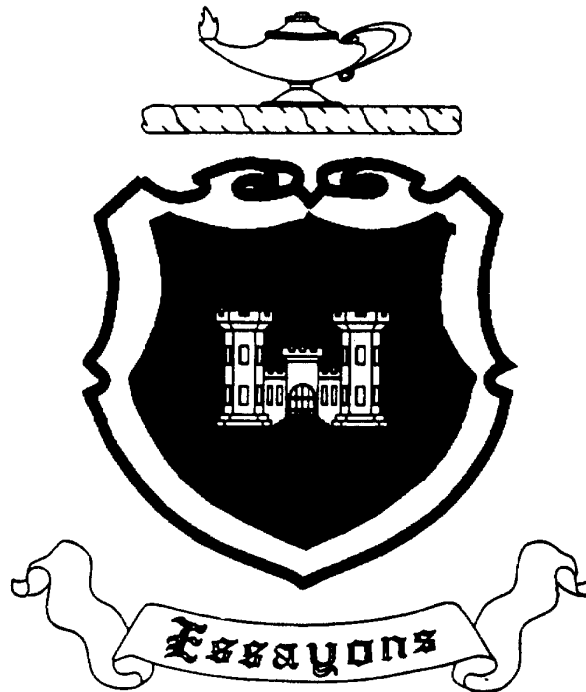


**SUBCOURSE
EN5155**

**EDITION
A**

US ARMY ENGINEER CENTER AND SCHOOL

CARPENTRY I



"LET US TRY"

**THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT
ARMY CORRESPONDENCE COURSE PROGRAM**

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**THRU
GROWTH**

CARPENTRY I

Subcourse EN5155

EDITION A

United States Army Engineer School
Fort Leonard Wood, Missouri 65473

7 Credit Hours

Edition Date: July 1995

SUBCOURSE OVERVIEW

We designed this subcourse to teach you the basic skills of an Army carpenter and the building materials and tools you will use. Contained within this subcourse is instruction on construction prints, building materials, hand tools, and power machinery.

There are no prerequisites for this subcourse.

This subcourse reflects the current doctrine when this subcourse was prepared. In your own work, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

TERMINAL LEARNING OBJECTIVE:

This course is designed to give soldiers practical knowledge of basic carpentry.

ACTION: You will learn to read, understand, and interpret construction prints (also called *working drawings*); to identify, use, and requisition building materials; and to care for and use hand tools and power machinery.

CONDITION: You will be given the material in this subcourse and an Army Correspondence Course Program (ACCP) examination response sheet.

STANDARD: To demonstrate competency of this task, you must achieve a minimum of 70 percent on this subcourse.

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LESSON 1

CONSTRUCTION PRINTS AND BUILDING MATERIALS

OVERVIEW

LESSON DESCRIPTION:

In this lesson you will learn to read construction prints, identify drawing legends and symbols, prepare a bill of materials (BOM), and become familiar with basic building materials.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn to read prints; prepare a BOM; and learn the basic types of building materials.

CONDITION: You will be given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of this lesson.

REFERENCES: The material contained in this lesson was derived from the following publications: Field Manual (FM) 5-426 (to be published within six months) and Technical Manual (TM) 5-704.

INTRODUCTION

One of the basic skills in carpentry is the ability to read, understand, and interpret architectural drawings. Architectural drawings consist of a preliminary sketch and construction prints. Carpenter should also know how to prepare a BOMs to requisition materials needed for a construction project. They must also be familiar with basic building materials such as lumber and hardware.

PART A - CONSTRUCTION PRINTS FOR BUILDINGS

A set of construction prints (also called *working drawings*, or a *set of plans*) consists of all drawings necessary for the carpenter to construct a building. The set is composed of plan views (called *plans*), elevation views (called *elevations*), and

detailed drawings (called *sections* and *details*); a schedule of drawings; and notes and information (called *specifications*). Specifications consist of information such as the quality and quantity of the materials and the construction methods to be used. A well-drawn set of prints and well-written specifications will help prevent disagreements and misunderstandings.

The purpose of construction prints is to be exact about shape and size. They are generally scale-size (with dimensions). It is very important to know how to read and use construction prints.

1-1. Information on Drawings. Drawings contain different lines, scales, and symbols. To read drawings, you must be able to interpret these items. They also include other information in the form of schedules, notes, and tables.

a. Schedule of Drawings. A schedule of drawings lists the drawings by number, title, and sheet number (Table 1-1). It is usually on the first drawing of a set of prints.

Table 1-1. Schedule of drawings

Drawing Number	Description	Sheet Number
13-12	Plans	1-2 of 2
13-4	Window details	1 of 1
99-98	Standard details	1 of 2
34-19	Wood frame construction shop-heavy-duty	1-12 of 12

b. General Notes. General notes give additional information that is needed (Figure 1-1). For example, item number 3 is for the carpenter.

- | |
|---|
| <ol style="list-style-type: none"> 1. Refer to TM 5-303 or building-shell requirements. 2. For national stock number (NSN) BOM, refer to TM 5-303 by facility number. 3. Wood-frame structures are to be based on standard shop heavy-duty buildings. The column heights are to be reduced so that the clear height is 13 feet (3.962 meters) minimum below ductwork fixtures. |
|---|

Figure 1-1. General notes

c. Graphic and Ratio Scales. Because of the sizes of the objects being represented, different scales are used for drawings (Figure 1-2).

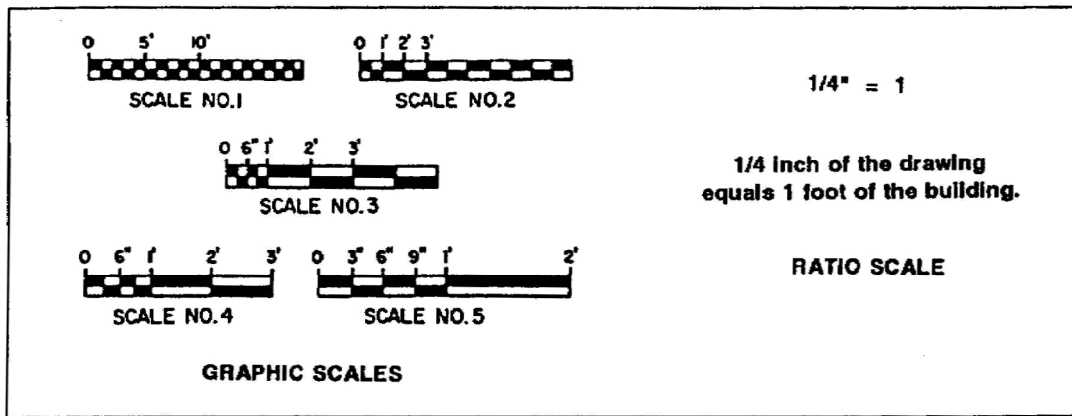


Figure 1-2. Graphic and ratio scales

d. Lines on Drawings (Figure 1-3, page 1-4). Line conventions most often seen on working drawings are-

(1) Visible Lines. A heavyweight unbroken line is used for the primary feature of a drawing. For drawings of objects, this line convention represents the edges, the intersection of two surfaces, or the surface limit that is visible from the viewing angle of the drawing. This lines is often called the *outline*.

(2) Hidden Lines. A medium weight line of evenly spaced short dashes represents an edge, the intersection of two surfaces, or the surface limit which is not visible from the viewing angle of the drawing.

(3) Center Lines. A thin (light) line composed of alternate long and short dashes of consistent length is called a centerline. It is used to signify the center of a circle or arc and to divide object into equal or symmetrical parts.

(4) Dimension Lines. A solid, continuous line terminating in arrowheads at each end. Dimension lines are broken only to permit writing in dimension. On construction drawings, the dimension lines are unbroken. The points of the arrowheads touch the extension lines which mark the limits of the dimension. The dimension is expressed in feet and inches on architectural drawings and in feet and decimal fractions of a foot on engineering drawings.

(5) Extension lines. An extension line is a thin (light), unbroken line that indicates the extent of the dimension lines. The extension line extends the visible lines of an object when it is not convenient to draw a dimension line directly between the visible lines. There is always a small space between the extension line and the visible line.


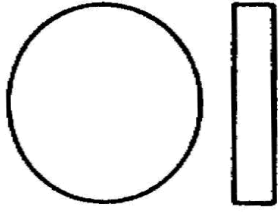



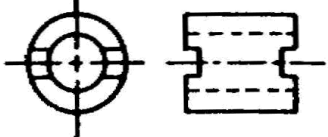

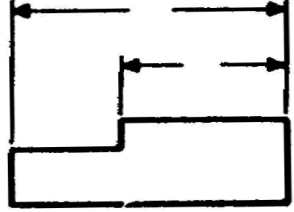

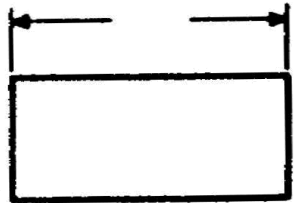
LINE CONVENTIONS			
NAME	CONVENTION	DESCRIPTION AND APPLICATION	EXAMPLE
VISIBLE LINES		HEAVY, UNBROKEN LINES USED TO INDICATE VISIBLE EDGES OF AN OBJECT	
HIDDEN LINES		MEDIUM LINES WITH SHORT, EVENLY SPACED DASHES USED TO INDICATE CONCEALED EDGES	
CENTER LINES		THIN LINES MADE UP OF LONG AND SHORT DASHES ALTERNATELY SPACED AND CONSISTENT IN LENGTH USED TO INDICATE SYMMETRY ABOUT AN AXIS AND LOCATION OF CENTERS	
DIMENSION LINES		THIN LINES TERMINATED WITH ARROWHEADS AT EACH END USED TO INDICATE DISTANCE MEASURED	
EXTENSION LINES		THIN, UNBROKEN LINES USED TO INDICATE EXTENT OF DIMENSIONS	

Figure 1-3. Line conventions

e. Architectural Symbols. These symbols are used on drawings to show the type and location of doors, windows, and material conventions. To understand construction drawings, you must be able to recognize and interpret these symbols (Figure 1-4).

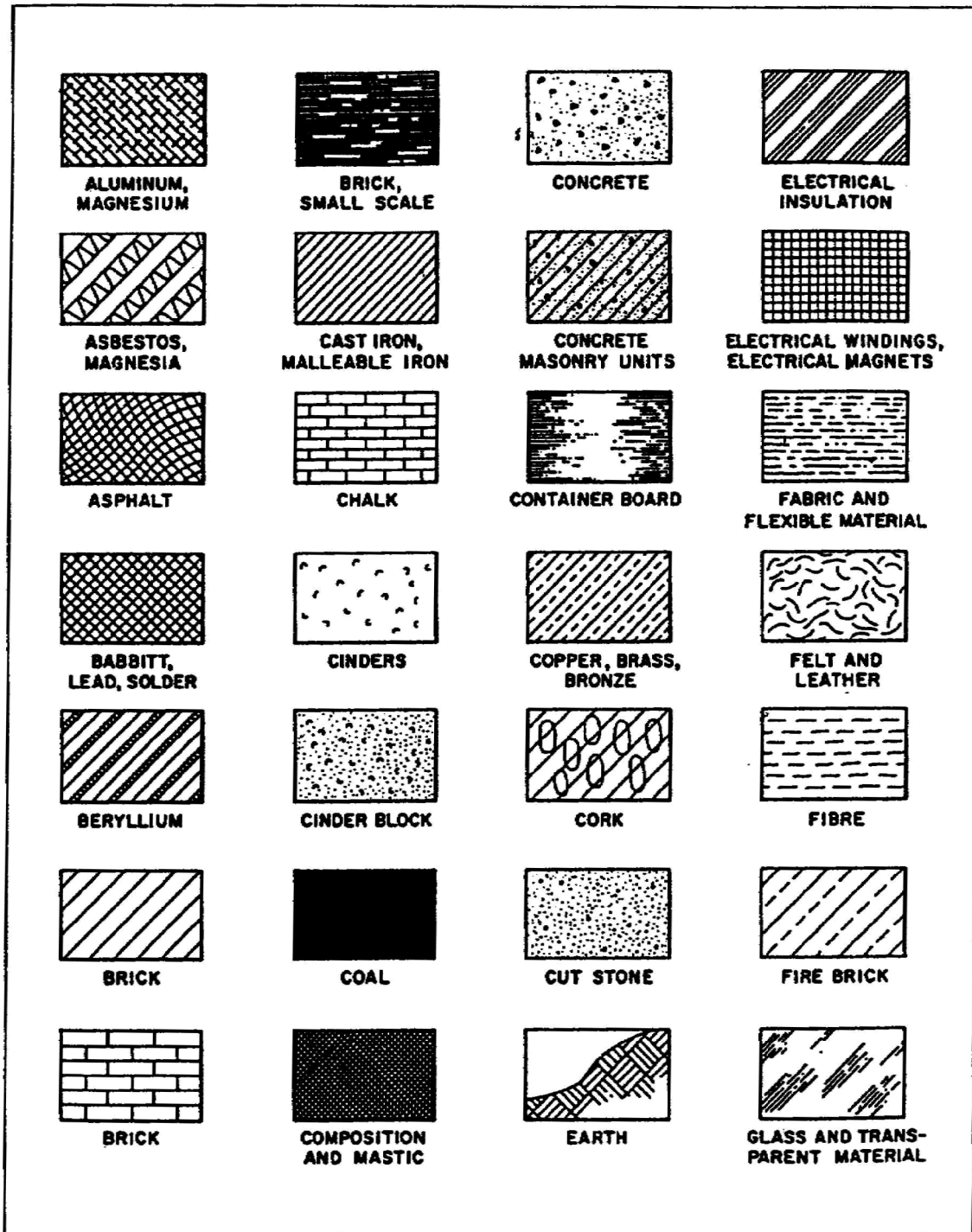


Figure 1-4. Architectural symbols

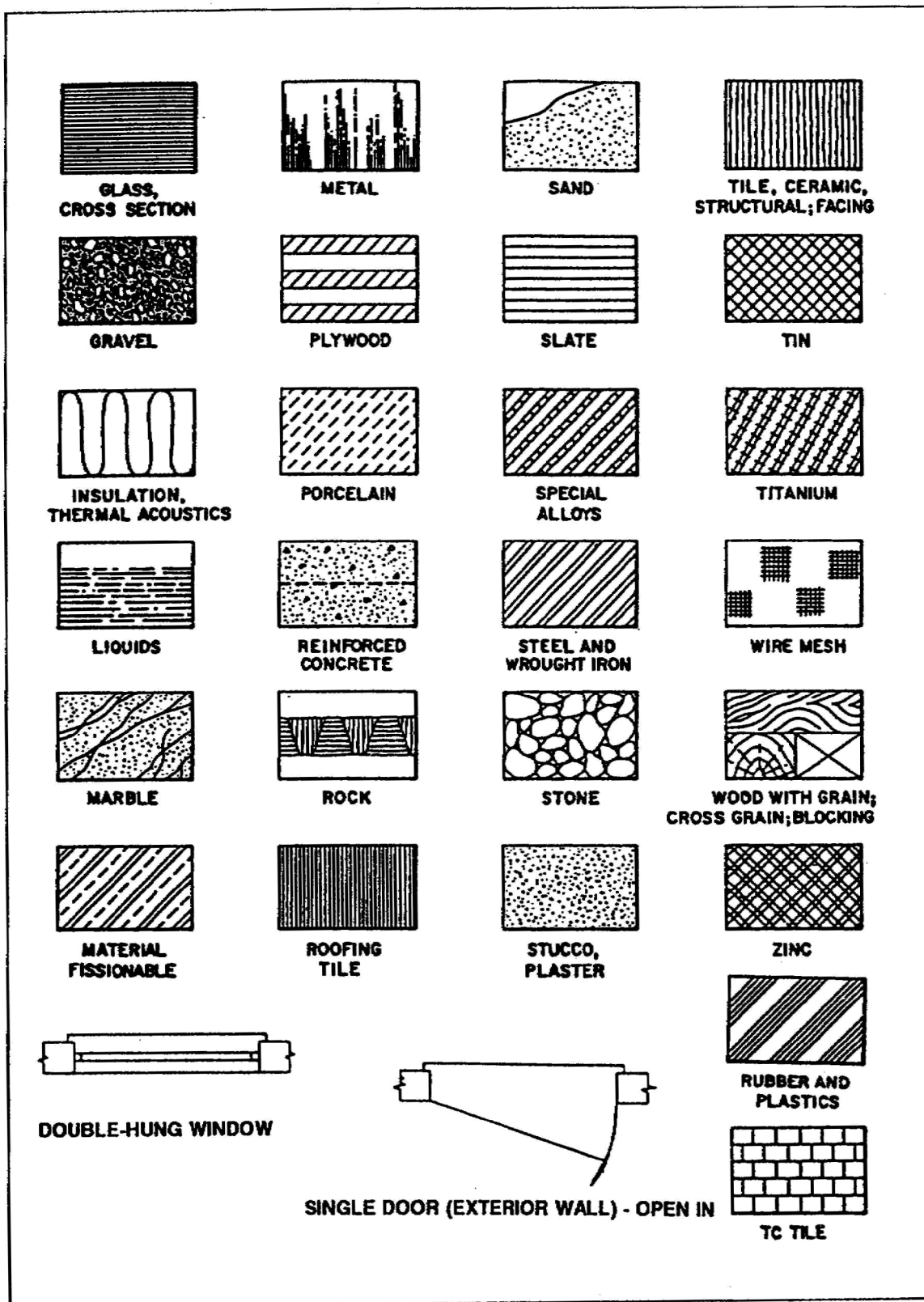


Figure 1-4. Architectural symbols (continued)

1-2. Working Drawings. Working drawings and specifications are the main sources of information for supervisors and technicians responsible for the actual construction. The construction working drawing gives a complete graphic description of the structure to be erected and the construction method to be followed. A set of working drawings includes both general and detail drawings. General drawings consist of plans and elevations; detail drawings consist of sections and detail views.

a. Site Plan. A site plan (also called a *plot plan*) (Figure 1-5) shows the boundaries of the construction site, the location of the building in relation to the boundaries, the ground contour, and the roads and walks. It may also show utility lines such as sewer, gas, and water. This type of plan is drawn from a survey of the area by locating the corners of the building at specific distances from the established reference points.

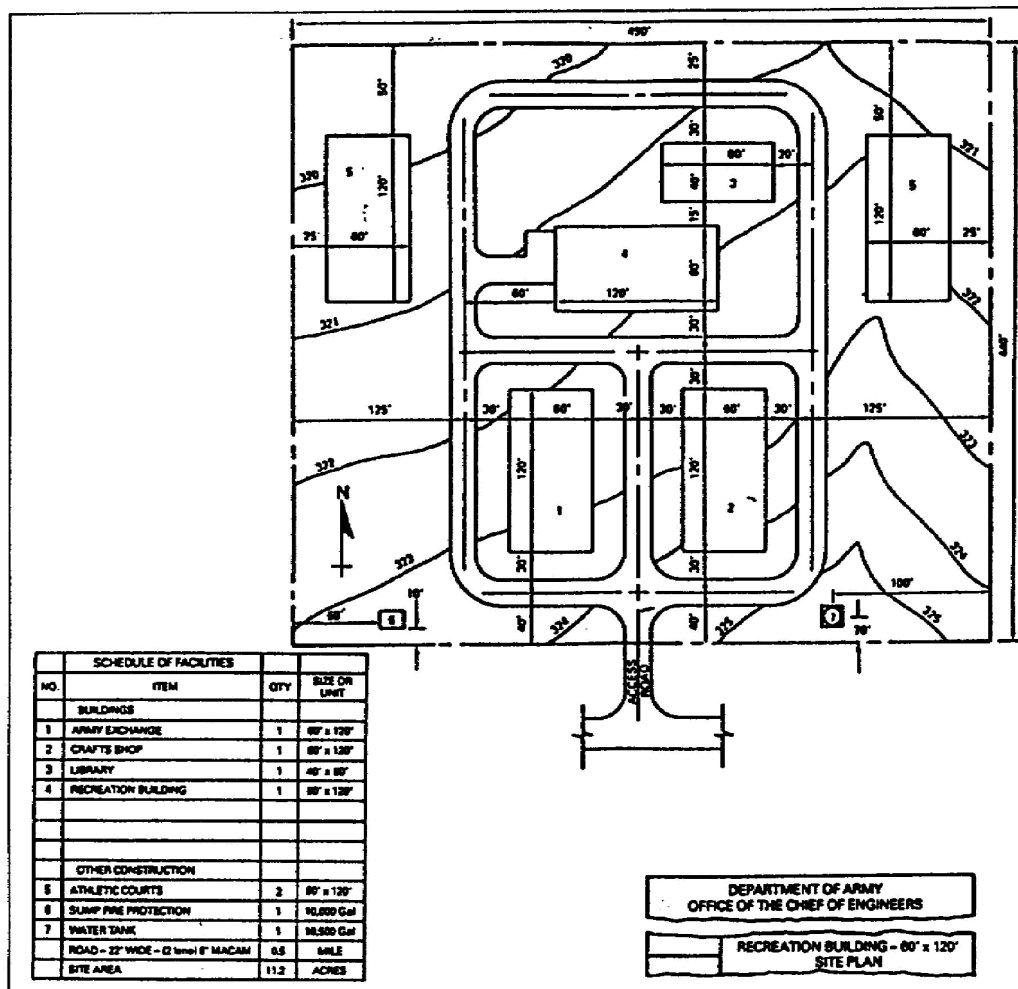


Figure 1-5. Site plan

b. Elevations. Elevations are drawings that are commonly used to show exterior views of a structure from the front, rear, left, and right sides (Figure 1-6). They show a picture-like view as it would actually appear on a vertical plane. You must have a good overall idea of the structure before you examine it in detail. Elevations also show the types of doors and windows (drawn to scale) and how they will appear on the finished structure. Ask yourself does the structure have a simple roof? Is the floor level close to ground level (grade)?

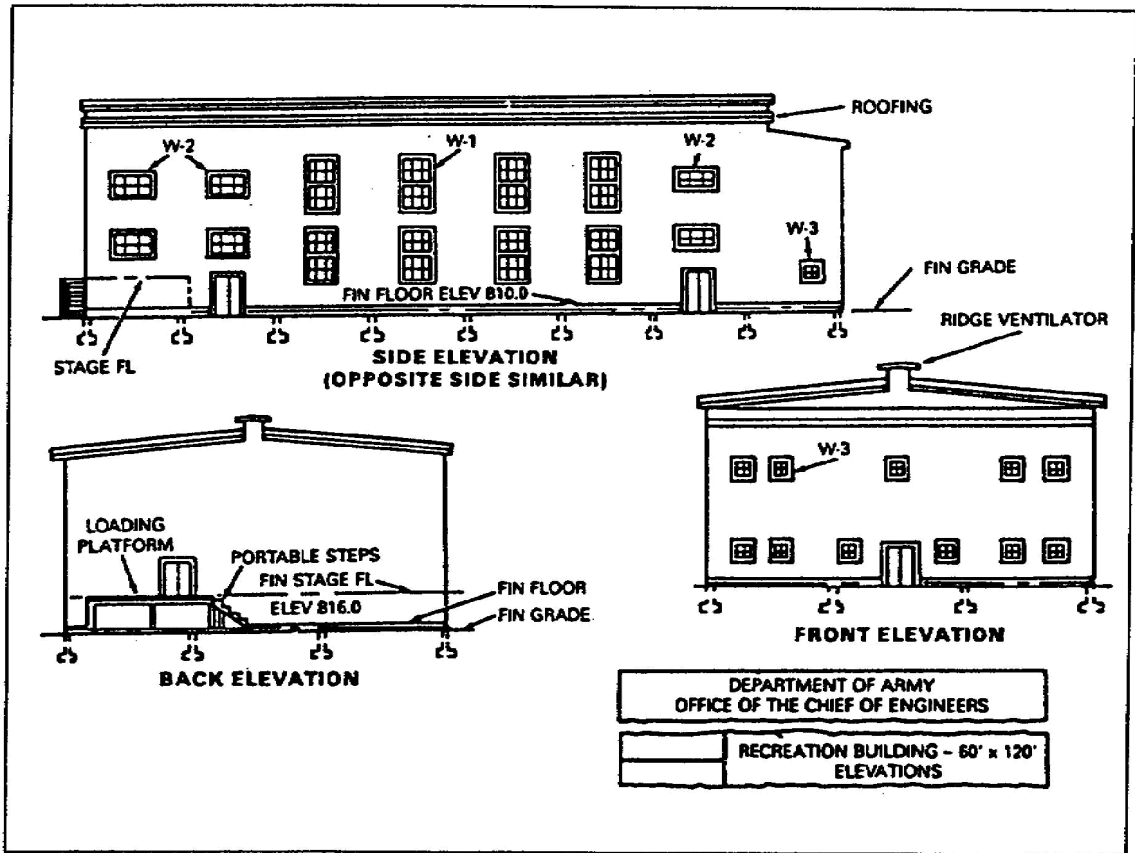


Figure 1-6. Elevation views

Elevations are made more lifelike by accenting certain lines and adding straight lines to represent the types of materials used on the exterior (Figure 1-7). Lines that may be accented are window, door, roof, and building outlines. When accenting lines, you must assume that the light is coming from a certain direction and that accented lines represent shaded areas. Using straight lines to suggest the texture of exterior materials is a form of architectural rendering. Rendering, as applied to architectural drawings, is the use of a pencil, ink, watercolors, or a combination of these to depict (paint) a structure and bring out its form or shape.

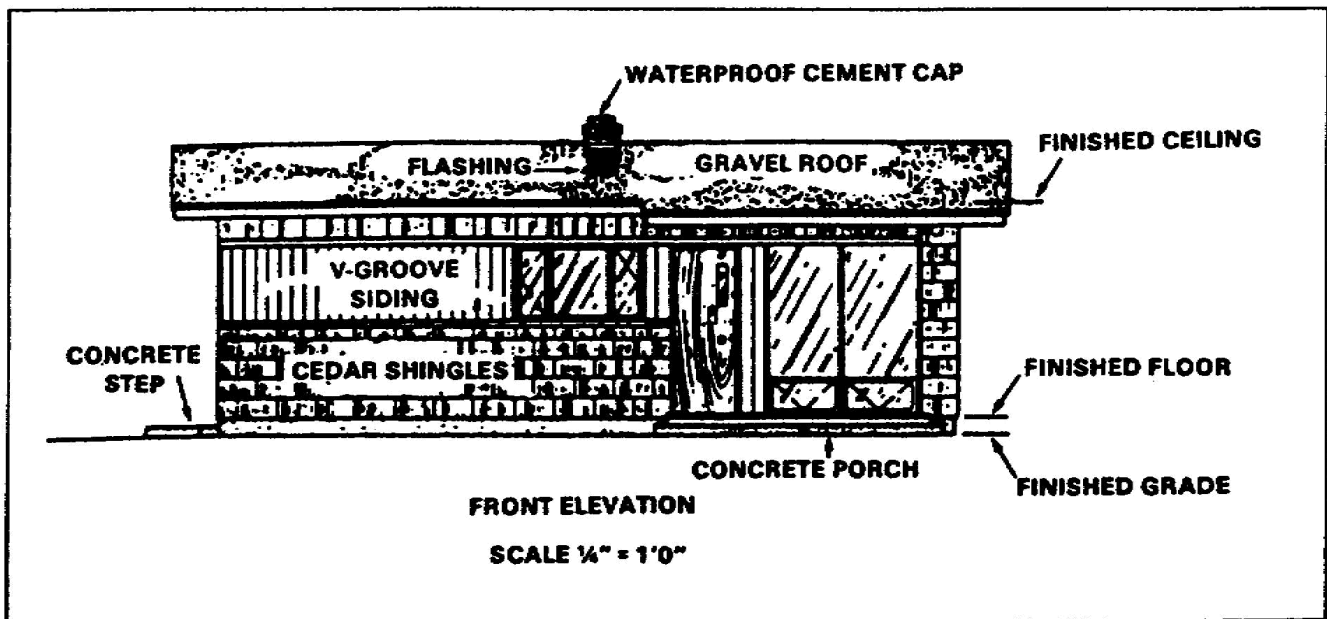


Figure 1-7. Accent lines

c. Floor Plan. A floor plan is a cross-sectional view of a building. The horizontal cut crosses all openings, regardless of their height from the floor. The development of a floor plan is shown in Figure 1-8, page 1-10. Note that a floor plan shows the outside shape of the building the arrangement, size, and shape of the rooms; the type of materials; and the length, thickness, and character of the building walls at a particular floor. A floor plan also includes the type, width, and location of the doors and windows; the types and locations of utility installations; and the location of stairways. A typical floor plan is shown in Figure 1-9, page 1-11.

(1) Drawings and Specifications. Drawings and specifications inform the contractor, owner, material dealers, and tradespeople of decisions made by the architect and owner of the structure. Floor plans are usually drawn to scale ($1/4" = 1'$ or $3/16" = 1'$). Symbols are used to indicate different types of fixtures and materials.

NOTE: Electrical, heating, and plumbing layouts are either on the floor plan or on separate drawings attached to the floor plan.

(2) Floor Plan details. Detailed drawings may appear on the plan or on separate sheets attached to the plan. When detailed drawings are on separate sheets, a reference symbol is drawn on the floor plan. A door and window schedule is presented on the plan (see sample on Table 1-2 on page 1-10 is a sample showing the information given on the schedule).

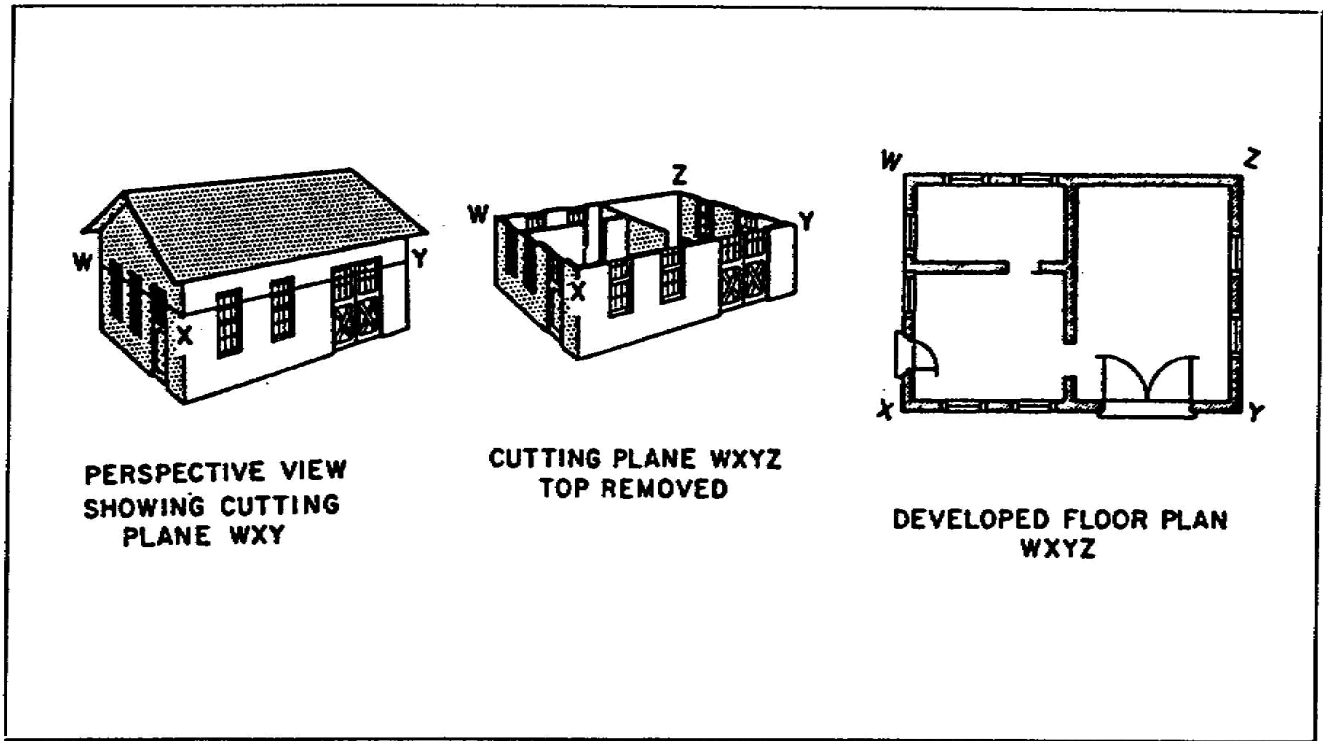


Figure 1-8. Floor-plan development

Table 1-2. Door and window schedule

Door Schedule				
Location	Type	Size	Quantity	Remarks
1	A	3'-0" x 6'-0" x 1 3/4"	1	Insulated
2	B	4'-0" x 6'-0" x 1 3/4"	2	Insulated
3	C	1'-0" x 6'-8" x 1 3/4"	1	
4	D	4'-0" x 6'-0" x 1 3/4"	1	
5	E	2'-4" x 6'-8" x 1 3/8"	2	
6	F	2'-4" x 6'-8" x 1 3/8"	3	
7	G	2'-4" x 6'-8" x 1 3/8"	2	
8	H	3'-0" x 2'-6" x 1 3/8"	1	Louvered
9	I	4'-0" x 6'-8" x 1 3/8"	1	Double bifold
10	J	1'-6" x 6'-8" x 1 3/8"	4	Double bifold
11	K	4'-0" x 2'-6" x 1 3/8"	8	Double bifold
12	L	2'-4" x 6'-8" x 1 3/8"	2	Double bifold
Window Schedule				
1	A	4' - 1" x 2'-1"	6	Insulated glass
2	B	4' - 1" x 5'-3"	6	Insulated glass
3	C	4' x 1" x 4' x 1"	4	Insulated glass

d. Detail Drawings (Sections and Details). Detail drawings are drawn to a larger scale than plans and elevations to give more elaborate information, dimensions, and details. For example, they may give the size of materials and show the placement of parts in relation to each other.

(1) Sections. Sections are drawn to a large scale showing details of a particular construction feature that cannot be given in a general drawing. They show-

- Height.
- Materials.
- Fastening and support systems.
- Any concealed features.

(a) Wall section. A typical section, with parts identified by name and/or size, is illustrated in Figure 1-10. This figure shows how a structure looks when cut vertically by a cutting plane. Wall sections are very important to construction supervisors and to the craftsmen who do the actual building. They show the construction of the wall, as well as the way in which structural members and other features are joined to it. Wall sections extend vertically from the foundation bed to the roof. Sections are classified typical and specific. Figure 1-11 shows a typical window section.

(b) Typical sections. Typical sections are used to show construction features that are repeated many times throughout a structure.

(c) Specific sections. When a particular construction feature occurs only once and is not shown clearly in the general drawing, a cutting plane is passed through that portion.

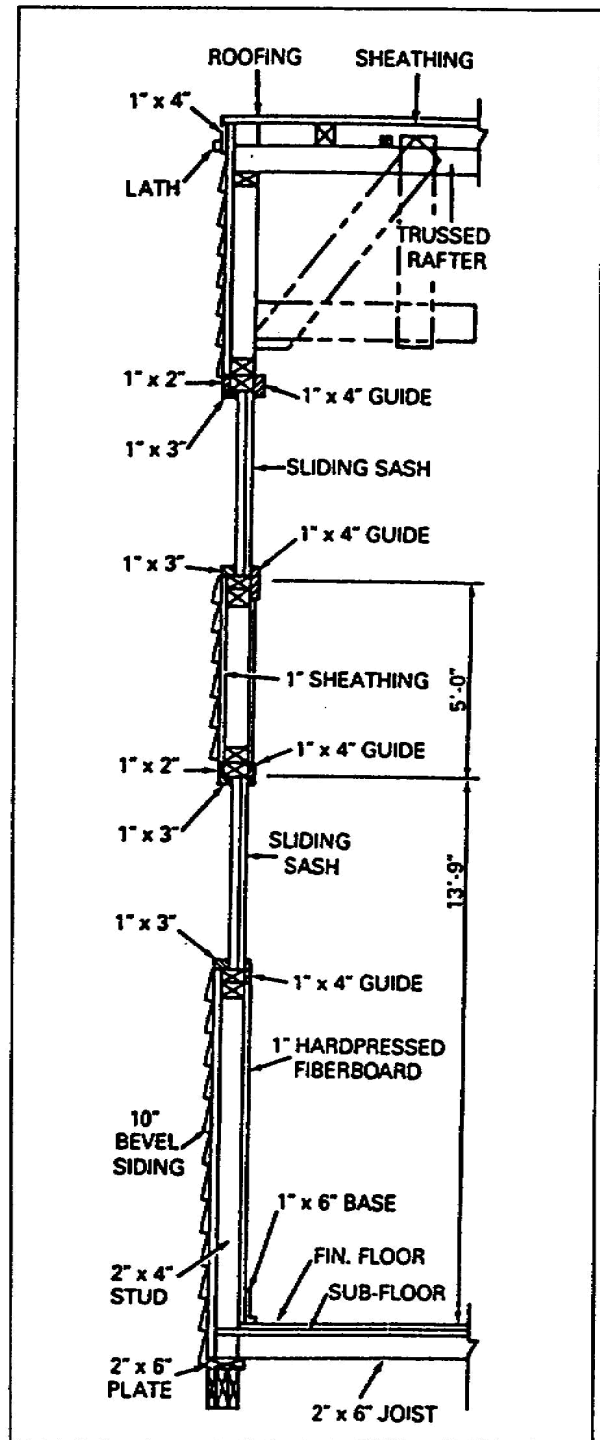


Figure 1-10. Typical wall section

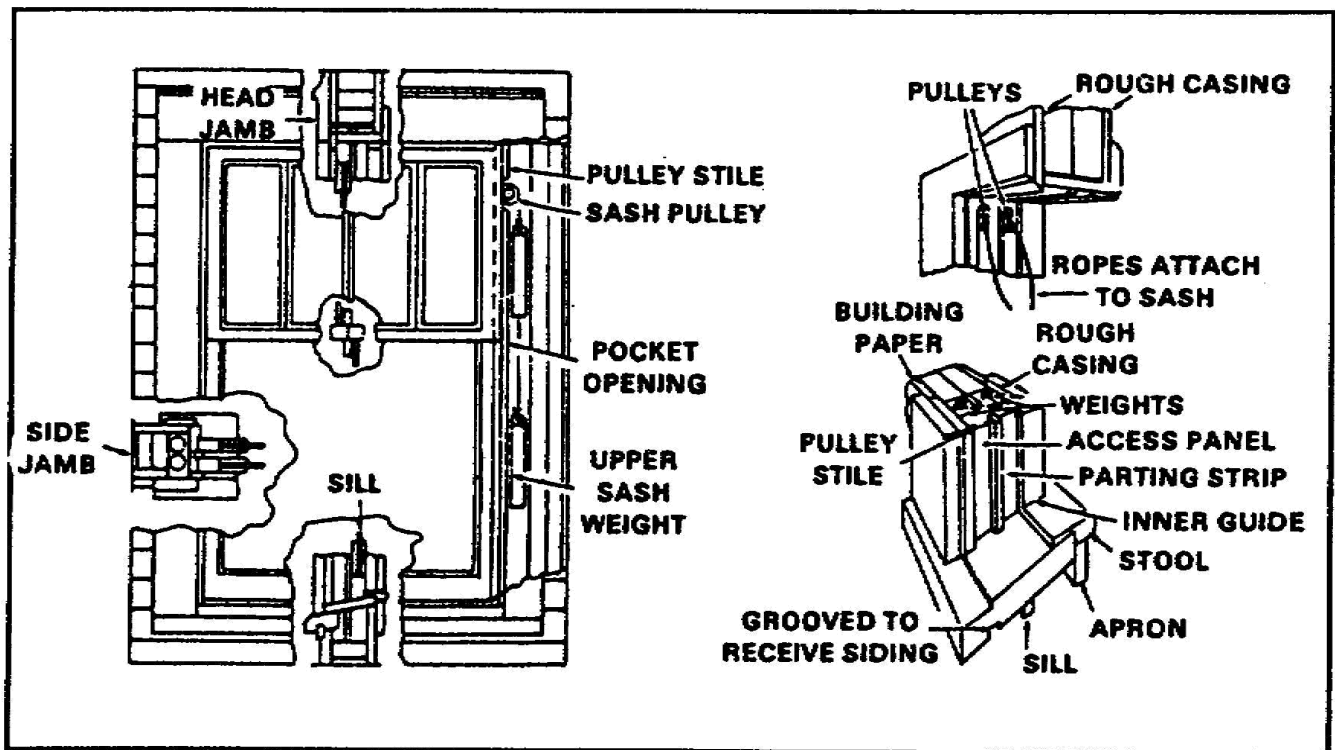


Figure 1-11. Window section

(2) Details. Details are large-scale drawings which show features that do not appear (or appear on too small a scale) on the plans, elevations, and sections. Sections show the builder how various parts are connected and placed. Details do not have a cutting-plane indication but are simply noted by a code. The construction of doors, windows, and eaves is usually shown in detail drawings. Figure 1-12, page 1-14, shows some typical door-framing details, window wood-framing details, and an eave detail for a simple type of cornice. Other details that are customarily shown are sills, girder and joint connections, and stairways.

Figure 1-13, page 1-15, shows how a stairway is drawn in a plan and how riser-tread information is given. For example, on the plan, DOWN 17 RISERS followed by an arrow means that there are 17 risers in the run of stairs going from the first floor to the floor below, in the direction indicated by the arrow. The riser-tread diagram provides height and width information. The standard for the riser, or height from the bottom of the tread to the bottom of the next tread, ranges from 6 1/2 to 7 1/2 inches. The tread width is usually such that the sum of riser and tread is about 18 inches (a 7-inch riser and 11-inch tread is standard). On the plan, the distance between the riser lines is the width of the tread.

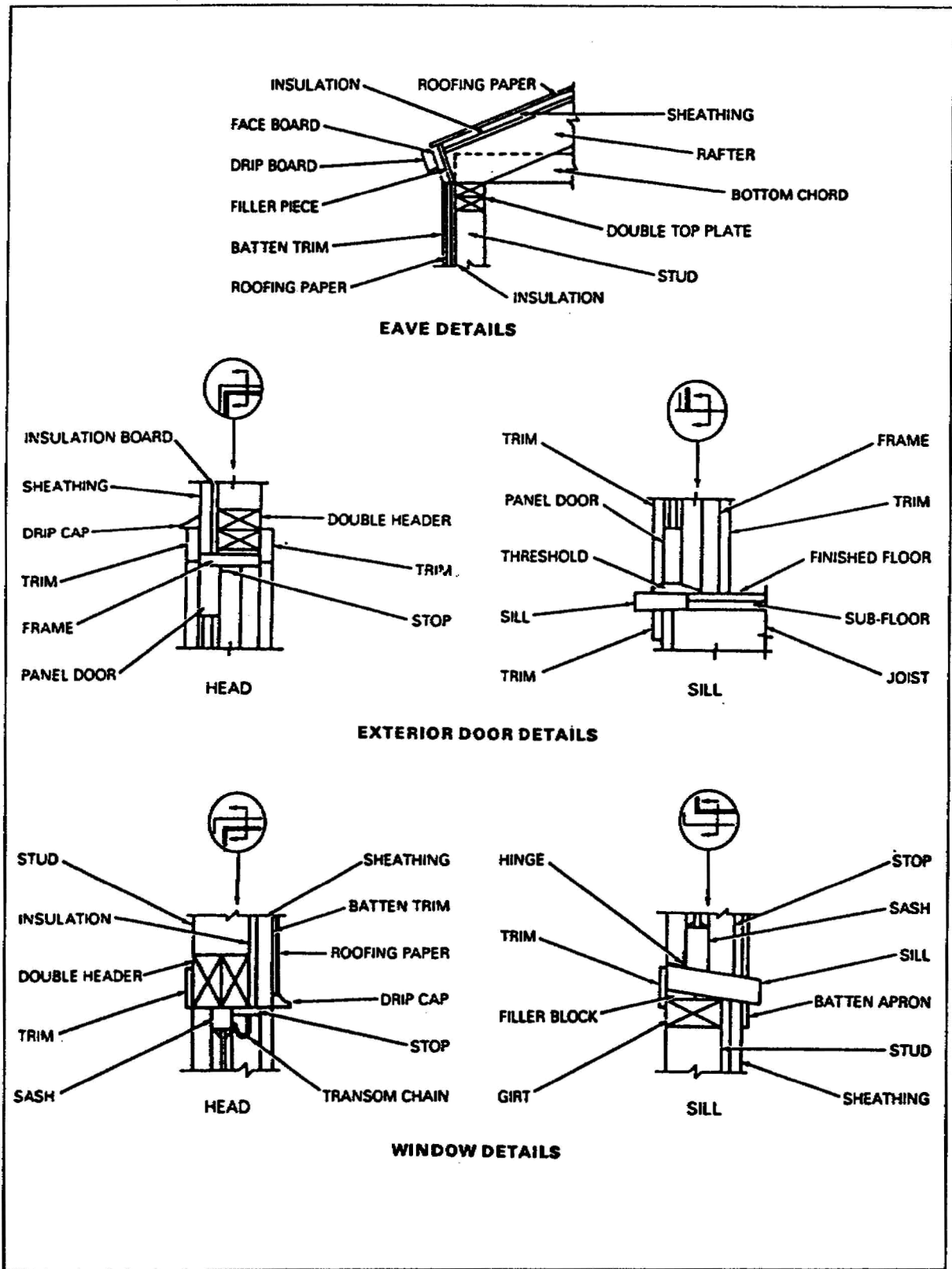


Figure 1-12. Typical eave, door, and window details

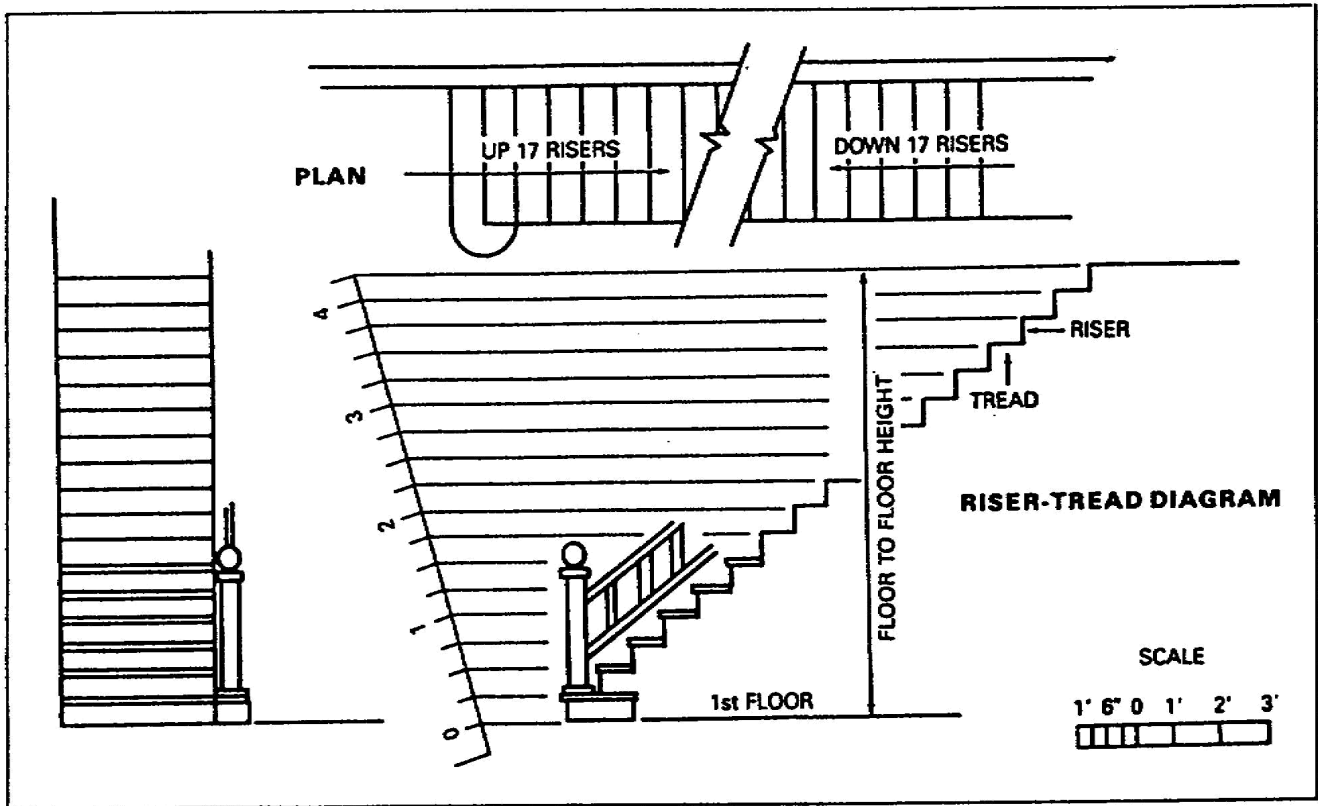


Figure 1-13. Stairway and steps

e. Wood-Framing Drawing. Framing plans show the size, number, and location of the structural members constituting the building framework. Separate framing plans may be drawn for the floors, walls, and roof. The floor-framing plan must specify the sizes and spacing of joists, girders, and columns used to support the floor. Detail drawings are added, if necessary, to show the methods of anchoring joists and girders to the columns and foundation walls or footings. Wall-framing plans show the location and method of framing openings and ceiling heights so that studs and post can be cut. Roof-framing plans show the construction of the rafters used to span the building and support the roof. Size, spacing, roof slope, and all necessary details are shown. Working prints for theater of operation (TO) buildings usually show details of all framing.

f. Light Wood Framing. Light framing is used in barracks, bathhouses, administration buildings, light shops, hospitals, and similar structures. Detailed drawings of foundation walls, footings, posts, and girder details normally used in standard TO construction are shown in Figure 1-14, page 1-16.

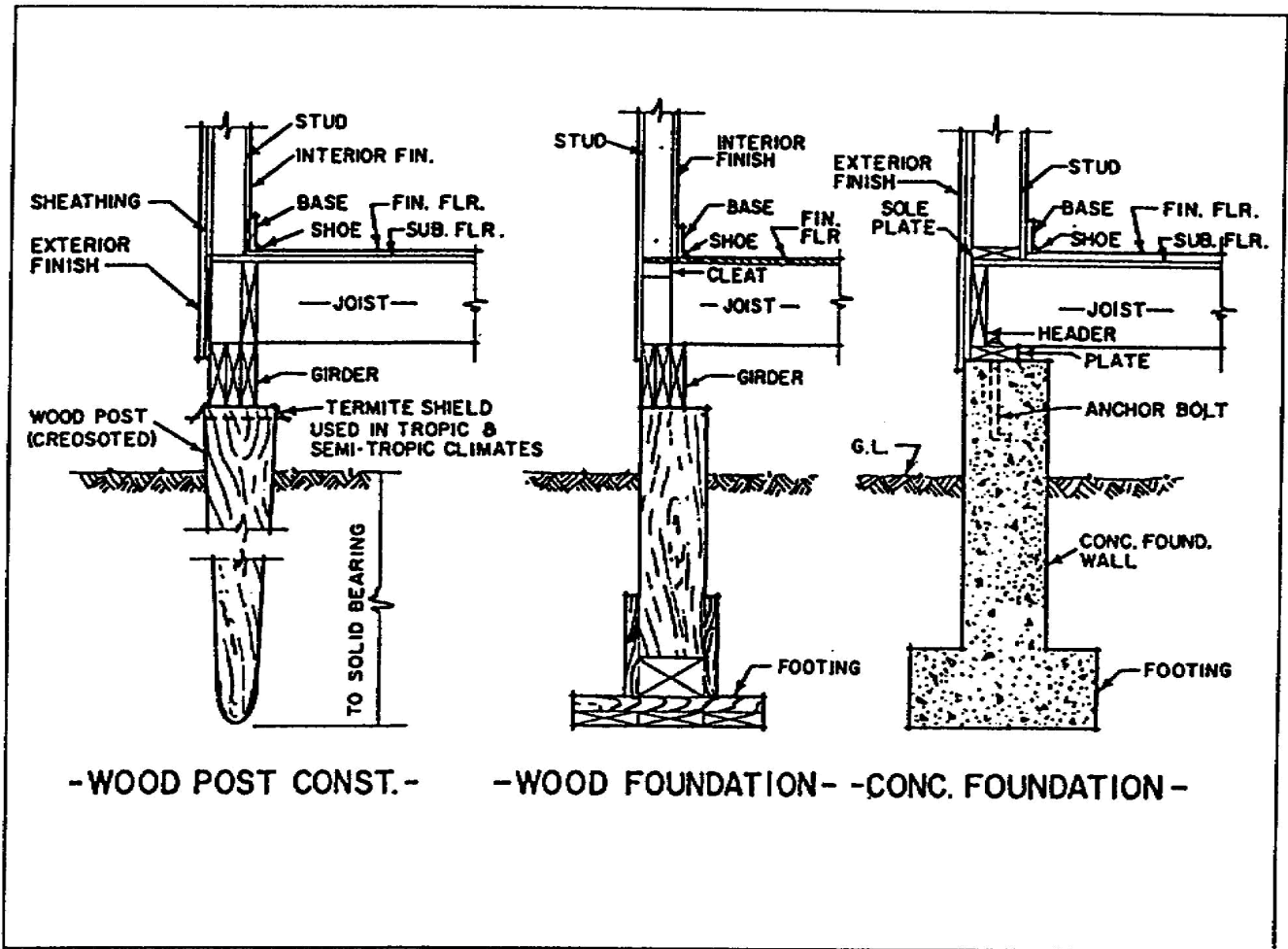


Figure 1-14. Typical foundation wall, post, footing, and girder details

The various details for overall framing of a 20-foot-wide building (including ground level, window openings, brace, splices, and nomenclature of framing) are shown in Figure 1-15, page 1-17.

A construction drawing shows the type of footings and size of the various members. Some drawings give the various lengths, while others specify the required lengths on the accompanying BOM. Figure 1-16, page 1-18, shows floor-framing details showing footings, posts, girders, joists, reinforced sections of floor for heavy loads, section views covering makeup of certain sections, scabs for joint girders to posts, and post-bracing details as placed for cross sections and longitudinal sections.

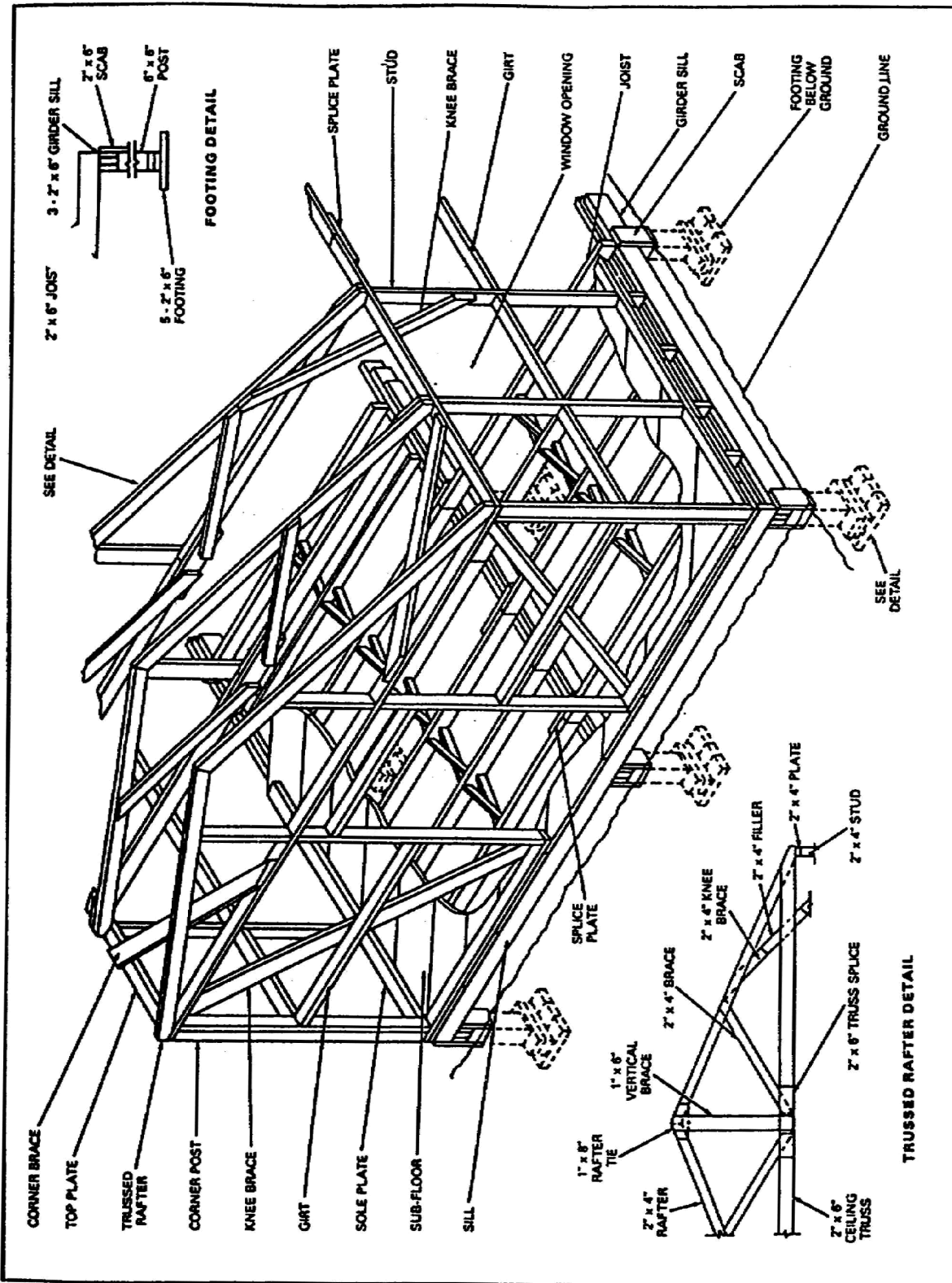


Figure 1-15. Light framing details (20-foot-wide building)

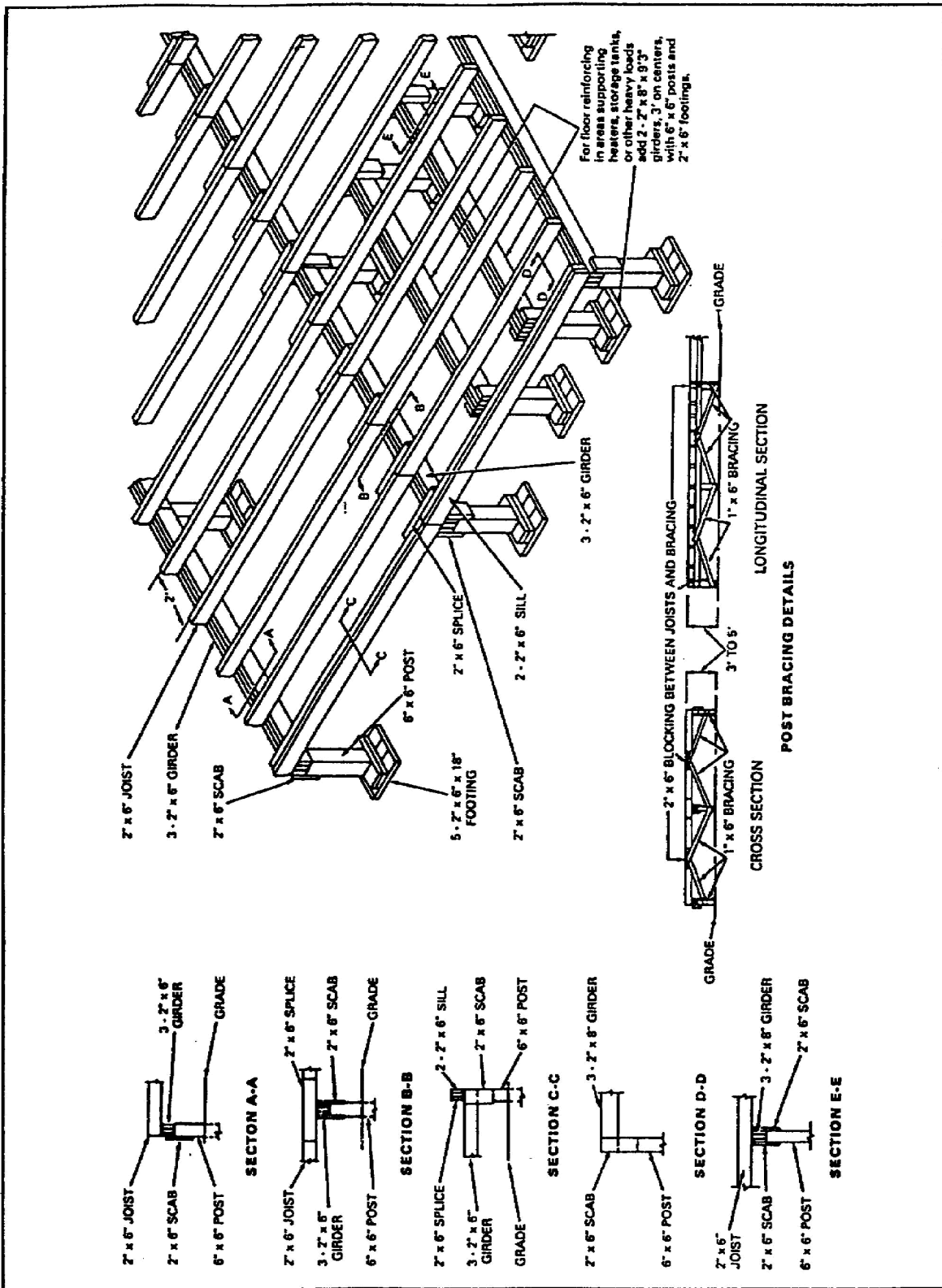


Figure 1-16. Floor-framing details (20-foot-wide building)

Wall framing for end panels is shown in view A in Figure 1-17. Wall-framing plans are detail drawings showing the locations of studs, plates, sills, and bracing. They show one wall at a time. The height for panels is usually shown. From this height, the length of wall studs is determined by deducting the thickness of the top or rafter plate and the bottom plate. Studs placed next to window openings may be placed either on edge or flat, depending on the type of windows used. Details for side panels (view B) cover the same type of information as listed for end panels. The space between studs is given in the wall-framing detail drawing, as well as height of girt from bottom plate and types of door and window openings, if any. For window openings the details specify whether the window is hinged to swing in or out, or whether it is to be a sliding panel.

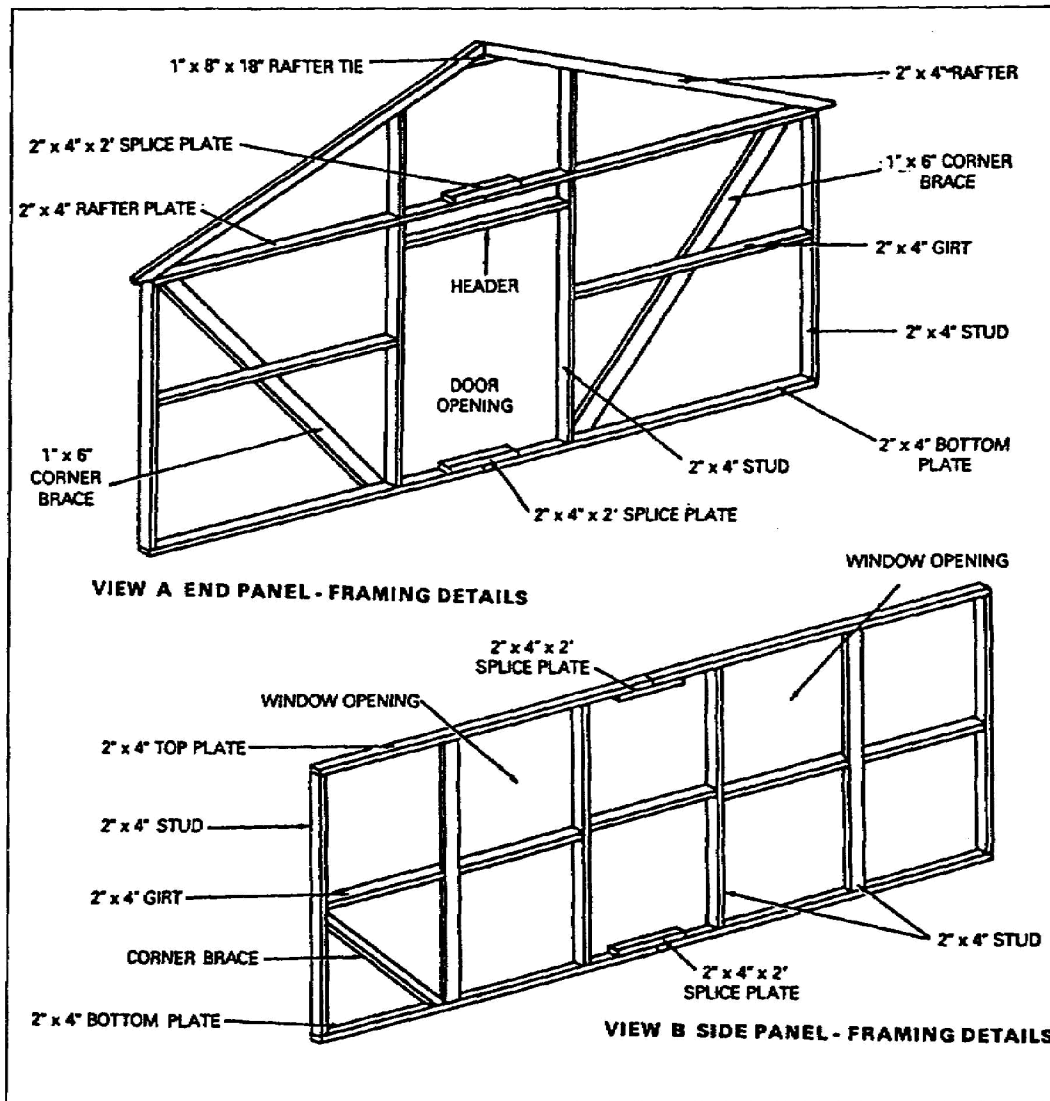


Figure 1-17. Typical wall-panel framing details

Examples of drawings showing the makeup of various trussed rafters are given in Figure 1-18. A 40-foot trussed rafter showing a partition bearing in the center is shown in view A. The drawing shows the splices required, bracing details, the stud and top plate at one end of the rafter, and the size of the members.

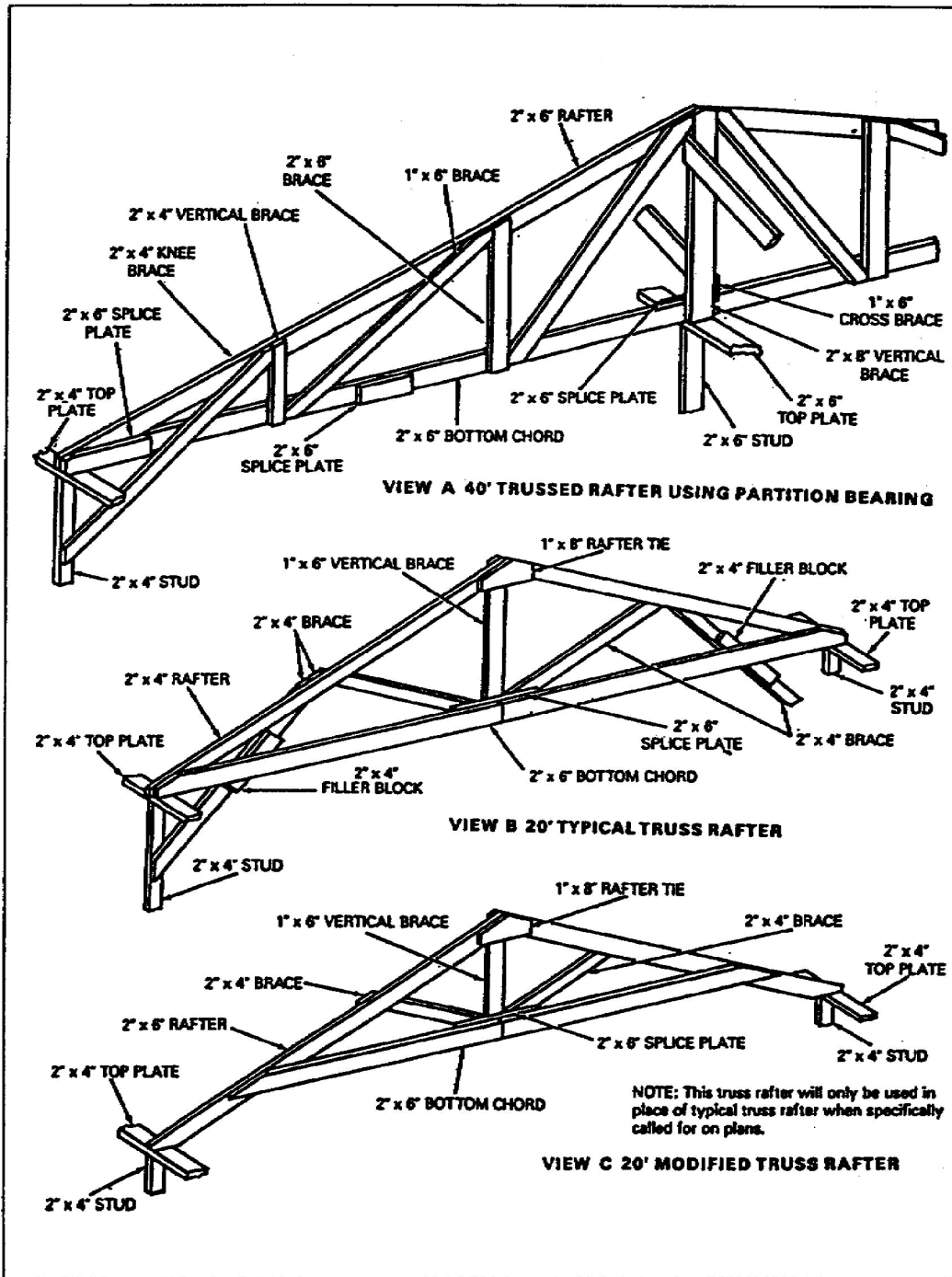


Figure 1-18. Trussed-rafter details

A typical detail drawing of a 20-foot truss rafter is shown in view B. Use filler blocks to keep the brace members in a vertical plane, since the rafter and bottom chord are nailed together rather than spliced. The drawing shows placement of the rafter tie on the opposite side from the vertical brace. Usually the splice plate for the bottom chord (if one is needed) is placed on the side where the rafters are to be nailed so that it can also serve as a filler block.

Use a modified truss, shown in view C, only when specified in plans for certain construction. It should not be used in areas subject to high wind velocities or moderate to heavy snowfall. In this type of trussed rafter, the bottom chord is placed on the rafters above the top plate. The construction plans specify the best type of trussed rafter for the purpose. The drawings must show, in detail, the construction features of the rafter selected.

g. Heavy Wood Framing. Heavy wood framing consists of framing members (timber construction) at least 6 inches in dimension (for example, 2 by 6 inches or 4 by 12 inches). Examples of this type framing are heavy roof trusses, timber-trestle bridges, and wharves. The major differences between light and heavy framing are the size of timber used and the types of fasteners used.

h. Foundation Plan. Figure 1-19, page 22 shows a foundation plan. The foundation is the starting point of the construction. Detail drawings and specifications for a plan are usually attached on a separate sheet.

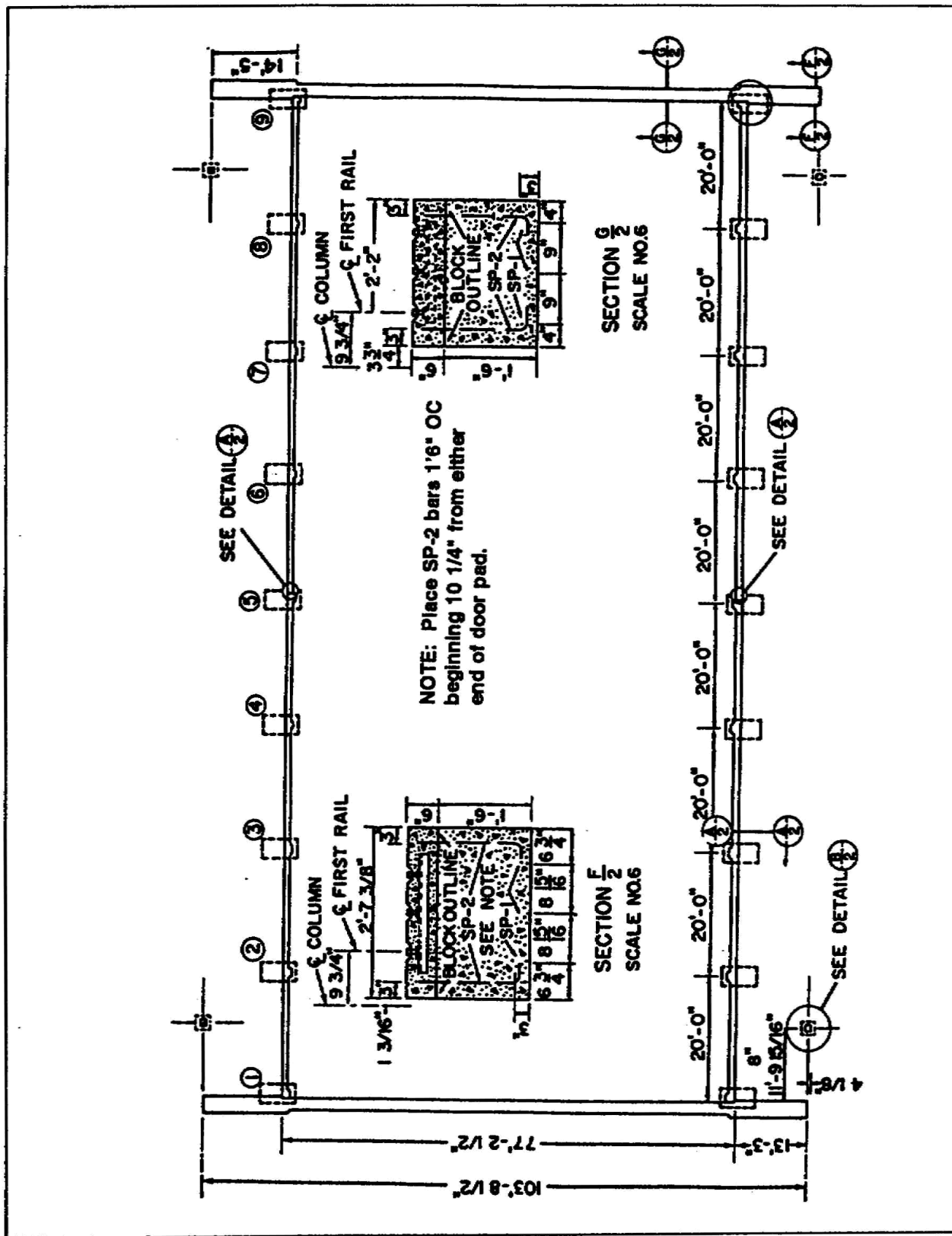


Figure 1-19. Foundation plan

PART B - BILL OF MATERIALS

Before any construction project is started, make out a BOMs to requisition building materials. However, you should first make a materials takeoff list and a materials estimate list, before making out the BOM.

1-3. Materials Takeoff List. This list is the first step leading to preparation of a BOM. It is a listing of all parts of the building, taken off the plan. Table 1-3 shows a materials takeoff list for the building substructure shown in Figure 1-20, page 1-24.

Table 1-3. Sample materials takeoff list

Item Name or Use of Piece	No of Pieces	Unit	Length in Place	Size	Length	No Per Length	Quantity
1. Footers	45	pc	1' - 5"	2x6	10'	7	7
2. Spreaders	30	pc	1' - 4"	2x6	8'	6	5
3. Foundation post	15	pc	3' - 0"	6x6	12'	4	4
4. Scabs	20	pc	1' - 0"	1x6	8'	8	3
5. Girders	36	pc	10' - 0"	2x6	10'	1	36
6. Joists	46	pc	10' - 0"	2x6	10'	1	46
7. Joist splices	21	pc	2' - 0"	1x6	8'	4	6
8. Block bridging	40	pc	1' - 10 3/8"	2x6	8'	4	10
9. Closers	12	pc	10' - 0"	1x8	10'	1	12
10. Flooring	800	BF	RL	1x6	RL	—	—

1-4. Materials Estimate List. A materials estimate list puts materials takeoff list information into a shorter form; adds allowance for waste and breakage; and estimates quantities of materials needed (Table 1-4, page 1-25). The lumber required is listed by board feet (BF).

1-5. BF Computation. A BF is a unit measure representing an area of 1 foot by 1 foot, 1 inch thick. The number of board feet in a piece of lumber can be computed using one of the following methods:

a. Rapid Estimate. You can estimate BF rapidly by using Table 1-5, page 1-25. For example, reading the table, you can see that if a 2-inch by 12-inch board is 16 feet long, your board feet would be 32.

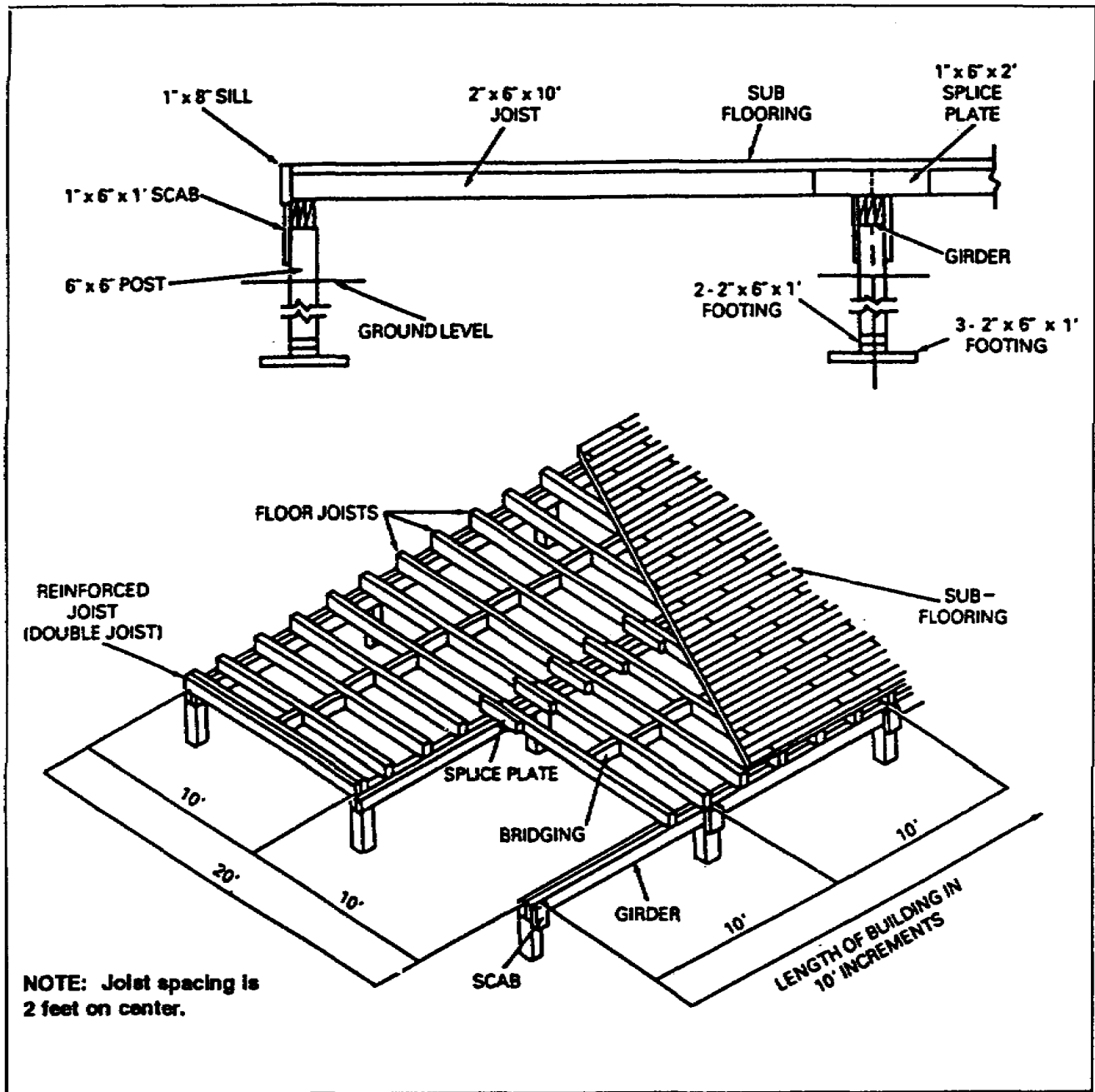


Figure 1-20. 20 x 40-ft-wide building substructure

NOTE: Spreaders and closers are not shown in the drawing but are part of the materials takeoff list.

Table 1-4. Sample materials estimate list

Item	Size and Length	Unit	Takeoff Quantity	Waste Allowance	Additional Requirements	Total Quantity	BF Measure
1.	6 x 6 x 12	pc	4	1	None	5	180
2.	2 x 6 x 10	pc	89	9	None	98	980
3.	2 x 6 x 8	pc	15	2	3 for temporary bracing	20	160
4.	1 x 8 x 10	pc	12	2	None	14	91
5.	1 x 6 x 8	pc	9	2	2 for batter boards	13	52
6.	1 x 6 x RL	BF	800	160	None	960	960
7.	16d	lb	—	—	36 framing nails	36	—
8.	8d	lb	—	—	23 flooring nails	23	—

Table 1-5. Board feet

Nominal (standard) Size (in inches)	Length (in feet)					
	8	10	12	14	16	18
1 x 3	2	2 1/2	3	3 1/2	4	4 1/2
1 x 4	2 2/3	3 1/3	4	4 2/3	5 1/3	6
1 x 6	4	5	6	7	8	9
1 x 8	5 1/3	6 2/3	8	9 1/3	10 2/3	12
1 x 10	6 2/3	8 1/3	10	11 2/3	13 1/3	15
1 x 12	8	10	12	14	16	18
2 x 4	5 1/3	6 2/3	8	9 1/3	10 2/3	12
2 x 6	8	10	12	14	16	18
2 x 8	10 2/3	13 1/3	16	18 2/3	21 1/3	24
2 x 10	13 1/3	16 2/3	20	23 1/3	26 2/3	30
2 x 12	16	20	24	28	32	36
4 x 4	10 2/3	13 1/3	16	18 2/3	21 1/3	24
4 x 8	21 1/3	26 2/3	32	37 1/3	42 2/3	48
6 x 6	24	30	36	42	48	54
6 x 8	32	40	48	56	64	72
8 x 8	42 2/3	53 1/3	64	74 2/3	85 1/3	96
8 x 10	53 1/3	66 2/3	80	93 1/3	106 2/3	120
10 x 10	66 2/3	83 1/3	100	116 2/3	133 1/3	150
10 x 12	80	100	120	140	160	180
12 x 12	96	120	144	168	192	216

b. Arithmetic Method. To determine the number of BF in one or more pieces of lumber use the following formula:

$$\text{Board feet} = \text{Number} \times \frac{\text{Thickness (in)} \times \text{Width (in)} \times \text{Length (ft)}}{12}$$

NOTE: If the unit of measure for length is in inches, divide by 144 instead of 12.

$$\text{Board feet} = \text{Number} \times \frac{\text{Thickness (in)} \times \text{Width (in)} \times \text{Length (in)}}{144}$$

SAMPLE PROBLEM 1: Find the number of BF in a piece of lumber 2 inches thick, 10 inches wide, and 6 feet long (Figure 1-21).

$$1 \times \frac{2 \times 10 \times 6}{12} = \frac{120}{12} = 10 \text{ BF}$$

SAMPLE PROBLEM 2: Find the number of BF in 10 pieces of lumber 2 inches thick, 10 inches wide, and 6 feet long.

$$10 \times \frac{2 \times 10 \times 6}{12} = \frac{1,200}{12} = 100 \text{ BF}$$

SAMPLE PROBLEM 3: Find the number of BF in a piece of lumber 2 inches thick, 10 inches wide, and 18 inches long.

$$1 \times \frac{2 \times 10 \times 18}{144} = 2 \frac{1}{2} \text{ BF}$$

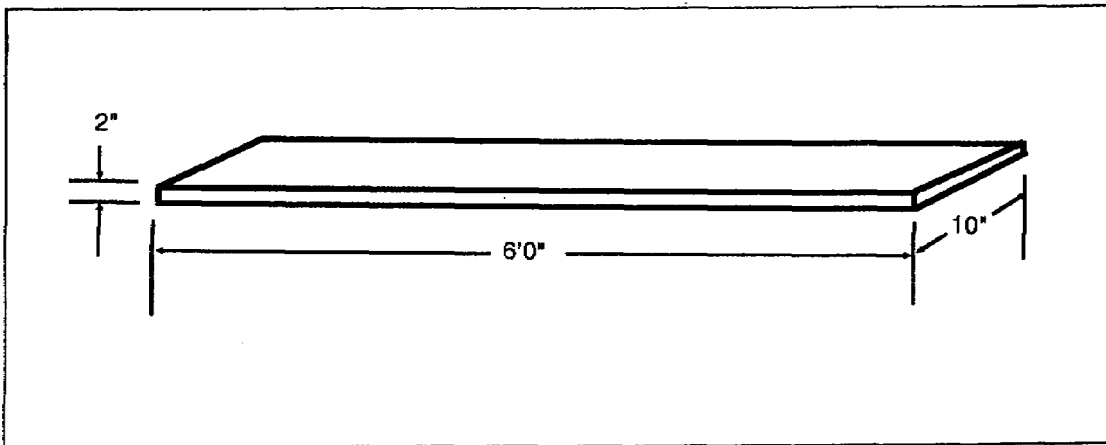


Figure 1-21. Lumber dimensions

c. Tabular Method. The standard essex board measure table (Figure 1-22) is a quick aid in computing BF. It is located on the back of the blade of the framing square. In using the board measure table, make all computations on the basis of 1-inch thickness. The inch markings along the outer edge of the blade represent the width of a board 1 inch thick. The third dimension (length) is provided in the vertical column of figures under the 12-inch mark.

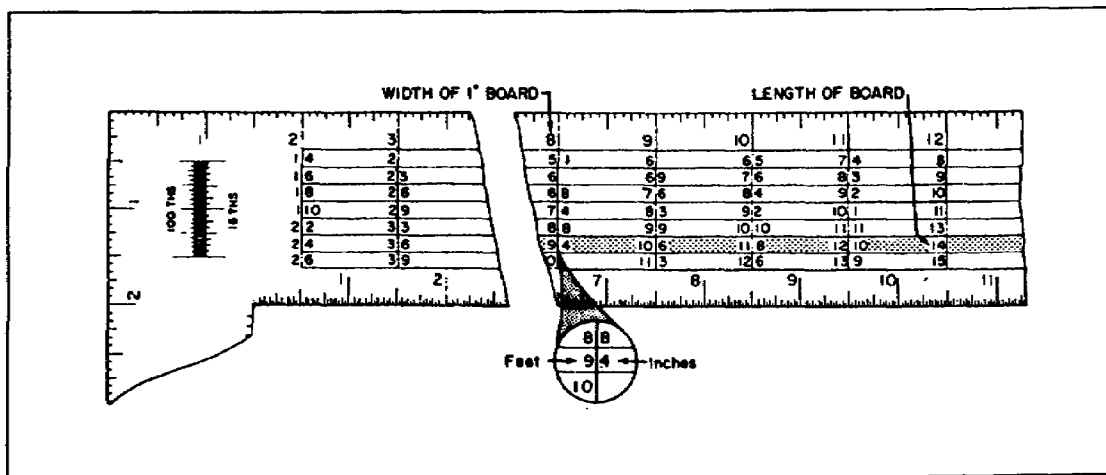


Figure 1-22. Essex board measure table

SAMPLE PROBLEM: To compute the number of BF in a piece of lumber that is 8 inches wide, 14 feet long, and 4 inches thick-

1. Find the number 14 in the vertical column under the 12-inch mark.
2. Follow the guideline under number 14 laterally across the blade until it reaches the number on that line that is directly under the inch mark matching the width of the lumber.

Example: Under the 8-inch mark on the guideline, moving left from 14, the numbers 9 and 4 appear (9 and 4 should be on the same line as 14). The number to the left of the vertical line represents feet; the number to the right represents inches.

3. The total number is 37 1/3 BF. BF will never appear in a decimal form.

Example solution: 1" x 4" x 8' x 14' Feet Inches

$$\begin{array}{r}
 9 \quad 4 \\
 \underline{4} \quad \underline{4} \\
 36 \quad 16/12 \\
 \quad 1 \ 4/12 \\
 36 + 1 \ 1/3 = 37 \ 1/3 \text{ BF}
 \end{array}$$

NOTE: 1" x 4" = Always multiply the number of pieces by the thickness and multiply the feet and inches by the sum of pieces and thickness.

1-6. Estimating the Quantity of Nails Required. The sizes and pounds of nails needed should be added to the list. To estimate number of pounds, use the following formulas:

- For flooring, sheathing, and other 1-inch material:

$$\text{Number of pounds} = \frac{2d \text{ to } 8d}{4} \times \frac{BF}{100}$$

- For framing materials that are 2 inches or more:

$$\text{Number of pounds} = \frac{10d \text{ to } 60d}{6} \times \frac{BF}{100}$$

where-
d = penny

1-7. BOMs. Information for the BOM is taken from the materials estimate list. Department of the Army (DA) Form 2702 (Figure 2-23) is used to requisition these materials. When preparing a BOM, follow the building sequence. For example, on most frame buildings, the first pieces of lumber used would be the footers; next would be floor joists, girders, subflooring, sole plates, and studs.

ACCOUNT CODE NO. XXXXX		BILL OF MATERIALS For use of this form, see DA Pam 4206; the proponent agency is COE.			DATE XX/XX/XX	
PREPARED BY (individual requestor)			DESIRED DELIVERY DATE XX/XX/XX		JOB ORDER NO. XXXXX	
DELIVER MATERIAL TO (requesting unit)					WORK REQUEST NO. XXXXX	
STOCK OR PART NO.	DESCRIPTION OF ARTICLE	UNIT	QUANTITY	UNIT PRICE	TOTAL COST	
0000-00-000-0000	Lumber, 6x6x12; 180 bd ft	PC	5			
	Lumber, 2x6x10; 980 bd ft	PC	98			
	Lumber, 2x6x8; 160 bd ft	PC	20			
	Lumber, 1x8x10; 94 bd ft	PC	14			
	Lumber, 1x6x8; 52 bd ft	PC	13			
	Lumber, 1x6x8L; 960 bd ft	BF	960			
	Nails, 16d	LB	36			
	Nails, 8d	LB	23			

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Figure 1-23. Sample BOMs

PART C - BUILDING MATERIALS

This part covers basic building materials, which include lumber and hardware. The term *hardware* is used to identify the metal items used by carpenters. The two general types of hardware are *rough* and *finish*. Rough hardware is usually used where extra strength is required. It is not decorative. Finish hardware is used for ornamental purposes, such as hinges, drawer pulls, or other miscellaneous items.

1-8. Lumber. Sizes of softwood or building construction lumber are standardized for convenience in ordering and handling.

a. Lumber is sawn in standard (nominal) sizes:

- Length: 8, 10, 12, 14, 16, 18, and 20 feet.
- Width: 2, 4, 6, 8, 10, and 12 inches.
- Thickness: 1, 2, and 4 inches.

The actual width and thickness of dressed lumber are less than the sawn dimensions because of drying and planing (or *finishing*). For the relative difference between sawn (*rough* or *nominal*) dimensions, and actual sizes of construction lumber, see Table 1-6.

b. Plywood is usually 4 feet by 8 feet and varies in thickness from 1/8 to 1 inch.

c. Stock panels are usually 48 inches wide; lengths vary in multiples of 16 inches (up to 8 feet) because the accepted spacing for studs and joists is 16 inches.

1-9. Nails. Nails are the most commonly used items that are under the classification of rough hardware.

a. Types. Nails come in different sizes and are divided into two general types: *wire* and *cut*. Also, special nails are available for some jobs.

(1) Wire Nails. Wire nails are divided into five main types: finishing, casing, box, common, and duplex-head.

Table 1-6. Nominal and dressed sizes of lumber

Nominal Size (rough) (in inches)	Actual Dressed Size (in inches)
1 x 3	3/4 x 2 1/2
1 x 4	3/4 x 3 1/2
1 x 6	3/4 x 5 1/2
1 x 8	3/4 x 7 1/4
1 x 10	3/4 x 9 1/4
1 x 12	3/4 x 11 1/4
2 x 4	1 1/2 x 3 1/2
2 x 6	1 1/2 x 5 1/2
2 x 8	1 1/2 x 7 1/4
2 x 10	1 1/2 x 9 1/4
2 x 12	1 1/2 x 11 1/4
3 x 8	2 1/2 x 7 1/4
3 x 12	2 1/2 x 11 1/4
4 x 12	3 1/2 x 11 1/4
4 x 16	3 1/2 x 15 1/4
6 x 12	5 1/2 x 11 1/2
6 x 16	5 1/2 x 15 1/2
6 x 18	5 1/2 x 17 1/2
8 x 16	7 1/2 x 15 1/2
8 x 20	7 1/2 x 19 1/2
8 x 24	7 1/2 x 23 1/2

(a) Finishing Nails. Finishing nails (Figure 1-24) and box nails are made of the same diameter wire. The head of a finishing nail is only slightly larger in diameter than the body of the nail so that it can be embedded (set) into the surface of the wood. There is a slight depression on the top of the head to prevent the nail set from slipping off the head. The small hole that is made in the wood is filled with putty or some other type of filler to hide the nail when the surface is finished.

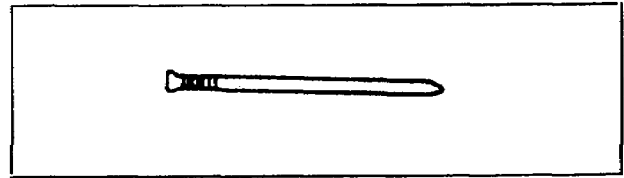


Figure 1-24. Finishing nail

(b) Casing Nails. Casing nails (Figure 1-25) are similar in appearance to the finishing nail. The head, however, is slightly larger and has no depression in the top. These nails are used to nail doors and window casings in place.

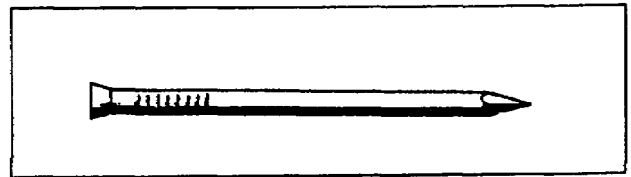


Figure 1-25. Casing nail

(c) Box Nails. Box nails (Figure 1-26) are used in box construction or whenever there is a possibility of splitting the wood with a common nail. The head of a box nail is somewhat thinner and larger in diameter than the head of a common nail. Box nails are sometimes coated with a special cement to give them better holding quality.

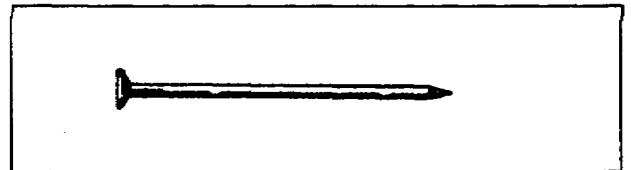


Figure 1-26. Box nail

(d) Common Nails. Common nails (Figure 1-27) have a thick flat head. They are used for most phases of building construction.

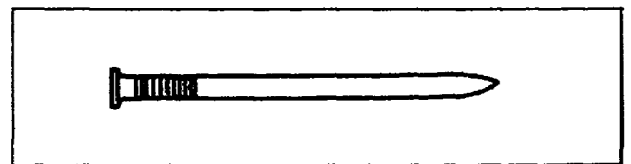


Figure 1-27. Common nail

(e) Duplex-Head or Double-Headed Nails. Duplex-head or double-headed nails (Figure 1-28) are used in temporary construction such as form work and scaffolding. The advantage of using this type of nail is easy removal. It has a collar that keeps the head away from the wood, and the claw of the hammer can easily engage the head for removal.

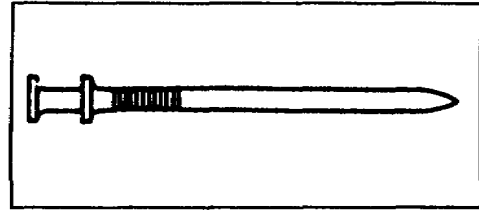


Figure 1-28. Duplex-head or double-headed nail

(2) Cut Nails. Cut nails are wedge-shaped with a head on the large end (Figure 1-29). They are often used to nail flooring because they have good holding power and are made of very hard steel.

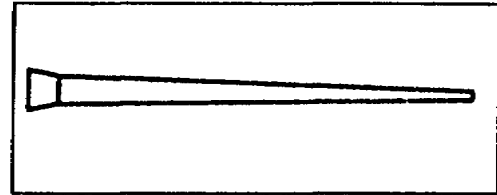


Figure 1-29. Cut nail

(3) Special Nails. Rustproof nails are sometimes used when the head is exposed to the weather. The head often rusts and causes a black streak along the grain of the wood, even though it is painted. Therefore, it is desirable to use a nail that will not rust. Plain wire nails that have a zinc coating are often used where there is a possibility of rusting. These are called *galvanized nails* (such as a roofing nail).

(4) Drywall Nails. Drywall nails (Figure 1-30) are used for hanging drywall and have a special coating to prevent rust.

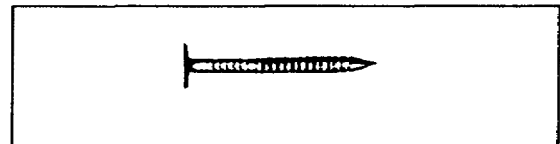


Figure 1-30. Drywall nail

(5) Masonry (Concrete) Nails. Masonry nails (Figure 1-31) are available in lengths from 1/2 inch to 4 inches, with a single head. These nails are usually hardened steel. Concrete nails are thicker and are used to fasten metal or wood to masonry or concrete.

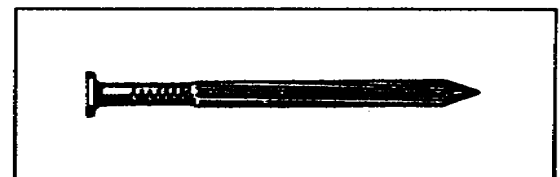


Figure 1-31. Masonry nail

b. Sizes. Nail sizes are given by penny number from twopenny to sixty penny (Figure 1-32). A small letter *d* is the recognized abbreviation for penny. The penny number refers to the length of the nail. Nails are normally packaged in 50-pound boxes. Table 1-7, page 1-34, gives the general sizes and types of nails preferred for specific applications.

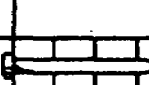
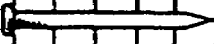
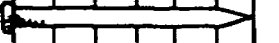
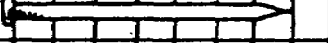

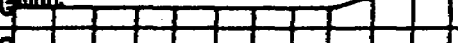

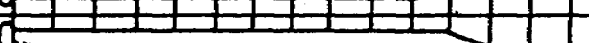

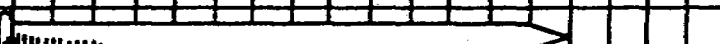






Size	LENGTH(INCHES)						Diameter (Inches)	Steel Wire Gauge	Number Per Pound
	1	2	3	4	5	6			
2d							.072	15	900
3d							.08	14	615
4d							.098	12	322
5d							.098	12	254
6d							.113	11	200
7d							.113	11	154
8d							.131	10	106
9d							.131	10	85
10d							.148	9	74
12d							.148	9	57
16d							.162	8	46
20d							.192	6	29
30d							.207	5	23
40d							.225	4	17
50d							.244	3	14
60d							.262	2	11

Figure 1-32. Nail sizes

Table 1-7. Sizes, types, and uses of nails

SIZE	LGTH(IN)	DIAM(IN)	REMARKS	WHERE USED
2d	1	.072	Small head	Finish work, shop work
2d	1	.072	Large flathead	Small timber, wood shingles, lathes
3d	1¼	.08	Small head	Finish work, shop work
3d	1¼	.08	Large flathead	Small timber, wood shingles, lathes
4d	1½	.098	Small head	Finish work, shop work
4d	1½	.098	Large flathead	Small timber, lathes, shop work
5d	1¾	.098	Small head	Finish work, shop work
5d	1¾	.098	Large flathead	Small timber, lathes, shop work
6d	2	.113	Small head	Finish work, casing, stops, and so forth, shop work
6d	2	.113	Large flathead	Small timber, siding, sheathing, and so forth, shop work
7d	2	.113	Small head	Casing, base, ceiling, stops, and so forth
7d	2¼	.113	Large flathead	Sheathing, siding, subflooring, light framing
8d	2¼	.131	Small head	Casing, base, ceiling, wainscot, and so forth, shop work
8d	2½	.131	Large flathead	Sheathing, siding, subflooring, light framing, shop work
8d	2½	.131	Extra-large flathead	Roll roofing, composition shingles
9d	1¼	.131	Small head	Casing, base, ceiling, and so forth
9d	2¾	.131	Large flathead	Sheathing, siding, subflooring, framing, shop work
10d	2¾	.148	Small head	Casing, base, ceiling, and so forth, shop work
10d	2¾	.148	Large flathead	Sheathing, siding, subflooring, framing, shop work
12d	3	.148	Large flathead	Sheathing, subflooring, framing
16d	3	.162	Large flathead	Framing, bridges, and so forth
20d	3¼	.192	Large flathead	Framing, bridges, and so forth
30d	3½	.207	Large flathead	Heavy framing, bridges, and so forth
40d	4	.225	Large flathead	Heavy framing, bridges, and so forth
50d	4½	.244	Large flathead	Extra-heavy framing, bridges, and so forth
60d	5	.262	Large flathead	Extra-heavy framing, bridges, and so forth
	5½			
	6			

This chart applies to wire nails, although it may be used to determine the length of cut nails.

1-10. **Screws.** Screws are another means of fastening one member to another. Screws have some advantages over nails. They have greater holding power, present a neater appearance, and have more decorative possibilities than nails. They also have the advantage of being easily removed or tightened.

a. **Phillips Head.** Screws are usually either slotted-head or Phillips head (Figure 1-33). Phillips head screws require a special screwdriver for driving them. Some advantages of Phillips head screws are that the screwdriver does not slip out easily and that the head is not as apt to break as that of a conventional type screw.

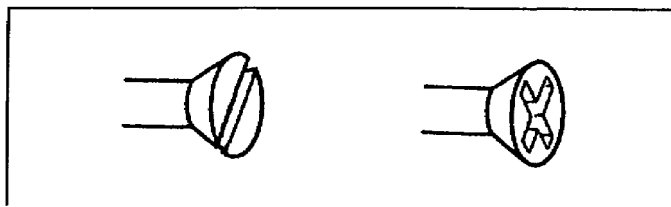


Figure 1-33. Slotted and Phillips head

b. Wood Screws. Wood screws are made of iron, bronze, brass, copper, or other metals; however, some are coated with nickel or chrome to match special-finish hardware. The main types of wood screws are roundhead, oval head, and flathead, which can be either slotted or Phillips head.

(1) Roundhead Screws. Roundhead screws (Figure 1-34) are usually used on a surface where the heads will show. The head is not countersunk, and for this reason it should have a pleasing finish—either blued or polished. If slotted-head, the screw slot should always be left in a parallel position to the grain of the wood.

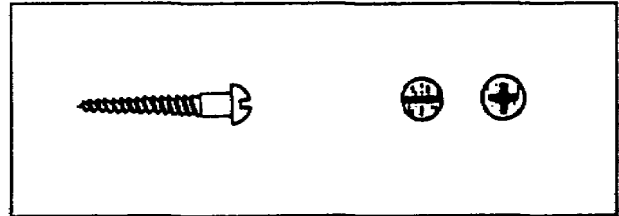


Figure 1-34. Roundhead screw

(2) Oval-head Screws. Ovalhead screws (Figure 1-35) are used to fasten hinges or other finish hardware to wood. If slotted-head, the screw slots of these screws should be parallel to each other for better appearance.

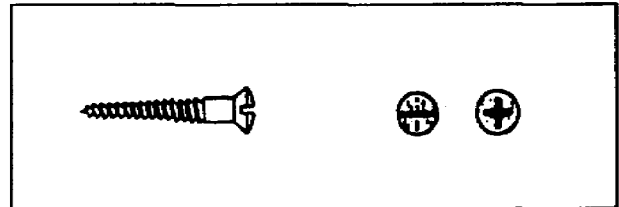


Figure 1-35. Ovalhead screw

(3) Flathead Screws. Flathead screws (Figure 1-36) are used where the head will not show. The head should be countersunk until it is level with or slightly below the finished surface. If flathead screws are used on an exposed area, they should be countersunk in a hole that can be plugged.

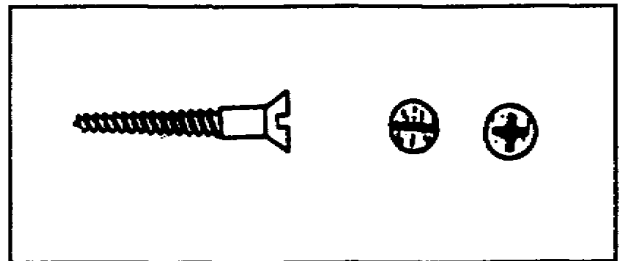


Figure 1-36. Flathead screw

(4) Other Screws.

(a) Lag Screws. Lag screws are longer and heavier than the common wood screw and have coarser threads. They have square and hexagon heads (Figure 1-37). They are used when ordinary wood screws would be too short or too light and spikes would not be strong enough.

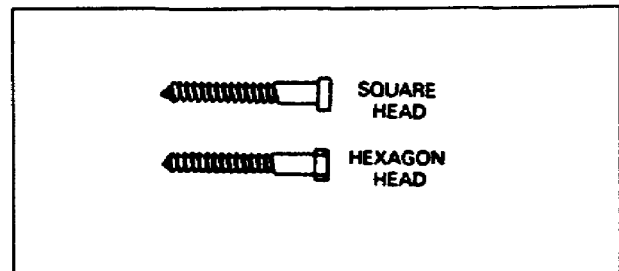


Figure 1-37. Lag screws

(b) Drive Screws. Special screws, made to be driven with a hammer, are called *drive screws* (Figure 1-38). They may have a roundhead but are usually made with a flathead, and they may have no slot for a screwdriver. (They also come in larger sizes with square or round heads.) The

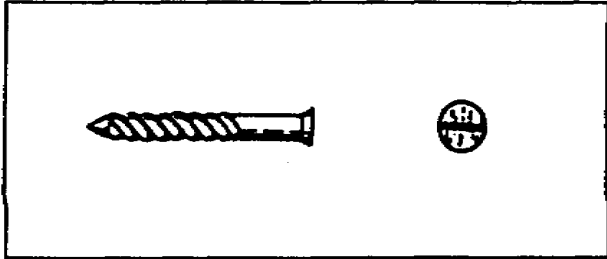


Figure 1-38. Drive screw

threads are far apart. Drive screws are available in the same size as wood screws.

(c) Special Screws. Many special hanging and fastening devices have a screw-type body (Figure 1-39). The screw eye is often used on picture frames, screen doors, and many other items. The curved screw hook and square screw hooks are mainly used for hanging articles. The curved screw hook is usually used in the ceiling, while the square screw hook is more often used on vertical walls.

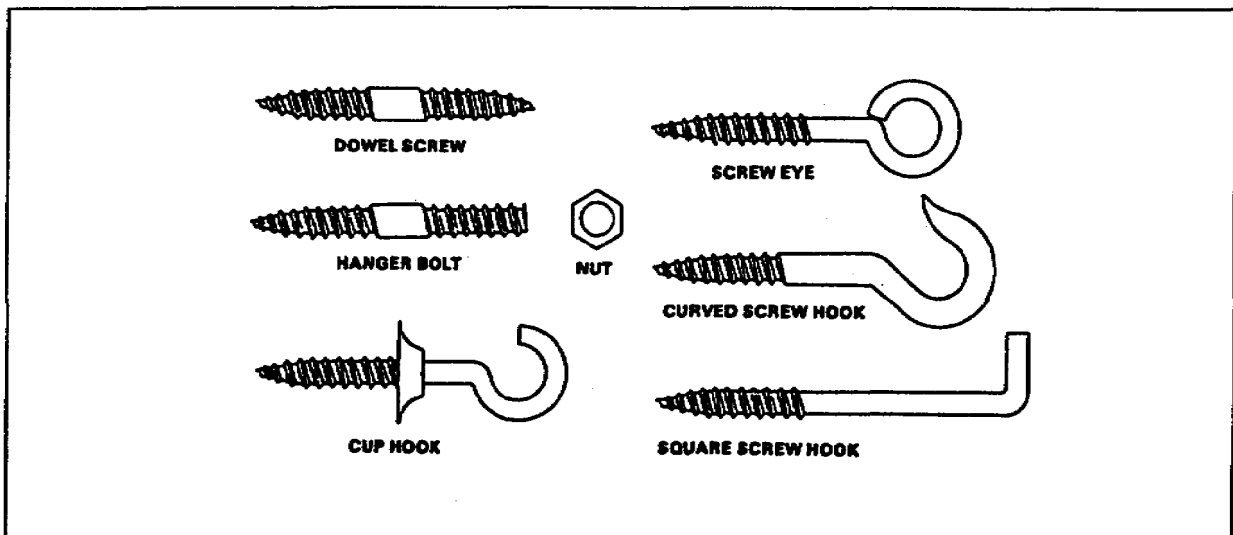


Figure 1-39. Special screws

c. Sheet-Metal Screws. Like wood screws, sheet-metal screws can also be slotted or Phillips head. They are used for the assembly of metal parts. They are steel or brass with four types of heads: flat, round, oval, and fillister, as shown in Figure 1-40.

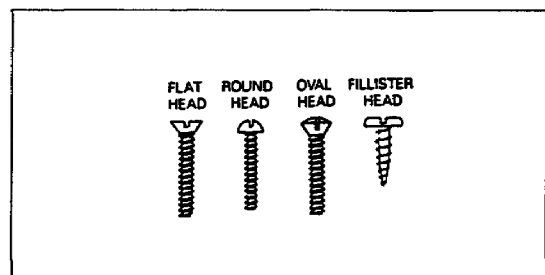


Figure 1-40. Sheet metal screws

d. Pilot and Starter Holes. Prepare the wood for receiving a screw by boring a pilot hole (the size of the diameter of the screw) into the piece of wood. A smaller, starter hole is then bored into the piece of wood that is to act as anchor or hold the threads of the screw. The starter hole has a diameter less than that of the screw threads and is drilled to a depth 1/2 or 2/3 the length of the threads to be anchored. This method (shown in Figure 14-1) assures accuracy in placing the screws and reduces the possibility of splitting the wood.

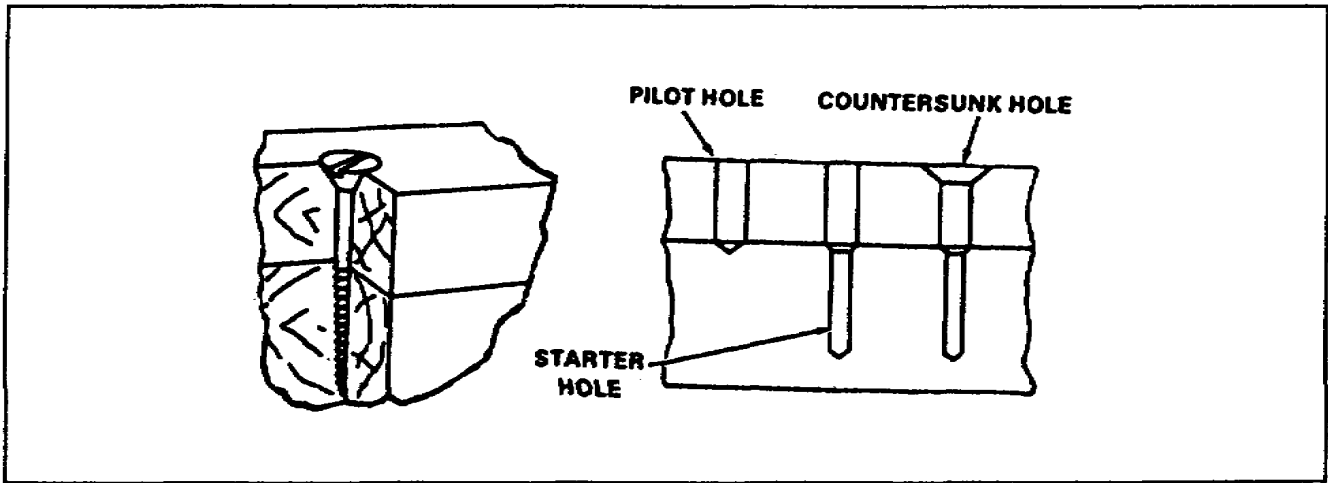


Figure 1-41. Sinking a wood screw

e. Covering Material. Both slotted and Phillips flathead screws are countersunk enough that a covering material can be used (Figure 1-42).

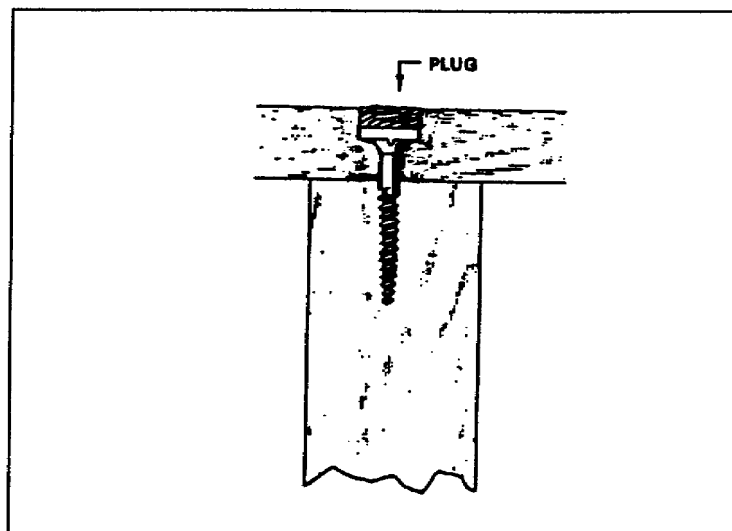


Figure 1-42. Screw-covering material

1-11. Anchors. Fastening wood or other materials to concrete or other materials has always been a task for carpenter's. Anchors (fasteners) for such work can be divided into three general categories. The first group includes anchors installed during the initial construction. The second group includes anchors installed in solid concrete or masonry after construction is completed. The third group includes anchors installed in masonry, plastic, or drywall that has a hollow space behind it.

a. Anchor Bolts. Anchor bolts (Figure 1-43) are used to fasten sills to masonry foundations. These bolts are used to fasten the sill to the footers. Anchor bolts are installed when placing the footer while the concrete is still wet.

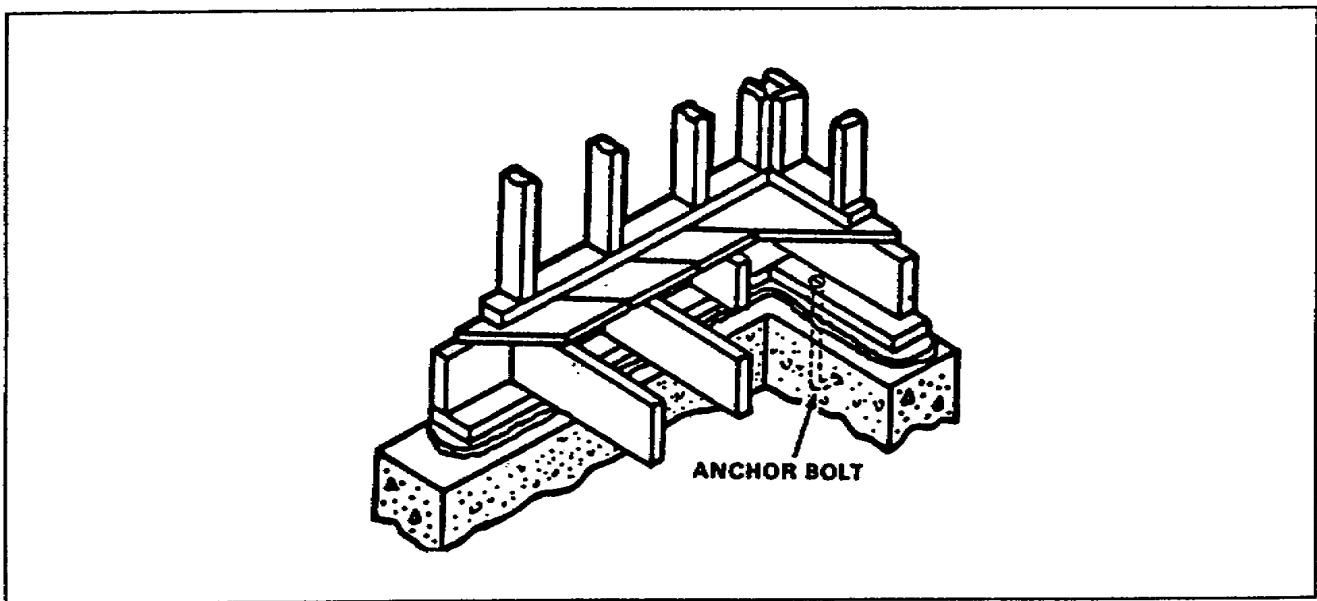


Figure 1-43. Anchor bolt installation

b. Expansion Anchor Bolts. Lead screws, plastic anchors, and lag expansion shields all work with the same basic idea. Drill a proper size hole and insert the expansion shield into the hole. The insertion of the screw or lag bolt expands the fastener to provide a secure hold. Figure 1-44 shows how expansion anchors work.

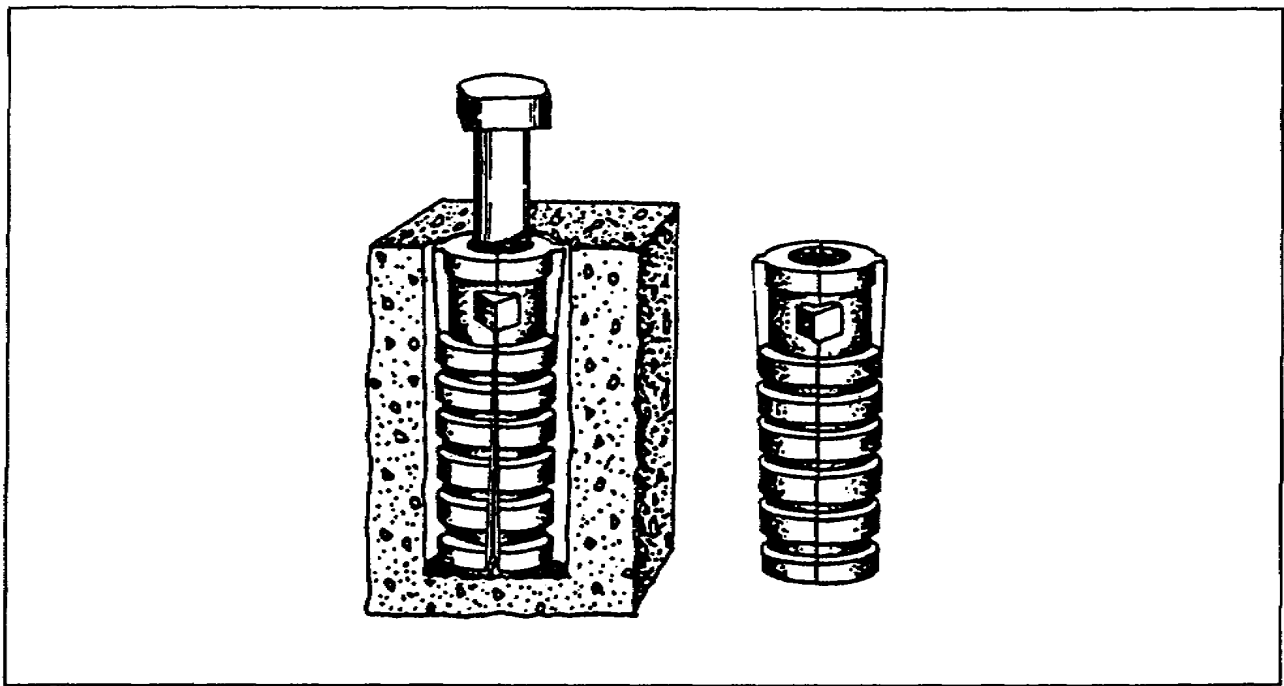


Figure 1-44. Expansion anchor bolt

c. *Molly* Universal-Screw Anchors. Molly fasteners (Figure 1-45) provide a solid means of attaching fixtures to interior walls. A hole is drilled the same size as that of the outside diameter of the fastener. These fasteners are designed to expand behind the wall covering.

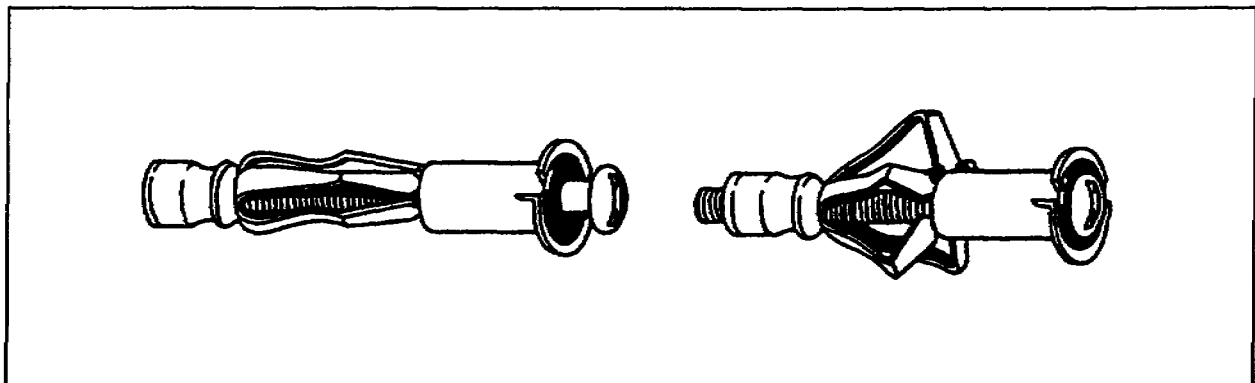


Figure 1-45. Molly universal screw anchors

1-12. Bolts. Bolts are made of steel with either round, square, or octagon heads and threaded shanks. The threads may run the full length of the bolt, or they may stop a certain distance from the head, leaving a smooth upper shank. Bolts are used to fasten timber, steel, or other materials. They range in diameter from $3/16$ to $1\ 1/2$ inches, and in lengths from $3/4$ to 30 inches. They are available in three main styles: stove bolts, machine bolts, and carriage bolts.

a. Stove Bolts. Stove bolts are used mostly with small items of hardware. Roundhead or flathead stove bolts (Figure 1-46) range in length from 3/8 to 6 inches. They are used in light construction.

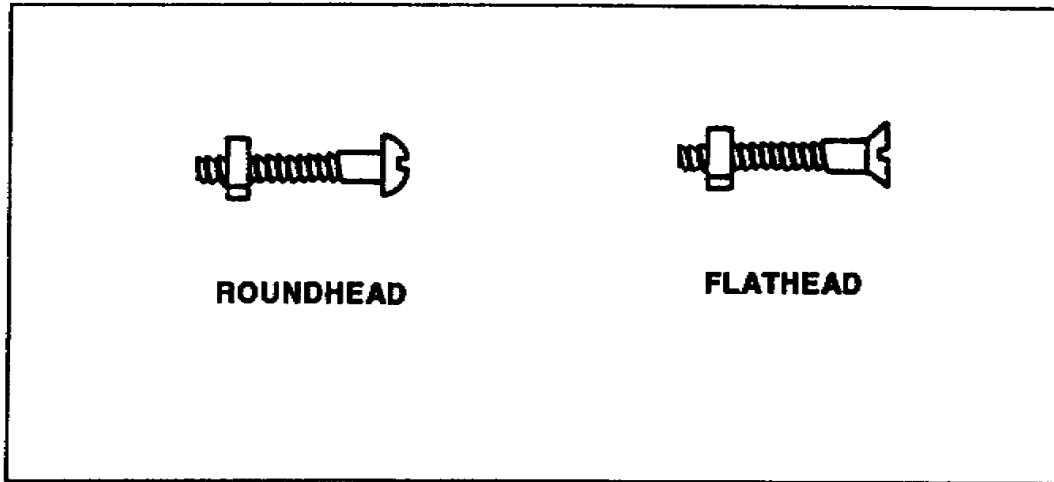


Figure 1-46. Stove bolts

b. Machine Bolts. Machine bolts (Figure 1-47) are used in woodwork. They usually have square heads and square nuts. A metal washer is usually used under both the head and the nut. These washers prevent the head from embedding into the wood and keep the nut from tearing the wood fibers as it is turned. Two wrenches are required when tightening machine bolts.

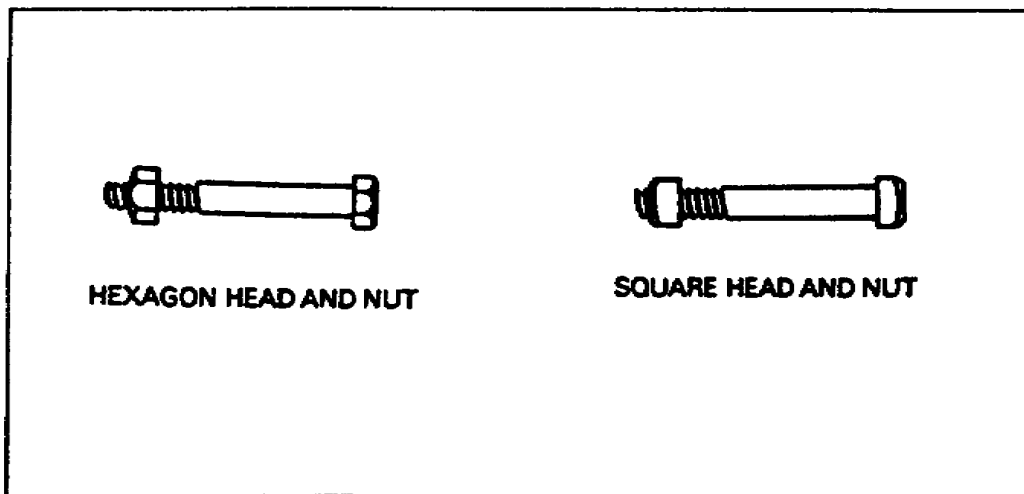


Figure 1-47. Machine bolts

c. Carriage Bolts. Carriage bolts are like machine bolts except for the heads, which are round (Figure 1-48). The shank of the carriage bolt has a square portion, which

is drawn into the wood to prevent the bolt from turning as the nut is tightened. A washer is used under the nut, but not under the head of this bolt.

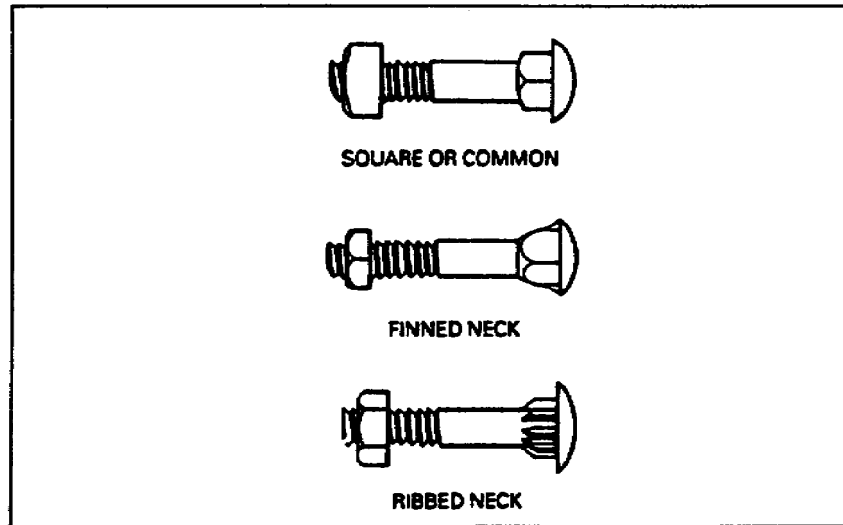


Figure 1-48. Carriage bolts

d. Toggle Bolts. Toggle bolts are used to fasten fixtures to hollow walls. The two types of toggle bolts are the pivot type and the spring-wing type. Both types have heads similar to those of ordinary wood screws. Both come in various sizes.

(1) Pivot-Type. The pivot-type has a bent-steel channel with the nut slightly off-center so that one end of the channel is heavier than the other (Figure 1-49). A hole is drilled into the hollow wall or block. The heavy end of the nut drops down at a right angle to the bolt when it is inserted into the hole. The nut will pull up tight against the drywall or block as the bolt is tightened.

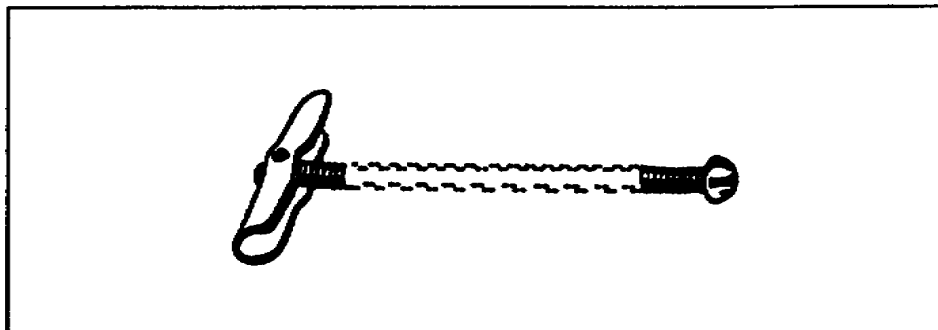


Figure 1-49. Pivot-type toggle bolt

(2) Spring-Wing Type. Spring-wing type toggle bolts are made like the pivot type except that the wing is hinged in the center. It is held open with a small spring and

is closed while inserting it into the hole. It snaps open when it enters the hollow cavity of the wall, as seen in Figure 1-50.

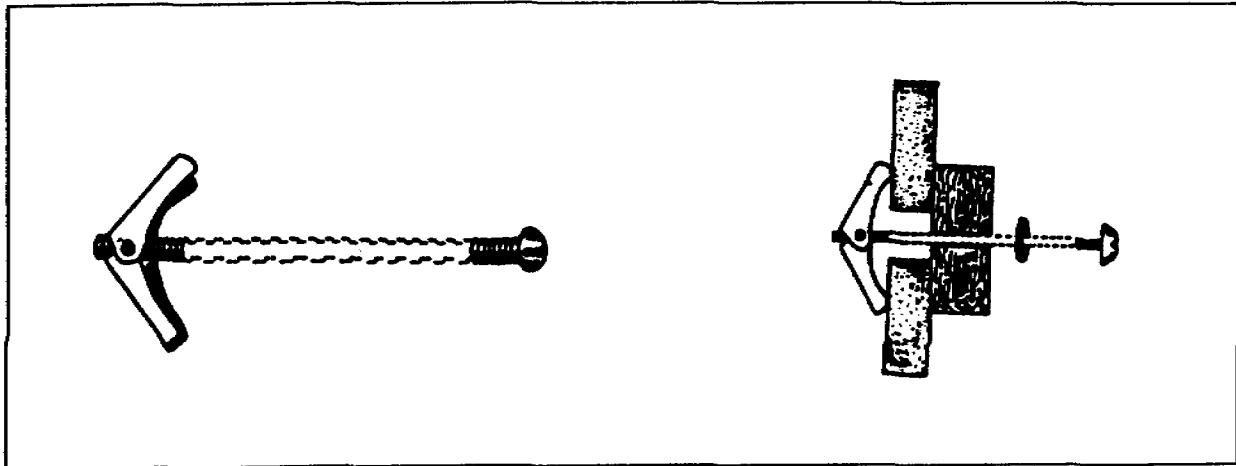


Figure 1-50. Spring-wing toggle bolts

1-13. Hinges. All hinges are used to make a movable joint between two pieces of material. A hinge consists primarily of a pin and two plates. There are three most commonly used hinges: full-mortise, half-surface, and full-surface. Figure 1-51 shows the basic design of a common door hinge.

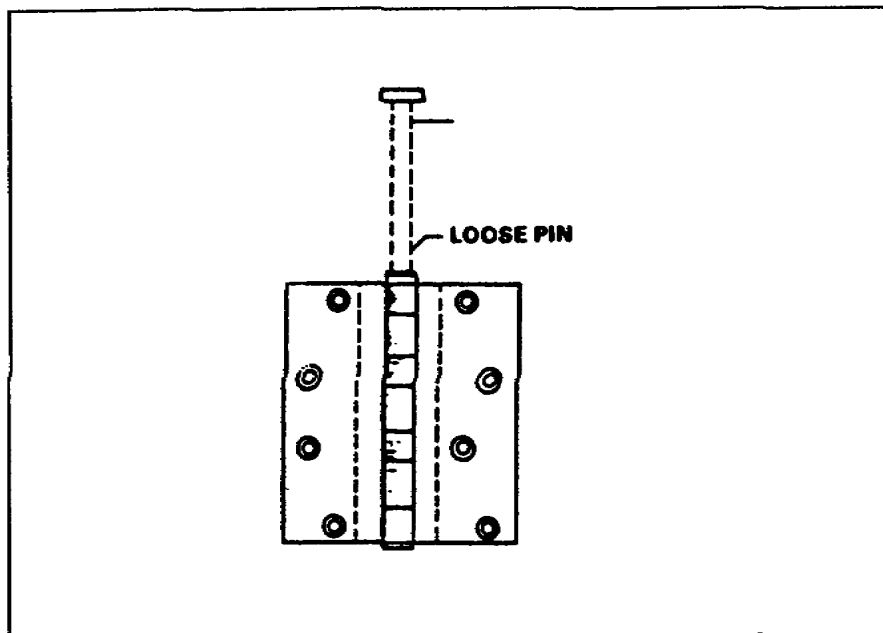


Figure 1-51. Common door hinge

a. Full-Mortise. The full-mortise hinge (Figure 1-52) is cut or mortised (gained) into both the doorjamb and the door. The leaves of a full-mortise hinge are completely hidden, leaving only the barrel exposed when the door is closed.

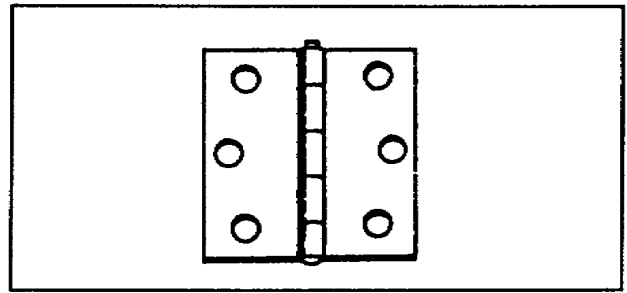


Figure 1-52. Full-mortise hinge

b. Full-Surface. The full-surface hinge (Figure 1-53) is fastened directly to the door and jamb, and no mortise is required. Note that the edges of the full-mortise are beveled. The surface of the frame and door must be flush when full-surface hinges are used.

c. Half-Surface. As shown in Figure 1-54, the half-surface butt-type hinge is like the other hinges, except that one leaf is fastened on the surface of the door and the other leaf fits into a grain in the frame.

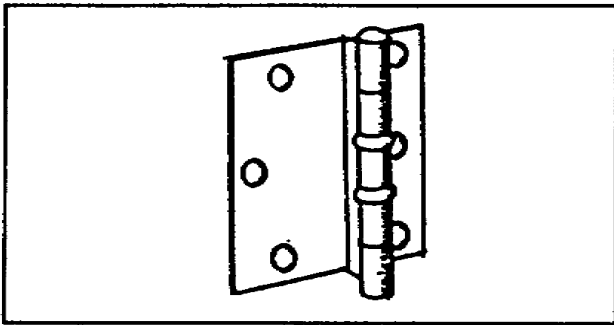


Figure 1-53. Full-surface hinge

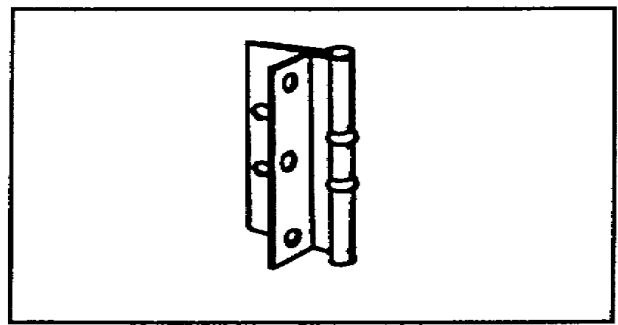


Figure 1-54. Half-surface hinge

d. Cabinet Hinges. Hinges come in many styles and finishes for every type of cabinet. Either full-mortise, full-surface, or half-surface hinges are used for cabinet work. A few of the designs of cabinet hinges are shown in Figure 1-55.

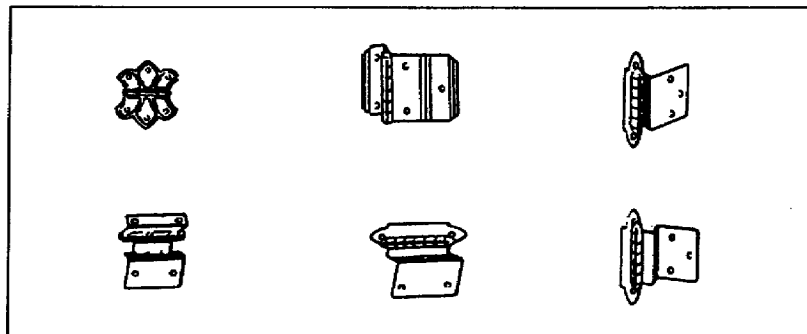


Figure 1-55. Cabinet hinges

e. Special Hinges. Many other types of hinges are available. Several are shown in Figure 1-56.

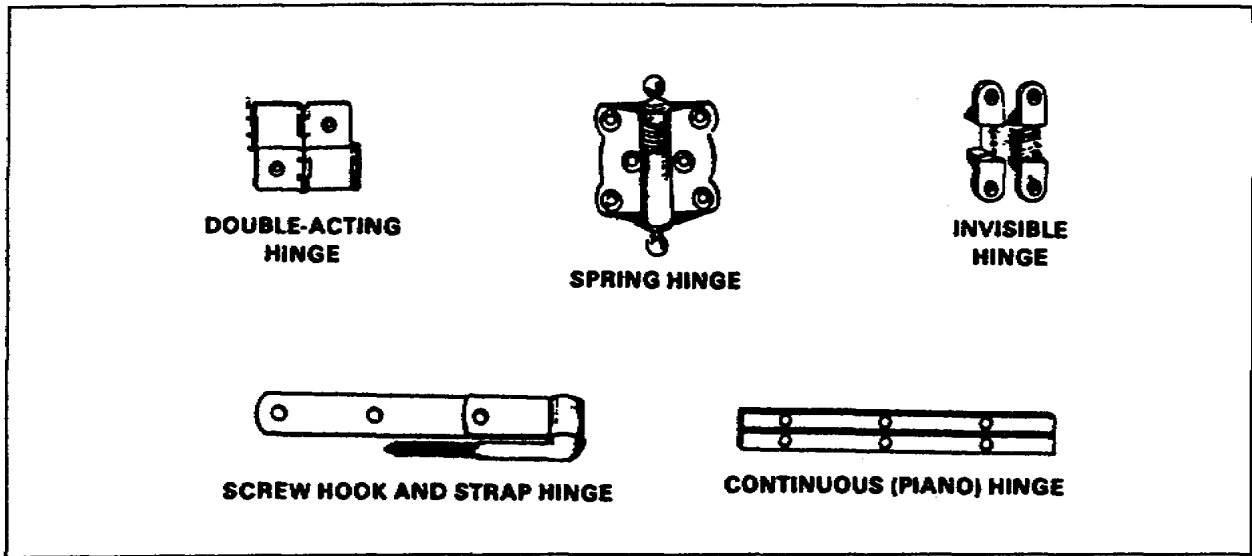


Figure 1-56. Special hinges

1-14. Hinge Hasps. Hinge hasps are like hinges, except for the leaves (Figure 1-57). One leaf has screw holes for fastening the hasp in place. The other leaf is longer with a slot cut near the outer end. A metal loop, riveted to a square metal base, is used with the hinge hasp. The base of the loop is fastened in place with four screws. The slot in the long leaf of the hasp fits over the loop. A hinge hasp is used with a padlock as a locking device. The long leaf of the safety hasp covers the heads of all screws when it is in the locked position.

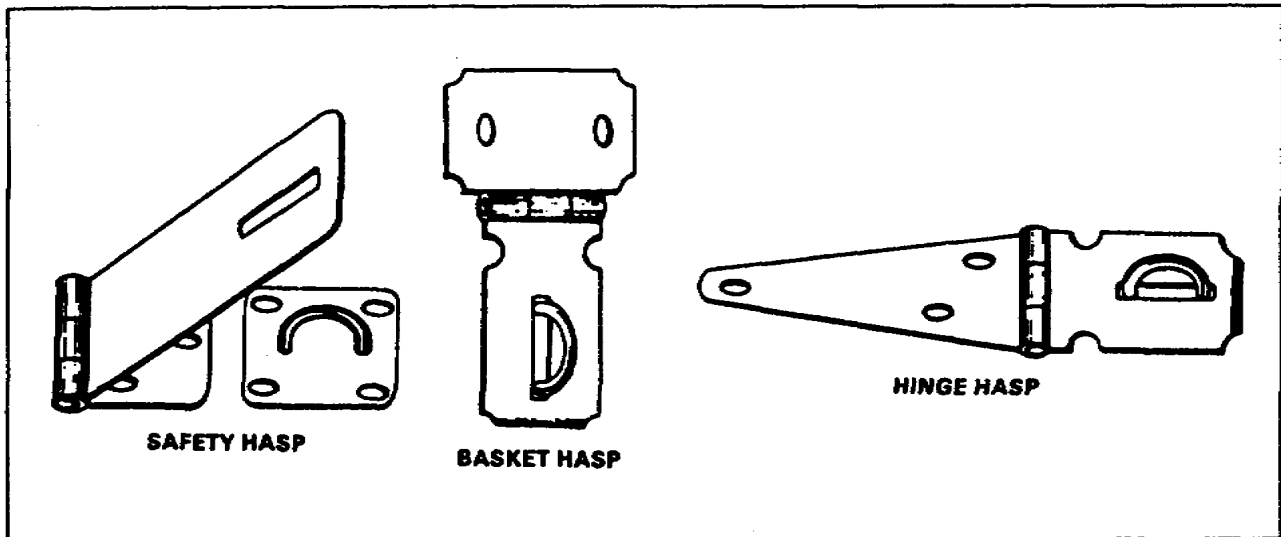


Figure 1-57. Hinge hasps

1-15. Locks and Striker Plates. The three general types of door locks are: the tubular, the cylindrical, and the mortise lock. Dead-bolt and rim locks can be installed to provide additional security.

a. Tubular Locks. Tubular locks have all the advantages of mortise locks, but are much easier to install because they only need bored holes. They are used mainly for interior doors for bedrooms, bathrooms, passages, and closets. They are available with a key tumbler lock in the knob on the outside of the door or with a turn button or push button on the inside. Figure 1-58 shows a tubular lock set.

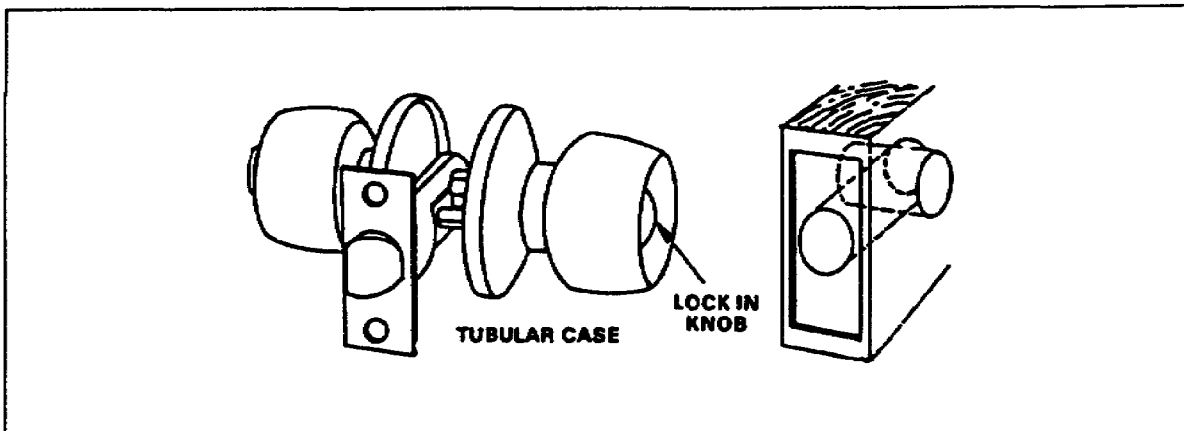


Figure 1-58. Tubular lock

b. Cylindrical Locks. Cylindrical locks (Figure 1-59) are basically the same as the tubular type. The cylindrical lock is a sturdy, heavy-duty, and stronger lock, which is used on exterior doors for maximum security.

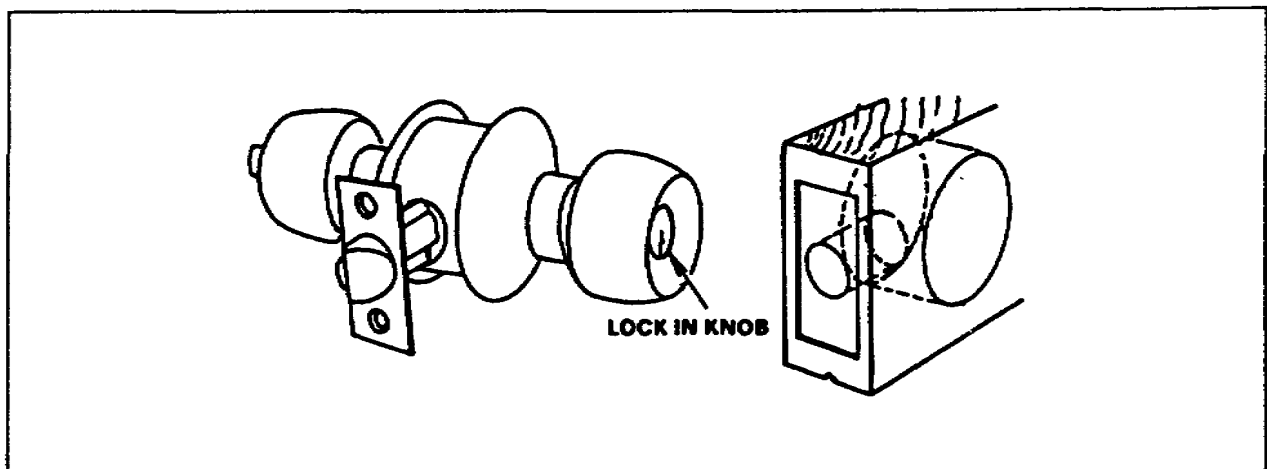


Figure 1-59. Cylindrical lock

c. Mortise Locks. Mortise locks (Figure 1-60) are used mainly on front or outside doors for high security. The present trend is away from using mortise locks because of the difficulty and time required to install them.

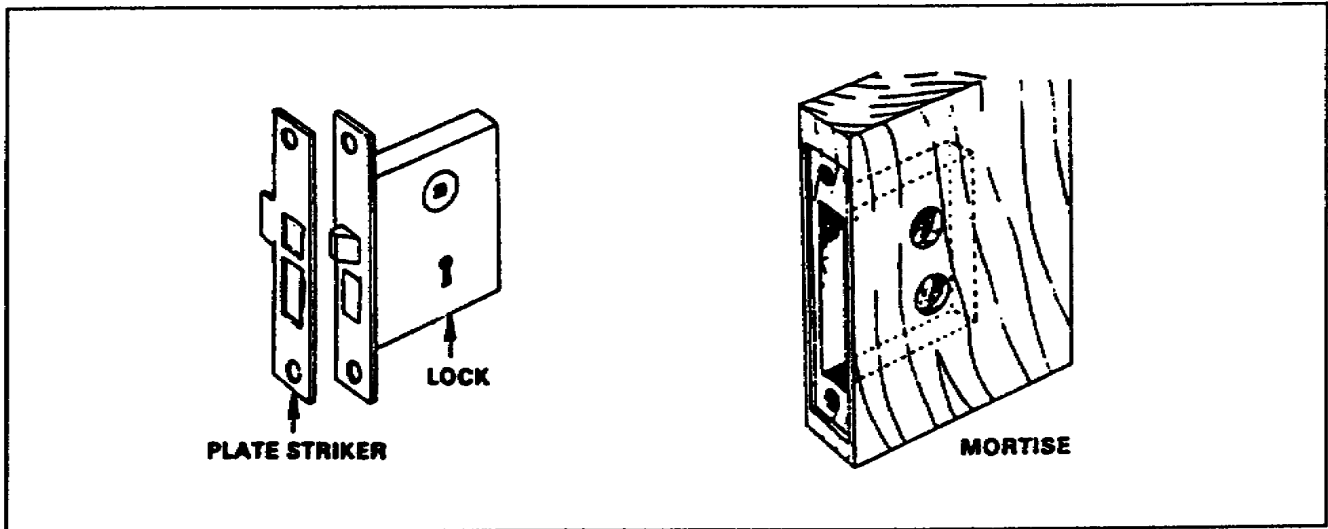


Figure 1-60. Mortise lock

d. Dead Bolts. Dead Bolts are used where added security is needed. They are constructed of very hard steel. Figure 1-61 shows a combination dead bolt and combination dead bolt and latch.

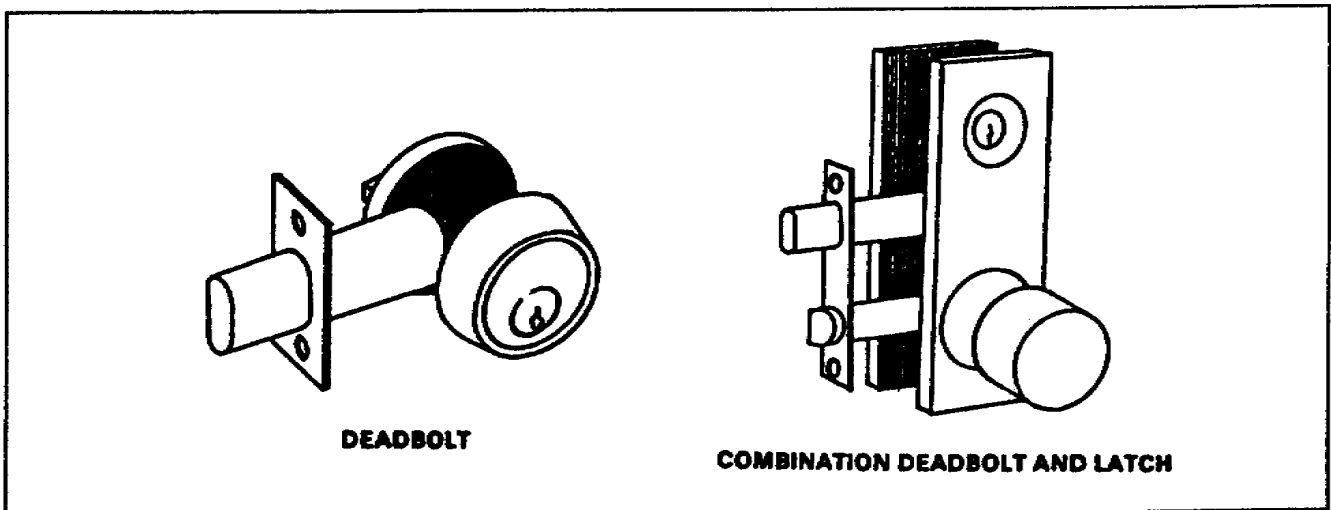


Figure 1-61. Dead bolt locks

e. Rim Locks. Rim locks (Figure 1-62) are easier to install because they are normally installed on the inside surface of exterior doors. One bored hole is usually all that is required. On some types, however, a recess must be cut for the lock.

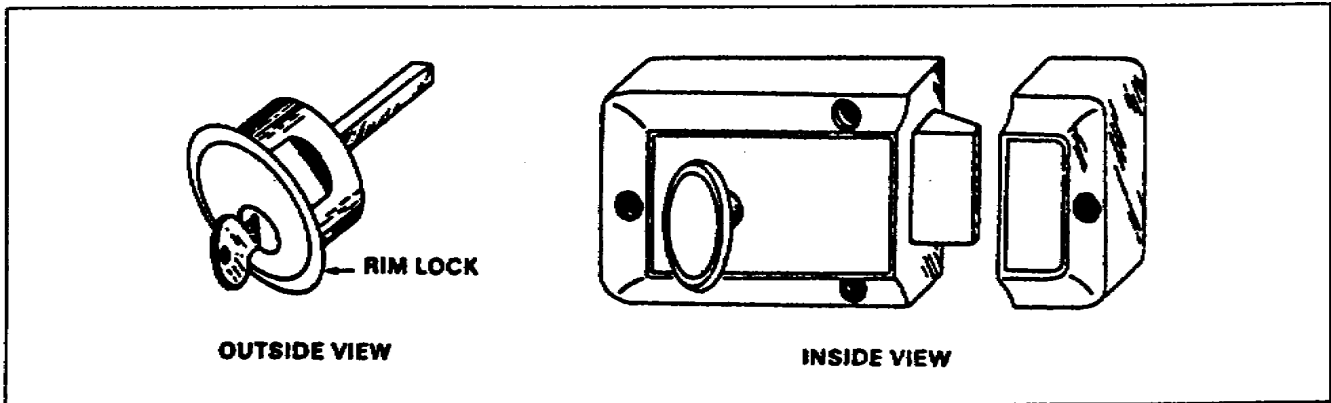


Figure 1-62. Rim lock

f. Striker Plate. A striker plate (Figure 1-63) is usually mortised into the frame of the opening for a lock. It prevents the wood from wearing or splitting and cannot be pried loose easily.

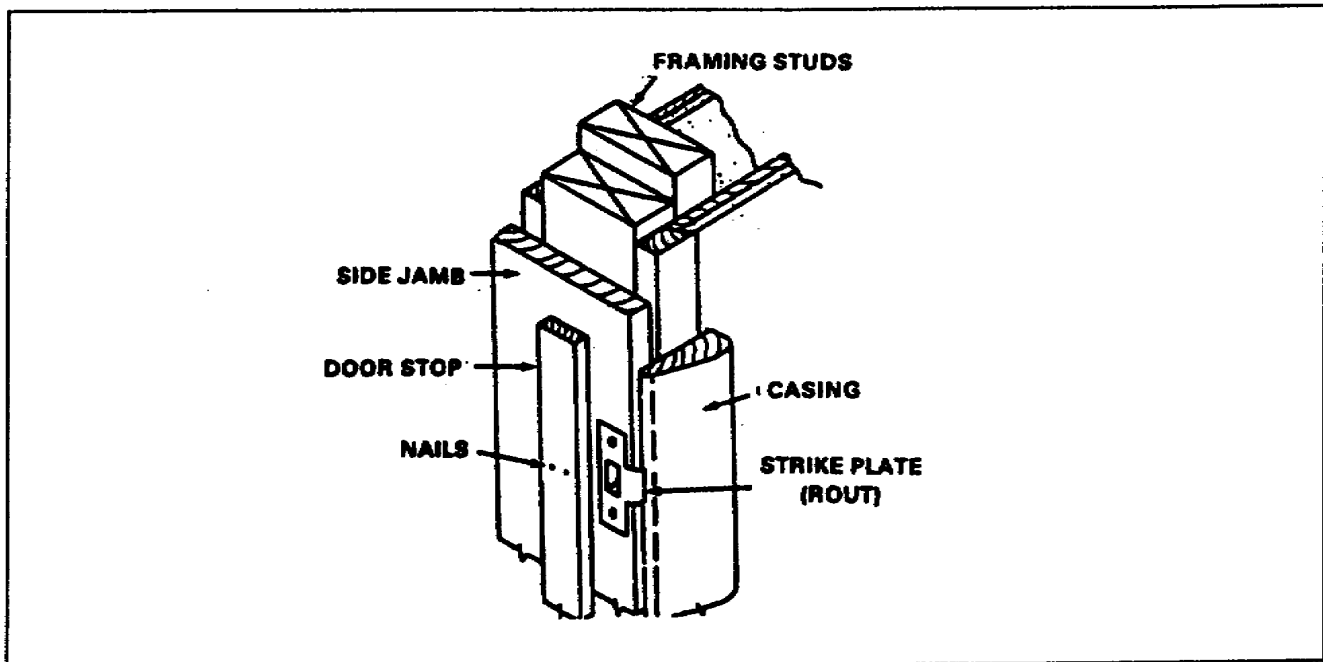


Figure 1-63. Striker plate

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LESSON 1

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part the lesson which contains the portion involved.

1. You need to know where a certain door belongs that was delivered to the construction site. What plan/schedule would you use to find this information?
 - A. Site plan
 - B. Plot plan
 - C. Door schedule
 - D. Door plan

2. How many BF are there in 36 pieces of lumber in 1 inch by 4 inches by 20 inches long?
 - A. 20
 - B. 30
 - C. 40
 - D. 50

3. Why does a finish nail have a light depression in the head?
 - A. Appearance
 - B. Classification
 - C. Holding power
 - D. Nail set

4. Nails are ordered by the penny starting with twopenny through sixtypenny. What letter of the alphabet stands for *penny*?
 - A. a
 - B. d
 - C. f
 - D. p

5. Why are general notes written on a construction drawing?
- A. To give additional information
 - B. To give architectural information
 - C. To provide special notes for supervisors
 - D. To explain the materials list
6. What are the lines on a construction drawing that represent the edges of surfaces and are somewhat heavier called?
- A. Center
 - B. Extension
 - C. Hidden
 - D. Visible
7. Refer to Table 1-5, page 1-25. How many BF are there in a 2-inch by 12-inch board that is 16 feet long?
- A. 32
 - B. 21
 - C. 18
8. What are the three most commonly used hinges?
- A. Full-mortise, cabinet, and hinge harp
 - B. Full-mortise, spring, and continuous
 - C. Full-mortise, full-surface, and half-surface
 - D. Full-mortise, special, double-acting locks, and striker plates
9. Why are screws better to use in wide ranges of construction?
- A. They cost less.
 - B. There are more sizes.
 - C. They are harder than nails.
 - D. They have better holding power.

10. What is the first list that you should make before you make out a BOM?

- A. The materials takeoff list.
- B. The estimating cost list.
- C. The building hardware list
- D. The estimating lumber list.

LESSON 1

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

<u>Item</u>		<u>Correct Answer and Feedback</u>
1.	C	Door schedule A door and window...(page 1-9, para 1-2c(2) and page 1-10, Table 1-2)
2.	A	20
3.	D	Nail set. There is a slight depression...(page 1-31, para 1-9a (a))
4.	B	d A small letter <i>d</i> is the recognized...(page 1-32, para 1-9b)
5.	A	To give additional information. General notes give additional information that is needed. (page 1-2, para 1-1b)
6.	D	Visible A heavyweight unbroken...(page 1-3, para 1-1d(1))
7.	A	32 (page 1-25, Table 1-5)
8.	C	Full-mortise, full-surface, and half-surface. There are three most commonly used...(page 1-42, para 1-13)
9.	D	They have better holding power. They have greater holding power,...(page 1-34, para 1-10)
10.	A	The materials takeoff list. However, you should make...; This list is the first... (page 1-23, Part B Introduction and para 1-3)

LESSON 2

TOOLS AND EQUIPMENT

OVERVIEW

LESSON DESCRIPTION:

At the end of this lesson, you will be able to describe the methods used to maintain tools and equipment.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will perform maintenance on carpentry/masonry tools.

CONDITION: You are given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of this lesson.

REFERENCE: The material contained in this lesson was derived from the following publications: FM 5-426 (to be published within six months) and TM 5-704.

INTRODUCTION

The quality of a carpenter's work is greatly affected by the tools and machinery he uses and their condition.

PART A - CARE AND USE OF HAND TOOLS

2-1. Boring Tools

a. Types of Boring Tools. All wood-boring augers and drill bits, held by a brace or hand drill, are *boring tools*.

(1) Auger Bit. Auger bits come in sizes from 1/4 inch to 1 inch. The number on the tang shows the size of the bit in 1/16-inch increments. For example, in Figure 2-1, page 2-2, the number 6 means that it is 6/16 (or 3/8) inch.

The marked part of the bit is used to start the hole. The spur is made like a screw, which pulls the bit into the wood as you turn the bit. The parts marked *lip* and *nib* are the cutting parts. The *twist* portion removes the shavings from the hole. The *shank* ends in a tang, which fits into the brace.

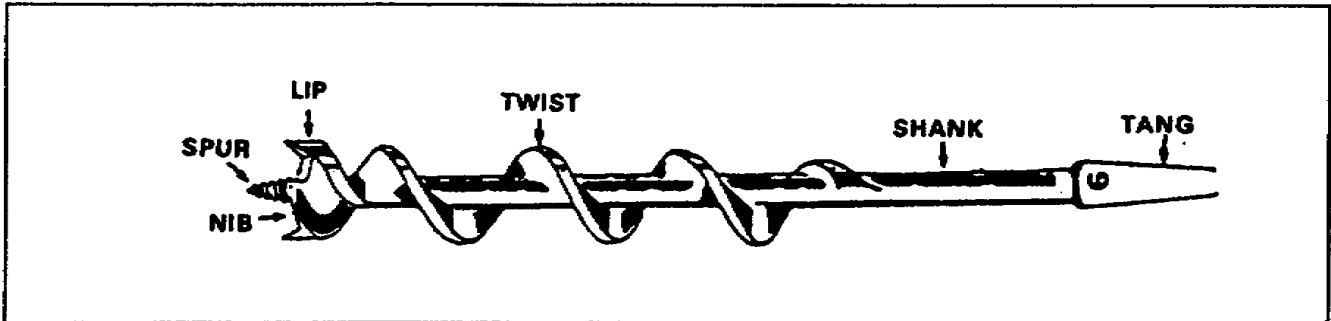


Figure 2-1. Auger bit

(2) Expansion Auger Bit. An expansion bit (Figure 2-2) is used to bore a hole larger than 1 inch, such as for a door lock. Notice that the cutting bit has a scale for adjusting the size of the hole needed. The screw shown is used to lock the cutting blade into position. The screw must be tightened to keep the blade from moving and changing the size of the hole. This bit also has a tang to fit into the hand brace.

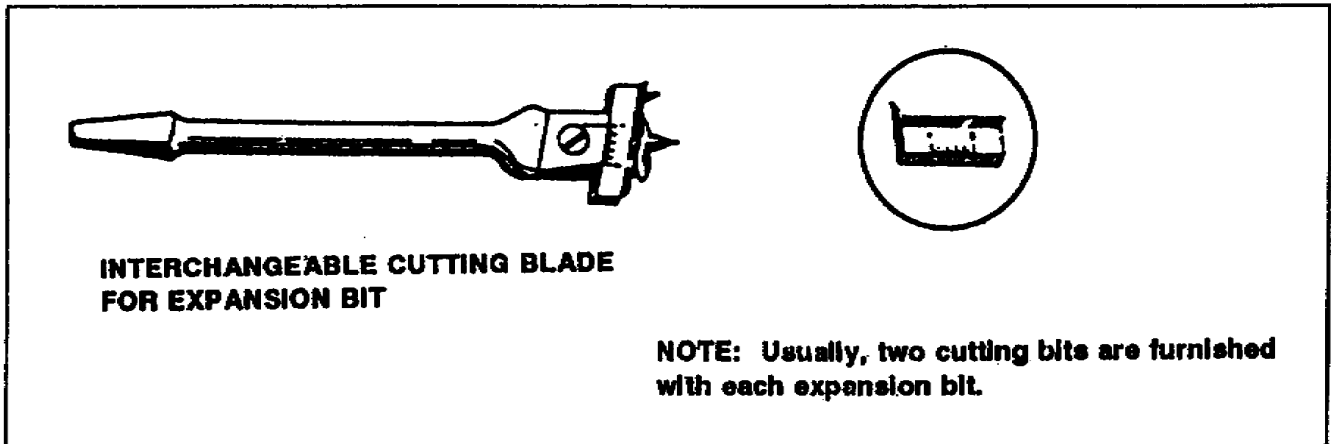


Figure 2-2. Expansion auger bit

(3) Twist Drill. A twist drill is used to make holes in wood, metal, fiber, plastic, and other materials. Carpenters often drill holes in metal to which some type of wood or fiber will be bolted. This requires the use of a special type of twist drill (Figure 2-3). Twist drill bits are driven by electric or hand drills (Figure 2-4).

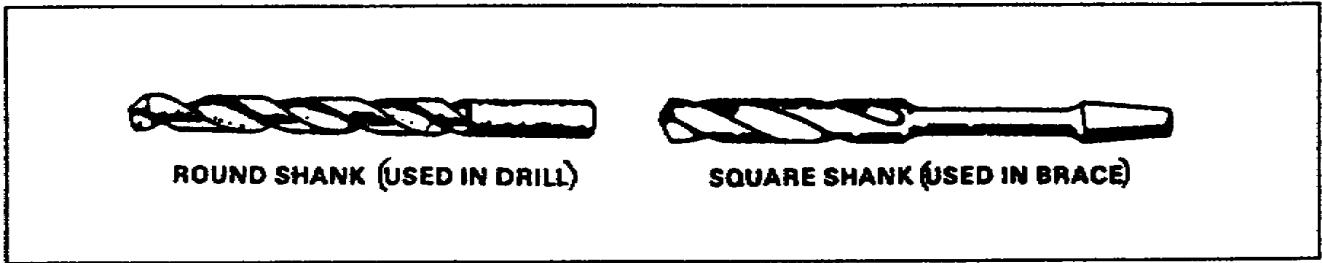


Figure 2-3. Twist drills

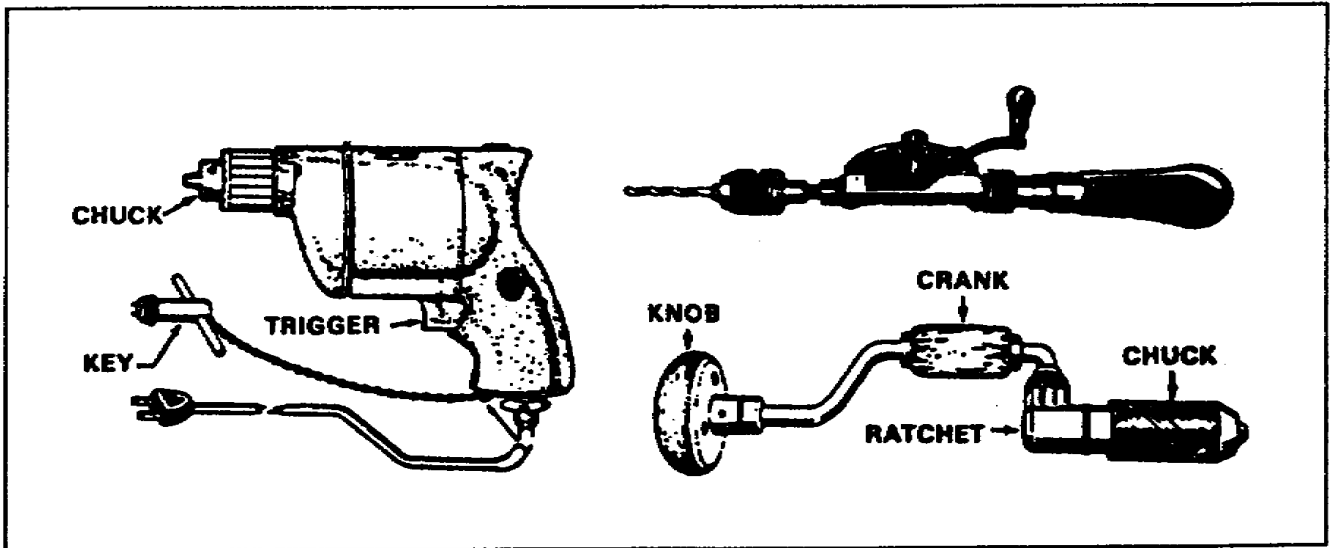


Figure 2-4. Electric and hand drills

(4) Countersink Bit. A countersink bit is used to increase the diameter of the top of a drilled hole to receive the head of a screw (Figure 2-5).

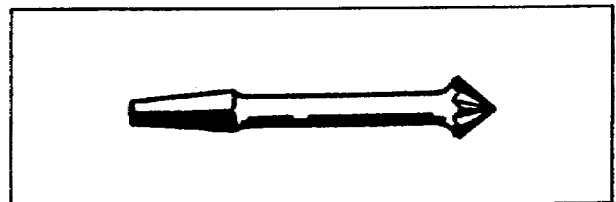


Figure 2-5. Countersink bit

b. Care and Use of Boring Tools. To cut a clean, splinter-free hole, the cutting parts must be kept sharp. The spur must be kept sharp so that it will pull the bit into the wood. The lip must be kept sharp to prevent tearing of the material being bored. Because these are all sharp edges, the lip should be protected from damage through contact with other tools. Bits should be stored a special case, or the point wrapped with a rag to protect the cutting edges.

2-2. Tooth-Cutting Tools. Both manually operated saws and power saws are tooth-cutting tools.

a. Types of Tooth-Cutting Tools. Manually operated saws used by carpenter's are mainly the crosscut saw, ripsaw, compass saw, coping saw, hacksaw, and miter saw.

(1) Crosscut Saw. A crosscut saw (*handsaw*) (Figure 2-6) is designed to cut across the grain of the wood. Its teeth are sharpened like a knife so they will cut the fibers of the wood on each side of the saw cuts (or *kerf*). A crosscut saw is 20 to 26 inches long and has 8 to 12 teeth per inch. The number of teeth per inch is stamped on the blade near the handle.

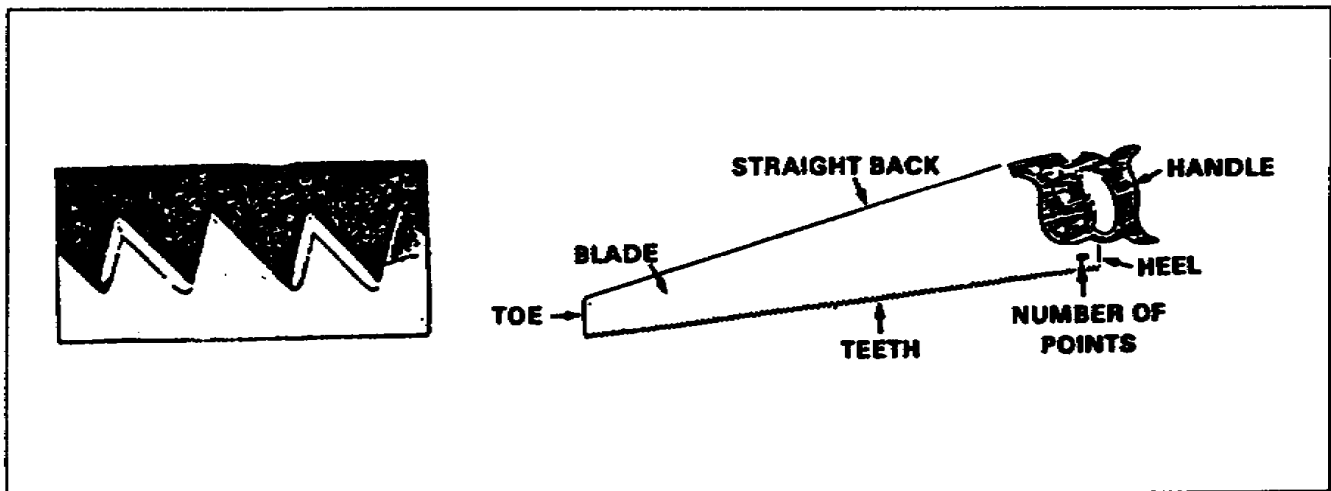


Figure 2-6. Crosscut saw

(2) Ripsaw. This saw is used to cut with (or *parallel* to) the grain of the wood. The teeth of a ripsaw (Figure 2-7) are a series of little chisels set in two parallel rows. On each full stroke of the saw, the edges chisel off a little from the end of the wood fibers. This cut is also called a *kerf*.

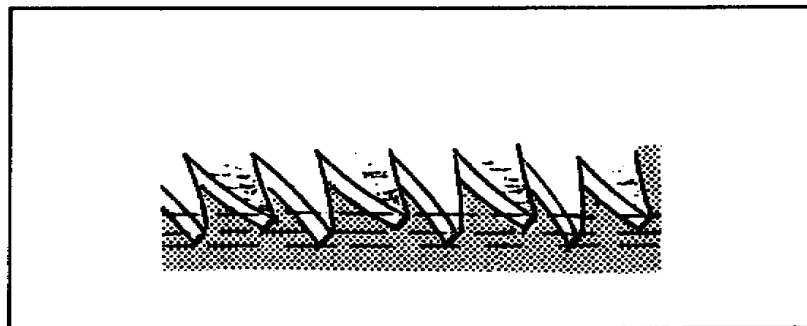


Figure 2-7. Ripsaw teeth

(3) Compass Saw. The compass saw (Figure 2-8) has 10 points to the inch. It may be equipped with a blade (with 13 points to the inch) for cutting nails. Its main function is cutting holes and openings such as electrical outlets, where a power tool would be too large.

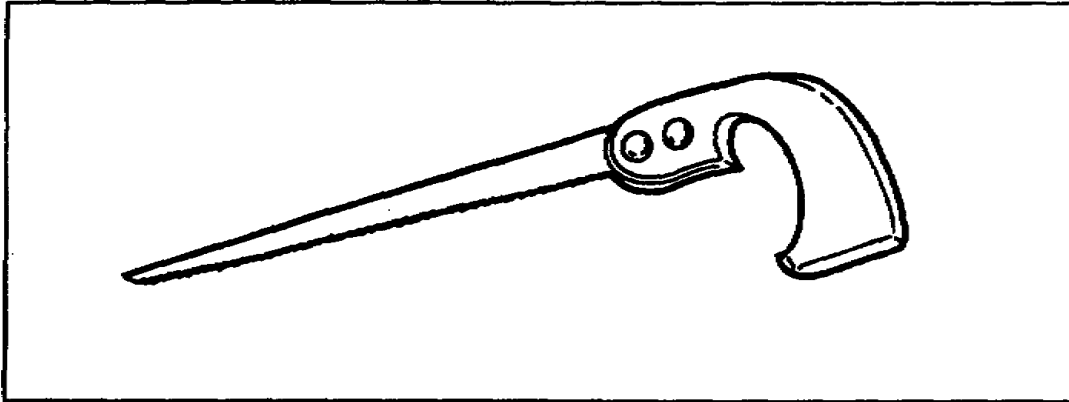


Figure 2-8. Compass saw

(4) Coping Saw. The blade of a coping saw can be turned to change the direction of the cut or to cut sharp angles. This saw is also used for cutting curved surfaces and circles. Coped joints are sometimes used when joining moldings at right angles. One piece of stock is cut away to receive the molded surface of the other piece (Figure 2-9).

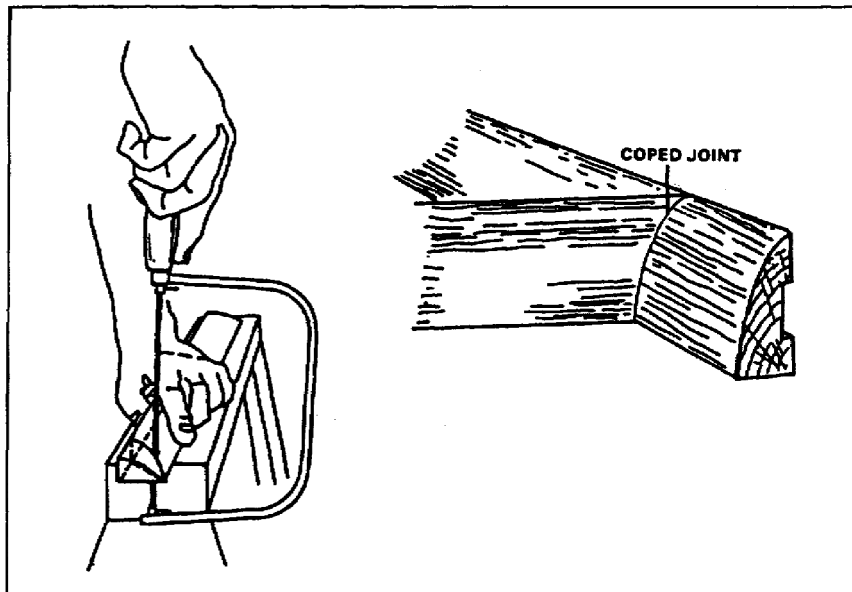


Figure 2-9. Coping saw and coped joint

(5) Hacksaw. This saw is 10 to 12 inches long; it has 14 to 32 points per inch (Figure 2-10). It is used to cut metal, such as metal trim or aluminum thresholds. It should not be used to cut wood.

WARNING

Do not use the hacksaw with heavy pressure for a long period; stop and let the blade cool. If the blade gets too hot, it will break.

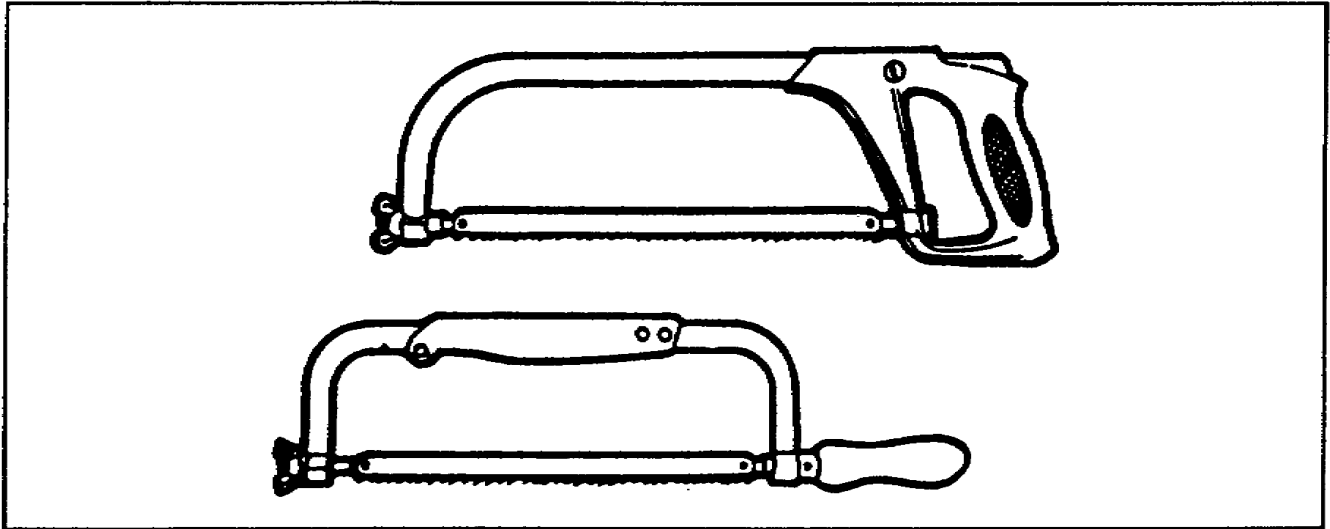


Figure 2-10. Hacksaw

(6) Miter Saw. A miter saw is used with a miter box. The saw is held in a horizontal position and can be adjusted to cut various angles. It is used to cut moldings and picture frames to fit. It can be adjusted to cut at right angles for small pieces of wood. To cut a piece of molding to a specified angle: set the saw to the prescribed angle, insert the piece in the proper position against the fence, and move the saw back and forth across the material (Figure 2-11).

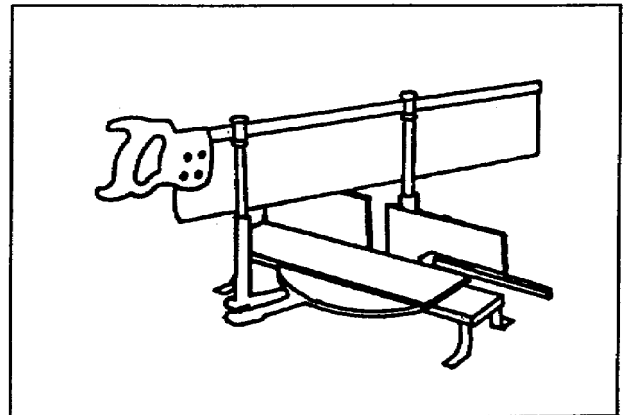


Figure 2-11. Miter saw

b. Care and Use of Cutting Tools. Cutting tools, like boring tools, have sharp edges and points, which need to be sharpened and protected. The term *sharpen* is used here in a broad sense to include all of the operations required to put a saw in first-class condition. The master carpenter is an expert in using the right tool in the right way.

(1) Jointing. When a saw comes from the factory, the teeth are all uniform in size, length, bevel, pitch, and set. After being used and sharpened a few times, the teeth become distorted. When this occurs, they must be filed to a straight line. This operation is called *jointing* (Figure 2-12). When you joint a saw, place it in a saw vise with the handle to the left. Starting with the heel end of the saw, lay a flat file on top of the teeth and move it lightly along the top of the teeth. Do not top the file. Continue this operation until all teeth are even, with a slight crown at the top of each tooth. If you find that the teeth are too short, which would make them hard to set, file them to the proper shape before they are set.

(2) Setting. After the teeth are made even by jointing, they must be set. This means that every tooth will be bent a little to give the blade sufficient clearance. For a handsaw, the set should be half the thickness of the blade. This rule applies to both crosscut saws and rip saws. When using a saw set (Figure 2-13), bend every other tooth (halfway from the point), starting at either end of the saw. Do not attempt to hurry this operation; it takes skill and practice to do it properly.

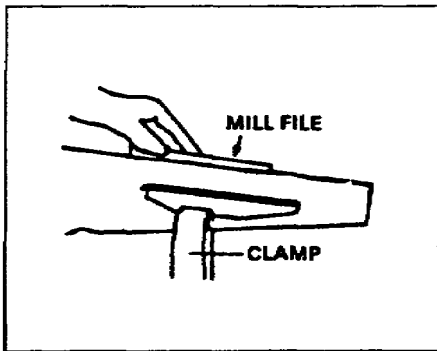


Figure 2-12. Jointing a saw

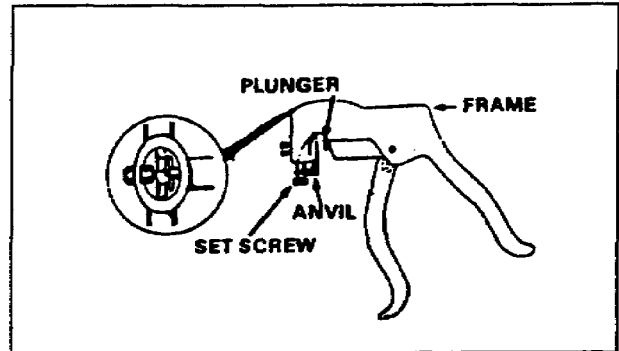


Figure 2-13. Saw set

(3) Filing. To file a crosscut saw (Figure 2-14, page 2-8), place the saw securely in a saw vise with the handle to the left. Using a three-cornered file, start filing from the heel end. Place the file between two teeth and incline it toward the small or tapered end of the saw. File both teeth at once, using one or more strokes and putting the same pressure on each stroke. Work down the length of the saw, then turn the saw around so that the handle is to the right. Incline the file to the tapered end, which is now to the left, and again work down the length of the saw.

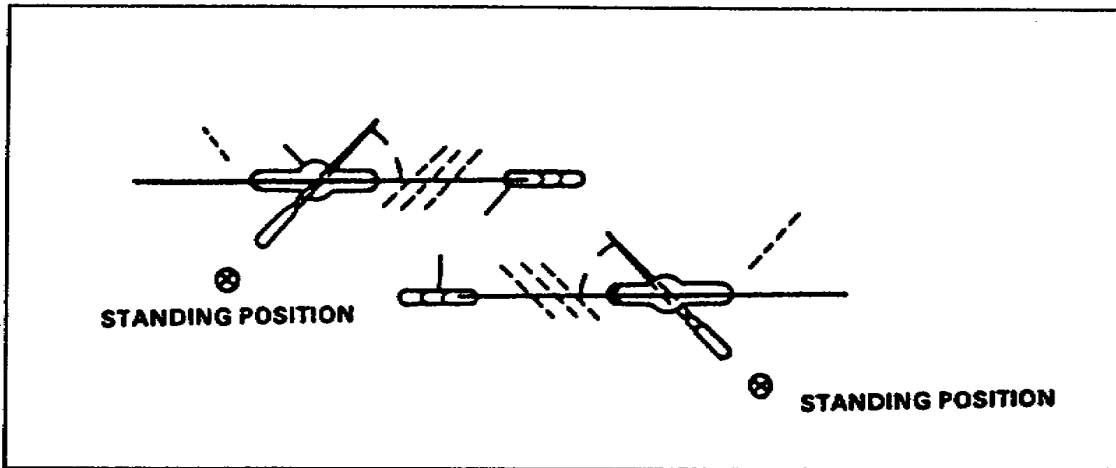


Figure 2-14. Filing a crosscut saw

(4) Beveling. To file a rip saw, place the saw securely in a saw vise. File straight across the front of the teeth using a three-cornered file. Lower the file handle from 2 to 3 inches. This gives a bevel on the top of each tooth that leans away from you. File down the length of the saw, starting with the heel end and using the same amount of pressure on each stroke (Figure 2-15).

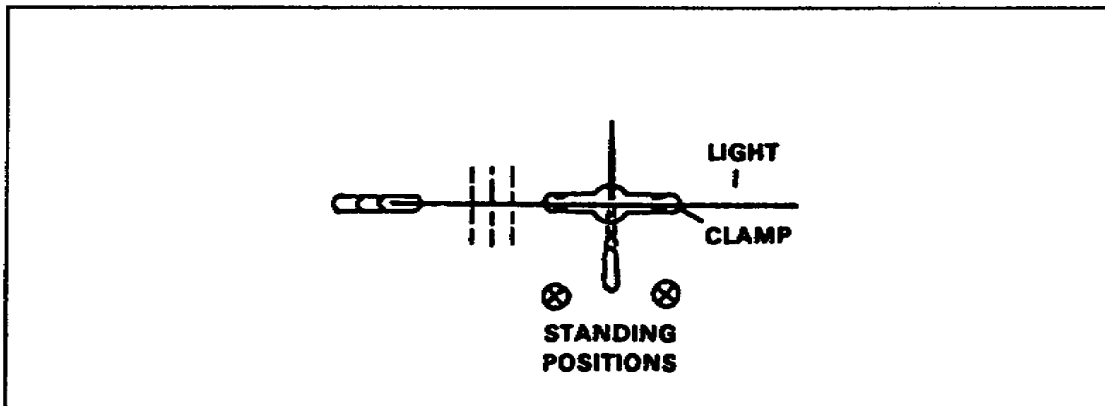


Figure 2-15. Beveling a rip saw

(5) Side-Dressing. After you file the saw, lay it flat on a board and run the flat side of the file gently along the side of the teeth. Turn the saw over and repeat the operation on the other side. This is called *side-dressing*. No setting may be needed for the next two or three filings. In this case, side-dress with an oilstone to remove the burrs (Figure 2-16).

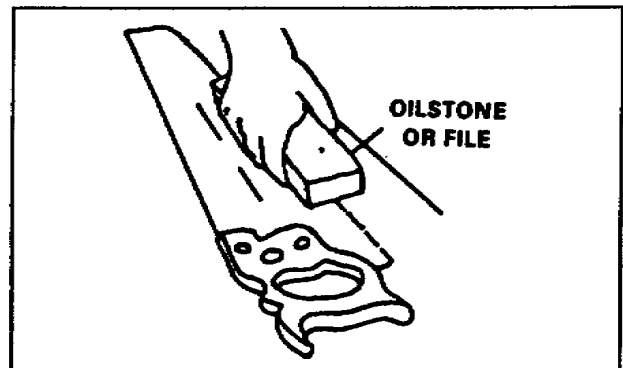


Figure 2-16. Side-dressing a saw

2-3. Sharp-Edged Cutting Tools. Chisels are considered sharp-edged cutting tools. The chisel is an indispensable tool and is often the most abused. It should be used solely for cutting wood surfaces. It should never be used for prying or as a screwdriver. A chisel is a flat piece of steel (of varying thicknesses and widths) with one end ground to an acute bevel to form a cutting edge.

a. Types of Sharp-Edged Cutting Tools.

(1) Paring Chisel. A paring chisel (Figure 2-17) is used for shaping and preparing large surfaces. It is used with a steady sustained pressure of the hand and should never be driven with a mallet.

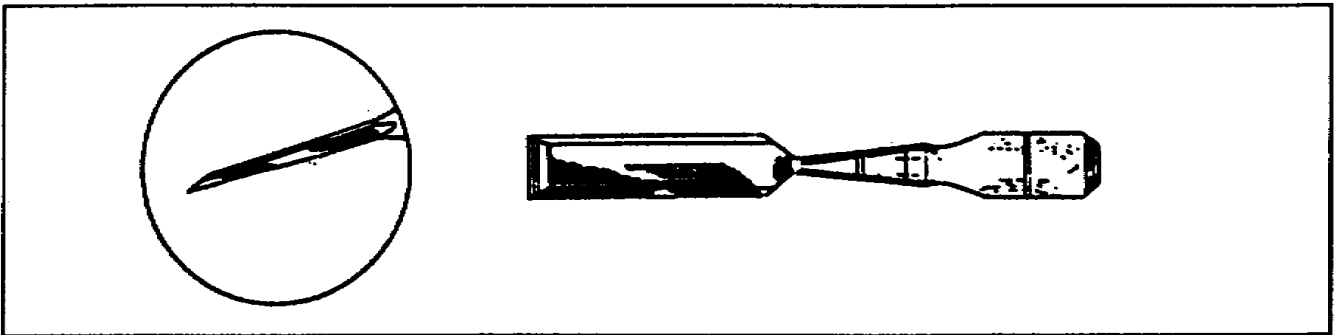


Figure 2-17. Paring chisel

(2) Firmer Chisel. The *firmer* chisel (Figure 2-18) is more substantial tool than the paring chisel. It is usually used for routine work, but may be used for paring or light mortising. When paring, drive the chisel by hand pressure. For light mortising, use a mallet.

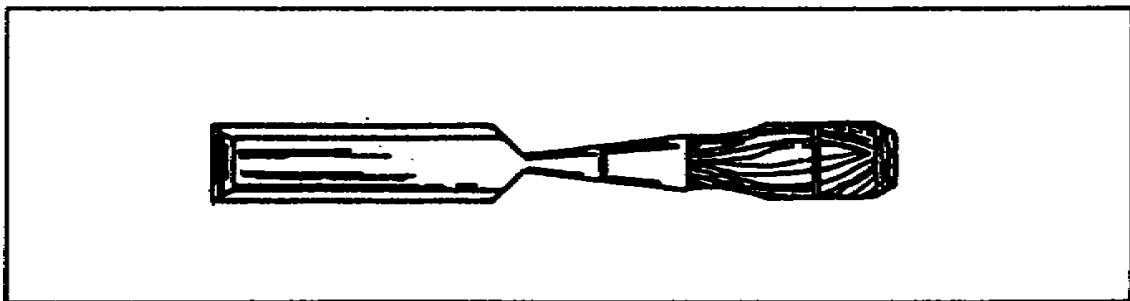


Figure 2-18. Firmer chisel

CAUTION

Never use a hammer or metal tool to drive a chisel-use wood to wood. This will help preserve the handles of your chisels.

(3) Framing Chisel. A framing (or *mortise*) chisel (Figure 2-19) is a heavy-duty tool, which is used for heavy work. These chisels have an iron ring fitted to the end of the handle to prevent splitting when it is struck with a heavy mallet.

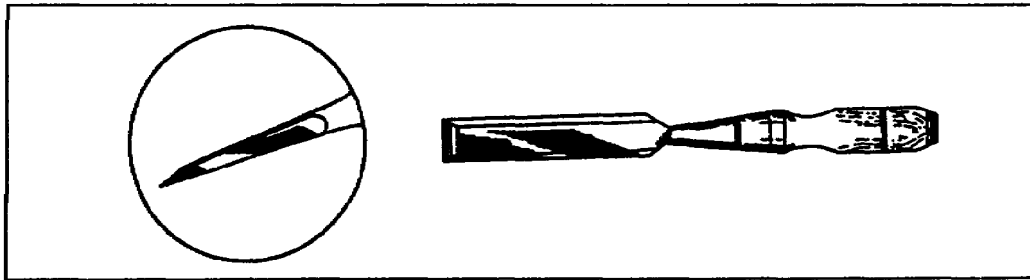


Figure 2-19. Framing chisel

(4) Slick Chisel. Any chisel having a blade wider than 2 inches is called a *slick chisel*. Regular sizes range from 2 1/2 to 4 inches. They are used on large surfaces where there is considerable material to be removed or where unusual power is required.

b. Care and Use of Sharp-Edged Cutting Tools. For most effective use, keep all chisels properly ground and sharp. When chisels are not being used, keep them in a toolbox or other approved storage place such as a rack, to prevent dulling or nicking the cutting edges. To prevent rusting during storage, coat the metal portion of the chisel with light oil.

(1) Replacing the Wood Chisel Head. A wood chisel with a mushroomed head (Figure 2-20) should be replaced immediately, because a mallet can glance off its mushroomed surface easily and spoil the work surface or cause injury.

NOTE: A slightly battered wood handle can be smoothed with a wood rasp and sandpaper.

(2) Whetting the Cutting Edge. The cutting edge of the wood chisel can be kept in shape by whetting it on an oilstone (Figure 2-21), unless its edge is nicked or the bevel has become too rounded with careless whetting. In this case, the chisel must be ground, taking care the bevel is ground straight. Keep the length of the bevel about two times the thickness of the unbeveled part of the blade.

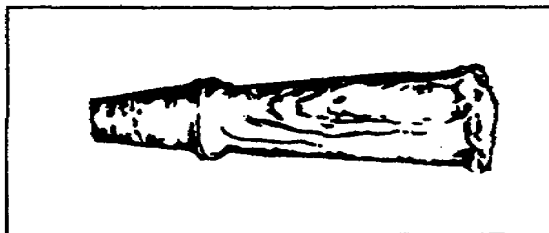


Figure 2-20. Mushroomed chisel head

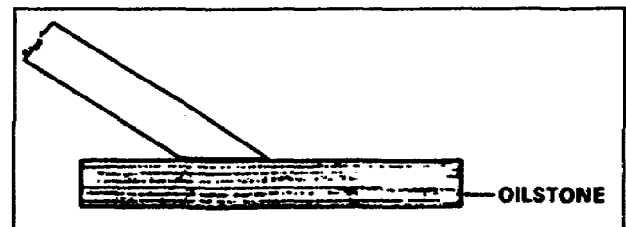


Figure 2-21. Whetting a chisel cutting edge

(3) Grinding a Wood Chisel. To grind a wood chisel, first square the cutting edge. To do this, hold the chisel at a right angle to the grinding wheel with the bevel up and move it from side to side (Figure 2-22). Dip the chisel in water frequently to avoid loss of temper. Check the edge with a small square to be sure the edge is at a right angle to the sides of the blade.

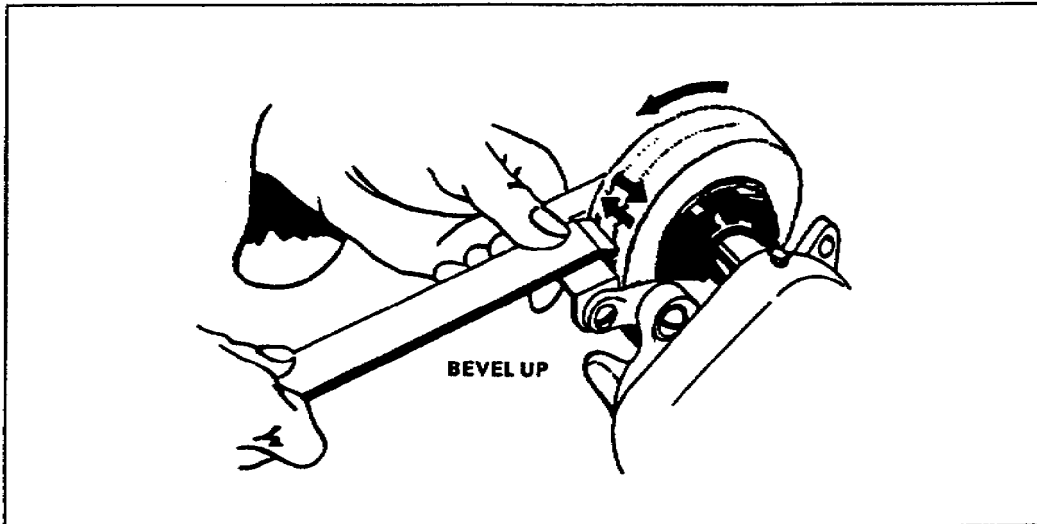


Figure 2-22. Grinding a chisel cutting edge

(4) Restoring the Bevel. To restore the bevel, readjust the grinder tool rest to a position that will give the chisel the correct bevel (usually 30 degrees). Hold the bevel lightly against the wheel (Figure 2-23) and grind with the same side-to-side motion used in squaring the cutting edge. To avoid loss of temper, cool the chisel by dipping it in water during the sharpening process.

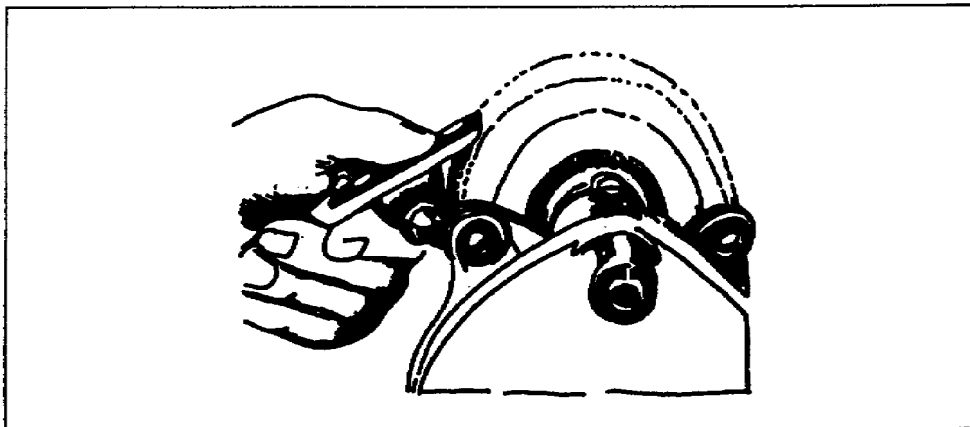


Figure 2-23. Restoring a bevel chisel cutting edge

(5) Grinding and Honing. Figure 2-24 shows a properly ground and properly honed chisel. Remember X should equal twice the width of Y.

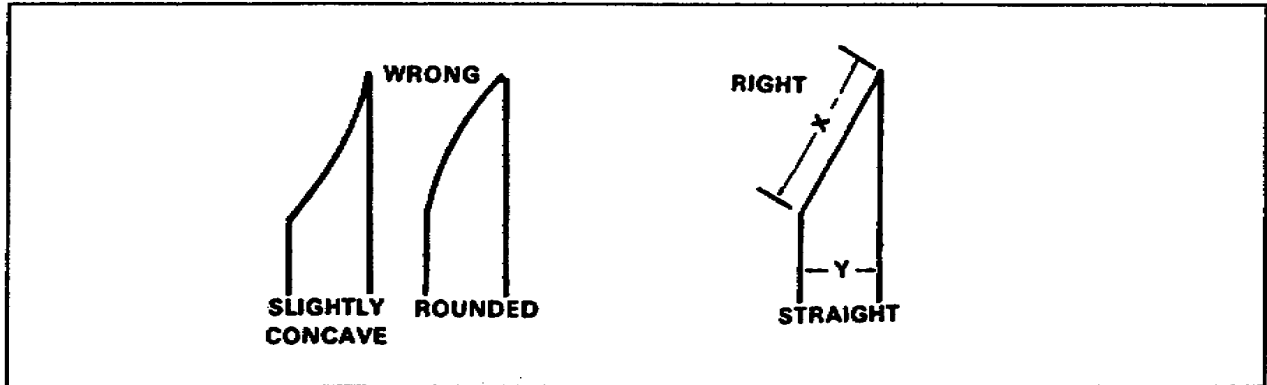


Figure 2-24. Ground and honed chisel

2-4. Smooth Facing Tools.

a. Types. Smooth facing tools called *planes*, are sharp-edged cutting tools in which the cutting edge is guided by the body of the tool instead of by the hands. The plane bit, for example, is positively guided by contact of the body of the tool with the work, giving a smooth cut in contrast to the rough cut made by hand-guided chisels.

(1) Hand Plane. A plane is a finishing tool used for smooth surfaces (Figure 2-25). It consists of a wood or iron stock or a combination of the two, with the cutting edge projecting from a slot on the underside. The cutter inclines backward and has a chip breaker in front to dispense the shavings. The plane is light and easy to use in finishing and bringing wood down to the desired thickness. Hold the plane with both hands and, with long strokes push it away from you.

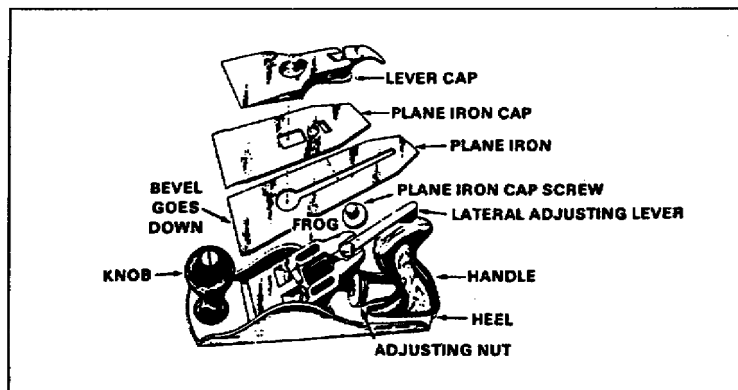


Figure 2-25. Hand plane

(2) Block Plane. This is the smallest plane (Figure 2-26). It varies in length from 3 1/2 to 7 1/2 inches and can be used easily with one hand. Primarily, it is used for planing end grain or across the grain of wood. No chip breaker is needed to break the shavings because there are no shavings when planing across the grain.

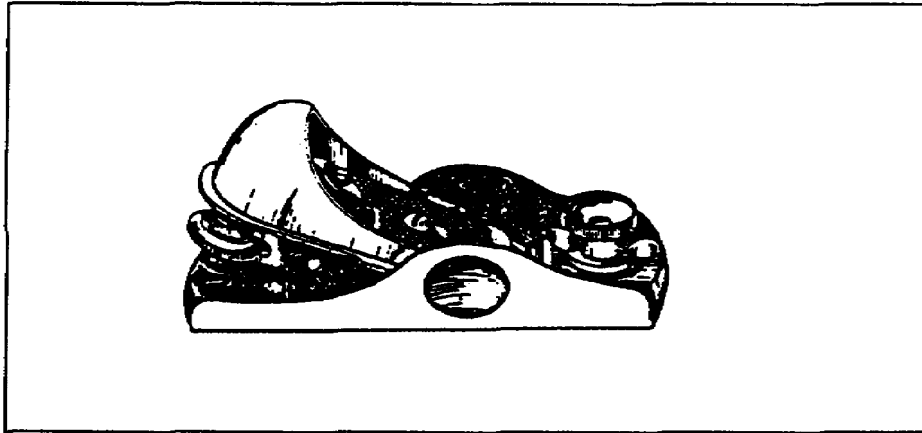


Figure 2-26. Block plane

(3) Smoothing Plane. The smoothing plane is a short, finely set plane, which averages 12 inches in length (Figure 2-27). It is used for finishing uneven surfaces.

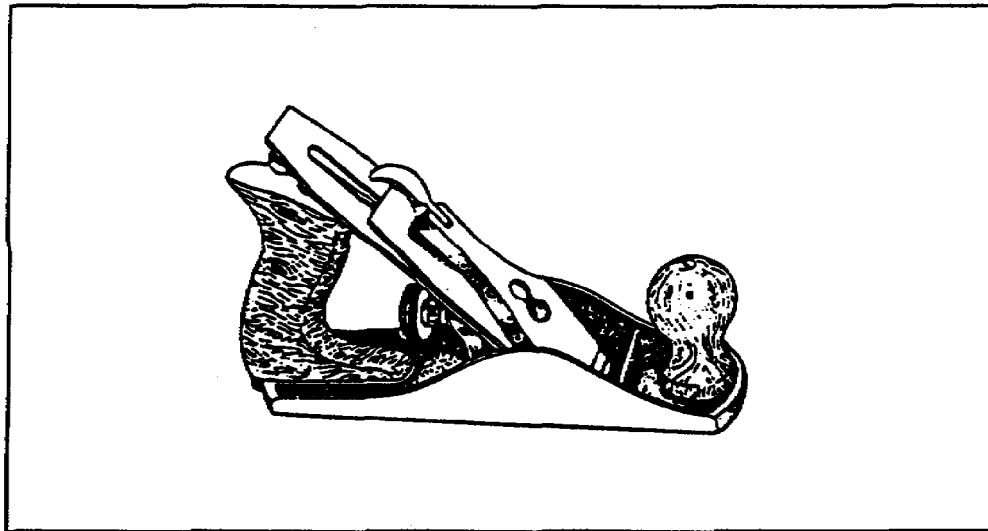


Figure 2-27. Smoothing plane

(4) Jointer Plane. This plane is the largest of the plane family (Figure 2-28). It varies in length from 20 to 24 inches. The great length of this plane makes it possible to smooth a large surface or to make the edge of a board true so that two such surfaced areas will fit closely together.

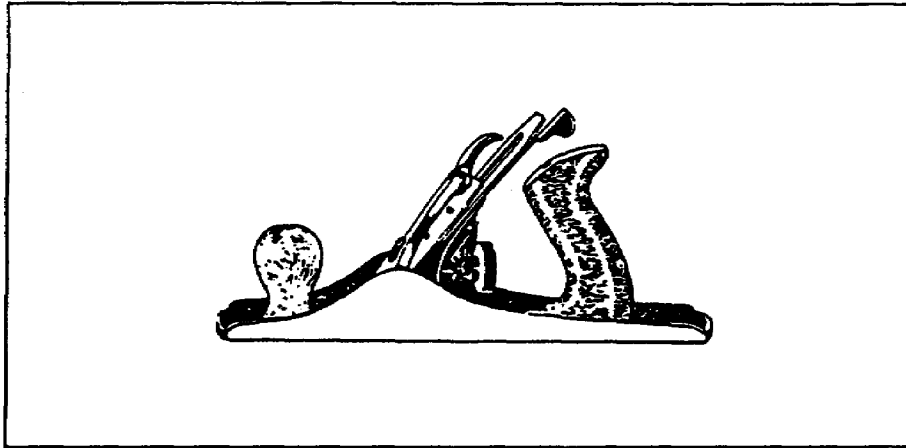


Figure 2-28. Jointer plane

b. Care and Use.

(1) Sharpening Plane Bits. The length of the plane determines the straightness of the cut. If you keep your plane bits sharp, they will produce a true and smooth surface. To get the best service from your planes, the bit should be ground and honed properly. When grinding and honing plane bits, the same rules apply as for wood chisels. The cutting edge should be straight on jointer-, smoothing-, and block-plane bits and slightly curved on jack-plane bits.

(2) Using and Storing A Plane. Satisfactory results from a plane depend on how it is used. On the forward stroke, hold the plane flat on the surface to be planed. On the return stroke, lift the back of the plane so that the cutting edge does not rub against the blade. When the plane is not in use, place it on its side. For storage, withdraw the blade into the body of the plane. This helps keep the cutting edge sharp.

2-5. Rough Facing Tools. Rough facing tools are called *striking tools* because the work is done by a series of strokes. The cut made by this method is rough compared to cuts made by other tools.

a. Hand Axe. The hand axe has a curved cutting edge and a long, flat-faced peen. It is sharpened with a bevel on each side of the blade. The broad hatchet and half hatchet are sometimes referred to as *hand axes* (Figure 2-29).

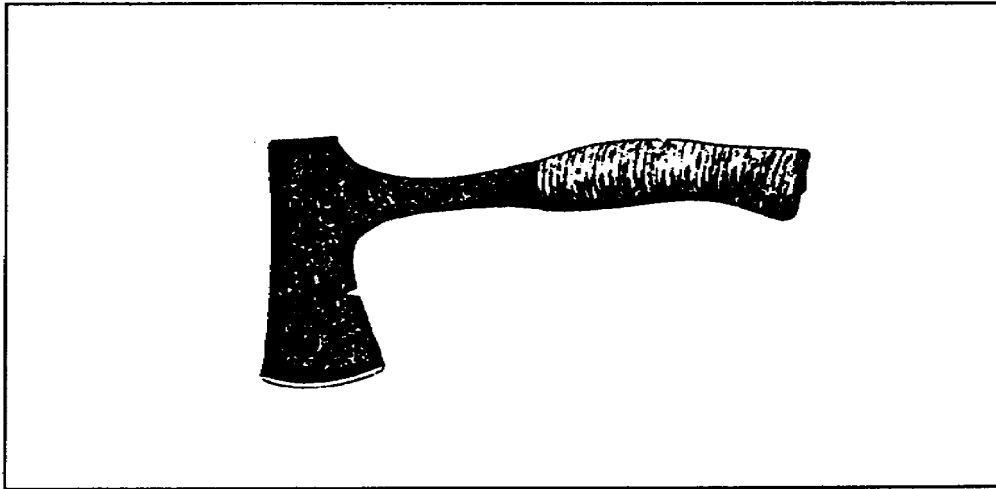


Figure 2-29. Hand axe

b. Axe. This is similar to the hand axe but larger, with a long handle. As you can see in Figure 2-30, it is intended for heavy cutting and should be used with both hands. It is sharpened in the same manner as the hatchet.

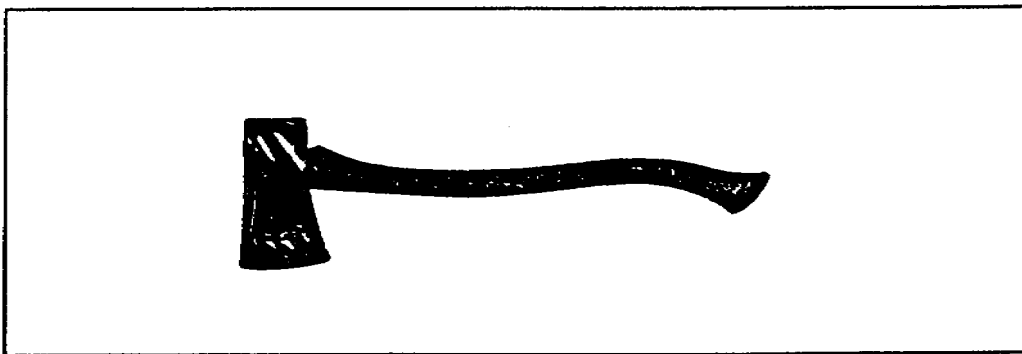


Figure 2-30. Axe

2-6. Driving Tools.

a. Types of Driving Tools. Driving tools include such tools as claw hammers, tack hammers, and mallets, which are designed for specific uses; however, the one most frequently used is the claw hammer.

(1) Claw Hammer. The best claw hammers are made from the best steel, which is carefully forged, hardened, and tempered. Hammers differ in the shape of the claw-curved or straight-and in the shape of the face-flat or rounded. The style of the neck, the weight, and the general finish of claw hammers differ according to the intended use. Figure 2-31, page 2-16, shows straight and curved claw hammers. The average weight of claw hammers is 5 to 20 ounces. Good-

quality or high-grade hammers have hickory handles and are made from well-seasoned, straight-grained stock. Other hammers of good quality have steel handles with shock-absorbing rubber grips.

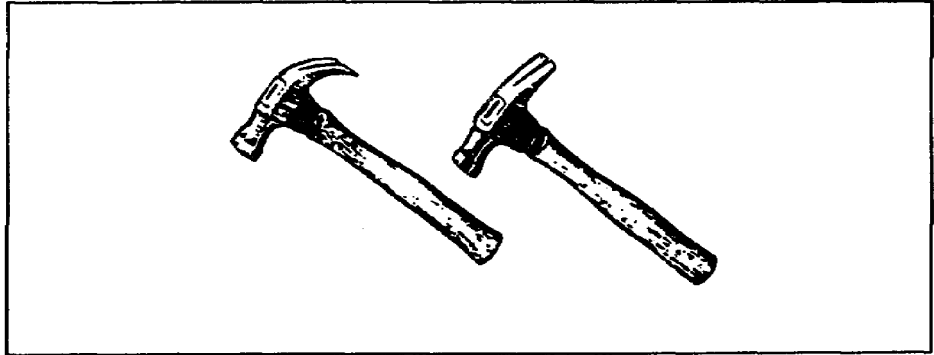


Figure 2-31. Claw hammers

(2) Mallets. Mallets are, in reality, wooden hammers. Although not considered a driving tool, they are used the same way as hammers. You will use mallets primarily for driving chisels and wedges. Depending on their use, mallets can vary in size from a few ounces to a few pounds. Many woodworkers make their own mallets to suit their personal touch. Figure 2-32 shows three types of mallets.

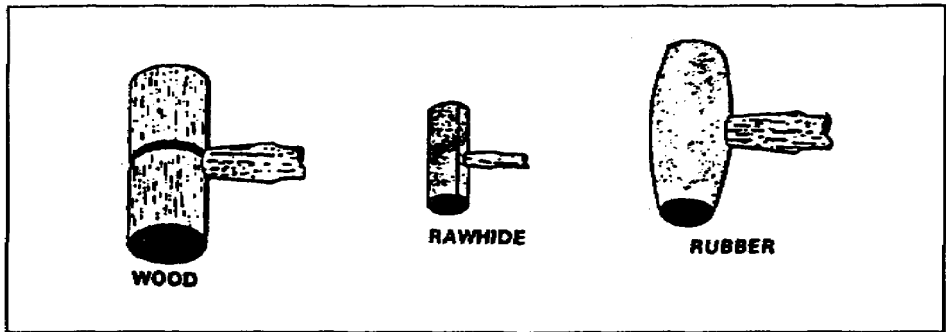


Figure 2-32. Mallets

b. Care and Use of Driving Tools.

(1) Driving Nails. When you use driving nails with a claw hammer, guide the nail with one hand and grasp the hammer with the other down near the end of the handle. Avoid holding the hammer near the neck. Use a wrist motion, tapping the nail lightly to start it, then use a few sharp blows to finish driving the nail. After the nail has been driven, it can be set below the surface with a nail set. This prevents hammer marks or *cat paws* from marring the surface of the wood. Nail sets are made in several sizes. Figure 2-33 shows one type of nail set.

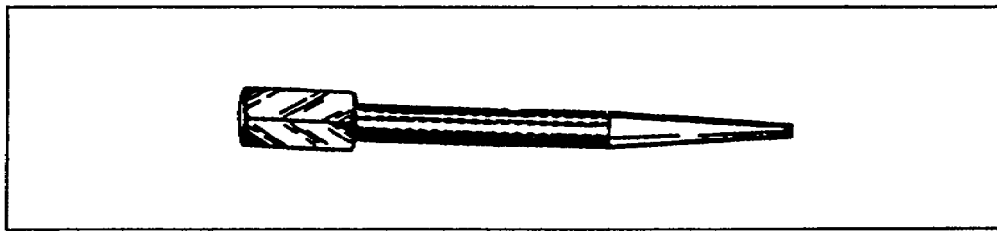


Figure 2-33. Nail set

(2) Removing Nails. Use the claw of the hammer to remove nails. To properly pull a nail, place a block under the claw for leverage. If the nail is large, use a nail puller or a wrecking bar (Figure 2-34).

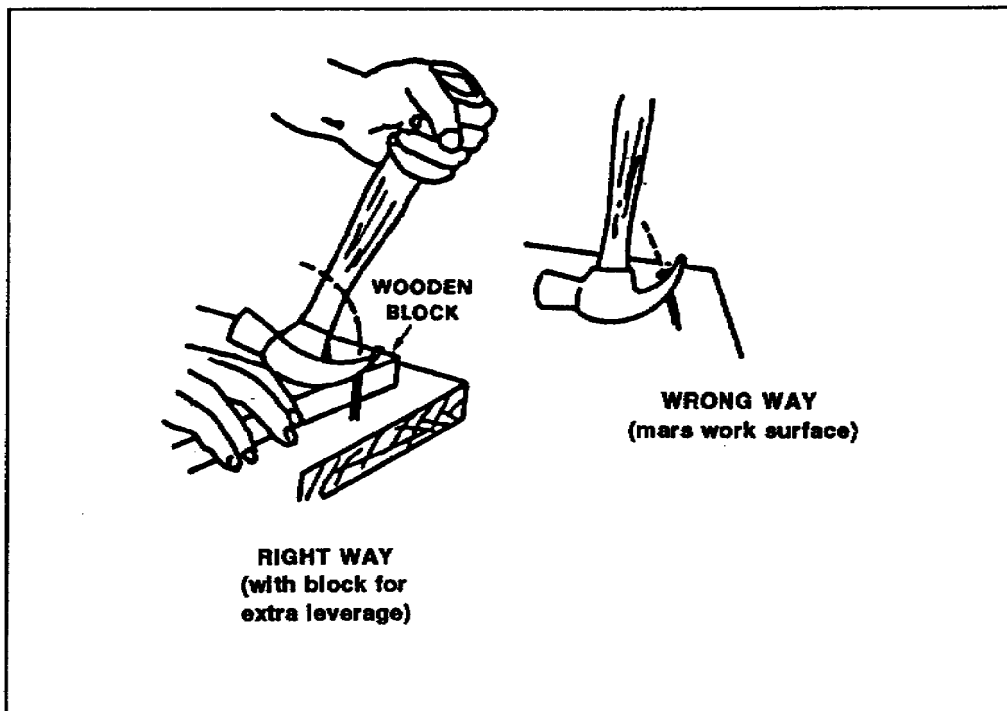


Figure 2-34. Removing nails

2-6. Fastening Tools. Fastening tools are used to join parts or materials together with screws or bolts. These tools include screwdrivers and wrenches.

a. Screwdrivers. There are many different types, shaped ends, and lengths of screwdrivers. The automatic screwdriver (Figure 2-35, page 2-18) is a labor and time saver, especially where great numbers of screws are to be driven. The bits for this tool come in different sizes for slotted and Phillips-head screws and can be changed to fit the different sizes of screws. The automatic screwdriver has a

ratchet assembly, which you can adjust to drive or remove screws. You can also lock it in position and use it as an ordinary screwdriver.

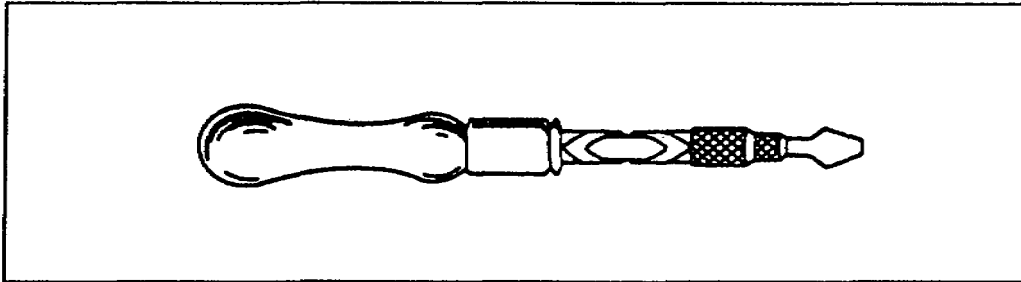


Figure 2-35. Automatic screwdriver

b. Phillips Screwdrivers. Phillips screwdrivers are used only for driving Phillips screws (Figure 2-36). Phillips screws have a head with two V-slots, which cross at the center. The tip of the Phillips screwdriver blade is shaped like a pointed or beveled cross to fit into these slots. This type of screwdriver cannot slip out of the slot, therefore preventing damage to expensive finishes.

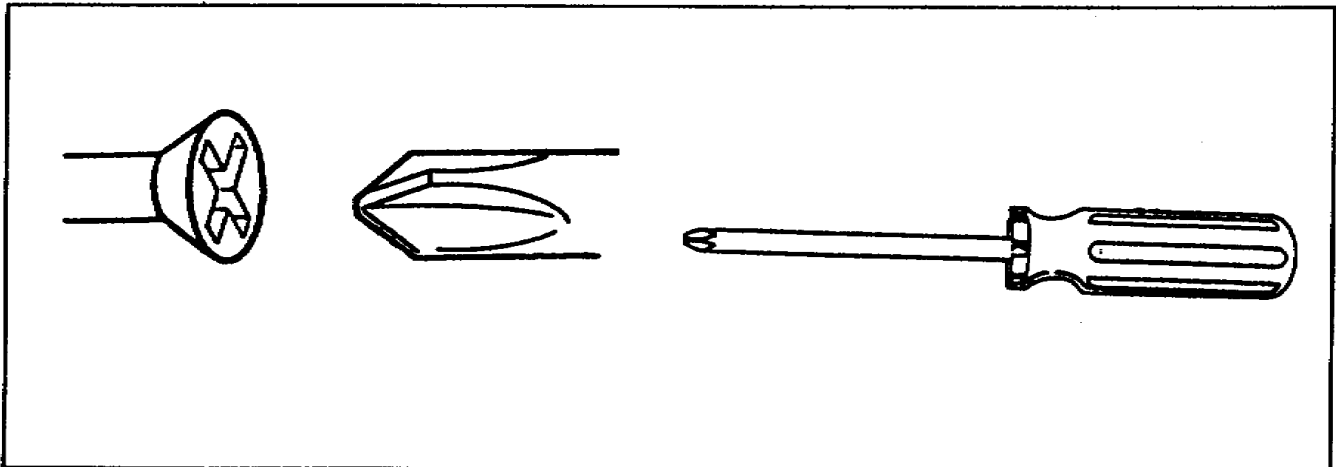


Figure 2-36. Phillips screwdriver

2-7. Holding Tools.

a. Supporting Tools. Supporting tools consist of sawhorses or trestles used to support workers and materials. Figure 2-37 shows a pair of sawhorses, which you might use to support a piece of lumber that you are cutting.

b. Retaining Tools. Retaining tools consist of various types of clamps, which fall into the following general categories: C clamp, double-screw clamp, and bar clamp (Figure 2-38).

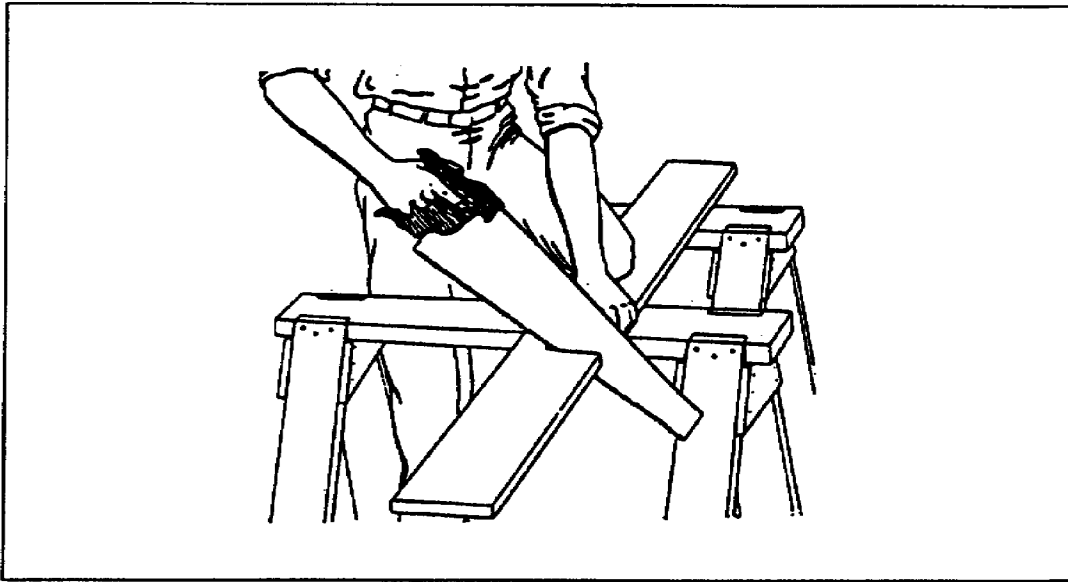


Figure 2-37. Sawhorses

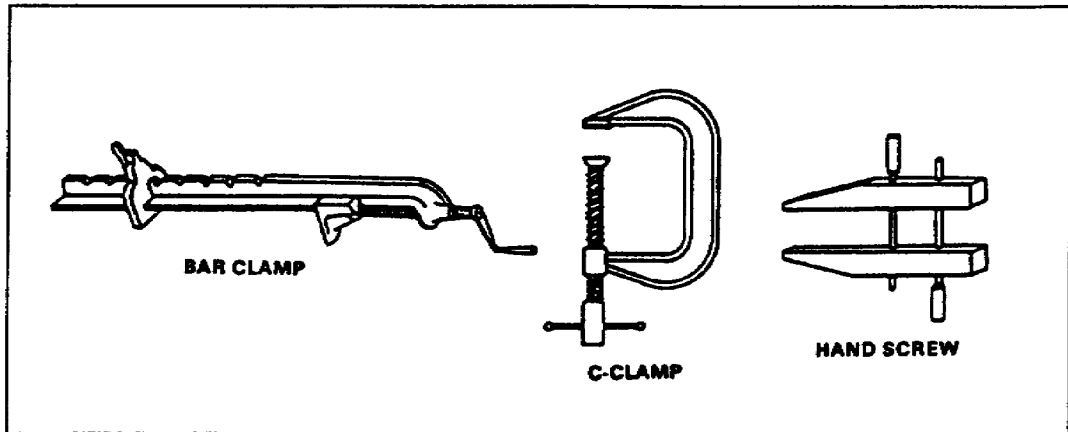


Figure 2-38. Clamps

c. Vises. Vises can be fitted to the top of a workbench, and some are adapted to slide underneath the top of the workbench. Most vises used by carpenters are fitted with wood between the jaws to protect the work from scars, dents, and scratches (Figure 2-39, page 2-20).

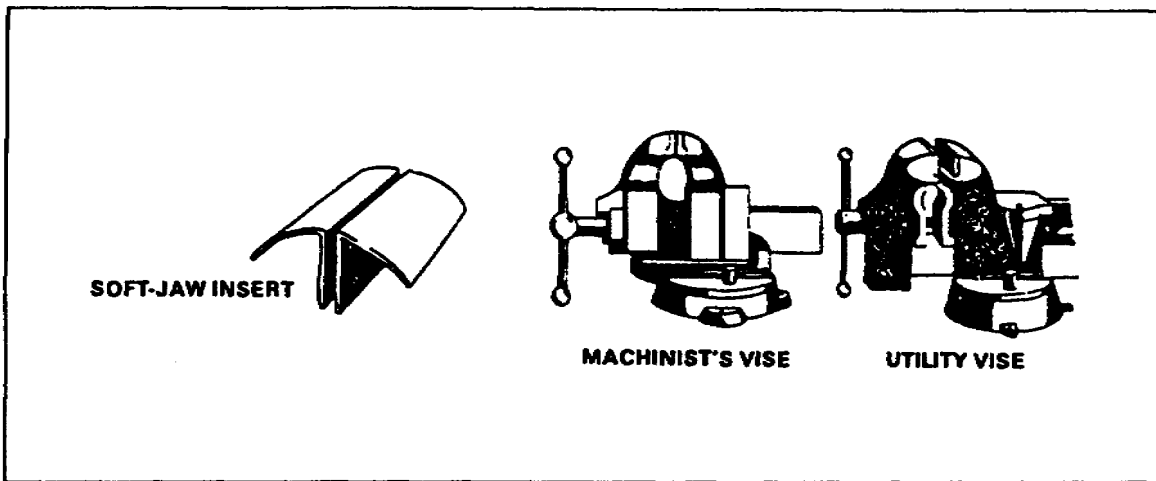


Figure 2-39. Vises

2-8. Leveling Tools.

a. Common Level. The common level (Figure 2-40) is used for both guiding and testing when bringing work to a horizontal or vertical position. The level has a long rectangular body of wood or metal, which has a built-in glass spirit tube on its side and near the end. Each tube contains a nonfreezing liquid with a small air bubble free to move within the tube. The side and end tubes are at right angles to each other. When you center the bubble of the side tube with the hairline, the level is horizontal; when you center the bubble of the end tube with the hairline, the level is vertical. By holding the level against a surface to be checked, you can determine whether the surface is truly level (or *plumb*). Levels should be hung up when not in use.

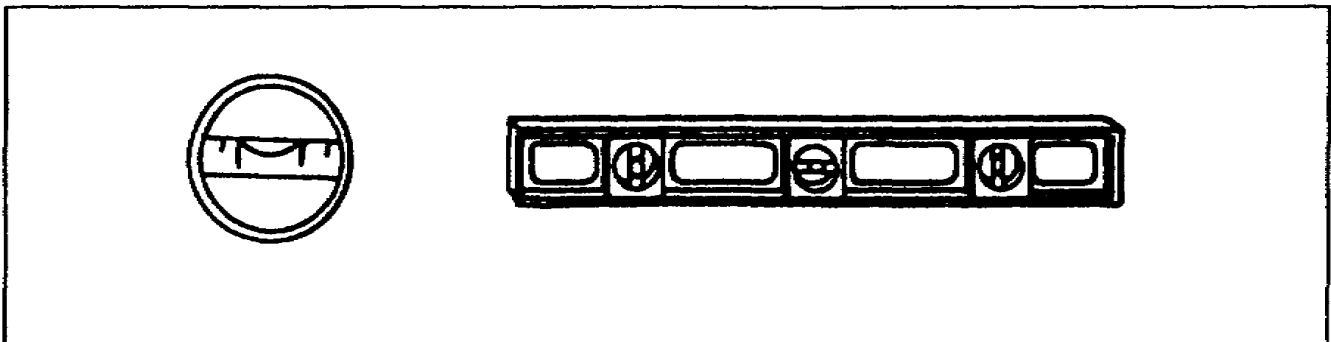


Figure 2-40. Common level

b. Plumb Bob. A plumb bob is made of metal, usually brass. It usually has a screw-type cap with a hole in the center. A string or plumb line is inserted through the hole and fastened inside. The bottom end has a point in direct line with the hole in the cap (Figure 2-41). The string is absolutely perpendicular to the horizontal when the plumb bob is suspended on it. It can be used for the

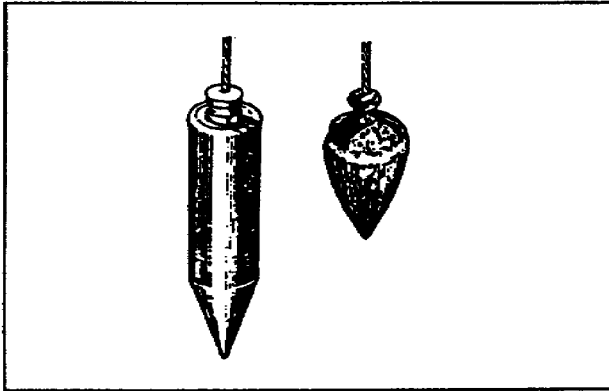


Figure 2-41. Plumb bobs

same purpose as the plumb glass on a level; however, the plumb bob is not accurate when used in the wind.

c. Chalk Line. This is a strong, lightweight cord used to make a straight line between two widely separated points. To snap a straight line, rub chalk on a cord held taut between two points. Then pull the cord straight up from the center and release it, to allow it to spring back into place. Chalk lines come in metal or plastic cases. Figure 2-42 shows how to snap a chalk line.

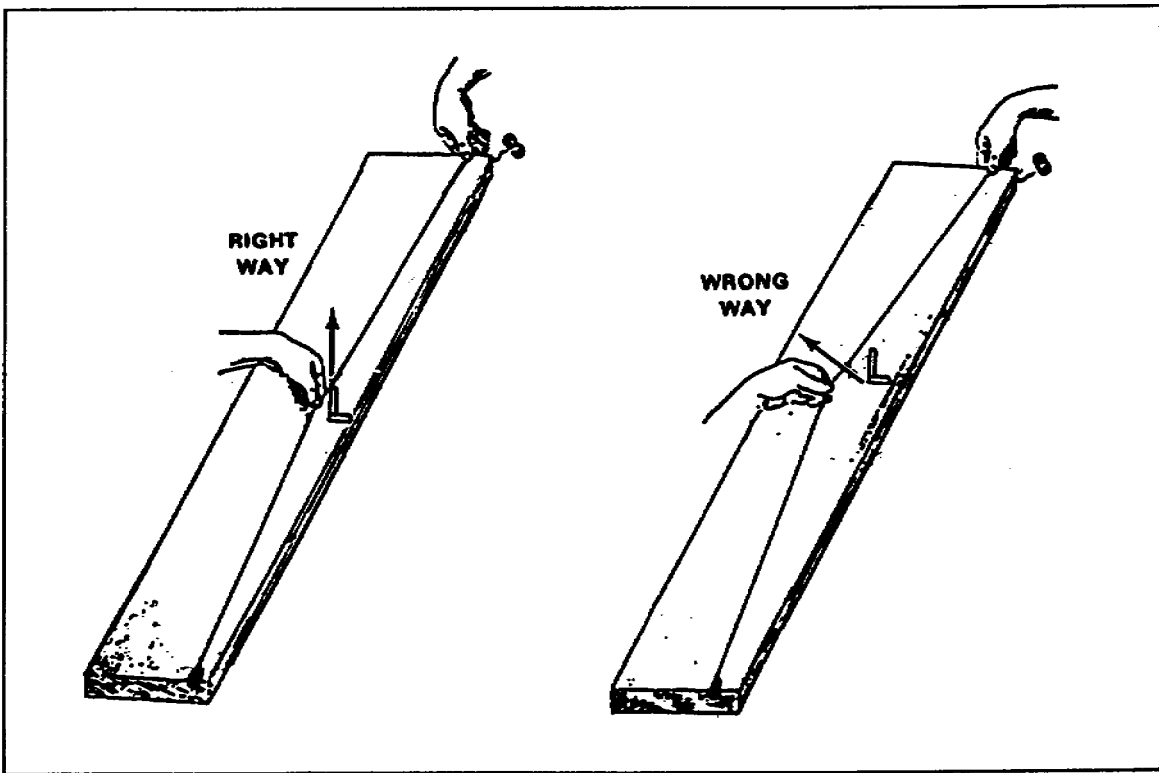


Figure 2-42. Snapping a chalk line

2-9. Measuring Tools. The most used and important tools that you must learn to use are those for measuring and layout work. Carpenter's measuring tools include rulers and tapes. Layout tools include various types of squares, dividers, and compasses and a marking gauge. The square is used for drawing angles. Dividers and compasses are used to scribe circles or transfer measurements. The carpenter's scribe is in the same class as a compass; it is used to scribe lines on building material for irregular joints. The marking gauge is used to mark lines parallel to a surface, an edge, or the end of a piece of lumber. Measuring and layout must be accurate; therefore, use a very sharp pencil or a knife blade.

When measuring, lay out your ruler or tape from your starting point and measure the distance called for by your plan. Place a mark opposite the required distance and square or angle the line as required by your layout.

a. Folding Rule. A folding rule is made from boxwood and has a concealed joint or rivet that holds it stiff and rigid when opened. Usually 6 feet in length, it is marked off in feet and inches and graduated in sixteenths of an inch. Figure 2-43 shows the folding rule most often used by carpenters.

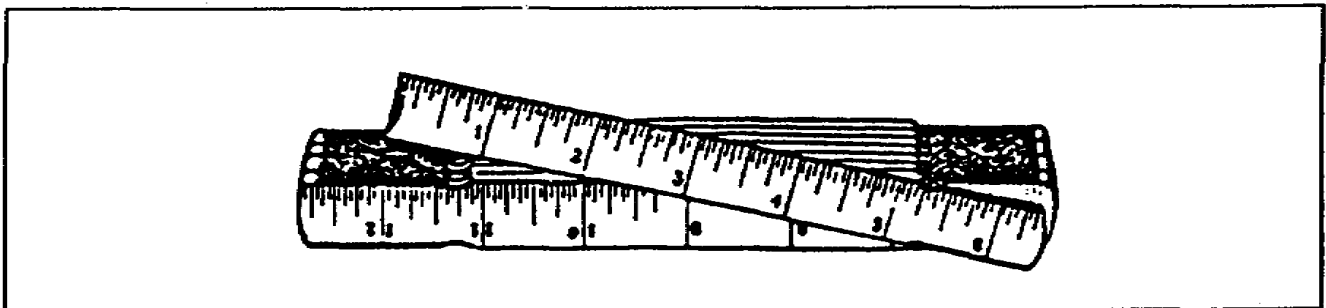


Figure 2-43. Folding rule

b. Steel Tape. In recent years, the flexible steel tape has been replacing the folding rule. It is also marked off in feet and inches and graduated in sixteenths of an inch. The flexible steel tape is housed in a metal casing with a spring attachment, which retracts the tape into the casing when the end is released. This type of rule is best because of its compactness and suitability for taking inside measurements (Figure 2-44).

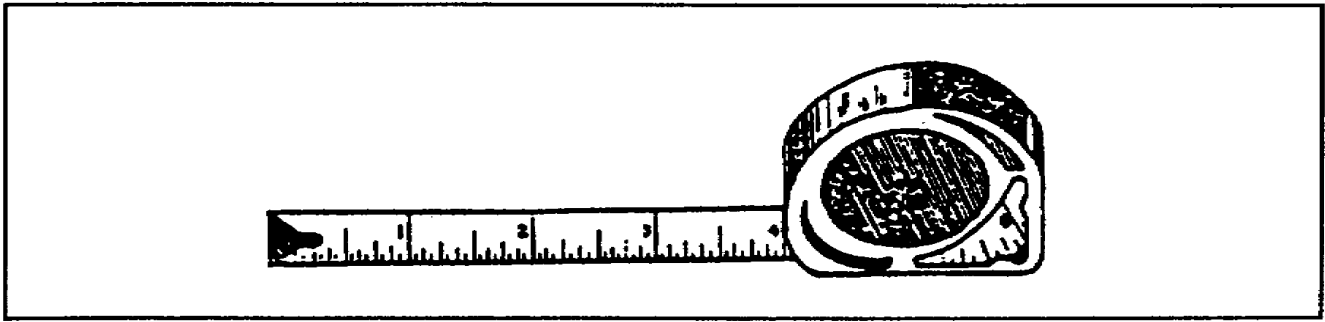


Figure 2-44. Steel tape

2-10. Framing Square. Much could be written about the framing square because of its many uses. However, we will cover only the correct nomenclature (names of terms and symbols) of its parts and the tasks for which it can be used.

In construction work, especially in house framing, the framing square is an invaluable tool and has a use that is common to all squaring devices. It is used for checking the squareness of building materials and for the squaring or angling of a mark placed on the building material. One arm of the square is placed against the edge or face of the building material. The other arm, with measuring units on it, is placed next to the desired mark on the building material. A line is then drawn across the material to the desired length or depth. It can also be used as a calculating machine, a means of solving mathematical problems. You will use it for laying out common, valley, hip, jack, and cripple rafters in roof construction and for laying out stringers for steps.

Figure 2-45, page 3-24, shows the framing square and its principal parts. The body of the square is the wider and longer member the tongue is the shorter and narrower member. The face is the side visible both on the body and the tongue when the square is held with the tongue in the left hand and the body pointing to the right. The various markings on a square are scales and tables. The square most generally used is one with a 16-inch tongue and a 24-inch body.

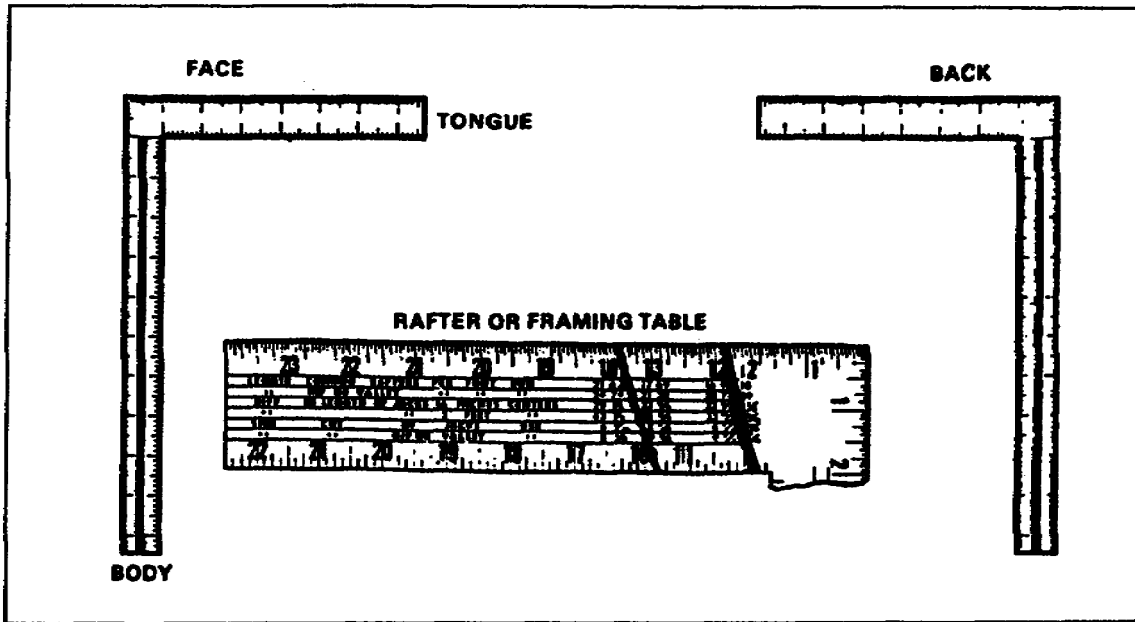


Figure 2-45. Framing square

a. Try Square. The try square (Figure 2-46) is so called because of frequent use as a testing tool when squaring up wood stock. It consists of a steel blade 8 inches long at right angle to the stock, which is usually made of hardwood and faced with brass to preserve the wood from damage. The blade usually has a scale divided into eighths of an inch.

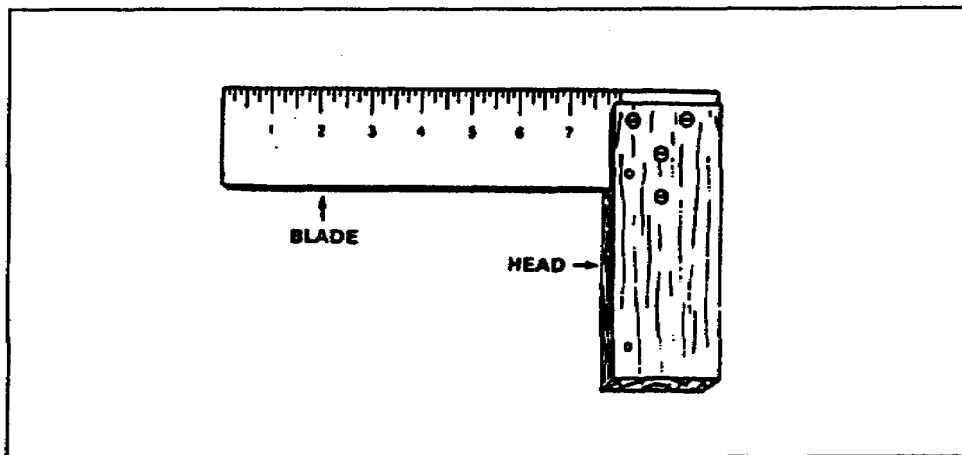


Figure 2-46. Try square

b. Miter Square. The term *miter* means any angle except a right angle, but as applied to squares mean an angle of 45 degrees (Figure 2-47). It is similar to a try square, but the stock of a miter square has an angle or 45 degree set in the

stock. When using the miter square, the 45 degrees face of the stock is placed against the edge of a board; then the blade will be at a 45 degree angle with the edge of the board. The scale on the blade is divided into eighths of an inch.

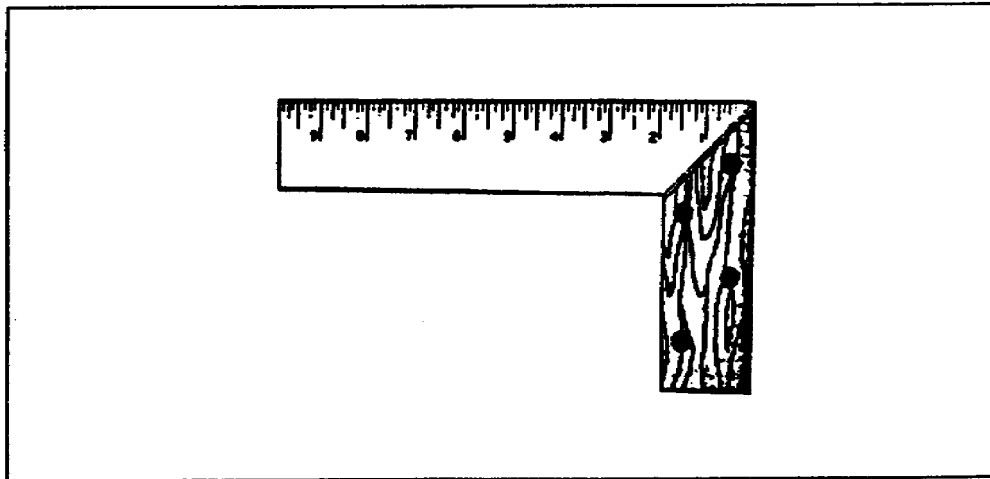


Figure 2-47. Miter square

c. Combination Square. A combination square does the work of a rule, square, depth gauge, and level (Figure 2-48, page 2-26). The name *combination* square indicates that you can use it as a try or miter square. It differs from the try and miter squares in appearance, and you can move the head to any desired position on the blade. The head slides in a groove located in the center of the blade. This groove also permits removal of the head so that the blade may be used as a rule or a straightedge. A spirit level is installed in the head, permitting it to be used as a level. A centering head, which can be substituted for the head, is used to locate the center of shafts or other cylindrical pieces. A scribe is also inserted in the head to be used for laying out work. The protractor head is used to set different angles. In the construction of this tool, the blade is hardened to prevent the corners from wearing round and detracting from its value as a measuring instrument.

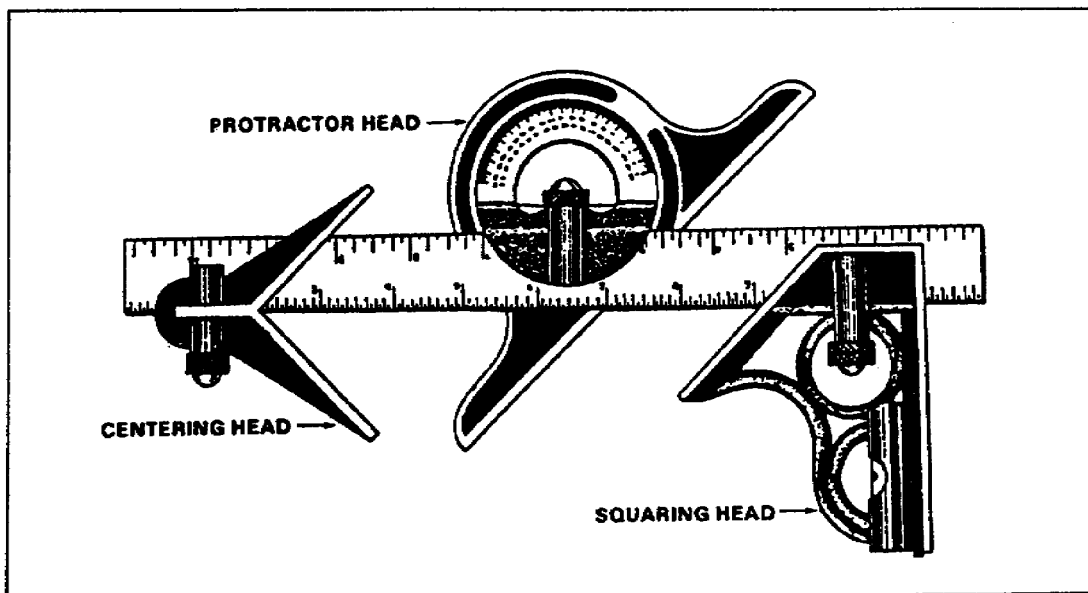


Figure 2.48. Combination square

2-11. Sharpening and Smoothing Tools. Two main types of tools are used to sharpen and smooth other tools: stones and files.

a. Grindstones. Most bench grinders found in carpentry shops are equipped with two grinding wheels: one of coarse grit and one with fine grit. Grinding wheels are held to the shaft by nuts, which squeeze the wheel between two special side washers. Grinding wheels are also rated by the turning speed they can withstand. Be sure you use stones made to withstand the rated revolutions per minute of the grinder electric motor. A tool rest is attached to the grinder frame and is adjustable for height as well as for distance from the stone. Most grinders are equipped with heavy-duty glass guards to permit watching as you grind. If there is no eye guard, you must wear safety goggles to protect your eyes. It is considered poor practice to use the side of the wheel for grinding. When the surface of the stone becomes irregular or filled with metal particles, use a stone dressing tool (Figure 2-49) to restore a good grinding surface. A water container, attached to the base of the grinder, is used for cooling parts being ground. Always cool the blades of tools you are sharpening to prevent destroying the temper of the metal with the excess heat generated from grinding. Heavy grinding is done on the coarse wheel, and light or finish-type grinding is done on the fine grit stone. Most cutting edges should be finished by hand, using a fine oilstone.

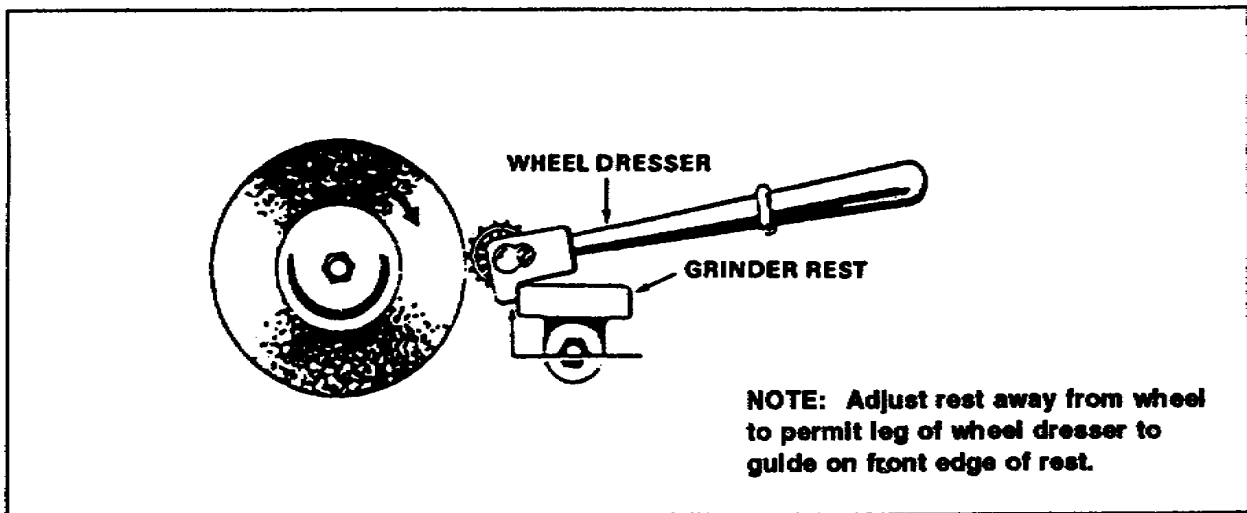


Figure 2-49. Grindstone

b. Oilstones. Oilstones are used after the grinding operation to give a tool the keen, sharp edge required for smooth cutting (Figure 2-50).

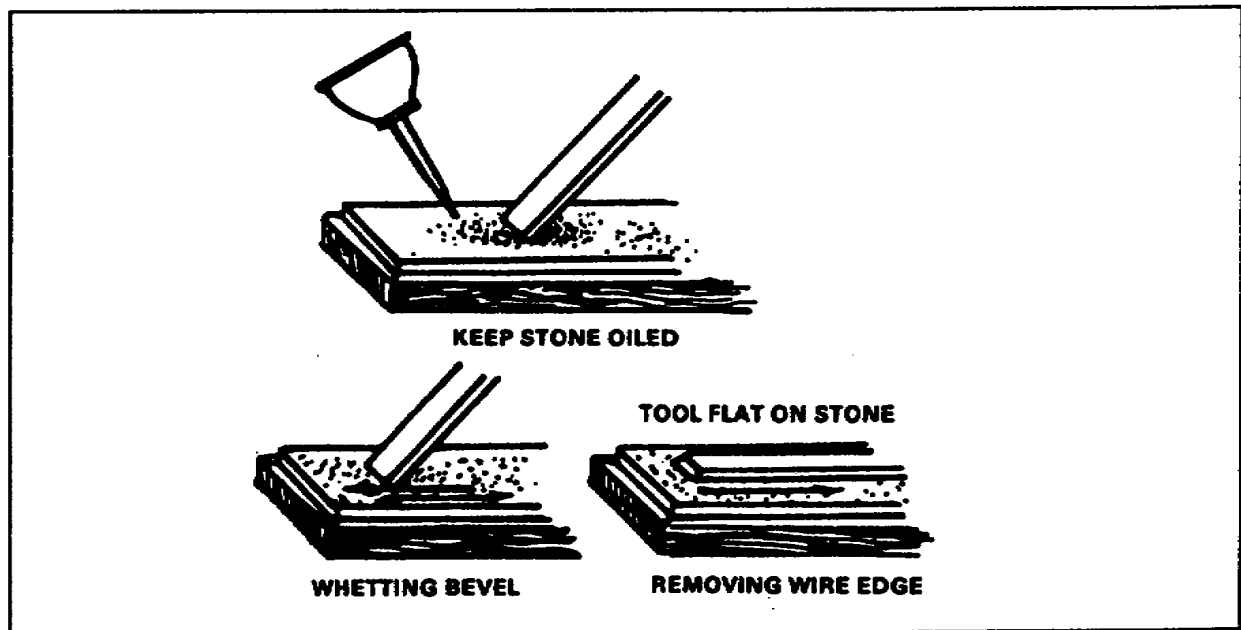


Figure 2-50. Oilstone

c. Artificial Stones. These stones have coarse, medium, or fine grades. Coarse stones are used for general work where fast cutting is required. Medium stones are used for sharpening tools that do not require a keen edge. They are recommended for sharpening tools that are used for working softwoods. Fine stones are used where a keen edge is desired. Cabinetmakers whose tools require a very fine, keen edge use the fine type of stone.

d. Files and Rasps. A file is a steel instrument used for cutting and smoothing metal and wood. A rasp is a very coarse file that differs from an ordinary file in teeth size and shape. Figure 2-51 shows the types of files. Wood files are usually tempered to work lead or brass; they should not be used on any harder surface. When using a file, never allow it to drag on the backward stroke; it cuts only on the forward stroke. When using a rasp, fix the work firmly in a vise and grasp the rasp in both hands, with one hand holding and the other applying a light pressure to the rod (Figure 2-52).

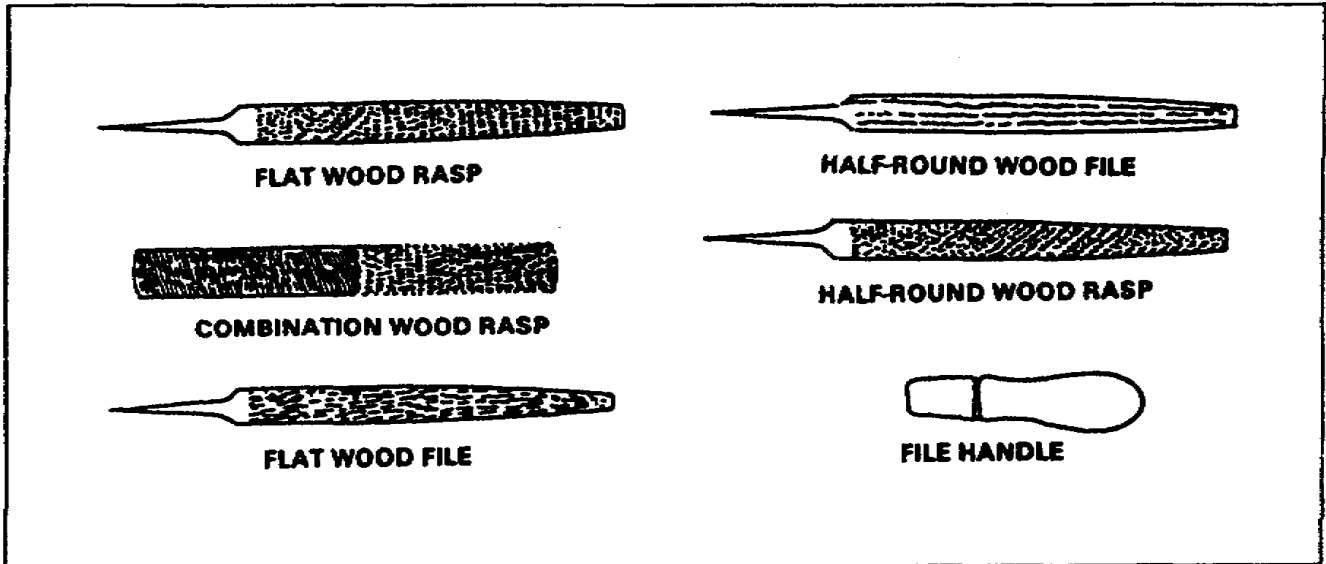


Figure 2-51. Files and rasps

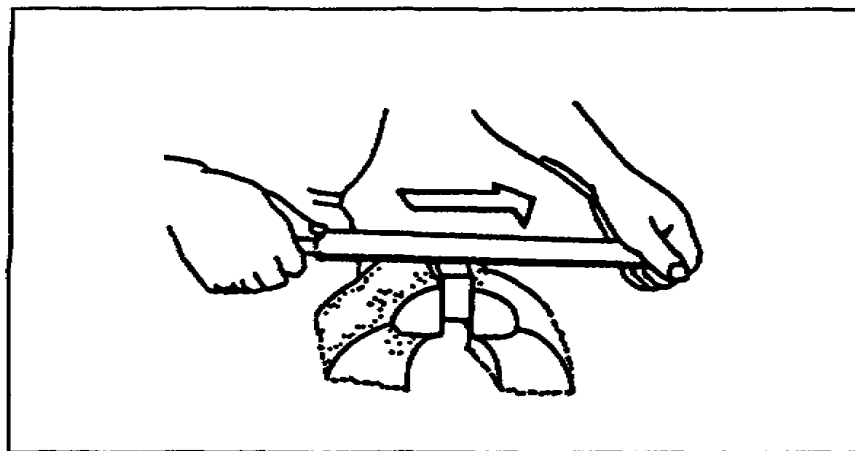


Figure 2-52. Using a rasp

2-12. Pulling Tools. Pulling tools are used for pulling nails, for prying, and for lifting. They are also used extensively for dismantling buildings, crates, boxes, and other wood products. They include nail pullers and wrecking bars.

a. Nail Pullers. Nail pullers (Figure 2-53) are used for removing nails, especially those that are driven flush or below the surface of wood. A nail puller has two jaws that set over the nailhead. Pressure is applied by a series of bows from the sleeve. The sleeve, which fits over the handle and slides up and down, is usually equipped with a guard to protect your hand from the sliding sleeve. The average length of a nail puller is 18 inches.

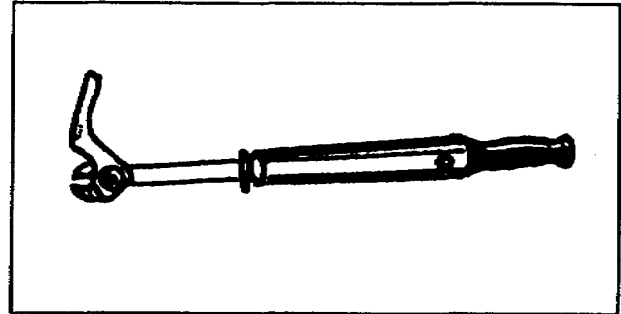


Figure 2-53. Nail puller

b. Wrecking Bars. Wrecking bars are usually made of forged, tempered steel. They are hexagonal in shape, with a curved, slotted neck for pulling large nails. The average length is 24 to 36 inches. They are used to dismantle and tear down wooden structures. A bar of the same type without a curved neck is called a *pinch bar*. Its use is similar to that of a wrecking bar. Figure 2-54 shows the types of wrecking bars.

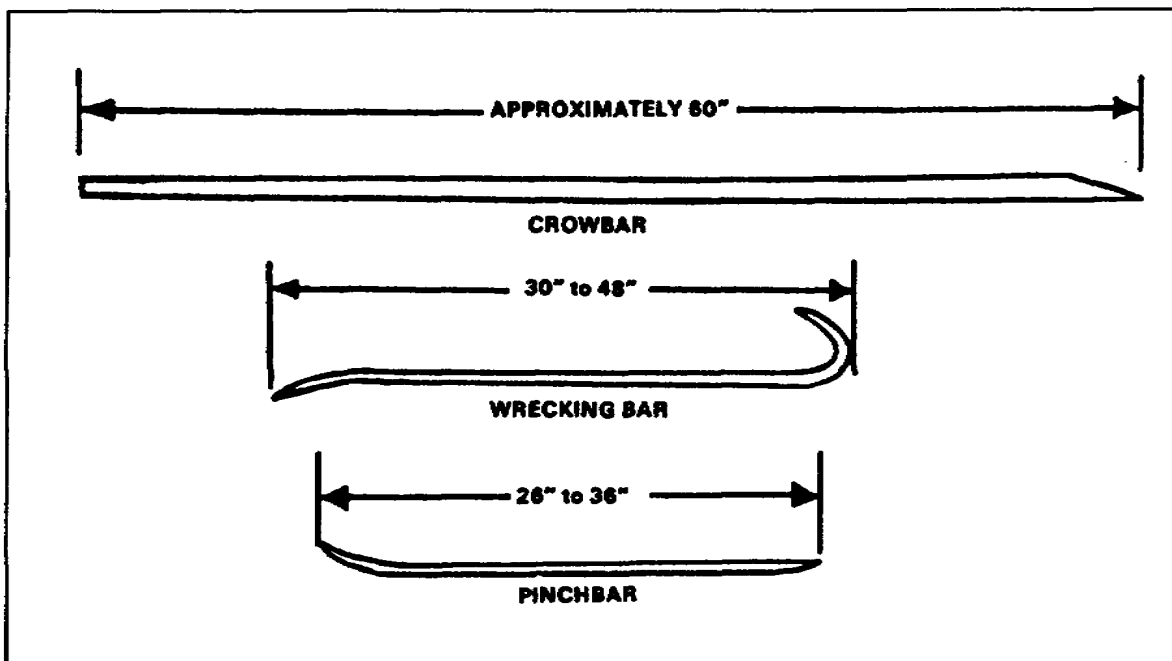


Figure 2-54. Wrecking bars

PART B - CARE AND USE OF POWER MACHINERY

2-13. Portable Power Saws. Electric circular saws are primarily used for crosscutting or ripping and usually come equipped with a combination rip and crosscut blade. Other blades are available for cutting plywood, masonry, and hardboard.

a. Blade Sizes. The most commonly used blades are 7 1/4-inch and 7 1/2-inch blades. The diameter of the saw blade controls the depth of cut that may be made with the saw.

b. Electric Handsaw. Figure 2-55 shows the parts of the electric handsaw. Learn these parts and become very familiar with the operation of the saw before trying to use it.

c. Circular Saw. The circular saw has a calibrated scale to control the depth of the cut by raising or lowering the base shoe of the saw. The saw may also be tilted to cut up to a 45-degree bevel cut. Figure 2-55 also shows the scale and tilt lock knobs.

d. Safety Guard. The operator is protected by a safety guard (Figure 2-55), which is pushed back by the piece being cut and returns automatically when the saw is removed from the work.

CAUTION

This safety device is of vital importance in preventing bodily injuries. Do not be take it off, tie it, or jam it back.

e. Ripping Fence. A very important accessory available for the portable power saw is the ripping fence (or *guide*) (Figure 2-56), which permits ripping of lumber to a predetermined width. It is used to ensure an exact cut of a predetermined distance from the board edge. Many carpenters reverse the hand position shown here in ripping. Use the most comfortable position.

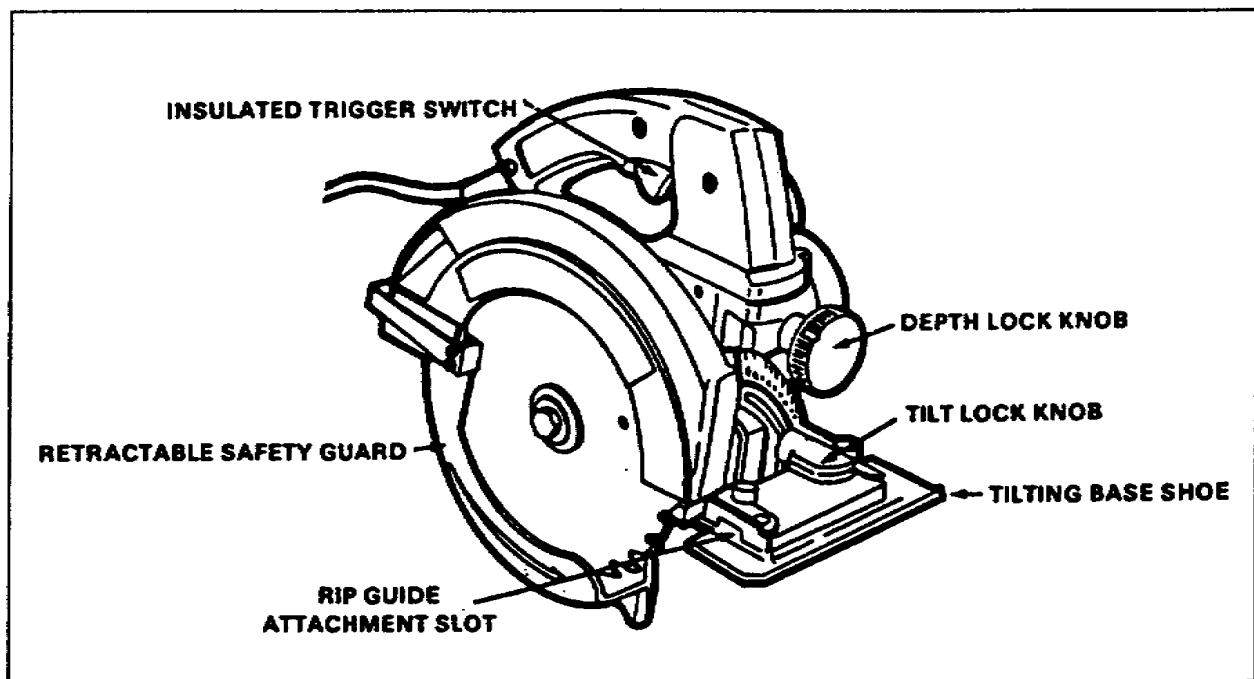


Figure 2-55. Electric handsaw

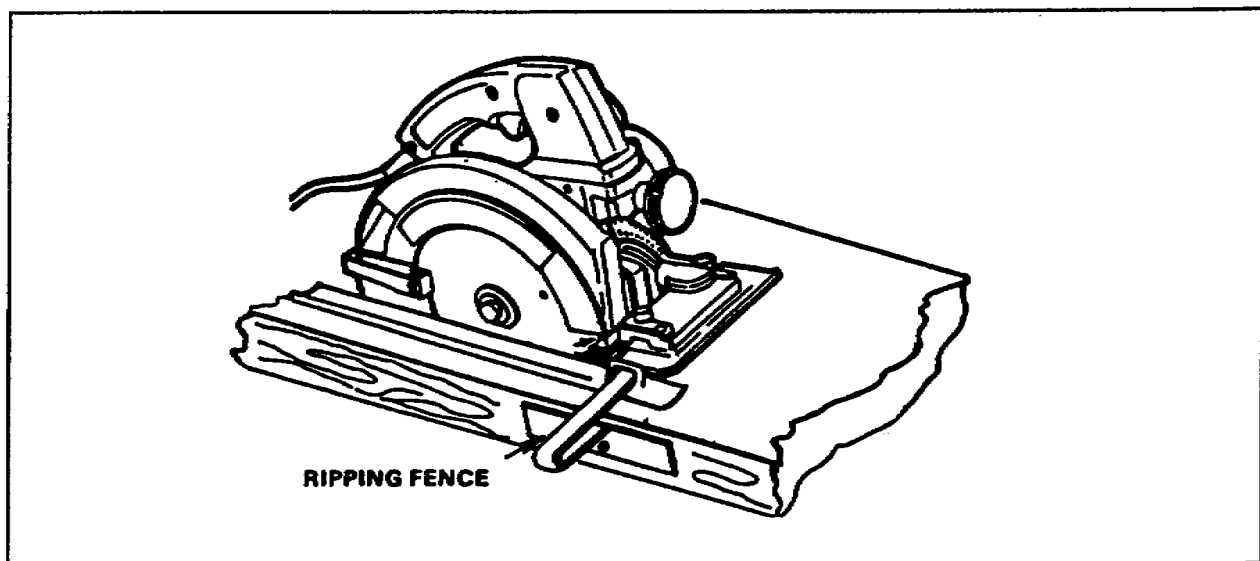


Figure 2-56. Ripping fence

f. Blade Types. The four common types of blades are shown in Figure 2-57, page 2-32. The combination blade is a multipurpose blade that can be used for crosscutting or ripping.

2-14. Radial Saw. A radial saw (Figure 2-58, page 2-32) is a very versatile power tool, that can be used in all types of construction, such as timber construction, house construction, and form construction.

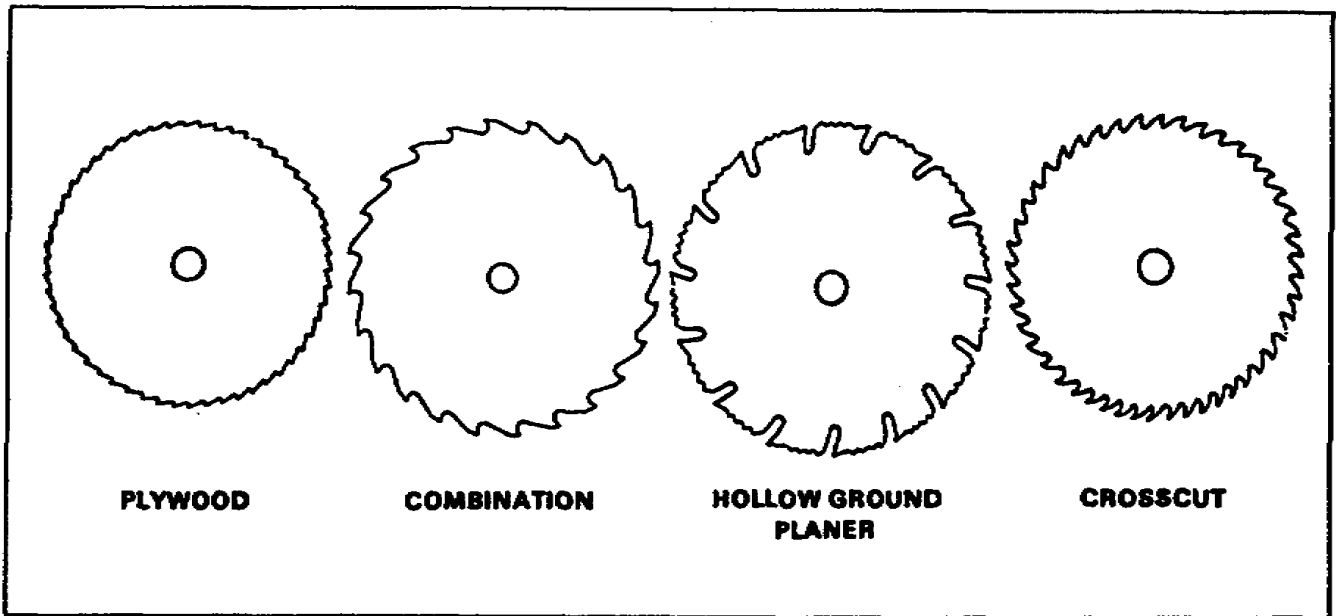


Figure 2-57. Types of blades

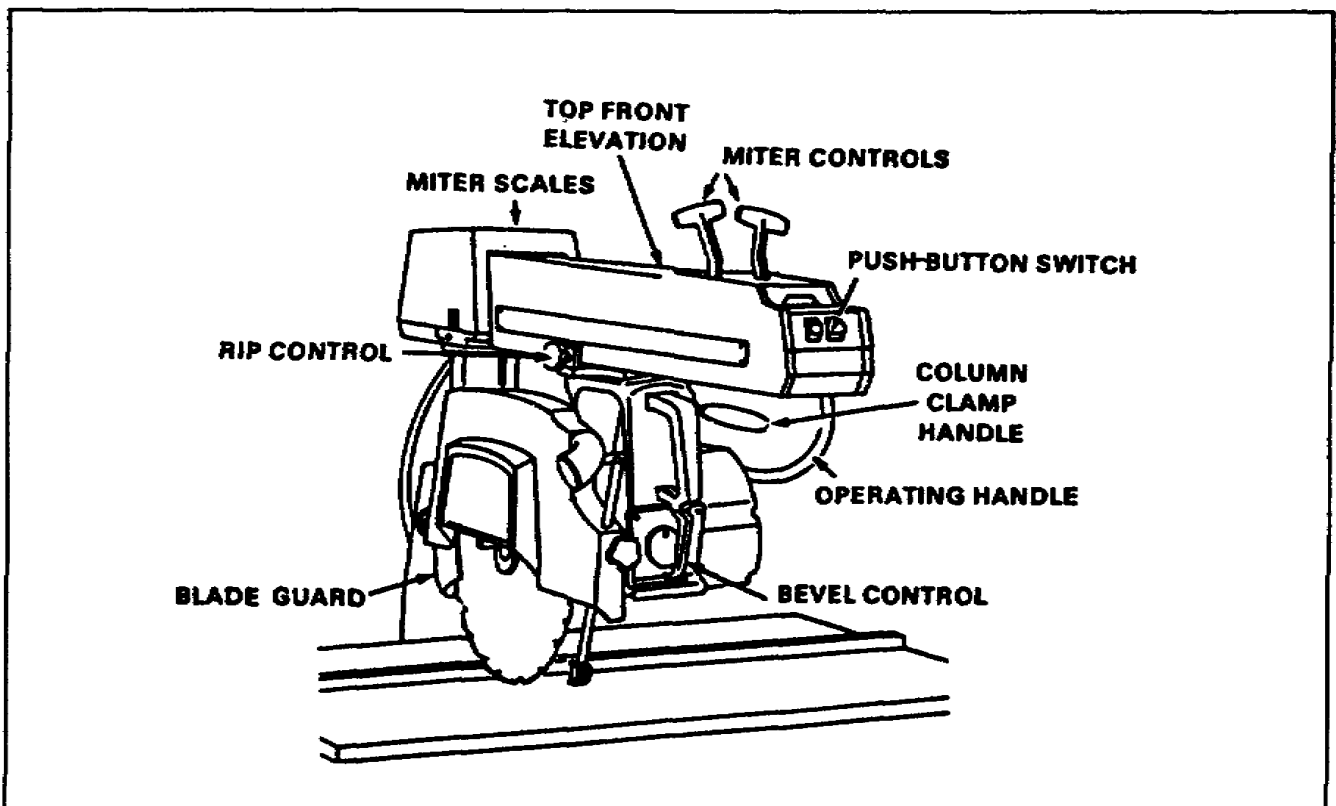


Figure 2-58. Radial saw

a. Blade Guard. Over the blade is a guard that protects the operator from an exposed saw blade. It also channels sawdust out through the opening of the guard.

b. Crosscutting. Crosscutting is done by placing the board flat on the table with one edge against the backrest. The saw blade should be pulled evenly through the material. Lower the saw only enough to cut through the board.

c. Ripsawing. Ripsawing is very similar to the table saw, except that the saw blade is above instead of below the work. When ripping a board, feed it along the table making sure the teeth of the blade revolve toward the operator.

d. Bevels and Angles. Bevels and angles are cut in much the same manner as crosscutting. The head of the saw can be rotated or tilted to various angles. The procedures apply for crosscutting and ripping.

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LESSON 2

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. What adjustable bit is used to bore holes in wood?
 - A. Auger
 - B. Countersink
 - C. Expansion
 - D. Twist

2. The crosscut saw has a number stamped on the blade near the handle. What does this number indicate?
 - A. The length of the blade.
 - B. The number of teeth per inch.
 - C. The size of the saw.
 - D. The width of the saw blade.

3. How do you joint a saw?
 - A. Set the saw blade
 - B. File the teeth to a straight line
 - C. Use a three-cornered file
 - D. Sharpen the saw

4. What is the largest type of plane?
 - A. Hand
 - B. Jack
 - C. Jointer
 - D. Smooth

5. What is the purpose of the nail set in the carpenter's tool kit?
- A. To set nails on a hinge.
 - B. To prevent hammer marks.
 - C. To drive nails in drywall.
 - D. To drive concrete nails.
6. You are building a wall section and you want to check the vertical and horizontal positions. Which tool should you use?
- A. A plumb bob
 - B. A common level
 - C. A chalk line
 - D. A folding rule
7. Which type of square has a 16-inch tongue and a 24-inch body?
- A. Combination
 - B. Framing
 - C. Miter
 - D. Try
8. Heavy grinding is done on the coarse wheel. What is light finish-type grinding done on?
- A. The file
 - B. The grinding wheel
 - C. The oilstones
 - D. The rasp
9. What are the most commonly used blade sizes on a circular saw?
- A. 7 1/4" and 7 1/2"
 - B. 8 1/4" and 8 1/2"
 - C. 9 1/4" and 9 1/2"
 - D. 10 1/4" and 10 1/2"

10. The head of the saw can be rotated or tilted. Which type of saw is described?

- A. Band
- B. Crosscut
- C. Circular
- D. Radial

LESSON 2

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

<u>Item</u>	<u>Correct Answer and Feedback</u>
1.	C. Expansion Expansion Auger Bit. (page 2-2, para 2-1a(2))
2.	B. The number of teeth per inch. The number of teeth per inch...(page 2-4, para 2-2a(1))
3.	B. File the teeth to a straight line. When you joint a saw...(page 2-7, para 2-2b(1))
4.	C. Jointer This plane is the...(page 2-14, para 2-4a(4))
5.	B. To prevent hammer marks. This prevents hammer marks...(page 2-16, para 2-6b(1))
6.	B. A common level The common level...(page 2-20, para 2-8a)
7.	B. Framing The square most generally...(page 2-23, para 2-10)
8.	C. The oilstones Oilstones are used (page 2-27, para 2-11b)
9.	A. 7 1/4" and 7 1/2" The most commonly (page 2-30, para 2-13a)
10.	D. Radial The head of the saw...(pages 2-31 through 2-33, para 2-14d)