cases it may be desirable to have two or more men apply the glue in order that the pieces may be assembled before the glue has cooled and hardened.

DEFINITION OF TRADE TERMS.

The definitions in this information unit are intended to serve as a trade dictionary. Urge the student to refer to it frequently in order to become familiar with the tools, appliances, material, and construction elements of framed buildings. The student should not memorize these terms immediately but study them in connection with the performance of the various jobs. From time to time direct attention to this list of definitions and encourage the student to add these words to his vocabulary.

Early in the course call attention to some common and important trade terms, such as the common timbers of a house frame; the sill, plate, joists, studs, rafters, etc. The classification of lumber into boards, planks, scantling, and timbers should be clearly brought out in a group demonstration since many carpenters use these terms loosely.

QUESTIONS AND ANSWERS.

1. What should be used to tie wooden beams and joists to a masonry wall?

Some form of iron anchor. It should be fastened to the sides of the beams or joists near their ends and project into the masonry wall to furnish suitable anchorage.

2. If a wooden beam has a section of 4 x 6″, how should the beam be placed for greatest strength? Why?

The beam should be placed to have the 6″ dimension carry the load. Generally speaking, the 6″ dimension should be up and down.

3. What is the purpose of a belt course on a building?

A belt course is an architectural feature setting off a floor line of a building above the first floor.

4. Assuming a 6 x 8″ girder is required in a building, would it be better to use a solid 6 x 8″ timber or three 2 x 8″ planks spiked together?

Generally it would be better to use three 2 x 8″ planks spiked together, as it is difficult at the present time to secure large timbers which are well seasoned and free from defects. Also, it would be cheaper to use the built-up planks.

5. Why and where is it necessary to use counterflashing?

Counterflashing is used at the intersection of brick walls, such as those of a chimney or parapet wall, with a roof. It is necessary to prevent snow and rain from being driven up and around the flashing at such places.

6. Why is a nosing used on the tread of a stair?

A nosing adds to the width of the tread and improves the appearance of the stairway.

7. Why is it desirable to drive wooden piles so as to lie entirely under water?

Wooden piles decay very slowly when always wet.

8. Under what conditions is a girder used in a building?

Girders are used in a building when it is necessary to use an intermediate support for beams or joists between the walls.

9. What are the advantages of the use of concrete instead of brick or stone for foundation walls?

A concrete wall is stronger, more uniform, and better bonded together than either a brick or stone wall. In many localities where good building stone or good brick are not available, a concrete wall is cheaper to construct than one made of brick or stone. It also resists frost action and other weathering effects better than other materials.

TIMBER.

Do not attempt to make the student memorize the names and properties of the various kinds of well-known woods described in this information topic. However, he should read it occasionally and gradually become familiar with the names and properties of various woods used in construction work.

Samples of the common woods should be secured showing the different grains, so that the student may become familiar with the appearances and methods of cutting different kinds of lumber for building purposes. It may be possible to secure sections of small trees which will show the various defects in timber.

If there is a sawmill near the school, take the class to the mill on an inspection trip in order that the methods of milling timber and sawing and surfacing of lumber may be seen.

Discuss the most suitable wood for various kinds of jobs. For example, A frames are intended for rough, temporary purposes, and can be economically constructed of yellow pine, spruce, or hemlock, while the bookcases are a higher grade of work than the A frames and hence a better grade of material, such as white pine, should be used. These bookcases will be more permanent and durable and probably more attractive if constructed of oak. However, the oak is more expensive than white pine, and its use would not be justified for beginners to work on.

QUESTIONS AND ANSWERS.

1. What are the characteristics of a wood suitable for the frame of a house?

The frame of a house should be built of a common, moderately priced wood of fairly high strength, such as Douglas fir and yellow pine. The higher priced lumber, such as oak and fir, would be stronger, but the greater expense does not justify their use.

2. In building a moderately priced house, what woods would be the most suitable for the exterior trim, the inside finish, and the upper floors?

It would be advisable to use cypress, pine, or fir for the exterior trim; cypress, gum, or selected pine for the interior finish; and oak for the upper floors.

3. If a section of a building is to be supported on wooden posts, what kind of wood should be used for the posts?

A form of timber which does not deteriorate when it comes in contact with the soil should be used. Cypress, cedar, and catalpa are good woods for this purpose.

4. In what class of work can cross-grained wood be used?

Cross-grained wood can be used to advantage for the panels of doors, paneling, and for other places where an ornamental effect is desired.

5. Is it permissible to use lumber containing many knots?

Knots weaken lumber, and hence lumber containing many knots should never be used where strength is required. Pine or hemlock containing many knots may be used for sheeting or boarding where it is to be covered, inside and outside, as on the walls and roof of a building.

6. Why should green lumber not be used in a building?

Because of warping and shrinking.

7. What methods can be used in seasoning lumber?

Open air and dry kiln.

8. Where is quarter-sawed lumber used to the best advantage?

Quarter-sawed lumber is generally used for inside trim where the effect of the grain is desired for ornamental purposes.

9. How should cypress or poplar be cut so as to produce the most attractive grain for interior finish?

So as to produce a uniform grain with an occasional variation.

10. How should the log be cut to secure the least amount of shrinkage or cracking in lumber?

By quarter-sawing.

11. Is a coarse, brittle wood suitable for interior finish?

No; it is not attractive and is liable to split.

12. How should logs be sawed so as to secure wood finish with a curly grain?

Certain timber, such as maple and redwood, can occasionally be cut across the grain so as to secure a curly effect due to the irregularities of the grain.

JOINTS.

Discuss with the class, from time to time as opportunity offers, the various kinds of joints used in timber structures. Point out the methods of connecting timbers in the direction of their length at acute and right angles to one another and in compression and tension.

Show the different types of joints used for ordinary framing and for heavy timber framing. Outline the kind and direction of stress or force in each piece and the method of transferring stress from one piece to another at the joint. For example, in the heavy timber joints shown in Figures 88, 89, and 90 there is compression in the batter posts which tends to push out the ends of the posts and also to push down on the end of the ties. The batter post is stepped into the tie in order to take up this "push-out" action. The bolts are used to assist the steps in resisting this pushing or thrusting out action of the batter posts.

Point out the parts of the building where the various types of mortise and tenon joints are used. Discuss the framing of studs into the sills or plates, the framing of trimmer beams into a girder, the joints in window sashes and doors, and the use of built-up planks for truss and other interior work. The ease and economy of making joints in built-up trusses may be demonstrated from Figure 90 and by inspecting the cantonment type of building, constructed in the camps and posts, during the World War.

QUESTIONS AND ANSWERS.

1. Why should the abutting surfaces in a joint be made, as nearly as possible, perpendicular to the pressure which it is to carry?

Since this is the condition of greatest strength.

2. Is it necessary to make a joint so that the pressure may be distributed uniformly over the abutting surfaces?

Uniform distribution of pressure makes the best joint.

3. When are fishplates used in a joint?

To stiffen the joint against transverse or bending pressure.

4. What is the best form of a scarfed joint for resisting tension?

One with several small abutting surfaces and a wedge as shown in Figure 80.

5. In what cases should a stub tenon be used?

Where it is undesirable that the tenon should project through lumber into which it frames as in interior finish like cases, chests, closets, etc.

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6. In what class of work should a double tenon be used? What is the purpose of a tusk tenon?

A double tenon is used where great strength is required. The tusk tenon is used where it is necessary to secure a greater bearing of one timber on another as in the framing of the trimmer beam or a tie into a girder.

7. In what class of building construction is an oblique tenon used?

An oblique tenon is used for joining timbers which meet at an acute angle, such as the connection between the top and bottom chords of a timber frame or truss.

8. What is the strongest method of fastening a lapped joint? A fished joint?

The strongest methods of fastening both lapped and fished joints is with the use of iron plates, the ends of which are slightly grooved and bolted into the sides of the timbers.

9. When is it desirable to use fish plates with a scarfed joint?

When the joint is to be subjected to bending stress.

10. Under what conditions should a half joint be beveled?

The beveling of a half joint will help to resist any tendency to change the angle between the two timbers.

STANDARD A FRAME.

This is the first job in which the student is required to lay out angle cuts. Direct the student to a careful study of Unit Operation No. 19, especially with relation to the use of the steel square in the laying out of the special angle cuts for the feet of the 2 x 4 batter posts.

Check up with each student his computations for the amount of the angle which should be expressed as 2″ in 12″, making certain that he understands the method of using the 12″ on the blade of the square and the 2″ on the tongue of the square to lay out the special angle cut on the 2 x 4. Note that the upper ends of the 2 x 4 are cut square.

After each man has laid out and cut one 2 x 4, have him cut the 1 x 4 braces. Question the student as to why the angle cuts at the ends of these braces are the same as at the feet of the 2 x 4.

Emphasize the proper method of bringing together the various pieces so as to secure accurate results. You should start at the bottom of the frame, nailing on the lower 1 x 4″ cross pieces with the 2 x 4 laid on a horizontal surface and the upper ends of the 2 x 4 posts temporarily tacked in their proper position. After the lower 1 x 4″ cross braces are provisionally nailed, with one nail at each joint, fasten the 1 x 4 chocks in place and then nail on the upper 1 x 4″ cross pieces. It is well to nail or "tack" the frame together temporarily until it is finally and completely fastened. Thus, if it is necessary to remove or change a member it will be easy to pull out the single nail, the head of which is often left projecting about ¼ inch beyond the surface of the piece for ease in extraction.

Direct attention to the necessity of carefully checking up the frame from time to time to be sure that it is being put together with the pieces in their proper relation.

The student will probably take more interest in this job and also in Job No. 6, which is similar, if he understands the purposes for which these frames are constructed. If there are trenches near the school take the class to see the frames and trench boards in position. Remember that the men will be much more interested in building something when they appreciate and understand the purpose for which it is used.

QUESTIONS AND ANSWERS.

1. In what order should the 1 x 4″ crosspieces be fastened to the 2 x 4 sides?

It would be desirable to start with the lower crosspieces and tack them on with a single nail, then fasten on the chocks and finally the upper crosspieces.

2. Why are the 1 x 4″ chocks used?

The 1 x 4″ chocks are used as spacers between the 1 x 4″ cross braces.

3. Why is the strap iron used?

The strap iron is used as a "shoe" or protection for the outside surface of the lower part of the frame.

4. How should the strap iron be fastened to the frame?

The best method of fastening the strap iron to the frame is with screws. However, fastening with screws is slow and expensive and the use of fourpenny nails is satisfactory when speed is required.

SPECIAL A FRAME.

The remarks relating to the construction of the standard **A** frame, Job No. 5, also apply to this job. It may be desirable for the student to compute the angle that the special angle cut makes with the vertical or crosswise dimension of the member, using the diagram of Figure 67, Unit Operation No. 19. This problem furnishes a definite idea of what an angle is and how it is computed and measured.

QUESTIONS AND ANSWERS.

1. How is the angle or bevel cut for the ends of the 1 x 4″ crosspieces determined?

The angle or bevel cut for the ends of the 1 x 4″ crosspieces is the same as for the ends of the 2 x 4″ batter posts, and is determined as follows: Subtract the width of the bottom of the frame, 3′—6″, from the total width of the top of the frame, 4′—6″, which gives 1′ or 12″. Then the run or offset of the 2 x 4″ post is one-half of 12″, or 6″, and the rise or height is 3′ or 36″. Thus the angle is 2″ in 12″. with the 12″ laid out on the blade of the square for the working dimension or rise and the 2″ laid out on the tongue for the horizontal dimension or run.

2. Should the steel square or **T** bevel be used to lay out the bevel cut for the ends of the 1 x 4″ cross pieces?

The simplest and most direct method would be to use the steel square with 12″ on the blade and 2″ on the tongue. However, it would be of value and interest to the student to use the **T** bevel in laying out these bevel cuts.

3. Why use three nails to fasten each joint?

Three nails insure a secure and rigid connection.

PORTABLE ARTILLERY BRIDGE.

This job continues the practice in laying out special angle cuts, especially along the grain of the timber, as in the cutting out of the stringers for the bridge. Note also that the abutting ends of the side rails must be mitered in order to make close-fitting joints.

Although the cutting out and framing of this bridge is work of a rough, heavy nature, direct the student to lay out and make each and every cut with care so as to develop manual skill and dexterity. In work of this nature the student is apt to regard care and accuracy as unnecessary and to slight this side of the work. A higher degree of accuracy in rough work of this character than is required in ordinary practice is justified in order to develop skill on the part of the student.

Discuss how the load is transmitted from flooring to the stringers and thence to the sills at the ends of the bridge. Also bring out the fact that the principal wear comes directly on the flooring or planking which should be of tough, durable wood.

Discuss with the class the factors of strength which determine the size and spacing of stringers, and especially point out the need of making such a structure several times stronger than is necessary to "just carry" the load.

QUESTIONS AND ANSWERS.

1. Why are the stringers tapered?

To decrease the weight of the bridge.

2. Why are sills used?

To distribute the load on the bridge over a larger surface.

3. What is the purpose of the side rails?

To prevent vehicles from sliding or skidding off the bridge.

4. How many nails should be used to fasten the planks at each stringer bearing?

Two nails are generally sufficient for 6″ plank.

5. How should the joint be made between the floor planks at the breaks in slope?

The abutting edges of the floor planks, at the breaks in slope, should be beveled so that the planks will have a fairly tight joint.

LOW BOOKCASE.

Note that there is quite a gap in the character of the work that occurs at this point. The first three jobs deal with work of rather a rough, heavy nature, while the last three take up work of a much higher degree of finish.

In the construction of the low and high bookcases, draw attention to the fact that a rather soft wood—white pine—is used and great care and accuracy must be used in order to secure true, tight joints. Since this material cuts very easily caution the student to set the plane so as to make fine shavings in dressing its surfaces.

Remember that there is always a great temptation to the beginner to cut out his various pieces carelessly and to rely upon "doctoring" the work after it is assembled. Insist upon careful and accurate work upon each and every piece, so that the case will go together with a reasonable degree of accuracy, when it is assembled. Rather than allow a student to patch up a poor or bungled job, direct him to remake the parts of the work necessary to secure the desired results.

Discuss with the class before the work commences the best method of making the tenons at the ends of the shelves. Direct attention to the difficulty of cutting out the wood between the tenons and by questions lead the students to suggest various methods of doing this. Also discuss the best method of grooving out the sides and top of the bookcase to receive the wall board back. Show the various types of planes which can be used for cutting this groove, such as a routing plane and the plow. This job involves the use of the keyhole or compass saw in the making of the curved cuts at the lower end of the side pieces.

QUESTIONS AND ANSWERS.

1. Why are the shelves mortised into the side pieces?

In order to secure a stronger connection between the shelves and the side pieces.

2. Why is the wall board backing grooved into the case?

The wall board backing is grooved into the case in order to make a tighter, closer fitting and better finished connection between the back and the frame of the case.

3. Why are the shelves spaced as shown in the drawing?

The spacing of the shelves is made so as to hold standard size books of different sizes and to provide just enough clearance to permit inserting and removing books.

4. Why does the top board project over the side pieces?

For the sake of appearance and for protection against dirt and water spilled from above.

5. Why should not the case be made 5 feet long instead of 3 feet 6 inches?

The width of the case is determined largely by the length of the shelf which can properly carry the load of books imposed upon it. The length is also governed by the size which would be convenient to handle and to use in the ordinary wall space of a room.

6. Why is the bottom shelf placed above the floor?

The bottom shelf is placed above the floor so that it will be possible to clean out under the shelf without moving the case and to keep the books above the floor dirt.

HIGH BOOKCASE.

The principal difference between this job and the low bookcase is that the shelves are dadoed into the sides. The instructor should point out the importance of even greater accuracy and care in making the dadoed parts than was necessary in making the mortise and tenon joints. There are enough grooves, 14 in number, so that the student should acquire considerable skill or proficiency in making dadoed cuts.

Suggest the desirability of using some form of straight edge to guide his sawing in making the side cuts of the dadoes. Also caution him against carrying the cuts below the proscribed lines. Point out that it is preferable to make the cuts not deep enough rather than too deep. Have the student check up each dado carefully before he completes it and proceeds with the next cut so that the gain in skill can be seen. Point out, however, the advisability of making all the saw cuts before the chiseling is begun.

The beginner will endeavor to saw out the shelves too rapidly and will probably get them of varying lengths. Indicate the possibility of making all, or at least, several of them, from one pattern or templet.

QUESTIONS AND ANSWERS.

1. Why are the shelves dadoed into the side pieces?

The shelves are dadoed into the side pieces in order to secure stronger joints by having the ends of the shelves bear upon the part of the cross-section of the side pieces.

2. What uses do the wall board backing have?

The wall board backing is used to provide a back for the bookcase to hold the books in position and also to keep out the dirt.

TOOL TRAY.

This is the last job for the training of the basic carpenter. It requires even more care and skill in cutting and dressing the material in order to secure a good job than is required in any of the preceding jobs. The joints must be accurately made to produce a satisfactory piece of work. Screws are used for the fastening of joints. Countersunk screw holes should be made for inserting the screws in order that the heads may be flush with the surface of the material and for instruction in this operation. This job offers an excellent opportunity to develop the skill of the student in dressing and finishing the surfaces of the material. Caution the student to use fine sandpaper, No. 0 or 00, and to rub the sandpaper along the grain so as not to mar or scratch the surfaces.

Make sure that each piece is carefully and accurately cut before it is assembled. Do not allow much trimming after the box is put together. Direct attention to the possibility of cutting out two or three pieces at the same time in order to get them of the same dimension. This is especially true of the three cross partitions.

QUESTIONS AND ANSWERS.

1. How is glue prepared for use? What is the difference in use between cold and hot glue?

Ready prepared cold glue can be used for this job. However, it is better to use glue prepared from flakes, which must be melted and heated in a glue pot. The hot glue can be spread thinner, sets quicker and makes a stronger joint than can be secured with the cold glue.

2. How can the top of the screw be made flush with the surface of the wood?

The screw holes should be countersunk with a countersink bit before the screws are inserted.

3. What other types of joints may be used in making the corners of the box?

The corners of the box could be made with rabbeted, dove-tail, or mitered joints.

INSTRUCTOR'S GUIDE FOR CARPENTERS

TRAINING MANUAL No. 12.

GENERAL CARPENTER

INDEX.

	Page.
Foreword	86
Unit Operations:	
24. Leveling and plumbing	87
25. Making wood foundations and forms for concrete foundation	88
26. Laying sills and girders	90
27. Cutting and placing joists and bridging	91
28. Laying rough flooring	92
29. Laying out walls and partitions	93
30. Framing and erecting stud walls, partitions, and joists	94
31. Framing around windows and door openings	95
32. Placing ceiling joists	96
33. Cutting and framing lookouts	97
34. Laying out common rafters	98
35. Laying out hip and valley rafters	99
36. Laying out jack rafters	100
37. Erection roof frames	101
38. Framing dormers	102
39. Erecting scaffolds	103
40. Putting on sheathing	104
41. Waterproofing around exterior openings	105
42. Roof sheathing and stripping	106
43. Flashing	107
44. Putting on siding	108
45. Putting on shingles	109
46. Placing plaster grounds	110
47. Furring	111
48. Placing insulation materials	112
49. Building straight stairways	113
Information Topics:	
6. Foundations	114
7. Main frame	115
8. Roof frame	116
9. Floors	117
10. Wall covering	119
11. Roof covering	121
Jobs:	
11. Double garage	122
12. Lumber shed	124
13. Bridge	126

FOREWORD.

Training Manual No. 12, General Carpenter, teaches the more general construction units in carpentry that at least 2 per cent of the soldiers of the army should have. This course covers ordinary wooden frame building and wood bridge construction from foundations and scaffolding to floors and trusses.

This is the third convenient step in training a master carpenter. The instructor should note that it is not necessary for the student to take up this course directly upon the completion of the basic carpenter course, but that it is often desirable for the student to work at the trade for a while in order to gain more skill in the general use of the tools before starting the construction jobs of this manual. The average student will gain proficiency in the trade in the measure that he has a wide experience, and this can often be secured by encouraging cooperation in the organization commanders in the assigning of students to work for which they have been trained.

Graduates receive a certificate of proficiency as General Carpenter and are eligible for appointment to this rating. Special mention will be made of those students who have attained the grades of "Superior" and "Above average." Graduates with native capacity for estimating and laying out difficult work are eligible to take the course contained in Training Manual No. 13, Master Carpenter.

LEVELING AND PLUMBING.

The purpose of leveling is to place the piece in a level or horizontal position. As the piece may not be true throughout its length, care must be taken to have the main bearing parts horizontal. The same remarks apply to the plumbing. If the bearing or contact points are set in a vertical plane, any irregularities of the surface may be adjusted or removed by fastening or dressing.

Long surfaces should be leveled and plumbed by using a long, straight edge with the level. Fit the straight edge to the surface so that bearing or contact points and the general length will lie in the same horizontal or vertical plane.

The use of the plumb bob to plumb long vertical pieces requires good judgment. Use center line marks on the face of the piece as a guide. The student's judgment, or guess as to the location of the center of a side should not be allowed. Call attention to the error of attempting to plumb a post by testing one corner. A careful observer may get good results by this method by sighting along the plumb line toward and parallel to the corner, but the student should be instructed to use the method described and only use the corner method as a check.

QUESTIONS AND ANSWERS.

1. Why is it necessary to test two adjoining sides of a post when plumbing?

Each side plumbs in one direction only.

2. Why should a level be held parallel with an edge of a timber or board to be leveled?

So that the timber will be accurately plumbed or leveled.

3. How should a spirit level be tested to find whether it is true?

Place the level on a trued surface of a board and move the board until the bubble is centered. Reverse the level; and if the tool is in adjustment, the bubble should again be in the center of the tube. If not, the bubble tube should be adjusted by moving the bubble halfway back to the center.

MAKING WOOD FOUNDATIONS, AND FORMS FOR CONCRETE FOUNDATION.

Pile footings:

Describe to the class the different methods of pile driving; by hand with a heavy maul or sledge, and by machine with a drop hammer or steam hammer. A simple, self-contained type of drop hammer is often used and consists of a pair of leads or guides about 15 feet long arranged to be bolted to the top of the pile. The leads are suspended from an **A** frame or derrick. A drop hammer runs in the leads and is operated by a hand or steam winch.

Discuss the selection of piles, to secure sound, reasonably straight timber which is free from large or decayed knots and large projections. Describe the preparation of piles for driving. The bark should be removed, although in emergency work piles may be driven with the bark on.

The marking of the posts preparatory to cutting off their tops for the sills furnishes a good job in leveling, using a long straight edge with the carpenter's level.

Wood post footings:

Discuss the importance of having the bottom of the pits accurately leveled off to the proper grade. If any back fill is necessary, the earth should be well tamped to prevent subsequent settlement.

Wall forms for concrete foundations:

Discuss the scheme of making up forms in sections or panels which can be reused several times in building the wall by making the form panels sufficiently strong and rigid to stand repeated usage and also as light as practicable for ease of handling.

Describe the function of the form as a wall to hold the liquid concrete in place until it sets and the strength required to take the pressure of the concrete, which as a liquid varies with the depth. Between the vertical cleats on a wall form, the boarding or sheathing acts as a restrained beam and the spacing of the cleats depends on the thickness of the boarding or sheathing and pressure of the fluid concrete. The form panels must be braced sufficiently not only to prevent their breaking down but also their bending under pressure.

As there is a large duplication of pieces in form panel work, provision should be made for the cutting of pieces in multiple, using a power saw when available.

QUESTIONS AND ANSWERS.

1. Why is it necessary to brace wall forms thoroughly at the top and bottom?

To hold the forms in place under the pressure of the wet concrete.

2. Why is it desirable to use tongued and grooved boarding with tight joints for formwork?

To give a smooth surface to the concrete and to prevent leakage of the wet concrete.

3. How would the spacing of the cleats on wall and post forms vary with the height of the forms?

The spacing of the cleats would be the closest at the bottom where the pressure is the greatest and decrease toward the top.

4. Why should the nails holding the form sections together not be driven clear in?

So that they can be pulled out easily without damaging the sections.

5. What is the purpose of the double-headed form nail?

For the easy removal of the nails holding adjacent form sections together.

6. What is the advantage of having the mills furnish lumber of standard width, such as 4¾″, 5¾″, 6¾″, 7¾″, etc., for beam and girder sides and bottoms?

Knowing that from lumber of dressed stock will be furnished in such standard widths, the beam and girders will be so designed as to utilize these sizes with the minimum amount of cutting in the field, and thereby keep construction costs down.

7. What other form of cleats or yokes could be used to hold the sides of post forms together?

Instead of using bolts or rods with the yokes, clamps similar to those used by the carpenter may be used to hold the sides together. Wedges are commonly used to secure greater tightness of the form sections.

8. What kind of lumber is best suited for concrete forms? Should lumber be dry or relatively green?

Lumber that is durable and strong and easily worked should be used. Lumber should be relatively green or only partly seasoned so that it will not expand too much when filled with concrete.

LAYING SILLS AND GIRDERS.

Discuss with the class the importance of properly splicing adjacent sections of a sill or girder, especially where the sections meet at an angle. Emphasize the frequent use of the steel square in squaring up the sill with the foundation and adjacent pieces at the corners.

Discuss the special adaptability of the box sill for ordinary building construction, especially where the balloon frame is used. Explain why clear, straight material should be selected and thoroughly spiked together.

Direct attention to the importance of splicing timbers away from the corners and other important connections such as breaks in the wall lines and girder junctions. Two adjacent timbers should not be spliced at the same place.

QUESTIONS AND ANSWERS.

1. Why should a box sill never be spliced less than three joists from the corner?

To secure maximum strength. Splices near corners introduce an element of weakness.

2. Why is it better to locate the bolt hole centers by measuring across from the bolts on the sill rather than to transfer measured distances from foundation to sill?

Direct transfer of measurements are more accurate, since there is opportunity for error in laying out distance on the sill from measurements.

3. What provision is made in the reconstruction of the sill for keeping mice and vermin out of the house?

The rough flooring is carried across the top of the sill.

4. What provision is made in the construction of the sill for preventing the spread of fire?

The flooring is carried over the sill, and makes a tight joint with the wall boarding, thus preventing a draft or flue action.

5. How should sills be framed at the corners?

Solid sills should be spliced with half-lapped joints, while box sills should be lapped and solidly nailed.

6. Which is the better type of sill, solid or boxed?

The solid type of sill is the stronger and better for heavy framework, while the box sill is the better adapted to light, balloon type of framing.

7. Why are bolt holes made one-eighth inch larger than the diameter of the bolts?

To allow for irregularities in setting the bolt and in the bolt itself.

CUTTING AND PLACING JOISTS AND BRIDGING.

Discuss the importance of selecting straight, clear timber, free from cracks, splits, and large knots for joists. Timbers that are warped, cracked, split, checked, or with large knots should never be used for load-carrying members such as joists and girders. If the timbers have a crowning edge, the measuring and cutting should be done with a view to placing this edge up in the floor.

Describe the function of the ledger F, Figure 101, in supporting the ends of the joists. The joists could have been notched into the sides of the girder in order to secure suitable bearing. Call attention to the possible use of the iron stirrup for the support of the ends of the header beam B, Figure 101. All abutting end connections should be strongly spiked with at least two spikes where there is lower support, such as the sill section of a box sill, and three spikes where there is no lower support.

Caution against nailing the lower ends of the cross bridging before the lower or rough flooring is laid. The latter must be laid first in order to secure a reasonably level floor surface.

QUESTIONS AND ANSWERS.

1. Why is it necessary to frame around a chimney so that no wood will come into contact with it?

To prevent the heat from the flue setting fire to the timber.

2. Why are headers and trimmers made in pairs?

To secure greater supporting strength to carry the weight of the floor about the opening.

3. Why is bridging nailed at its upper ends before flooring is laid?

It would be very difficult to nail the upper ends of the cross braces after the flooring is laid.

4. Why are joists generally laid the shortest way between supporting walls?

To secure greater strength and rigidity in the floor construction. The cross-section of a beam varies directly with the clear span.

5. Is the bearing strip "F" on the girder necessary?

The bearing strip is not necessary, but is desirable as a support or bearing for the ends of the joists.

6. Should all joists be notched? How will the notching affect the ceiling?

Joists should be notched only when necessary to bring their top edges in the same plane. Should there be a variation in the depth of the joists greater than one-eighth inch, strips should be nailed to their lower edges to bring them into the same plane.

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LAYING ROUGH FLOORING.

Discuss the importance of selecting stock for rough flooring that is well seasoned and free from large knots, checks, and splits. Since flooring is subject to a moving load while wall coverings are not, use as long boards as possible and do not make joints near the side of a room. In fitting the flooring around wall studding, mark the length of a board by placing it in position with the cut end against the wall plate.

QUESTIONS AND ANSWERS.

1. Why should joints of rough flooring always be at the center line of joists?

To give equal bearing to the ends of the adjacent boards.

2. Should the floor be nailed at every joist?

The floor should be nailed at every joist for strength and stiffness.

3. How should the material for rough flooring be milled?

Floor boarding is generally milled by sawing the edges parallel and dressing the sides parallel.

LAYING OUT WALLS AND PARTITIONS.

Point out the importance of using over-all dimensions when laying out the studs for the sides of door and window openings and of measuring from the same starting point, which is usually the outside edge of the plate. Have the student lay out several distances by the over-all and the separate measurement methods, to bring out the greater inaccuracy of the latter method through accumulative errors.

Where there are several parallel walls or partitions in a building, the stud spacing may be laid out on a pole or templet and then transferred to the sills or plates after the latter are placed in position. Another method of accomplishing the same purpose would be to place the sills side by side and lay out the stud spacing on all the sills simultaneously.

QUESTIONS AND ANSWERS.

1. Why is it necessary to locate the position of the studs?

The plans or specifications of a building give the stud spacing and location of all openings. Hence it is necessary to locate the position of each stud to comply with the requirements.

2. How should the stud spacing be kept uniform in walls and partitions having door and window openings? Why is it necessary to keep the stud spacing uniform?

The stud spacing should be made uniform so as to tie in with the floor construction and provide regular bearings for nailing on laths. One side stud of a door or window opening should be carried through where practicable, but if the width of the clear opening is less than the regular spacing of two or more studs, a header (double timbers) can be fastened between the studs adjacent to the boundaries of the opening and side studs set at the proper location and fastened to the floor plate and header. Note that the stud spacing in outside walls is made without regard to the location of openings, which are determined independently and often made after the walls are erected.

FRAMING AND ERECTING STUD WALLS, PARTITIONS, AND JOISTS.

In the balloon frame, which is the type of frame used in ordinary building construction, the outside wall studs are run through from sill to plate and should be made of single timbers if practicable. When necessary to use two pieces, splice at least 3 feet above second floor with fishplate joint. The final lining up of the wall is done by the setting of the floor joists.

When an interior partition intersects a wall or one partition butts against another, the end of the intersection should be made solid, generally U-shaped, with the bottom of the U forming the end of the intersecting partition.

QUESTIONS AND ANSWERS.

1. Why are double studs used at the door and window openings?

To give greater strength and rigidity to the sides of the openings.

2. In a two-story house, should the outside wall studs extend the full height of the house?

The outside wall studs should extend the full height of the house for greater strength and to reduce shrinkage.

3. What form of corner posts should be used?

Corner posts should be of such form as to give greatest strength and rigidity in all directions. In a simple frame building, of the balloon type, corner posts are built up, the U form being an excellent type in general use.

FRAMING AROUND WINDOW AND DOOR OPENINGS.

Call attention to the regular spacing of exterior wall studs regardless of location of openings. Emphasize the need of cutting off the ends of the studs horizontally so that the stool and header may have proper bearing. Care should be taken in the cutting of the headers and stools to get a snug fit against the studs.

Illustrate and explain to the class, the ordinary method of trussing the head of a wide opening. The diagonal members serve as braces to carry the wall load to the sides of the opening. In openings 3 feet to 4 feet in width, it is often customary to use two 2 x 4's set on edge as the header of an opening.

QUESTIONS AND ANSWERS.

1. Why is the header at a, Figure 110, set into the side pieces?

The header is set into the side pieces to secure increased bearing and greater strength.

2. Why are the braces b, in Figure 110, carried through from stool to header?

To transmit the load from the window above to the sides of the opening below.

3. Why are the heads of door and window openings over 4 feet in width trussed?

To transmit the wall load from above to the sides of the opening below.

AND FRAMING LOOKOUTS.

...iss the advantages and disadvantages of the ...tion shown in Figure 114. In the type shown ...boarding is generally carried up only to the ...ts, while in the type shown in the figure at the ...s carried up to the under side of the rafters. ...ves a tighter construction at the eaves, and also ...of the lookouts without regard to the placing ... It is evident that in the construction shown ... must be placed directly over or at one side of

...jection is 18″ or over the gable lookouts should ... the outer edge of the second rafter as shown in

QUESTIONS AND ANSWERS.

...ditions of construction would the lookouts be ...Figure 114a?

... are over or nearly over the studs.

...essary at the ends of the lookouts as shown in

...he lookouts may be toenailed directly to the wall

...ookouts in the gable different from those on the

...kes it necessary to use different types of lookout ...gable lookouts often form an ornamental feature ...sides are always covered.

...rpose of the lookout in its various locations?

... of cornice the lookout forms a support for the ...gable the lookouts support the ends of the roof

PLACING CEILING JOISTS.

Discuss with the class the particular uses and advantages of the two types of eaves construction shown in Figures 113a and 113b, especially with relation to the framing of the ceiling joists. In Figure 113a, the rafters are continued beyond the plate to form the eaves, and the ceiling joists are nailed to the sides of the rafters and toenailed to the top of the plate. In Figure 113b, the ceiling joists are cantilevered over the plate and cut out for the gutter. As the rafters come down on top of the ceiling joists, the upper plate A is used and a line of bridging is placed at the face of the studding to tie the plates together and stiffen the framing in the plane of the ceiling joists.

In the construction shown in Figure 113b it is important that the ceiling joists be of the same depth in order that the tops of the lookouts be in the same horizontal plane as well as the lower edges of the ceiling.

QUESTIONS AND ANSWERS.

1. Why should the lower edges of ceiling joists be kept even?

In order to make the ceiling a flat surface.

2. How can they be evened up when necessary?

By nailing strips such as lath to their lower edges or by nailing boards to their sides.

3. What is the purpose of solid bridging above the plate?

To tie the upper and lower plates together and to stiffen the framing at the eaves.

4. What is the purpose of the upper plate shown at A, Figure 113b?

To serve as a bearing for the rafter.

CUTTING AND FRAMING LOOKOUTS.

Discuss with the class the advantages and disadvantages of the two types of construction shown in Figure 114. In the type shown at the left, the wall boarding is generally carried up only to the bottom of the lookouts, while in the type shown in the figure at the right, the boarding is carried up to the under side of the rafters. The latter method gives a tighter construction at the eaves, and also permits the placing of the lookouts without regard to the placing of studs and rafters. It is evident that in the construction shown at the left the rafters must be placed directly over or at one side of the studs.

Where the gable projection is 18″ or over the gable lookouts should be extended back to the outer edge of the second rafter as shown in Figure 116.

QUESTIONS AND ANSWERS.

1. Under what conditions of construction would the lookouts be framed as shown in Figure 114a?

Where the rafters are over or nearly over the studs.

2. Are cleats necessary at the ends of the lookouts as shown in Figure 114b?

No; the ends of the lookouts may be toenailed directly to the wall boarding.

3. Why are the lookouts in the gable different from those on the sides of the roof?

The framing makes it necessary to use different types of lookout construction. The gable lookouts often form an ornamental feature while those on the sides are always covered.

4. What is the purpose of the lookout in its various locations?

In the box type of cornice the lookout forms a support for the plancier. In the gable the lookouts support the ends of the roof strips or boarding.

LAYING OUT COMMON RAFTERS.

Point out the value of the use of a fence on the steel square in measuring along the edge of a rafter and in marking the cuts. Be sure that the meaning of the terms "run" and "rise," and "rise per foot of run" are understood. This is best tested by giving simple problems such as a roof with a span of 24′ and a rise of 6′, giving a pitch of one-quarter, run of 12′ and rise per foot of run of 6″. Have the students lay out roofs of various pitches on paper and lay out the cuts.

It is important to teach the student to check his work, and the best check is, of course, that made by different methods. It will therefore be advisable to have the student make two rafters independently and then compare them.

QUESTIONS AND ANSWERS.

1. Why use the unit rule of 12″ of run in the laying out of rafters?

The unit rule of 12″ of run is used as the simplest unit that can be laid off on the blade of the square and used for measuring the length of the rafter.

2. What would be the figures on the blade and the tongue of the square if the run of the rafter was 8′ and the total rise 6′—6½″?

12″ on blade, 9 13/16″ on the tongue.

3. What is meant by full pitch, one-half pitch, and one-third pitch?

As the pitch is the ratio of the rise to the span, a full pitch would mean a rise equal to the span, a half pitch would mean a rise equal to one-half the span or the run, and a third pitch would be a rise equal to one-third of the span or two-thirds of the run.

4. What is the purpose of the ridge board? Is it necessary to use it?

The ridge board is of special use in erecting the roof to hold the ends of the common rafters in place during erection. It also serves to stiffen the roof frame. It is not necessary to use it.

5. Why should the rafter be placed with the convex edge up?

The convex edge should be placed up, so that the rafter will become approximately straight as it sags.

LAYING OUT HIP AND VALLEY RAFTERS FOR SQUARE-CORNERED BUILDING WITH ROOFS OF EQUAL PITCH.

The chief point to be emphasized is that the plumb cut is parallel to the rise of the roof.

QUESTIONS AND ANSWERS.

1. Why is 17 inches on the square used per foot of run in laying out hip or valley rafters?

Seventeen inches is the diagonal of a 12-inch square, and therefore is the unit of run for the hip or valley rafter and corresponds to the 12″ of run for the common rafter.

2. What is meant by backing the hip? Dropping the hip?

Backing the hip is setting it toward the interior of the house in order to bring the roof boards into line without chamfering the corners of the top edge of the hip rafter. Dropping the hip is lowering it for the same purpose.

3. Why is it unnecessary to drop or back the valley rafter?

Because the center line of the top edge of the timber is in the plane of the roof.

4. Which is the more practical method, to back or drop a hip rafter?

Dropping is generally used on account of its simplicity.

5. What would be the run of a hip rafter in a roof of one-fourth pitch on a building 28 feet wide with an overhang of 18″?

19.8 feet or 19′—10″.

LAYING OUT JACK RAFTERS FOR SQUARE-CORNERED BUILDING WITH HIP ROOF OF EQUAL PITCH.

A jack rafter has the same seat cut and eaves projection as a common rafter. The new feature is the cheek cut and the shorter length. Hence the lower end of the jack rafter may be cut using the lower end of a common rafter as a templet or pattern.

It should be noted that jack rafters are cut in pairs.

QUESTIONS AND ANSWERS.

1. Why is the length of the run of a jack rafter equal to the distance from the wall line to the center of the jack measured at right angles to the run of the rafter?

Because on a square-cornered roof of equal pitch the length of the run and the right-angle distance to the adjacent wall form the adjacent lines of a square, and are therefore equal.

2. What would be the run of the fourth jack if spacing was 24″ on centers, overhang of roof being 15″?

The run of the fourth jack would be equal to its right-angle distance from the adjacent wall line, or three times 24″ plus 1″, or 73″. The first jack rafter is a short one placed at the wall line.

3. Why is the run of the cripple jack rafter the same as the distance between the centers of hip and valley rafters?

The run of the cripple jack rafter is the same as the horizontal distance between the centers of hip and valley rafters, measured along the cripple, as this is the horizontal projection of the cripple.

4. Would the method of getting length of jack rafters in a roof of equal pitch be the same in one of unequal pitch? Why?

No, it would not be the same because the length of the jack would not be the right angle distance from the adjacent side.

5. How would you get the angle of the cheek cut of a jack rafter by the steel square method? Show by sketch the figures used on the square and position on the rafter of a one-third pitch roof.

Lay the framing square across the top edge of the rafter taking 17″ on the tongue and length of hip or valley rafter per foot of run of common rafter for the pitch required on the blade, and scribe along the blade.

For the sketch lay the square across the top edge of rafter taking 117″ on the tongue and 18 and 13/16″ on the blade.

On 1/3 pitch roof the rise per foot of common rafter =8″ hence the length of hip rafter per foot of common rafter equals $\sqrt{17^2+8^2}=$ 18 and 13/16″.

6. On a hip roof with open cornice how would the rafters be spaced?

As nearly uniform as possible.

ERECTING ROOF FRAMES.

Discuss with the class all the possible methods of erecting a roof frame such as erecting a pair of common rafters at or near each end of the building nailing them securely at the plates, but only temporarily tacking them together at the ridge. Then erect the ridge board in place, brace it in two directions to the ceiling joists, and fill in the other rafters. Another method would be to erect the ridge board on a light framework and then place the rafters in pairs preferably working from the two ends to the middle.

QUESTIONS AND ANSWERS.

1. The ends of valley jacks must be placed so that the upper edge of the cheek cut at the valley rafter is some amount above it. How much? How would you find it other than by trial?

The amount of projection depends upon the pitch of the roof, and is made enough to make the projection of the jack rafter strike the middle of the valley.

To find it lay off one-half of the width of the valley rafter and at right angles a vertical line. From the end of the first line draw a diagonal parallel to the slope of the roof. The length of the vertical thus cut off will give the distance the jack should project above the valley rafter.

2. Why is it necessary to locate on either the hip or valley rafter the positions of the cripple jacks?

The cripple jacks are all of the same length and their position must be noted before nailing in place.

3. How is the length of the ridge board found?

The length of the ridge board of a plain gable roof is equal to the length of the house plus the two gable projections. For a hip roof the ridge would be equal to the length of the house less the distances from the outside of the end plates to the inside of the intersection of the pairs of hip rafters.

4. Find the length of the ridge board of a square-cornered building, 24′ x 32′ hip roof of equal pitch. Ridge board to be 1″ thick and hip rafters to be 2″ thick.

Subtract from the length of the house (32′) the width (24′) and add 3″, making 8′—3″ the length of the ridge board.

FRAMING DORMERS.

Dormer framing should be done primarily without weakening the roof frame. The point to be emphasized is the necessity for reinforcing the timbers supporting the dormer and at the same time retaining the rigidity of the main roof frame. Note that the framing of a dormer is the simple application of the principles presented in preceding instruction units on roof framing.

QUESTIONS AND ANSWERS.

1. Why are the upper headers and corner posts of dormers made up of two pieces?

To furnish greater strength and rigidity to the roof construction.

2. Should the spacing of the studs of a dormer be the same as for the walls?

It is not necessary except for convenience in lathing.

ERECTING SCAFFOLDS.

The important point in teaching the erection of scaffolds is the necessity of building a framework out of available material with the idea of the reuse of the material, also the necessity of rapid construction, of great rigidity, but only temporary and easily taken down. Use sufficient nails at each fastening, but leave the heads projecting for easy and rapid removal. Scaffold brackets are especially adapted to light construction at high elevations. Planks should be tacked to the crosspieces to prevent their sliding out of place.

QUESTIONS AND ANSWERS.

1. What is the purpose of the cross bracing?

To stiffen the structure and hold the posts in position.

2. How many nails should be used at the ends of the horizontal pieces?

At least three 10d. nails.

3. How many nails should be used to connect the horizontal 1 x 6's to the posts?

Not less than three 10d. nails.

4. Why are the blocks used at the ends of the horizontal pieces?

The blocks make a stronger connection between the ends of the pieces and the wall boarding and are easily removed.

PUTTING ON SHEATHING.

Discuss the quality and the various kinds and types of boards which may be used for wall and roof sheathing. In the better class of work, shiplap is preferable on account of the possibility of securing tighter joints than with plain boarding.

QUESTIONS AND ANSWERS.

1. Why should joints of sheathing be along the center line of studs?

In order to properly fasten the boards and to give each board an equal bearing on the stud.

2. Which is the better way to lay sheathing, diagonal or at right angles to the studs?

Diagonal sheathing is preferable in frame buildings where the frame is not well braced, but in ordinary construction where the frame is well braced at the corners horizontal sheathing is suitable and less expensive.

3. Should the sheathing be nailed at every joist?

Yes; to prevent the springing out of the sheathing in case of warping, shrinking, or settlement of the building.

4. What is the minimum number of nails that should be used at the ends of sheathing boards?

Not less than three nails should be used at each end of the board.

WATERPROOFING AROUND EXTERIOR OPENINGS.

Discuss with the class the importance of insulation around openings and the importance of applying such insulation carefully and thoroughly. Indicate the necessity for having the insulation continuous and of such character and material that it will serve as a diaphragm between the wall boarding and the frames to prevent the passage of wind and rain. The strips of insulation material should be cut, not torn, from the original rolls and have the widths and lengths greater rather than less than the required dimensions.

QUESTIONS AND ANSWERS.

1. Why are the top and bottom strips made to extend beyond the edges of the opening?

So as to lap by the side strips.

2. Why are the side strips folded back along the edges of the opening?

To form a thicker layer or cushion to better prevent the passage of wind and rain.

ROOF SHEATHING AND STRIPPING.

Roof sheathing is generally laid parallel to the edges of the roof and should be made with even tighter joints than required for the wall sheathing.

QUESTIONS AND ANSWERS.

1. Under what conditions should roof sheathing be used solid and as stripping?

Roof sheathing should be used solid when roofing material such as tar and felt, Barrett specification, or similar sheet material is used. Stripping can be used when various forms of shingles or tile are used as the roofing material.

2. Why not lay roof sheathing diagonal to the rafters?

The additional expense of laying roof sheathing diagonal would not justify its use in this manner.

FLASHING.

Discuss with the class the use and purpose of flashing the tops of openings, and especially roof intersections. Show the importance of using a thin sheet material which is easily bent or shaped and fastened in place. Discuss the relative durability of different materials such as sheet iron, tin, zinc, lead, and copper and why one should be used having a life equal to that of the roofing material. Block tin is reasonable in price and durable. Copper is more durable and more expensive and is therefore used on the more expensive work, especially where appearance is an important factor.

Emphasize the importance of imbedding in the joints of brick walls the upper edges of the flashing. These joints should be pointed up after the flashing is placed, in order to hold it securely.

QUESTIONS AND ANSWERS.

1. Why is the flashing at B, Figure 134X, turned into the joint of the masonry?

So that the vertical part of the flashing will be held in place against the wall of the masonry, and especially to prevent the rain and snow from running down along the masonry into the roofing.

2. Why is metal generally used for flashing?

Because of durability and permanency.

3. What are the forms of flashing shown on Figure 134 called and what purpose do they serve?

The flashing shown at X and Y, Figure 134, indicates simple flashing used on the upper and lower sides of a chimney while the flashing at Z, Figure 134, is called counterflashing, and is desirable in order to furnish more effectual weatherproofing of the intersection.

107851—23——8

PUTTING ON SIDING.

Discuss the importance of applying the siding uniformly and with special relation to the securing of properly distributed spacing between the bottoms and tops of openings. It should be selected to secure clean, uniform material, free from splits, cracks, and knots and milled to a uniform section and straight, especially along the thicker or exposed edge.

Be sure that each student understands the twofold purpose of the preacher, the guide for the uniform spacing of the siding and a marking strip for scribing end cuts. Emphasize the importance of making square cuts and tight joints between adjacent pieces of siding in order to secure smooth and uniform wall surfaces.

All joints should be tightly nailed with one of the nails near the lower edge of each board in order to prevent the springing up of the board due to shrinking and warping.

QUESTIONS AND ANSWERS.

1. Why should beveled siding line up either with the top or bottom of window sills?

For appearance.

2. Is there any advantage in using beveled siding?

Beveled siding generally gives a tighter wall surface than can be obtained with the use of drop or novelty siding.

PUTTING ON SHINGLES.

Note that all flashing and roof or wall insulation material must be applied before the laying of shingles is begun. The butts of shingles should be laid carefully along straight lines for the sake of appearance and all joints broken in order to make a tight weather-proof roof. Very wide shingles should not be used, as it is difficult to fasten and hold them in place and also to provide for the proper breaking of joints.

Caution against the laying of shingles with tight joints, especially if the stock is dry, since provision must be made for expansion due to swelling when wet. Emphasize the importance of having all nails covered in order that their heads may not rust and pull through the shingle in weathering.

QUESTIONS AND ANSWERS.

1. Why should shingles be laid to break joints?

To make a water-tight roof.

2. Why is it more efficient to lay three courses of shingles at a time?

Experience proves that a workman can lay three courses of shingles at a time, thus saving the time and effort of moving across the roof for each course. When more than three courses are laid this advantage disappears since the workman must then move up and down.

3. Why should no nailheads show on the surface of the roof?

Exposed nailheads will rapidly rust out.

PLACING PLASTER GROUNDS.

Although the placing of plaster grounds is a comparatively simple and rough class of work, considerable care should be used in placing them parallel to the sides of openings and in such position that they will be properly covered by the casings and provide sufficient space for fastening the ends of the laths on the studs. The same thickness of stock should be used throughout, especially around openings where the close and uniform fitting of the casing is very important.

QUESTIONS AND ANSWERS.

1. How is the door jamb placed when the type of grounds described in paragraph 5 is used?

The door jamb is placed flush with the outside surface of the grounds and thus furnishes two bearing surfaces for the trim or casing.

2. Why use two grounds at the bottom of the walls?

The use of two grounds at the bottom of the walls furnishes two bearing surfaces for the nailing on of the baseboards and does away with the necessity of carrying down the plaster to the bottom of the studs.

3. What other method of providing for grounds could be used at the base of a room?

Instead of using two lines of grounds at the base of a room one line of horizontal grounds could be used and placed about half an inch below the top of the baseboard and then vertical strips nailed on the studs below this ground.

FURRING.

Discuss the necessity of plates to which the furring studs may be fastened at their tops. These plates are generally made of single 2 x 4s and nailed to the lower edges of a floor or ceiling joint. The furring studs are generally placed after the rough flooring has been laid and are toenailed at their bottoms to the floor.

QUESTIONS AND ANSWERS.

1. Why are the furring strips or studs set flat or with their faces parallel to the masonry surfaces?

To reduce the space necessary for the thickness of the wall.

2. Why not nail the furring strips directly to the masonry wall?

It is not only difficult to drive nails into mortar joints but they seldom hold well after being driven.

3. Why are the furring strips placed at least 1 inch from the surface of chimneys?

To prevent fires.

4. What is the purpose of furring? Why not plaster directly on the masonry wall?

Furring is used to provide a suitable air space between the inside surface of the masonry wall and the plaster wall. Plaster applied directly to a masonry wall will generally deteriorate by the passage of moisture through the wall into the plaster and also through lack of proper allowance for shrinkage.

PLACING INSULATION MATERIAL.

Discuss the importance of placing insulation material so as to furnish a continuous and impervious membrane between the boarding and the outer or finished material by properly lapping adjacent layers and breaking joints.

Point out the benefit of using wood strips between the insulation and the outside finish, not only as an aid to the application of the outside finish, but also in the furnishing of a dead-air space which increases the insulating quality of the construction.

QUESTIONS AND ANSWERS.

1. Why are strips necessary where felt or quilt is used?

To secure uniform and even nailing surface for the outer finish and to prevent wrinkling and tearing.

2. Why is an insulation material used on walls, roof, and between floors?

To prevent the passage of wind, sound, moisture, and vermin.

3. What are the best kinds of insulation to provide for the following: fireproofing, waterproofing, vermin and rat repellent, and soundproofing?

An asbestos material is the best insulation against fire; tar or asphalt composition material furnishes the best waterproofing; and also is excellent in keeping out vermin and mice. Cork, felt, or quilt, made of seaweed, are excellent for soundproofing.

BUILDING STRAIGHT STAIRWAYS.

Discuss the importance of adapting the stairways to their use. Cite a number of cases from the wide easy stairs of public buildings to the narrow, steep, basement stairs.

In laying out the stair carriage, make suitable allowances for the thickness of tread and riser. This is especially important where a pitch board is used.

Note that after one carriage has been cut, this may be utilized as a templet for the marking of the other carriages for the stairway.

On all but very rough work the risers should be rabbeted into the treads in order to secure tight joints. Caution the student to make suitable allowance for these rabbeted edges in cutting the risers.

QUESTIONS AND ANSWERS.

1. Why will there be one more riser than tread in a stair?

The last tread will be the upper floor.

2. How should provision be made for drainage of treads of porch steps?

The treads of porch steps should either be made in strips with spaces between, solid boards with occasional circular holes, or solid boards sloped to the front of the steps.

FOUNDATIONS.

Supplement the information given by discussing the importance of carrying foundations to proper depth and especially below the influence of frost action. Point out the heaving action of frost and the softening action of water on clay soil.

Explain the methods of checking the lines of a square-cornered building, especially by means of measuring the diagonals. Batter boards must be firm, so that wall lines and reference points will maintain their accurate location.

In the construction of the forms for concrete walls the method of placing the concrete should be known so that the number of sets of panels may be determined before construction begins. Generally two sets are necessary, and usually three sets are advisable in order that one set may be moved while the other two sets are in use. Concrete walls are generally poured in alternate sections, unless the job is sufficiently small so that a side wall may be poured at one time.

QUESTIONS AND ANSWERS.

1. If it is necessary to locate a house near the foot of a hill, what provision should be made to secure a dry cellar?

Provision should be made for the interception of surface and subsurface water on the uphill side of the house. This can be done by surface and subsurface drains placed above the house.

2. In order to secure uniform settlement of a building, how should the footing course be designed?

So that each square foot will support the same load.

3. Why should the outside, rather than the inside, of a foundation wall be waterproofed?

So that the foundation wall will resist the pressure of the water against the waterproofing.

4. Where should the waterproofing be placed when the bituminous-shield method is used?

The bituminous shield should always be placed in the wall and near its outside surface.

5. How does the subsoil water get into a tile drain?

The subsoil water enters the bottom of the joints of the tile drain.

6. What methods should be used in placing concrete to secure dense walls?

Concrete should be made fairly dry and thoroughly tamped and spaded in the forms.

7. How can an even and smooth outside wall surface be secured?

By thoroughly spading the concrete adjacent to the forms.

MAIN FRAME.

The class should be taken on an inspection trip through various types of wooden frame buildings in the camp or post and the important parts of the frame, such as the sill, the plate, studs, joists, braces, bridging, girders, etc., pointed out. If there are various types of buildings available, especially older buildings with a full or combination frame and the temporary or cantonment type with balloon frame, note the difference in the methods of framing the timbers together, the various classes of stock used, methods of bracing, etc.

Discuss the importance of placing timbers in such a position as to utilize their greatest strength, especially where they are used as beams in floors and roofs. Also point out the advantage of built-up U or box sections to secure strength in taking direct loads as in the case of posts and columns.

Discuss with the class the relative practical and economical advantage of using built-up sections rather than solid timbers, especially in trusses and frames where the joints and splices are an important feature of the work. Show how built-up sections may be spliced and lapped in trusswork and strong joints secured by the use of bolts.

QUESTIONS AND ANSWERS.

1. Why is the balloon frame the most economical type of construction for buildings?

It is made up of stock easily secured in the open market and readily erected.

2. Why is the shrinkage less in a balloon frame than in a full or braced frame type of construction?

As the studding in a balloon frame is continuous, the shrinkage will be less than in a full or braced frame, where the studding is broken at the story levels.

3. To what extent should a balloon-framed house be braced?

A balloon-framed house should be well braced at the corners between the corner posts and sills and plates at the top and bottom of the house and also at the floor levels.

4. Why are the crowning edges of joists placed up?

To allow for deflection of the floor.

5. What is the purpose of bridging?

Bridging is used to tie the joists together and to increase the carrying capacity of the floor.

6. Why is it necessary to spread the floor joists under a partition to provide a space between them?

To provide proper space for pipes, conduits, and stacks.

ROOF FRAME.

While on the inspection trip recommended under Main Frame point out to the students the fact that the simple structural element of a truss or roof frame is in the shape of a triangle which can not change its shape without changing the length of one or more of its sides. If a four-sided figure is used, such as a square, rectangle, or parallelogram, it will be necessary to connect opposite corners with diagonals (thus converting the original figure into two triangular shaped figures) in order to secure stability. The simplest form of a roof frame is triangular, consisting of the two rafters resting upon the side walls and connected at the base with some form of tie, which very often in a building is the line of top story ceiling joists.

Discuss the various parts of a roof such as the common rafter, hip rafter, valley rafter, jack rafter, cripple jack, ridge board, roof boarding, etc.; and the common terms used in roof design and construction, rise, run, pitch, slope, overhang, etc. Pitch is always based on the total span of the roof, and slope on the run or half the span.

Roof framing is one of the most difficult operations in carpentry, and the making of the plumb, side, and seat cuts involves considerable study and reasoning. Demonstrate these on full size models.

QUESTIONS AND ANSWERS.

1. What advantage has the gambrel roof over the ordinary gable roof?

The gambrel roof provides more room space than the gable roof.

2. What is the purpose of the ridge piece?

The ridge piece is used simply as a bearing or abutting surface for the upper ends of the common rafters.

3. Why is it necessary to strengthen roof frames having spans of 30 feet and over with collar beams and braces?

Roof frames with spans of 30 feet and over must be braced with collar beams and diagonal braces in order to reduce the clear span of the rafters.

4. In a balloon frame should the ceiling joists and rafters frame together on top of the wall plates?

Yes; in order that a direct transference of the load from the roof to the side walls may be insured.

FLOORS.

The laying of rough or under flooring requires care in the laying of the boards with fairly tight joints. To this end ship-lap is preferred over ordinary boarding. Before lower flooring is laid, the student should go over the tops of the joists to insure their freedom from projections and to provide for proper bearing for the floor boards. In cases where the tops of the joists are cut, split, broken or otherwise defective, the student should be shown how to spike a 2 x 6″ board along the side so as to furnish the proper bearing surface.

The laying of the upper floor requires a great deal more care, skill, and thought than the laying of the lower floor. If the lower floor is laid diagonally, the upper floor may be laid in either direction, but it is generally customary to lay the boards parallel to the longer side of the room. In no case should the upper floor be laid parallel with the lower floor. Use as long boards as possible so as to reduce the number of transverse or end joints. Always nail each board near the end in order to prevent its springing up as a result of usage. Care must be taken to insure tight joints between adjacent finished floor boards, but space for expansion should be provided at the sides of the room; otherwise buckling may occur.

QUESTIONS AND ANSWERS.

1. Why is a floor laid diagonally better than one laid at right angles to the joists?

The diagonal flooring has the effect of a brace in tying the tops of the joists together.

2. Why is it necessary to use underflooring dressed on one side to a uniform thickness?

To furnish a uniform bearing for the upper floor.

3. Should the underflooring of the first floor be laid before the outside stud walls are erected?

Yes. So that the sill of the stud wall may be laid directly on top of the flooring.

4. Why is it desirable to use two nails to fasten each board to a bearing?

One nail may work loose and the board spring up under use.

5. Why should the upper floor be laid at an angle with the direction of the lower flooring?

If the upper floor is laid parallel to the direction of the lower floor, the shrinkage of the lower floor will open up the joints of the upper floor.

6. When should the upper flooring be laid?

The upper flooring should be laid after the interior finish of the room, with the exception of the base board and molding, has been completed.

7. What precautions should be taken in the breaking of joints in the flooring?

Precautions should be taken to break end joints in both upper and lower flooring.

8. Is it preferable to use flooring in short or long lengths?

Flooring should be used in as long lengths as possible.

WALL COVERING.

Wall covering for buildings of a temporary character is usually drop or novelty siding where a simple, economical wall surface is required. On better classes of building construction, the beveled siding is used, as it gives a more attractive surface effect. Shingles, especially when placed in double rows, give a still more attractive outside surface wall finish, but are more difficult and costly to apply than beveled siding and are used only in the better class of carpenter work.

Discuss the two classes of wall board now in general use; fiber or composition wall board and the plaster or gypsum boarding. It should be noted that the latter is rather difficult to apply, as it is usually broken and cracked in fastening it to the studs with the nails. However, the gypsum board is preferable on account of its greater durability, insulation, and fireproofing qualities.

QUESTIONS AND ANSWERS.

1. What are the relative advantages of shingles, siding, and stucco as wall coverings? Which is the cheapest?

Stucco makes the tightest wall to prevent the passage of air and moisture. It never requires painting, and therefore its upkeep costs nothing. However, it is heavy and requires a strong frame for its support. If the building settles unevenly, the stucco will crack. Shingles furnish an attractive appearance and if dipped in a preservative stain will require no painting for several years. Siding has a less first cost than shingles or stucco, but requires more frequent painting. The choice will be determined by the desire of the owner.

2. From what portion of the log does the clapboard or beveled siding come?

Beveled siding should be taken from the interior part of the log and cut radially so as to secure a uniform and clear grain.

3. What advantages does siding have over clapboards?

Siding is generally simpler and less expensive to put on than clapboards.

4. What qualities should wall insulation material possess?

The insulation material should be, as far as practicable, wind, rain, and fire proof.

5. Is it preferable to place the insulation material in horizontal or vertical strips?

The insulation material should be applied in horizontal strips.

6. What are the relative advantages and disadvantages of plaster, plaster board, and compo board?

Plaster board and compo board are less expensive than plaster and can ordinarily be applied more quickly and with carpenter labor. Plaster requires the services of another trade, namely, the plasterer. Plaster board is preferable to compo board, as it is more rat, vermin, and fire proof.

7. What kind of interior wall surface gives the best protection against vermin, mice, and fire?

Plaster or gypsum board gives the best protection against vermin, mice, and fire.

8. What are the relative advantages and disadvantages of wood and metal lath?

Wood lath is less expensive than the metal lath and under some conditions is more durable. However, the metal lath is more quickly applied and gives a stronger wall surface.

ROOF COVERING.

Discuss the importance of the selection of the proper type of roof covering for various types and slopes of roofs and the importance of applying the outer roof material carefully in order to provide for a surface which will be, as far as practicable, impervious to snow, wind, rain, and fire. Point out the desirability of having the character of the roof conform to the character of the building, that is a simple, inexpensive roof such as a two-ply roofing, used on the cantonment type of building would not be suitable for a brick apartment building or quarters where greater permanence is desired. In the latter type of building with a gable roof, slate or asphalt shingles would be more appropriate.

The carpenter ordinarily applies wooden and composition shingles, while special types of roofing are put on by roofers. However, the experienced carpenter or builder should be thoroughly familiar with the qualities and methods of application of various types of roofing material.

Flashing is a part of roof construction which is often done by the tinsmith or sheet-metal worker, but it should be thoroughly understood by the carpenter, who is often required to prepare and apply the flashing before the roof surface is laid.

QUESTIONS AND ANSWERS.

1. What form of roofing is best for a flat roof? For a roof having a quarter pitch, and for a roof having a half pitch?

A good composition roof such as Barrett specification would be suitable for a flat roof; wooden or asphalt shingles would be suitable for a roof having a quarter pitch, while slate and asbestos cement shingles would be well adapted for a roof having a half pitch.

2. Why is the exposure for wooden shingles on roofs less than for shingles used on the walls?

Because of the importance of securing a greater protection on the roof against rain and wind action.

3. Give the types of roofing in order of their fireproof quality.

Asbestos, cement shingles, and tile roofing for the best fireproof quality. Slate, asphalt, tin, sheet iron, and wood.

4. If wooden shingles are to be used, what kind of wood should be selected for durability?

Cedar or cypress shingles resist weather longest.

5. What methods should be used for constructing a roof that will be warm in winter and cool in the summer?

An air space should be provided under a roof in order to provide insulation which will keep out the cool air in winter and the hot air in summer.

DOUBLE GARAGE.

Each student should examine the wall, roof, and floor sections of the standard Burpal portable barrack building in connection with the drawing of the portable garage, in order that he may have a thorough understanding of the method of construction. Then a complete bill of material for the building should be made out, listing the various types of sections used and the amount of stripping, roofing, siding, bracing, the doors, windows, hardware, etc. The instructor should check over each bill of material with the student to make sure that the latter understands the drawing.

It is of much greater importance in this job than in the previous jobs of a simple character that the student fill out the Job Assignment Sheet. List instruction units in the order of use. The instructor should check over each list before the student is allowed to start work on the job, although he may be only one member of a group or gang which is to construct a building. Direct the attention of the students to the desirability of laying out and cutting stripping, bracing, and siding in multiple in order to effect economy of time and labor. Note in this connection that the opposite sides or gable ends of the building are the same.

This job is one of the first which is of sufficient size to require the handling of the work by groups of men. The instructor should divide up the men into groups of three or four men to erect each building and each group should be organized with one man in charge, and the remaining men of the group assigned to various parts of the work. If several of these garages are being built simultaneously, there is opportunity for the bringing out of competitive spirit in the men by charting the daily progress of the various groups. This method of procedure will stimulate the various groups to so plan their work as to expedite it.

The instructor should realize that the students who have reached this stage of their training should be required to use their own initiative and resourcefulness to the greatest extent and stimulated to analyze the job and plan their work independently. The grading of the men should not depend entirely upon the skill exhibited, but should now take account of these important factors of initiative, resourcefulness, self-reliance, and ingenuity.

QUESTIONS AND ANSWERS.

1. How would you erect the roof frame?

The roof frame should be bolted together on the ground and lifted into place.

2. What is the purpose of the long 2 x 4 diagonal braces?

To tie the roof frame to the front wall and thus add stiffness to the building.

3. What is the purpose of the knee braces?

To stiffen the structure at the eaves.

4. Why are the sills set on a cinder bed?

To provide for a simple type of floor which will drain itself.

107851—23——9

LUMBER SHED.

This job furnishes a splendid opportunity for the application of the principles with which the students have become familiar and in which they have acquired experience up to this stage of their training, although the entire class will work on one building. Nevertheless, it is important that each student be required to analyze and plan the entire job independently in order that he may receive the greatest benefit from the job. This means that each student should completely fill out the Job Assignment Sheet and check over the statements with the instructor before the work is started.

It would be time well spent to have each student thoroughly study the drawing and satisfy himself that he understands each detail of construction. The instructor should question the students regarding the various details of construction to be sure that the entire class has visualized the job.

Careful consideration should be given the organization and order of work so that each group will work on all phases of the work. Each group should have a man in charge who will be held responsible for the work of the group.

Caution the men to brace the framework thoroughly as it is erected, so that the main frame will be thoroughly aligned and braced before roof framing is begun. It will be easier to plumb up and brace a frame at its erection than it is to straighten up a distorted frame which has not been properly plumbed and braced during construction.

QUESTIONS AND ANSWERS.

1. Why are the building sills placed above the ground and supported on posts?

To provide proper air space under the building and to keep the superstructure free from wet soil conditions.

2. What is the least distance below the ground surface that the footings should be placed?

The footings should be placed below the frost line.

3. What is the purpose of the knee and cross braces?

To tie together, brace, and stiffen the various members of the main frame.

4. How would you level up the tops of the posts prior to setting the sills?

The tops of posts should be cut off at the same elevation by leveling across and marking. It is often possible to excavate the bottom of the trenches to the same elevation and set posts of the same length.

5. Describe in detail the steps you would use in erecting the frame of the building.

The 4 x 6 sills should be placed first and the main frame raised, commencing with the 6 x 6 corner posts, followed with the 6 x 6 intermediate posts, plumbing and bracing the posts as they are set on the sills. Then place the 6 x 6 plates at the second story level and fit the intermediate 4 x 4 posts that are framed in the space between the sills and plates. The second story framing should be set in a similar manner up to the top plates. The roof frame should be erected commencing with the corresponding pairs of common rafters near the ends of the building and following with the hip rafters and jack rafters. Care should be taken to plumb and brace each set of story posts as the work proceeds.

6. Why is intermediate studding necessary between wall posts?

To furnish the support for the lumber which is to be stored in the building.

7. How would you erect the roof frame?

The simplest method to erect a roof frame would be to carry the middle 4 x 4 posts up to the required elevation. Set the ridge board upon the tops and then place pairs of common rafters and follow with the hip and jack rafters.

BRIDGE.

The instructor should realize and point out to the class the similarity between bridge and building construction. The methods of laying out for square and beveled cuts, making the cuts and the framing together of the timbers similar.

Amplify the data on heavy timber joints given in Information Topic No. 5 of Training Manual No. 11, and discuss the use of spikes and bolts on wooden trestle and bridge work. (See Manual on Bridges.)

All joints should be made with true bearing surfaces, and provide by direct bearing one piece on another for the transmission of the loads from member to member.

INSTRUCTOR'S GUIDE FOR CARPENTERS. TRAINING MANUAL No. 13. MASTER CARPENTER.

INDEX.

	Page.
Foreword	128
Unit Operations:	
50. Estimating	129
51. Laying out foundations	130
52. Setting window and door frames	132
53. Framing for concealed gutters	133
54. Hanging verge boards	134
55. Coping	135
56. Making cornices	136
57. Bending boards	137
58. Putting on interior trim	139
59. Fitting doors	140
60. Hanging windows	141
61. Building winding stairways	142
62. Wainscoting and paneling	144
63. Hanging sliding doors	146
64. Laying finished floors	147
65. Fitting standard hardware	148
66. Underpinning	150
67. Making hopper joints	152
Information Topics:	
12. Estimating	153
13. Inside finish	154
14. Outside finish	156
15. Finish hardware	158
Jobs:	
14. Quarters	159

FOREWORD.

Training Manual No. 13, Master Carpenter, teaches the more skilled operations in construction that at least 1 per cent of the soldiers of the Army should have. This course covers the more advanced operations of carpentry, including estimating and the laying out of foundations, underpinning, and the various types of finish work.

The instructor should know that this course includes operations which are unnecessary for the training of the carpenter in the combat units, but which includes the skills necessary for the carpenter in the arms of the service which are engaged in building construction on a large and somewhat permanent basis. The carpenter in combat units during long periods in post or camp may be called upon to perform all the operations listed.

This course is the final step in training the master carpenter, and the completion of this course should give the student sufficient practice to qualify him to work successfully in civil life as master carpenter on wooden building construction. The graduate will receive a certificate of proficiency as master carpenter. Special mention will be made of those students who have attained the grades of "Superior" and "Above average."

ESTIMATING.

Estimating is a phase of the trade which involves considerable thought, care, and practice. It should be given considerable attention in this course. Each student should make an estimate of the job in this part, and this estimate should be carefully checked up by the instructor in order that the student may correct and understand his errors. It will probably be necessary for the instructor to outline carefully to the whole class the customary methods of estimating, and indicate by a simple example the method of "taking off" material in detail for various sections of the building.

In many of the posts and camps examples of the open-shed type of cantonment building illustrated in this instruction unit are available, and it will be well for the students to measure up and take off the quantities of material directly from the existing structure where possible. Thus a student will become familiarized with the methods of estimating both from plans and from the structure.

QUESTIONS AND ANSWERS.

1. Why is the number of joists or rafters $\frac{3}{4}$ times the number of feet in length or width of building when 16″ O. C.?

The term $\frac{3}{4}$ corresponds to the relation $\frac{12}{16}$.

2. In estimating number of studs required why allow one for each foot of wall of partition?

Where the spacing is 16″ on centers one stud is allowed for each foot of wall on account of the extra studs required at the corners and for doubling at each side of openings.

3. What area is meant by the term "square"?

An area equal to a square 10 feet on a side or 100 square feet.

LAYING OUT FOUNDATIONS.

The laying out of a foundation brings into use one of the simple elements of surveying, namely, laying out lines with a tape. The instructor should point out that the laying out of a foundation is simply the transfer of the basement plan to the ground on full-sized scale, hence lines must be laid out horizontally regardless of the irregularities of the surface.

In order that the structure may be built in accordance with the plans, it is highly important that the foundation should be accurately determined. Hence, the corners of the building as shown by nails in the tops of the stakes must be carefully checked by measuring the diagonals of the building.

The batter boards should be set far enough away from the building so as not to interfere with the excavation nor be interfered with by the work as it progresses. The batter boards should be solid and substantial and not easily displaced by being struck or jarred by adjacent moving loads. In the case of high basement walls, it would probably be desirable to place the batter boards several feet above the ground, and in this case they should be strongly braced in at least two directions. In some cases, the horizontal braces are set at a given elevation, but this is not desirable on account of the liability of displacement. Reference points for elevation should be set near or below the ground surface and protected.

Heavy fishline or binding twine is generally used to mark the outside wall lines and is stretched tightly between the batter boards. However, where these lines have a length greater than 50 feet it would be advisable to use fine steel wire which can be anchored in place back of the batter boards and tightened by means of a turnbuckle or clamp.

QUESTIONS AND ANSWERS.

1. How may the squareness of a corner be checked with a steel tape?

Place the zero of the steel tape at the corner to be checked. Sight in the tape along the side of the building and place a steel pin on the line at the 16′ point of the tape. After looping the tape around the pin to some convenient even foot mark, such as 20 feet, hold the 16′ and 20′ marks of the tape at this first pin. Secure the 40′ point of the tape and make a loop in the tape at a convenient even foot, say beyond the 40′ point, holding the 40′ and 44′ points together. Bring the 56′ point of the tape to the corner of the building and hold it at the zero point of the tape. Stretch the tape out until the 3 sides of the tape are tight and place a pin at the point where the 40′ and 44′

marks of the tape are held together, If the corner is square the point just established will lie on the second line of the building. The figures 12, 16, and 20 are used as multiples of 3, 4, and 5.

2. What precautions should be taken in the use of cloth or metallic tapes?

The cloth or metallic tape stretches with use. If such a tape is used it should be compared with an accurate steel tape in order that its true length may be ascertained and suitable corrections made in measuring.

3. How should a batter board of two posts and one crosspiece be placed?

Back of the proposed corner of the building and at an agle of about 45° with the adjacent sides.

4. Under what conditions should batter boards be placed more than 2 feet high?

When it is necessary to lay out lines for a building wall which is more than 2′ above the general surface of the ground.

5. How should batter boards 10 feet high be built?

Of 4 x 4 posts and 2 x 4 horizontal pieces and thoroughly braced back to stakes driven in the ground.

SETTING WINDOW AND DOOR FRAMES.

Explain to the class the importance of having door and window frames set square and plumb in the walls. The frames may be true and square when they leave the mill, but are apt to be somewhat twisted or distorted when they are ready to be set in the building, and hence they should be carefully trued, squared, and leveled while being set.

In setting doorframes it is important that the doorsill should have a good bearing on the lower floor. Level all sills and casings carefully before they are finally nailed in place.

Caution the students to check the height and width of frames before they are set in their openings and to test opposite corners with the steel square before finally nailing in place. It is well to tack diagonal strips and braces across the edges of the frames to hold them square, if such braces are not provided when the frames are delivered on the job.

If doorframes are subjected to the turning and twisting action of the load from the swinging door, it is important that the jambs should be well shimmed and tightly fastened in place. Care should also be taken to see that the faces of the jambs are flush with the finished wall surfaces.

QUESTIONS AND ANSWERS.

1. Why are casing nails used in setting window frames?

So that the heads can be set below the surface.

2. What size nails should be used?

8d. nails.

3. Why is it necessary that there be no wind in a doorframe?

If there is a wind in a doorframe, the door will not hang or swing properly.

4. Why is the distance from finished floor to head jamb ½ inch longer than the door?

A ½″ clearance is allowed for a carpet or rug space under the bottom of the door.

5. Is it better to make inside doorframes on the job rather than to have them made at the mill?

Ordinarily it is better to have doorframes made at the mill. However, there are exceptional cases when the frame can be made and fitted to better advantage on the job.

6. Why are the door casings set back ¼″ from the face of the jambs?

In order that the door in closing will not strike and injure the edge of the casing.

FRAMING FOR CONCEALED GUTTERS.

The instructor should note that framing for a concealed gutter practically consists of building a cornice along the side of the building. This job involves accurate exterior finish work at a considerable height above the ground and the use of scaffolding. Scaffolding should be framed and placed firmly, since men are apt to be careless with temporary work which must soon be torn down.

QUESTIONS AND ANSWERS.

1. Why is the gutter sloped?

To allow the water to flow through the gutter to the down spout.

2. How may the accuracy of the chalk lines on the rafter tops and ends be tested?

By measuring out from the wall line.

3. Why is the gutter floor placed before the sides?

In order that it may be given the proper slope and that the sides may be properly framed into it.

4. Why are abutting edges of gutter boards painted before being set in place?

To make a tight and waterproof joint and prevent decay of the wood.

5. Why not carry lookouts through and nail to studs?

The lookouts can only be carried through and nailed to the studs if the rafters are above the studs, and in this case it would be necessary to cut the boarding around lookouts in order to carry it up to the roof boarding. Hence, it is simpler and easier to place the wall boarding first and fasten the ends of the lookouts to it.

6. Why are the straps used along the tops of the gutter?

To hold the side of the gutter in place, especially against excessive weight of water and ice.

7. Are the cleats at the wall ends of lookouts necessary?

The cleats are not necessary, as it is possible to toenail the ends of the lookouts directly to the wall boarding. However, the cleat connection is stronger and better than the simple toenail.

HANGING VERGE BOARDS.

The placing of verge boards requires considerable care in measuring, laying out, and cutting. Unless contact surfaces are carefully trued and fitted, the shrinkage of the boards will cause large cracks, which will detract greatly from the appearance of the work.

QUESTIONS AND ANSWERS.

1. How should the verge boards be framed to make a closed or box type of cornice?

The verge board would generally consist of a fascia and a plancier placed along the sides of the lookouts similar to the type of construction shown for concealed gutters.

2. What methods of construction could be used to secure ornamental effects with verge board?

The verge boards are often carved or made with an ornamental lower edge or otherwise ornamented for architectural effect.

3. Why are verge boards used?

To give a finished appearance to the gable end of a building.

4. What are the advantages of the open type of cornice described in this operation?

The open type of cornice is simple and economical of construction.

COPING.

Coping is a simple operation, but requires considerable care in order to make a good joint. The cutting of a miter in a miter box is the first and easiest part of the operation. The undercutting of the end of the piece with the coping saw is the part of the job that requires a careful following of the scribing mark. Caution the student to cut to the outside of the mark so that the final fitting may be done by trimming with a knife and finishing with fine sand paper.

QUESTIONS AND ANSWERS.

1. Why will mitering a piece give the correct line on the face for coping?

Cutting into the face at an angle of 45° gives an outline on the face which is the same as a transverse section which is the correct line for coping.

2. Does coping make a better molding joint than mitering? If so, why?

Yes; since it gives an abutting joint which does not show the crack when the wood shrinks.

MAKING CORNICES.

Cornice work requires great care and accuracy in the laying out, cutting, and fitting of the various parts, especially for contact surfaces and edges. The various members should not be cut too small as it is always better that they should overrun rather than underrun in fitting on the framework of the building. It is much easier to work down a piece than it is to build up a piece which has been cut too small.

In order to insure tight joints between the various members of a cornice it is important that the boards be tightly nailed at each bearing, otherwise subsequent shrinkage and settlement will be apt to cause the springing or distortion of part of the framework.

Especial care must be taken in the cutting of the miter joints at the gable ends of the building. Mark for these cuts by placing the end boards in position, thus laying out for length with the board in place.

QUESTIONS AND ANSWERS.

1. Why is the wall boarding carried up to the underside of the roof boarding?

To make a tight attic space.

2. What different types of gutters could be used for these two classes of cornice?

A hanging metal gutter could be attached to the edge of the roof along the fascia or a built up gutter could be placed on the slope of the roof just above the fascia.

3. Why are crown and bed moldings used?

To cover up the vertical joints between the fascia and the edge of the roof and the frieze and plancier and are also used for architectural effects.

BENDING BOARDS.

The experienced carpenter will often curve a board, using his own judgment, without making any computations or trial cuts, and secure fair results. However, the inexperienced workman should not be allowed to do this character of work except by careful trial.

The piece to be bent should be of as clear and uniform grain as possible and should be selected with greater care than a piece which is to be used on a straight or plain surface. A large knot in the piece will often cause a break, crack, or split when the piece is bent adjacent to the knot. In bending the piece make all changes in direction slowly and carefully, as a quick bend or twist will often break or crack the wood, especially along the outside or convex surface.

The cutting of a molding to secure bending by small sections or laminations involves very careful cutting or lapping along the grain. The student must be cautioned to saw to one side of the line so as to secure a full-sized piece. It should be noted that it will require two sections of molding to secure the proper number of full-sized pieces for the contemplated bent molding.

In erecting a molding very thin layers of glue should be used and the pieces should be applied consecutively and fastened tightly in place as each piece is bent.

QUESTIONS AND ANSWERS.

1. What determines the depth to which the kerfs should be made when bending a board?

The depth depends upon the sharpness of the curve, because the sharper the curve the deeper the kerfs required.

2. How may the spacing of the kerfs be determined when starting one at the center of the piece to be bent?

If the kerf is made at the center of the piece, hold the section of the piece on a flat surface and bend up the other section and note the deflection of the piece. This deflection will give the kerf spacing as shown in Figure 174.

3. Why can a piece of wood be bent after soaking it in water?

The soaking softens up the grain and makes it more pliable and susceptible to bending.

4. Why is boiling or steaming the best treatment for wood to be bent?

The board is stronger than when bent by using saw kerfs. Boiling or steaming is quicker than soaking in water and gives better results.

5. Why is it not practicable to bend a molding by kerfing or steaming?

Molding can not be bent by kerfing or steaming, as it will twist and bend on account of the curvature of its face.

6. How should the kerfs be made in a beveled board similar to a molding in order to bend the board in a horizontal plane?

If it is desired to bend a beveled board in a horizontal plane, the kerfs must be made diagonally along its back in a direction depending upon the slope of the bevel with regard to the horizontal plane.

PUTTING ON INTERIOR TRIM.

The instructor should realize and impress the students with the very high class of work required in putting on interior trim. Ordinarily the highest-skilled carpenters on a building are used for this class of work. All abutting surfaces and joints must be made with the greatest care, and all cuts and edges finished true and smooth, in order that the work may have a proper finished appearance. The character and value of a building are often judged by the appearance of the interior finish or trim. As this class of work requires such a high degree of accuracy and finish, it is necessary that all tools should be in excellent working order, sharp, and properly adjusted.

Instruct the students to lay out all casings in place, so that the pieces will fit the frames and make tight, closed joints. Fit one piece at a time and scribe the end cuts with the piece in place wherever practicable. The fastening of the casings should be done with care so as to secure tight joints with the use of a minimum number of nails. A large number of nail heads, although puttied, will detract from the general appearance of the finish. Note that base moldings should be coped for all interior angles. Care should be taken not to make joints too tight by wedging baseboards in place, as later swelling of the boards may force them out of line away from the wall.

QUESTIONS AND ANSWERS.

1. Why not splice casings?

Casings should always be made in single pieces or lengths for the sake of appearance.

2. How should the grain of end blocks be placed?

With the grain vertical.

3. How should the end cuts of casings be marked to make good joints?

Scribed in place so as to secure good joints.

4. Why are stools and aprons of window trim "returned" on their ends?

For finish and appearance.

5. When are stops, baseboards, base, and picture moldings made with coped rather than mitered joints? When are mitered joints used?

They are coped at interior angles and mitered on exterior angles.

FITTING DOORS.

The fitting of doors requires very careful measuring and cutting on the part of the student, who should be instructed to follow each step slowly and carefully. Check up the doorframe to insure that it is true, free from wind, and square. In using the jack, care should be taken not to injure or force the jamb out of place.

The scribing for height and width should be done with great care so as to secure edges parallel to the surfaces of the door jamb. Make all cuts to the outside of the scribed lines, as the tendency is always to cut off too much and thus leave too great a clearance between the door and the frame. In locating the position of hinges, be sure that the door hangs true in the frame and parallel to its sides in order that scribing for hinges may be properly done.

QUESTIONS AND ANSWERS.

1. Why should the bottom of the door be scribed rather than merely cut square across?

In order that it may be cut parallel to the finished floor surface.

2. Why is $\frac{3}{32}''$ allowed in the width of a soft wood door and about $\frac{1}{16}''$ in the width of hardwood doors?

The greater allowance for clearance is made in the case of a soft wood door than that of a hardwood door to allow for swelling of the wood.

3. Why is a threshold often used?

To make a tight joint under the door when closed and to determine the clearance for the carpet or rug when open.

HANGING WINDOWS.

The students should take the same precaution in fitting windows as in fitting doors as regards the scribing of edges with the sash in place and in the careful making of cuts in order to secure true and reasonably tight joints. Special care should be taken not to have more than $\frac{1}{16}''$ clearance on each side of the sash, otherwise the sash will hang too loosely in the frame and rattle under wind pressure.

Point out the importance of properly hanging the sash and fastening the windows to the sash cord. Loosely hung sash and weights often result in the pulling out of the cord from the sash or weight when the window is thrown open with force. Caution the student to use the proper weights for the upper and lower sash, noting that the heavier weights should be attached to the upper sash and the lighter weights to the lower sash. Basement windows should be scribed and hung so that the bottom of the sash will not strike the edge of the frame in closing. However, too much clearance should not be left as dirt will blow in from the outside ground surface.

QUESTIONS AND ANSWERS.

1. Why is the top sash fitted first?

The top sash is toward the outside, and since both sashes are fitted from the inside of the building the top sash must be fitted first.

2. When fitting the sash of a double-hung window, should the distance between the tops of the meeting rails of the sash be laid off on the inside or outside of the bottom rail of the bottom sash?

From the outside, in order that a true fit may be secured with the rabbetted edge of the stool.

3. How much space should be left between the meeting rails?

Not more than $\frac{1}{16}$ inch clearance.

4. What kind of a knot should be made in attaching the cord to the weight so that it will not work loose?

A slip knot.

5. If the weight is placed after the wall is plastered and casing set, how should the sash cord be run through the pocket and pulley?

By means of a weight such as a spike or ball attached to its end.

BUILDING WINDING STAIRWAYS.

Winding stairways are generally not used in the temporary camp buildings, but are generally found in the permanent quarters at various posts. Whenever available, such stairways should be visited by the class and the instructor should point out and explain the various parts of the stairway.

In the construction of a winding stairway great care must be taken to secure a proper and accurate layout not only of the stairway in its plan but also of the wall and face strings and winders. The work should be subdivided so that each group of students will have an opportunity to lay out and cut at least one string and one winder. These layouts can be made on building paper, and should be carefully checked by the instructor before they are used as a guide or templet for the laying out and cutting of the finished product. The use of the pitch board and the marginal and the housing templets should be fully discussed.

The student should visualize each and every step, so that he may anticipate any difficulties that may arise in the placing and fastening of any of the parts of the structure. This is especially important in the placing of the face string and corner post of the third flight, which should be placed before the edge or nosing of the finished second floor is laid.

The building of a winding stairway is one of the most difficult parts of the interior finish of a building and requires the highest degree of skill and the use of considerable thought and ingenuity. Only the more skillful and advanced students should be allowed to work on a job of this character.

QUESTIONS AND ANSWERS.

1. Why is the first step of a stairway often made wider than the regular run?

Partly for the sake of appearance and partly to furnish a sort of "take off" in ascending the stairs.

2. What is a "bull-nosed" step, and why is it used?

A "bull-nosed" step is a step with a rounding end, and is used at the bottom or beginning of a stairway for appearance.

3. Why should the rise and run of a stairway not be varied?

To make the ascent and descent as uniform as possible.

4. Why not build "winders" of a stairway as shown by the dotted lines at A, Figure 180? Why are the "balanced" stairs, shown at B, Figure 180, the best form of "winders"?

"Winders" of a stairway as shown by the dotted lines at A, Figure 180, furnish too narrow a tread along the line of travel, and are dangerous to use. The width of tread of the "balanced" type is wider along the line of travel and therefore safer.

5. What distance apart should the carriages supporting a stairway be placed?

Not more than 30″ on centers. Generally for a stairway 3 feet or more in width, an intermediate line of strings is used.

6. What is a "closed-string" type of stairway, and how would the carriages be placed?

A "closed-string" type of stairway has "face strings" which extend above the tops of the treads and encase the outer ends of both treads and risers. In this type of stairway the outer carriages would be placed near the outer face of the stairway.

7. What is meant by "headroom" for a stairway? What is the usual minimum headroom?

"Headroom" in a stairway means the clear space between the underside of the floor above and the nearest tread directly below. This clear space should never be less than 6 feet 6 inches.

8. Describe three different methods of applying balusters to a stairway.

Balusters can be toenailed directly to the tops of the treads, tenoned into the treads, or half jointed to the tops of the treads and the outer surface of the face string.

9. Why is it desirable to house the treads and risers into the wall string?

In order to provide proper bearing and to make tight joints.

WAINSCOTING AND PANELING.

Discuss with the class various methods of boarding up or wainscoting a room. Selected matched, or tongued and grooved boarding should be utilized for this class of work. All stock should be clear, uniform grained, and free from large knots, cracks, or splits. Special attention should be given to the use of continuous and undamaged edges.

The number of furring strips that should be used as nailing strips depends upon the height of the wainscoting. Generally two will be sufficient, one near the top and the other from 6 to 9 inches from the floor. Special care must be taken in nailing on the first board or two in order to secure true and vertical alignment. Successive boards should be driven up tight and fastened in place by blind nailing.

Paneling is generally built in sections from careful measurements made of the sides of the room, and later these sections are fastened in place. As the corners and finish of a room are rarely true and plumb, it will be necessary to fit the sections of paneling. However, if they have been carefully made from accurate measurements, this fitting can be easily done by chiseling or planing the edges of the paneling as it is being set up in place.

Paneling requires extreme care and accuracy, especially in the making of joints, and this work should only be done by students who have attained a high degree of skill in grooving and mortising and tenoning. This instruction unit furnishes an excellent opportunity for familiarizing the student with the use of the various types of grooving planes such as a router and a plow. The entire paneling of the section should be cut and fitted before it is finally assembled with glue and nails. The final finish of joints and paneling surfaces should be made with a fine grade of sandpaper. Caution the students to glue and fasten all joints securely so as to prevent their splitting and opening up under a wide range of temperature conditions.

QUESTIONS AND ANSWERS.

1. Why is it preferable to lay the matched boards vertical instead of horizontal?

For the sake of appearance and in order to secure tighter joints and smoother surface finish.

2. Should a base or base molding be used with wainscoting?

Yes.

3. Would it be better to use nails or screws in fastening the paneling to the wall? If screws are used, where should they be placed?

Paneling is generally fastened to the wall with nails. If screws are used they should be placed in the top and bottom rails and set below the surface with plugged holes.

4. How should panels be held in place to prevent splitting or cracking?

Panels should be fastened in place by gluing the edges into grooves cut in the rails and stiles. If necessary to nail the edges of the panels, this should be done indirectly by using rabbeted strips, which are nailed to the rails and stiles, and hold the edges of the panels in place. The panel will expand and shrink as the atmosphere is wet or dry. Therefore it will split if the edges are nailed or screwed in place.

5. Should the molding in paneling be nailed to the panels?

The moldings should never be nailed to the panels but should be nailed to the edges of the rails and stiles.

6. Under what conditions would the end or corner stiles be carried through, and the top and bottom rails housed into them?

At the corners or breaks in a room, the end or corner stiles are often carried through and the top and bottom rails housed into them.

HANGING SLIDING DOORS.

Discuss with the class the method of framing a double partition, especially with relation to the "head," which must be made sufficiently rigid not only to carry the dead and moving load of the doors but also to maintain the true alignment. The track for hanging doors must be placed in position before the walls are lathed and plastered.

QUESTIONS AND ANSWERS.

1. What kind of stud partition is necessary for sliding doors?

A double-stud partition.

2. How should the top of the sliding-door opening be framed?

It should be well braced in order to keep the track from buckling and sagging.

3. What method is used to guide the bottoms of sliding doors?

The bottoms of sliding doors are generally allowed to hang free, but in the case of large heavy doors a metal guide is sometimes used. This guide is screwed to the floor and projects sufficiently into grooves in the bottom of the doors to hold them in line.

4. What is the best form of track to use for sliding doors?

The best form of track is a steel bar of sufficient strength and rigidity to maintain its alignment.

LAYING FINISH FLOORS.

Call attention to the importance of laying the first line of boards parallel to the side of the room and well fastened in place. Special care must be taken to drive and nail each board tightly against the preceding board, using small tongued-and-grooved blocks in order to prevent damaging the edges of the flooring.

QUESTIONS AND ANSWERS.

1. Why is it necessary to leave a space between the first line of floor boards and the wall?

To allow for the expansion or swelling of the flooring.

2. Why is it necessary to drive the nails at an angle of about 50 degrees with the floor?

So as not to split the tongue of the board and to tighten the board against the preceding one.

3. What benefit is derived from greasing or oiling the ends of the nails?

Prevents splitting and makes driving easier.

4. How should a board which is sprung or bent be nailed?

Commence at one end and drive the nails close together in order to hold the board tightly in place.

5. What care should be taken in the selection of the floor boards for surface finish and grain?

Boards of similar grain and color only should be used in a room.

6. Is it necessary to nail the upper floor at joists?

No.

FITTING STANDARD HARDWARE.

Demonstrate before the class the method of applying a set of door butts and a mortise lock in order to emphasize the importance of careful scribing and cutting out for gains. Overcutting generally results not only in bad appearance but an uneven hanging and fastening of the door or window. Show the need of chiseling out the cut slowly and carefully, testing it from time to time with a piece or section of the hardware to be fitted.

Illustrate the method of driving screws so as always to force the hardware tightly into place. Where a screw has gone wrong or run out of line, withdraw the screw, plug the hole, and reinsert it in proper place and direction. In fastening locks and catches on doors and windows allowance should be made for edge joints of the doors and for a space between the meeting rails of the windows. These locks or fastenings should always be placed so as to draw the adjacent members when the appliance is locked.

Instruct the student always to bore a small hole in which to start a screw. Some carpenters try to hammer a screw into the wood in order to expedite the work. This method will sometimes work out satisfactorily in soft wood, but it is difficult in this way to drive a screw straight, and the forcing of the screw through the wood breaks the fiber and greatly reduces the holding power of the screw. A screw can be started with a gentle tap of the hammer, but should always be inserted with a screw driver.

QUESTIONS AND ANSWERS.

1. Can a mistake be made in fastening a butt wrong side up on a door? Are there right and left hand butts or hinges?

The common butts should always be placed with the pin section on the frame and the top section on the edge of the door. The ordinary butt may be reversed so that it can be used either for a right or left hand opening of the door.

2. If the door hangs away from the frame on the hinge side, how may the hinge be reset to straighten the door?

Remove the section of the butt and chisel the gain deeper on the front.

3. If the door strikes the jamb at the hinge and will not close, "hinge bound," how may the hinge be reset to straighten the door?

Loosen the screws of the hinges of the butt that binds and insert a piece of heavy paper or cardboard along the entire edge of the gain.

4. Why is the selvage of the lock set back from the face of the stile?

So that it may not strike the edge of the frame in closing.

5. If a door fails to latch, what should be reset and how?

If a door fails to latch, it has probably settled or deflected out of line. The jamb plate should be raised or lowered the required amount.

6. How would you make a templet for use in fitting a number of locks of the same size?

A piece of cardboard can be cut to the outline of the lock and centers punched for the knob and keyhole. This pattern or templet could be used for the laying out of several locks of the same type and size.

UNDERPINNING.

Underpinning buildings for the purpose of raising or lowering them requires great skill and judgment, especially in the placing of the heavy timbers and the screws or jacks.

The instructor should explain the function of the various parts of the underpinning and how the load is transmitted from the building to the needle beams and then to the runners or longitudinal beams, and from these members through the screws or jacks and supporting timbers to the ground surface. Explain the importance of placing sufficient needle beams to carry the building without undue or unequal deflection or settlement, and that each of the supporting members must be strong and rigid enough to take the load without perceptible deflection or displacement.

Indicate to the class the importance of properly distributing the load on the supporting floor or soil by a grillage or platform support, in order that the load may be carried with slight and uniform settlement. Although some settlement may occur in the handling of a building, it should be made as uniform as possible to prevent cracks or other damage. Where there are unusual or concentrated loads, such as at the corner of a building, the supports should be placed proportionately closer together than along the walls.

The simultaneous turning of the screws or jacks for raising or lowering buildings can be effected by signals, and of course it will be necessary to have one operator at each jack. The amount of turn at each jack at each signal should be the same.

QUESTIONS AND ANSWERS.

1. Where should the needle or supporting beams be placed in order to carry best the weight of the building?

Directly under the sill or line of main supporting timbers of the structure. The spacing of the needle beams should be made sufficient to carry uniformly the load from the superstructure.

2. What size cross timbers should be used for the needle or supporting beams?

This will depend upon the load to be carried and the spacing of the timbers. Ordinarily they will range from 4 x 6's to 6 x 8's. Steel I-beams are often used for this purpose.

3. What is the purpose of the "runners" or longitudinal timbers?

The runners are used to tie the needle beams together and distribute any inequalities of load.

4. What size of timbers should be used for the runners?

Runners will vary in size from 4 x 4's to 6 x 10's.

5. Why is it necessary to support the main floor girders?

The main floor girders carry intermediate loads such as chimneys, partitions, etc., and must be supported the same as the outside walls.

6. Why is it necessary to carry the timber supports to the depth of the new foundation?

In order that subsequent excavations for the new foundation will not cause a caving in and settlement of the building.

MAKING HOPPER JOINTS.

This instruction unit furnishes a splendid opportunity for the student to acquire skill in using the T bevel in laying out angles and in cutting beveled surfaces. Review this problem before the class, making large scale illustrations on the blackboard and showing full size models. Subsequently each student should be required to make a large scale layout on paper, and it would probably be desirable to have each student make a box and make the necessary patterns for the sides to full scale.

The instructor should question each student in order to be sure that he gains a clear conception of the method of making a beveled cut where two angles are concerned. If the student has successfully followed through the method of laying out and making a cheek cut for a jack rafter, he will have no trouble in understanding this problem.

If the student has made a square hopper maybe it would be well to have him lay out and make a hopper of rectangular or irregular cross section in order to give him facility in the use of angles other than 45°.

QUESTIONS AND ANSWERS.

1. For a square hopper, will the sides be the same size if butt joints are used? If miter joints are used?

No, but the pairs of opposite sides will be the same. If miter joints are used, the sides will all be the same.

2. When does squaring the lines BC, EF, etc., on the top and bottom edges give the lines for the side cuts bevel for butt joints?

For a square hopper where the angles are the same for all joints.

ESTIMATING.

The importance of properly estimating material and labor costs for building construction should be discussed. Show when and why various methods are used. Point out the degree of accuracy required by each method and why.

Encourage the students to become familiar with the term "board measure," the use of the tables given in the Topic, and to have in mind average output of labor for the various classes of work. Practice in estimating will cause the student to absorb unconsciously a great deal of the data which has been furnished.

QUESTIONS AND ANSWERS.

1. Why are the "cubage" and "square" methods of estimating inaccurate?

They are based on the average of data from a number of buildings, and very few buildings conform to the average.

2. When is it advisable to use the cubage and square methods of estimating?

Only for preliminary or approximate estimates.

3. Is it necessary for the contractor to take account of allowances other than material and labor in making a bid for the construction of a building?

Yes; such as workmen's liability insurance, fire insurance, superintendence, office expenses, profit, etc.

4. How many feet board measure in a plank 2″ x 12″ x 16′ in length?

32 ft. B. M.

5. How many feet board measure in a girder made up of three 2 x 8's, 20′ in length?

80 ft. B. M.

6. Why should an allowance of 25 lineal feet be made for bridging for each 100 square feet of flooring?

Experience has indicated that 25 lineal feet of 2 x 4's will properly bridge 100 square feet of flooring.

INSIDE FINISH.

The student should read this unit carefully in order to understand clearly the steps in placing the inside finish of a building. It should be applied in a definite way to coordinate with the other trades working on the building and proceed with all due expedition. For example, when the plaster is dry or when the wall surface has been completed, the window and door trim are placed, the sash and doors hung, stairways built, floors laid, and base board and picture molding set. The openings are finished and covered in as soon as practicable so that the interior finish may be carried on under cover. The finished floors should be the last thing placed as working and walking over them will dirty and damage the surface.

QUESTIONS AND ANSWERS.

1. Why is it necessary to place the interior finish after the interior wall surface has been completed?

The interior finish is applied to and covers part of the interior wall surface and hence should be placed after the interior wall surface has been completed.

2. Why must stock for interior finish be kiln-dried?

In order that it may not warp, twist, or spread open at the joints after it is placed.

3. Why should the carpenter wait until the wall plaster is thoroughly dry before placing the interior finish?

So that the wood will not absorb the moisture from the wall and warp.

4. Why are window openings covered with building paper or cheesecloth during the plastering?

In order to keep out the wind and rain.

5. Why not place the window sash before the interior wall surface is applied?

To prevent its becoming soiled and damaged during the plastering.

6. Why is it necessary to have the door jambs vertical?

So that the doors will open and close properly.

7. Why are the head casings for door and window openings generally placed last?

In order to make proper joints with the side casings.

8. Why does the carpenter often place the shoe mold several weeks after the finished floor has been laid?

To permit the complete shrinkage and settlement of the floor.

9. Why are the treads and risers generally housed into the wall string?

To make tight joints and to fasten the stairs to the wall.

10. Why is it desirable to commence placing the treads and risers at the bottom rather than at the top of the stairs?

For proper fitting into one another.

11. Why are the treads and risers tongued and grooved into one another?

To secure tight joints.

12. What is the advantage of built-up or veneer doors? Is it advisable to use this type of door on the outside of buildings?

A built-up or veneer door does not warp, split or crack when exposed to changes of temperature and moisture like a solid door. It is therefore especially adapted to exposure to the weather.

OUTSIDE FINISH.

The instructor should outline to the class the various steps in the application of the outside finish of a building, though this is not as important as in the case of interior finish. However, the work should be thoroughly planned and systematized so that it may be done as economically and expeditiously as possible. It is generally customary to start at the bottom of a building, placing the water table at the first floor level, then following with the corner boards, belt course, cornice, and gable finish. The door and window frames may be placed independent of the elements of trim previously mentioned. However, it is evident that door and window frames must be placed before the exterior wall surface, such as siding, shingles, or stucco is applied.

QUESTIONS AND ANSWERS.

1. Why should white lead and oil be used on the edges of tongued and grooved flooring for the outside porch?

In order to make water-tight joints and prevent decay.

2. Should outside finish be as thoroughly seasoned or dried as inside finish?

No. The outside finish is subject to greater changes of temperature and variations in moisture conditions.

3. Is it necessary to take as much care in fitting and placing outside finish as for inside finish?

No.

4. Why should the corner boards, belt course, and water table be placed before the shingles or siding are applied?

In order that the shingles or siding may be fitted along the edges of this trim.

5. Why should the cornice and gable ends be set before the roofing is applied?

In order that the roofing may be fitted around and against this finish.

6. Why are corner boards used on a building?

To give a finished appearance to its corners.

7. Why are the jambs or pulley stiles grooved for the parting strip?

So that the parting strip may be easily removed and replaced when it is necessary to take out and put back the sash.

8. How much space should be allowed between the jambs and studs for window weights?

A space of about 1½″ should be allowed between the jambs and studs for the window weights.

9. Is it more desirable to house the head and sill of a window frame into the pulley stiles or the pulley stiles into the head and sill?

It is preferable to house the head and sill of a window frame into the pulley stiles in order to secure greater bearing and more weatherproof joints.

10. Why are the jambs of a door frame rabbeted?

In order that the door may fit into the frame and thus make closer and more weatherproof joints.

11. Why are the ends of a door sill housed info the jambs?

To secure proper bearing.

12. Why does a box cornice make a house warmer than an open cornice?

Since it furnishes a complete framework about the eaves.

13. Why are the tops of window and outside door frames flashed?

To prevent the wind and rain from passing between the top of the frames and the outside wall surface.

FINISH HARDWARE.

Take the class on an inspection trip around the various buildings of the post in order that the students may become familiar with the various kinds, types, styles, and finish of the finish hardware. It is suggested that each student be required to prepare a list of the finish hardware needed for an outside door, an inside door, a window, a cupboard door, a drawer, and a closet.

Question the student to make sure that he knows the construction and uses of the various types of hinges and butts, of locks, lifts, and fastenings.

Discuss the various types of finish used for finish hardware, calling attention to the enamel or lacquer finish for the brass, steel, or iron hardware used on the cheaper classes of work, and the oxidized finish for the better classes of work, and bronze for the highest class of work, especially where moisture conditions would cause deterioration. Point out to the student steel hardware on outside doors which has become badly rusted.

QUESTIONS AND ANSWERS.

1. Why is it desirable to use brass, bronze, or copper for exterior hardware?

Brass, bronze, or copper are desirable for exterior hardware in order to resist the corrosive effects of the outdoor air.

2. What is the advantage of the **T** form of strap hinge?

Strength.

3. Why is a strap hinge made of wrought iron more durable than one made of steel?

A strap hinge made of wrought iron will not rust as quickly as one made of steel.

4. Why are butt hinges often made with several bearing surfaces?

In order to distribute the weight of the door over several surfaces.

5. What kind of locks are used on thin doors?

Rim locks.

6. What is the most important advantage of the cylinder lock?

A cylinder lock with its safety form of key is better adapted to the securing of doors where it is important that they should be kept locked against breaking and entering.

7. What is the purpose of the escutcheon plate?

The escutcheon plate is used as a surface finish for the keyhole of the door lock.

8. Is it preferable to swing a casement window in or out of the building?

A casement window should be swung out of the building in order to provide water-tight edges of contact between the sash and frame.

QUARTERS.

This job is the last in the typical course for training carpenters and is intended to cover and summarize all the elements of the trade outlined in the training manual. Hence, the job will furnish a thorough review of the skills and knowledge acquired in the three preceding parts of the manual as well as a drill in the advanced construction skills of the fourth part.

The instructor should require the advanced students to study carefully the plans and specifications until they have acquired a clear conception of the entire problem. After considerable time has been spent in individual study of the job, assemble the class and have a complete discussion of the work; the parts of the house, methods of construction, materials and tools to be used, etc. Draw out each member of the class by questions and lead him to ask all possible questions so as to insure as far as possible that the entire class will have a thorough and complete understanding of the work.

It should be noted that the plans and specifications are complete and include excavation, masonry, sheet-metal work, painting, plumbing, steam heating and lighting, as well as the carpenter work. It is not intended that the men in the carpenter class shall have a sufficient understanding of the other trades to perform them. However, it is important that they should know in a general way the character and scope of the work which is to be done in these other trades in their relation to the carpenter work which they have to perform. Invite attention to the fact that the carpenter has to work in close cooperation with the members of the other trades, as for example in figuring excavations the proper size, for the form work for the foundation walls, cutting holes for pipes and conduits, and providing supports for fixtures. The successful builder must be able to visualize the entire job before it is started and prepare a preliminary time schedule of the work so as to bring about a proper cooperation between the various trades involved. The lack of such a schedule often entails delays and friction between the various tradesmen; hence is will be necessary for the supervisor to confer with all of the instructors in order that a suitable program or schedule of the work may be prepared before the work is begun.

The building of a house may furnish instructive work for all classes of students, helpers, basic carpenters, general carpenters, and master carpenters by a careful organization of the work. By reference to the occupational index in the manual, each class of students may be assigned work in the operations included in the course as laid out for that step or grade. Advanced students may have beginners assigned to them as helpers, but care must be exercised to prevent their becoming merely laborers. They must be given opportunity to lay out square cuts, saw to a line, dress material, etc.

Men enrolled in the basic carpenter course should sharpen and set saws, sharpen edge tools, lay out special angle cuts, etc., as listed in the instruction units for their course. Men enrolled for the general carpenter course should lay out the sills and girders, cut and place joists and bridging, lay out the common rafters, and other work as prescribed in the manual for that course.

Constant care must be exercised to assure *training* for each man in the work of his course, as the tendency will be to allow each man to do the kind of work in which he is already most skilled, which will prevent his acquiring more skills as planned in the manual.

The entire job should be carefully planned with a view to giving instruction to as many of the class as possible in the various phases of the work. For example, it will be important that all of the men shall have experience in making, placing, and removing concrete forms, erecting stud walls and partitions, laying out, cutting, and erecting the various parts of the roof frame, laying rough and finished floors, placing interior and exterior trim, etc. To accomplish this it may be necessary to rotate groups of men on the various parts of the work, so that one group will not lay out and cut all of the rafters, studs, or joists. The job is sufficiently large and comprehensive so that this method of rotation is feasible.

The instructor should have in mind the development of foremanship for the advanced class. He should select a leader for each group, and perhaps it would be practical to place some exceptionally able man in charge of each phase of the work, such as cutting and erecting the main frame, cutting and erecting the roof frame, applying the siding, putting on interior trim, etc. The men should be rotated from time to time in order that each may develop foremanship ability.

Considerable latitude is given, in the specifications relative to the selection and use of available material. The instructor should consult with students relative to the selection of material for the various parts of the work, calling their attention to the good qualities and defects of material which is available and must be used. However, it is important that the instructor use good judgment himself and not utilize material which is so poor and defective that its use will impair the attractiveness or utility of the completed structure.

The entire job should be divided into a series of smaller jobs, such as the foundation work, main frame, roof frame, application of interior trim, etc., and each member of each group should make out a complete analysis and plan of the work before it is started. This analysis and plan should include a list of instruction and information units in the order of use, a bill of material, and a list of tools to be used. These lists should be reviewed and approved by the instructor before the students are allowed to estimate the particular job on hand. The instructor should be thoroughly impressed with the fact that the purpose of this job is not production but instruction, and sufficient time should be taken in each and every step so that the student may acquire the desired tool and construction skills and trade knowledge.

The instructor may find at any time that it will be desirable to discuss with a group or the entire class some problem which has arisen on the job. Do not hesitate to stop the construction work in order that the lesson may be driven home to the students and that a thorough understanding of right and wrong methods of construction may be had while the matter is fresh in their minds.

Wherever practicable, when several groups of men are working on the same class of work, stimulate their interest and activities by pitting one or more groups against each other, both as to quality of work and speed of execution. The results of such a competition may be shown graphically by a large chart which can be hung in the class room or shop and be seen daily by the students. The instructor should impress upon the students that this job is to be their masterpiece and that they must exert every effort to make it a lasting monument of their skill and knowledge.

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