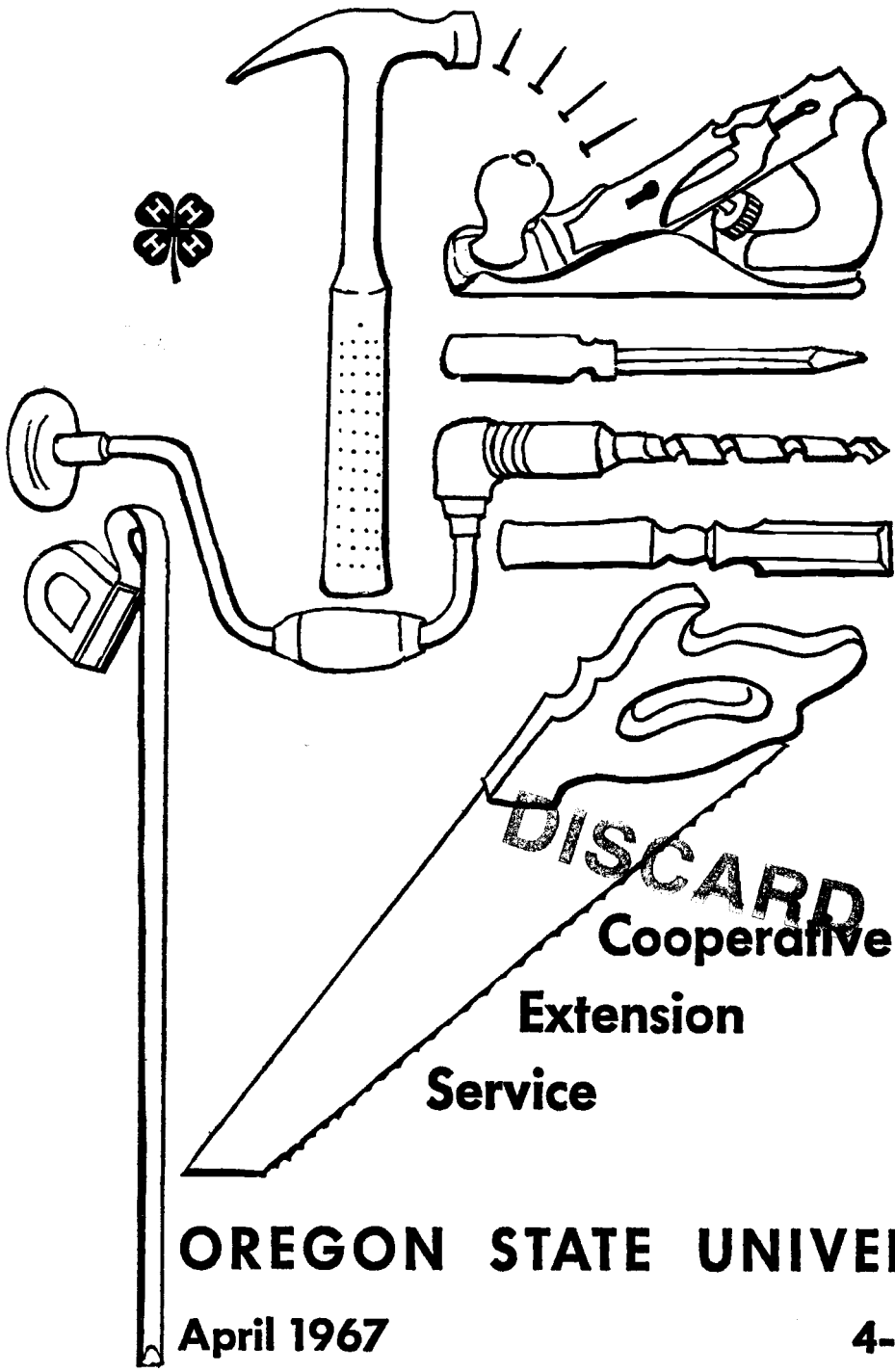
# 4-H WOODWORKING SKILLS











Cooperative Extension Service

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# Contents



This manual was prepared by Norbert Vandehey, Glenn Klein, and F. Dale Hoecker, members of the Cooperative Extension Service staff of Oregon State University. Some of the material was adapted from the Michigan State University 4-H Woodworking series and similar publications from other states.

# 4-H Woodworking Skills

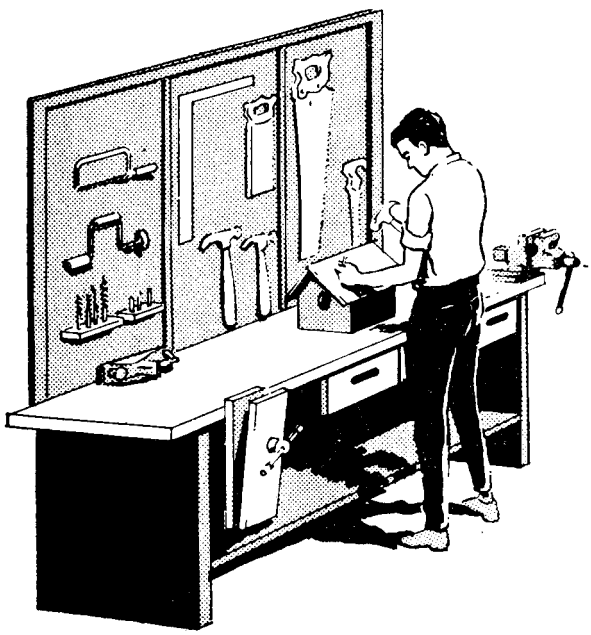
# Unit I. Selection and Use of Tools

## Selecting Tools

Good tools make good work. Take care of your tools. Keep them dry, sharp, and in order. The best tool is no good if you cannot find it when you need it.

Rust and careless handling are great enemies of hand tools. A good, clean place to work helps you give your tools proper care.

Learn to use the tools necessary to make the articles you have selected. Then learn to identify and use other tools.



**WORKBENCH AND TOOL HOLDER**

Some of the basic tools that it would be desirable to have in the home workshop are listed below. If you do not have all of them, you may be able to share tools with another 4-H member working on this project.

1. Claw hammer
2. Hand saw or a set (nest) of saws with one handle that fits on several saws
3. Folding rule or steel tape
4. Screwdrivers
5. Block plane
6. Combination square
7. Coping saw
8. Wood chisel (one ½-inch size, if you do not have a set)
9. Nail set
10. Sliding T-bevel (square)
11. Drill

The more experienced woodworker will probably need some additional tools, such as the following:

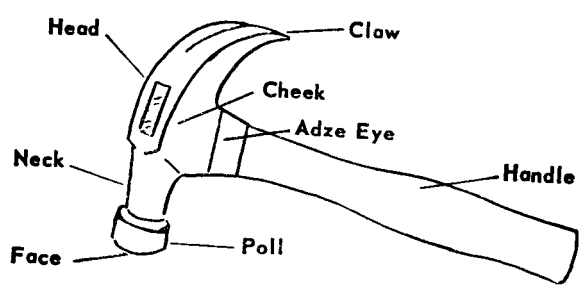
1. Wrecking bar
2. Marking gauge
3. Keyhole or compass saw
4. Mallet (wood or plastic)
5. Hand drill and bits
6. Carpenter's level
7. Counter sink bit
8. Bench vise
9. Back saw
10. Try square
11. Smooth or jack plane
12. Hand scraper
13. Steel square (framing)
14. Rip saw (a light-duty electric saw is probably more practical today)

When buying tools, you should look for quality in relation to the use you intend to make of each tool. Inexpensive, moderately priced, and expensive tools are available. In general, the more expensive tools will last the longest and give the best service. However, these tools are generally for the carpenter or tradesman who uses them every day in his work. Inexpensive tools or moderately priced tools will be adequate for the average home workshop where occasional or light duty is needed. Many stores now have "bargain bins" containing a variety of tools, all at one low price. These tools are usually of low-quality steel and lack precision manufacturing. However, sometimes they will do the job if you only plan to use them once or twice. In general, however, "bargain bin" tools should be avoided.

## Using Tools

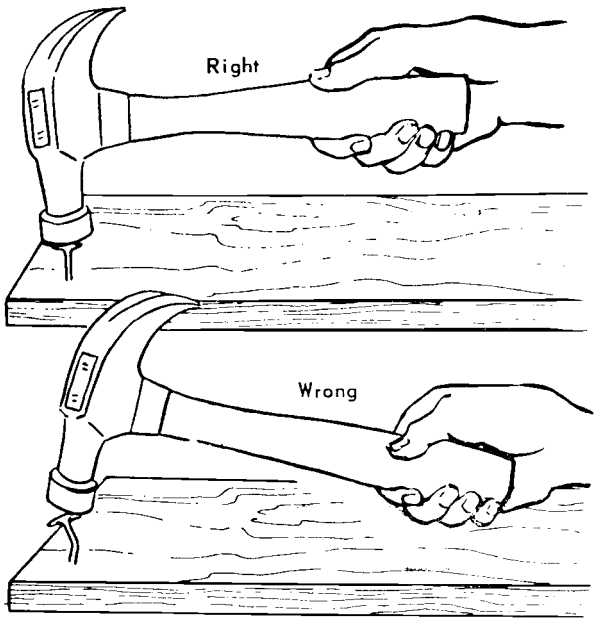
### The claw hammer

The claw hammer is perhaps the most used, as well as the most abused tool. To use it safely and well, remember a few simple rules.

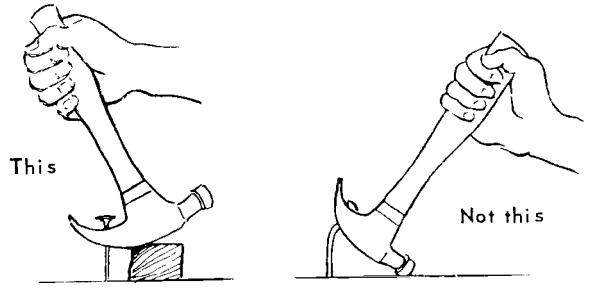


To start a nail, hold the nail high, just under the head, with the thumb and forefinger of the left hand. This saves bruised fingers—if the hammer slips off the nail head, fingers will be knocked out of the way rather than be mashed between the hammer and the board. If necessary for control, you may hold the hammer near the head while starting the nail.

Drive the nail with full, strong blows. Learn to use wrist action and hold the handle near the end. Keep the handle parallel to the work at the point of impact. Hit the nail squarely to prevent bending the nail and leaving marks on the wood. *Practice helps.*




To pull a nail, insert the claws under the nail head. Do not pull the handle past a straight up and down position. When the handle has reached the vertical, place a block of wood under the head before the nail is pulled farther.




- Do not use a hammer that is "loose on the handle." Someone may be hurt.
- Do not use the side of the hammer to pound with. The cheek (see illustration) is the weakest part of the hammer head and may be broken.
- Do not use a claw hammer to pound a cold chisel or other hard metal objects.

Use your hammer well and it will serve you well. Awkwardness disappears with practice. Remember to hold the hammer near the end of the handle when driving larger nails. For starting nails and driving small nails, hold the hammer closer to the head if necessary.

## SAWS

There are several types of saws. Hand saws are found in most homes and many people today own light-duty electric hand saws. Each type of saw is made for a specific purpose. Usually, only carpenters and tradesmen can afford all types of saws. You can get along with only a couple of basic saws.

Basically, differences in various saws consist of the number and kind of teeth and the thickness and depth of the blades. To cut a circle, you need a small blade and small teeth. The coping saw and the keyhole saw are examples of saws designed to cut circles. In general, saws with finer teeth are used for making smooth finish cuts. *Most* home workshops do not contain a very fine-toothed saw. You can use a regular saw and plane, file, or sand the cut to make it smooth.

Some saws have a number stamped on the blade near the handle; this designates the number of teeth per inch. The larger the number, the finer the teeth.

Start the cut by drawing the saw toward yourself. Use short strokes for the first few cuts. Guide it with the forefinger of your left hand until the cut is deep enough to hold the saw steady.

**Be careful.** Saws are designed to cut through hard wood. Your thumb is much softer. Saw with steady, long strokes, taking care not to kink the blade. It is much easier to keep a saw kerf straight than it is to straighten a crooked one.

If you are ripping, hold the saw at 60 degrees to the work (1 o'clock position). If you are cutting across the grain, the angle should be 45 degrees (2 o'clock position). When you are using a coping or compass saw to cut circles, the blade must be kept vertical (90 degrees or 12 o'clock position) in order to make a straight cut.

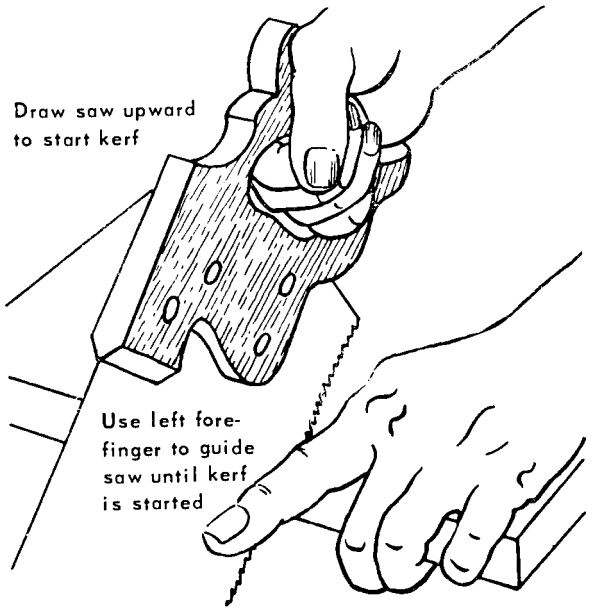
**Kerf** is the term carpenters use to describe the cut left by the saw.

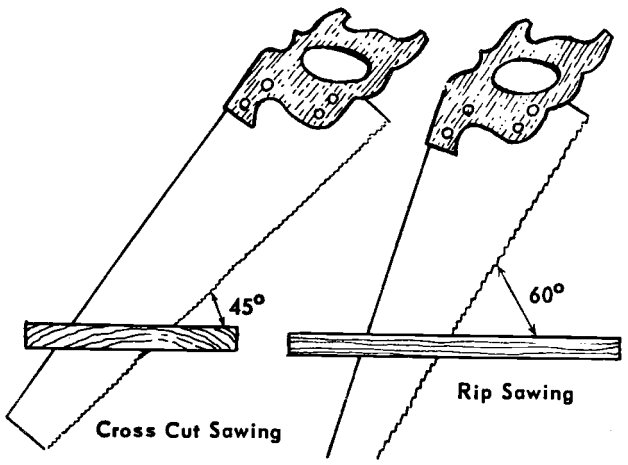
Keep the kerf on the waste side of the line (waste side is that side not used for the article)—not on the line—nor on the inside of the line. You can guide the saw to some extent by twisting it in the desired direction. Finish the cut with gentle strokes, holding the waste end of the work in position. If you just let it fall, it probably will split or splinter your work.

Oil or wax the saw lightly after using. Keep it in a dry place. Rust can ruin a saw—or any cutting tool—very quickly. Rust can be removed by careful polishing with pumice stone or brick powder.

### The hand saw

The hand saw is the most common saw and one that is necessary for the woodworker. The hand saw may have 8, 10, or 11 teeth per inch. The most commonly used handsaw is an 8. It is an all-around saw and one you will probably want to have in your workshop. The teeth are shaped and "set" to cut across the grain of the wood. The teeth cut like two rows of knife points and crumble out the wood between the cuts. This saw can be used as a rip saw (to cut with the wood grain), but more effort and about twice as much time will be required.




### The rip saw

The rip saw is used to cut with the grain of the wood. Its teeth are big, only 5 to 6 per inch. Rip saw teeth are like chisels. They cut like a gang of chisels in a row. Not many home workshops have rip saws. The electric hand saw is used for ripping by many people. Many lumberyards will rip boards for you when you buy your lumber. Some of them charge a small amount for this service.

### The compass saw

A compass saw is often used to start a cut in the center of a piece of work. A hole is drilled and the slender blade inserted. This saw can also be used to cut large circles or gentle curves.

### The keyhole saw

The keyhole saw is similar to the compass saw. It generally has a thinner blade and smaller teeth, making it possible to make small circle cuts.

### The coping saw

A coping saw is used to cut figures from thin stock. It can be turned on a very short radius. Always insert the blade to cut on the pull stroke.

### The back saw

A back saw is used for cabinet work and in mitre boxes. Its thin blade and fine teeth make precise work possible. The reinforcement of the blade gives the saw its name.

### The nest of saws

Most stores sell what is termed a "nest" or "set" of saws. These include one handle and a variety of different saw blades like a small (16 to 24 inch) hand saw, compass, keyhole, back saw, and sometimes a pruning saw. They are generally less expensive to buy than one hand saw. They make a nice set for the home workshop and are a good size for the young woodworker to start with. A standard hand saw can be added later.

### The electric hand saw

It is becoming popular for homeowners and hobbyists to buy inexpensive light-duty electric hand saws or attachments that fit on electric drills. These saws are not good for finish work, but they take some of the harder work out of sawing, particularly ripping and crosscut sawing, if you have a lot to do. The kind of electric saw that attaches to an electric drill is quite dangerous to use. There is no blade guard and, therefore, this type of saw should be avoided.

It is not recommended that beginners use the electric hand saw; however, intermediate and advanced woodworkers with parents' approval may use one. Electric hand saws should not be operated unless one of your parents, your leader, or another adult is in the shop with you. Someone should teach you how to use the saw properly before you try it.

**A word of caution.** You may be working with used lumber in some of your projects. Be careful of hidden nails and boards that have a lot of old paint on them. They will break or dull your saw teeth, making it necessary to have the saw blade sharpened. Examine used lumber carefully and remove all nails before you saw.

When your saw begins to get dull, take it to a saw sharpener to have it filed or reconditioned. It is impossible to file saws unless you have proper equipment. If you want to learn to file your own saws, ask your leader where to get information.

## PLANES

There are two principal types of planes. The block plane is a small plane generally used with one hand. It is very versatile and extremely useful in the home workshop. The other type is the smooth or jack plane. It is larger and longer. It requires two hands and is best for leveling a long board.

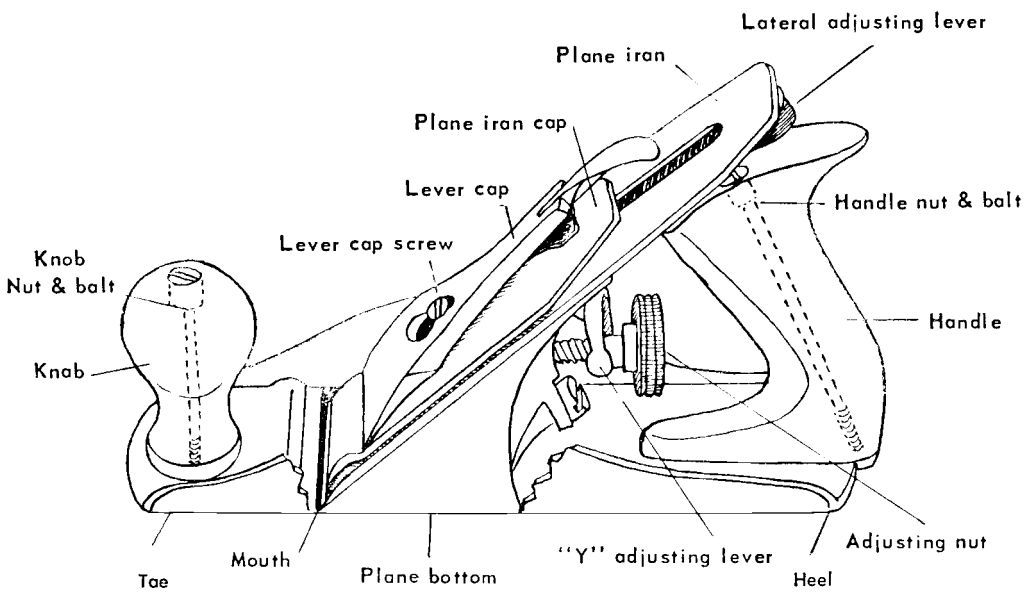
A plane is the tool that removes the rough and ridged surface left by sawing. It helps you in bringing stock down to size when a fraction of an inch is all that needs removing. To adjust the plane, bring the cutting edge just below the plane bottom. (See the illustration below.) If one side of the cutting edge is lower than the other, use the lateral adjusting lever to even it up. Try the plane on a piece of scrap. If the shaving is too thick or too thin, readjust until a satisfactory thickness of cut is reached.

When using a plane, take precautions to protect the cutting edge. Lay the plane on one side, not in an upright position, when it is not in use.

Store your plane carefully. If it cannot be stored so that the cutting edge is protected, use the adjusting nut to bring the cutting edge above the plane bottom before you put it away.

When using the plane, push it straight ahead, keeping it square with the work. Press down on the toe at the start of a stroke—press on the heel at the end of a stroke. This prevents rounding the work. Always plane with the grain.

**THE SMOOTH OR JACK PLANE**

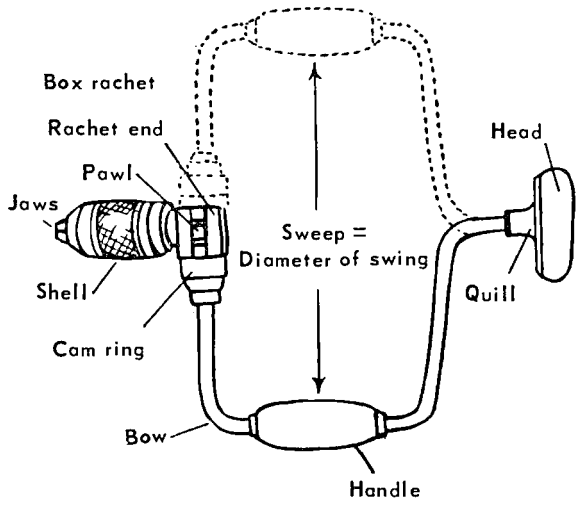



## DRILLS

Most woodworking will require drilling holes of some type. A hand brace and hand drill with sets of bits may be used. However, the average woodworker and homeowner will probably find an inexpensive light-duty electric drill much more useful and practical. A variety of drills and attachments can be purchased that make the electric drill extremely useful around the home and home shop. The cost of a brace, hand drill, and bits is about the same as a light-duty electric drill and a set of bits.

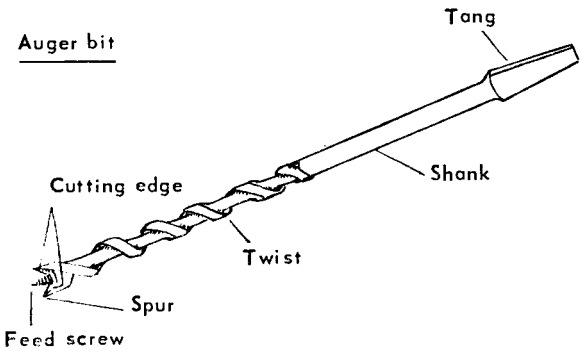
**Brace or breast drill**

The bit brace is another tool that the woodworker uses often. Pictured is the ratchet type which has the advantage of being usable in corners and tight quarters.

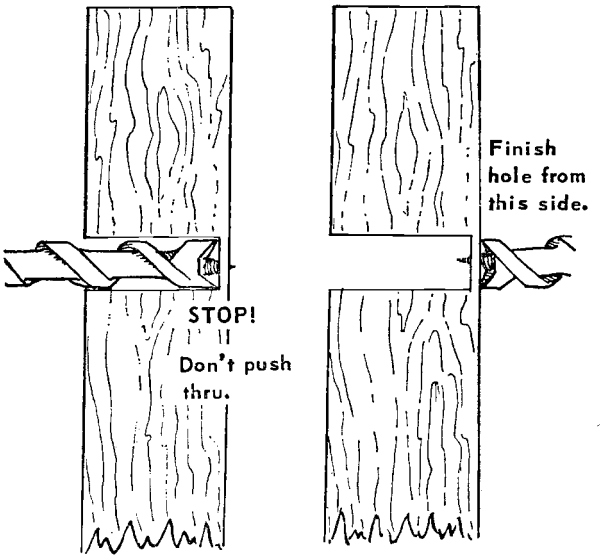



THE BIT BRACE

The auger bit is sized by 16ths of an inch, measuring the diameter. Bits vary in length from 7 to 10 inches. Dowel bits are the same, but shorter.



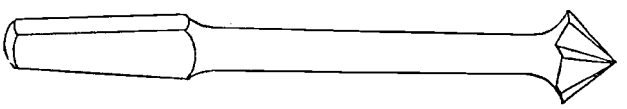

Practice drilling a few holes in scrap lumber. Check with the try square to see that the hole is straight. To avoid splitting and splintering, drill from the opposite side as soon as the lead screw has pushed through. Take care to place the bit accurately when starting a hole. The location should be clearly marked on the wood.




Store the bits so that the cutting edges, spur, and lead screw are protected. One good method of doing this is to drill a block of wood and keep the bits in the holes.

Bits are marked for size by a single number. The numerator of the fraction stands for the diameter of the bit. Auger and fostner bits are marked by 16ths. No. 8 means 8/16 inch or 1/2 inch. Twist bits for wood are usually marked in the same way by 32nds of an inch. No. 8 means 8/32 inch or 1/4 inch.

The countersink bit is a tool used to shape the top of a screw hole so that the head of a flat head screw may be driven flush with or slightly below the surface of the work.



**Hand drill**

The hand drill operates by turning a small crank attached to a cog drive wheel. It uses only small-sized bits and is used principally for making starter holes for nails and screws.

**Electric drill**

The electric drill is a very versatile drill. A light-duty $\frac{1}{4}$-inch electric drill can be purchased for about the same cost as for a brace drill and hand drill. A variety of bits are available at less cost than for the brace and hand drills. Bits may be purchased in sizes of from 1/16 to 1/2 inch for boring in wood or metal. If you plan to use them to drill metal once in a while, buy the "high speed"

bits. They cost slightly more than regular or "carbon" bits, but they add to the usefulness of your drill around the home.

Wood-boring, chisel-type bits are available singly or in sets of from 1/4 to 1 1/4 inches. Screw set bits are also available in a variety of sizes.

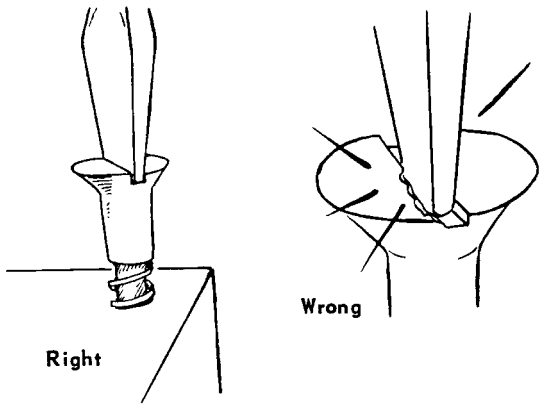
**FILES AND RASPS**

Several different kinds of files and rasps are available. They are handy to have in the workshop. Some files can be used only on steel, to sharpen or cut down. Others can be used on steel or wood, and some can be used only on wood. Rasps are used only on wood. A coarse rasp and a medium wood file with one side flat and one side half round are very useful. A rattail file is a round file used to make holes larger or to make other irregular surface openings. Several companies manufacture a new tool that is between a "rasp" and a "plane." They make fast cutters and leave a relatively smooth surface.

**SCREWDRIVER**

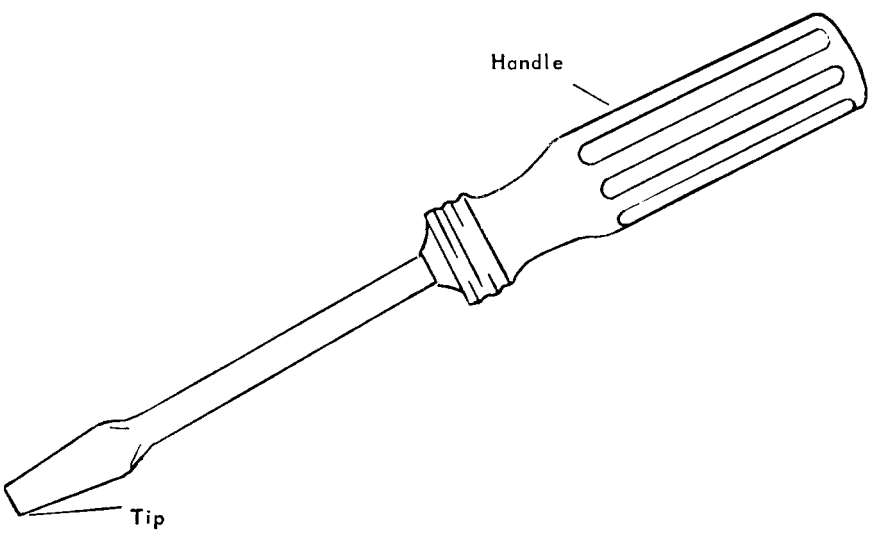
The screwdriver is another useful tool that gets more than its share of abuse. It is easy—but not smart —to ruin a good screwdriver by failing to observe the following points:

- The blade should fit the slot snugly. Do not use a screwdriver that is too large or too small.
- Hold the screwdriver square with the work. Keep a firm downward pressure as the twisting motion is applied. You will find a long screw driver easier to hold.
- Do not hammer on a screwdriver. A screwdriver is not a substitute for a cold chisel.
- Do not sharpen the tip to a point. If it is too thin, it will break. A tip that is rounded on the corners will ruin screw slots. Note the illustration below.



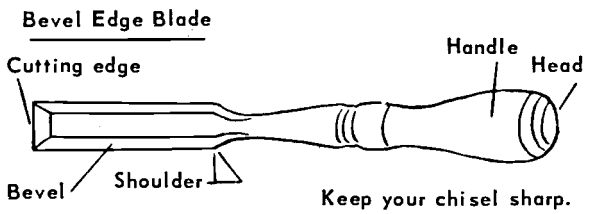

- Pliers should not be used on the blade to give greater turning force.

Choose a screwdriver with a plastic handle or a good wooden handle. Cheaper wooden-handled screwdrivers often become loose and useless.

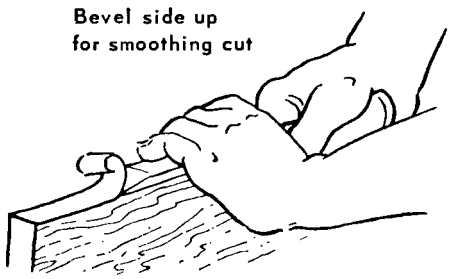


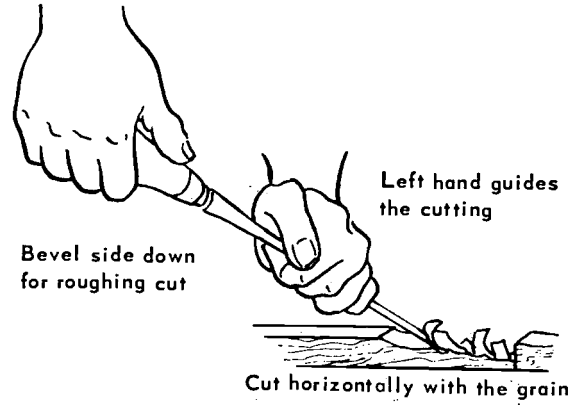
## THE WOOD CHISEL

The wood chisel may be regarded as a more primitive plane. Because its blade is unprotected, it can be used in routing (cutting grooves) and gouging. ***Be careful.*** The chisel is the most dangerous of hand woodworking tools. Always keep both hands on the chisel.




As with the plane, work with the grain whenever possible. Angle the blade a little, or move it from side to side as it moves forward and you will find that it will cut more smoothly and evenly.




For most work, the bevel is held up. For rough gouging, the bevel may be held down.

Protect the blade during storage. A wall rack is one of the best storage methods.

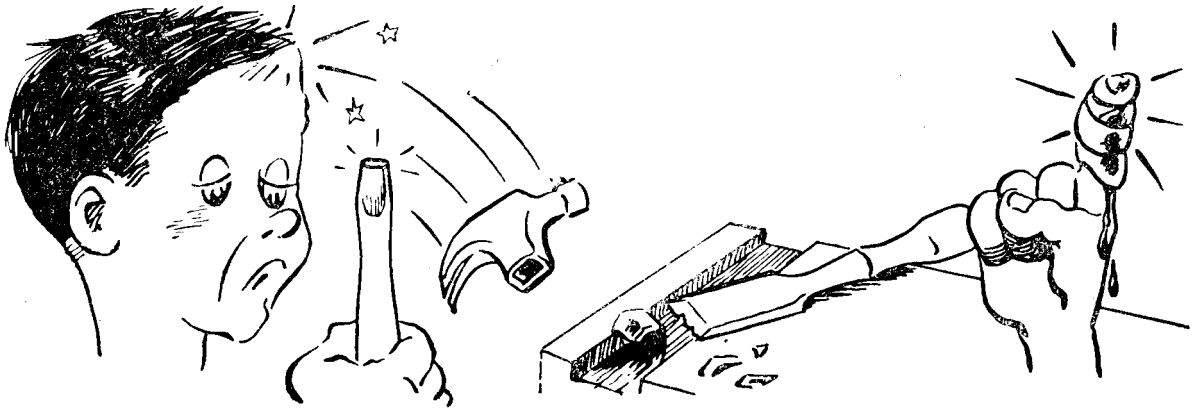
## SANDPAPER

Sandpaper is used to give a final, smooth finish to your work. Do not use it until you are certain that edged tools are no longer necessary. Sand left in the pores of the wood will dull a plane or a saw used afterward.

Use a moderately coarse sandpaper and work with the grain. Very coarse sandpaper may leave deep and hard-to-remove scratches in the surface. For a smooth job, use a sanding block. Then you will cut off the high spots and will not "drag" the corners. Finish with fine sandpaper.

Sometimes it is desirable to use very fine sandpaper on paint, before applying the last coat. A "wet" type sandpaper which can be used with water is useful in work of this kind.

# Unit II. Safety in Woodworking



CARELESS HANDLING RUINS TOOLS

Keep your safety rating high. Prevent accidents to yourself and fellow workers. In the woodworking project, remember these two important rules:

- Develop skillful, efficient, and safe work habits.
- Use these habits when making all articles—from the plan to the finished article.

Think about the tools you will work with. What do you expect of them? Each one has a special job to do. Learn what it should do; then use it correctly.

If you had to earn the money to buy all your tools, you would certainly learn how to use and care for them properly. Many men earn their living with just such tools as are found in the shop; they learn early in life that tools should be treated as friends for best results. Correct use prevents injuries to the worker and to others and reduces breakage and damage.

Keep your tools sharp. Dull tools are hard to use, do unsatisfactory work, and are usually the ones that cause accidents.

Your first work in this project calls for the use of only a few tools. As you advance to jobs which require more skill, you will use other tools.

### Treatment of injuries

It is important that all injuries be treated promptly, however slight. Even a scratch may start infection. A slight injury treated at once is not likely to develop into serious trouble.

Every workshop should have a handy first-aid kit for treating injuries and wounds immediately.

### Clothes to wear

Loose collars are comfortable. For safety, do not wear a tie while working. Sleeves should be rolled to the elbows or cuffs buttoned. Clothing should be free but never bulging or flying.

### To protect your eyes

Your eyes cannot be replaced. Do not expose them to unnecessary danger. Wear approved goggles when you use a high-speed power grinder. Metal particles, abrasives, nails, sawdust, and shavings may cause eye injury—keep them cleaned up.

## Care of Tools

Have a clean, dry place for your tools and return each one to its proper place after using. Tools may be kept in a cabinet over the bench, in drawers in the bench, or in a tool box. Oil keeps tools from rusting, but it should be used very sparingly. If tools become rusty, remove the rust by rubbing them with pulverized pumice stone; then oil them thoroughly.

A good workman has a place for everything and keeps everything in its place. He keeps his bench and tools clean and ready to use and his work area in order. You will take pride in working in a clean and orderly shop and also be able to find your tools and materials easily.

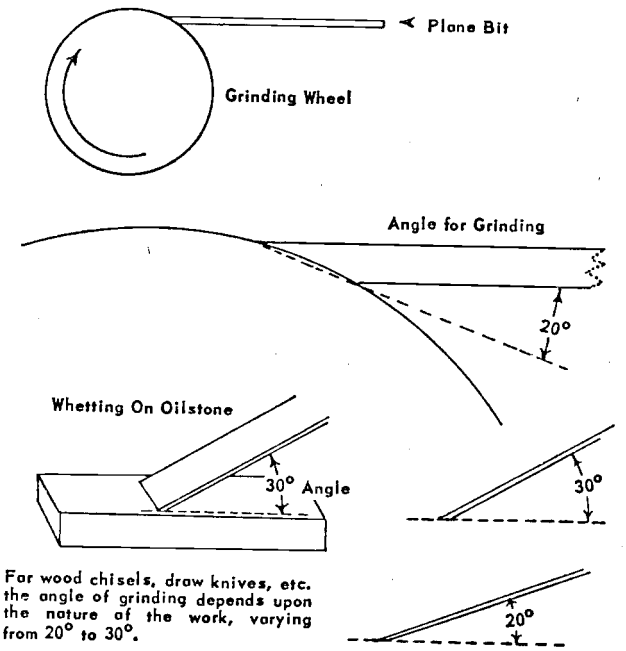
**Sharpening your tools**

Tools must always be kept in good condition and sharp. When you use the grinding wheel, you will notice that it leaves a coarse, feathery edge. This must be removed on an oilstone. Take care to keep the correct bevel while sharpening a tool. Be sure to use a tool rest for safety.

For sharpening, you will need a grinding wheel, an oil or carborundum stone, a three-cornered file, a flat file, a saw jointer, and a saw set. Saws and auger bits are sharpened with files. Unless you have all the equipment, do not try to sharpen a saw; send it to a saw filer.

A common oilstone of coarse grit on one side and a fine grit on the other is used to sharpen a chisel. Plane irons are sharpened by first grinding on a wheel, then whetting on an oilstone. Sometimes grinding is not necessary. The diagram below shows the proper way to sharpen the blades and the angles used to hold the chisel to the stone.

For wood chisels, draw knives, and so forth, the angle of grinding depends upon the nature of the work, varying from 20° to 30°.




For wood chisels, draw knives, etc. the angle of grinding depends upon the nature of the work, varying from 20° to 30°.

# Unit III. How to Read a Drawing or Sketch

Before starting to build your 4-H woodworking project you should know how to read a drawing or picture of what you are going to make. A working drawing or sketch is a group of views of an object which shows you what an object is like. These views also give dimensions (measurements) such as width, length, height, and thickness of the various parts.

Each line in a working drawing is used for a definite purpose and should not be used for anything else. Outlines and visible edges in a detailed drawing should be fairly thick. Center lines and dimension lines should be thin. This gives the drawing contrast, making it easier to read.

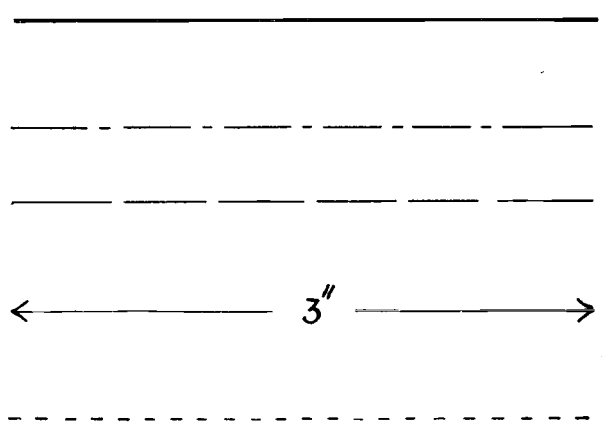
It is usually impossible to make a drawing as large as the full-sized project. So it is necessary to use a scale drawing, which is smaller than actual size. The scale may be 1/4 inch to the foot. This means that 1/4 inch in the drawing is equal to 1 foot of actual size.

Dimensions in a drawing are given in actual size—feet, inches, or a combination of the two. For example, 16 inches as 1 foot 4 inches or as 1′-4″.

The drawing on page 11 shows the different methods used in dimensioning lines, arcs, and circles.

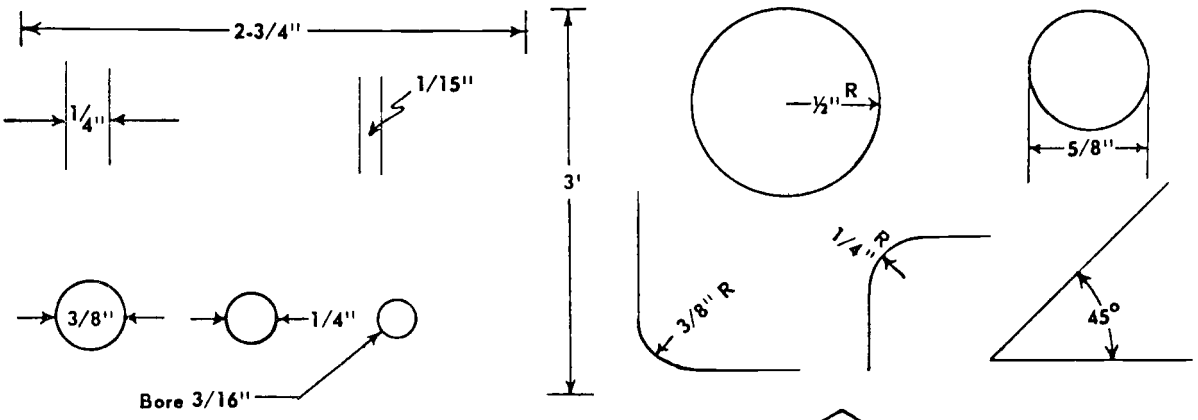
## Kinds of Lines in Working Drawings

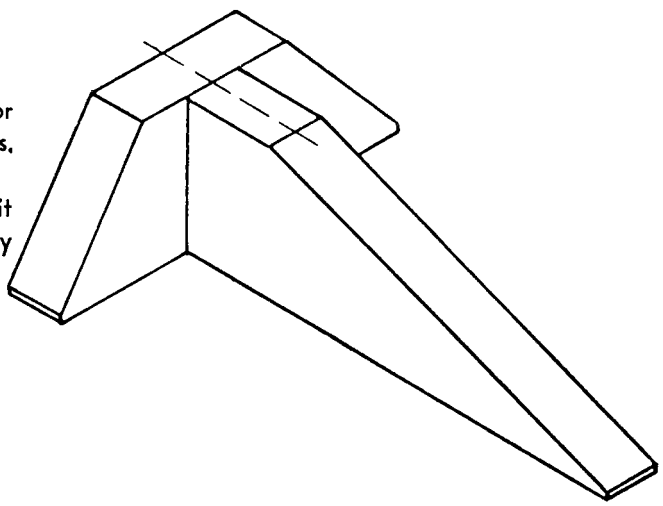
- Visible outlines are heavy, solid lines that show the outline of an object and the corners and edges which can be seen.
- Center lines are fine lines drawn with long and short dashes. They are used to locate centers.
- Extension lines are fine, long dash lines which extend out from the figure to show the limits of a dimension line.
- Dimension lines are fine, solid lines with arrowheads at the end. They are used to show distance between two points.
- Invisible lines are short dash lines, showing outlines hidden from view.



# Working Drawing

R equals radius
D equals diameter  o equals degree

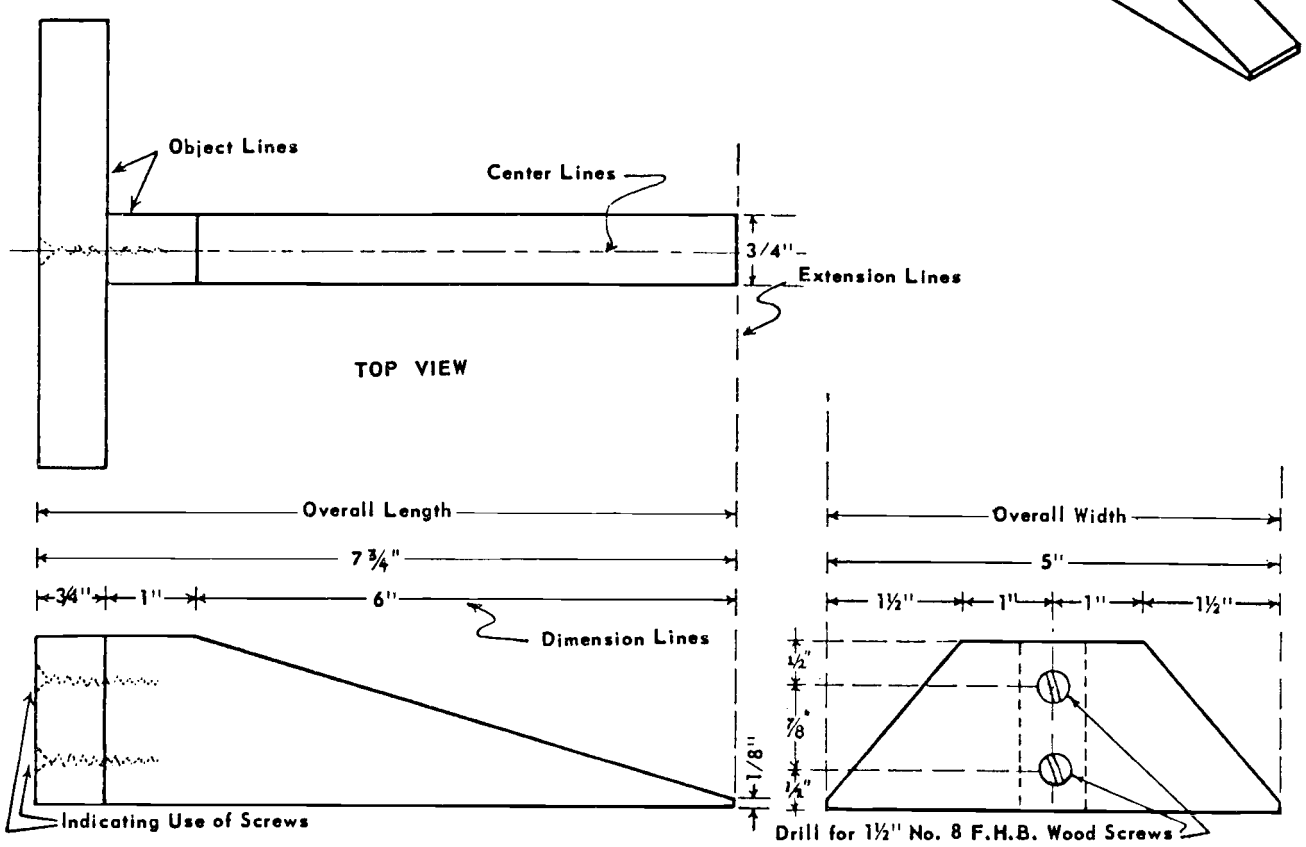


Look for a moment at this pictorial drawing of a door stop. It helps you see the relationship of the various parts, how they go together.

There are times when a drawing of this kind makes it impossible to show all details and it becomes necessary to make two or more separate views of the object.

This is the way it would look from directly above.



# Unit IV. Selecting Your Materials

The material you will use most in your woodworking project is wood. Today wood comes in all shapes and sizes and in many modified forms. You can become an expert in the selection of the wood that goes into your project. Take a trip with your club to a lumber yard to discuss the types, kinds, shapes, and sizes of wood materials.

To become expert at selecting wood materials you will want to consider the following:

• **Select your lumber for a particular need.** It is foolish to buy poor-quality lumber for a job that should have high-grade wood. Likewise, you would waste money if you used high-grade lumber on a job when a lower quality material would be good enough. You will learn that wood material is not an easy item to buy because each piece of material varies in quality, color, seasoning, and many other factors. You have to choose from a variety of species. This further complicates the problem.

• **Remember the quality and strength of wood is affected by moisture content.** The arrangement of fiber in the wood, called grain, may be irregular or curly in pattern. For some purposes you may want this quality. But if you want strength, you will prefer straight-grained material.

• **Be prepared for knotty problems with some boards.** Boards with sound knots can be painted to hide defects, but loose knots are a different story. If you are going to cut boards into smaller pieces, you may be able to use boards with knots by cutting around them when you lay out your project.

The most common wood materials you will be using are lumber, plywood, and particle-type boards. Let us look at lumber first.

## Buying Lumber

Lumber is sold by species or kind, by grade, and by size. To do an intelligent job of buying lumber for your project you will need to know about all of these things.

Your leader is best qualified to tell you about species of wood and their characteristics.

### Lumber grades

To indicate quality, lumber is sorted and assigned to grades. Grading rules specify the poorest quality board that is permitted in each grade. To give you added protection when buying lumber, many mills stamp the grade on the lumber, usually near one end.

*Construction grades* which have both finished and unfinished surfaces include lumber suitable for framing structures, rough building construction, and rough finished items, such as saw horses, seed flats, and feed troughs.

*Finished grades* include lumber recommended for floors, trim, cabinet work, and such items as book cases, end tables, shadow boxes, and so forth.

Grading rules are set up by lumber associations and may vary in different areas.

### Lumber size

When you buy a board you do not get full measure. For example, a 2″ x 4″ x 12′ board is actually 1 5/8″ x 3 5/8″ x 12′. The lumber was sawed to the dimension we commonly use in buying lumber. The planing process is used for smoothing, and then the board is trimmed 3/16 inch on each surface. So the actual size of the board you buy is somewhat smaller than its original size. The size we ask for when buying lumber is called the *nominal* or *dimension*. The actual size of the board we call the *dressed size*.

The following listing will show you the relationship of nominal to actual size:

**Sizes of Graded Lumber**

| Nominal | Actual |
|---|---|
| 2″ x 4″ | 1 5/8″ x 3 5/8″ |
| 2″ x 6″ | 1 5/8″ x 5 1/2″ |
| 1″ x 4″ | 3/4″ x 3 5/8″ |
| 1″ x 6″ | 3/4″ x 5 1/2″ |

Other materials (described below) are sold mostly in 4′ x 8′ panels.

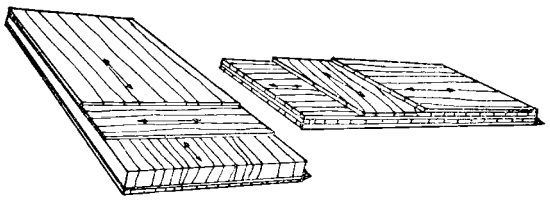
## Plywood

Veneer is the basis of all plywood construction. It is a thin sheet of wood made in any one of three different ways. The rotary cut method is the most common. In this method, a continuous strip of veneer is cut by rotating a log against the edge of a knife. The log or bolt is held in a big lathe. Sliced veneer is produced by moving a log, a bolt, or a portion of the same against a large knife so thin slices are removed. Sawed veneer is produced by sawing thin slices from a log, a bolt, or a portion of the same. Your club may wish to visit a veneer plant in your area.

There is great variation in the thickness of veneer. Common thicknesses vary from 1/32 to 3/16 of an inch, and it is possible to cut it 1/200 of an inch thick.

Plywood is made by glueing three, five, or any odd number of layers together. The alternate layers of ve-

neer have the grain at right angles to each other. The odd number of plies with the grains in opposite directions give the product a balanced construction. This tends to eliminate warping, shrinking, and expanding of the plywood.



Lumber Core Veneer Core

The various veneer piles may be of the same or different thickness. The center ply is called the core. If the core is a ply of veneer, the product is called all-veneer plywood. If the core is made of pieces of lumber glued together, the product is called lumber-core plywood. The outer layers are called face-and-face or face-and-back veneer. Douglas-fir is the most common facing, but birch, maple, mahogany, and other woods are also used.

In five-ply construction, the plies between the core and the outer plies are called crossbands.

Plywood is constantly being adapted to a greater variety of uses. At present, it is used extensively in building construction, wall paneling, drawers, doors, cabinets, furniture, and many other things.

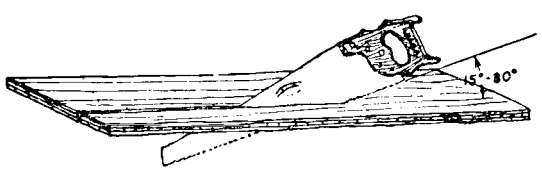
### Using plywood

In using plywood, use only the types recommended by the manufacturers. For example, use only plywoods designed for exterior use where the wood will be subject to moisture.

A few hints to follow when using plywood on articles that require a fine degree of craftsmanship are given below.

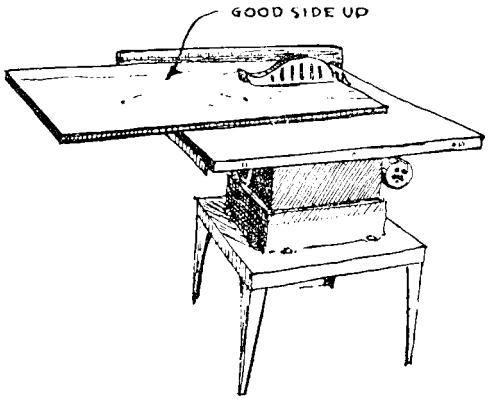
### Handsawing

Use a fine-tooth handsaw whether sawing with or across the grain of the face. Place the face of the panel up and hold the saw at a low angle (about 30°).




### Power sawing

Keep the power saw blades in excellent condition. A plywood-type blade is preferred for fine work. When using a bench saw, place the panel on the table with the

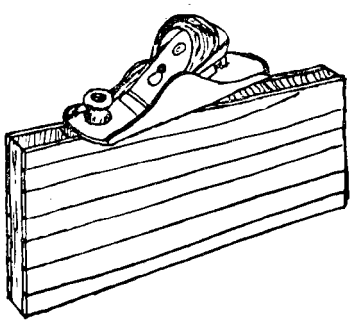



face up; and when using a portable electric saw, put the good face of the panel down. This way the teeth of the saw blade will always enter the panel from the face side. When using a saber saw, use a fine-tooth blade for a smoother job.

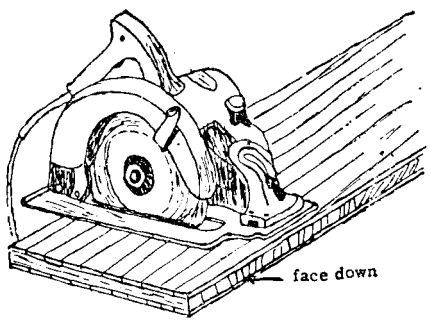
### Planing

Use a plane with a low angle, such as the block plane, to plane the edge of plywood. Hold the plane in an angled position as it runs along the plywood edge. Never plane over the end of the edge because this will cause the board to splinter. Turn the plane around and start at the other edge.

A special file-type plane is now available. It is economical and well adapted to planing the edges of plywood as well as for use on other planing jobs.

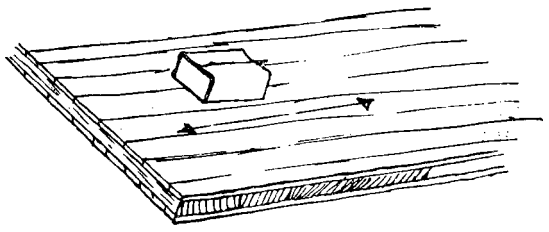


Planing



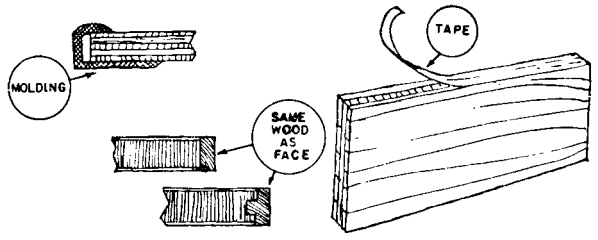
### Sanding

Move the sandpaper in the direction of the grain. If you sandpaper across the grain, scratches will be left on the surface. To get a fine finishing surface, start with medium sandpaper and follow this with fine sandpaper. Most plywoods are pre-sanded at the mill. These require only a light sanding with fine sandpaper before applying a finish.



### Treating the edge

Visible edges of the plywood can be made more attractive with a little extra effort. Some commercial concerns sell moldings (see the drawing below) that are easily applied. These extend over the edge onto the face and back of the plywood and may be objectionable in many places. Several concerns sell wood-like tape that can be applied to the edge of the plywood. Follow the manufacturer's recommendations in applying this tape. The edge may be capped with a strip of similar wood, nailed and glued in place.




## Hardboard

Hardboard is a fiber board, 1/8" to 5/16" thick, with one or two smooth, hard faces. Some of the boards are treated with oil, or tempered, and this makes them stronger and more water resistant. However, hardboard is not water resistant enough for exposed outdoor use. It is dense, uniform, cuts well, takes a good finish, and can be bent for certain purposes. In 4-H project work, hardboard makes good drawer bottoms, case backs, mirror backs, and insert panels.

## Particle Boards

Resin-bonded particle boards are made of wood particles glued together. They come in various colors and sizes of particles. They are all quite heavy, usually heavier than oak, and feel more so because of the large sizes. In addition, they are not too strong and will droop if not supported in several places when used as shelves or table tops. Particle boards are usually not made with waterproof glues and should not be exposed to high moisture areas or out of doors. Particle boards make good drawer sides, panels in furniture, and decorative panels when a clear finish is used.

## Nonwood Materials

### Surfacing materials

Some nonwood materials have value where hard wear is expected or where a cheaper construction material needs to be covered. The plastic laminates make excellent tops for tables where utility is desired in addition to beauty. Plastic laminates come in various sizes and colors, even wood-grain patterns. They make an exceptionally hard surface. The sheets are applied usually to a plywood backing, with contact cement. Edge trimming of plastic laminates is best done with a router; however, edges can be finished with a file if great care is used.

Where resistance to cutting is not necessary, vinyl plastic surfacing may be used. Unlike the plastic laminates, vinyl is flexible and may be bent around curves without difficulty. This material comes in various widths and in any length desired. It is bonded with a special adhesive.

## Hardware

Many kinds of hardware with several different finishes are available. Steel or iron hardware will rust if used out of doors unless it is cadmium plated. Some aluminum items are available to use in corrosive areas where formerly only brass could be used. Chrome, brass, copper, and black finishes are available on standard materials and the correct choice can enhance any project. A tour to a hardware store or lumber yard is the easiest way to learn about the many types and kinds of hardware available.

### Special items

Three basic types of hinges are available, best described by their use. The butt-type hinge is used for flush installations, the offset type for offset doors, and the flat hinge for concealed surface installation.

Decorative materials, such as grill cloth, knobs, and buttons, often can add to the appearance of projects even though they serve no structural purpose.

Drawer guides are sets of rails and plastic wheels that make drawer installation easy and improve their operation.

Metal legs, both straight and loop, can be obtained for use on projects. They come in various sizes.

Turned wood legs, complete with fasteners and feet, can be purchased.

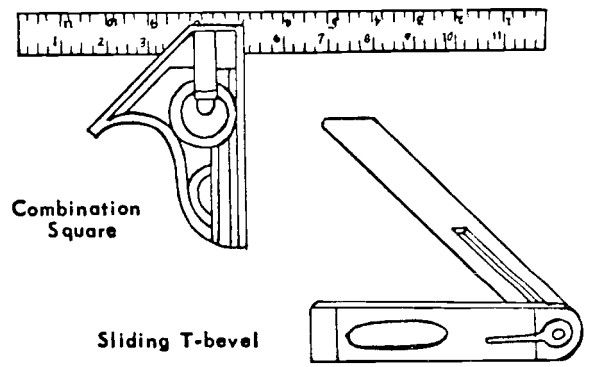
# Unit V. Laying Out the Job

Laying out your project is a most important step. Study the drawings. Know what you want to do. Then use your rule and square to mark the necessary cuts. Do not saw until you are sure of exactly where to cut. Accurate measurement is essential for good work.

There are many kinds of rules—folding, zig-zag, and bench rules, the flexible tape, and others. Most of these are marked off in eighths or sixteenths of an inch. They may be made of metal, wood, or plastic. Use them well and you will have taken a big stride towards craftsmanship. When laying out measurements, double check each one. Lay the rule so that the graduations touch the work. Then your eye cannot mislead you. Always use a sharp pencil.

### Tools for measuring

Use a square to mark boards before cutting them to length. Mark across the top and at least one edge. The mark on the edge will help you to judge whether or not your saw is straight up and down.

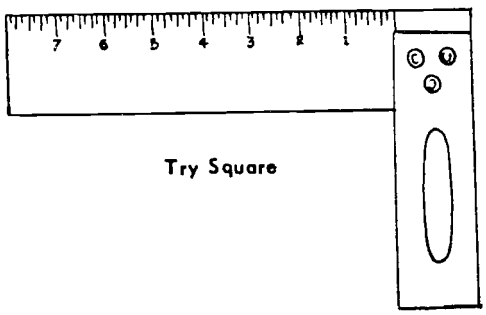


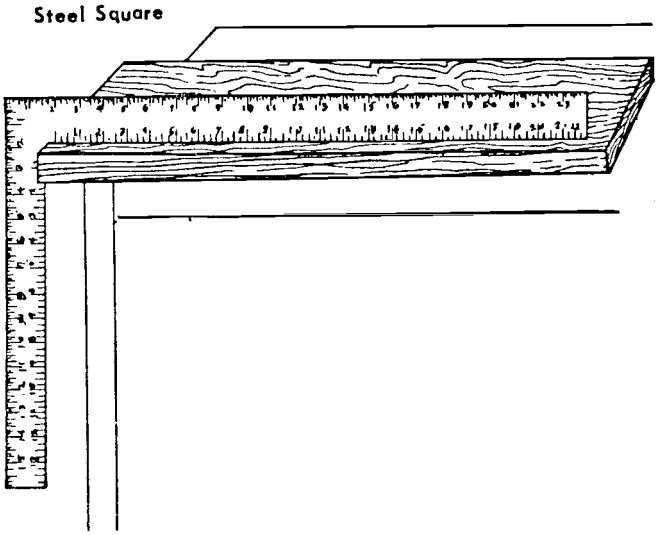

A combination square will lay off 90 or 45 degree angles.

The sliding bevel can be set for any angle and is used as much as the try square.

A try square is very handy for laying out projects as well as checking stock during squaring.

The steel square has two main parts—the blade and the tongue. The blade is the longer, wider part, while the narrow, shorter part is the tongue. Most squares are the same, with a blade 24 inches long and 2 inches wide. The tongue is 16 inches long and $1\frac{1}{2}$ inches wide. The inside corner at which the inside edges meet is called the heel; the side with the manufacturer's label is called the face; the other side is the back.




In addition to measuring lengths and determining if the end of a piece of lumber is square, the square can be used to determine angles. Note that the same number of inches is shown on both the tongue and the blade.

Remember that tools for measurement are precision instruments. After using them, wipe squares, rules, and steel tapes with an oil rag to protect the steel from rusting.

Never use a try square as a hammer—if the blade is loosened in the handle, the try square is useless.

### General rules

After selecting your project, study the working drawings until you know what you are going to do.

Lay out the work. Double check your measurements. If you do not understand the drawing, ask your leader to help you.

Work carefully. Remember that you can shorten a board, but you cannot stretch it.

Do your best. A neat, well-fitted project is worth the extra effort.

Remember, *length* is always measured with the grain, even though the board may be shorter than it is wide. Width and thickness are measured as shown in Unit IV.

## Steps in Laying Out an Article

1. Select the materials (Unit IV).
2. Check the ends of the boards to be sure that they are square. Make sure your handle (try square) is flat against the board.
3. Lay out the work so as to make the best use of your wood. Mark the parts to be sawed on each board. Watch for the grain of the wood. Double check your measurements.
4. Re-check to see that all of the pieces are laid out.

# Unit VI. Using Wood Fasteners

Pieces of wood can be joined together in a variety of ways. Glue is considered to be a fine means of assembling wooden parts for some types of woodwork. Screws have an important role as wood fasteners and nails are used in the greatest quantity of all. There are many special metal devices for assembling wooden parts and new ones are coming out all the time. A variety of metals are used in the manufacture of wood-fastening materials and many industries have been developed to manufacture them.

## Nails

The nail industry had its origin in England. The Englishmen forged the nails from iron by hand. At their peak production, they made 200 tons of iron into nails each week. Think of it, they did all the work of shaping those millions of nail points and heads by hand!

A man in the United States obtained the first patent for a nail-making machine. The first machine-made nails were of steel. They were really "cut nails"—cut from a tapered plate. The nails were cut one after another from the edges of the plates. Today you might think these early nails look funny. They had square bodies with blunt ends and the heads were also square and much smaller than the nails we use now. Yet many buildings made with these square nails are still standing.

Modern nails are made from wire and shaped in special machines. The nails are stamped out in special hard-steel dies to form the heads and points; then they are placed in a tumbler with sawdust to remove the oil and grease. This tumbling operation also polishes them. Modern nail factories have as many as 250 nail-forming machines going at once. Each machine can produce between 150 and 350 nails per minute, depending upon the size of nails being made. At the factory, the nails are packed in kegs and cartons of 50 to 100 pounds, marked to give the size and kind of nails they contain. In hardware stores and lumber companies, nails are usually sold by the pound.

There are many kinds of nails, each designed for a particular use. The ones you should recognize are so common that everyone ought to be familiar with them. They are: box nails, common nails, casing nails, finishing nails, and brads.

You ask for a size of nail by the term penny. When writing it on an order, most persons use the short symbol (d). One pound of 8-penny nails may be written as 1 lb. 8d nails.

The penny system of measuring nails probably originated in England, but many people disagree about what it first meant. Some claim the word penny meant pound. They say it referred to the weight of 1,000 nails. Thus, 1,000 nails weighing 6 pounds were called 6-penny nails. Others, also claiming the English origin of the term, say the penny is supposed to represent the price per pound of nails in pence—pence being an English coin. No matter where the system came from or how it originated, we are still identifying nails in the same way.

### Common nails

Common nails are larger in diameter and have wider heads than some other nails. They are used almost entirely in rough carpentry work.

### Box nails

Box nails are not as large in diameter as common nails, but they too have wide heads. Originally they were made for box and crate construction, but today carpenters often use them in constructing buildings in order to save money. There are more box nails in a pound and they do not split brittle woods as often as thicker nails. However, with their easier bending and thinner bodies, you must have more skill to drive box nails into wood without bending them. They are not usually used for finishing work.

# Nails for Many Uses

(All nail lengths are designated by "penny" (d) ; for example, 6d common, box, or finish nails are all the same length.)

FINE NAILS OR BRADS

Available in flat or finish heads in sizes from 1/2 inch to 1 1/4 inch in length and in several different gauge diameters. Used in fine cabinet or hobby work.

COMMON NAIL

Used for ordinary construction work.

FLOORING NAIL

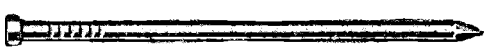
Used in nailing flooring.

BOX NAIL

Used where splitting of wood is to be prevented.

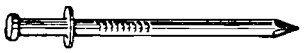
SHINGLE NAIL

Used in putting on cedar shingles.



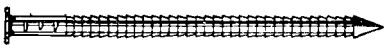
FINISHING NAIL

Used with a nail set where the head is to be set below the surface of the wood.



DUPLEX HEAD NAILS

Used on concrete forms, scaffolds, and other types of temporary construction. Extra head permits easy withdrawal of nail.

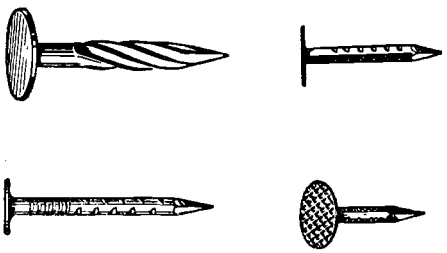


FETTER RING NAILS

Used where holding power, permanence, and strength are of primary importance. Provide maximum resistance to withdrawal, tightly engaging all wood fibers in driving.

LEAK PROOF ROOFING NAILS

Used in applying galvanized roofing. The mushroom head spreads and forms a perfect seal.

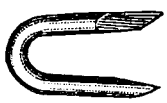


ROOFING NAILS

Many types and sizes are used in applying various kinds of smooth, asbestos, and grit surfaced roofing and shingles. Nails for aluminum roofing must be aluminum.

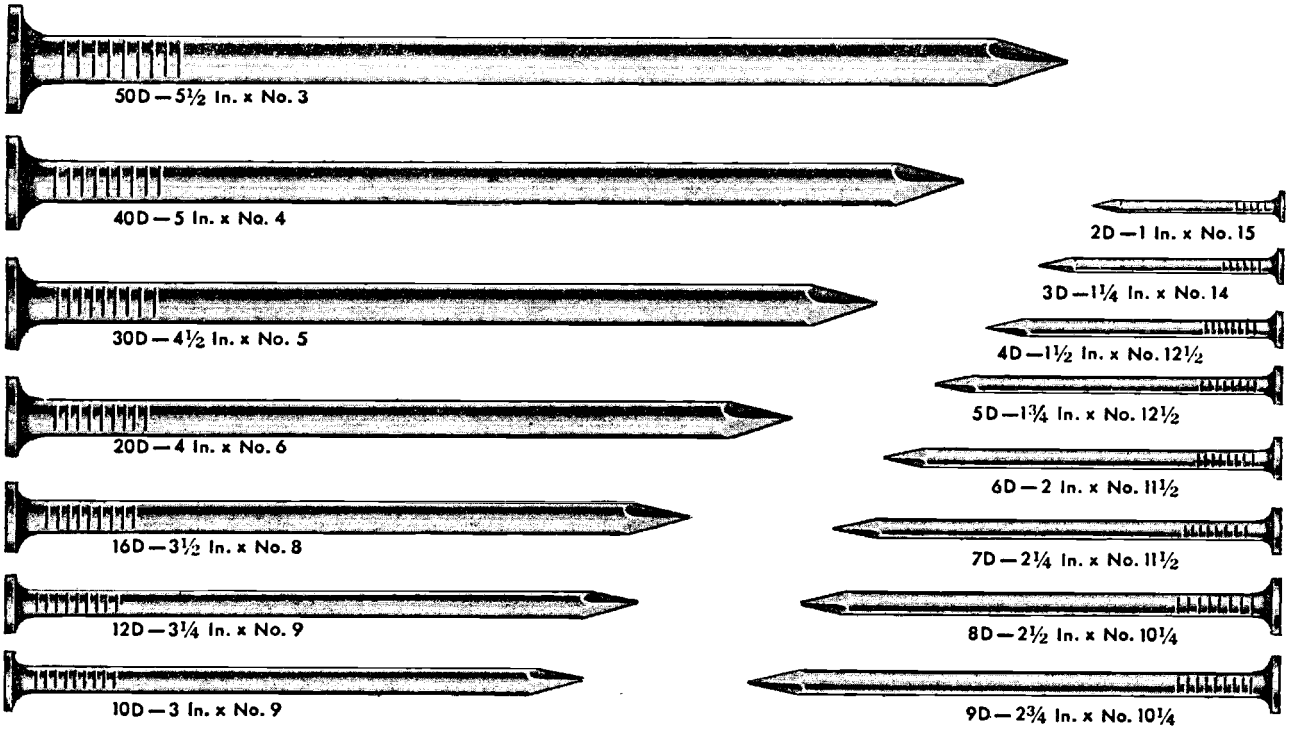
POULTRY NETTING STAPLES

Used in fastening poultry netting.



FENCE STAPLES

Used in building farm fences.




**Actual Nail Sizes**

Sizes and Lengths of Nails

| Size | Length in inches | Size | Length in inches |
|---|---|---|---|
| 3/4 | 3/4 | 9d | 2 3/4 |
| 7/8 | 7/8 | 10d | 3 |
| 2d | 1 | 12d | 3 1/4 |
| 3d | 1 1/4 | 16d | 3 1/2 |
| 4d | 1 1/2 | 20d | 4 |
| 5d | 1 3/4 | 30d | 4 1/2 |
| 6d | 2 | 40d | 5 |
| 7d | 2 1/4 | 50d | 5 1/2 |
| 8d | 2 1/2 | 60d | 6 |

**Finishing nails**

Finishing nails have a more slender body and are supplied in smaller sizes than box nails. They are used where larger nails would split the wood and smaller nails are adequate. These nails are used for furniture and other fine woodworking.

**Other nails**

The nails mentioned above are only those in common use. You will see many others made for special purposes, such as: shingle nails, lath nails, plaster board nails, cement coated nails, carpet tacks, felt roofing nails, and form nails with double heads. Nails are made from iron, steel, brass, aluminum, stainless steel, copper, and many other combinations of metals to serve special needs. Some inventive persons have even shaped nail shanks in special ways giving them holding power equal to three screws. Manufacturers are making them with ring shanks, barbed shanks, and many other special features.

## Selecting Nails

- **Length.** A good rule of thumb is to use a nail twice as long as the first board is thick.
- **Style.** Use a type of nail in keeping with the requirements of your finished product.
  - Finishing nails for furniture and finished work.
  - Common and box nails for general construction.
  - Special nails for holding power where vibration and strength are factors.
- **Special use.** If moisture is present, be sure to select rust-proof nails.

## Screws

Like nails, screws were at one time made by hand. Blacksmiths forged a piece of steel called a blank to the required shape on the anvil. Then they filed the screw threads on the blank by hand. As techniques were improved, lathes were used to turn the threads on screws. The machine age naturally brought about the development of simpler methods of making screws. The first machines for making screws were not as accurate as the machines in use today, but they did a much more uniform job than could be done by hand. Screws are made from steel, brass, bronze, and copper. They are also made of steel and coated with nickel or zinc.

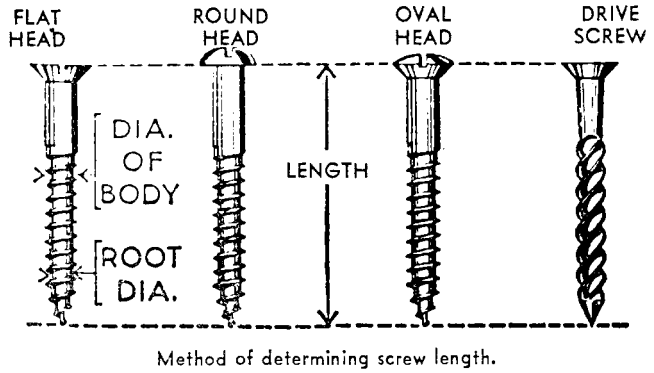
Some of the more common screws are: flathead, roundhead, oval head, lag screws, drive screws, screw hooks, and cup screws. Screws are packed in cardboard containers which hold one gross (144) each. They may also be purchased in smaller quantities.

It will help you to know how screws are identified, classified, and sold. They are made in lengths from $\frac{1}{4}$ inch to 5 inches and in wire guage sizes from 0 to 24. You need to remember that the wire gauge of screws is just the reverse of nails—the higher numbers are the bigger screws.

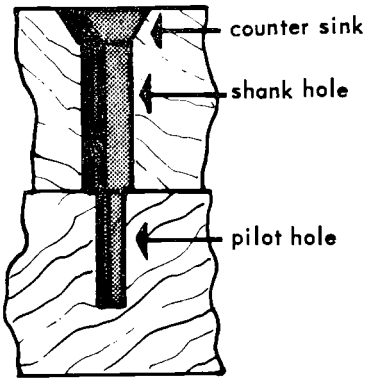
The gauge of a screw tells the "shank" or diameter as measured under the head. When you buy screws, give the length, shape of head, and type of metal you want.

Zinc, cadmuim, or nickel are used for coating screws for resistance to rusting. Brass screws are used to resist the corrosive effects of salt water. Chrome-plated and brass screws are also used for decorative effects.

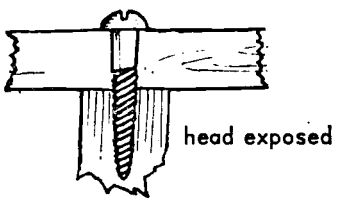
Pilot holes are recommended when using wood screws in soft wood, such as pine and fir. The size of the pilot hole should be equal to the root diameter of the screw. When using screws in hard wood, get the advice of your leader.

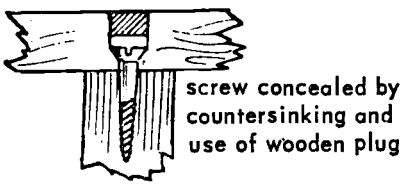


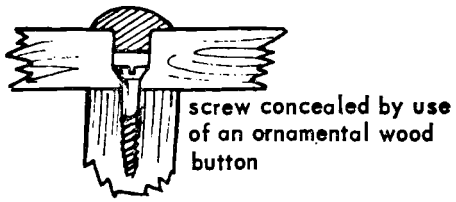
Method of determining screw length.



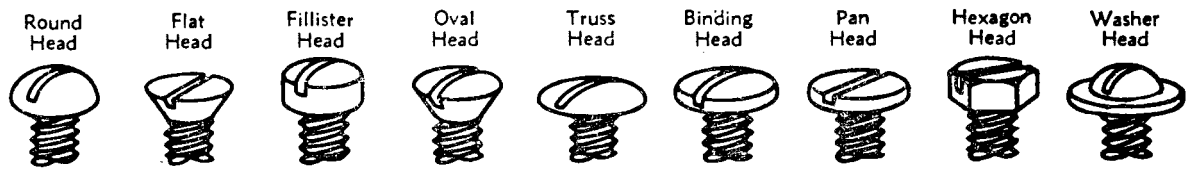
PILOT HOLE FOR SCREW



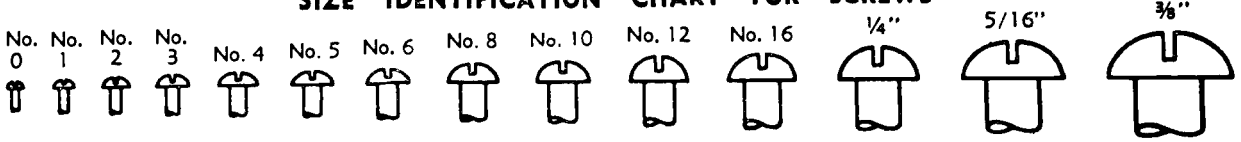




**STANDARD SCREW STYLES** Shown Here Are Actual Sizes of Screws




**SIZE IDENTIFICATION CHART FOR SCREWS**



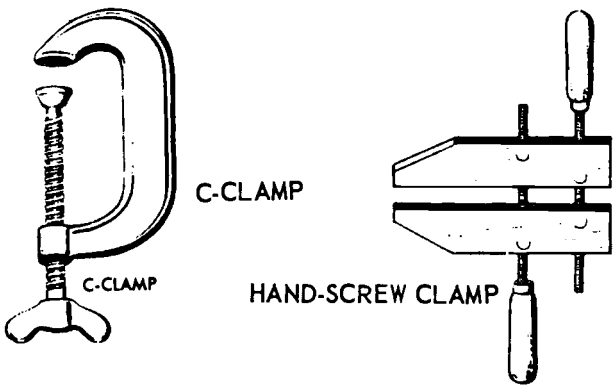
**Selecting screws**

- **Length.** Use the same rule of thumb as with nails, except that screws should not break through the back sides of the boards.
- **Style.** Choose screws that fit the design or style of the article to be made.
- **Special uses.** Moisture conditions may require brass, bronze, or other nonrusting screws.

## Glue

Glue is a wood fastener. Skill in making glued joints is one of the marks of craftsmanship.

Properly made glued joints may be stronger than the pieces of wood that are joined. The adjacent parts of a glued joint must be held together very tightly while the glue sets. You may need clamps for this purpose.




Glues for Woodworking

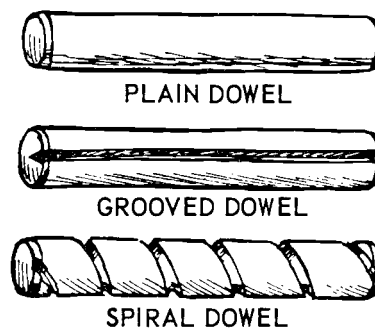
| | | |
|---|---|---|
| Water proof powder | Moderate to high water resistance<br>Used on boats, planters, etc. | Mix and apply cold<br>Press at room temperature |
| Nonwater proof powder | High to moderate dry strength<br>Use indoors only<br>May stain tools or wood | Mix and apply cold<br>Press at room temperature |
| Liquid white | High dry strength<br>Low resistance to moisture and high temperature | Ready to use<br>Press at room temperature |

Select the most suitable type of glue for the job to be done. Read the directions on the can or package before buying the glue to be sure you are getting one that is suitable for your needs.

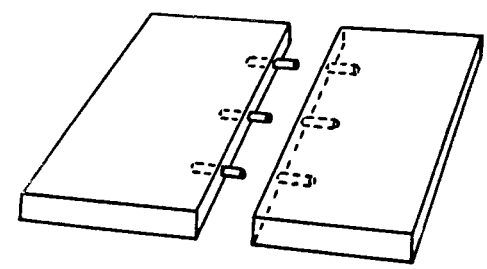
Before applying the glue to either wood surface, have everything in readiness. Be sure that the parts will fit together perfectly. Have your blocks, clamps, and all the pieces to be joined at hand and ready to use. Spread a thin coating of glue on both surfaces with a brush or paddle and apply the pressure with your clamps or other wood fasteners (screws or nails) immediately. *Follow the manufacturer's recommendations.*

## Dowels

Dowels commonly used in woodwork are round pieces of hardwood, usually birch or maple. They can be purchased from lumber stores in 3-foot lengths. Usual diameters are from 3/16 inch to 1 inch. Most dowels are plain round rods, but grooved and spiral dowels are also used.




Dowels may be used to fasten wood together in various positions. Usually they are so located that they are not visible in the finished work. The purpose of dowels is to give added strength to the glued joints and to help hold the adjoining pieces in proper position during gluing.

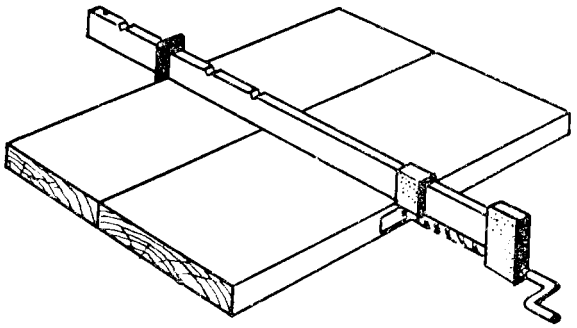


EDGES JOINED WITH DOWELS.

In selecting the proper size of dowel to use, a good rule is to choose one having a diameter equal to one-half the thickness of the stock in which it is to be used. For example, in 3/4-inch stock use a 3/8-inch dowel.

The dowel rods are cut into short lengths or pegs, usually from 1 inch to 3 inches long. The dowels should be cut a trifle shorter than the sum of the depth of the two holes into which they will be set.

After all surfaces of the joint have been prepared to fit properly, the holes for the dowels are bored. These holes must be very accurately located and carefully bored so that they will line up properly.



FURNITURE OR BAR CLAMP

All parts, including the dowels, should be fitted and clamped together before the glue is applied to make sure that everything fits properly. If any of the holes do not line up, plug one or both holes with a piece of dowel rod glued in; then cut off flush and bore new holes.

The bit used should be the same size as the dowel to assure a snug fit. Both the dowels and the wood must be dry when the glue is applied. Apply the glue to one dowel at a time and drive each dowel into place promptly as the glue is applied.

Next apply a thin coating of glue to both surfaces to be joined and to the projecting ends of the dowels, and press immediately with your clamps. Remove the excess glue with a damp cloth.

Read the directions on the glue package to determine how long the joint must be kept under pressure.

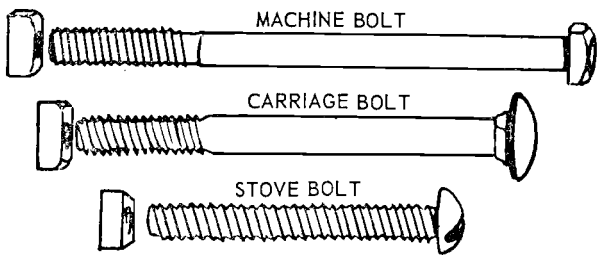
Scrape off the excess glue and smooth the joint with sandpaper.

## Bolts

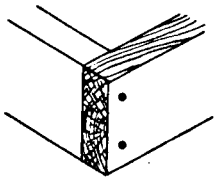
For certain uses, bolts are the most practical wood fasteners. Heavy equipment which is subjected to hard usage, articles that may need to be easily taken apart, and many articles used out of doors are usually held together with bolts.

When boring holes for bolts, match the size of the bit to the size of the bolt. Observe the usual precautions in the boring process.

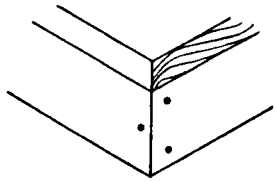
Both carriage bolts (round heads) and machine bolts (square heads) are available from hardware stores. Washers should be used under the nuts to protect the wood from being gouged when the nuts are tightened.



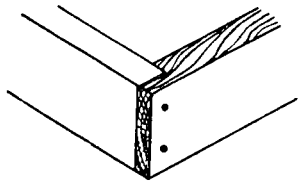
# Unit VII. Making Wood Joints



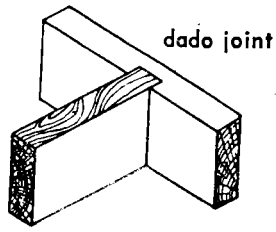
butt joint



miter joint



rabbet joint



dado joint

Nearly all articles or pieces of furniture which you will make are assembled of more than one part. So it will be necessary to join the various parts together. The attractiveness of your completed article will largely be determined by the care with which the joints are made.

The cuts must be made so accurately that the parts will fit together very closely. The parts must then be held together by some kind of fastener.

Not only must the joints be neatly constructed, but they must also be strong. The ideal joint in woodwork is as strong as the pieces that are joined together.

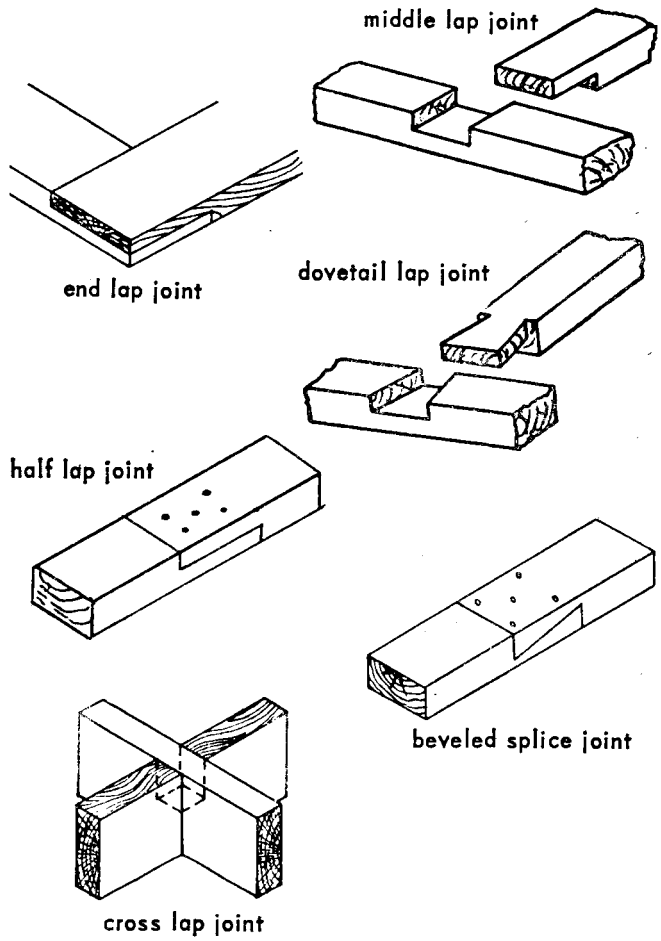
In order to make joints in woodwork which are neat and workmanlike:

- You must be skillful in the use of tools.
- The layout of the joint must be accurate so that the parts will fit snugly.
- The cuts must be accurately and smoothly made.
- The butting edges of the boards must be smooth and even.
- The fastener used must be suitable for the article on which it is used and it must be applied with care.

### Kinds of joints

There are two main kinds of joints: The edge joint in which the edges of two or more boards are joined together to make a wider piece; and corner joints in which the edges or ends of the stock come together to form a corner, such as for a box. These are the more common types of joints. You will want to become skillful in making the easier ones. The best way to improve your skill in joining pieces of wood is by practice. Make a few practice joints with scraps of wood before attempting to use them in your project.

More complicated joints are frequently used in furniture construction and nice cabinet work. Learn to recognize them and be able to judge how well furniture and other wooden articles are constructed. Later on, when you work with power tools, you will have need for such joints in cabinet work.




### Joints using nails, screws, or glue

**The butt joint** is the simplest. It is formed by butting the end of one board against the edge or face of another.

This joint is used at the corners of boxes and crates. The ends and edges of the boards should be square. Care must be taken when the two pieces are placed together. Use your try square to make sure that the boards are squared up with each other and that they remain in this position while you drive in the nails or screws.

**The miter joint** is one kind of butt joint. The joining surfaces fit together at an angle. Picture frames are usually mitered together at the corners. To produce a good miter joint, the cuts must be made very accurately. It is best to use a miter box for these cuts if you have one. Miter joints are usually held together with nails, screws, corrugated fasteners, or dowels and glue.

**The rabbet joint** is much like the plain butt joint. However, in making this joint, the rabbet is cut across the grain of the wood so that each piece overlaps the other. This joint is often used in drawer construction. The sides of the drawers are fastened to the front with rabbet joints. Such joints are usually held together with nails or screws and glue.

**The dado joint** is much like the rabbet joint except that the groove is not cut at the end of the stock. The groove is cut just wide enough to allow the end of the second member to fit into it. The position of the joint on the stock often determines the name.

Such joints are frequently used to hold the shelves of bookcases or the steps of a stepladder and in other furnishings in which both strength and attractiveness are required.

**Lap joints** are of several types. The names are taken from their position on the work. The *end* or *corner lap* is used in corner construction. It makes a much stronger joint than a plain butt joint.

*The middle lap joint* is similar to the end lap except that it is not located at the end of the stock. The two members which are joined together with a middle lap are usually at right angles to each other.

*The dovetail lap* is similar to the middle lap. It is harder to make but provides a stronger joint.

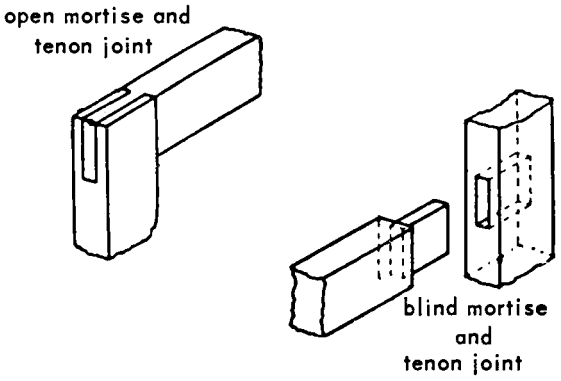
*The half lap* is used to join the ends of two pieces to increase the length.

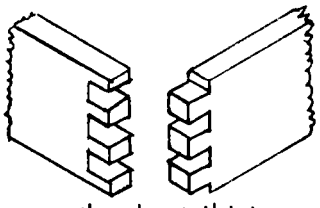
*The cross lap* is one of the more complicated forms of the lap joint. The two parts are each grooved to one-half their depth. When they are assembled, the grooves overlap to form a cross. Bases for pedestal-type tables are often made with cross-lapped joints.

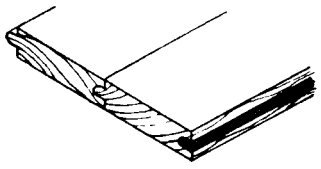
**Mortise and tenon joints** are among the strongest and most attractive of all if constructed so that the parts fit closely. These joints may be used at the end of the stock to form corners, as in the construction of screen doors or window sash. In the open or slip-type of mortise and tenon joint, the tenon is exposed on the side and end. The tenon of the blind mortise and tenon joint is concealed.

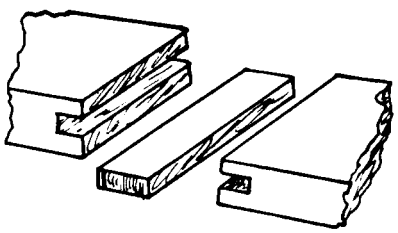
*Stub mortise and tenon joints* are used in furniture where the rails of a table fasten into the legs. True mortise and tenon joints are made with the tenon extending all the way through the piece to which it is attached.

**Dovetail joints** are used in the construction of fine furniture. Although it is possible to make the simpler dovetail joints by hand, the work is usually done by machines. Look for these joints on furniture and notice how nicely the parts fit together.





thru dovetail joint


tongue and groove joint


feather or spline joint

**Tongue and groove joints** are used on flooring and other similar lumber. The tongue of one board fits into the groove of the next one. Hardwood flooring is often made with tongue and groove joints at the ends as well as at the edges.

*The feather or spline joint* is similar to the tongue and groove joint except that the adjacent edges of both pieces are grooved. A strip of wood called the feather is fitted into the grooves to hold them firmly in place. Glue may be used in this joint.

**Doweled joints** are similar to feather or spline joints except that round wood dowel pins are used instead of the feather to hold the parts together. (See Unit VI.)

# Unit VIII. Completing the Project

The finish that you put on your article is your last decision. Always keep in mind that the finish should be well suited to the particular use that you have in mind for the article. Putting a high-quality finish on a nail box is about as useless as putting paint on a bread board. Your club or school library should have several leaflets, or perhaps a book, on finishing that will give you helpful ideas. Also ask your leader and other 4-H members for advice. In general, you will use simple, easy-to-apply finishes such as penetrating sealers, wax, or paint for most of the articles you make.

## The Surface

Of the many elements of wood finishing, probably the most important for success is a smooth surface. After you have built the article, the hardest work is still ahead. That is, scraping, planing, sanding, and polishing the wood to a smooth, clean surface without any irregularity; patching up all holes and dents; and removing grease spots, oil, and wax with a scraper, sandpaper, or a razor blade. You can take out grease spots and other discolorations from oily or sweaty compounds with a cloth dipped in turpentine or paint thinner. Sometimes dents spoil the surface. If this happens, wring out a piece of wet muslin and lay it on the dented surface, then press it with a hot iron. This light pressing operation often swells the wood enough to draw the dents out. Sandpapering will then level the surface.

Filling cracks and holes is difficult and takes patience and time, but it is so important that you will want to do it with care. Sometimes you can plug a large hole or a knothole by cutting a piece of wood to fit the hole and gluing it in. Sandpaper the plug, using a block, to make it level with the main surface.

Hide nails by using a nail punch to drive the nail head below the surface of the wood. Fill the nail holes, cracks, and crevices with a commercial filler that can be readily stained.

When you do this type of crack filling, put more than enough crack filler on the wood, then level it with fine sandpaper and a block so it matches the surface of the wood perfectly.

## Types of Finish

The types of finish are antique, period, modern, and enamel. Of these, the antique is the most interesting because of its softness of luster, its shaded antique appearance, and the simplicity (yet the artistry) of this type of finish.

Period furniture is "classically well done." That means it is "tops" in wood finishing; and the filling and staining of the wood, the sanding of the coats, and the rubbing out of the finishing coat are of the greatest importance.

The modern type of finish is different because it is used to bring out the beauty of fancy wood, particularly light treatments of those woods. This finish in its final coat is highly polished to produce a mirror-like appearance. On many woods, this type of finish will look tawdry and cheap; whereas on the finer, more exotic woods, it will produce richness matched by no other wood or finish.

The enamel finish is produced on any wood by undercoating and enameling to obtain a satin or high-gloss finish.

## Natural Finishes

### Staining

Stains are used on wood to beautify and intensify the natural grain. Stains will only add color and are not intended as a finish coat. You should cover and protect highly finished, stained articles with a clear shellac, sealer, or varnish.

The most popular stains for the amateur craftsman are the pigmented wiping stains. These are available in a range of colors which can be used as they come in the can or mixed to produce any desired color. Such stains, if properly made, will not raise the grain of the wood. These pigmented wiping stains are usually made from mineral pigments which produce permanent colors. They are very easy to apply and enhance the beauty of wood grain.

The first step in applying a pigmented wiping stain is to try the stain on a scrap of the same wood you plan to finish to make sure that the stain is the desired color and intensity. If you want a lighter color, reduce the stain with paint thinner or turpentine, testing after each reduction.

When you have decided on the color, apply the stain with a brush or any lint-free rag. Fold the rag into a pad, dip it into the stain, and apply generously and quickly, working with the grain of the wood. Allow the stain to "take" for a few moments. Then wipe off the excess and even out the color with a dry, lint-free cloth. Wipe clean, using a clean, lint-free cloth; work with the grain of the wood until the surface looks reasonably dry and the color is clear and even.

For best results, do one piece (such as a leg) completely at a time. Apply the stain and wipe it off before starting the next area. Stain the top of the piece last. Allow the stain to dry overnight before applying the next coat of finishing material.

### Sealing

Sealer is used to prevent plywood from checking and to prevent wood from absorbing too much surface-coating material. It also prevents some stains and fillers from bleeding into the surface coating. This is especially important after using an oil stain. Shellac is the oldest type of sealer, but other good sealers have been developed and are highly recommended by stain and varnish manufacturers.

The material may be applied without reduction, using a clean brush. The new "wipe-on" finishes may be applied with a pad made by folding cheesecloth or other soft, lint-free cloth. Apply finishes freely—with the grain whenever possible, using the fewest possible strokes. Inspect the work frequently to prevent "runs" and "sags." Level these out with short cross strokes because they are difficult to remove by sanding after they dry. Allow the finish to dry overnight.

When dry, sand the sealer coat with 6/0 paper. Be careful not to sand through the finish or the stain will be scratched. Be sure to sand with the grain of the wood. The purpose of this sanding is to remove dust or dirt particles that may have dried in the film. When you have dulled the glossy surface and done enough sanding, remove all traces of sanding dust.

### Finish coatings

Varnish, lacquer, shellac, linseed oil, and wax are often used as finish coatings. Varnishes and lacquers give a lustrous, hard surface with the least effort. *Never apply a lacquer finish on an oil-base sealer.* Lacquers dry more rapidly than varnish, but they require more applications. Recent development of synthetic finishes opens new possibilities for attractiveness. Your local paint dealer can tell you about them. Many finish coatings are available in glossy, satin, or dull finish.

Apply the clear finish coats in the same manner as the sealer, applying with the grain. Allow to dry overnight.

Wet-sand the final coat with No. 400 wet or dry paper, using water containing a little soap. Sand with the grain, taking care not to cut through the finish. When the surface is uniformly dull and free from all dust and dirt, wipe it dry with a soft cotton cloth.

The next operation should be a "steel-wooling" with 4/0 steel wool. This will produce a uniform surface of absolute smoothness. Fold the 4/0 steel wool into a pad and work with the grain. Do not apply too much pressure, particularly on the edges, or you may cut through the finish. Be careful when using steel wool or tiny splinters may lodge in your skin and become painful. When the surface is dull and smooth, wipe or dust the remaining particles from the work.

The final coat should be a good grade of furniture wax, not polish. Select one which contains a high percentage of pure Carnauba wax and which does not contain strong solvents. A good wax protects the finish and resists finger-marking and smudging. Apply according to the manufacturer's directions.

### How to apply a varnish finish

1. Flow varnish on with a fine bristle brush.
2. Make sure that each coat is thoroughly dry before sanding and before succeeding coats are applied.
3. Sand lightly between each coat with fine sandpaper.
4. Apply and dry varnish in a room at a temperature of 70° F. or above. Keep the room as dust free as possible.
5. Apply several thin coats rather than fewer heavier coats.
6. Thin varnish with turpentine.
7. Use turpentine to clean brushes that are used to apply varnish.

### How to apply an oil finish

The oil finish has been used for years. Little skill is needed to produce a good oil finish, but a great deal of effort and patience are demanded. A good finish requires several weeks' time and a good deal of rubbing. Materials for an oil finish are not expensive and the finish is easily repaired if damaged. Several procedures and formulas may be recommended; they will all produce good finishes.

One way of applying an oil finish is as follows:

**First coat:** Mix 1/4 cup of boiled linseed oil with 1/2 cup of turpentine. Apply with a soft cloth and rub until dry. If the surface is not rubbed dry, it will become sticky and then it will have to be removed with turpentine. Then the procedure will have to be repeated.

**Additional coats:** Usually at least four coats are necessary. Mix 1/2 turpentine and 1/2 boiled linseed oil for several additional coats; mix 1/3 turpentine and 2/3 boiled linseed oil for the final coats.

Apply the mixture with a soft linen or woolen cloth. Rub vigorously until the wood has absorbed as much oil as possible. This usually takes about 15 minutes. Then wipe off all the excess oil and rub until dry.

Each coat must have thoroughly soaked into the wood before another coat is applied. Under dry warm conditions, allow at least two days between the first and second coats. More time should be allowed between each successive coat.

If it appears that the wood grain has risen, sandpaper it lightly or go over it with fine steel wool to make it smooth.

If higher gloss is wanted, use the following mixture for a finish coat:

1/3 cup boiled linseed oil
2/3 cup turpentine
1/2 cup clear waterproof varnish

### Rubbing

Varnish gloss can be reduced by rubbing with pumice stone and water or polishing oil. Fine waterproof sandpaper and water may also be used. The final sheen varies with the fineness of the abrasive. Coarse powders make a dull surface and fine powders make a bright sheen. To produce very smooth surfaces with a high polish, the final rubbing is done with rotten-stone and oil.

### Polishing

Waxes have been used for years as a protection for other finishes. A thin layer of wax rubbed until dry and hard will give long-lasting protection to the finish. Waxes need to be renewed from time to time to maintain a fine appearance. Wax will not withstand water or excessive heat.

## Paint Finishes

The science of paint chemistry has made rapid strides during the past generation. Modern developments in resins, pigments, oils, and driers have produced paints which are far superior to earlier types.

To realize the importance of paint, remember that a film only a few thousands of an inch thick will protect and beautify a surface for many years. Of course, paints are made to do a particular job on a particular surface, and this section discusses paints and where they should be used.

### Characteristics of paint

Paint may be defined as white, black, or colored material which, when applied to a surface in liquid form, dries to a solid, continuous film. It consists of one or more pigments which give it color and of oils and other organic compounds which form the film or "binder" which hold the pigments in it. Paint also contains solvents or thinners which make the paint fluid enough to apply easily and driers to make the film dry rapidly.

Paints of all types have two basic jobs to do. Most important of all is to form a protective coating which preserves surfaces from the harmful action of wind, rain, snow, ice, heat, cold, and sun.

Their second job is to give a decorative coating which adds brilliance and color, warmth, and interest.

## Finishing Do's and Don'ts

- Put enough paint on new work. Apply paint thinly when repainting.
- Do not paint too often.
- After the priming coat, cover all knots or sappy places with shellac before applying the second coat.
- Break in new brushes on the priming coat after soaking them in linseed oil overnight.
- Clean shellac brushes in alcohol only.
- Clean varnish brushes in turpentine; lacquer brushes in lacquer thinner.
- Keep brushes in a place that is not too hot. Heat will cause them to shrink or curl. Suspend them in raw linseed oil or paint if they are to be stored overnight. If brushes are not to be used for some time, clean them in turpentine, thinner, or kerosene. Always complete the cleaning by washing them in soap and water. Then wrap them in paper and lay flat.
- Do not leave brushes standing in paint or varnish.
- Never use a paint brush for dusting if it is to be used later for painting, as dust will get into the paint.
- Cover all paint cans at night. Do not add gum turpentine until just before brushing the paint. Otherwise, the gum turpentine evaporates and leaves a thick paint for brushing.
- Stir paint often when it is being applied.
- Use filler after the priming coat has been applied.

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