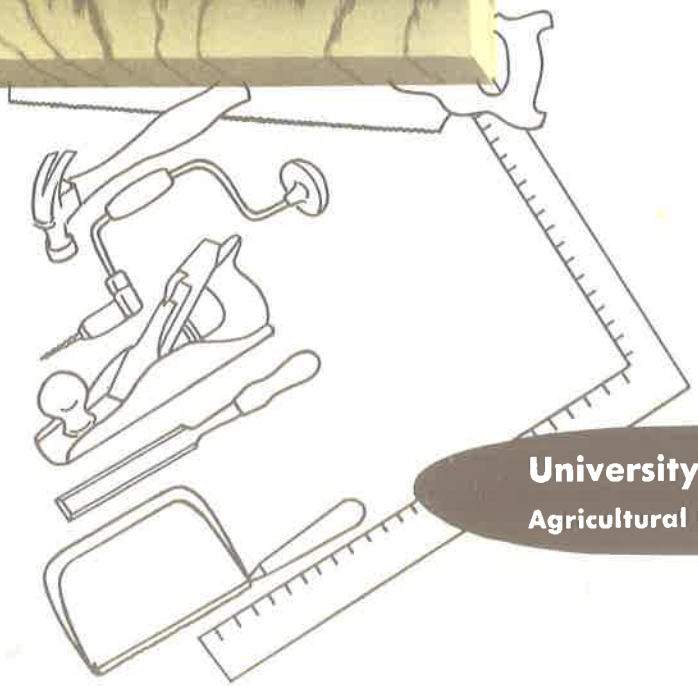
AGRICULTURAL ENGINEERING PROJECT
IN

WOODWORKING



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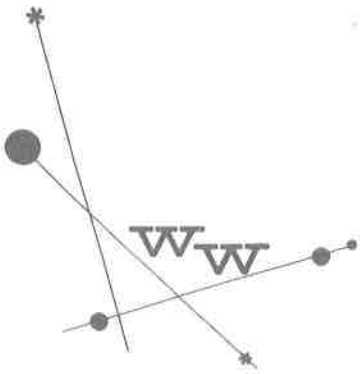


Subject material used in this manual has been adapted and compiled by George Shambrook, Farm Advisor, Santa Clara County, from material in Marin County 4-H Woodworking Project Outline, and Oregon State College 4-H Woodworking Bulletin.

Woodworking Project

In this project, you will learn how to use tools to build simple wooden articles for use on the farm and around the home. The skills you learn in this project will be useful to all members with projects in livestock or crops, home furnishing, and home grounds beautification.

You will learn to select the proper kind of wood for articles you build. You will learn to practice safety in working with tools. Many good demonstrations can be developed from this project. Look at your project outline to find out what you will have to do to complete this project.

PROJECT REQUIREMENTS

1. Club members must be between 10 and 21 years of age as of January 1 of the club year.
2. Each member shall agree to follow carefully the directions of the project leader.
3. Each member shall keep complete and accurate records of his project in the 4-H Club Record Book.
4. Each member must furnish his own tools and material for the items he makes.
5. Each member will fulfill the requirements for the unit in which he is participating.
6. Each member will practice at home the instruction given at the regular project meetings.
7. No power tools will be used in this club unless in the fourth year unit, and then only under competent supervision.

SAFETY IN WOODWORK

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

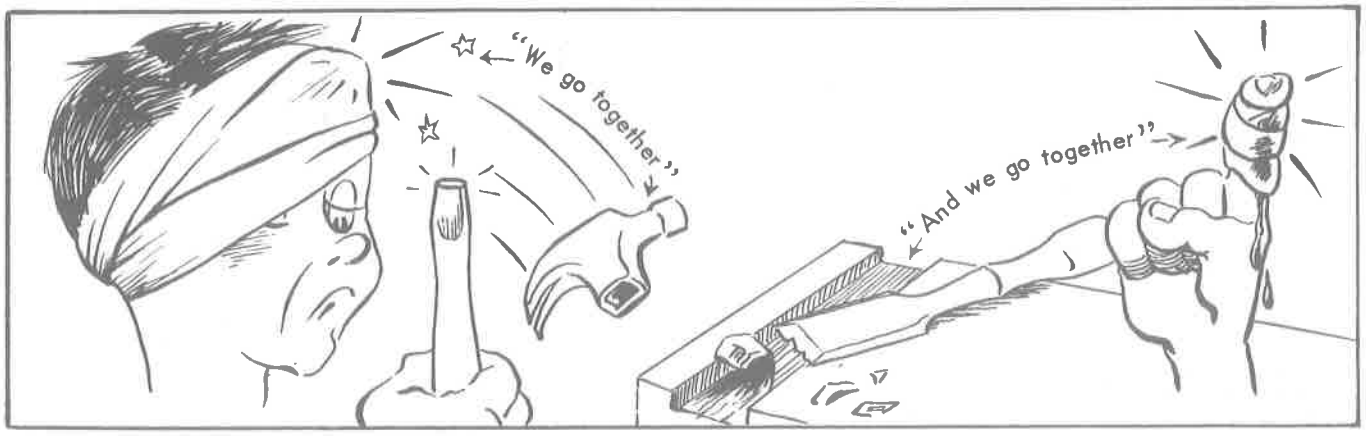
- Develop skillful, efficient and safe work habits.
- Use these habits when making all articles – from the plan to the finished article.

Think about the tools you'll work with. What do you expect of them? Each 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'd certainly learn how to use and care for them properly. Many men, who earn their living with just such tools as are found in the farm shop, learn early in life that tools should be treated as friends for best results. Correct use prevents injuries to the worker and others, and lessens 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.



MORE SAFETY TIPS

CLOTHES TO WEAR. Loose collars are comfortable. For safety, don't wear a tie while working. Sleeves should be rolled to the elbows, using an inside roll so the cuffs won't catch. Clothing should be loose, but never bulging or flying.

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

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

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

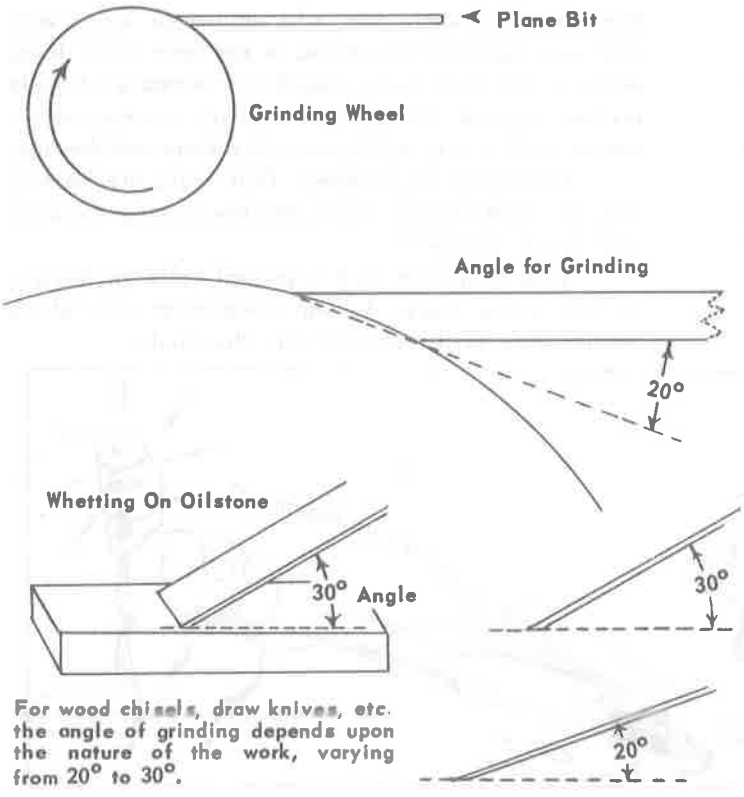
Every workshop should have a handy first aid kit for treating injuries and wounds immediately.

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 should be used very sparingly. If tools become rusty, remove the rust by rubbing with pulverized pumice stone, then oil thoroughly.

All tools bearing an edge should be kept well-sharpened. It is not easy to use dull tools.

grinding tools



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

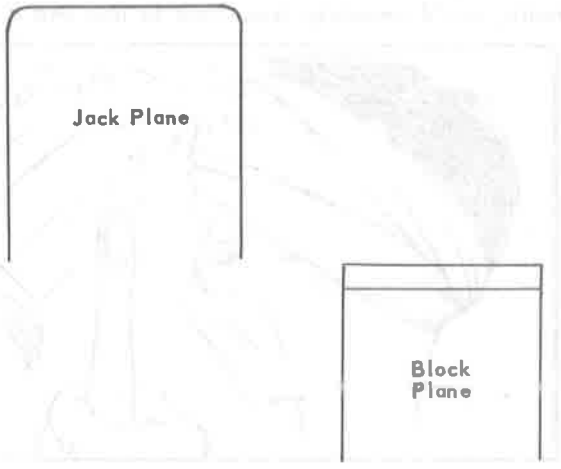
sharpening tools

Tools must be kept in good condition and sharp. When you use the grindstone, 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.

For sharpening, you'll need a grindstone, 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, don't try to sharpen a saw; send it to a saw filer instead.

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

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



KINDS OF WOOD

Wood is probably the most commonly used material in the world today. Lumber is more than just a piece of wood. It has taken years to grow and skill to shape. Unwise logging and the ravages of insects, fire, and storm, have caused the great virgin forests of America to dwindle until only very small areas of original timberland now remain.

Today trees are grown as a crop to furnish wood. There are two general classes of wood – softwood and hardwood. Wood is also graded according to quality, with grades of select and common. The select grades are "B" and "Better," "C" and "D." Common lumber is graded as No. 1-2-3-4, and is distinguished from the select by its coarseness of appearance, and one or a combination of defects.

Some hardwoods are oak, hickory, black walnut, and maple. They are used for flooring, furniture, interior finishes and cabinetwork.

Some softwoods are fir, white pine and redwood. Softwoods are used for framing, foundations, siding and other general construction uses.

CEDARS are fragrantly-scented soft woods. They include eastern red cedar, northern white cedar, western red and yellow cedar. Eastern red cedar is a popular wood for lining closets and chests because moths dislike its odor. The heartwood, or center, of cedar is dark red in color. The sapwood, or outside, is white. Cedar's many knots add beauty to the wood, but make it difficult to plane. Cedar is best dressed with the cabinet scraper. The wood seasons rapidly. It shrinks and checks very little and the heartwood is very durable for outside use. It is used like soft pine, but because of its great durability it is preferred for shingles. The smaller trees are used for fence posts and railroad ties.

DOUGLAS FIR is one of the largest trees native to North America. It is the most cut of any wood of commerical importance. Although it is distinctly a western species, it is also used in many parts of the middle-west and east for structural timbers, railway ties, rough and finished lumber, flooring, plywood, furniture, lath, tanks, and many other articles. The sapwood is white and the freshly-cut heartwood is light reddish yellow in color. When exposed to light and air it becomes distinctly reddish. Sometimes it turns cherry red or brown. The average fir lumber from the west coast is strong, moderately hard, moderately heavy, and very stiff. It splits easily and is rather difficult to work with hand tools.

REDWOOD, one of the largest trees known, grows only in the extreme western part of the United States. Redwood is very durable in contact with soil and is widely used for flower boxes, fence posts, water pipes, railway ties, and water tanks. It is used also for siding and shingles in house construction. Both the bark and the wood are cinnamon brown. The wood is light, soft, moderately strong, and easily worked with tools.

WHITE OAK is grayish brown, with a reddish tinge and has an open grain. The medullary rays of the oak, running out from the center of the log, are very prominent. When the log is quartersawed, these rays produce an attractive flaky-looking surface. Oak is used for interior finish, cabinet work, furniture, flooring, implement parts, and for heavy construction such as bridges and railroad ties. White oak is strong, hard, tough, elastic, durable, beautiful in grain, and rather easy to work. Oak furniture is never out of style and modern methods of finishing have increased the demand for it.

WHITE PINE is perhaps more in demand for carpentry and building than any other kind of wood. It is nearly white in color, light in weight, works easily, and when properly seasoned, it warps little. It is used in building and for door and window frames. The heartwood is moderately durable in contact with soil and moisture. The heavier the wood, the darker, stronger, and harder it is, and the more it shrinks and checks. The cheaper grades of white pine are used for general carpentry.

YELLOW PINE grows in the southern part of the United States. It is used largely for building construction. From the Longleaf and Slash pines comes most of the commercial resin and turpentine of the United States. Yellow pine is hard and the summerwood portion of the annual rings is dark colored. It warps little and the heartwood is moderately durable. The grain is usually straight. There is a tendency to split during nailing. Yellow pine is used for heavy structures such as bridges, trestles, wharves, piling, ship frames, and docks. It is used for house sills, foundation timbers, and for concrete forms.

LUMBER
some symbols and sizes

Lumber comes in standard sizes. Softwood comes in thicknesses of 1 to 3 inches, widths of 1 to 12 inches, and 8 to 20-foot lengths, in multiples of 2 feet. Lumber is either rough or surfaced. It it is surfaced on two sides, it is known as S2S. If all sides are surfaced, it is S4S.

SYMBOLS

" means inches
' means feet
x means by

A mark such as 2"x1'-8" is read "two inches by one foot and eight inches."

SIZE. Most lumber is sold by board measure. The unit of board measure is a board foot, which is equal to a board 1"x12"x12". When ordering lumber, each size is listed separately, giving the number of pieces, the thickness, width, and length. For example — 6 pieces 2"x4"x12' equals 48 board feet. If the cost is $110 per M (thousand board feet), the cost of the 2"x4"s would be $5.28.

Be sure to get lumber that is not warped. It is in the interest of conservation and economy to use lower grades of lumber and shorter lengths whenever possible without affecting your project.

Keep in mind, when ordering, that you don't get all the lumber you bargain for. For example, when you buy a one-inch finished board, you'll find it measures only 7/8 inches in thickness. The board was one inch thick when it came from the saw mill. But it was planed to take off the saw marks and make it smooth on both sides, reducing it to 7/8 inches in thickness. Width is also reduced by planing. Length, however, will be the same as or a little more than you order. Some materials, such as plywood and pressed board, will have the same thickness, width, and length you order.

abbreviations and equivalents

Sq. ft. = square foot
Bd. ft. = board foot
pcs. = pieces
1" = one inch
1' = one foot
lb. = pound
qt. = quart
gal. = gallon
4 qts. = 1 gal.

M = one thousand
s2s = surface 2 sides
s4s = surface 4 sides

useful facts and formulas

$$\text{Board feet} = \frac{\text{Number of pieces} \times \text{inches thick} \times \text{inches wide} \times \text{feet long}}{12}$$

$$\text{1 board foot} = \frac{1" \times 1" \times 12" \times 1'}{12}$$

$$= 1" \text{ thick } 12" \text{ wide } 1' \text{ long}$$

$$= 144 \text{ square inches}$$

Square foot measure = width in feet x length in feet

One square (roof) = 100 square feet (10'x10')

Lumber is usually purchased —

1. Per thousand (M) board feet
2. Per running foot
3. Per square foot
4. Per bundle (shingles, lath, etc.)

Lumber usually comes in even lengths —

8' 10' 12' 14' 16'

Lumber may be purchased rough or smooth. In ordering lumber, list pieces, dimensions, kind of wood, and finish.

WIDTH. Below on the left, are "nominal" or rough-lumber widths; on the right is the width the finished lumber will be.

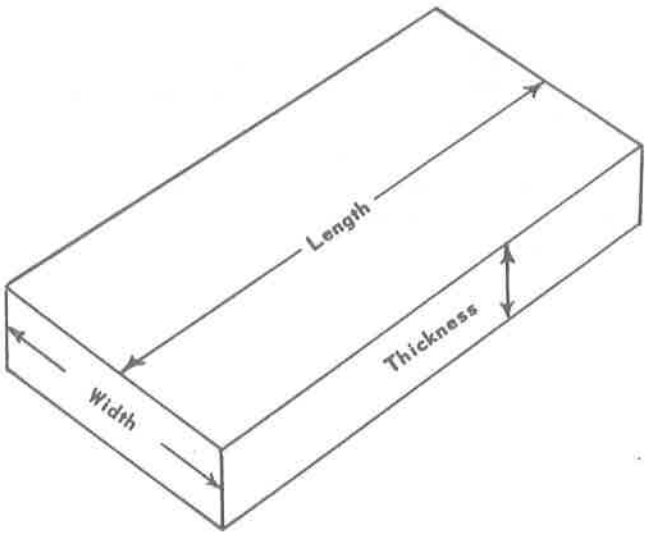
2"	dressed to 1-5/8"
4"	dressed to 3-5/8"
6"	dressed to 5-5/8"
8"	dressed to 7-1/2"
10"	dressed to 9-1/2"
12"	dressed to 11-1/2"

THICKNESS. Below on the left, are "nominal" or rough-lumber sizes. On the right is the thickness the finished lumber will be.

3/8" dressed to	1/4"
5/8" dressed to	1/2"
3/4" dressed to	5/8"
1" dressed to	7/8"
1-1/4" dressed to	1-1/8"
1-1/2" dressed to	1-3/8"
2" dressed to	1-7/8"

Lumber from some mills will be thinner than these measurements.

Notice here that in the smaller widths the finished size is 3/8 inch less than the nominal size; in larger widths, it is 1/2 inch less. Softwood lumber comes in even-numbered widths, such as 2, 4, 6 inches. Hardwood lumber may come in various other widths.



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 can't 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 listed in this project outline. Then learn to identify and use other tools.

Every home shop should have these tools –

1. Claw hammer
2. Cross cut saw (8 point)
3. Rip saw (5½ point)
4. Folding rule or steel tape
5. Screw drivers
6. Brace and bits
7. Jack plane
8. Wood chisels
9. Ripping bar
10. Framing square
11. Try square
12. Nail set

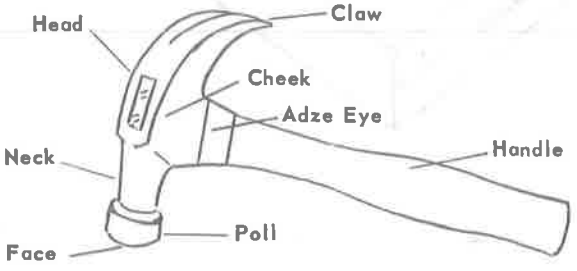
The more experienced woodworker will use more tools, including –

1. Combination square
2. Coping saw
3. Marking gauge
4. Key hole (compass) saw
5. Mallet (wood or plastic)
6. Hand drill and bits
7. Carpenter's level
8. Counter sink
9. Bench vise
10. Back saw
11. Draw knife
12. Block plane
13. Hand scraper

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.

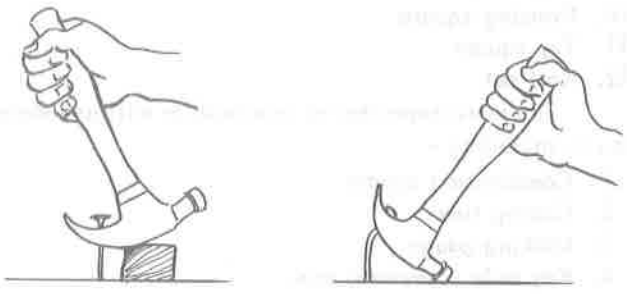
This kind of careless handling ruins tools quickly. Don't do it. Protect cutting edges; keep tools out where you can see the one that is needed.



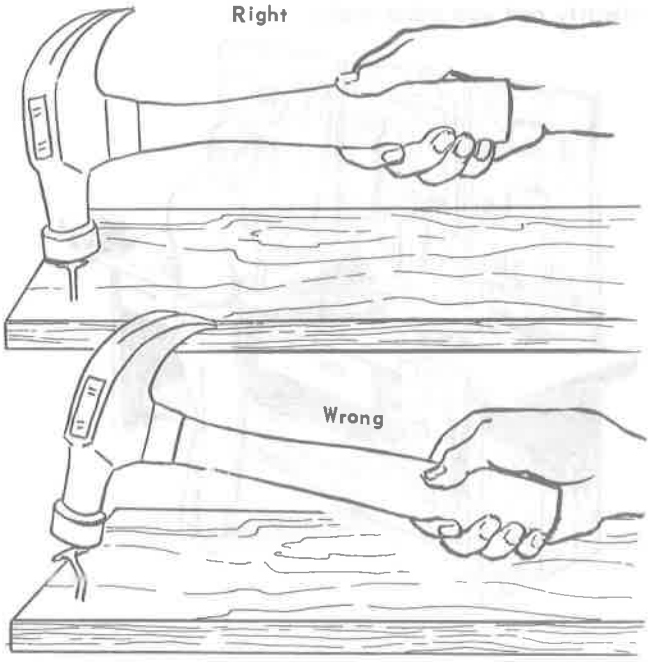
Drive the nail with full, strong blows. Learn to use wrist action and hold the handle near the end. Keep the handle parallel to the work at the point of impact. Hit the nail squarely to prevent bending the nail and leaving marks on the wood. Practice helps.

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.

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.

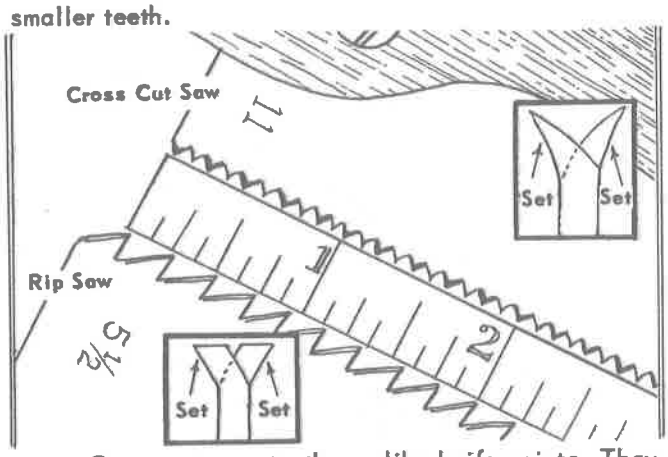


This Not This



- 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.

THE HAND SAW is the next tool to consider. The two most used types are the cross cut saw and the rip saw. The cross cut saw is used to cut across the grain of the wood. The rip saw is used to cut with the grain. The most obvious difference is in the size of teeth – the rip saw has large teeth, the cross-cut has smaller teeth.



Cross cut saw teeth are like knife points. They cut like two rows of knife points and crumble out the wood between the cuts.

Rip saw teeth are shaped like chisels. They cut like a gang of chisels in a row.

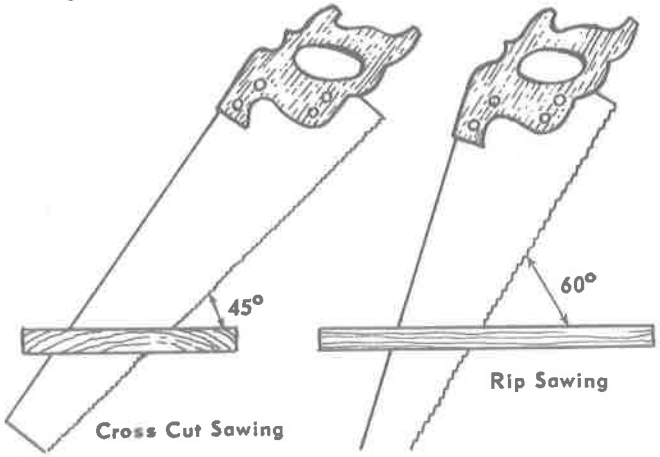
Saws are designated by the number of tooth points to the inch. A cross cut may have 8, 10, or 11. A rip saw will have only 5, 5½, or 6. Usually this number will be found stamped on the blade near the handle.

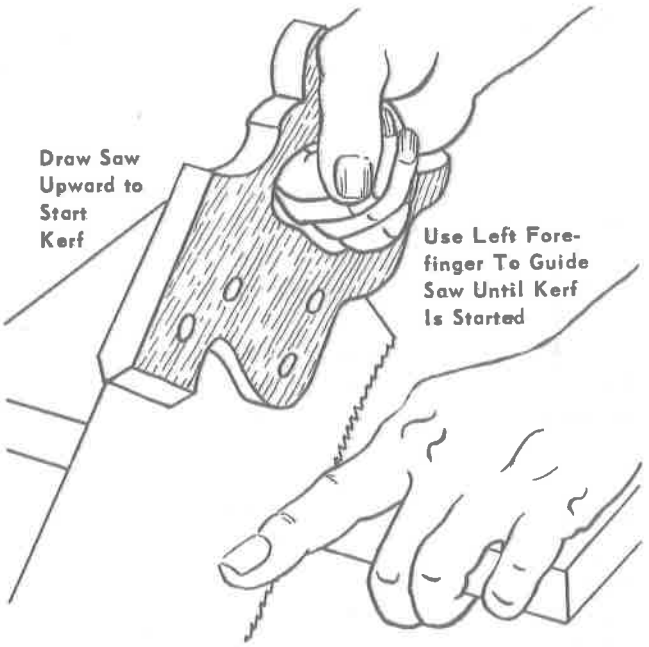
Start the cut by drawing the saw toward yourself. Guide it with the thumb of your left hand until the cut is deep enough to hold the saw steady.

BE CAREFUL. The saw is 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 straight than it is to straighten a crooked one.

If ripping, hold the saw at 60 degrees to the work. If cutting across the grain, the angle should be 45 degrees.





It takes practice to keep the cut vertical. While learning, you can use the try square to check. The side of your saw should be square with the board.

STARTING THE KERF. Kerf is the term carpenters use to describe the cut left by the saw.

Keep the kerf on the waste side of the line – 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 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 KEYHOLE 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. It can also be used to cut large circles or gentle curves.

THE COPING SAW is used to cut figures from thin stock. It can be turned on a very short radius.

THE 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.

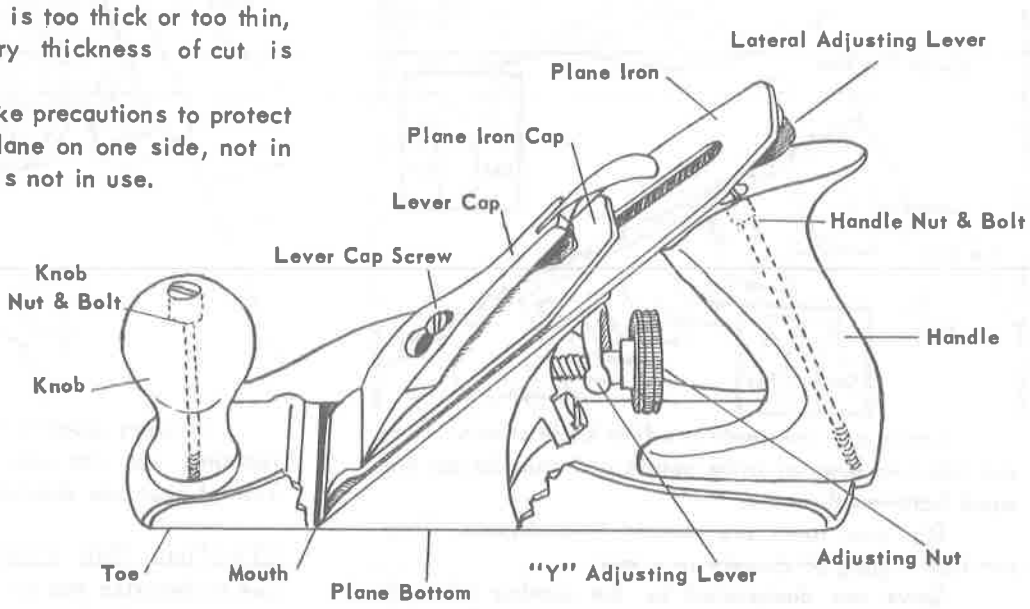
A WORD OF CAUTION. You may work with used lumber in these projects. Be careful of hidden nails. They will break or dull teeth, ruining your saw. Examine used lumber carefully and remove all nails before you try to cut it.

THE 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. Note the illustration. If one side of the cutting edge is lower than the other, use the lateral adjusting lever to even it up. Try the plane. If the shaving is too thick or too thin, readjust until a satisfactory thickness of cut is reached.

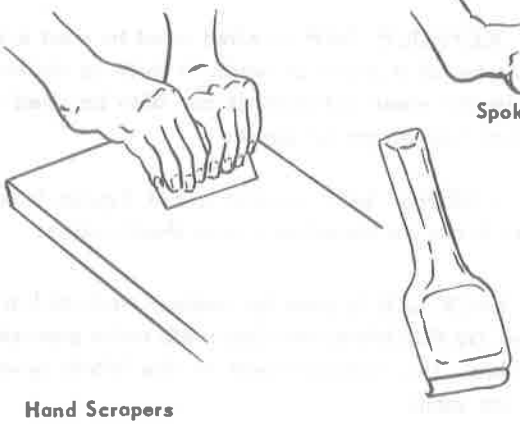
When using a plane, take precautions to protect the cutting edge. Lay the plane on one side, not in an upright position, when it is not in use.

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.



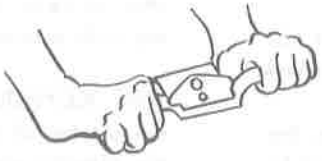
A HAND SCRAPER or cabinet scraper may be used if the grain is rough and cannot be smoothed with a plane. The hand scraper is a flat steel blade, one edge of which is sharpened by drawing a file along the scraper edge. To use grasp by the top with both hand and push or pull in the direction of the grain. It is sloped about 75 degrees to the work, leaning toward the direction of travel.



Hand Scrapers

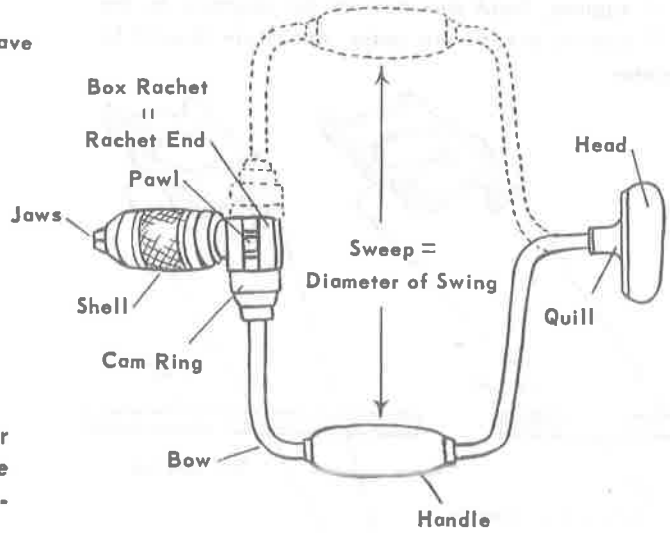
THE DRAW KNIFE and SPOKE SHAVE are other smoothing tools.

Draw Knife



Spoke Shave

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.

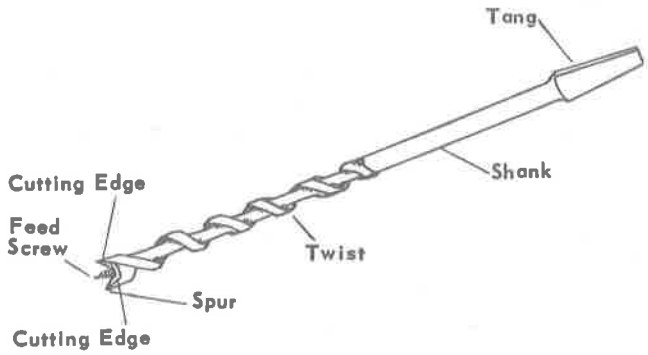


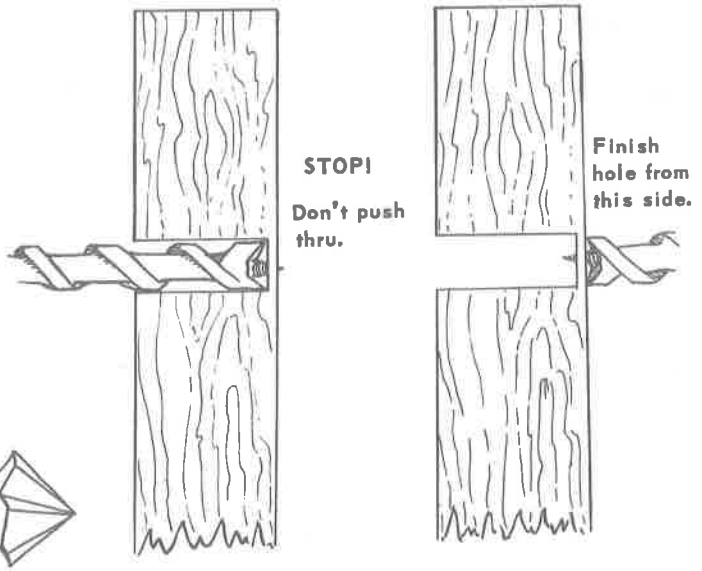
THE AUGER BIT, shown at right, is sized by 16ths of an inch, measuring the diameter. Bits vary in length from seven to ten inches. Dowel bits are the same, but shorter.

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.

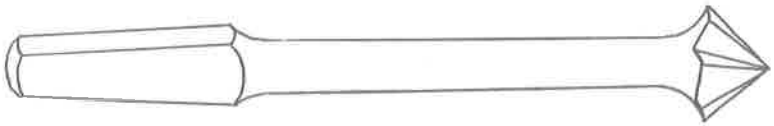
Store the bits so that the cutting edges, spur, and lead screw are protected. One good method of doing this is to drill a block of wood and keep the bits in the holes.

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





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.



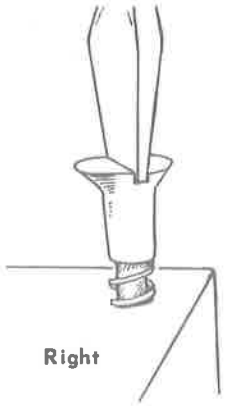
THE SCREWDRIVER is another useful tool that gets more than its share of abuse. It is easy – but not smart – to ruin a good screwdriver by failing to observe the following points.

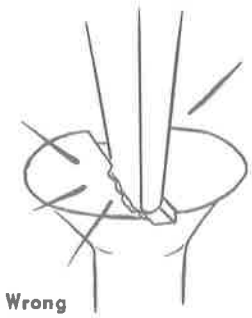
The blade should fit the slot snugly. Don't use a screwdriver that is too large or too small.

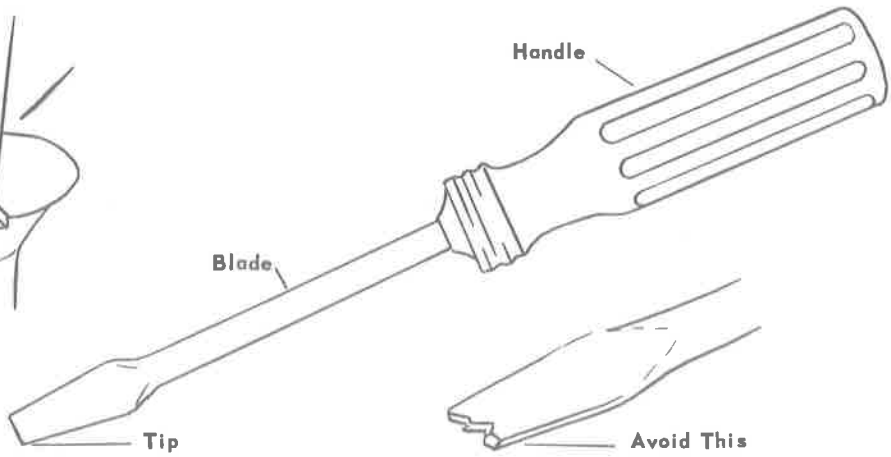
Hold the screwdriver square with the work. Keep a firm downward pressure as the twisting motion is applied. You will find a long screwdriver easier to hold.

- Don't hammer on a screwdriver. A screwdriver is not a substitute for a cold chisel.
- Don't 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.





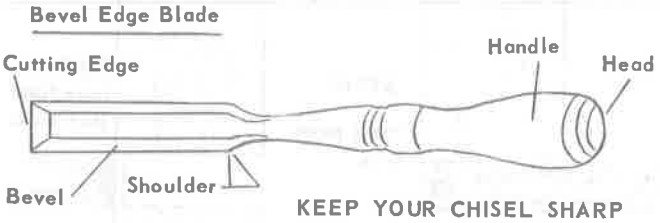


THE WOOD CHISEL may be regarded as a more primitive plane. Because its blade is unprotected, it can be used in routing (cutting grooves) and gouging. Be careful. The chisel is the most dangerous of hand woodworking tools. Always keep both hands on chisel.

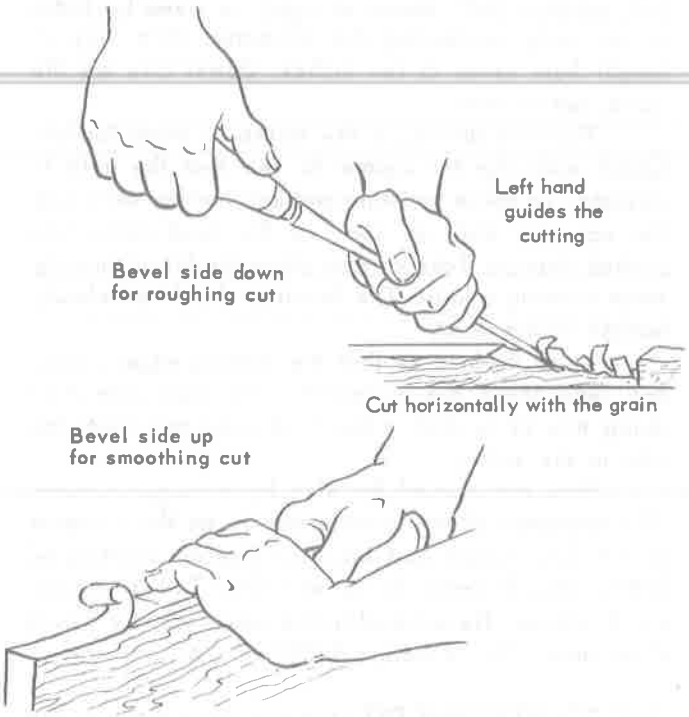
As with the plane, work with the grain whenever possible. Angle the blade a little, or move it from side to side as it moves forward. You will find that it will cut more smoothly and evenly.

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.



KEEP YOUR CHISEL SHARP



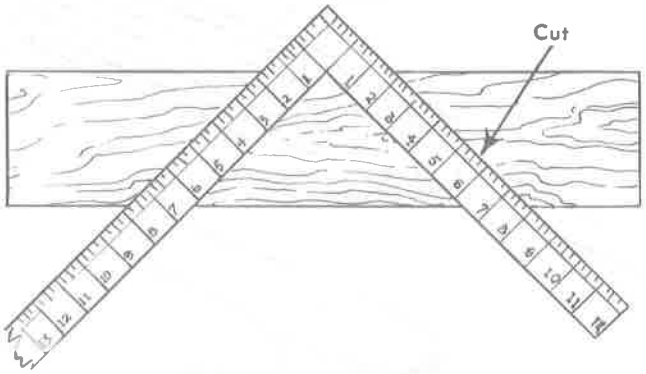
SANDPAPER is used to give a final, smooth finish to your work. Do not use it until you are certain that edged tools are no longer necessary. Sand left in the pores of the wood will dull a plane or a saw used afterward.

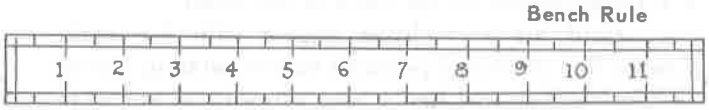
Use a moderately coarse sandpaper and work with the grain. Very coarse sandpaper may leave deep and hard-to-remove scratches in the surface. For a smooth job, use a sanding block. Then you will cut off the high spots and will not "drag" the corners. Finish with fine sandpaper.

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 type.

HOW TO LAY OUT THE JOB

LAYING OUT YOUR PROJECT is the most important step. Study the drawings. Know what you want to do. Then use your rule and square to mark the necessary cuts. Don't saw until you are sure. Accurate measurement is essential for good work.





There are many kinds of rules – your familiar school ruler, the yard stick, 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.

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.

The illustration shows the use of a FRAMING SQUARE in marking a board.

A COMBINATION SQUARE will lay off ninety or forty-five 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 the blade being 24 inches long and two inches wide. The tongue is 16 inches long and one and one-half 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.

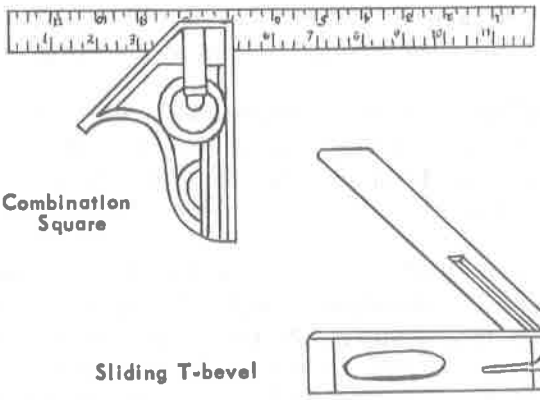
In addition to measuring lengths and determining if the end of a piece of lumber is square, the square can be used to determine angles. A 45° angle is shown being marked in the figure on Page 12 for cutting. Note the same number of inches is shown on both the tongue and blade.

Rafter angles can be laid out using the rise and run in feet reduced to inches on the square. Some squares have special markings for angles.

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

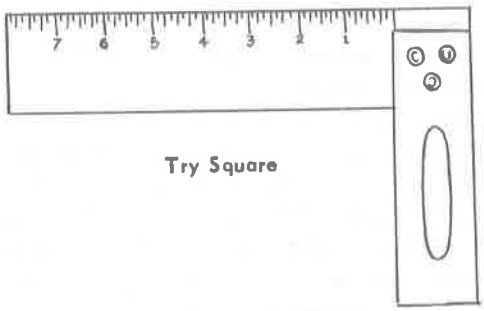
Never use a try square as a hammer – if the blade is loosened in the handle, the try square is useless.

IT WON'T S-T-R-E-T-C-H!



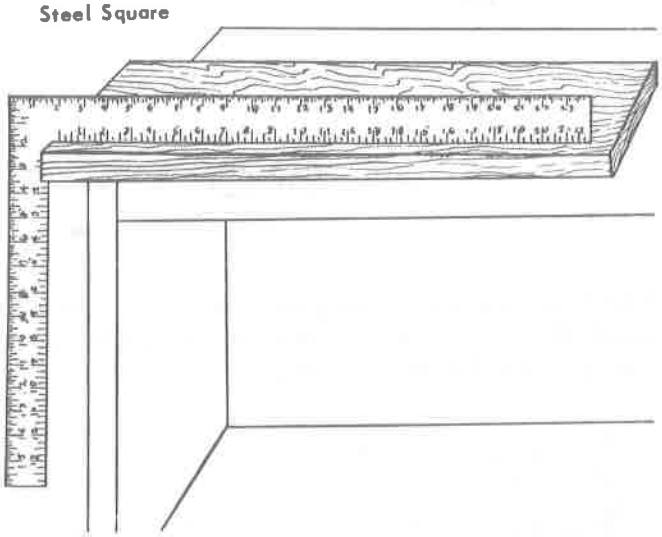
Combination Square

Sliding T-bevel



Try Square

Steel Square



After selecting your project, you should study the working drawings until you know about what you are going to do. If you chose a project from this manual, you will find the steps of construction outlined for you.

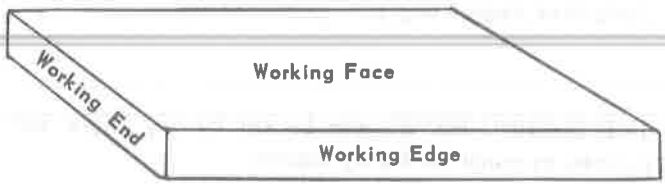
Select the material.

Lay out the work. Double check your measurements. If you do not understand the drawing, ask your leader to help you. Don't saw until sure.

Work carefully. Remember that you can cut a board down with a plane, but you can't stretch it.

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

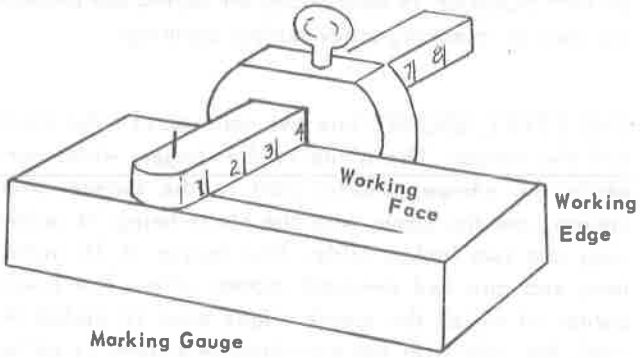
In order to avoid confusion, you should know a few terms used in carpentry and woodworking.



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 on pages 6 and 7.

WHEN SQUARING STOCK, follow this procedure:

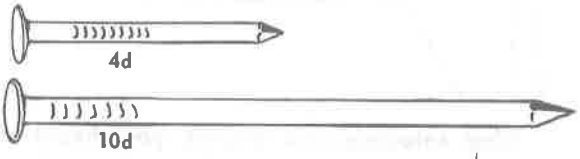
1. Select a WORKING FACE. For accurate work, this face should be planed true and smooth. Don't depend on your eye – check for high spots with a bench rule or the blade of your try square. When you have it true, mark with a pencil.
2. Select a WORKING EDGE. Plane this true, using your try square to square it with the working face. Mark this edge.
3. Square and mark a WORKING END.
4. Measure the desired length from the working end. Saw to length. Remember to saw on the waste side of the line leaving part of the line on the work.
5. Mark the stock to proper width, measuring from the working edge. A marking gauge will help you here. Saw and/or plane to width.
6. Measure the thickness from the working face. Plane to line.



Much of the quality of your work depends on the care with which you perform the preceding steps. Check often with the try square, and watch the line to which you are planing.

WOOD FASTENERS

NAILS are the most widely used method of joining wood. They are handy and fast. Use them where you can, but remember their limitations.



SIZE is designated by the "penny" system. The symbol for penny is the letter "d." Larger nails have bigger numbers. Sizes range from 2 penny to 60 penny. The illustration shows a 10-penny and a 4-penny nail, actual size.

There are a number of special types of nails for special jobs. Some of the more common are listed below.

1. Common nails are used for general purposes – sheathing, flooring, framing, etc. The nails shown are common nails.
2. Box nails are lighter than common, and are less apt to cause splitting. They are used with light or easily split lumber.
3. The finishing nail is preferred when it is desirable to have no nail heads showing. It can be sunk below the surface of the wood with a nail set. (A nail set is a sort of a punch.) The heads are covered with putty or plastic wood before the finish is applied.
4. Common brads are similar to finishing nails. The small sizes are frequently used in fine assembly work, such as model making.
5. Shingle nails are used for putting on roofing materials. They are usually coated with zinc for resistance to corrosion.
6. Corrugated fasteners are used to join the edges of boards together. Sometimes you will find them used in fastening corners of screen frames. More often they are used for repair work. Corrugated fasteners are made with plain edges for hard wood and saw edges for soft wood. They can be purchased in different sizes.

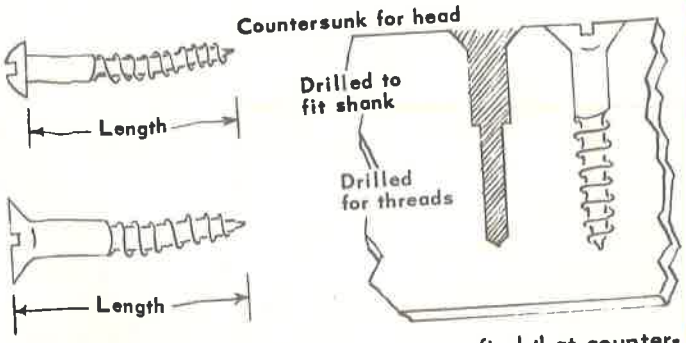
SCREWS are second only to nails as fasteners of wood joints. They have the advantage of making a much stronger joint than nails, but they require more time and work.

There are two common types of wood screws, the flat head and the round head. The flat head screw can be countersunk to leave a smooth surface, as shown in the illustration to the right.

Most screws are steel. If you are making an item that will be exposed to severe weather or use, you may want to use a plated screw to avoid rusting. Zinc, cadmium, and nickel are used for coating steel screws. Brass screws are used to resist corrosion by salt water, and for decorative effects.

In joining two pieces of wood with screws, a hand drill is a great help. Use the following procedure:

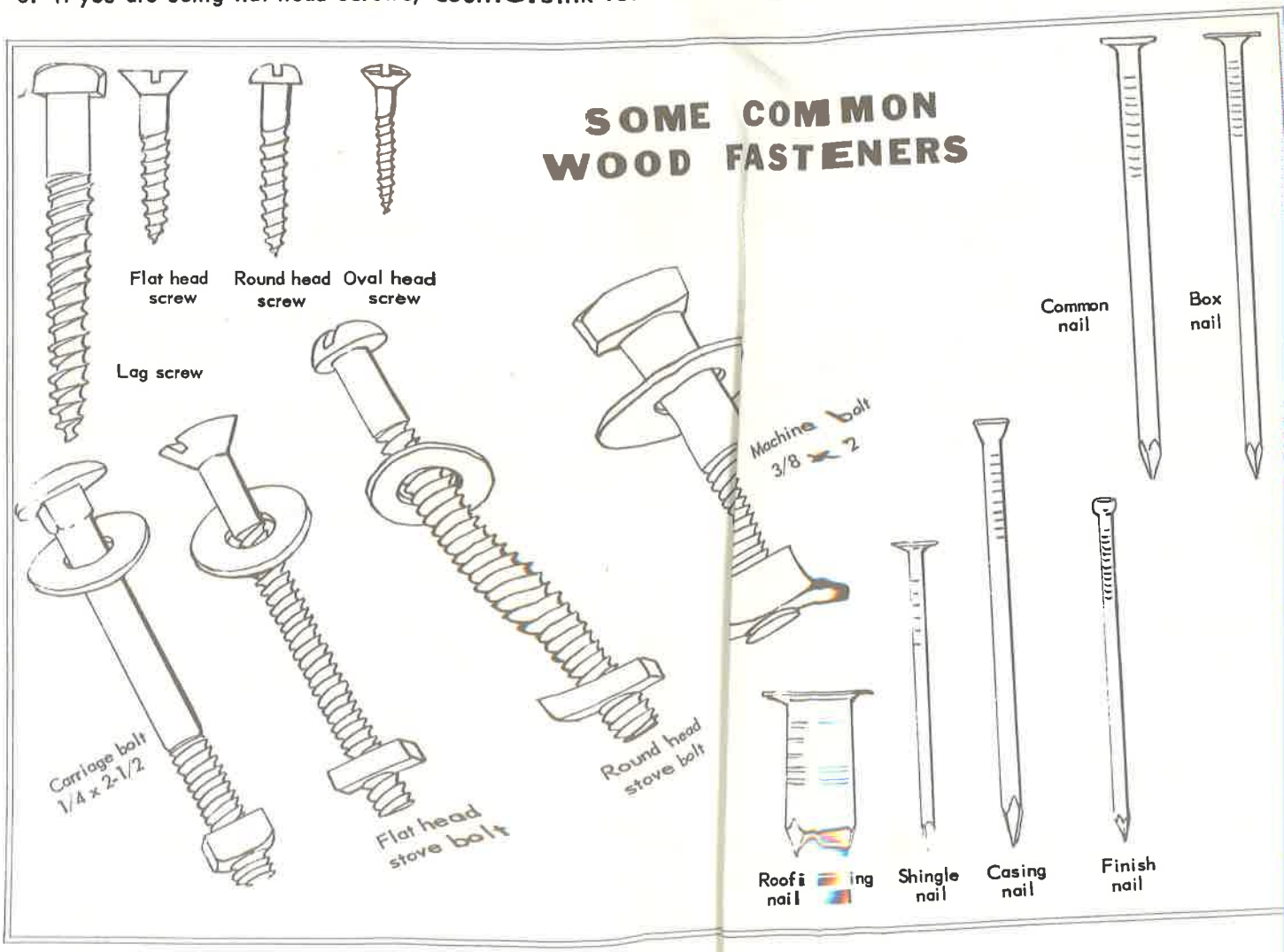
1. Select a bit equal in size to the shank of the screw. Drill a hole equal in depth to the length of the shank.
2. Using a bit slightly smaller than the diameter of the screw as measured between threads, make the hole equal in depth to the length of the screw.
3. If you are using flat head screws, countersink for the heads. In soft wood, you may find that countersinking is not necessary.



If you have many screws to drive, you will find some sort of depth gauge handy. One method that may be used is to drill a hole through a dowel, so that it fits over the bit to be used. This dowel is cut off so that when it slides over the bit and against the chuck of the drill, only enough bit is left exposed to make a hole of the depth wanted.

Soap applied to the threads of a screw makes it much easier to drive in hardwood.

Remember the rules for proper use of the screwdriver.



HOW TO READ A DRAWING

Each line in a 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 will give the drawing contrast, and make it easier to read. If all lines are the same thickness, the drawing has a flat appearance and is hard to read.

HERE ARE THE KINDS OF LINES YOU'LL FIND IN WORKING DRAWINGS

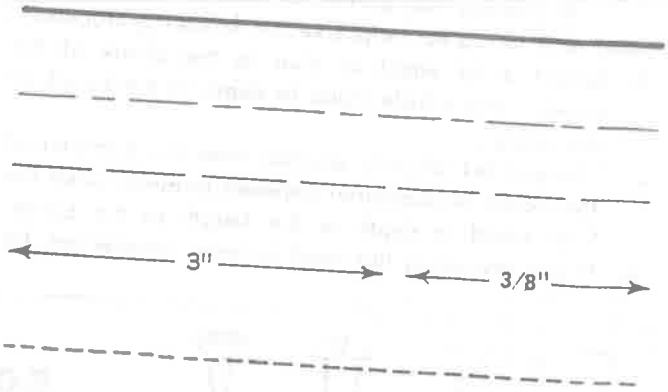
Visible outlines are heavy, solid lines that show the outline of an object and the corners and edges which can be seen.

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.

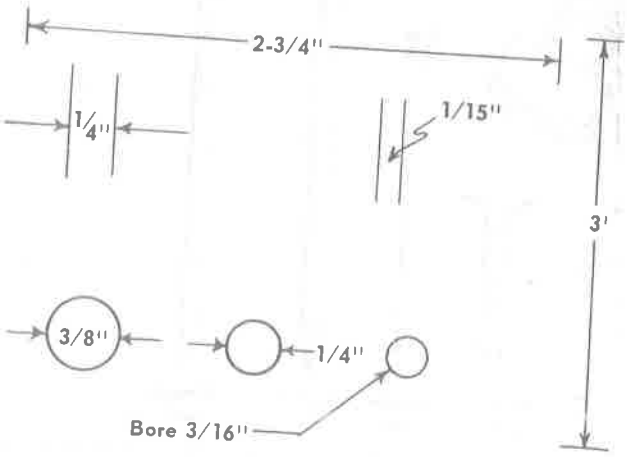
Dimension lines are fine, solid lines with arrowheads at the end. They are used to show distance between two points.

Invisible lines are short dash lines, showing outlines hidden from view.



HOW TO TELL SIZE

It is usually impossible to make the drawings as large as the full size of the article to be made. Therefore it is necessary to use a scale drawing, smaller than actual size.. The plans used with this circular are reduced scale drawings. The full size dimensions are given, even though the drawing has been made smaller.

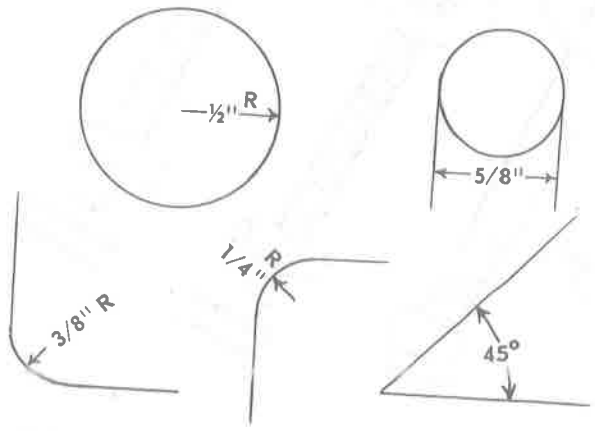


Dimensions are given in feet, inches, or a combination of the two. For example, 16", as 1 ft. - 4", or as 1' -4".

The drawings below show the different methods used in dimensioning lines, arcs, and circles. You will find some more symbols:

R equals radius

D equals diameter o equals degree



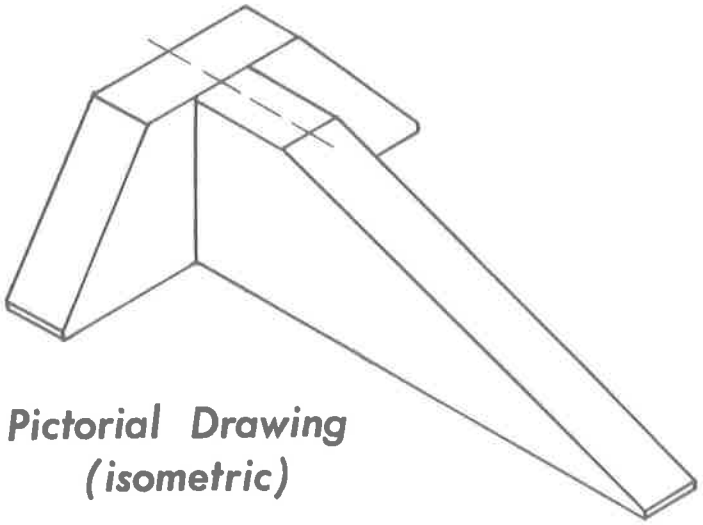
LET'S READ A DRAWING

Before starting to build, we must know how to read a drawing or a picture of what we are going to make. A working drawing is a group of views of an object which show you what the object is like. These views also give the dimensions such as widths, length, height, and thickness of the various parts.

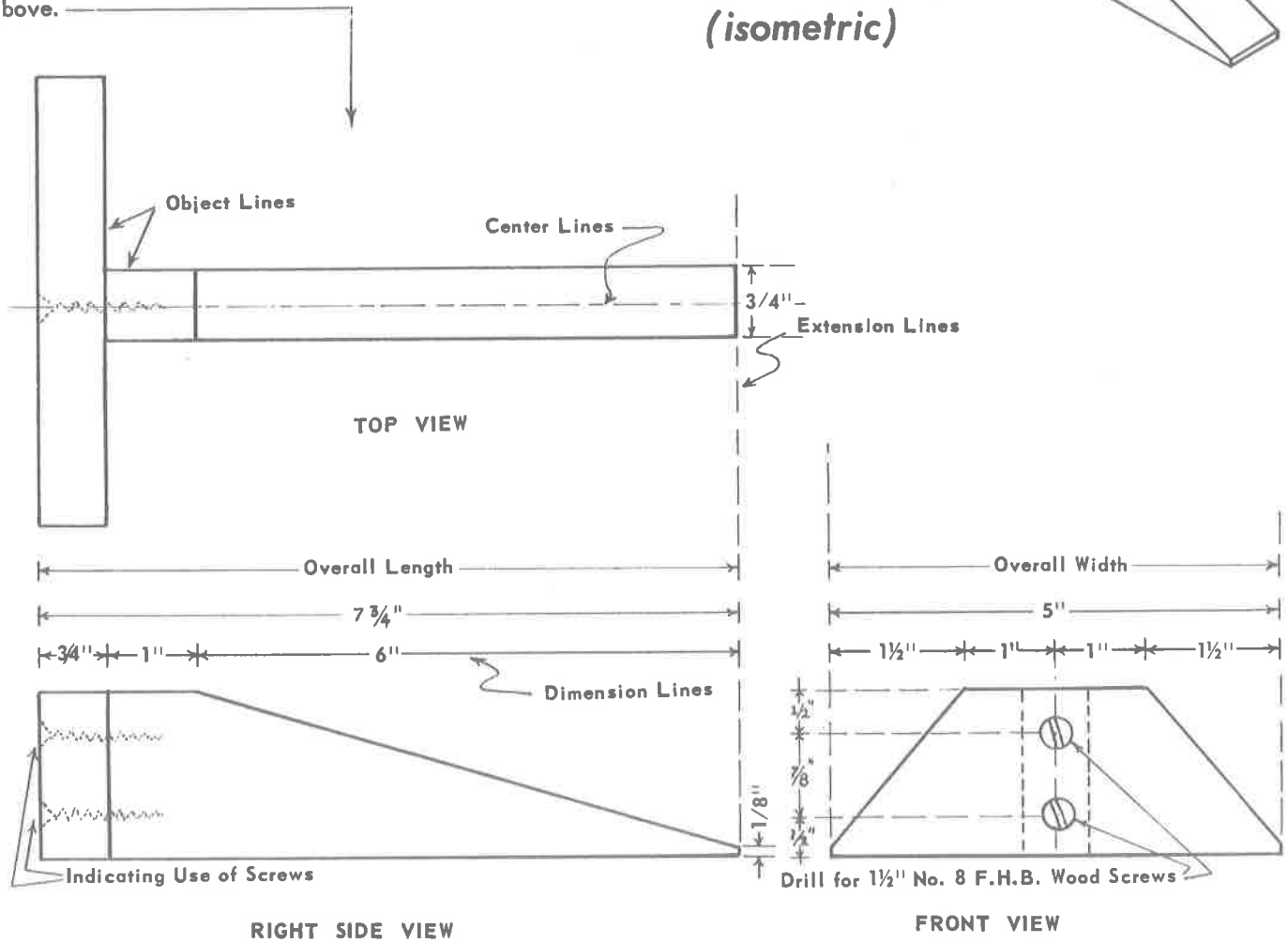
Look for a moment at this pictorial drawing of a door stop. It helps you see the relationship of the various parts, how they go together.

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.

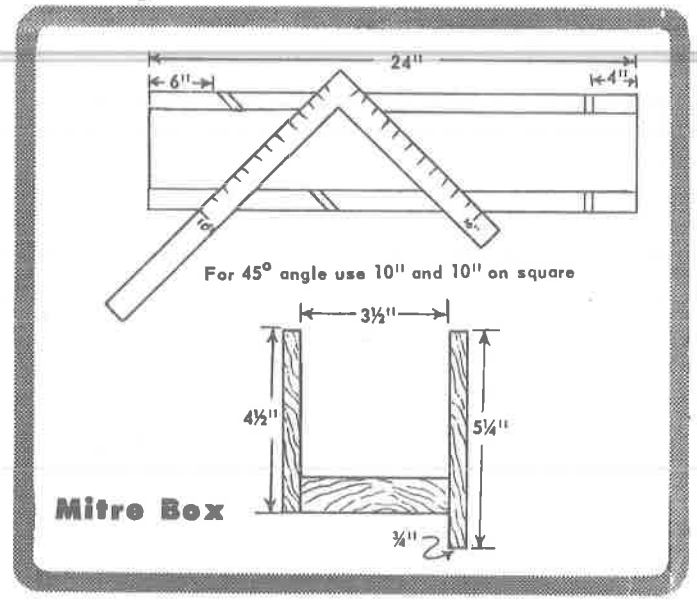


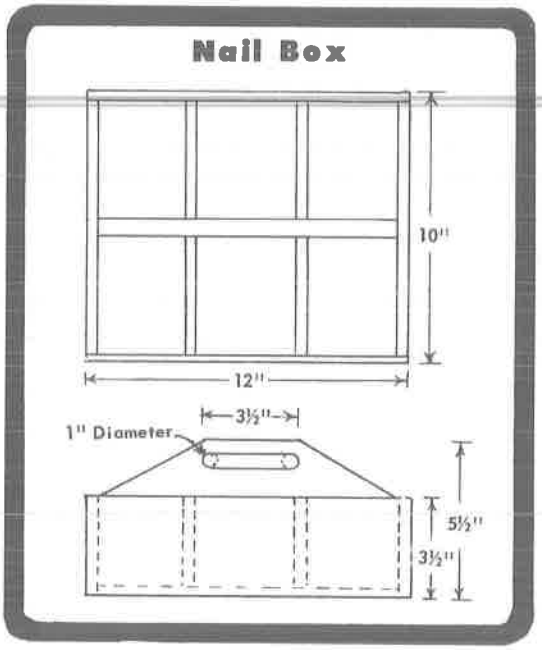
Pictorial Drawing (isometric)



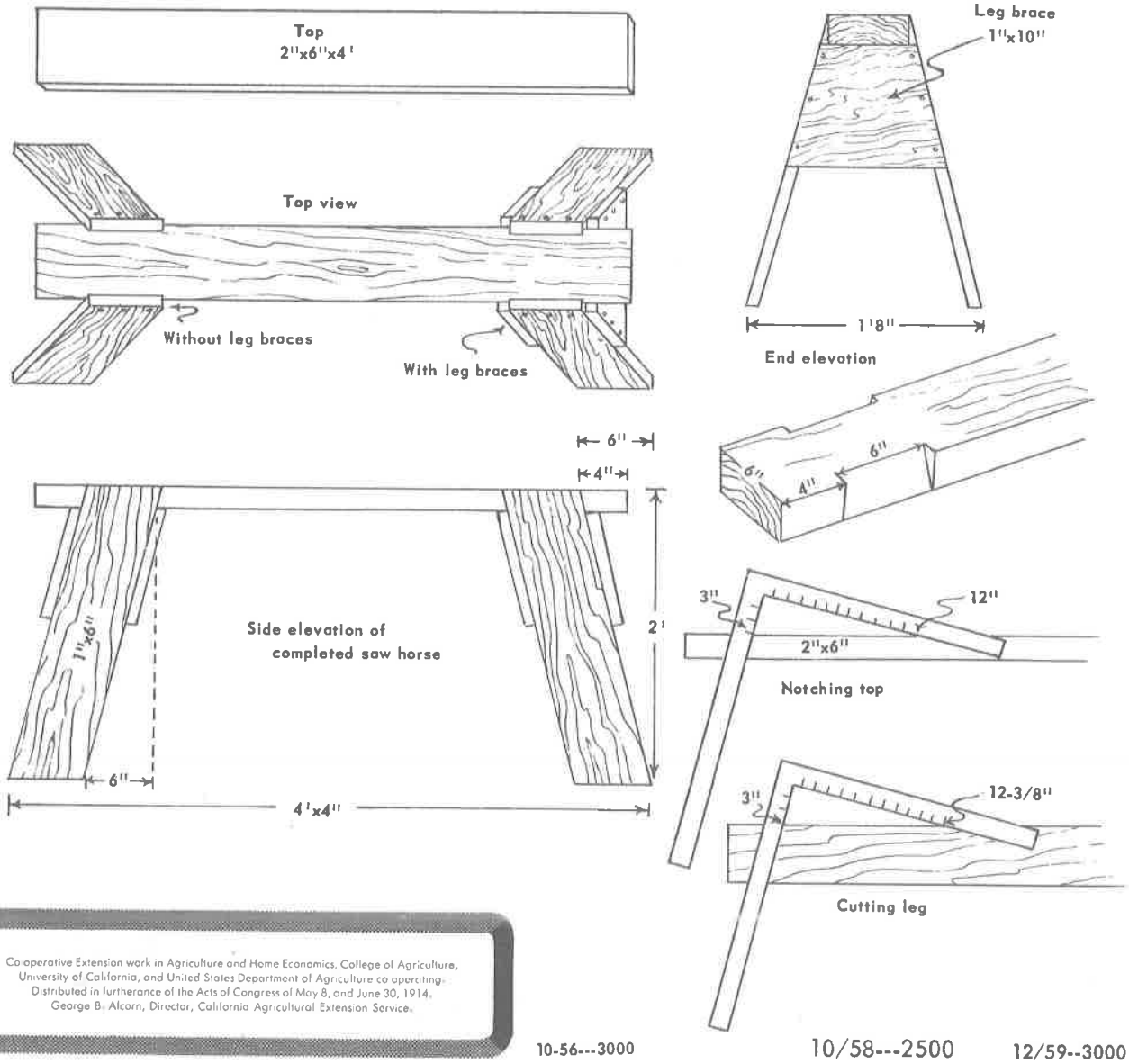
Working Drawing (orthographic)

Project Plans • • •





Saw Horse



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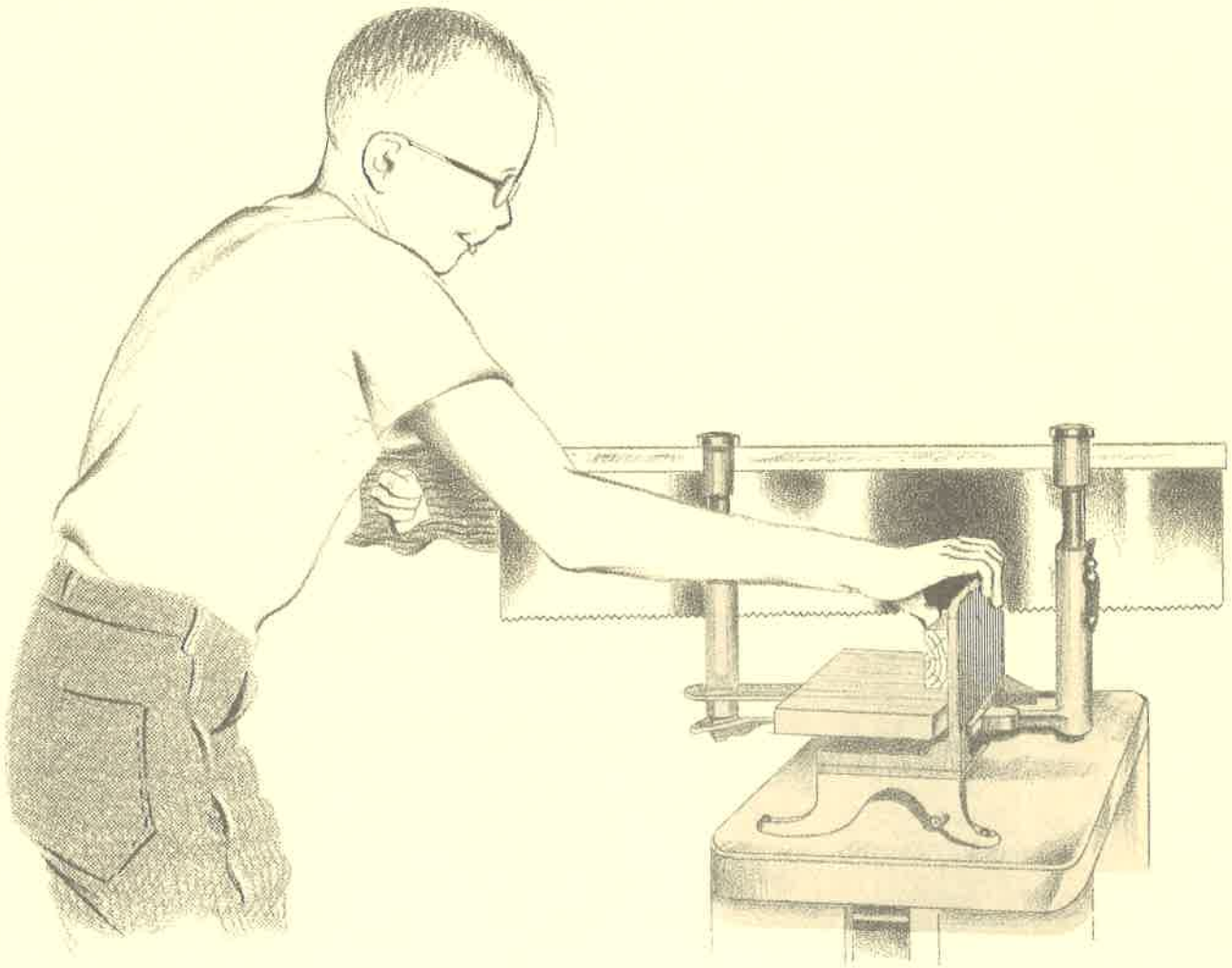
4-H AGRICULTURAL ENGINEERING

WOODWORK UNIT FIRST YEAR



UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

4-H–Ag142

The authors are, Don Brittsan, Farm Advisor Marin County; R. G. Curley, Extension Agricultural Engineer; R. F. Davis, 4-H Club Specialist; and Bob Sheesley, Farm Advisor Fresno County.

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JUNE 1966 **OCTOBER 1968--10M**

WOODWORKING PROJECT

UNIT I

You spend much of your life using wood or wood products—the house you live in, the paper you write on, the chair you sit in, and many other everyday items. You will be able to use carpentry, woodworking, and building knowledge on the farm or around your home. Also, what you learn in this project will help you in future 4-H projects in agricultural engineering, livestock, crops, home furnishings, and beautification of home grounds.

THINGS TO LEARN

In this unit you will learn:

1. The proper, safe use and care of:
   a. Measuring tape
   b. Crosscut saw
   c. Ripsaw
   d. Claw hammer
   e. Wood chisel
   f. Brace & bit
   g. Screwdriver
   h. Plane
   i. Nail set
   j. Wood rasp
   k. Combination square
   l. Try square
2. How to use a plan.
3. How to use nails and wood screws properly.
4. To identify kinds and grades of wood (visit a lumberyard).

THINGS TO MAKE

In this project you'll have an opportunity to choose articles to make from the following list. Remember to use your tools safely. Use the plans to help you make your articles the right size and shape.

1. First article — choose one
   a. Sandpaper block
   b. Cutting board
2. Second article — choose one
   a. Bolt and screw rack
   b. Toolholder (nail or screw brackets)
   c. Hardware display board of common wood fasteners
3. Third and fourth articles — choose two
   a. Toolbox
   b. Hoe rack
   c. Miter box
   d. Toolrack with wood notches
   e. Bench hook
   f. Concrete float

THINGS TO DO

Keep a record of your project.

Give one or more demonstrations on your project.

Exhibit what you have made.

Identify nail sizes and 12 common wood fasteners.

GETTING STARTED

SELECT YOUR PROJECT from the list of Things To Make in this unit.

STUDY THE WORKING DRAWINGS. A company that builds a skyscraper, a rocket launching pad, a jet airplane, or anything else, must have a plan to work from before any construction takes place. As a woodworker, you also must have a plan of the project you will make.

The working drawing is your plan of work. A working drawing shows all the dimensions as well as how to construct the article. Look at the drawing to find the thickness, width, and length of each part of the article before you do any sawing or hammering.

WORK CAREFULLY AND SAFELY. Remember, you can cut down a board with a plane, but you can't stretch it.

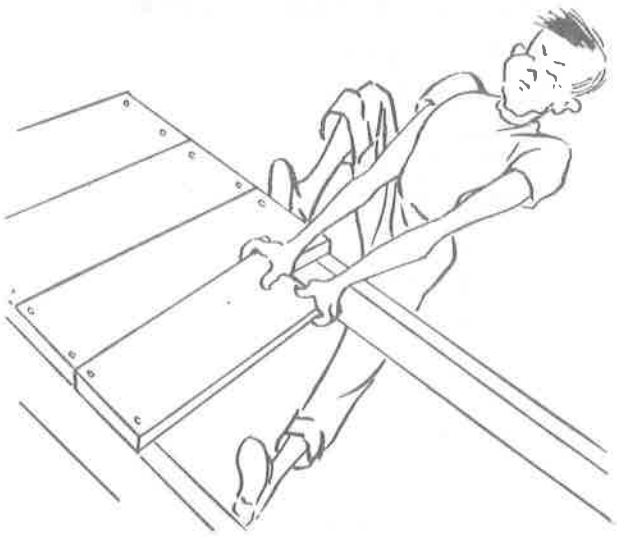
DO YOUR BEST. A neat, well-fitted project is worth the extra effort.

In later units of the Agricultural Engineering Project you will learn how to make working drawings. But first, read the drawings on pages 18 to 21. These plans will give you a picture of the items you will make in this unit. Think of these working drawings as pictures of your projects, and use the dimensions given to guide you in constructing each item. If you follow the plans, you'll save time and your construction materials.

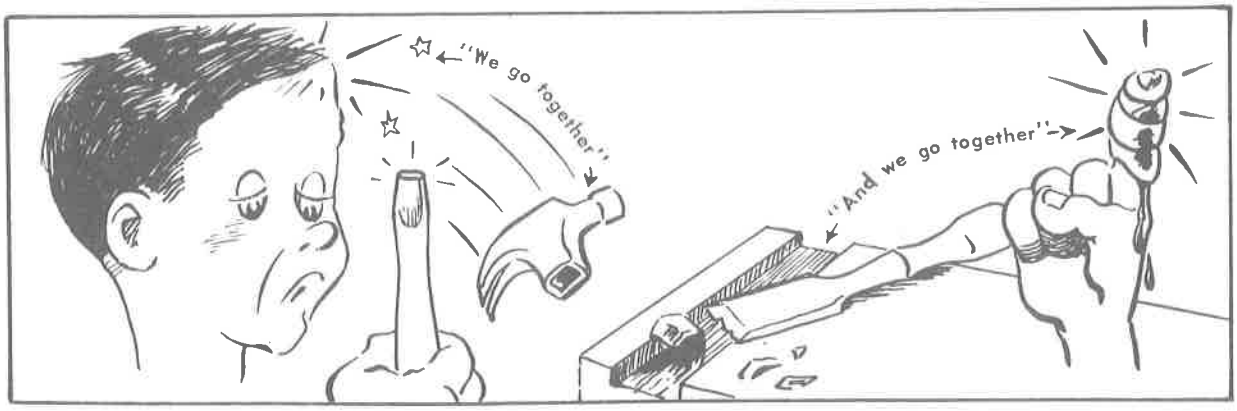
SELECT YOUR MATERIALS after you learn the requirements of the project from the working drawing.

LAY OUT YOUR PROJECT. Doublecheck your measurements and then use your rule and square to mark the necessary cuts. 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 judge whether or not your saw is straight up and down. Lay the rule so that the graduations touch the work; then your eye cannot mislead you. Accurate measurement is essential for good work. If you don't understand the drawing, ask your leader to help you. **Don't saw until you are sure.**

It won't s-t-r-e-t-c-h!



SAFETY IN WOODWORKING



Keep your safety rating high. Prevent accidents to yourself and your fellow workers. In this 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 use. What do you expect of them? Each 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'd certainly learn to use and care for them properly. Men who earn their living with tools, such as those in the home shop, learn very early in life to treat their tools as friends for best results. Correct use prevents injuries and lessens breakage and damage.

LEARN SAFETY HABITS

DRESS FOR SAFETY. Loose collars are comfortable. For safety, don't wear a tie while working. Roll your sleeves to the elbow, using an inside roll so the cuffs won't catch. Clothing should be loose, but never bulging or flying.

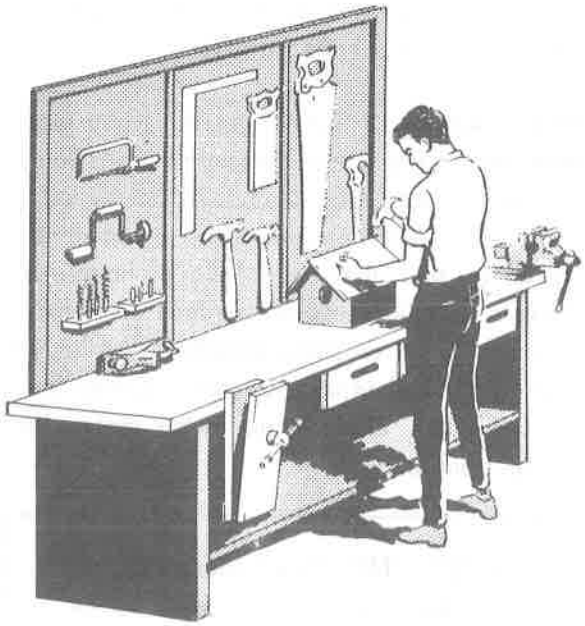
PROTECT YOUR EYES. Your eyes cannot be replaced. Do not expose them to unnecessary danger. Wear goggles when you use high-speed grinders or other equipment. Metal particles, abrasives, nails, sawdust, and shavings may cause eye injury. Keep the goggles clean.

TREAT ALL INJURIES, no matter how slight. Even a scratch may start an 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 immediately.

KEEP TOOLS IN GOOD SHAPE. Keep tools that bear an edge well sharpened. Dull tools are hard to use, they do unsatisfactory work, and usually are the ones to cause accidents. Also, be sure that the heads of hammers, mallets, and hatchets are wedged on tightly. If they are not properly attached, the heads may fly off and injure someone. Loose handles on saws, chisels, and other tools also cause trouble.

> **SAFETY TIP:** Don't leave nails in a board where you may step on them and injure your foot.

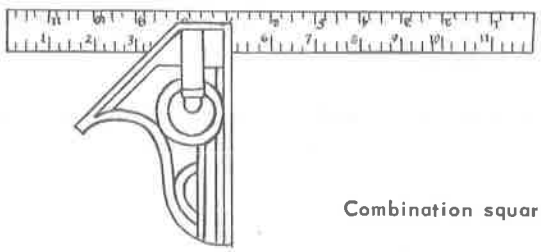
Good tools do good work. Take care of them. Have a clean, dry place for your tools — in a cabinet over a bench, in drawers in a bench, or in a toolbox. Wherever you keep your tools, always return each to its proper place after using it. The best tool is no good if you can't find it when you need it. A good workman keeps his bench and tools clean and ready for use, and his work area in order. Keep your tools dry. Rust and careless handling are great enemies of handtools. Oil helps prevent tools from rusting, but use it sparingly. If your tools become rusty, remove the rust by rubbing with pulverized pumice stone; then oil thoroughly.



Workbench and toolholder

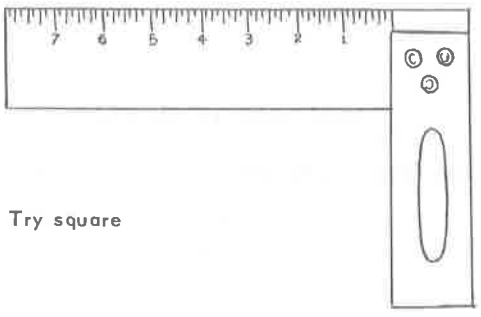
TOOLS AND EQUIPMENT

A COMBINATION SQUARE will lay off 90° or 45° angles. In addition to measuring lengths and determining whether or not the end of a piece of lumber is square, you can use a square to determine angles. Remember that measuring tools are precision instruments. Wipe squares, rules, and steel tapes with an oil rag to protect the steel from rusting.



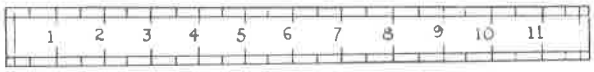
Combination square

A TRY SQUARE is handy for laying out projects as well as checking stock during squaring.



Try square

Bench rule

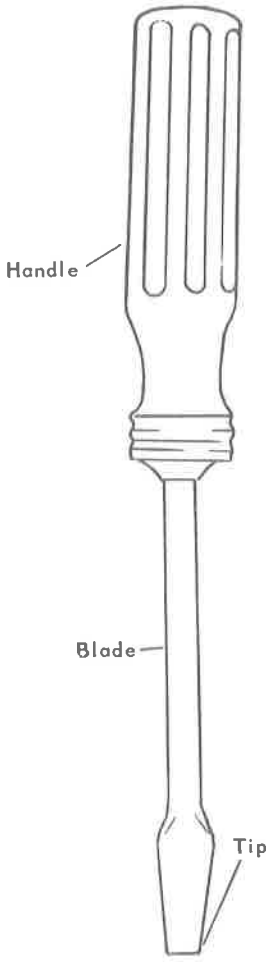


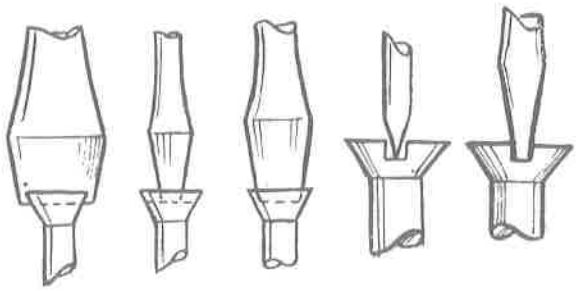
RULES include the bench rule, school ruler, yardstick, flexible tape (made of plastic, wood, or metal). Most are marked off in eighths or sixteenths of an inch.

SCREWDRIVERS get more than their share of abuse. It is easy to ruin a good screwdriver by misusing it. So remember:

- Don't use a screwdriver with a blade too large or too small to fit the screw slot snugly.
- Hold the screwdriver square with the work. Keep a firm downward pressure as you apply the twisting motion. A long screwdriver is easier to hold.
- Don't hammer on a screwdriver. A screwdriver is not a substitute for a cold chisel.
- Don't sharpen the tip to a point. If it is too thin, it will break. A tip that is rounded on the corners will ruin the screw slots.
- Don't use pliers on the blade to give greater turning force.
- Choose a screwdriver with a plastic handle or a good wooden handle. Cheaper wooden handles often become loose and useless.

Screwdriver

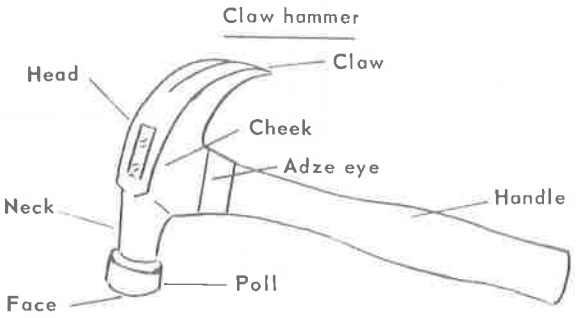


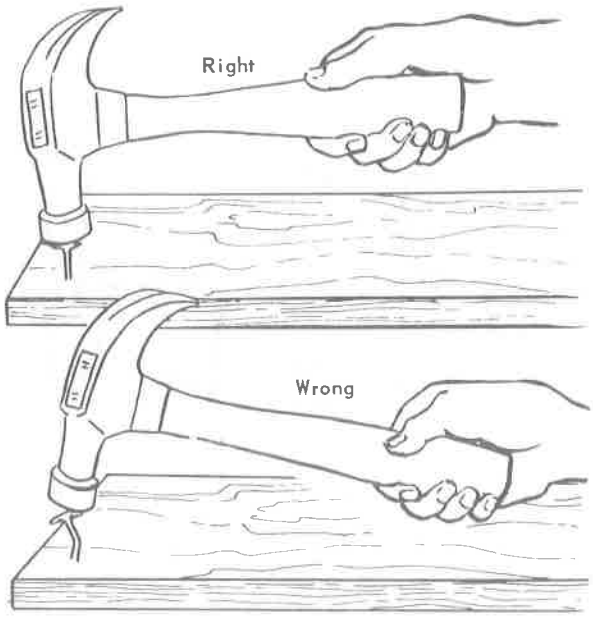


Wrong	Wrong	Right	Wrong	Right
Too wide. Will damage wood.	Too narrow. Will damage screw.	Tip same width as slot.	Tip too sharp. May slip out.	Sides of tip parallel with sides of screw.

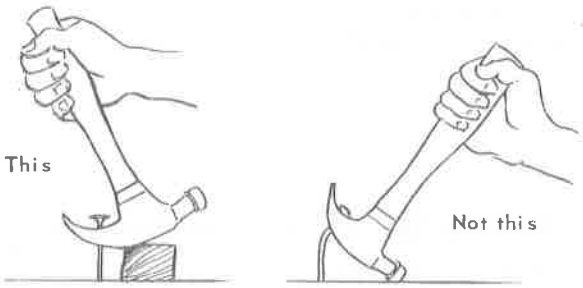
CLAW HAMMER is perhaps the most used and most abused tool. To use it safely and well, remember these simple rules:

- To start a nail, hold the nail high, just under the head, with the thumb and forefinger of the lefthand. This saves bruised fingers—if the hammer slips off the nailhead, it will knock fingers out of the way rather than mashing them between the hammer and the board. If necessary for control, you can hold the hammer near the head while starting the nail.
- Drive the nail with full, strong blows. 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 avoid bending it and marking on the wood. Practice helps.





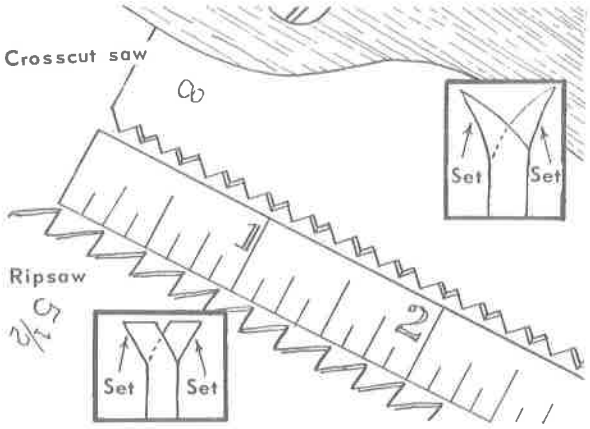
- To pull a nail, insert the claws under the nailhead. Do not pull the handle past the the straight-up-and-down position. When the handle has reached the vertical, place a block of wood under the head before you pull the nail further.



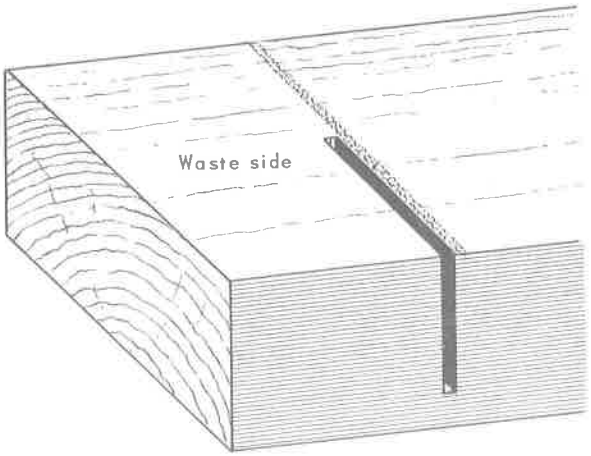
- Don't use a hammer that is "loose on the handle." Someone may be hurt.
- Don't use the side of the hammer to pound. The cheek (see diagram) is the weakest part of the hammerhead and may be broken.
- Don't use a hammer to pound a cold chisel or other hard metal objects.
- Careless handling ruins tools. Don't do it. Protect cutting edges. Keep tools where you can see the one that is needed.

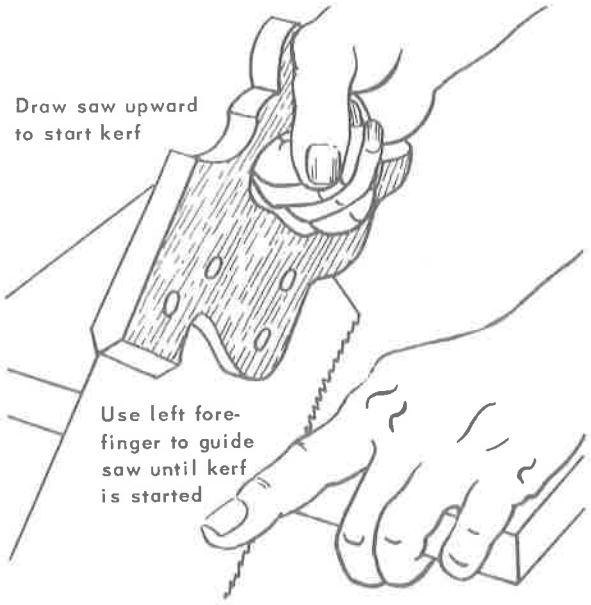

Careless handling ruins tools

THE HANDSAW is another useful tool. Two frequently used types of handsaws are the crosscut saw and the ripsaw. The crosscut saw cuts across the grain of the wood, with saw teeth like two rows of knife points. The wood is crumbled out between the cuts. Ripsaw teeth are chisel shaped and cut with the grain. They cut as a gang of chisels in a row. Saws are designated by the number of tooth points to the inch. A crosscut may have 8, 10, or 11. A ripsaw will have only 5, 5½, or 6. Usually you will find this number stamped on the blade near the handle.



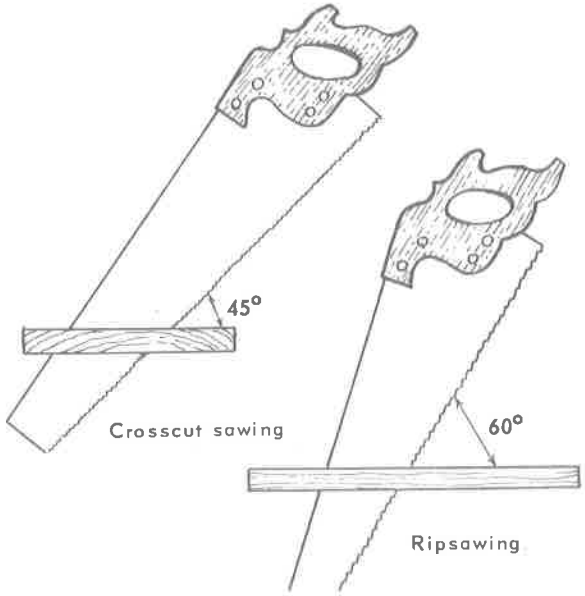
Kerf is the term carpenters use to describe the cut made by the saw. Keep the kerf on the waste side of the line—not on the line nor on the inside of the line. Saw with steady, long strokes, taking care not to "kink" the blade. It is easier to keep a saw straight that to straighten a crooked one.





To start the kerf, draw the saw toward you. Guide it with the forefinger of your left hand until the cut is deep enough to hold the saw steady. **Be careful.** The saw is designed to cut through hard wood; your finger is much softer.

Hold a ripsaw at a 60° angle to the work. If using a crosscut saw, hold it at a 45° angle. It takes practice to keep the cut square. The side of the saw should be square with the board. While learning, you can use a try square to check. You can guide the saw to

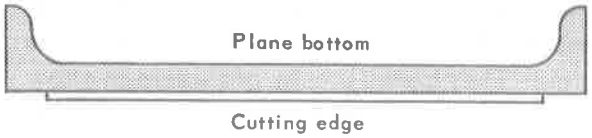


some extent by twisting it in the desired direction. Finish the cut with gentle strokes, holding the waste end of the work in position. If you let it fall, it probably will split or splinter your work.

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

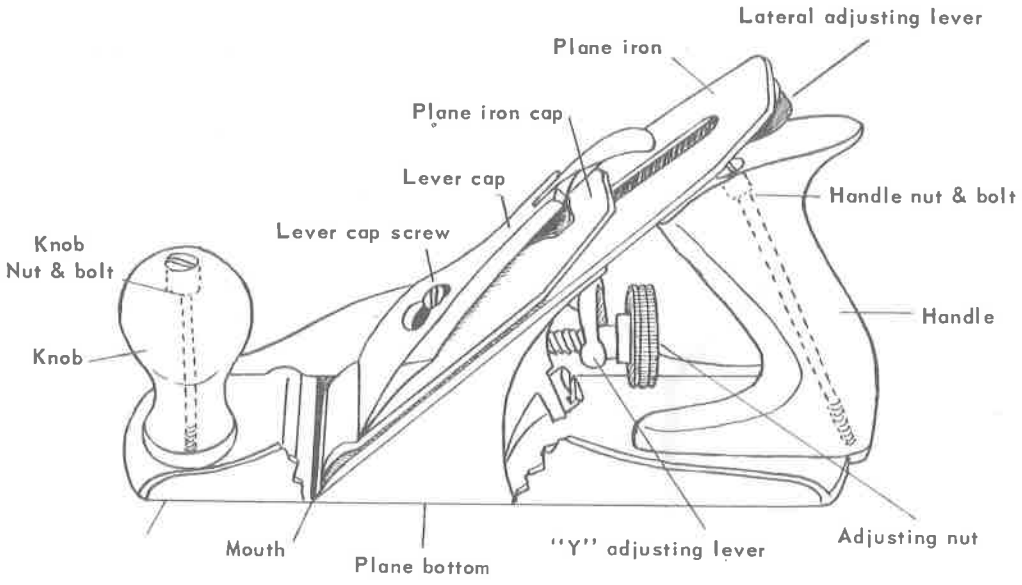
Watch out for nails. You may work with used lumber in your project. Be careful of hidden nails. They will break or dull teeth, ruining your saw. Examine used lumber carefully and remove all nails before you try to saw it.

A PLANE removes the rough and ridged surface left by sawing. It helps bring stock down to size when you need to remove only a fraction of an inch. To adjust the plane, bring the cutting edge just below the plane. (Note the illustration.) If one side of the cutting edge is lower than the other, use the lateral adjusting lever to even it. Try the plane. If the shaving is too thick or too thin, readjust until you reach a satisfactory thickness of cut.



When using your plane, push it straight ahead, keeping it square with the work. Press 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. Protect the cutting edge when using and storing your plane. When not in use, store your plane on one side, not in an upright position. If you can't store it to protect the cutting edge, use the adjusting nut to bring the edge above the plane bottom before you put it away.

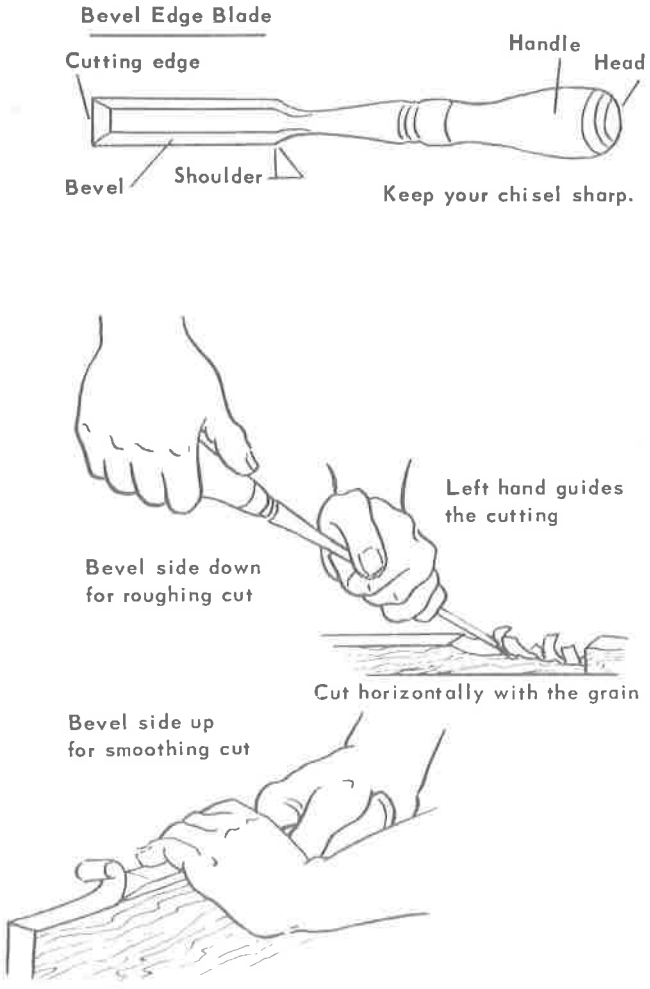
Plane



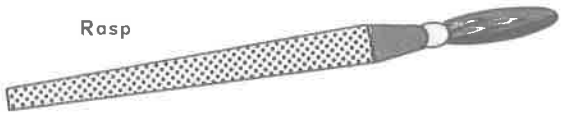
THE WOOD CHISEL may be regarded as a more primitive plane. Because its blade is unprotected, you can use it for routing (cutting grooves) and gouging. Be careful. The chisel is the most dangerous of woodworking tools. Always keep both hands on the chisel except when driving it with a mallet.

As with the plane, work with the grain whenever possible. Angle the blade slightly or move it from side to side as it moves forward. You'll find it cuts more smoothly and evenly. For most work, you will hold the bevel side up. For rough gouging, you may hold the bevel down.

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

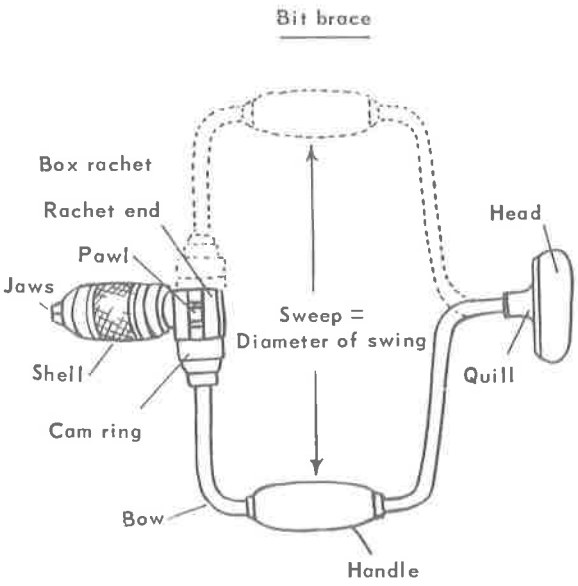


THE WOOD RASP is used for rough shaping a piece of wood. The rasp is used as a file with teethlike projections cutting the wood.

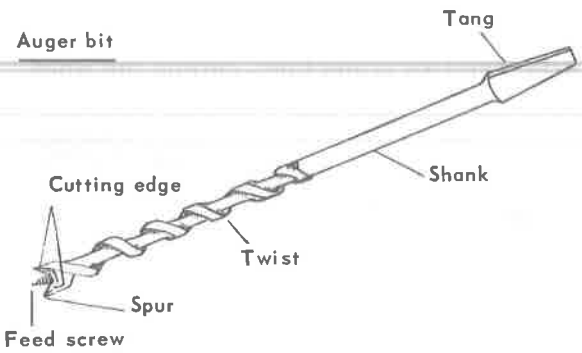


SAFETY TIP — Never use a rasp that has a tang without a handle.

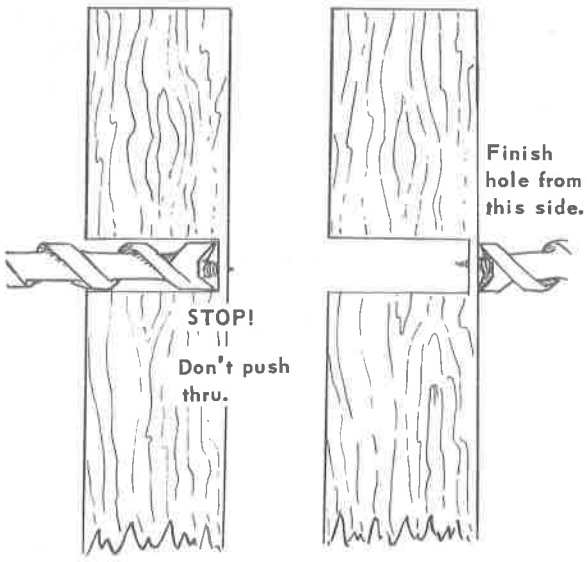
THE BIT BRACE is another tool woodworkers use often. Pictured is the rachet type which you can use in corners and tight places.



THE AUGER BIT is used for drilling wood. It varies in length from 7 to 10 inches. (Dowel bits are shorter.) Auger bits are sized by the number of sixteenths of an inch in the diameter. A bit marked No. 8 is $^{8}/_{16}$ inch (or ½ inch) in diameter. Twist bits are marked in the same way by thirty-seconds of an inch; No. 8 means $^{8}/_{32}$ inch or ¼ inch.

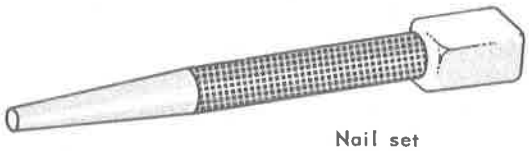


Practice drilling a few holes in scrap lumber. Take care to place the bit accurately when starting a hole. Mark the location clearly on the wood. Check with the try square to see that the hole is straight. To avoid splitting and splintering, drill from the opposite side as soon as the lead screw pushes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



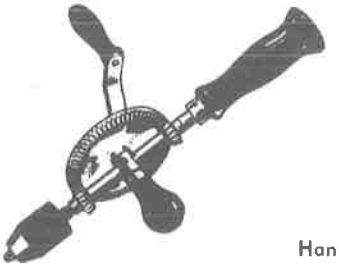
Store the bits to protect their cutting edges, spur, and lead screw. A good storage method is to drill a block of wood and keep the bits in holes.

THE NAIL SET. To drive nailheads below the surface of the wood, we can use a nail set or a slightly larger size nail. Finishing nails have small indentations that allow the use of a pointed nail set.



Nail set

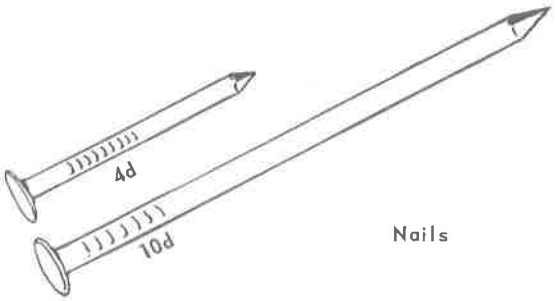
THE HAND DRILL works in the same way as an eggbeater. Cranking a geared side-wheel causes the drill to revolve, drilling a hole.



Hand drill

WOOD FASTENERS

NAILS are most widely used in joining wood because they are handy and fast. We figure nail size by the "penny" system, based originally on the weight of a silver penny. The penny number of a nail means it is equal in weight to that many silver pennies. The symbol for penny is the letter "d." Sizes range from 2 penny to 60 penny. Larger nails have larger numbers.



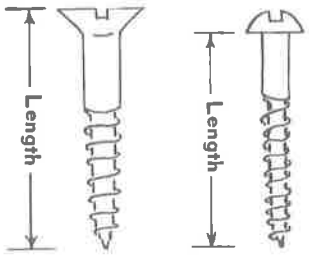
Nails

It's easy to remember the lengths of various sizes of nails through the 10-penny size, if you follow this rule: Divide the penny number by 4 and add ½ inch to obtain the length in inches. (For example, a 4d nail is 1½ inches long, and a 6d nail is 2 inches long.)

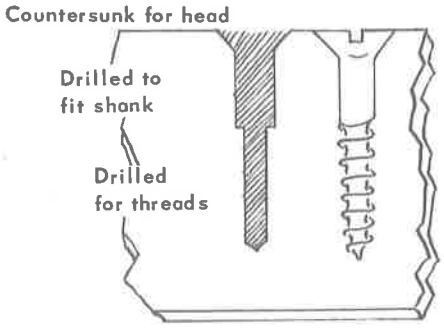
Certain types of nails do special jobs. Here are some different types of nails:

- **Common nails** are for general purposes—sheathing, flooring, framing, etc. The nails on page 10 are common nails.
- **Box nails** are lighter than common nails. They are used with light or easily split lumber because they are less apt to split the wood.
- **Finishing nails** are preferred when we don't want nailheads to show. Use a nail set to sink them below the surface of the wood. Then cover the heads with putty or plastic wood before you apply the finish.
- **Common brads** are similar to finishing nails. The small sizes frequently are used in fine assembly work, such as model making.
- **Shingle nails** are used for putting on roofing materials. They usually are coated with zinc to help them resist corrosion.
- **Corrugated fasteners** join the edges of boards together. Sometimes they are used to fasten the corners of screen frames—more often for repair work. Corrugated fasteners may have plain edges for hard wood and saw edges for soft wood. They are available in different sizes.

SCREWS make a much stronger joint than do nails, but they require more time and work. Two common types of wood screws are the flathead and the roundhead. The flathead screw can be countersunk to leave a smooth surface.



Screws



Most screws are steel. If you are making an item that will be exposed to severe weather or use, you may want a plated screw to avoid rust. Zinc, cadmium, and nickel are used for coating steel screws. We use brass screws to resist corrosion, salt water, and for decorative effects.

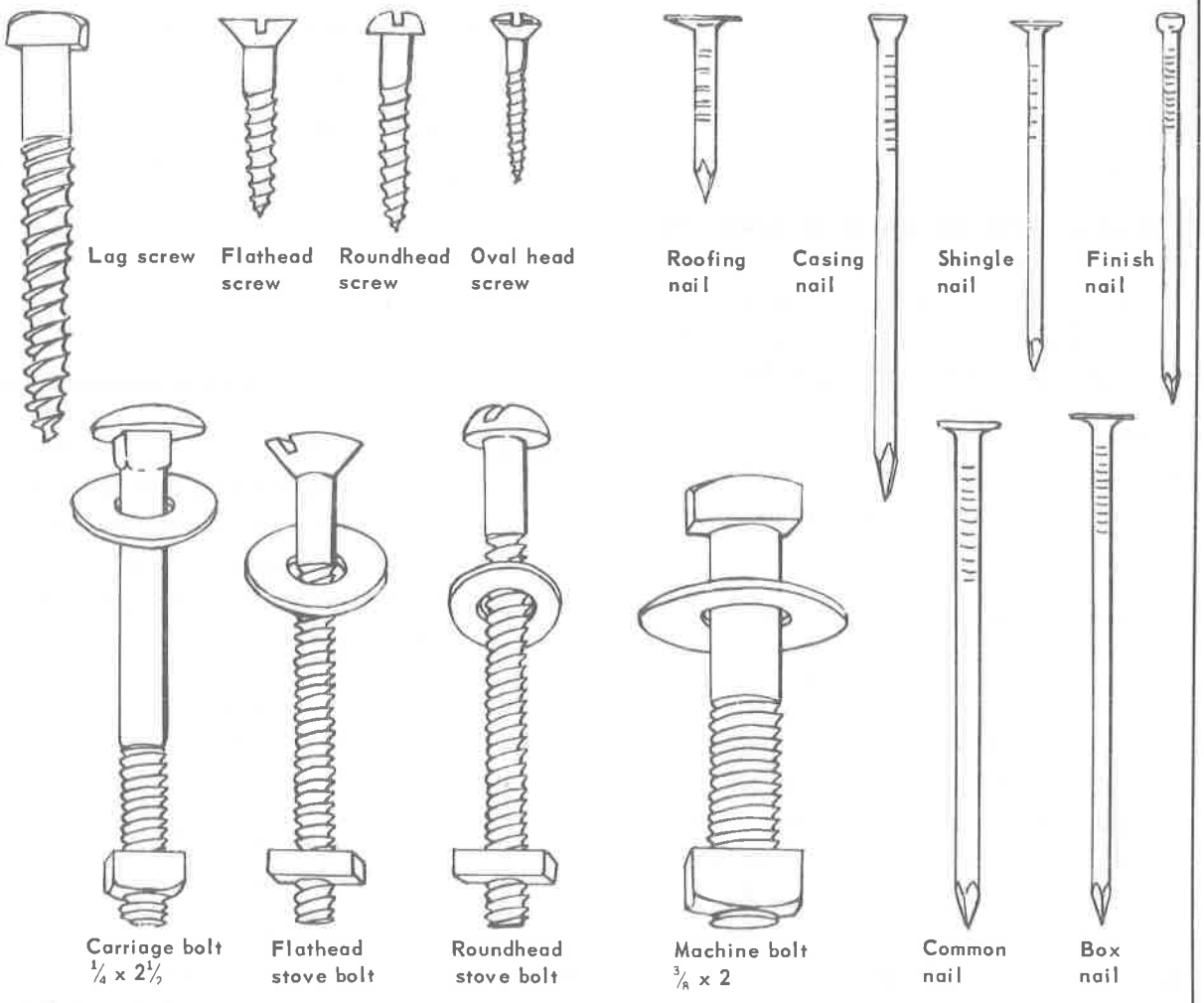
Use the following procedure to join two pieces of wood with screws:

- Select a bit for your hand drill equal in size to the shank of the screw. Use the hand drill to drill a hole equal in depth to the length of the shank.
- Use a bit slightly smaller than the diameter of the screw as measured between the threads. Make a hole equal in depth to the length of the screw.
- If you are using flathead screws, countersink for the heads. In soft wood, you may find that countersinking is not necessary.

- If you have many screws to drive, some sort of depth gauge is helpful. To make a depth gauge, drill a hole through a dowel so that it fits over the bit to be used. Cut off this dowel so that when it slides over the bit and against the chuck of the drill, only enough bit is exposed to drill the proper depth. Soap applied to the threads of the screw makes it much easier to drive in hard wood.

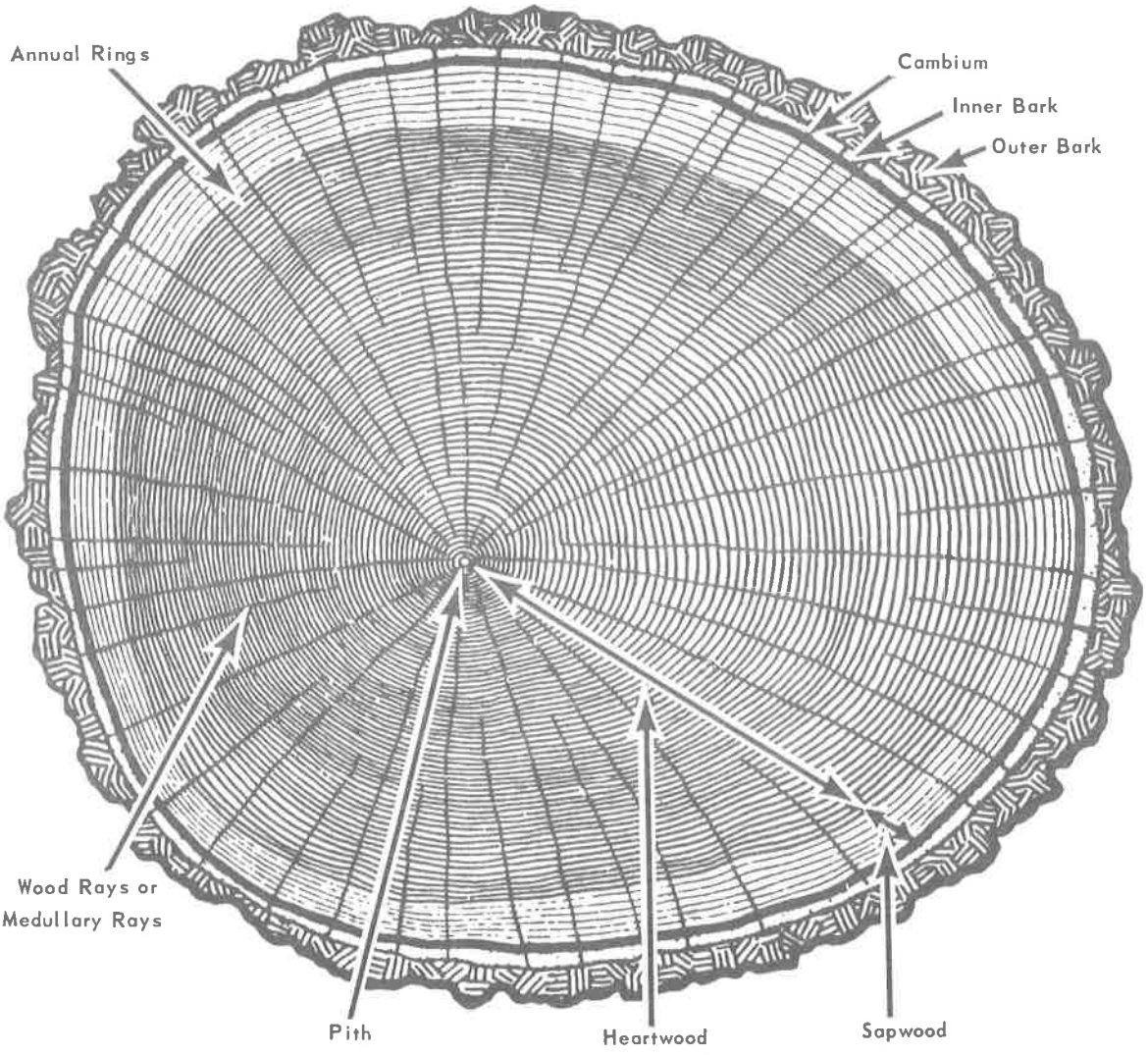
SAFETY TIP —
Throwing and catching tools cause injuries.

SOME COMMON WOOD FASTENERS



SAFETY TIP – Never put brads, tacks, or screws in your mouth. If you cough or stumble while they are in your mouth, you may swallow them. Screws and nails also carry germs and might cause infection in your mouth.

STRUCTURE OF WOOD



PITH is the soft core in the center of the tree. It may be round, oval, triangular, or more or less star shaped. It usually is less than ¼ inch in diameter.

HEARTWOOD surrounds the pith. Earlier in the life of the tree, it was sapwood. As the tree grew, the inner layers of sapwood turned into heartwood. As heartwood, it no longer contains living cells. Its chief function is to support the weight of the tree crown. The heartwood is generally darker in color than sapwood. The heartwood is more durable than the sapwood of the same species.

SAPWOOD, or outer layer of wood next to the bark, contains the living cells and reserve materials. The sapwood of most species is lighter colored than the heartwood.

CAMBIUM is a layer too thin to be seen with the naked eye. All growth in thickness of the bark and the wood takes place in the cambium. It is located between the sapwood and the bark.

INNER BARK is moist and soft. It carries prepared food from the leaves to all growing parts of the tree.

OUTER BARK is composed of dry dead cells. It protects the growing areas from external injuries and serves as insulation.

ANNUAL RINGS are the light and dark circles that appear on the cross section of a tree. They represent the growth layers a tree puts on in a single year. The light rings are composed of soft, thin-walled cells, formed as the cambium layer cells divide in the spring. The dark rings are composed of small, thick-walled cells formed during the slow summer growth. Therefore, an annual ring usually consists of one dark ring and one adjoining light, soft ring. By counting the rings on a log or stump, it is possible to tell the approximate age of a tree. Trees growing in a fully stocked mature forest will have narrower growth rings than the same species in a second-growth forest. The second-growth trees grow faster because they are younger and possibly have less competition.

WOOD RAYS or **MEDULLARY RAYS** are the strips of cells extending radially from the center of the tree to the bark. These rays conduct sap across the grain. In some species of wood, the rays are extremely small; in others, such as oak, they are very large and prominent.

KINDS OF WOODS

Wood probably is the most commonly used material in the world today. Lumber is more than just a piece of wood; it has taken years to grow and skill to shape. Unwise logging and the ravages of insects, fire, and storm have caused the great virgin forests of America to dwindle until only very small areas of the timberland now remain. Today we grow trees as a crop to furnish wood.

There are two general classes of wood — softwoods and hardwoods. Wood also is graded according to quality, with grades designating **finish uses,** where appearance is most important, and **structural and construction uses** where strength is the first requirement.

Hardwoods come from trees with broad leaves. Softwoods have needles and carry their seeds in cones. "Hardwoods" are not always harder than "softwoods." Cedar, fir, white pine, yellow pine, and redwood are classified as softwoods. We use softwoods for framing, foundations, siding, and other general construction. Some trees classed as hardwoods are oak, hickory, birch, black walnut, and maple. They are used for flooring, furniture, interior finishes, and cabinet work.

SOFTWOODS

CEDARS are fragrant softwoods. They include the eastern red cedar, northern white cedar, western red and yellow cedars. Eastern red cedar is a popular wood for lining closets and chests because moths dislike its odor. The heartwood of cedar is dark red. The sapwood is white. Cedar's many

knots add beauty to the wood, but make it difficult to plane. Cedar is best dressed (smoothed) with a cabinet scraper. The wood seasons (dries) rapidly. It shrinks and checks (cracks) very little, and the heartwood is durable for outside use. It is used as we use soft pine, but because cedar is so durable, we prefer it for shingles. The smaller trees are used for fenceposts and railroad ties.

DOUGLAS-FIR, a softwood, is one of the largest trees native to North America. It is the most frequently cut wood of commercial importance. Although it is distinctly a western species, it also is used in many parts of the Middle West and East for structural timbers, railway ties, rough and finished lumber, flooring, plywood, furniture, lath, tanks, and many other articles. The sapwood is white, and the freshly cut heartwood is light reddish yellow. When exposed to light and air it becomes distinctly reddish. Sometimes it turns cherry red or brown. The average fir lumber from the West Coast is strong, moderately hard, moderately heavy, and very stiff. It splits easily and is rather difficult to work with handtools.

REDWOOD, another softwood, is one of the largest trees known. It grows only in the extreme western part of the United States. Redwood is very durable in contact with soil and is widely used for flower boxes, fenceposts, water pipes, railway ties, and water tanks. It also is used for siding and shingles in home construction. Both the bark and the wood are cinnamon brown. The wood is light, soft, moderately strong, and easily worked with tools.

WHITE PINE is more in demand for carpentry and building than any other kind of wood. It is nearly white, lightweight, works easily, and warps little when properly seasoned. We use it in building and for doors and window frames. The heartwood is moderately durable in contact with soil and moisture. The heavier the wood, the darker, stronger, and harder it is, and the more it shrinks and checks. The cheaper grades of white pine are used for general carpentry.

YELLOW PINE grows in the southern part of the United States. It is used chiefly in building construction. Most of the commercial resin and turpentine of the U.S. come from longleaf and slash pines. Yellow pine is hard, and the summerwood portion of the annual rings is dark colored. It warps little and the heartwood is moderately durable. The grain usually is straight. The wood tends to split during nailing. It is used for house sills, foundation timbers, concrete forms, and also for heavy structures such as bridges, trestles, wharves, pilings, ship frames, and docks.

HARDWOODS

BIRCH grows best in northern United States and Canada. It is hard, tough, and elastic. Its heartwood is reddish brown, and the sapwood white. The wood is heavy, strong, of fine texture, and handsome with a satiny luster. The wood shrinks considerably in drying. It takes a good polish, but is not durable if exposed.

Birch is difficult to work because the grain is irregular and it is very hard. It takes a beautiful natural finish as well as a good stained finish. Birch is an excellent base for a white enameled surface. It may be stained to imitate mahogany, walnut, and maple.

MAPLE trees generally are divided into two main groups—hard and soft maple. The most common hard maple is sugar maple. Its sap is used for making maple sugar and maple

syrup. Soft maple is of lesser importance. Red and silver maple trees are classed as soft maple.

Hard maple wood is one of the most popular cabinet woods. It is light brown to white, with darker heartwood. Maple is either curly grained or straight. When hard maple contains a figure, it is called bird's-eye, landscape, or curly maple. It can take a high polish because of its fine, uniform texture. Although not easy to work, it can be brought to a good surface and will turn well on a lathe.

Hard maple grows best in the northeastern part of the United States. We use maple extensively for veneering, furniture, musical instruments, woodenware, tool handles, ships, bowling pins, athletic equipment, school apparatus, and millwork products such as flooring and fine interior trim.

WHITE OAK is grayish brown, with a reddish tinge and has an open grain (visible pores). The oak's medullary rays (streaks running out from the center of the logs) are very prominent. When the log is quartersawed, these rays produce an attractive flaky-looking surface. We use oak for interior finish, cabinetwork, furniture, flooring, implement parts, and heavy construction such as bridges and railroad ties.

White oak is strong, hard, tough, elastic, durable, beautiful in grain, and rather easy to work. Oak furniture is never out of style, and modern finishing methods have increased the demand for it.

BLACK WALNUT was used for fuel and fences during colonial times. Acres and acres of black walnut trees were wasted when land was cleared. Despite the fact that these trees were cut without regard for value or supply, there is enough black walnut growing in American forests, under proper control, to meet the demand for many years.

Black walnut is one of the finest and most beautiful of hardwoods. This ideal American cabinet wood is noted for its rich color, fine grain, durability, and beauty. It grows mainly in the eastern half of the United States and requires a deep, rich soil. Stump and burl walnut are very valuable for veneers and panel work. More walnut is used for fine furniture than any other wood.

The heartwood of black walnut is rich, chocolate brown. It does not warp or check when properly seasoned. The wood is heavy, brittle, hard, strong, and coarse grained. The sapwood is pale brown and must be artificially darkened to match the heartwood. Walnut is used for fine furniture, cabinets, interior trim, gunstocks, airplane propellors, musical instruments, fine boats, and many other articles.

PLYWOOD

CONSTRUCTION of all plywood is based on veneer. Veneer is a thin sheet of wood made by one of three methods. The rotary cut method is 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 by a big lathe. Sliced veneer is produced by moving a log, bolt, or portion of same against a large knife to remove thin slices. Sawed veneer is produced by sawing thin slices from a log, bolt, or a portion of same.

The thickness of veneer varies greatly. Common thicknesses are from $\frac{1}{32}$ inch to $\frac{3}{16}$ inch, and a slice $\frac{1}{200}$ inch thick is possible.

Plywood is made by gluing together three, five, or any odd number of layers (plies). The alternate layers of veneer have the grain at right angles to each other. This odd number of plies, with grains in opposite direc-

tions, gives the product a balanced construction. This tends to eliminate warping, shrinking, and expanding of the plywood.

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

Veneer core plywood

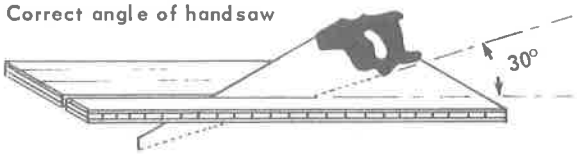
Lumber core plywood

Plywood is constantly being adapted to a greater variety of uses. It is used extensively in building construction, wall paneling, drawers, doors, cabinets, and furniture.

HINTS FOR USING PLYWOOD will help you construct wood articles successfully. Follow these suggestions when using plywood on articles that require a fine degree of craftsmanship.

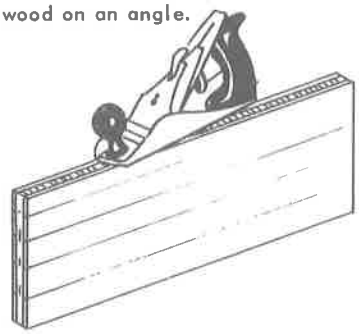
- Use only those types of plywood that the manufacturer recommends. For example, use only plywoods designed for exterior use where the wood will be subject to the weather.
- Use a fine-toothed handsaw whether sawing with or across the grain of the face, or good side. Have the face of the panel up and hold the saw at a low angle (about 30 degrees).

Correct angle of handsaw



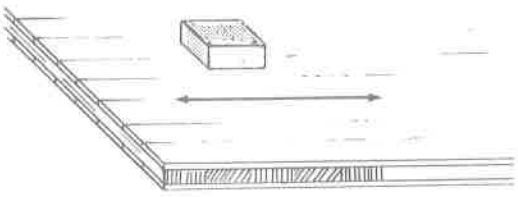
- To plane the edge of plywood, use a plane with a low angle blade, such as the block plane. Hold the plane in an angled position as it runs along the plywood edge. Never plane off the end of an edge; turn the plane around and start at the other edge.

Plane plywood on an angle.

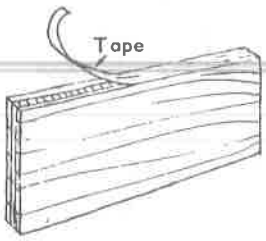


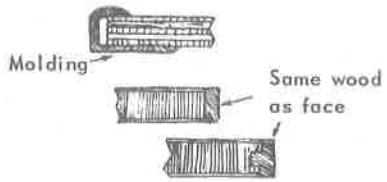
- When sanding plywood, always move the sandpaper in the direction of the grain. If you sandpaper across the grain, it will leave scratches on the surface. To obtain a fine finishing surface, start with medium sandpaper and follow with fine sandpaper. Many plywoods are pre-sanded at the mill. These require only light sanding with fine sandpaper before applying a finish.

Sand with grain of wood



- With a little more effort, you can make more attractive the visible edges of the plywood. Some commercial concerns sell easily applied cap moldings. However, they extend over the edge onto the face and back. This is objectionable in many places. Also available is woodlike tape to apply 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.





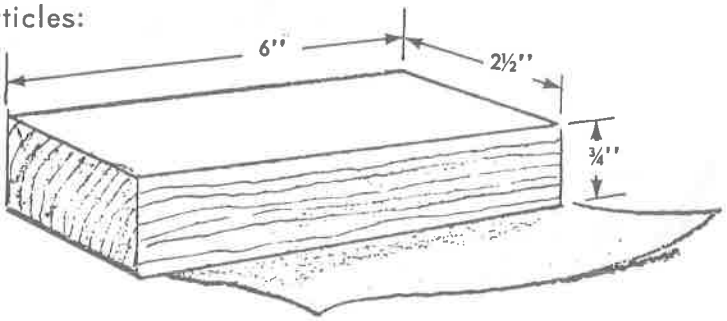
WORKING DRAWINGS

Make one of the following two articles:

SANDPAPER BLOCK

Material:

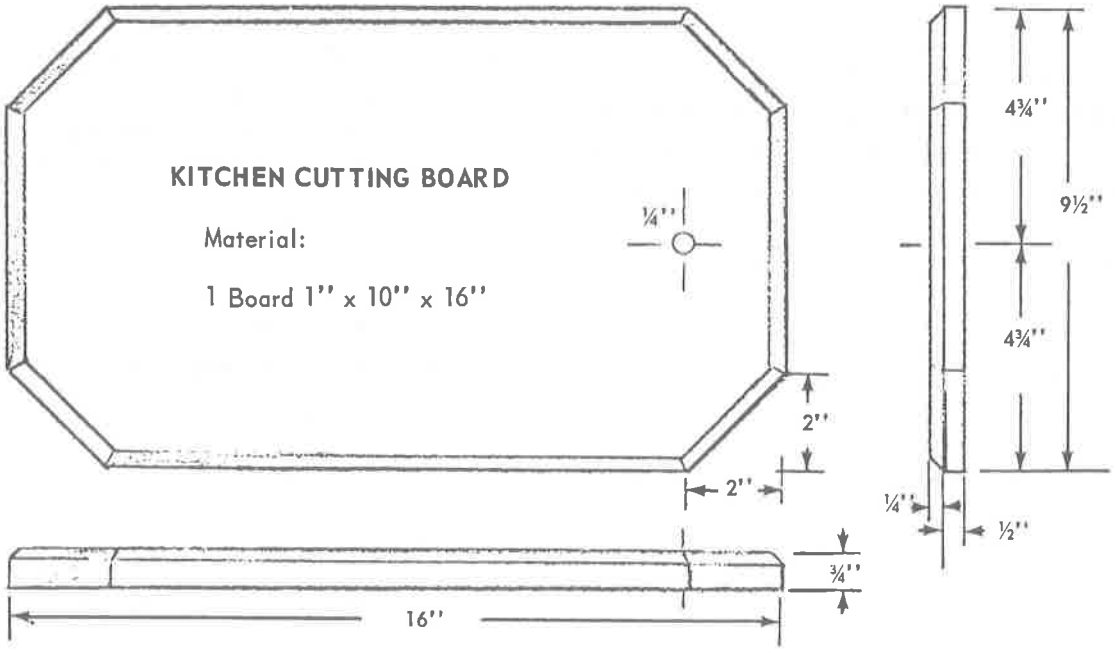
1 Board 1" x 3" x 6"
¼ Sheet sandpaper



KITCHEN CUTTING BOARD

Material:

1 Board 1" x 10" x 16"

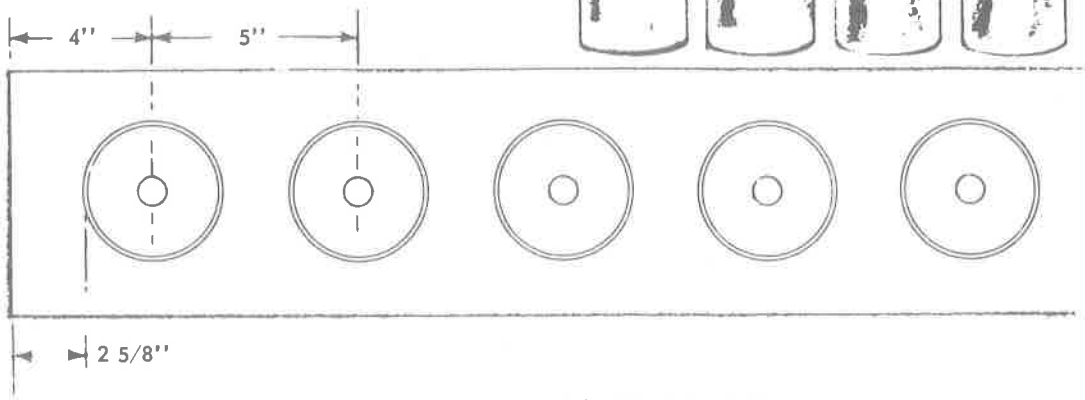


Make one of the following three articles:

BOLT AND SCREW RACK

Material:

1 Board 1" x 4"
Roundhead screws
Jars with lids



Screw lids of pint jars onto underside of storage shelf, and screw jars into lids.

TOOLHOLDER

See page 4. Use dimensions to suit your shopbench.

HARDWARE DISPLAY BOARD

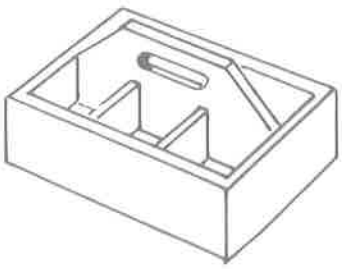
See the sketch on page 12. Plan to display at least 14 different kinds of wood fasteners. To fasten each nail, screw, or bolt, drill a small hole in the display board and tie the items to the board with fine cooper wire. Label each item.

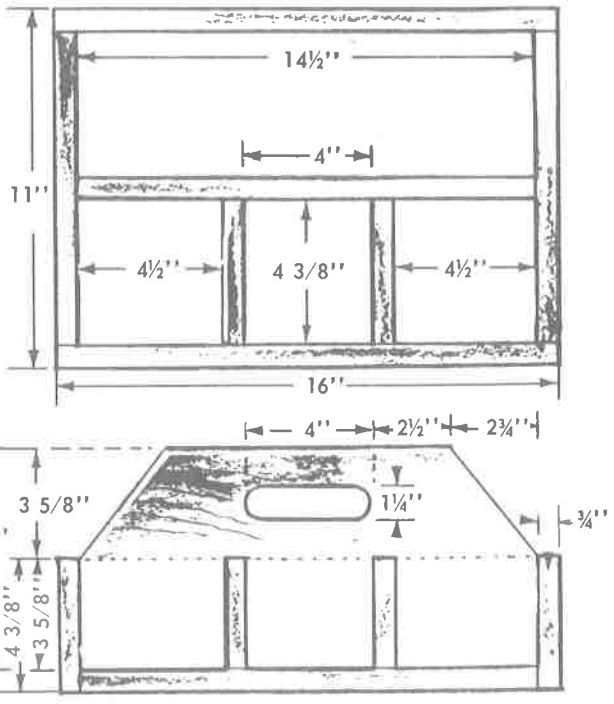
Make two of the following six articles:

TOOL AND NAIL BOX

Material:

1 Board 1" x 12" x 17"
1 Board 1" x 4" x 10"
1 Board 1" x 6" x 54"
1 Board 1" x 10" x 15"
Nails or screws

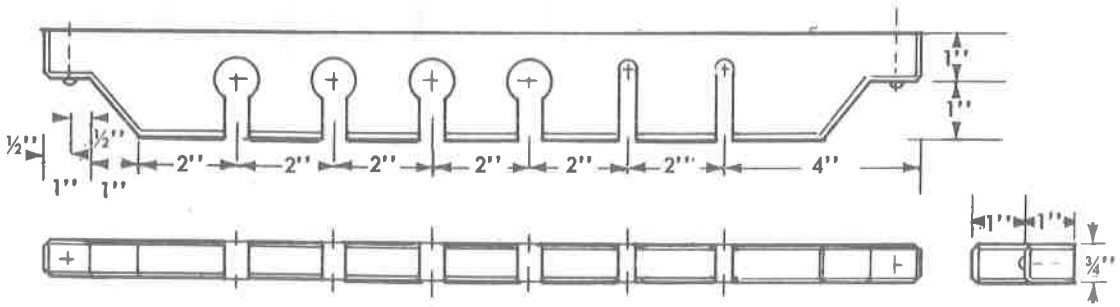




TOOLRACK

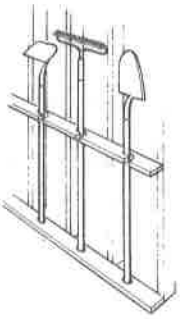
Material:

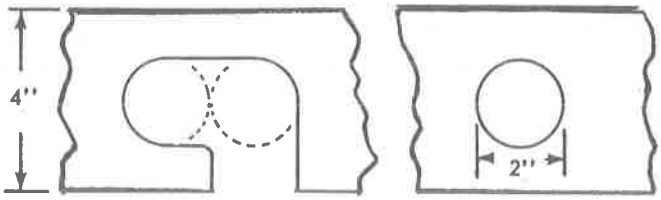
1 Board 1" x 2¼" x 18" (oversized dimensions of rough piece for square cutting and planing)
2 Roundhead screws, #6, 1½" long



HOE RACK

Hoes, rakes, spades, and brooms stay out of the way and within easy reach in notches made in rack close to wall.

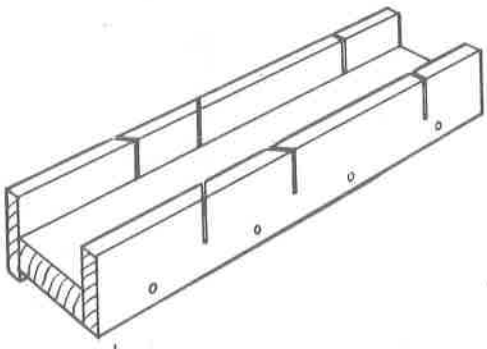


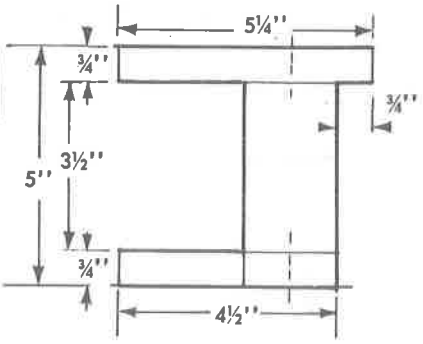


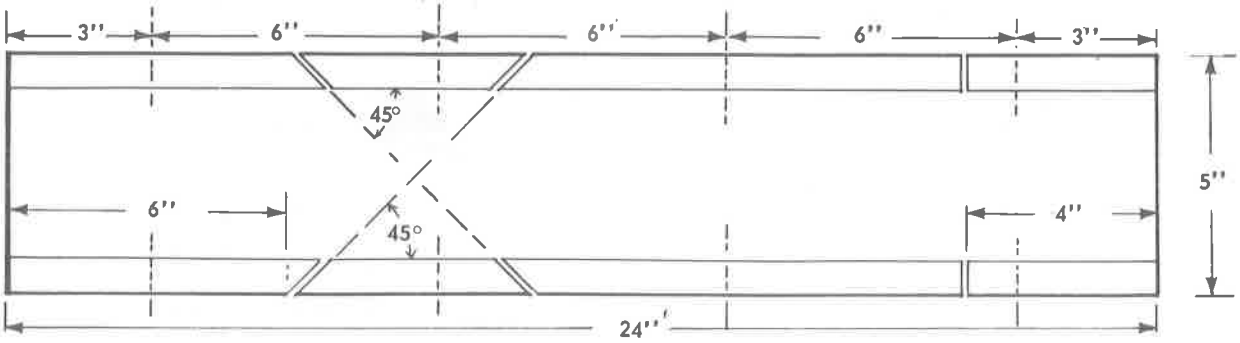
MITER BOX

Material:

2 Boards 1" x 6" x 24"
1 Board 2" x 4" x 24"
8 Flathead screws, #8



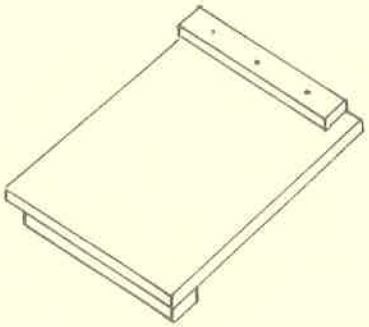


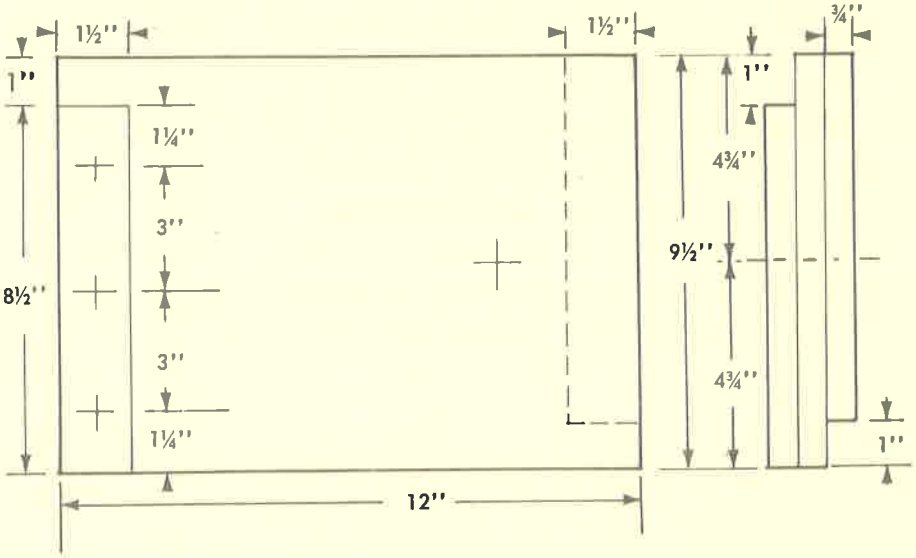


BENCH HOOK

Material:

2 Boards 1" x 2" x 8½"
1 Board 1" x 10" x 12"
6 Flathead screws, #4, 1¼" long

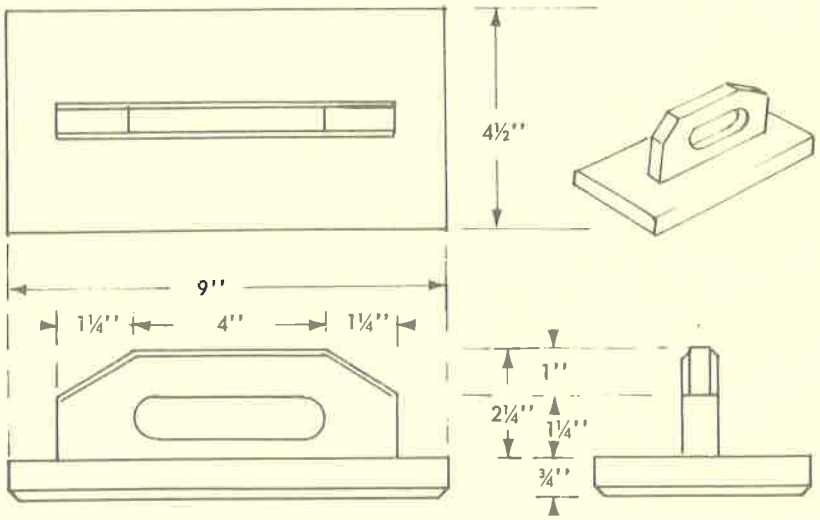




CONCRETE FLOAT

Material:

1 Board 1" x 9" x 4½"
1 Board 1" x 7" x 2¼"



DEMONSTRATIONS

Demonstrations are fun. A demonstration is a good and easy way for you to tell your friends what you are learning in the Agricultural Engineering Project. A demonstration puts words into actions. It may show how to make something or how to do something—the main thing is, you are **showing how** to make it easier for your friends to understand as you are **telling how.**

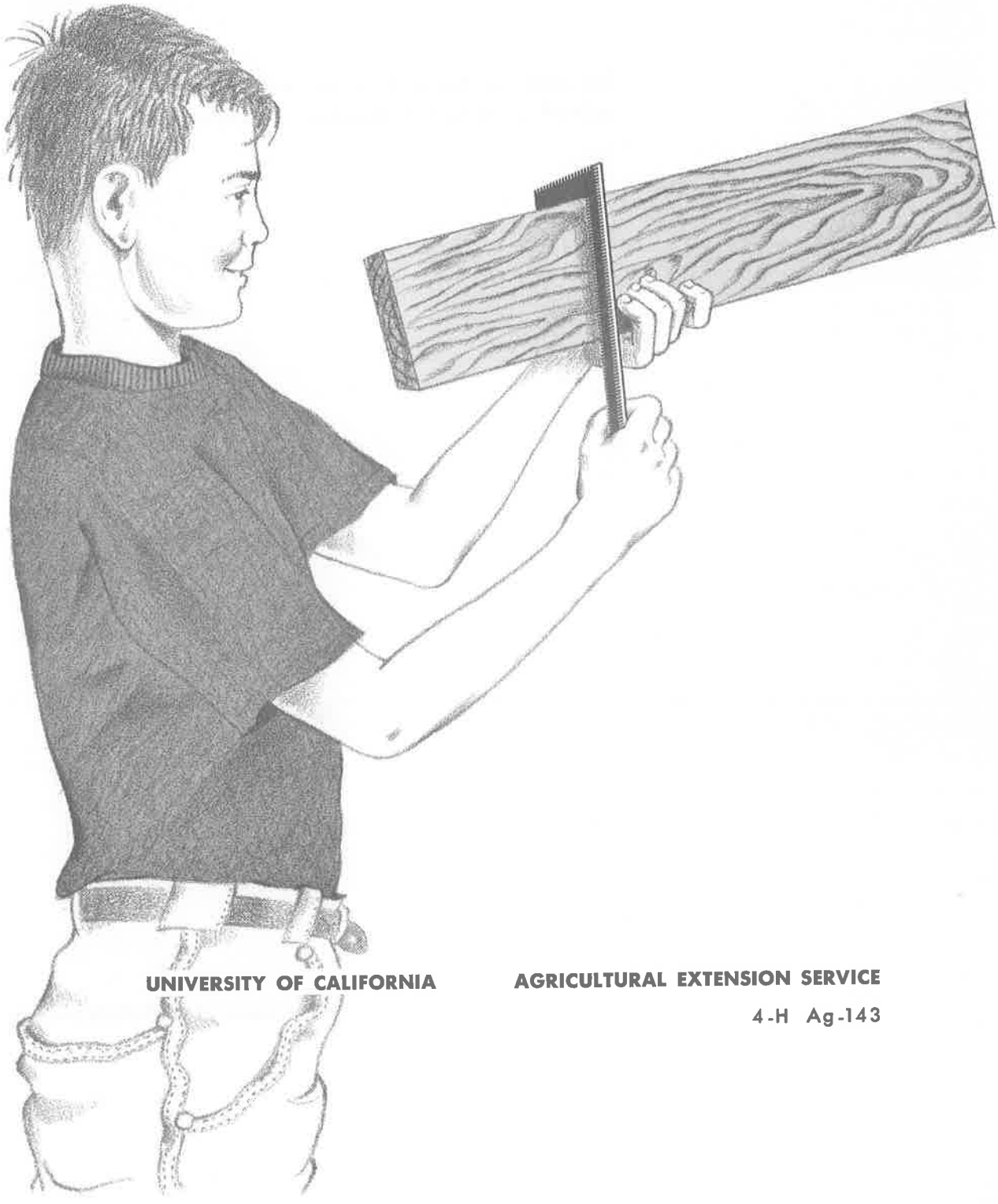
You will want to use the 4-H demonstration manual To Show How You Must Have the "Know Hows" of 4-H Demonstration to help you plan your demonstration. Your 4-H leader and farm and home advisors can advise you in preparing demonstrations.

Start by choosing a subject that you like and that is interesting to others. The skills you are acquiring in this project will make excellent topics for demonstrations. Here are a few:

- Proper use of tools
- Care of tools
- Sawing a straight line
- Use of wood fasteners
- Drilling holes
- Grades, kinds, and uses of woods
- Safety tips in using tools
- Pulling or driving nails
- Steps in constructing a project from wood

WOODWORKING PROJECT UNIT II

MECHANICAL SCIENCE



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4-H Ag-143

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assisted by Bernard C. Downing, 4-H Club specialist.

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George B. Alcorn, Director, California Agricultural Extension Service.

JANUARY 1967

WOODWORKING PROJECT UNIT II

MECHANICAL SCIENCE

In this unit you will learn some new skills and practice those you already know. The plans in this unit are designed to help you learn new ways of working with wood. You may select other items to make, if your leader agrees that they will help you learn the same kinds of skills.

The things you learn in this project can help you in many other projects—electricity, livestock, crops, and home furnishing—as well as help you improve your home or ranch.

THINGS TO LEARN

- How to read a drawing
- How to make a simple working drawing of an item you plan to make
- Preparing a list of materials for each item made
- How to measure and mark wood
- How to buy lumber
- How to use four kinds of wood fasteners
- How to use and care for:

  Carpenter's rule and tape
  Miter box
  Backsaw
  Coping or jigsaw
  Electric drill and orbital sander
  Block plane
  Sandpaper block
  Paintbrushes
- How to prepare wood surfaces for finishing, including puttying, sanding, and cleaning
- How to apply oils, stains, primer paints, and finish paints and varnishes

THINGS TO MAKE

Select two items from this group:

- Utility stool
- Spice rack
- Drawer dividers
- Kitchen vertical dividers
- Knife rack
- Kitchen half shelves
- Sleeveboard

Select one item from this group:

- Toolbox
- Tool cabinet
- Sheep-blocking table
- Show box--small
- Chair and step stool
- Garden trellis
- Storage unit of your choice

THINGS TO DO

- Exhibit items made in this project.
- Give one or more demonstrations.
- Keep up-to-date project records.

HOW TO READ A DRAWING

Each line in a 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 and makes it easier to read. If all lines are the same thickness, the drawing has a flat appearance and is hard to read.

Here are the kinds of lines you'll find in working drawings.

Visible outlines are heavy, solid lines that show the outline of an object and the corners and edges that 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 ends. They are used to show distance between two points. ←—3/8"—→

Invisible lines are short-dash lines, showing outlines hidden from view. – – – – – –

HOW TO TELL SIZE

It usually is impossible to make the drawings as large as the full size of the article to be made. Therefore, it is necessary to use a scale drawing smaller than actual size. The plans used in this manual are reduced scale drawings, with full-size dimensions given.

Dimensions are given in feet, inches, or a combination of the two. For example, 16 inches as 1 ft. 4 in. or as 1' 4".

The drawings in figure 2 show the different methods used in dimensioning lines, arcs, and circles. You also will find these symbols:
R = radius D = diameter ° = degree

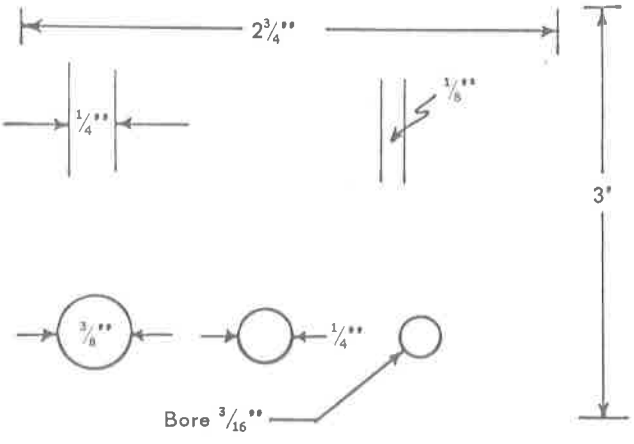


Figure 1.

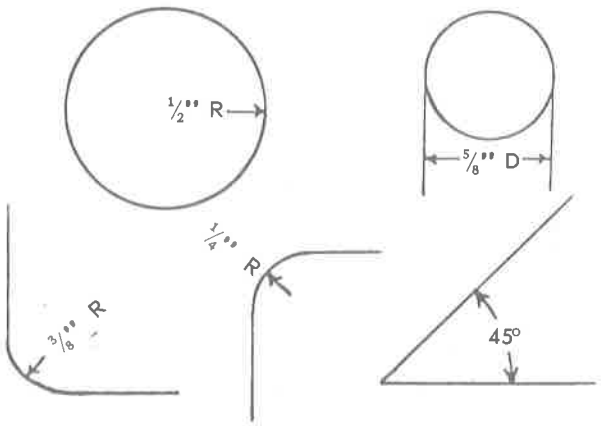


Figure 2.

LET'S READ A DRAWING

Before starting to build, we must know how to read a drawing or a picture of what we are going to make. A working drawing is a group of views of an object that show what the object is like. These views also give the dimensions such as width, length, height, and thickness of the various parts.

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

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

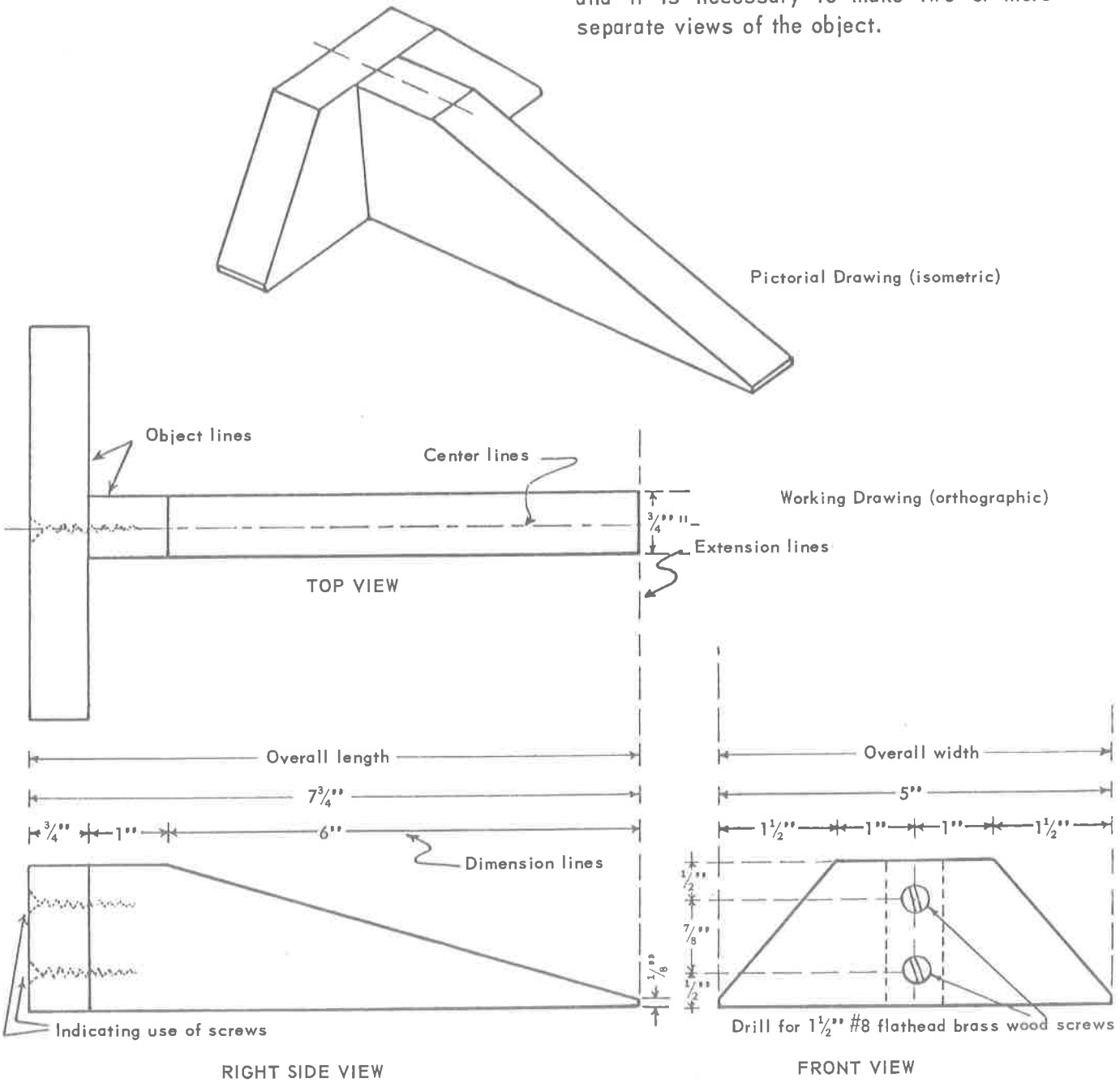


Figure 3.

HOW TO MAKE A WORKING DRAWING

To build an item, we need to know the length, width, and height of each piece and of the whole item. Here is a picture of a simple toolbox. We have added the dimensions for your use. Normally, the first step is to draw a plan view of the top of the item, showing all dimensions.

Before you start to draw, pick a scale for your drawing. If you let ⅛ inch on your drawing equal 1 inch on the box, your drawing will fit on a piece of paper. See the pictures of the doorstop under "How To Read a Drawing." This is to a scale of ½" =1'.

Put the top view at the top, left-hand side of your paper, and square with the paper. This shows the length and width of the box. Next, draw a side view just below the top view. This will show the height of the pieces and the thickness of the handle. Draw an end view just to the right of the side view. This shows the angle cuts and where to drill the hole for the handle. This drawing also shows that the bottom of the box is inside the sides and ends. Now, turn to page 26 and see if your drawing looks like the one shown.

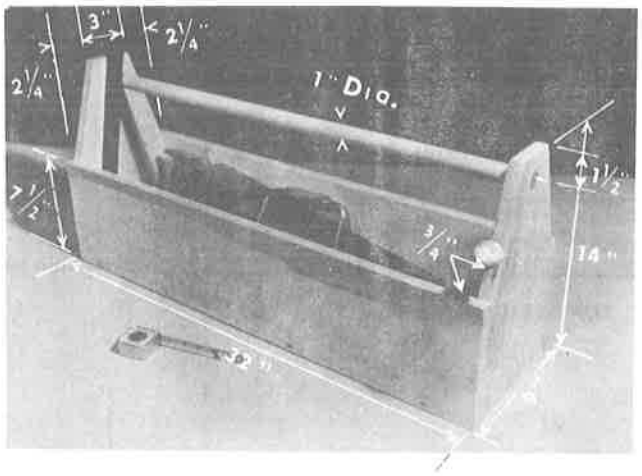


Figure 4.

PREPARING A MATERIALS LIST

In Unit I of this project, each plan had a list of materials. In this unit, you will learn to prepare your own lists. Let's take the doorstop as an example. For this simple item, you need one piece of wood 7 inches long, and one 5 inches long. Both pieces are ¾ inch thick and 1⅞ inches wide, so a piece of 1" x 2" (which is really about ¾" x 1⅞") 1 foot long will make both pieces. You also have two flathead screws 1½ inches long. Your materials list would look like this:

1 pc 1" x 2" x 12"
2 #8 x 1½" flathead wood screws

MEASURING AND MARKING WOOD

To avoid confusion, you should know a few terms used in carpentry and woodworking.

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 on page 9 under "How To Buy Lumber."

When squaring stock, follow this procedure:

1. Select a **working face.** For accurate work, plane this face true and smooth. Don't depend on your eye—check for high spots with a bench rule or the blade of your trysquare. When you have it true, mark with a pencil.

2. Select a **working edge.** Plane this true, using your trysquare to square it with the working face. Mark this edge.

3. Square and mark a **working end.**

4. Measure the desired length from the working end. Saw to length. Remember to saw on the waste side of the line, leaving part of the line on the work.

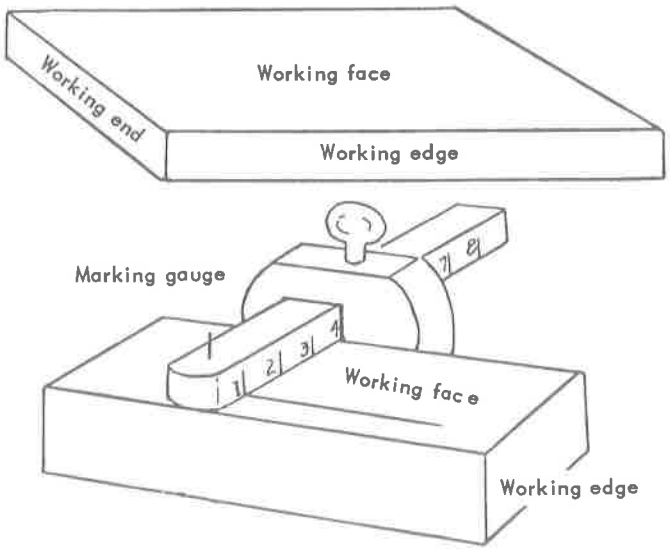


Figure 5.

5. Mark the stock to proper width, measuring from the working edge. A marking gauge will help you here. Saw and/or plane to width.

6. Measure the thickness from the working face. Plane to line.

Much of the quality of your work depends on the care with which you perform the preceding steps. Check often with the trysquare, and watch the line to which you are planing.

USING YOUR RULE

You may use a desk rule or ruler, a yardstick, square, folding rule, or steel tape. They all are divided into inches, and the inches are divided into smaller parts.

Study your rule carefully. Find the long mark that separates one inch from another. Find the numbers that tell how many inches from the end of the rule. Note the location of this number in relation to the inch mark. Sometimes it is below the mark. Sometimes a two-digit number, such as 11, has one number on each side of the mark.

Find the long mark at the center of the inch. This is the one-half-inch mark. It may be the same length as the inch mark, or just a little shorter.

The half inch (½) is divided in two to form quarter inches (¼). There are four ¼-inch units in an inch.

The ¼ inch is divided to form one-eighth-inch (⅛) units. There are eight ⅛-inch units in each inch.

The ⅛-inch units are divided in half to form units one-sixteenth ($\frac{1}{16}$) inch long.

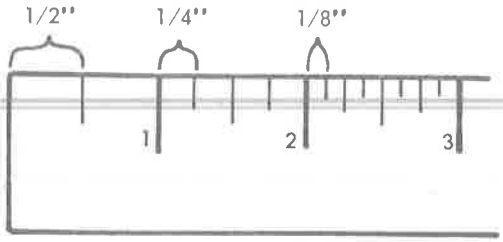


Figure 6. A rule divided into $\frac{1}{8}$-inch units.

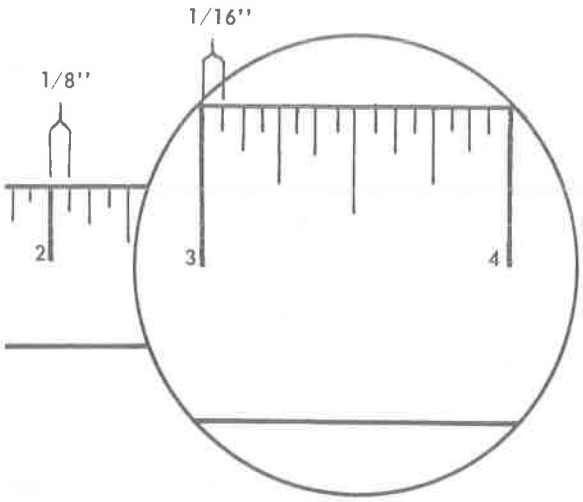


Figure 7. Section of rule enlarged to show $\frac{1}{16}$-inch divisions.

Some squares will have the inch divided into 12 parts instead of 16. Locate the following points on your rule or square: 2", 5", $7\frac{1}{2}$", $3\frac{1}{4}$", $8\frac{3}{4}$", $6\frac{1}{8}$", $\frac{5}{8}$", and $10\frac{3}{16}$". If you have trouble, ask your parents or leader to help you.

The unit of measurement larger than an inch is a foot. There are 12 inches to a foot. Some 6-foot rules number the inches from 1 to 72. Others number the inches 1 to 11, then the next number will be 1 foot, then 1-1, meaning 1 foot, 1 inch (13 inches).

Use a long rule when measuring long distances. Moving a short rule increases the chance of mistakes.

When making accurate measurements, place your rule on edge, and mark the distance with a sharp-pointed pencil.

Since rulers often become worn on the ends, you can measure more accurately by measuring from the 1-inch mark than from the end.

You also can use your ruler to divide a board into two, three, or more, even parts. For instance, if your board is 4 inches wide and you want to divide it in thirds, put the 2-inch mark on one edge of the board and the 8-inch mark on the other edge.

Figure 8.

Make a mark <u>on the board</u> at the 4-inch and 6-inch points on the ruler. Move your ruler to the other end of the board and repeat. Draw connecting lines, and your board is divided into three equal pieces.

Figure 9.

Place the rule flat for a measurement that does not have to be exactly accurate. Mark with a medium-soft pencil.

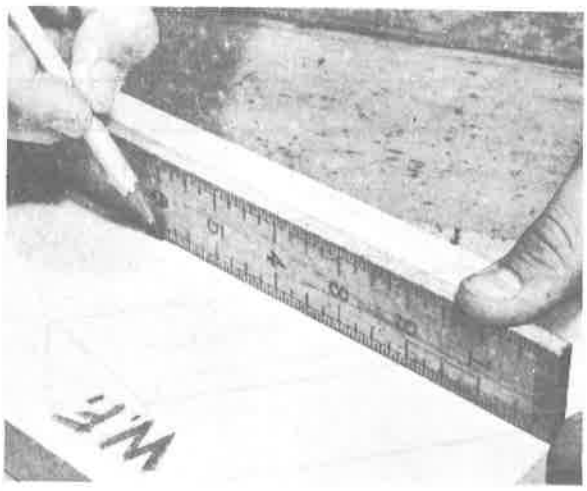


Figure 10. Measuring with rule on edge

USING YOUR SQUARE

Reading the inch marks on the square is the same as reading them on a rule. If you are having trouble, read the part about using your rule.

When a piece is to be cut from the end of a board, a line must be squared across its surface at the point marked. Use this line as a guide to get a square cut with the saw. It will help if you join this line with squared lines across the edges. Some people also square a line across the back of the board.

Figure 11. Squaring a line across a board with a utility square.

Either the trysquare, steel combination square, utility square, or framing square may be used.

1. Place the handle of the trysquare firmly against the straightest edge of the board. Hold the square tightly and mark along the blade with a sharp-pointed pencil. Press firmly with the pencil so it makes a clear line the first time. Do not mark over it a second time.

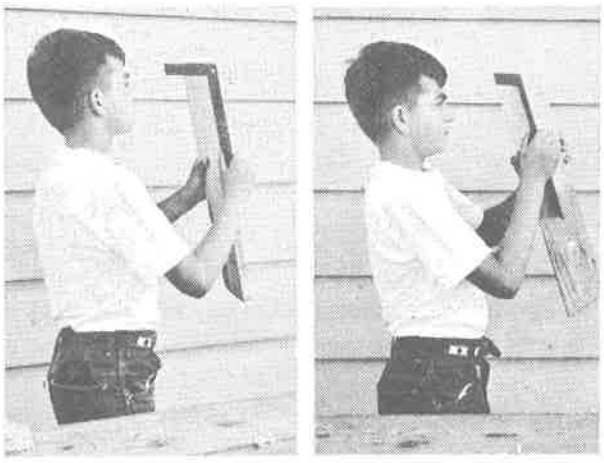


Figure 12. Use your square to check the squareness of the board.

2. From the surface, square lines across the edges.

3. To make the square line across the back, hold the square handle against the same edge as when you made the first mark.

Test the squareness of your saw cuts crosswise and edgewise of the board. If you can see daylight between the square and the board, the cut is not square.

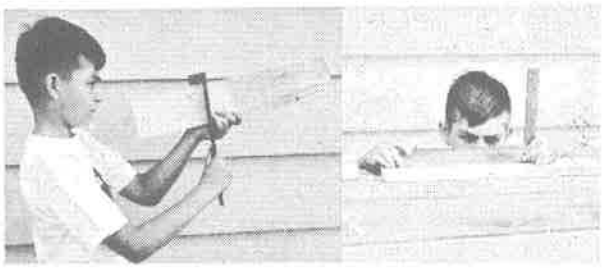


Figure 13. Use the edge of your square to check your board for straightness and flatness.

STEEL SQUARE

Most steel squares (also called framing squares) have blades 24 inches long and 2 inches wide. The tongue is 16 inches long and 1½ inches wide.

The blade of the framing square is divided into halves, quarters, eighths, sixteenths, and thirty-seconds. Some have smaller divisions per inch than others. One side of the blade will show 12 divisions per inch. Become familiar with the different scales on the square.

The steel or framing square has many uses. In addition to measuring lengths and laying off or checking right angles, it often is used to measure or duplicate various angles.

When cutting angles, take the readings as large as convenient to insure accuracy. A setting of 12 and 6 will be more accurate than 6 and 3 or 2 and 1.

Rafter angles can be laid out, using the rise and run in feet reduced to inches on the square.

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

After selecting your project, study the working drawings until you know what you are going to do. If you chose a project from this manual, you will find the steps of construction outlined for you.

Select the material. Lay out the work. Doublecheck your measurements. If you do not understand the drawing, ask your leader to help you. Don't saw until sure.

Work carefully. Remember that you can cut a board down with a plane, but you can't stretch it.

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

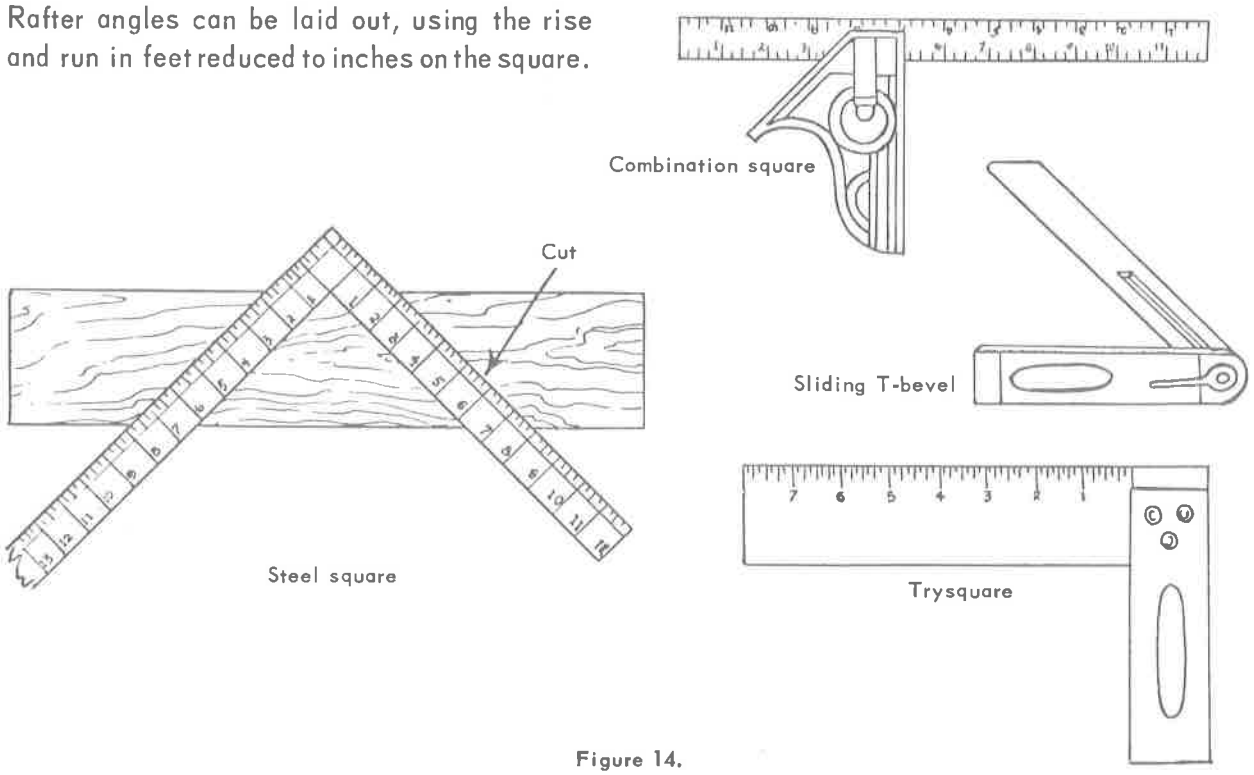


Figure 14.

HOW TO BUY LUMBER

Lumber comes in standard sizes. Softwood comes in thicknesses of 1 to 3 inches, widths of 1 to 12 inches, lengths of 8 to 20 feet, and in multiples of 2 feet.

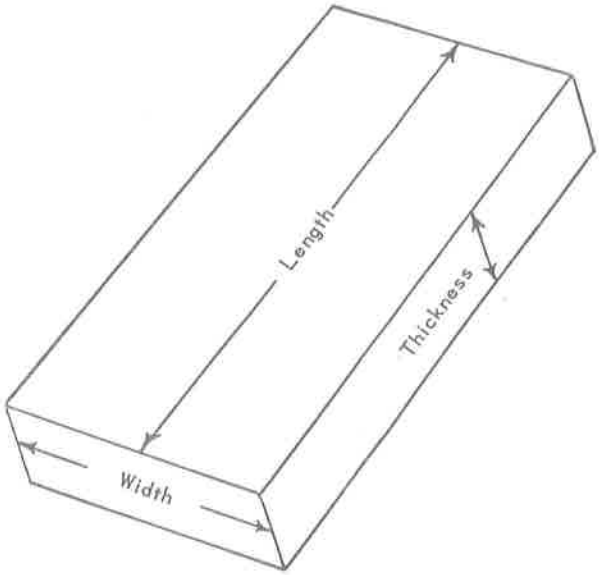


Figure 15.

Most lumber is sold by board measure. The unit of board measure is a board foot, which is equal to a board 1" x 12" x 12". Each piece of lumber below contains 1 square foot, or 144 cubic inches.

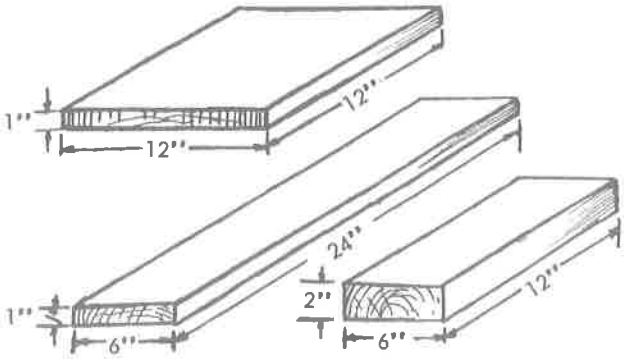


Figure 16.

Square foot measure = width in feet x length in feet

One square (roof) = 100 square feet (10' x 10')

Lumber is usually purchased--

1. Per thousand (M) board feet
2. Per running foot
3. Per square foot
4. Per bundle (shingles, lath, etc.)

Lumber usually comes in even lengths--
8' 10' 12' 14' 16'

Sq ft	=	square foot
Bd ft	=	board foot
pc	=	piece(s)
1"	=	1 inch
1'	=	1 foot
x	=	by
M	=	1,000
s2s	=	surface 2 sides
s4s	=	surface 4 sides

Two simple formulas are used in figuring board feet. The first is used when the length is given in feet:

$$\frac{\text{T" (thickness)} \times \text{W" (width)} \times \text{L' (length)}}{12} = \text{board feet}$$

When the length is given in inches, the following formula is used:

$$\frac{\text{T" (thickness)} \times \text{W" (width)} \times \text{L" (length)}}{144} = \text{board feet}$$

Either of these formulas can be used. Remember to divide by 12 if the length is given in feet, or divide by 144 if the length is given in inches.

To find the cost of a piece of pine lumber 1" x 6" x 8', first determine the board feet. Then multiply this times the cost. Let's try it at $300 per 1,000 board feet, which often is written $300 per M. This is the same as 30 cents per board foot.

1. $\frac{T'' \times W'' \times L'}{12}$ = board feet

$\frac{1'' \times 6'' \times 8'}{12}$ = 4 board feet

2. 4 board feet x 30¢ per foot = $1.20

Can you figure the board feet in a 1" x 8" x 12'; a 2" x 4" x 8'; and a 2" x 6" x 10'?

Lumber is either rough or surfaced. If it is surfaced on two sides, it is known as s2s. If all sides are surfaced, it is s4s.

When you buy a 1-inch finished board, you'll find it measures only ⅞ inch in thickness. The board was 1 inch thick when it came from the sawmill. But it was planed to take off the sawmarks and make it smooth on both sides, reducing it to ⅞ inch in thickness. Width also is reduced by planing. Length, however, will be the same or a little more than you order. Some materials, such as plywood and pressed board, will have the same thickness, width, and length you order.

Width. Below are "nominal" or rough-lumber widths, and the widths the finished lumber (dressed) will be.

1" dressed to ¾"	8" dressed to 7½"
2" dressed to 1⅝"	10" dressed to 9½"
4" dressed to 3⅝"	12" dressed to 11½"
6" dressed to 5⅝"	

Thickness. Below are "nominal" or rough-lumber sizes, with the thickness the finished lumber (dressed) will be.

⅜" dressed to ¼"	1" dressed to ⅞"
⅝" dressed to ½"	1¼" dressed to 1⅛"
¾" dressed to ⅝"	1½" dressed to 1⅜"
	2" dressed to 1⅞"

Lumber from some mills will be thinner than these measurements.

Notice here that in the smaller widths the finished size is ⅜ inch less than the nominal size; in larger widths, it is ½ inch less. Softwood lumber comes in even-numbered widths, such as 2, 4, 6 inches. Hardwood lumber may come in various other widths.

Lumber finished before it is thoroughly dry will shrink after being finished, and the finished size will be smaller than that shown above.

BILL OF MATERIALS

A bill of materials should indicate on what part of the project the various pieces are to be used, the number of pieces, the size, length, kind, etc. It usually is written as:

3 pc	2" x 12" – 8'	No. 1 Douglas-fir s4s	Top
2 pc	1" x 4" – 34"	No. 1 Douglas-fir s4s	Lower crosspieces
4 pc	2" x 4" – 30"	No. 1 Douglas-fir s4s	Legs

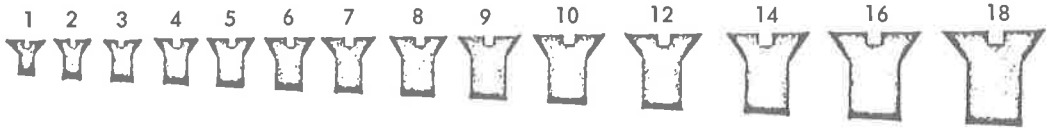
Hardware and other specialty items also should be listed.

HOW TO USE FOUR KINDS OF WOOD FASTENERS

In your first year in this project, you learned how to use nails, screws, and corrugated fasteners. This unit will give you a chance to learn to use stove bolts, carriage bolts, machine bolts, and glue.

To help you use screws more easily, here is a table of sizes for pilot holes and shank holes for screws of various sizes.

Determine Screw Shank Sizes by Comparison Below



Sizes of Bits or Drills To Bore Holes for Wood Screws

NUMBER OF SCREW		1	2	3	4	5	6	7	8	9	10	12	14	16	18
BODY DIAMETER OF SCREW		.073	.086	.099	.112	.125	.138	.151	.164	.177	.190	.216	.242	.268	.294
		5" / 64-	3" / 32-	3" / 32+	7" / 64+	1" / 8	9" / 64-	5" / 32-	11" / 64-	11" / 64+	3" / 16+	7" / 32-	15" / 64+	17" / 64+	19" / 64-
FIRST HOLE	TWIST-DRILL SIZE	5" / 64	3" / 32	7" / 64	7" / 64	1" / 8	9" / 64	5" / 32	11" / 64	3" / 16	3" / 16	7" / 32	1" / 4	17" / 64	19" / 64
	AUGER-BIT NUMBER							3	3	3	3	4	4	5	5
SECOND HOLE	TWIST-DRILL SIZE		1" / 16	1" / 16	5" / 64	5" / 64	3" / 32	7" / 64	7" / 64	1" / 8	1" / 8	9" / 64	5" / 32	3" / 16	13" / 64
	AUGER-BIT NUMBER												3	3	4

Figure 17. Exact sizes cannot be given for the holes for wood screws. The sizes in the table are right for average needs. Number and letter sizes of drills are available if more exact sizes are wanted. Try the screw size for fit in a piece of scrap wood.

Carriage bolts are useful when a smooth-finished surface is needed on one side, but with maximum strength. They are used for stock racks, fences, gates, truck floors, etc. In the two boards to be fastened together, bore holes the same size as the shank of the carriage bolt. The bolt should be ½ inch longer than the thickness of the two boards. Always use a washer between the wood and the nut. The square shank under the bolt head will pull down into the hole and hold the head securely.

Machine bolts, with either square or hexagonal heads, are used where extra strength is needed and where wood is soft and carriage bolt heads might not hold. Bore a hole through both pieces of wood, using a bit the same size as the bolt. When using machine bolts to fasten two pieces of wood together, put a washer under the head and one under the nut. If you are fastening wood to metal, only the end going through wood needs a washer. You might wish to use a lock washer under the nut where there is a lot of vibration or strain.

Stove bolts are used the same as machine bolts, only in sizes from ¼ inch or smaller. Both roundhead and flathead bolts have screwdriver slots in the heads. Flathead bolts are countersunk in wood or metal in the same way as wood screws. Roundhead stove bolts used with wood should have washers under the heads.

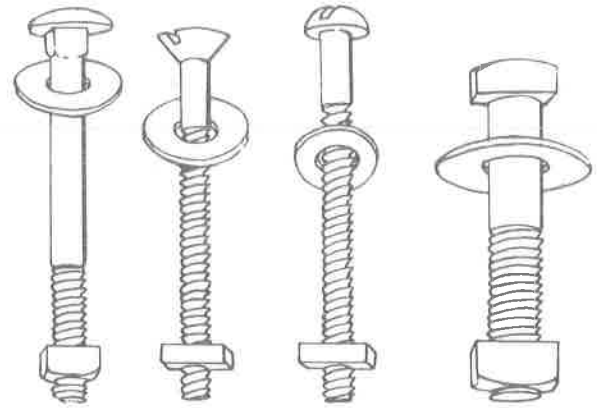


Figure 18. Some common wood fasteners.

Glue is a very useful wood fastener and is frequently the only fastener used. It also may be used with nails, screws, dowels, or bolts. Many kinds of glue are available today. White plastic resin glue is the most common and very effective. It does not stain and holds well. Dry-mix glues, "airplane" cement, epoxy glues, and many others also are available. Follow instructions on the package. Apply white glue in an even coat to clean, dry surfaces, and clamp to hold firmly until dry. Use C-clamps for small jobs, handscrew clamps for larger flat surfaces, and bar clamps for edge-to-edge gluing of large boards.

Dowels often are used with glue to make strong, concealed joints. You will learn how to use dowels in Woodworking Unit III.

CLAMPS

Clamps are temporary devices for holding stock together until the glue "sets." Clamps commonly used are the handscrew, bar, and C-clamp. It is important that the clamps be just tight enough to bring together the surfaces to be glued. Do not force the clamps, or they might injure the wood fibers.

A **handscrew clamp** may be used when two or more pieces of stock are clamped face to face. The jaws of the handscrew clamp may be adjusted so they fit firmly against the outside surface of the wood being glued. The clamp often is used in fastening irregular stock.

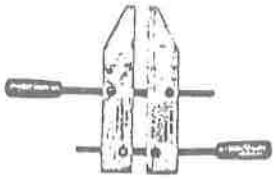


Figure 19. Handscrew clamp.

The **bar clamp** is useful around the farm shop for edge-to-edge gluing, such as tabletops, frames, and cabinet assembly. These clamps are made in various lengths and may be adjusted by bringing the adjustable jaw to the desired opening.

Figure 20. Bar clamp.

The **C-clamp** is used to hold small pieces of stock together while gluing, in repair work, and often in making duplicate layouts of parts.

Figure 21. C-clamp.

USING AND CARING FOR TOOLS

You already have learned how to use your **rule and measuring tape.** Keep these tools clean and dry, and store the rule so that the edges do not get dented. Tapes should be clean and dry before you roll them.

The **miter box** is used with a **backsaw** to make simple angle cuts in wood. When using the miter box, hold the wood firmly in place against the side and bottom of the miter box. Mark angles carefully before cutting. Be sure to hold the saw vertically when cutting. The guide slots in the miter box help, but there is some play, and the joint will not fit together snugly unless both angle cuts are made with the saw held vertically. The backsaw has fine teeth to permit accurate cutting; the ridge on the back prevents the saw blade from bending while cutting. Use it to cut small moldings, dowels, and other small pieces of wood when using a miter box.

Coping saw and jigsaw. The coping saw has a very thin blade with fine teeth. It is used for cutting curved lines and patterns in wood. To cut large holes or pattern areas inside a piece of wood, drill a small hole, insert the blade through the hole, insert the blade into the saw frame, and saw along the marked line. Use the coping saw and jigsaw with the teeth pointing down, and cut as the blade is pulled or driven down. When using the coping saw, hold the work on a flat surface and allow just enough to stick over the edge to allow the saw to cut up to the pattern line. The blade may be turned in the frame to reach hard-to-reach cuts.

The jigsaw is a mechanical coping saw, very useful for making accurate cuts in thin materials. When using the jigsaw or any power saw, **never** get fingers in front of the cutting teeth. Some jigsaws have tilting tables to make angle cuts possible. Read the manual carefully before using the jigsaw. There are several different types of power jigsaws, and each operates a little differently.

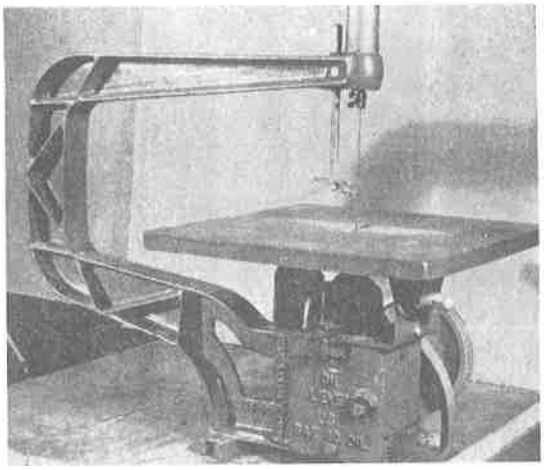


Figure 22.

With either the coping saw or jigsaw, always leave the pattern line and finish the piece with a file, sandpaper, or a sander, since the teeth in these saw blades leave a slightly rough surface. The only exception would be in cutting a jigsaw puzzle, when the blade makes the final cut.

Portable electric drills can be used on many repair or construction jobs around the farm and home, especially when the work cannot be taken to a drill press.

The heavy-duty ½-inch drill and the light-duty ¼-inch drill are the most common drills in the shop.

The heavy-duty ½-inch type will drill holes up to ½ inch in metal and 1¼ inches in wood. It operates at approximately 300 revolutions per minute (rpm) without load.

The ¼-inch type will drill holes up to ¼ inch in metal and ½ inch in wood. The ¼-inch drill operates at a higher speed than the ½-inch type. The rpm varies from 500 to 5,000 with different models and makes.

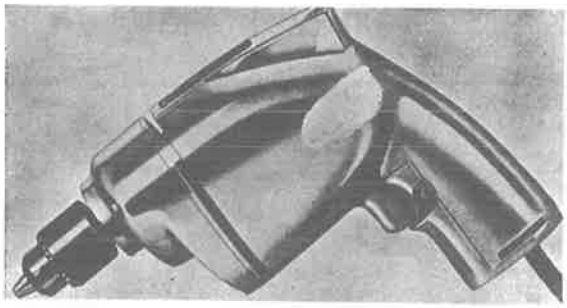


Figure 23. ¼" Drill

Twist drills, designed for metal, are often used in drilling wood. However, the special power bits for electric drills are preferred. The regular auger bit can be adapted for use by filing off the lead screw threads and cutting off the tang so the shank will fit the chuck.

Drill stands and many other accessories are available for use with the drills.

Electrical Safety

While in use, every electric tool should be grounded to protect the operator against shock. To do this, connect the tools to the power source with a cable or cord that has three conductors. The third wire, which is green, safely grounds the tool.

New tools are equipped with approved three-conductor cords and three-blade grounding-type attachment plugs, in accordance with the National Electrical Code. The plug shown below fits directly into the grounding-type receptacles. Each time the tool is plugged in, it is automatically grounded. A special grounding adapter can be obtained for use with two-wire receptacles, until the correct receptacle is installed. This is illustrated below.

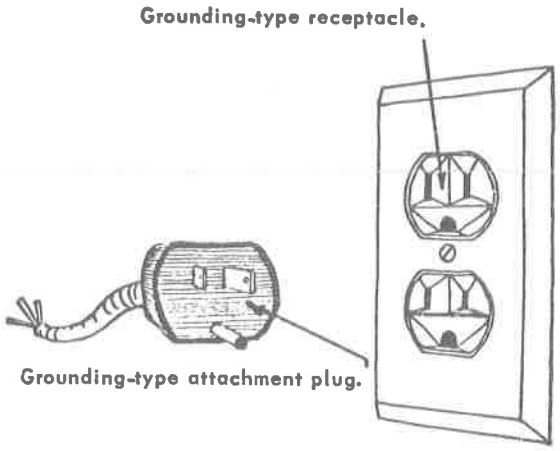


Figure 24.

The green grounding wire which extends from the side of the adapter must be connected to a permanent ground. A properly grounded outlet box, conduit, water pipe, or an 8-foot rod or pipe driven into the ground will serve as a permanent ground.

If your tool is equipped with a two-blade attachment plug, replace it with a three-blade grounding-type attachment plug. The cord may have the third wire in it. If not, replace the cord with a three-wire cord. If this is done, one end of the green wire must be permanently attached to the tool housing, and the other end to the grounding blade of the attachment plug.

Orbital or oscillating sanders move the sandpaper in a circular motion. They do not produce as good a finish as sanders with straight back-and-forth motion or belt sanders,

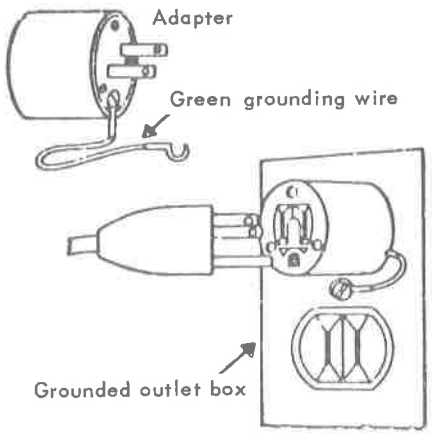


Figure 25.

but they are relatively inexpensive. They do a good job if you use them properly. Never use sandpaper any coarser than needed to do the job. Work the job with the coarsest paper needed, then a finer paper, and finally the finish paper, which should be 150 to 200 grit or finer. Use an open-grit paper, if possible. Do not exert pressure on the sander. Just guide the sander with your hand, and let the weight of the sander do the work. Lift the sander and tap the paper with the palm of your hand to help keep the paper from loading up with dust. As with the drill, be sure the tool is grounded with a three-wire outlet and cord.

The **block plane** is made for light cuts only. Use it for smoothing ends cut with a saw, or to lightly bevel edges of boards.

Be sure the blade is sharp, and that it is placed in the plane so that it projects equally all along the face of the plane. Hold the board to be planed in a bench vise or clamp so that only the plane moves.

Plane from the edge of the cut toward the center. Do not plane clear across to the opposite edge, as you may splinter off a part of the board. Check frequently with your square, as you plane down to your cutting line. After planing to the line, finish with medium and fine sandpaper.

Always store the plane on its side to protect the blade.

Sandpaper is needed to make a smooth finish. This material comes in 8- by 12-inch sheets. It comes in many grades and kinds. Ordinary flint paper is the cheapest and poorest. Garnet paper is more durable and cuts faster. Paper with carborundum or other open-grained, fast-cutting materials is even better. Sand first with coarse or medium paper (80 or 120 grit), depending on how rough your surface is. Finish with fine paper (150 to 400 grit). Usually, a quarter sheet is used at a time. Tear the paper against a sharp-edged board or ruler. Use a sanding board so that the surface will be flat with no low spots. Bang the sandpaper and board against your hand frequently as you sand, to knock out dust and to keep the grit open and cutting. Always sand with the grain of the wood. Sanding across the grain makes scratches that are hard to conceal. To sand on inside curves, use paper folded to two to four thicknesses and hold vertically to the surface with your fingers as you sand. When the surface is smooth as satin, wipe carefully with a clean rag moistened with a little paint thinner and varnish. A tack rag such as this will pick up all loose dust before you paint.

Paintbrushes are made from natural bristle and several kinds of synthetic bristles. Natural-bristle brushes hold paint a little better and perform better than most artificial-bristle brushes. They are needed for some paints that use thinners that will soften or dissolve synthetic bristles. Pick the brush to fit the job. Choose a brush wide enough to cover a working section of reasonable size.

For instance, if you were painting a trellis with parts no wider than 1 inch, a 1-inch brush would be large enough. For painting a large flat surface, such as the tool cabinet, you might use a 3- or 4-inch brush. House painters use 4- to 6-inch brushes, and 1½- to 2- inch sash brushes for trim and moldings.

Dip brush not over halfway into well-stirred paint. Touch gently to side of can, then brush on with the grain of the wood. Use smooth, even strokes, and don't try to cover too large an area with each brushful. Always be sure your brushes are thoroughly clean before beginning to paint, and clean the brushes thoroughly after you finish. For short storage, brushes can be hung in linseed oil. For storage longer than a few days, clean the brushes in thinner, and wash thoroughly with soap or detergent and warm water, and wrap carefully.

SEALERS...PAINTS AND VARNISHES

Wood may be left unfinished, stained, finished natural, or painted. Hundreds of different kinds of specialty paints, sealers, and varnishes are on the market today. We'll discuss only the use of simple sealers, stains, clear finishes, and latex or oil-base paints.

Open-grained woods must be filled before finishing with paints or varnishes. Natural wood filler or a combination filler and stain are the most common materials. Open the can carefully, stir well, brush on freely—with the grain, then across the grain. Allow to dry for 15 to 20 minutes (or follow directions on the can). Then wipe off with coarse cloth, wiping only across the grain. Allow to dry overnight, sand with fine sandpaper. Dust with tack rag and apply finish.

Sealers are used on close-grained woods such as pine or maple. They seal the fine pores and prepare the wood for the finishing coats. If you are planning to use a wood stain, always stain before using sealer. Most stains are brushed on, allowed to dry for a few minutes, then wiped off with a clean, soft cloth. Wipe with a tack rag, then finish.

Sealers make an attractive finish for stained or natural-wood finishes. They may be brushed on or wiped on with an old nylon stocking folded into a pad. Sand lightly with very fine paper between coats, and use the tack rag just before recoating. Apply finishes in a clean, well-ventilated area that is as dust-free as possible.

Latex paints can be applied over bare wood, but a coat of sealer applied first will make a more durable finish. It is better to apply several light coats than one heavy coat.

A number of wood doughs and crack fillers are available in addition to the standard linseed-oil putty. These are used to fill cracks and dents and nail holes in wood before painting or finishing.

For painted surfaces, apply a primer or seal coat before using putty to fill nail holes. Always fill holes so that the putty is above the wood surface. After the putty dries, sand carefully to make it level with the wood.

Wood dough or other plastic-type materials will not take wood stains. Stain the wood first, then fill the holes and cracks with a wood dough or plastic filler the same color as the stain.

If water-based putties are used, apply them to wood before priming. These are more suitable for wood that is to be painted.

Putty can be colored with stain before applying. Therefore, if wood is to be finished natural or stained, stain and seal it before

puttying. Color the putty to match the wood before applying it to holes or cracks.

Dents in wood often can be repaired without filling, if the fibers are not broken or torn. Use a hot iron over damp cloths placed on the dent. Sometimes, several applications will be needed to return the dented wood to its original shape. A steam iron also can be used to provide the needed steam to swell the wood fibers.

After applying sealers, stains, or oil-based paints, wash the brushes carefully in paint thinner, then wash thoroughly in soap or detergent and water, wrap carefully, and store. For water-thinned paints, such as latex paints, wash the brushes in soap and water, then wrap and store.

With most wood finishes, follow the directions on the can for best results.

Nail holes should be filled after the wood is sealed or has received one coat of surface finish. If the nail hole has not been sealed the wood will absorb the oil from the putty. This will make an oily spot under the wood finish.

To obtain the desired matching color, prepare a piece of scrap material in the same manner as the article you are going to finish. Drill some small test holes in this scrap. Mix the color and putty until the color is about what you want. This should be slightly lighter than the desired color because varnish when placed over it will darken it slightly. Fill a test hole with the mixture. Vary the mixture of color and putty until you get the desired color.

Colors in oil that are commonly used to tint the putty include raw and burnt umber, raw and burnt sienna, yellow ochre, and lamp black.

The mixed putty can be stored for future use by covering it with water.

UTILITY STOOL

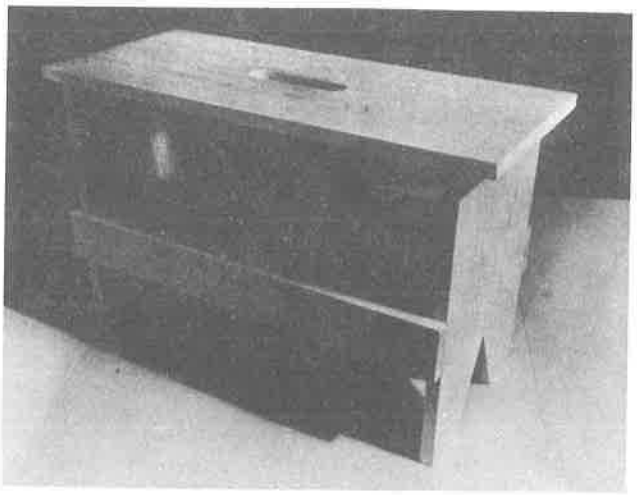
Material: ¾" clear pine

Top	–	1 pc	11½" x 27"
Ends	–	2 pc	11½" x 16½"
Shelf	–	1 pc	11½" x 22½"
Sides	–	2 pc	3" x 24"

8d nails, glue, sandpaper, plastic wood, and finishing materials.

Construction:

1. Lay out and cut materials as listed.
2. Lay out for hole in top piece.
3. Drill the curved edges of the hole in the top and finish cutting out with a coping saw.
4. Lay out the ends for the V-shaped cut and saw it out.
5. Sand all parts smooth.
6. Begin assembly by nailing the shelf to the ends.
7. Check for squareness.
8. Nail top to ends, checking for squareness.
9. Nail sides to shelf and ends.
10. Set the heads of the 8d box nails about ⅛ inch below the surface of the wood.
11. Fill the holes with plastic wood or putty.
12. After crack filler dries, sand the surface smooth.
13. Apply finish as desired.



UTILITY STOOL

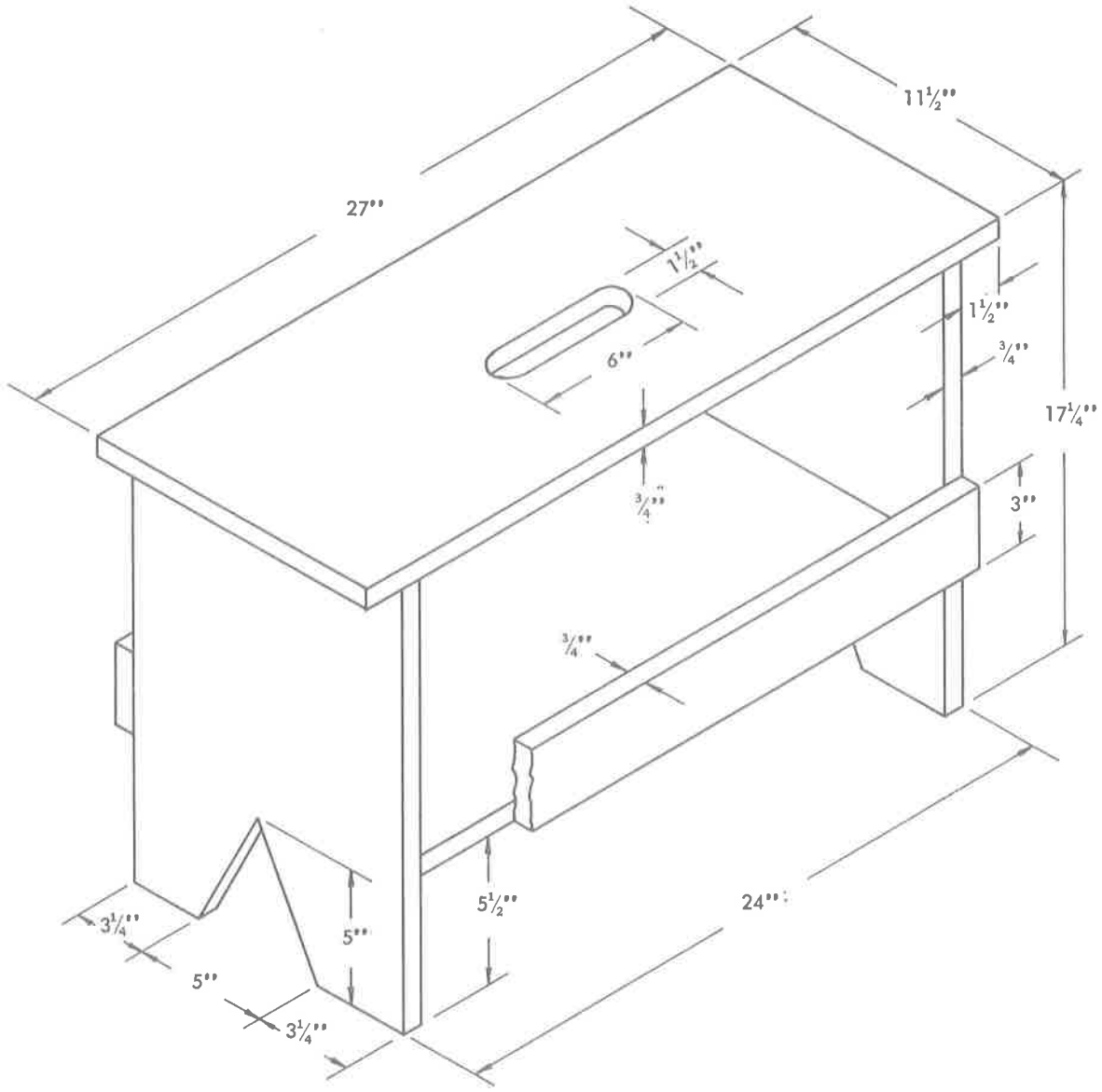


Figure 26.

SPICE RACK

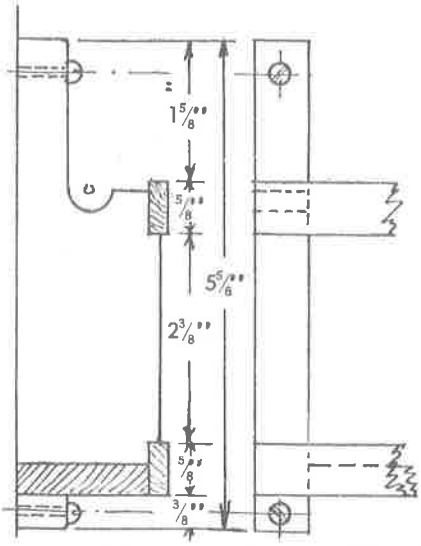
Material: Red birch

Large can rack, ends	1 pc 1" x 2" x 12"
Small can rack, ends	1 pc 1" x 2" x 8"
Bottom for each 8-can rack	1 pc $\frac{3}{8}$" x $1\frac{1}{2}$" x 20"
Bars for each 8-can rack	1 pc $\frac{1}{4}$" x $\frac{5}{8}$" x 42"

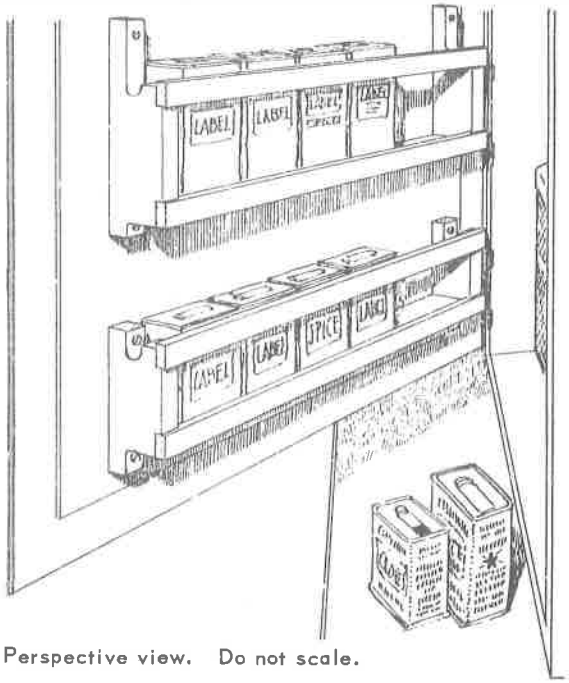
4 roundhead #4 $1\frac{1}{4}$" screws (if cupboard door has a thin panel, screws may have to be shorter)

Spice cans are $2\frac{1}{4}$" wide by $1\frac{1}{4}$" deep, but come in two heights. Small cans are $2\frac{5}{8}$" high; large cans are $3\frac{5}{8}$" high.

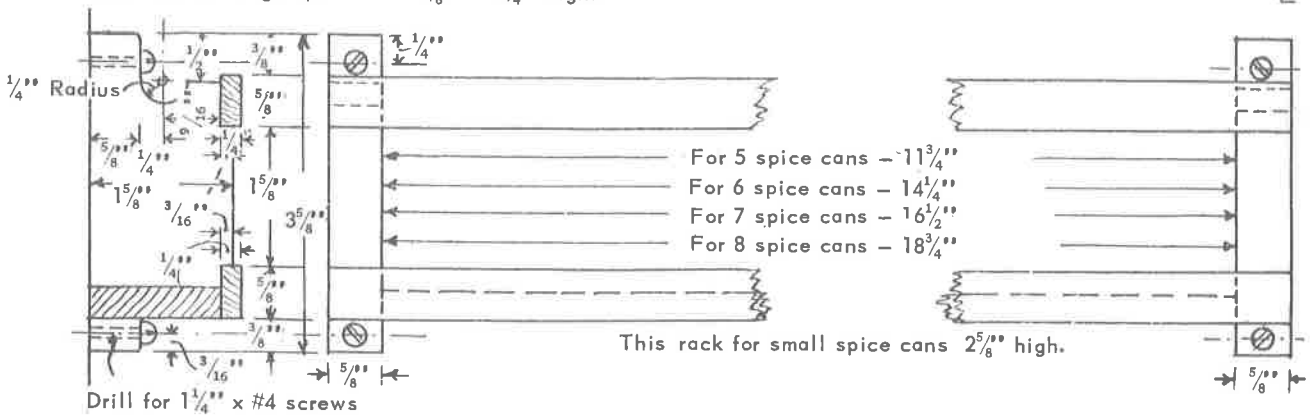
Caution: When spice racks are attached to the back of the cupboard door, be sure they do not strike against cupboard shelving and prevent the door from closing.



This rack for large spice cans $3\frac{5}{8}$" to $3\frac{3}{4}$" high.



Perspective view. Do not scale.



This rack for small spice cans $2\frac{5}{8}$" high.

Drill for $1\frac{1}{4}$" x #4 screws

Note: If cupboard door has a thin panel the screw length may have to be less.

Figure 27.

DRAWER TRAY

Material:

Cross-partition in small utensil tray
$\frac{3}{8}$" x $1\frac{5}{8}$" white pine or birch

Other partitions and bottom pieces
$\frac{1}{4}$" plywood

Knife handle supports
$\frac{1}{2}$" x $\frac{3}{4}$" white pine

Knife blade blocks
$1\frac{1}{8}$" x $3\frac{5}{8}$" white pine

Glue and small nails

Construction:

To assemble, nail and glue, using 1-inch wire nails or 1-inch wire brads.

Tray or divider can be planned to fit any existing drawer and to accommodate different types of storage.

This plan gives construction details and one planning idea.

Drawer tray is used to make better use of a deep drawer. Runners or glides are installed in existing drawer to hold tray near top.

The drawer divider is similar to tray but does not have sides or bottom.

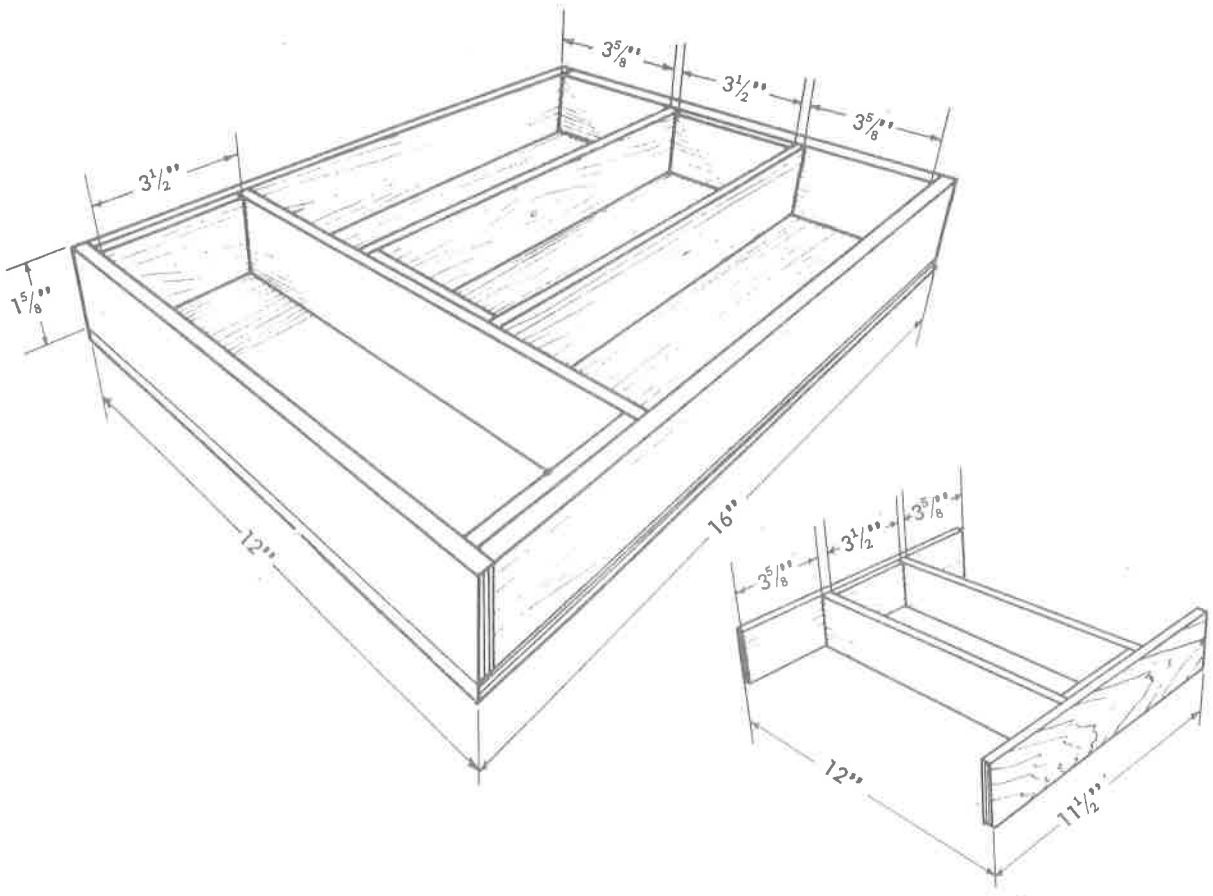


Figure 28.

KITCHEN VERTICAL DIVIDER

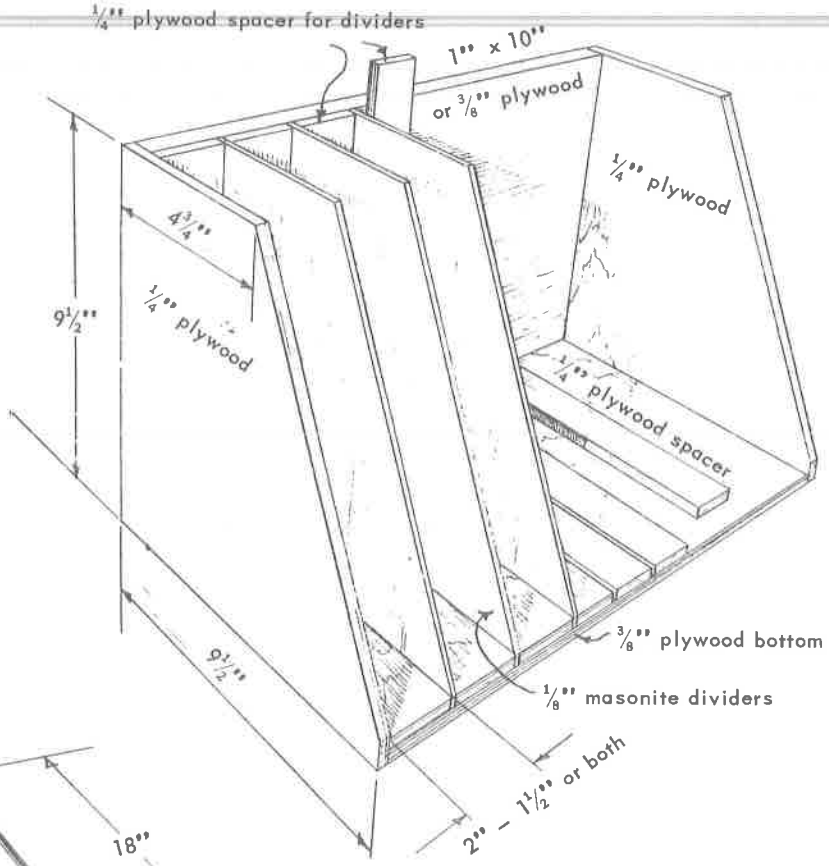
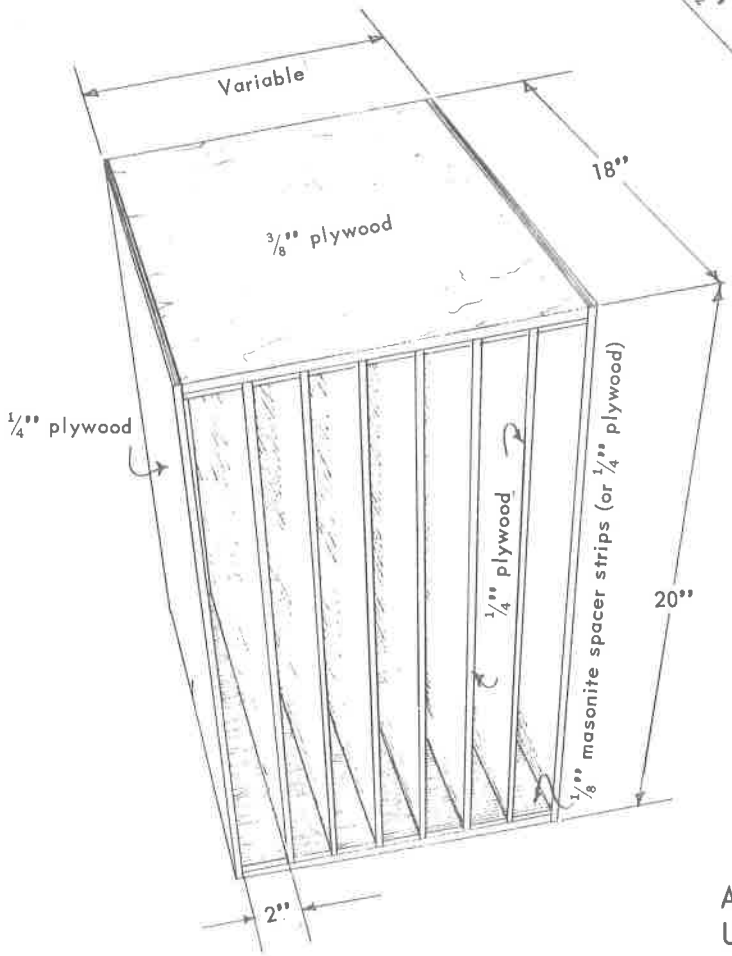


Figure 29.



Attach all spacer strips with glue and wire brads. Put in spacers and dividers a section at a time. Use ½-inch wire brads in assembly.

Make length to suit purpose.

Figure 30.

ALTERNATE VERTICAL DIVIDER

Assemble as for kitchen vertical divider. Use ⅜-inch wire brads and glue.

WALL KNIFE RACK

Material:

– 1 pc 1" x 8" x 12" or
plywood equivalent
1 pc 2" x 2" x 8"

Dowel – ½" x 4" or ¾" x 4"

Screws and glue

Alter knife-slot spacing dimension to accommodate your knives. Small knives can be closer together than large knives.

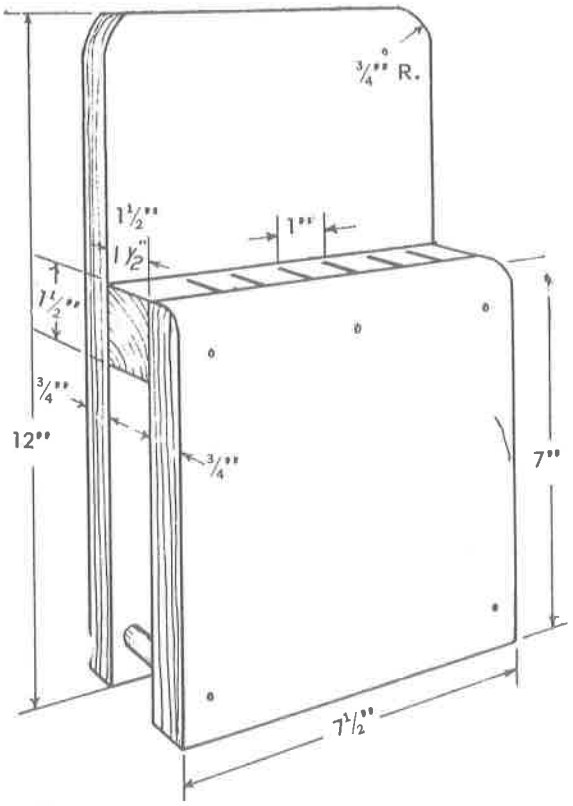


Figure 31.

DRAWER KNIFE RACK

– 1 pc 1" x 8" x 12" or
plywood equivalent

1 pc 1" x 2" x 8"

1 pc 1" x 1" x 8"

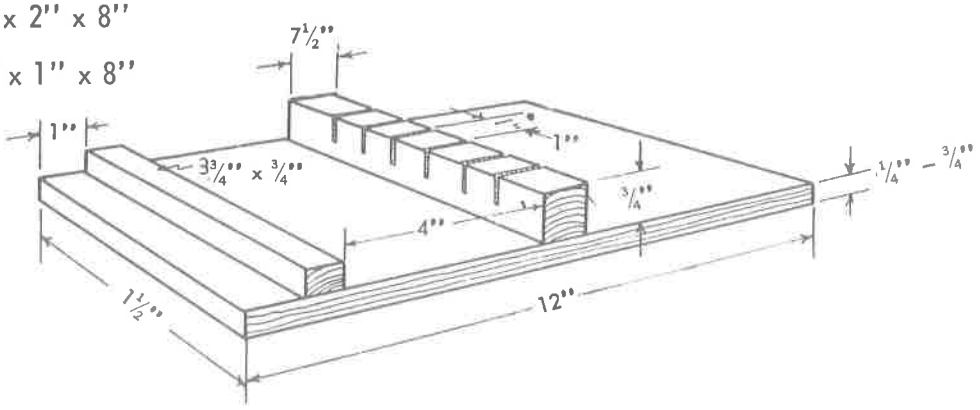


Figure 32.

HALF SHELF

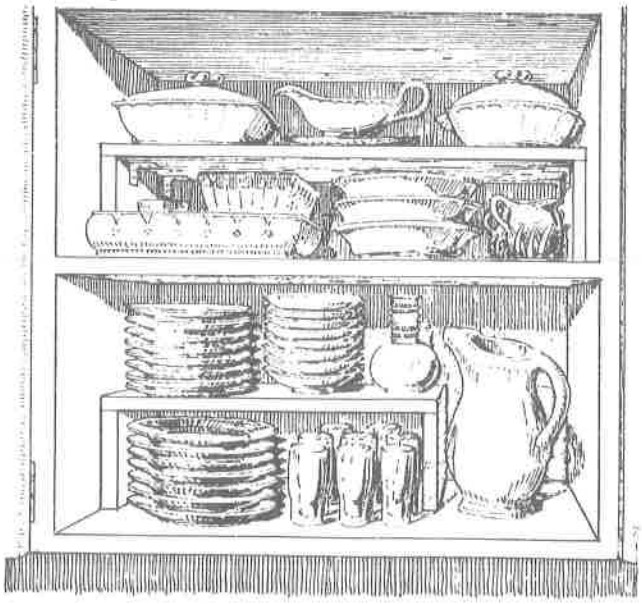
Material:

1" x 6" in length to suit

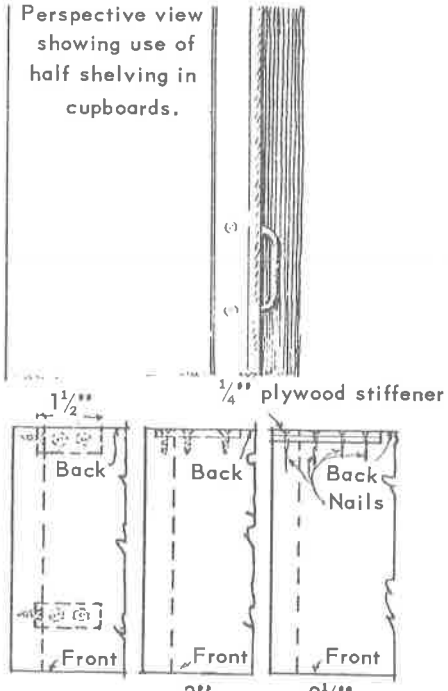
Use ½" plywood with ¾" uprights if paint or enamel is the finishing material.

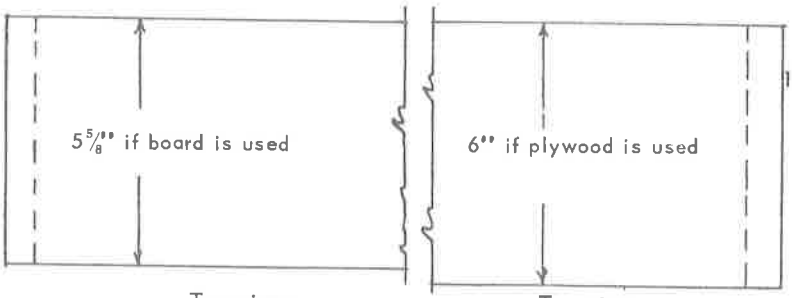
Short shelves do not need corner bracing.

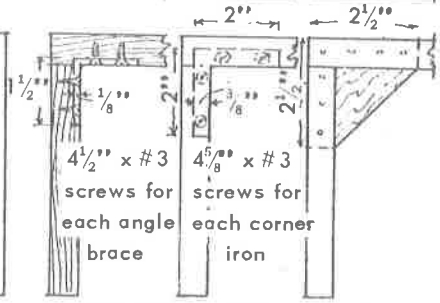
Shelves over 16" need braces. Glue all joints in addition to nailing.



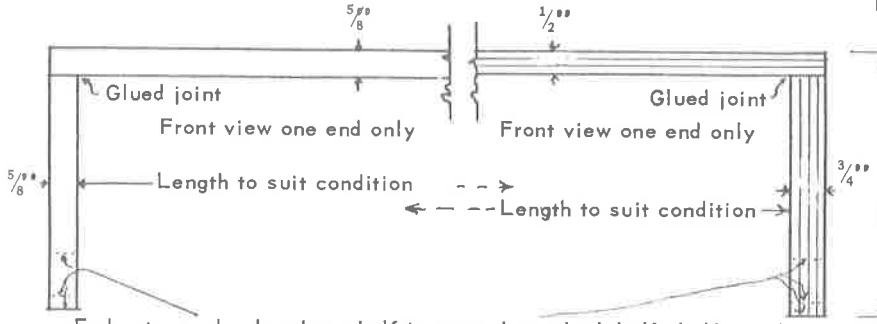
Perspective view showing use of half shelving in cupboards.

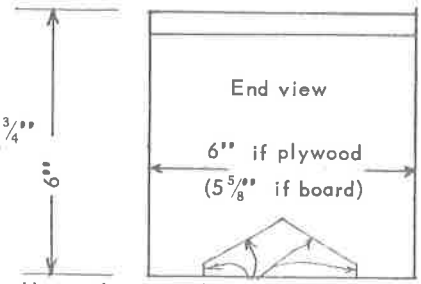






Details showing three methods of corner bracing for shelves over 16" long.





Use end cutout shown only in case shelf is warped on which half shelf stands

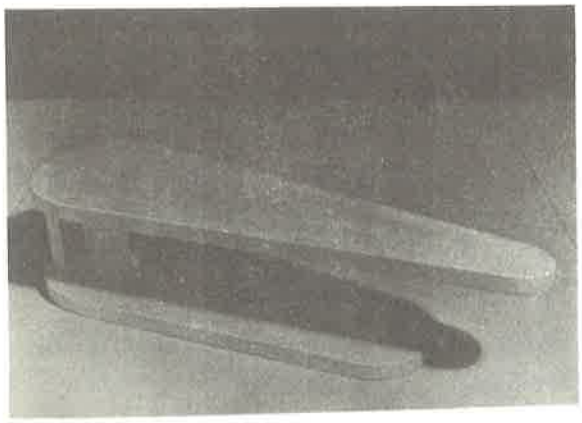
Figure 33.

SLEEVEBOARD

Material: ¾" clear pine

Bottom	– 1 pc 7½" x 18"
Top	– 1 pc 7" x 22"
Divider	– 1 pc 3⅝" x 3½"
Center support	– 1 pc 3½" x 3½"

8 – 1½" #8 flathead steel wood screws, sandpaper, glue, and finishing materials.



Construction:

1. Cut out materials, allowing for shaping and sanding.
2. Lay out the contours of the top, bottom, and dividing pieces.
3. Cut the pieces with a coping saw.
4. Smooth the edges with a file.
5. Sand the edges and surfaces thoroughly.
6. Drill for screws and assemble pieces with glue, being careful to align the parts properly.
7. Apply finish as desired.

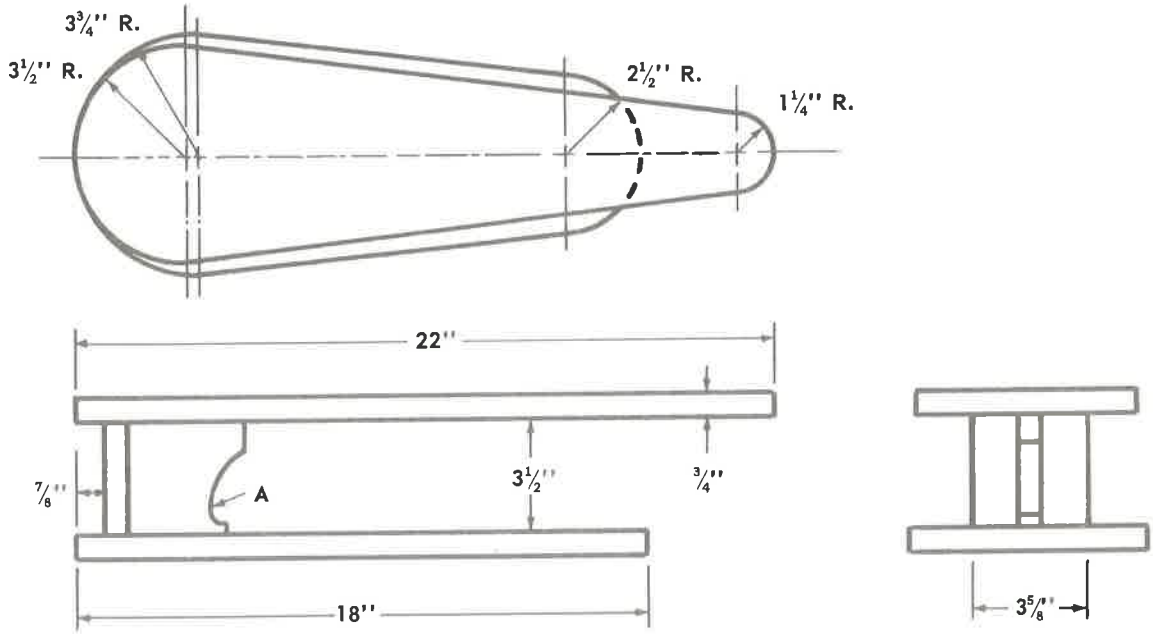


Figure 34.

TOOLBOX

Material: ¾" stock

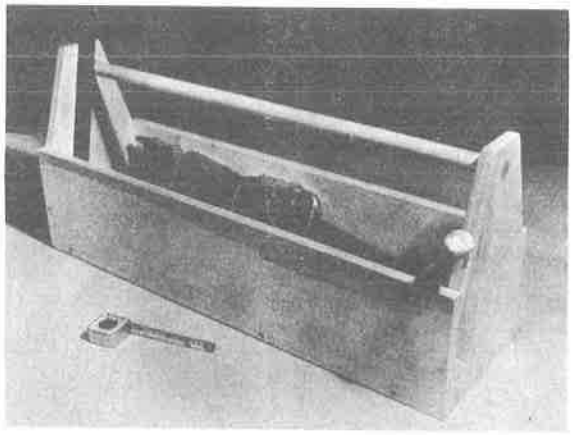
Sides – 2 pc 7½" x 32"

Bottom – 1 pc 7½" x 30½"

Ends – 2 pc 7½" x 14"

Handle – 1 pc 1" diameter dowel or broomstick

8d common nails, glue, and sandpaper



Construction:

1. Cut out various parts to the sizes given in the plan. Be sure all pieces are square and accurately cut.
2. Make special cuts on endpieces to conform to measurements given in the plan.
3. Bore holes in endpieces to fit round handle. Check the size of the handle, if an old broomstick is used.
4. Nail bottom to ends and check for squareness.
5. Nail sides to ends and bottom.
6. Install handle and fasten with nails or screws. If a very small hole is drilled down through the end and handle, it will lessen the chances of the wood splitting when the handle is secured.
7. Paint is a recommended finish for the toolbox.

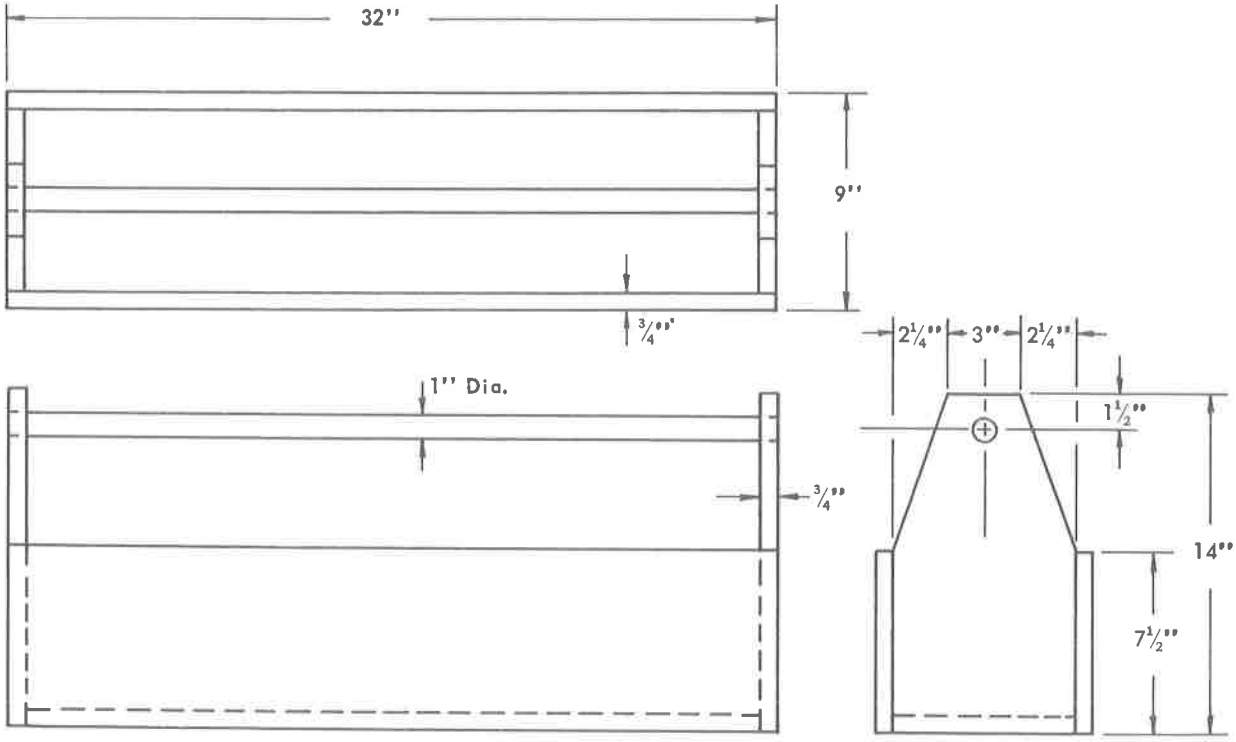


Figure 35.

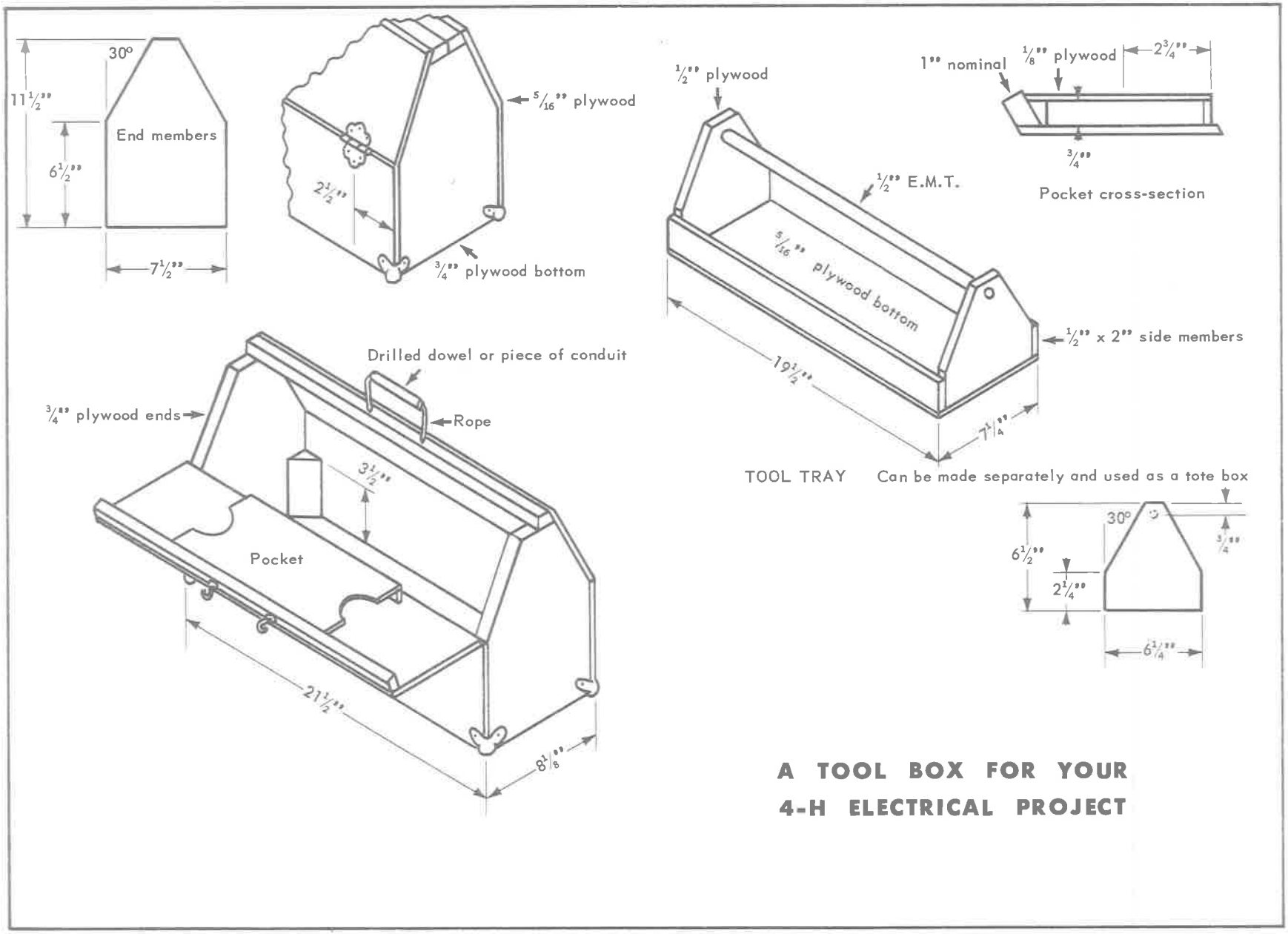


Figure 35 – continued

TOOL CABINET

Material:

1 pc 1" x 8" x 14' or ¾" plywood equivalent for outside frame

1 pc 4' x 6' ⅛" pegboard or equivalent

1 pc 3' x 4' ⅛" Masonite or equivalent

2 pc 1" x 2" x 12'

1 pc 1" x 1" x 6' or 1" x 2" x 3' to rip. See drawing for alternate.

½" plywood or lumber for door framework strips:

4 – ½" x 1⅝" x 36"

4 – ½" x 1⅝" x 24"

Water-resistant glue

⅝" wire brads

2 pr 2" x 2" butt hinges with screws

6d finishing nails

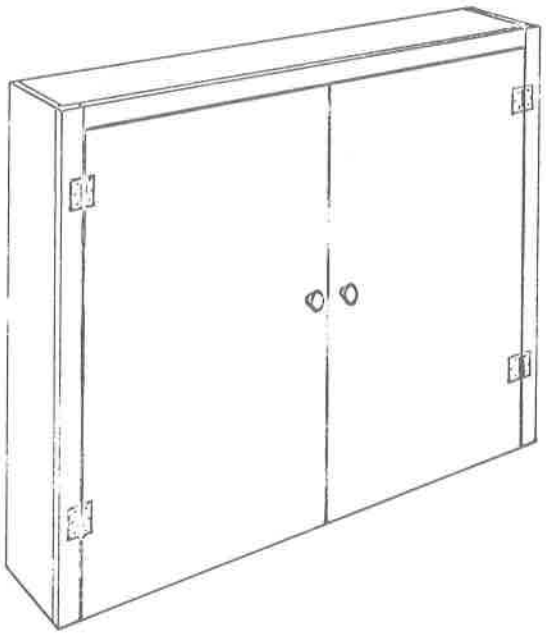
2 cabinet latches with screws

2 door or drawer pulls with screws

Penetrating wood sealer for finish or paint materials

Construction:

1. Cut and assemble outer frame.
2. Square, and hold with cleats tacked diagonally across the back.
3. Cut and install framing members in back adjacent to outer frame. Apply water-resistant glue and nail from outside in. Use 6d finish nails about 6" apart.
4. Cut and install pegboard back. Apply water-resistant glue, and nail with ⅝" wire brads about 4" apart.
5. Cut and install two intermediate supports at ⅓ points.
6. Attach front trim with 6d finish nails.
7. Measure door opening and check door size. Completed doors should have 1/16" clearance at top, 1/32" on hinge side, and 1/16" between doors.
8. Construct doors; nail frame at miter corners with 6d finish nails. Glue on pegboard and Masonite. Space brads 4" apart.
9. Finish with penetrating wood sealer or paint.



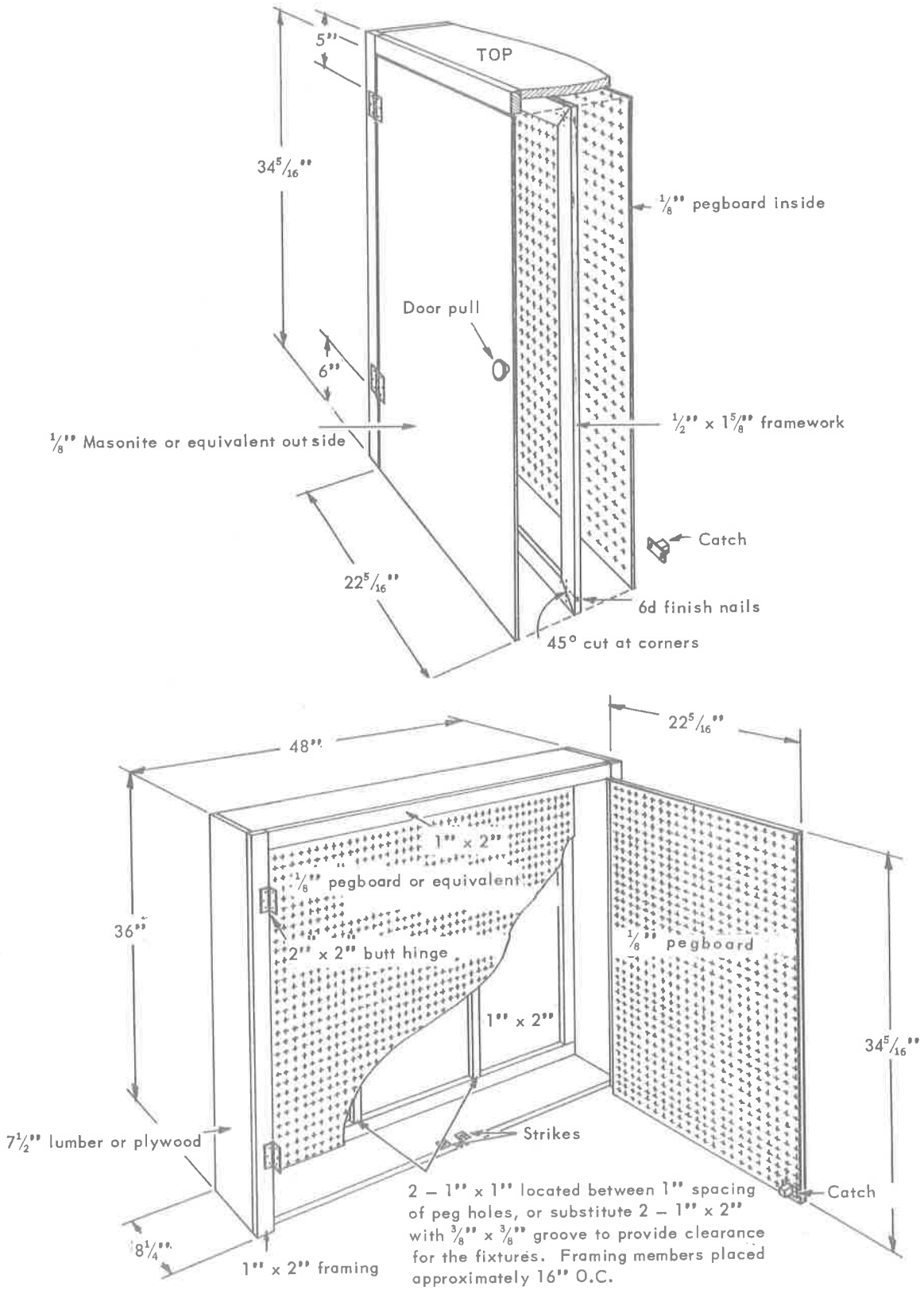

5"
TOP
34 5/16"
1/8" pegboard inside
Door pull
6"
1/2" x 1 5/8" framework
1/8" Masonite or equivalent outside
Catch
22 5/16"
6d finish nails
45° cut at corners
22 5/16"
48"
1" x 2"
1/8" pegboard or equivalent
36"
1/8" pegboard
2" x 2" butt hinge
1" x 2"
34 5/16"
7 1/2" lumber or plywood
Strikes
Catch
2 – 1" x 1" located between 1" spacing of peg holes, or substitute 2 – 1" x 2" with 3/8" x 3/8" groove to provide clearance for the fixtures. Framing members placed approximately 16" O.C.
8 1/4"
1" x 2" framing

Figure 36.

SHEEP-BLOCKING TABLE

Material:

4 pc 1" x 8" x 42"

2 pc 1" x 4" x 24"

16 – 1¼" #10 flathead wood screws

16 – 1" #10 flathead wood screws

4 pc ¾" pipe 30" long, threaded one end (legs)

1½" pipe flange

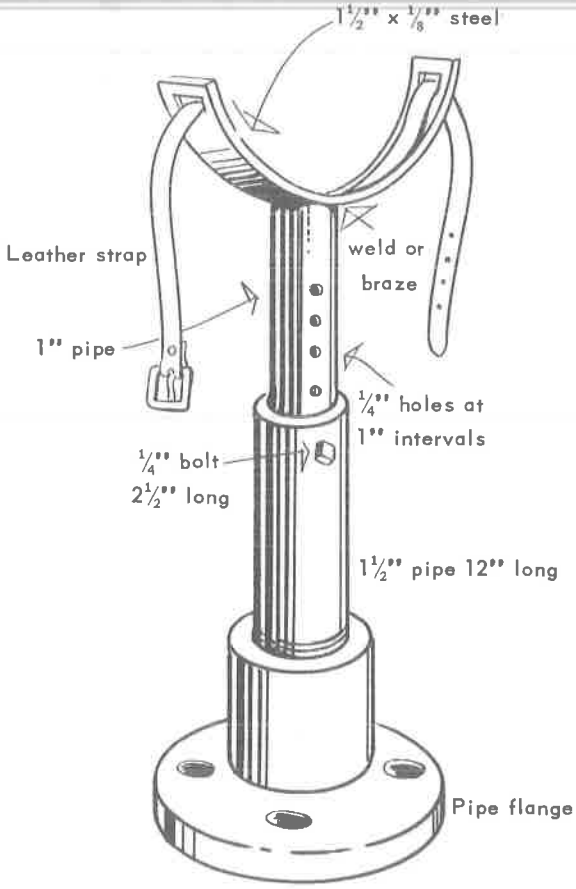
1 pc 1½" pipe – 12" long, threaded one end

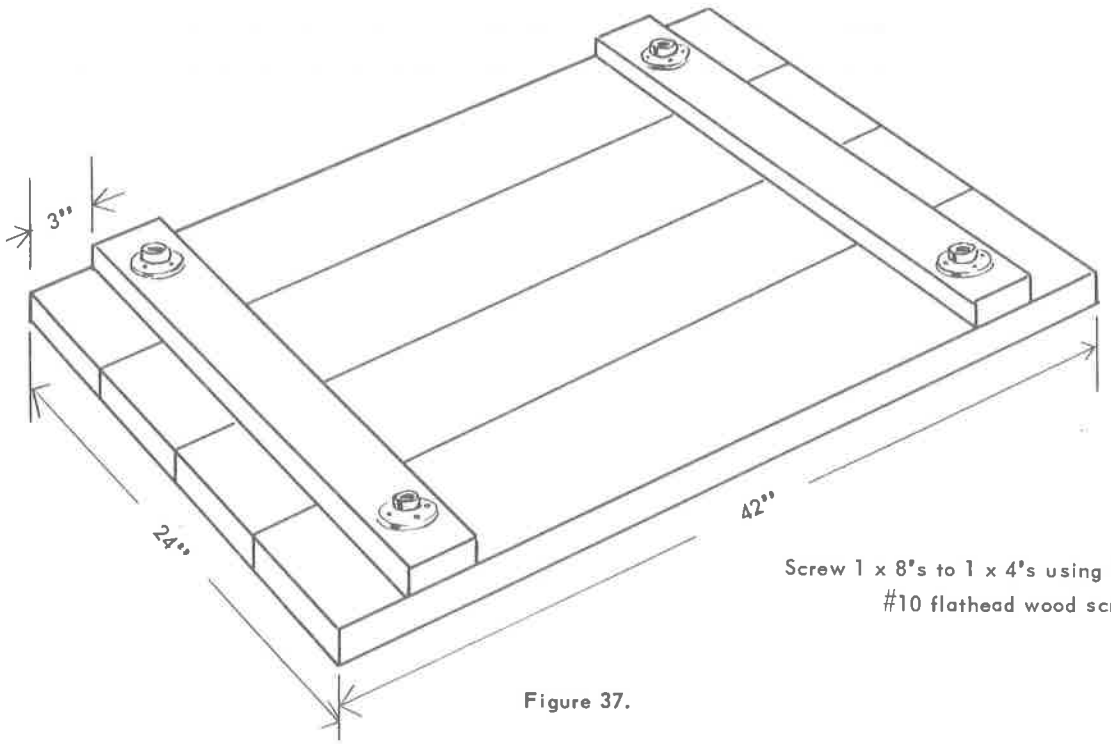
1 pc 1" pipe 2' long

1 – ¼" x 2½" bolt and wingnut

1 heavy leather strap with buckle

4 – ¾" pipe flanges





Screw 1 x 8's to 1 x 4's using 1¼" #10 flathead wood screws

Figure 37.

SMALL SHOW BOX

Material:

½ sheet (4' x 4') ½" exterior Douglas-fir plywood

2 hasps

1 screen door handle

4 dozen 1" #6 flathead wood screws

Glue

#4 finish nails

1 pair strap hinges

Construction:

1. Cut all parts as shown.
2. Assemble box with glue and #6 screws.
3. Screw rails to front and back, with top 4½" from the top of the box.
4. Assemble tray with nails and glue.
5. Screw on hardware.
6. Paint.

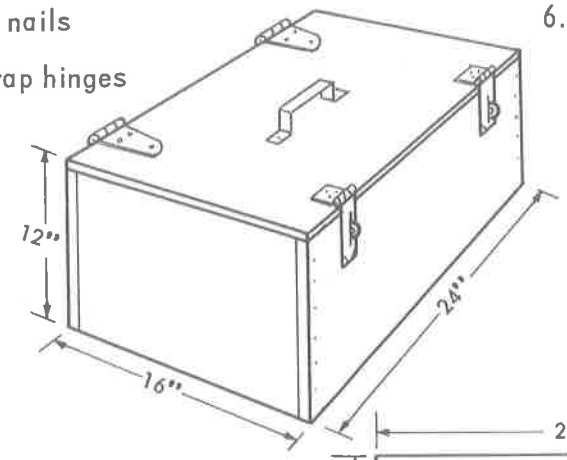
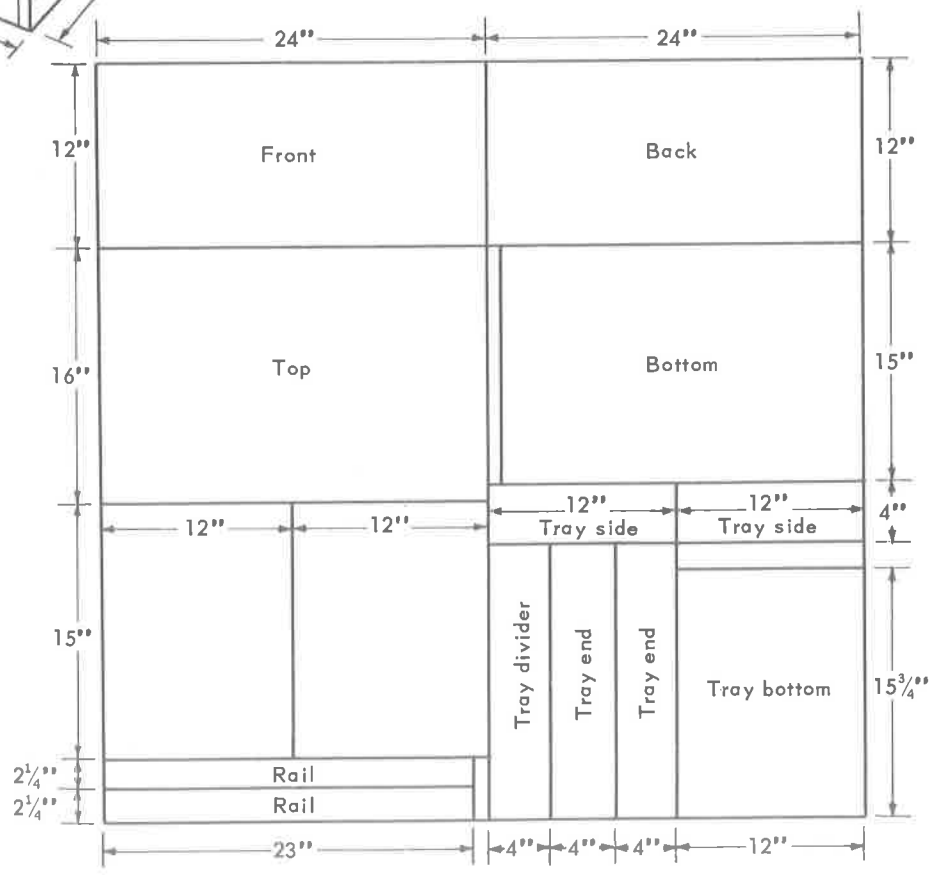


Figure 38.



COMBINATION CHAIR AND STEP STOOL

Material: ¾" plywood

Top – 1 pc 7½" x 11½"

Sides – 2 pc 7½" x 11"

Arms – 2 pc 3½" x 13½"

Step – 1 pc 3½" x 13½"

2 pc ½" dowel, 13" long

10 – 1½" #8 flathead steel wood screws

2 – 3/16" steel washers

Glue, sandpaper, crack filler, and finishing materials

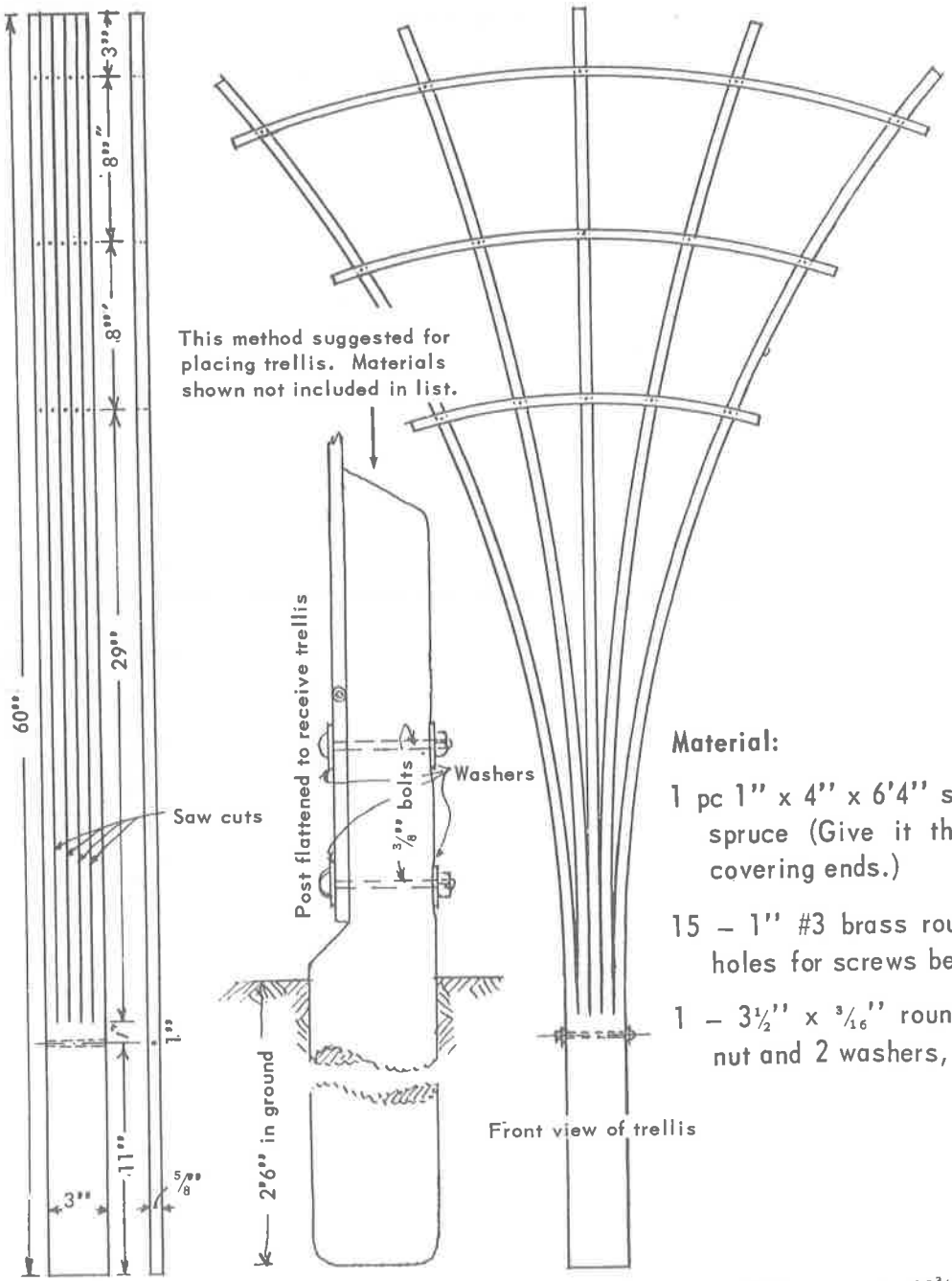
Construction:

1. Cut out parts to the sizes given in the materials list.
2. Lay out patterns for sides and arms on heavy paper.
3. Trace patterns on the plywood.
4. Cut out sides and arms with coping saw.
5. Round corners of top and step with a ½" radius.
6. Locate and drill ½" holes in the two side pieces.

Figure 39.

GARDEN TRELLIS

Note: Select a board without knots!

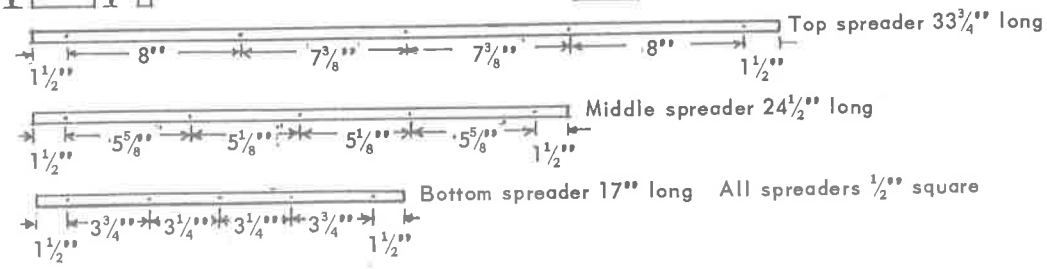


Material:

1 pc 1" x 4" x 6'4" straight-grained pine or spruce (Give it three coats of paint, covering ends.)

15 – 1" #3 brass roundhead screws (Drill holes for screws before driving them.)

1 – 3½" x 5/16" roundhead stove bolt with nut and 2 washers, O.D. 7/16", I.D. 2"



4-H WOODWORKING

PROJECT OUTLINE

MECHANICAL SCIENCE

UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

Woodworking is a 4-H mechanical science project designed to help the 4-H boy or girl develop in the following ways:

ATTITUDES	KNOWLEDGE	SKILLS
1. Good work habits	→ To work effectively	→ Using tools and materials
2. Striving to improve	→ To recognize high standards	→ Applying standards to tasks
3. Thinking ahead	→ How to plan	→ Effective use of time
4. Accepting responsibility	→ What responsibility is and means	→ Completing tasks begun
5. Using logic, facts, and values	→ The basic steps in decision making	→ Solving practical problems
6. Using money wisely	→ The value of money	→ Securing maximum usefulness from available funds
7. Originality	→ To recognize and develop new ideas	→ Applying new ideas and concepts
8. Competing with others	→ To recognize one's own ability	→ Using knowledge and ability to the fullest
9. Being considerate of others	→ To be tolerant of others' opinions	→ Listening and observing
10. Teaching others	→ How to teach (demonstrations)	→ Self-expression

WOODWORKING PROJECT UNIT I

MECHANICAL SCIENCE

You spend much of your life using wood or wood products—the house you live in, the paper you write on, the chair you sit in, and many other everyday items. You will be able to use carpentry, woodworking, and building knowledge on the farm or around your home. Also, what you learn in this project will help you in future 4-H projects in agricultural engineering, livestock, crops, home furnishings, and beautification of home grounds.

THINGS TO LEARN

In this unit you will learn:

The proper, safe use and care of:

- measuring tape
- crosscut saw
- ripsaw
- claw hammer
- wood chisel
- brace and bit
- screwdriver
- plane
- nail set
- wood rasp
- combination square
- try square

How to use a plan.

How to use nails and wood screws properly.

To identify kinds and grades of wood (visit a lumberyard).

THINGS TO MAKE

In this project you'll have an opportunity to choose articles to make from the following list. Remember to use your tools safely. Use the plans to help you make your articles the right size and shape.

First article — choose one

- Sandpaper block
- Cutting board

Second article — choose one

- Bolt and screw rack
- Toolholder (nail or screw brackets)
- Hardware display board of common wood fasteners

Third and fourth articles — choose two

- Toolbox
- Hoe rack
- Miter box
- Toolrack with wood notches
- Bench hook
- Concrete float

THINGS TO DO

Keep a record of your project.

Give one or more demonstrations on your project.

Exhibit what you have made.

Identify nail sizes and 12 common wood fasteners.

WOODWORKING PROJECT UNIT II

MECHANICAL SCIENCE

In this unit you will learn some new skills and practice those you already know. The plans in this unit are designed to help you learn new ways of working with wood. You may select other items to make, if your leader agrees that they will help you learn the same kinds of skills.

The things you learn in this project can help you in many other projects—electricity, livestock, crops, and home furnishing—as well as help you improve your home or ranch.

THINGS TO LEARN

How to read a drawing

How to make a simple working drawing of an item you plan to make

Preparing a list of materials for each item made

How to measure and mark wood

How to buy lumber

How to use four kinds of wood fasteners

How to use and care for:

- Carpenter's rule and tape
- Miter box
- Backsaw
- Coping or jigsaw
- Electric drill and orbital sander
- Block plane
- Sandpaper block
- Paintbrushes

How to prepare wood surfaces for finishing, including puttying, sanding, and cleaning

How to apply oils, stains, primer paints, and finish paints and varnishes

THINGS TO MAKE

Select two items from this group:

- Utility stool
- Spice rack
- Drawer dividers
- Kitchen vertical dividers
- Knife rack
- Kitchen half shelves
- Sleeveboard

Select one item from this group:

- Toolbox
- Tool cabinet
- Sheep-blocking table
- Show box—small
- Chair and step stool
- Garden trellis
- Storage unit of your choice

THINGS TO DO

Exhibit items made in this project.

Give one or more demonstrations.

Keep up-to-date project records.

WOODWORKING PROJECT UNIT III

MECHANICAL SCIENCE

This unit will lead you to greater adventures in woodworking. You will be introduced to some of the basic skills used in building construction and cabinetmaking. The things you make are designed to give you experience using these skills while making useful wood structures. We hope you enjoy this unit and achieve success and satisfaction from your efforts.

THINGS TO LEARN

In this unit you will learn:

The proper, safe use and care of:

- T-bevel
- compass saw
- chisel

How to compute lumber requirements (board feet) and cost

How to make and use common wood joints

How to use dowels

THINGS TO DO

Survey and make three needed repairs to buildings or fences.

Prepare a display of five or more wood joints.

Exhibit what you have made.

Give one or more demonstrations.

Keep a record of your project.

THINGS TO MAKE

Make one of the following or another item using a commercial or University of California plan of similar difficulty (with your leader's approval).*

- Sawhorse
- Show box (large)
- Wall desk
- Camping kitchen
- Doghouse
- Table bench
- Workbench (heavy-type)
- Workbench (cabinet-type)

Make one article of your own design. Prepare a working drawing showing top, side, and end views, with lumber requirements. Obtain your leader's approval before starting construction.

* Plans for many types of farm structures are available at your farm advisor's office. These plans are listed in the Agricultural Extension Service catalog under engineering. These one-sheet laborsavers include plans for pig and lamb brooder, farm gates, kitchen cabinets, fence bracing. livestock chart rack, and many others.

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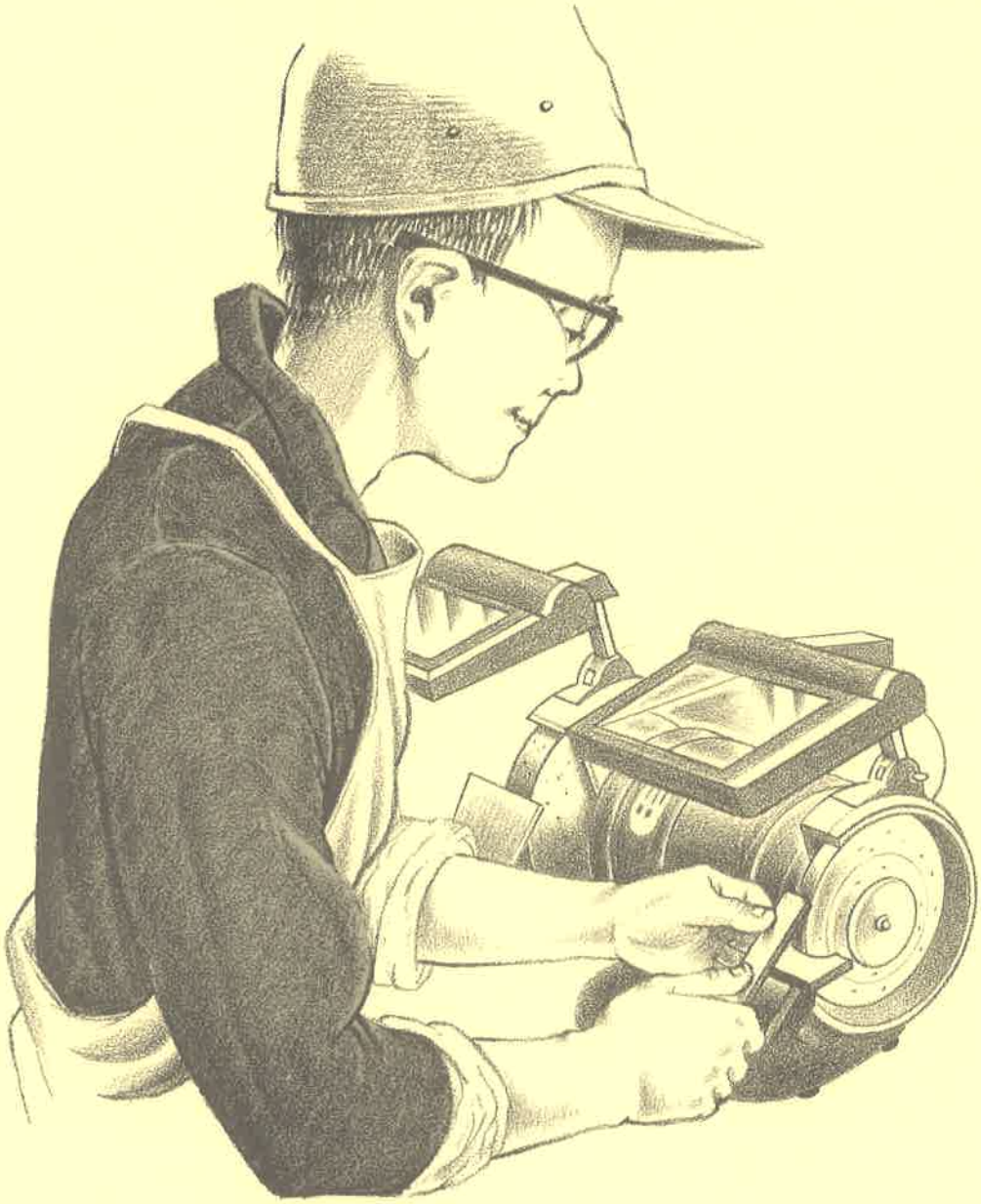
APRIL 1967

WOODWORKING PROJECT UNIT III

MECHANICAL SCIENCE



UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

4-H—Ag 144

The author is Bernard C. Downing, 4-H Club specialist,
assisted by Robert F. Davis, 4-H Club specialist.

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JANUARY 1967--3½M

WOODWORKING PROJECT UNIT III

MECHANICAL SCIENCE

This unit will lead you to greater adventures in woodworking. You will be introduced to some of the basic skills used in building construction and cabinetmaking. The things you make are designed to give you experience using these skills while making useful wood structures. We hope you enjoy this unit and achieve success and satisfaction from your efforts.

THINGS TO LEARN

In this unit you will learn:

- The proper, safe use and care of:
  T-bevel Chisel
  Compass saw
- How to compute lumber requirements (board feet) and cost
- How to make and use common wood joints
- How to use dowels

THINGS TO DO

- Survey and make three needed repairs to buildings or fences.
- Prepare a display of five or more wood joints.
- Exhibit what you have made.
- Give one or more demonstrations.
- Keep a record of your project.

THINGS TO MAKE

- Make one of the following or another item using a commercial or University of California plan of similar difficulty (with your leader's approval).*
  - Sawhorse
  - Show box (large)
  - Wall desk
  - Camping kitchen
  - Doghouse
  - Table bench
  - Workbench (heavy-type)
  - Workbench (cabinet-type)
- Make one article of your own design. Prepare a working drawing showing top, side, and end views, with lumber requirements. Obtain your leader's approval before starting construction.

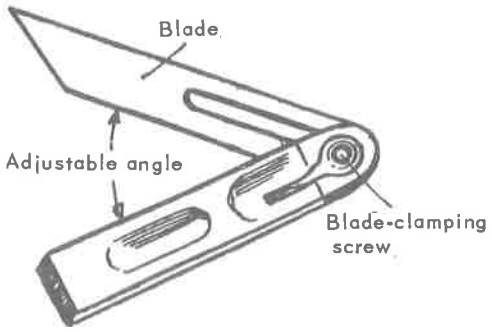
*Plans for many types of farm structures are available at your farm advisor's office. These plans are listed in the Agricultural Extension Service catalog under engineering. These one-sheet laborsavers include plans for pig and lamb brooder, farm gates, kitchen cabinets, fence bracing, livestock chart rack, and many others.

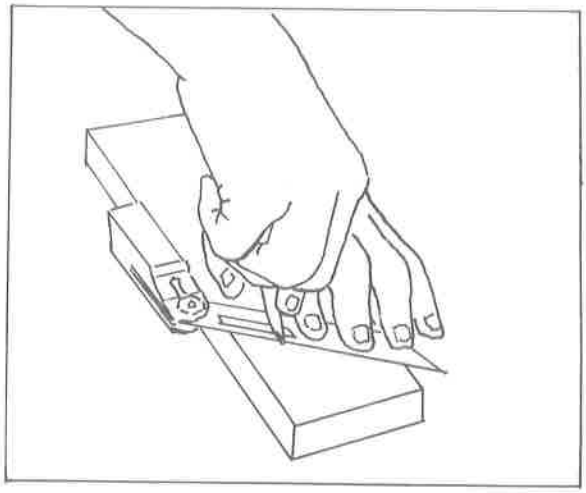
USING TOOLS

The first two units offered suggestions on the proper, safe use and care of several basic woodworking tools. This unit suggests additional tools useful to you as you develop more advanced skills and knowledge.

T-BEVEL

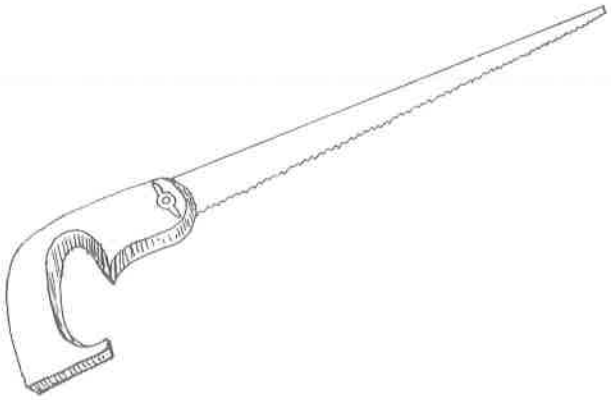
A T-bevel is used for laying out miters, testing mitered ends, beveled or chamfered edges, or duplicating lines drawn at an angle.



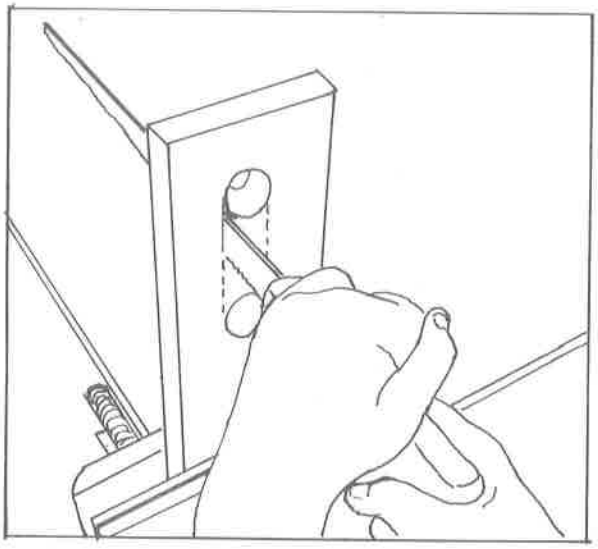


COMPASS OR KEYHOLE SAW

Both of these names often are used for the same saw; however, there is a slight difference between the saws. The compass saw is like a small ripsaw with a short narrow blade. The keyhole saw is similar, with a narrower blade. These saws are used to saw inside or outside curves on stock too heavy for a coping saw.



To start an inside cut with a keyhole or compass saw, bore one or more holes large enough to admit the point of the saw. Insert the saw and cut with smooth, even strokes.



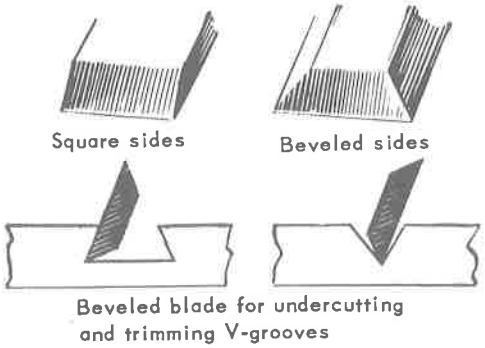
CHISEL

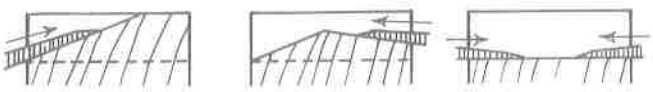
The chisel is a special wood cutting and wood-trimming tool. The three popular types of wood chisels are the gouge, the butt, and the firmer. Although chisels are available in many different sizes and shapes, those used most include, the ¼-inch, ½-inch, and the ¾-inch flat-bladed chisels.

Be very careful when cutting with a chisel, especially when finishing, to make the shavings thin and to cut with the grain of the wood so the surface will be left smooth and bright.

Hold the chisel at a slight angle to the cut, instead of straight. This gives a paring or sliding cut that is easier to make and leaves the work smoother on both the end grain and with the grain.

A chisel frequently is used for roughing. When cutting curves on ends, corners, and edges, both outward curves and inward curves (convex and concave), it is better to remove as much waste as possible with a saw. A coping saw may be used for curves in thin wood, a compass saw or turning saw for curves in thick wood, and a crosscut saw for straight cuts. Then use a chisel to finish the work.

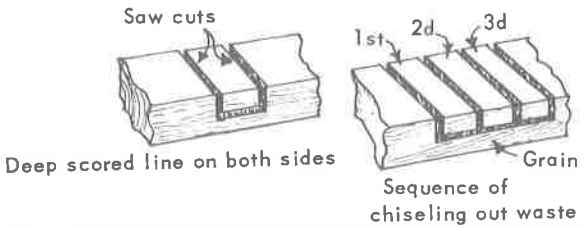


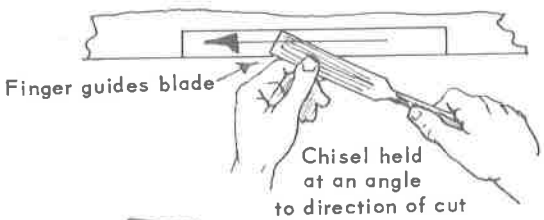


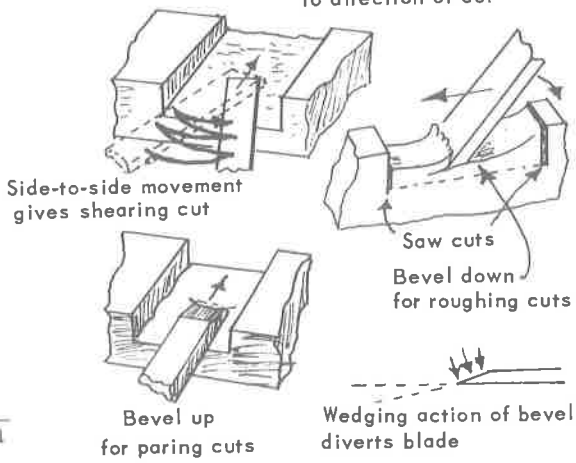
For light and delicate work, use both hands. Guide the blade with one hand while pushing with the other. For rough cutting, use a wooden or leather mallet to drive the chisel. Light taps permit better cutting control than heavy taps. Don't use an ordinary hammer in place of the mallet, because the hammer can ruin the chisel handle.

For roughing cuts and removing waste, cut to within 1 inch of the finished line, holding the chisel with the bevel down. For light cuts, hold the chisel with the bevel up (see illustrations).

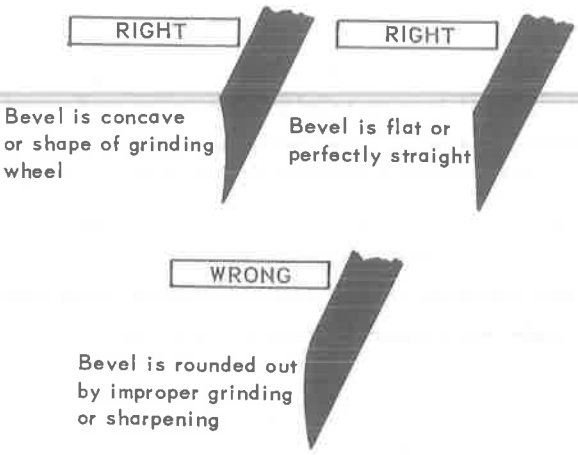
To avoid splintering the corners, cut from each edge toward the center. Remove the center portion last.







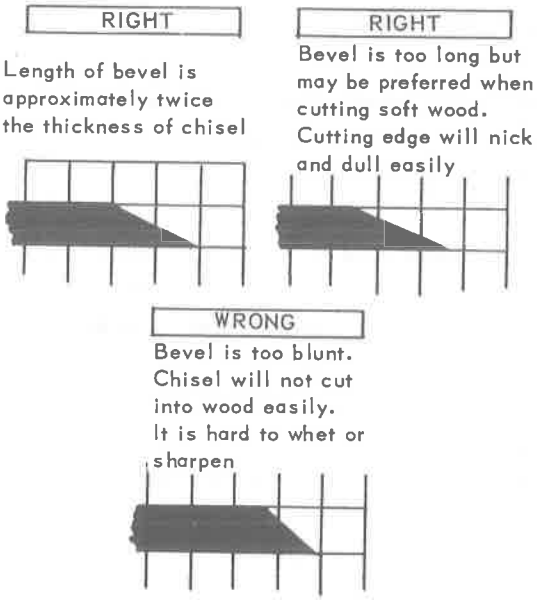
To sharpen the wood chisel and plane iron, whet them on the oilstone to give a very sharp cutting edge. When the cutting edge is nicked or the angle is incorrect, it is time to grind it. A grindstone is best for this, but a fine-grit emery wheel can be used. The grinding wheel should turn toward the chisel. Dip the chisel or plane iron in water frequently to prevent overheating.

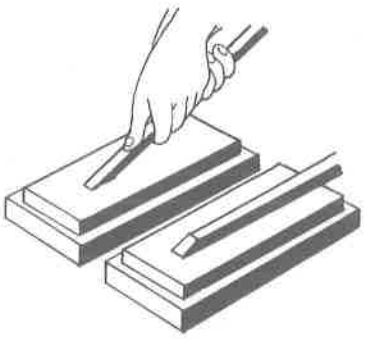


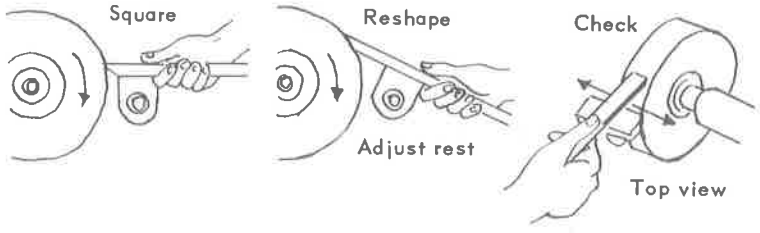
Once the chisel is ground, it can be kept sharpened for a long time by whetting (finish the blade tip on a whetstone) as often as necessary. Here are the steps in keeping the edge of your chisel razor-sharp.

1. Clean oilstone and place enough oil on it to wet surface.
2. Place a chisel on the stone (see illustrations).
3. Hold the chisel firmly and move it back and forth along entire length of stone, keeping the correct angle at all times.

   CAUTION: To avoid wearing a groove in the stone, move the chisel evenly over entire stone.
4. Place flat side of chisel on stone, as illustrated, and remove wire edge.
5. Repeat stoning of bevel and flat part until the chisel is sharp.
6. For an extremely keen edge, finish with a few strokes on a leather strap, or by stropping first on one side and then on the other side on a soft wood block.







WOOD JOINTS

Nearly all articles or pieces of furniture that you will make have more than one part, so it will be necessary to join the various parts. The attractiveness of your completed article will be determined largely by the care with which you make the joints.

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

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

To make joints neat and workmanlike in woodwork:

- 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 made accurately and smoothly.
- 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.

There are two main kinds of joints:

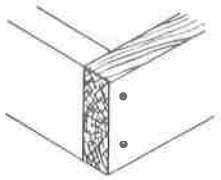
- **Edge joints**, in which the edges of two or more boards are joined, are used to make a wider piece.
- **Corner joints** are those in which the edges or ends of the stock come together to form a corner, as in a box.

On the following pages, many of the more common types of joints are illustrated and described. 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.

You also should study the more complicated joints illustrated. They frequently are used in furniture construction and nice cabinetwork. Learn to recognize them and be able to judge how well furniture and other wooden articles are constructed. Later, when you work with power tools, you will have need for such joints in the cabinetwork you will want to do. Keep this manual as a future reference.

JOINTS HELD TOGETHER BY NAILS, SCREWS, OR DOWELS

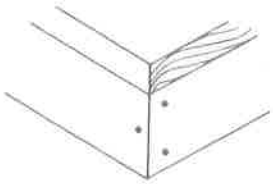
The butt joint is the simplest. It is formed by butting the end of one board against the edge or face of another.



Butt joint

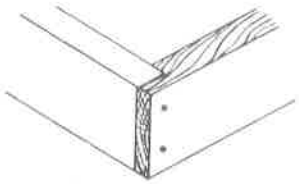
It is used at the corners of boxes and crates. The ends and edges of the boards should be square. Care must be taken when the two pieces are placed together. Use your trysquare to make sure that the boards are squared with each other and remain in this position while you drive in the nails or screws.

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



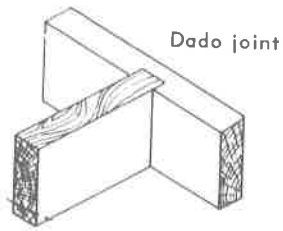
Miter joint

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 often is used in drawer construction. The sides of the drawers are fastened to the front with rabbet joints. Such joints usually are held together with nails or screws and glue.



Rabbet joint

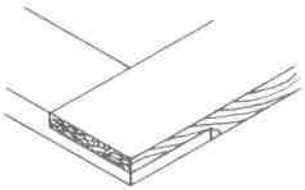
The dado joint is much like the rabbet joint, except that the groove is not cut at the end of the stock. Cut the groove just wide enough to allow the end of the second member to fit into it. The position of the joint on the stock often determines the name.



Dado joint

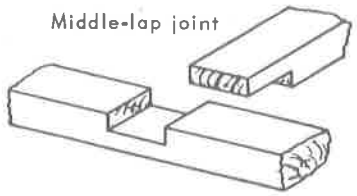
Such joints frequently are used to hold the shelves of bookcases, the steps of a stepladder, and in other furnishings in which both strength and attractiveness are required.

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.



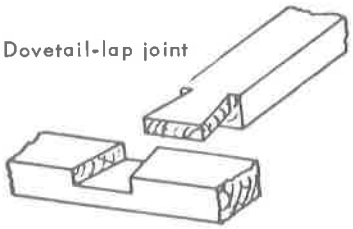
End-lap joint

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 usually are at right angles to each other.

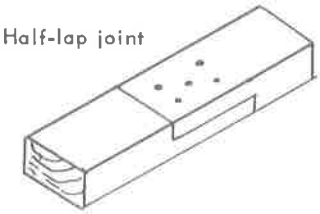

Middle-lap joint

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

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

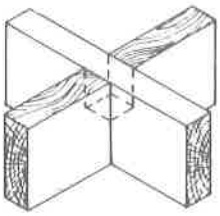

Dovetail-lap joint

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


Half-lap joint

The **cross-lap joint** is one of the more complicated forms of the lap joint. The two parts are each grooved to one-half their depth and, when assembled, the grooves overlap to form a cross.

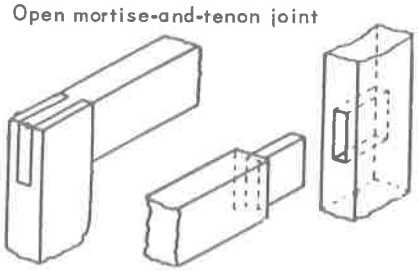
The bases for pedestal-type tables often are made with cross-lapped joints.


Cross-lap joint

Mortise-and-tenon joints are among the strongest and most attractive of all, if constructed so that the parts fit closely.

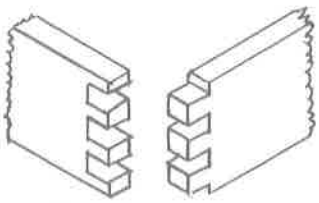
Mortise-and-tenon joints may be used at the ends of the stock to form corners, as in the construction of screen doors or window sash. In the open or slip-type mortise-and-tenon joint, the tenon is exposed on the side and end. The tenon of the blind mortise-and-tenon joint is concealed.

Open mortise-and-tenon joint


Blind mortise-and-tenon joint

Stub mortise-and-tenon joints are used in furniture where the rails of a table fasten into the legs.

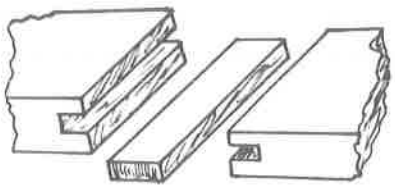
Through-mortise-and-tenon joints are made with the tenon extending all the way through the piece to which it is attached.


Through dovetail 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 often is made with tongue-and-groove joints at the ends as well as at the edges.

Tongue-and-groove joint

The feather or spline joint is similar to the tongue and groove 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.



Feather or spline joint

Doweled joints are similar to feather or spline joints, except round, wood dowel pins are used instead of the feather to hold the parts together.

Dowel rods are round pieces of hardwood, usually birch or maple. They generally come in 2- or 3-foot lengths. The diameters of these rods range from $\frac{3}{16}$ inch upward. Shorter grooved dowels are used in cabinetmaking but, for the average individual, dowels may be made easily by cutting the desired length from the dowel rod.

Plain dowel

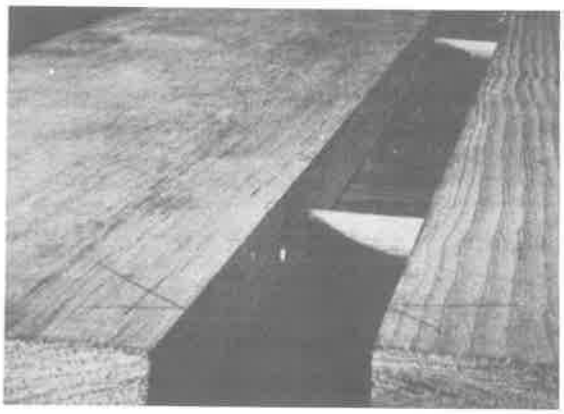
Grooved dowel

The dowel joint is a secret-type joint that is rather difficult and complicated. It is important that you bore the holes straight; line them up and carefully—otherwise the joints will not fit together properly. Use glue with this construction.

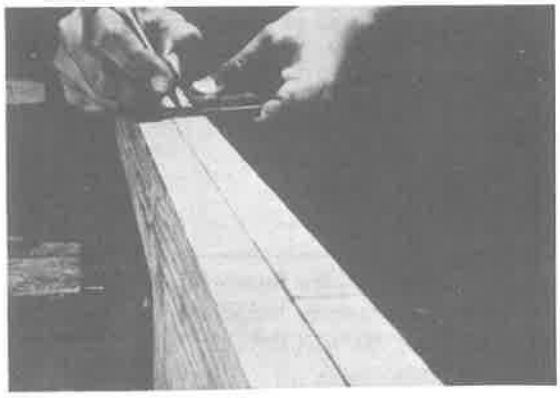
Spiral dowel

The dowel butt joint is used where two pieces of wood are the same thickness. This is done instead of driving nails into the lumber. Holes must be located carefully and care must be taken that the holes are bored straight.

Gluing boards edge to edge to make it possible to increase the width of the stock is an example of a butt joint. Generally, use three dowel pins when a board is more than 12 inches long.

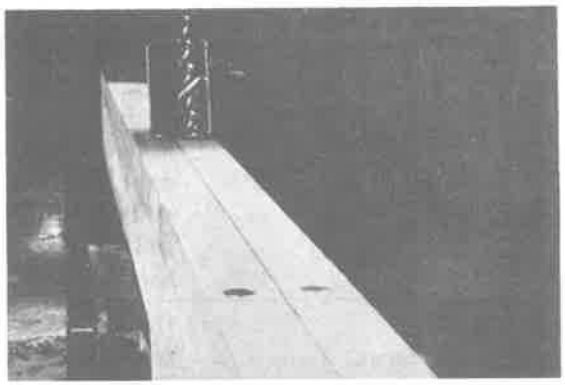


Care must be taken in laying out the location of these dowel pins and in boring the holes straight. Holes should be bored about 1½ inches deep.



Cut the dowel rod into lengths which will enable it to extend into both boards without the dowel holding it apart. For example, suppose that you bored holes 1½ inches deep into each member, then your dowel rod would be cut 2¾ inches long to allow plenty of clearance when clamping up. Cut the groove along the length of the dowel to allow glue and air to work its way along the length of the dowel. Bevel the ends of the dowel pin slightly to allow the dowel to go into the hole more easily. Before glue is applied, make a trial assembly. This is to make sure that everything will fall into proper position when clamped. When applying glue, place it in the holes and on the dowel pins. Turn the pins in the holes after the glue has been applied to make sure the glue completely covers the surface of the dowel. Clamp the stock and leave the clamps until the glue is dry, usually about 24 hours.

Dowels are so arranged that they are not visible from any angle. They give added strength to the common butt joint and often are used to strengthen other joints. When using ¾-inch stock, the ⅜-inch dowel is most commonly used. A good rule is to have the diameter of the dowel used equal to one-half the thickness of the stock in which it is to be used.



It would be worth your time to make these joints on pieces of scrapwood before attempting to use them in your project.

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 need clamps for this purpose.

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, be sure to 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.

Follow the manufacturer's recommendations.

CLASS	PROPERTIES	APPLICATIONS
Animal glue Dry and liquid forms. Quality variable.	High dry strength. Low resistance to moisture and damp conditions. Stains wood slightly, if at all.	Dry forms must be soaked and melted. Keep solution warm during application. Apply liquid forms as received. Press at room temperatures.
Casein and vegetable proteins Dry powder forms. Determine quality by tests on wood joints.	High to low dry strength. Moderate to low water resistance. Not recommended for outdoor exposure. Dulls tools badly. Stains some woods badly.	Mix with cold water and apply cold. Press at room temperature.
Urea resin Dry and liquid forms. Determine quality by tests on wood joints.	High strength both dry and wet. Moderately durable under damp conditions. Not suitable for outdoor exposure. Low resistance to temperatures above 150°F. Little or no staining of woods.	Mix dry form with water. Apply at room temperature. Cure at 60° to 110° F.
Resorcinol resin Some brands available as liquid. Hardener supplied separately. Relatively high priced. Test on wood joints for quality.	High in both wet and dry strength. Very resistant to moisture and damp conditions. Very suitable for outdoor exposure. Very resistant to high temperatures. Stains wood very slightly.	Mix with catalyst and apply at room temperatures. Cure at 70° F or above.
Polyvinyl resin emulsion White glue. Sold in liquid form ready to use. Test on wood joints for quality.	High dry strength. Low resistance to moisture and high temperatures. Joints tend to yield under constant pressure. Not recommended for edging and veneering. Stains wood little, if any.	Ready to use. Apply and press at room temperature. Very fast setting. Clamps may be removed in 30 minutes. Excellent furniture-joint adhesive.

CAMPING KITCHEN

This camping kitchen is planned as a durable, lightweight container for the camp stove, silverware, kitchen tools, condiments, nesting cooking kit, wax paper, aluminum foil, etc. Use ¼-inch plywood to keep weight at a minimum. The exterior corners are reinforced with Fiberglas cloth for maximum strength with smooth surfaces.

The unit may be placed on a picnic table or be used with its removable legs. This is only a suggested size. Alter to fit your equipment, etc.

Materials:

1 pc 4' x 6' x ¼" exterior grade plywood
2 pc ⅜" x 4¼" (actual dimensions) strips
Box lumber ⅛" thick, for knife holder
1 pc ½" x ¾" x 4' parting stop
1 pc 6" x 12" x ⅜" exterior grade plywood
1 pc ¼" x ¼" x 62" (actual dimensions)

½" wire brads
¾" wire brads
2 – 1 1/16" (open) x 24" continuous hinges or
1 – 48" long with ⅜" screws
4 bullet catches
8 – 3/16" x ⅝" roundhead stove bolts with nuts

4 – 3/16" x ⅝" flathead stove bolts with nuts
16 – 3/16" or ¼" steel washers
8 – 3/16" lock washers
6½' sash chain
48 – ⅝" #3 or #4 flathead wood screws

2' – ¼" rope or sash cord
Waterproof resorcinol glue
1 pc 1" x 8" leather for door, silverware and drawer pulls
Fiberglas cloth and epoxy resin to reinforce 4 exterior joints (4 strips 4" x 12")
1 – 1" x 60" luggage or boat straps
Wire staples to hold Fiberglas cloth while resin is setting

Legs:

4 pc ¾" x 2" x 46" (actual dimensions)
8 – ¼" x 1¼" machine bolts with wingnuts
16 – ½" steel washers

Construction:

1. Determine if your equipment will fit into the unit as dimensioned. Alter dimensions and plan as necessary.

2. Lay out cutting plan.

3. Cut pieces for top, bottom, and ends, and label.

4. Assemble outer frame. Use ¼" x ¼" x 10" reinforcing blocks with ½" brads and glue, and ¾" brads through endpieces into top and bottom pieces plus glue.

5. Attach shelf and partitions with glue at butt joints plus ⅝" screws placed about 3" apart.

6. Cut and attach doors. File off protruding hinge-screw tips. Attach door stiffener with bullet catches, using 4 – ⅝" screws. Fasten bullet-catch steel strike to ¾" x ¾" piece of ¼" plywood to top with glue and nail provided. Attach door support chains. Attach leather pulls.

7. Make trays. Put ¼" x ¼" x 10¾" runners under the kitchen tool tray, and leather pull on end of silverware tray.

8. Assemble knife holder and cutting board holders. Attach to top with ⅝" screws.

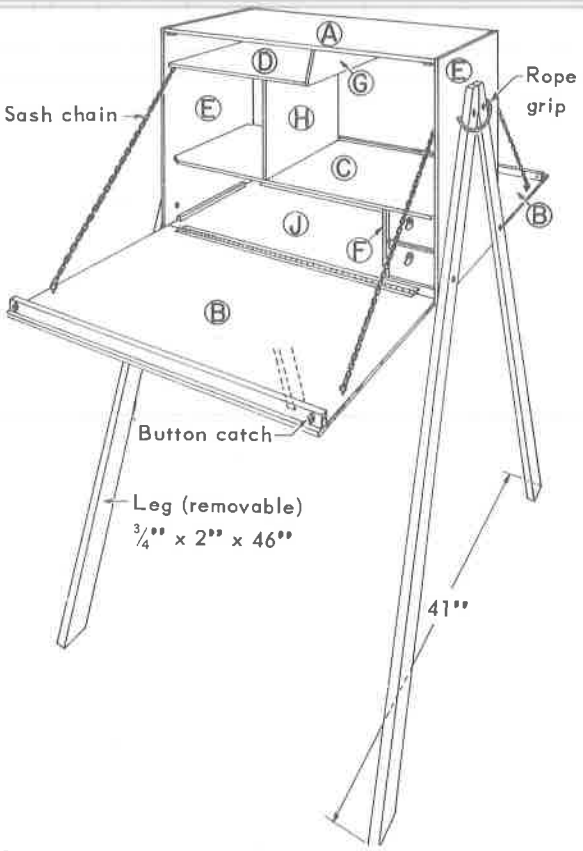
9. Drill holes for and attach rope handles.

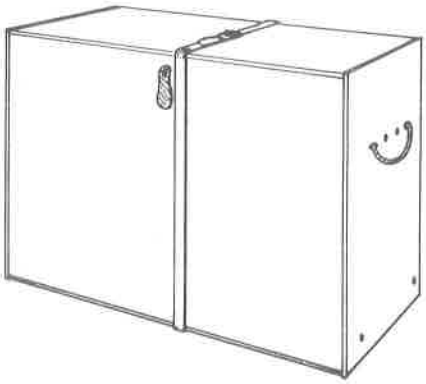
10. Make legs and drill holes in sides of kitchen.

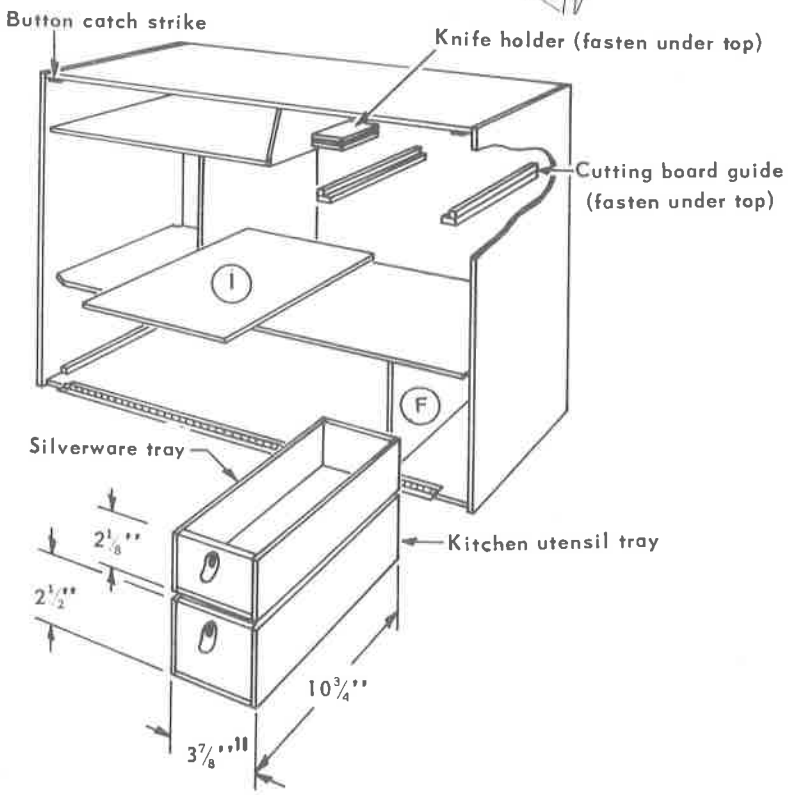
11. Slightly round all corners and edges.

12. Reinforce end joints at top and bottom by applying a 4" x 12" strip of Fiberglas cloth to the outside of each joint. Follow manufacturer's directions.

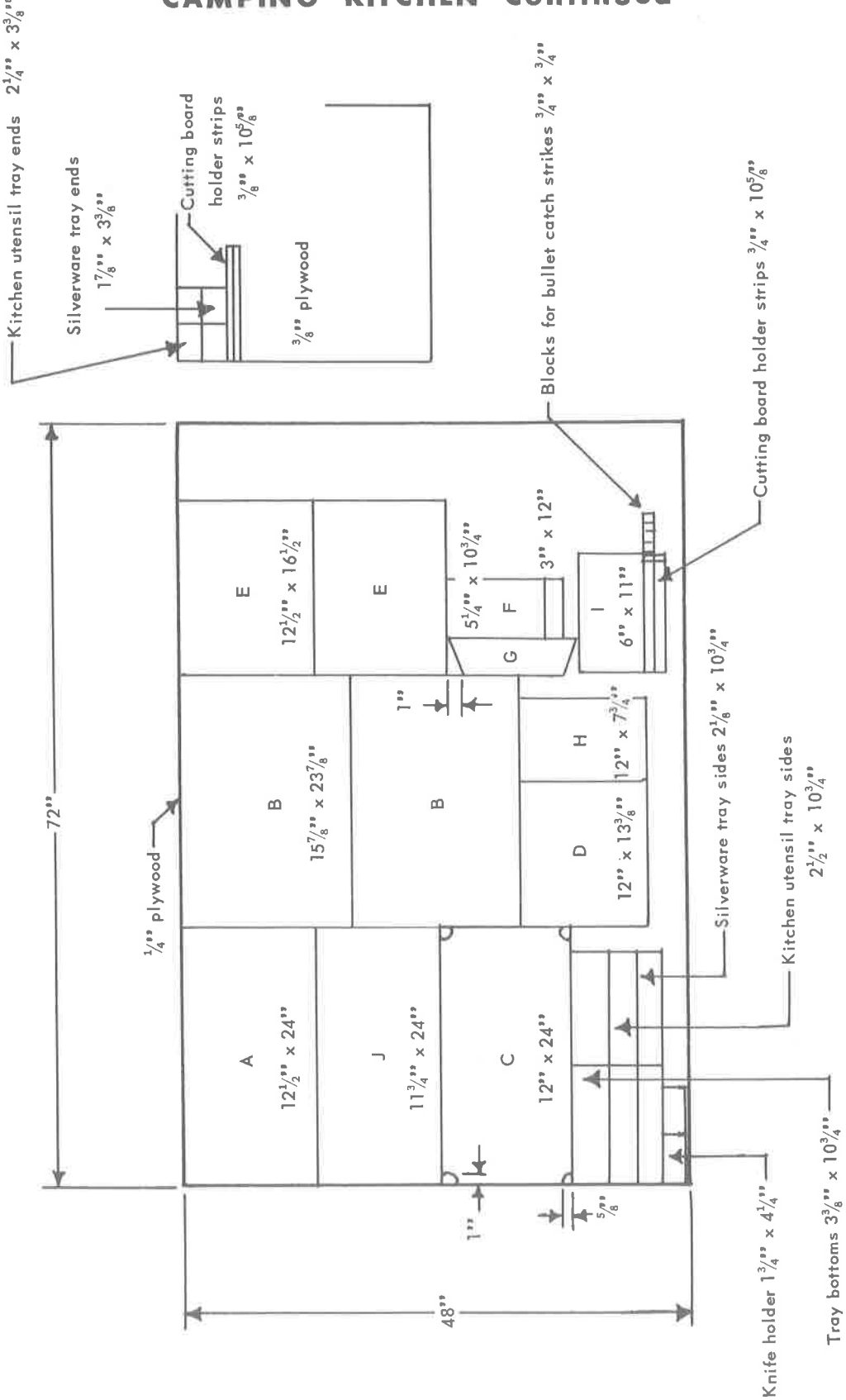
Note: To prevent glass cloth from buckling crosswise, staple about 2" apart in a line about 1" from the edge. Remove staples before applying second coat of resin.







CAMPING KITCHEN Continued



SHOW BOX (Large 1½' x 2' x 4')

Materials:

1 pc 1" x 4" x 10' pine s4s
3 pc 1" x 2" x 10' pine s4s
1 pc 1" x 2" x 12' pine s4s
1 pc 4' x 8' x ½" exterior grade fir plywood
1 pc 2' x 2' x ¼" interior grade fir plywood

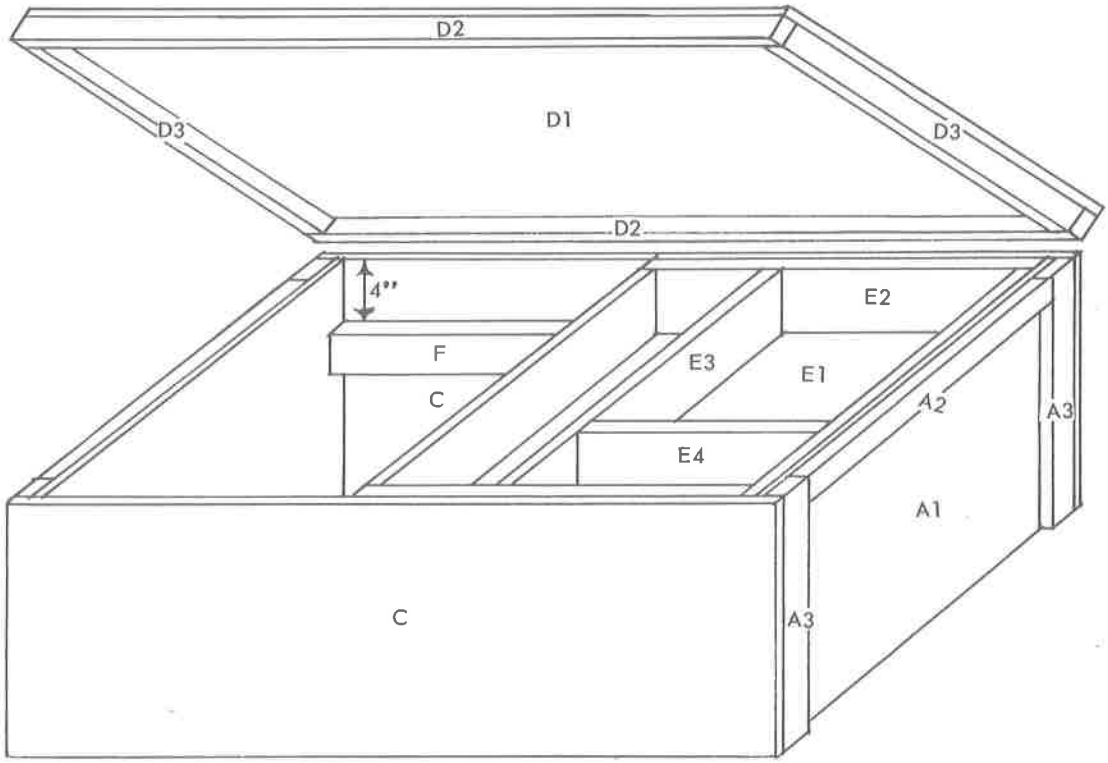
Parts Identification:

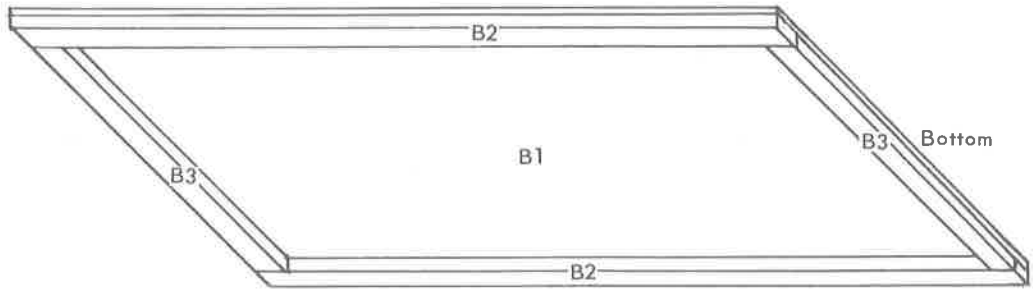
A2	–	1" x 2" x 18¾"	(2)
A3	–	1" x 2" x 16"	(4)
B2	–	1" x 2" x 45½"	(2)
B3	–	1" x 2" x 18¾"	(2)
D2	–	1" x 2" x 48"	(2)
D3	–	1" x 2" x 21½"	(2)
E1	–	23" x 21¾" (¼" plywood)	(1)
E2	–	1" x 4" x 23"	(2)
E3	–	1" x 4" x 20¼"	(3)
E4	–	1" x 4" x 12"	(1)
F	–	1" x 2" x 45½"	(2)

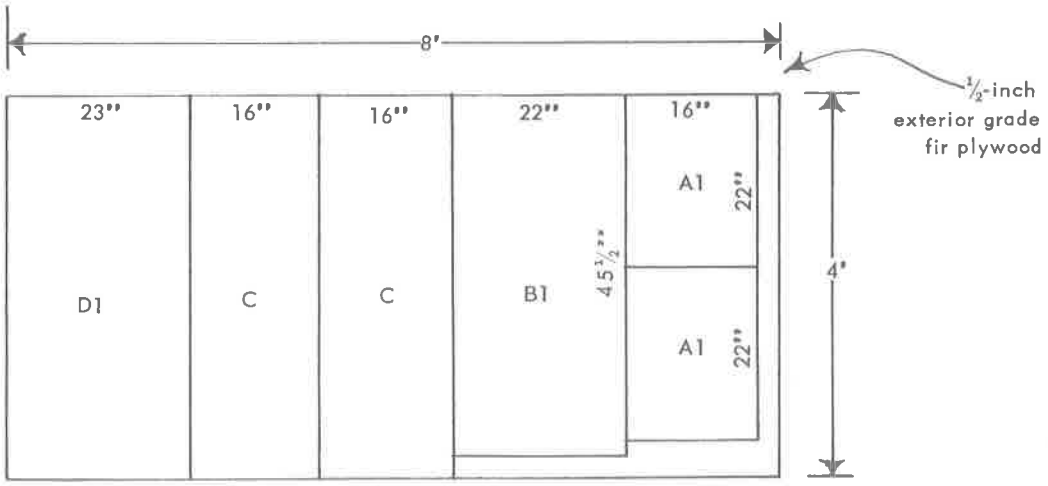
Construction:

1. Cut all pieces to exact measurements listed, or to fit your own requirements.
2. When assembling parts, fasten with water-resistant glue and finish nails or with screws.
3. Assemble all B parts to form the bottom of the box.
4. Assemble all A parts to form the two ends of the box.
5. Fasten the ends to the bottom.
6. Fasten parts C (the sides) to the bottom and ends.
7. Assemble all E parts to form the sliding tray.
8. Fasten parts F in the box 4 inches from the top, or at a height that will keep the tray from protruding above the top edge of the box.
9. Assemble all D parts to form the lid of the box.
10. Fasten the lid to the box, using a piano-type hinge.
11. Sand all joints so they look as if they grew together. Round off exposed edges of plywood to prevent splintering.
12. Add hardware as desired, such as handles, latches, corner protection, etc.

SHOW BOX (Large 1½′×2′×4′)







SAWHORSE

Materials:

1 pc 2" x 6" x 7' fir
1 pc 1" x 6" x 8' fir
1 pc 1" x 4" x 2' fir
16 – 8d common nails
24 – 1½" #8 flathead screws

Note: Sawhorse should be unfinished for exhibit.

Tools:

Hammer
Crosscut saw and ripsaw
Trysquare (if available)
Framing square
Rule
Pencil
Jack plane
Countersink bit

Construction:

1. Study the plan carefully and understand all dimensions and instruction methods before cutting any of the pieces.

2. Select working face on all pieces.

3. Apply glue to all joints during assembly.

4. Cut top 2" x 6" members to length.
   a. You may use the remaining 2" x 6" material to construct endpieces that fit between the two top members.
   b. Make sure top and bottom are straight and square, with a working face.

5. Place the 2" x 6" x 36" members outside the two endpieces.
   a. With a pencil, mark a straight line from the top and bottom of the endpieces across the ends of the 2" x 6"'s.
   b. Plane the 2" x 6" members down to mark, so that the three pieces form a straight line across top and bottom.

6. Cut the four legs to required length. Use framing square as shown in cutting method.

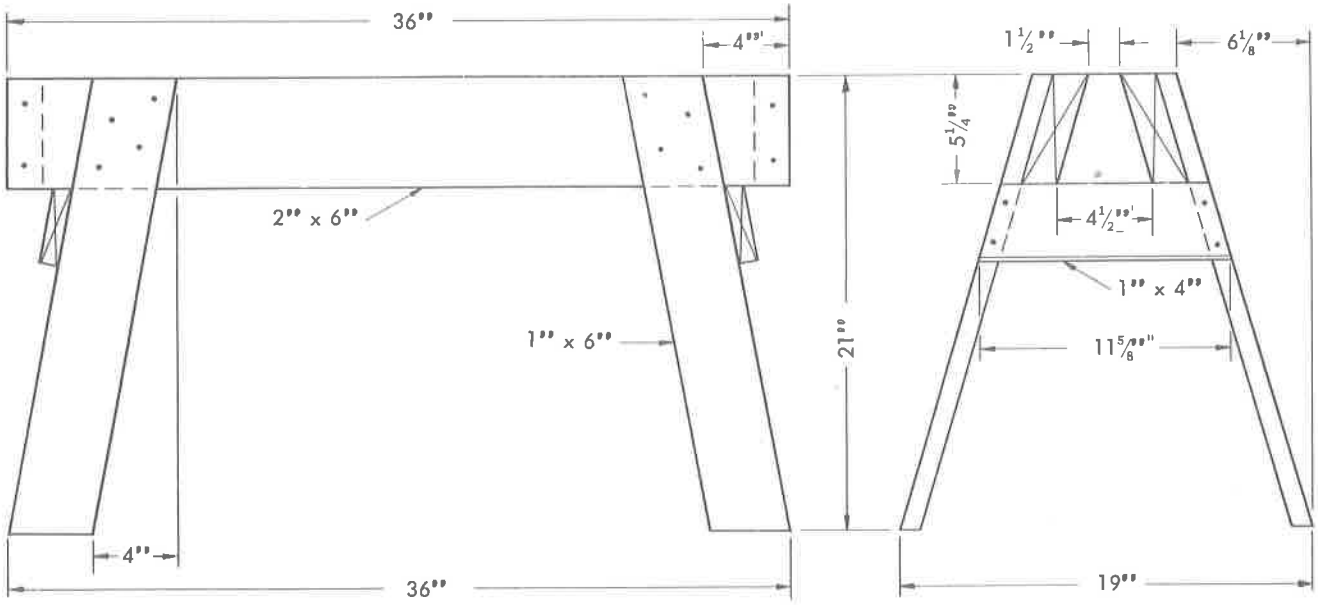
7. Attach legs to top members as shown, using #8 screws. Countersink all screws.

8. Cut leg braces to desired shape, and bevel top edge.

9. Attach braces to legs, using #8 screws.

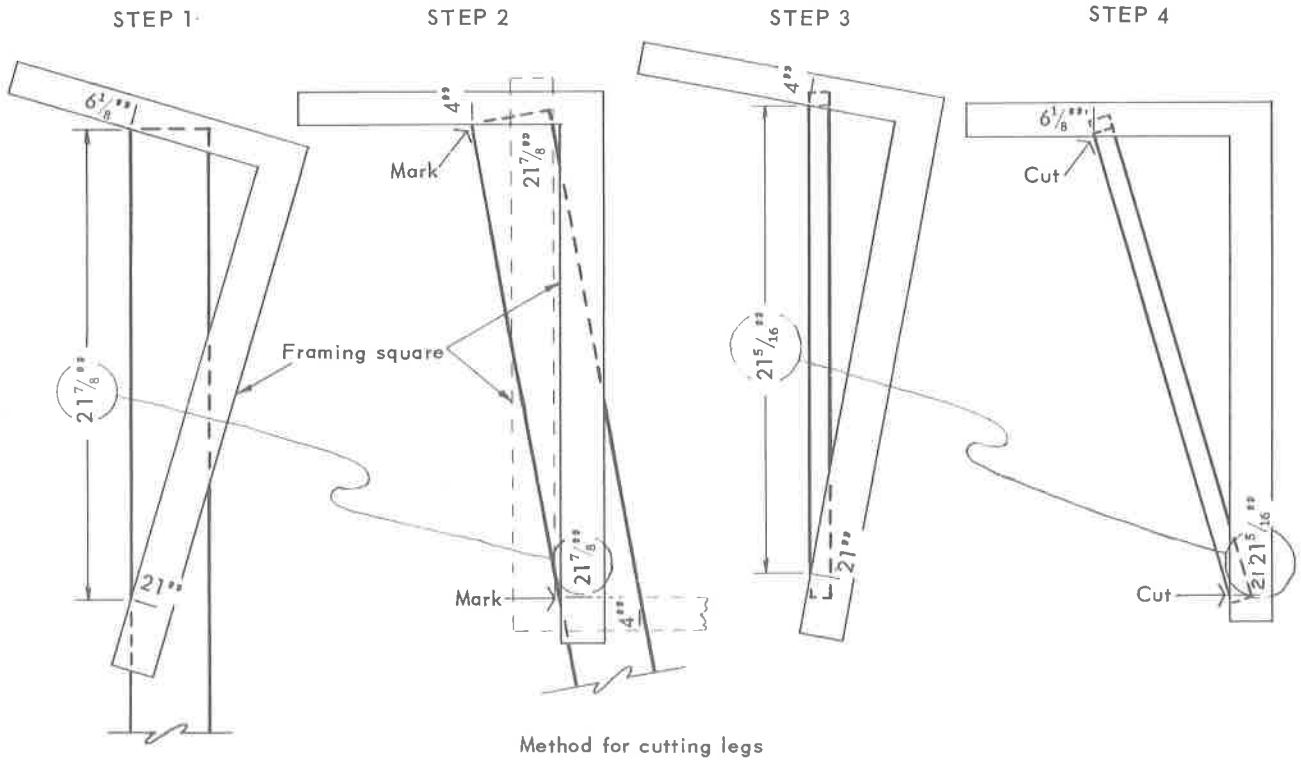
10. Nail endpieces between top members as shown, using 8d nails.

AN OPEN-END SAWHORSE



Side view

End view



Method for cutting legs

WALL DESK

This deskwill be handy in your room or shop. It takes little space and provides storage for papers and plans. Exterior plywood is better for hard usage or damp locations.

Materials:

Exterior plywood, grade A–A
(See cutting diagrams for sizes and thickness.)
2 lid supports, with screws
4 lineal feet, ⅜" dia., hardwood dowels
1 pc 14½" x 26½" plastic laminate
1 pc 28" long piano hinge, with hardware
6d finish nails
Glue
3 – 1½" x ½" corner braces
12 – ¾" #6 wood screws

Tools:

Crosscut saw
Trysquare
Rule
Marking gauge
Wood chisels
Brace and bits
Hammer
Nail set
Screwdriver

Parts Identification

A – Back of unit
B – Drawer parts and dividers
C – Vertical dividers
D – Side
E – Shelf
F – Bottom
G – Top
H – Desk lid

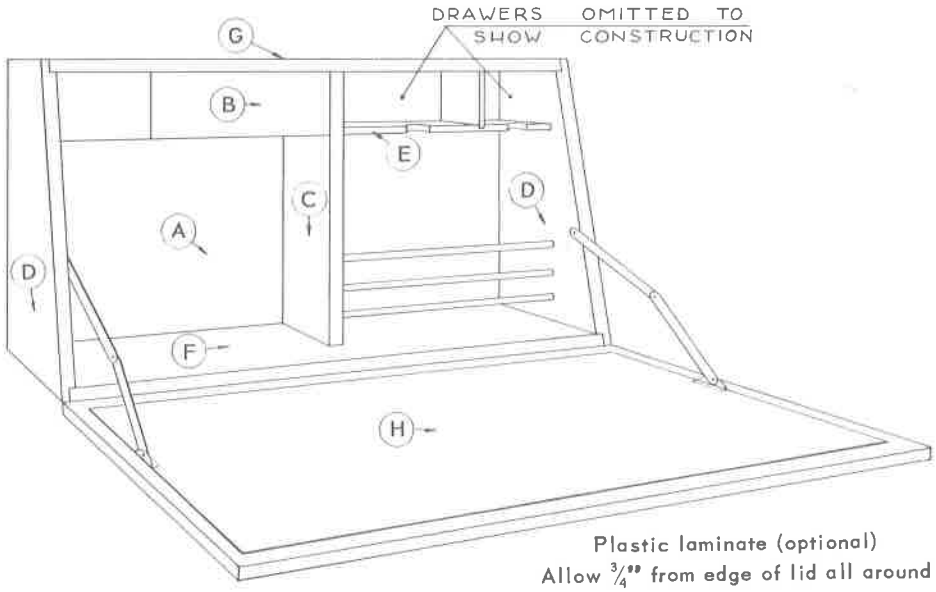
Construction:

Glue joints during construction, for added strength.

1. Complete all details on parts D, F, G before starting assembly.
2. Assemble parts D, F, and G.
3. Complete all details on parts A, C, and dowels.
4. Fit dowels into blind holes on D.
5. Fit C on dowels and locate in proper position.
6. Fasten parts; be sure dowels are glued to C and D.
7. Complete all details on parts E and dividers from group B on lower cutting diagram.
8. Assemble parts E and dividers to parts D and C; part E should be toenailed from bottom into part C.
9. Complete all details on parts in group B.
10. Assemble parts in group B.
11. Complete details of part H.
12. Assemble part H, with hardware, to parts F and D.

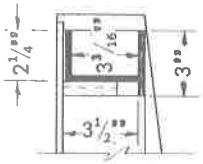
Finish: Remove all rough spots with fine sandpaper; use clear filler, shellac, and varnish.

WALL DESK

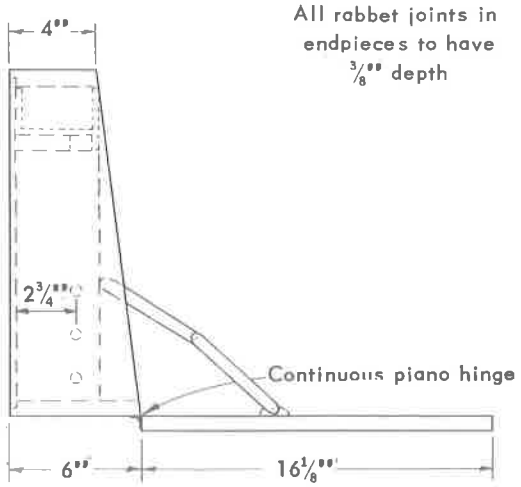


Plastic laminate (optional)
Allow $\frac{3}{4}$" from edge of lid all around

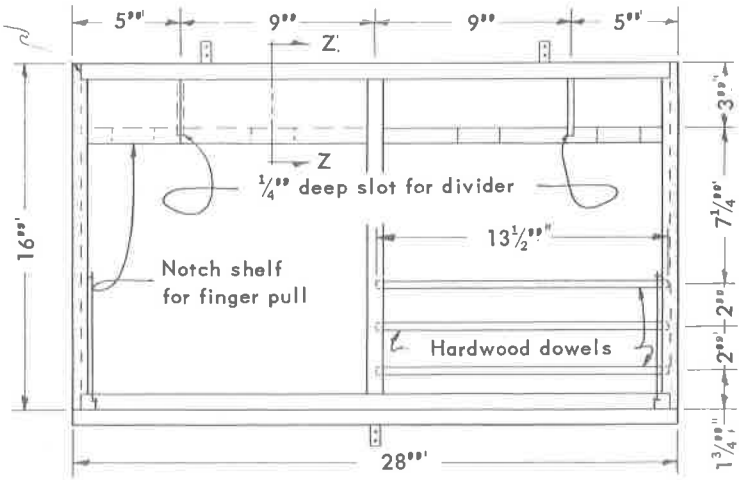
PERSPECTIVE



Drawer section
Z – Z

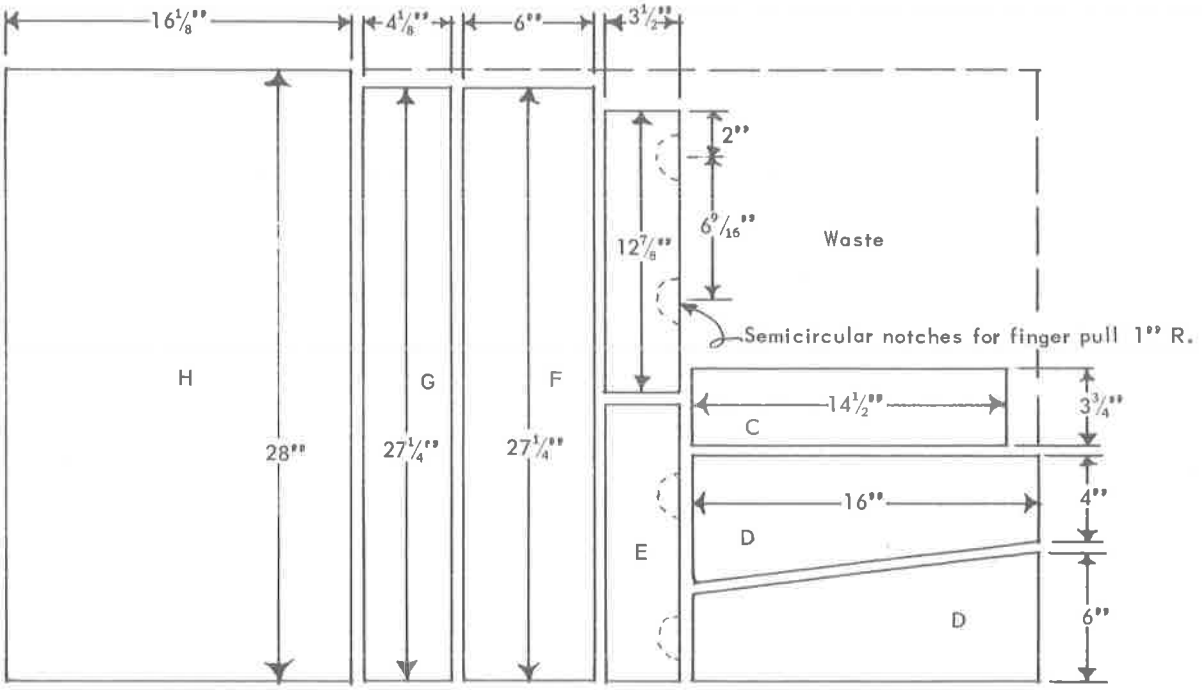


SIDE VIEW



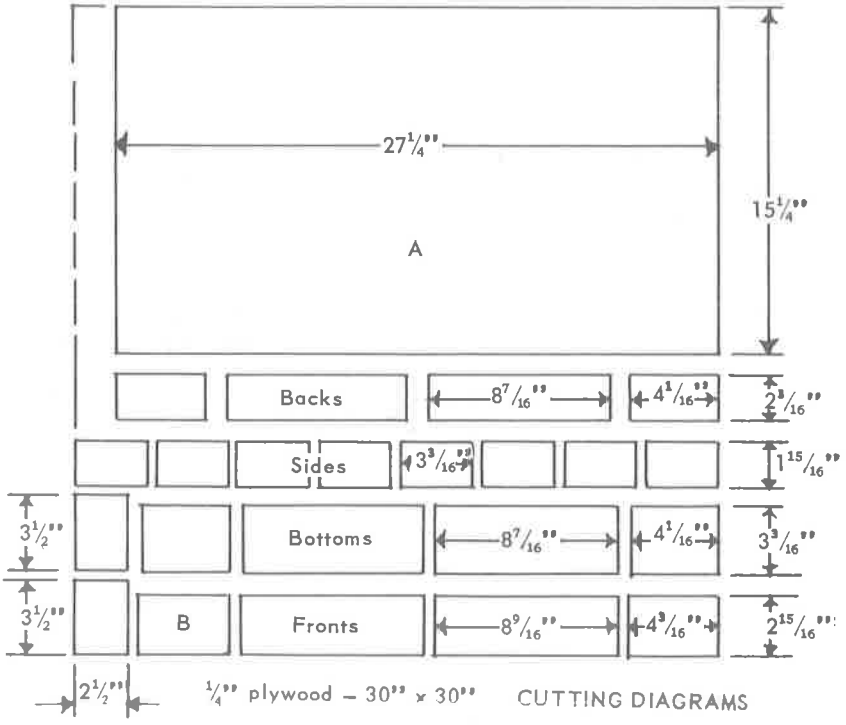
FRONT VIEW

WALL DESK Continued



3/4" plywood – 28" x 48"

Note: When cutting, allow for saw cut and finishing.



1/4" plywood – 30" x 30"

CUTTING DIAGRAMS

WORK BENCH - PLAN A

This is a basic plan to be altered in relation to material, height, and vise. Hip height is very comfortable. If you plan to do a great deal of hand planing, it may be desirable to lower it a few inches.

35" leg height and 24" x 60" plywood top

Materials:

1 pc ¾" x 4' x 8' exterior grade plywood
1 pc ¼" x 4' x 8' exterior grade plywood
1 pc 2" x 6" x 2' (E)
2 pc 2" x 4" x 12' (G)
2 pc 2" x 4" x 8' (A,B,C,D)
1 pc 2" x 2" x 12' (F,H,I)
1 pc actual dimension ⅜" x ⅜" x 8' door glides, hardwood preferred

2 pr 2" x 2" butt hinges, with screws
4 door or drawer pulls, with screws
2 door catches
12 – 1½" #10 flathead wood screws (attach top)
Penetrating wood sealer for finish
¾" wire nails
6d finish nails
6d common nails
8d common nails
10d common nails
16d common nails
40d common nails

Optional:

1 pc 2' x 5', ⅛" or ¼" Masonite or equivalent to cover plywood top

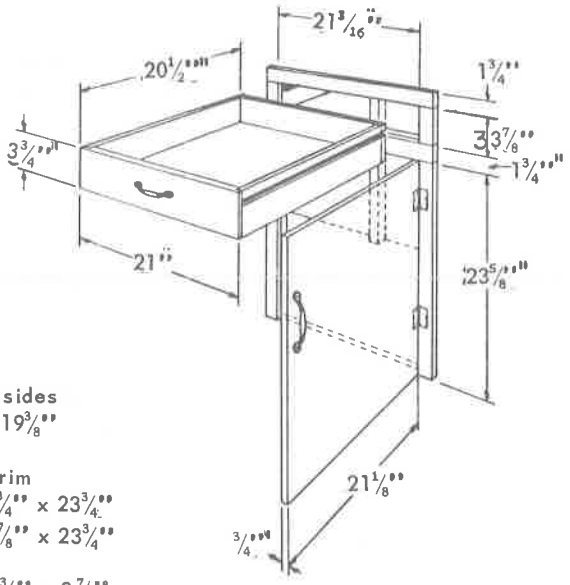
Variation: 22½" x 60" plank top (change leg width to 20")

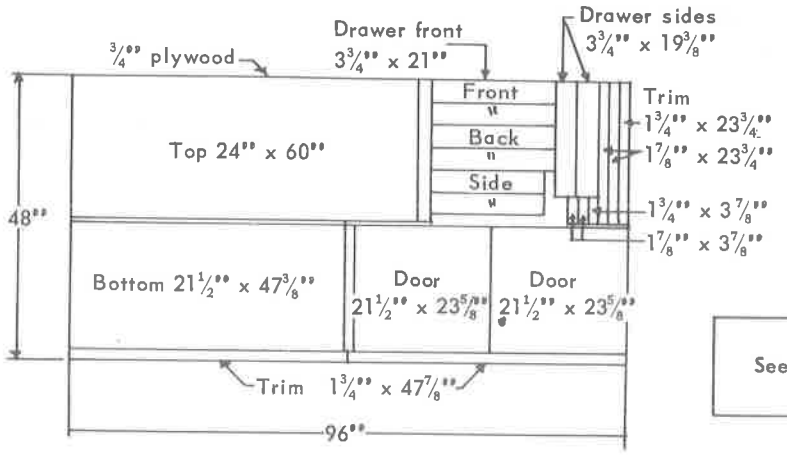
Add 3 pieces of 2" x 8" x 5' for top, attach with 18 – 3" #14 flathead wood screws
– 1" x 4" for drawer ends and sides
– ¾" x 1¾" and 1⅞" (actual dimensions) for trim pieces on front
Change ¾" plywood to 4' x 4' for doors and bottom

Construction:

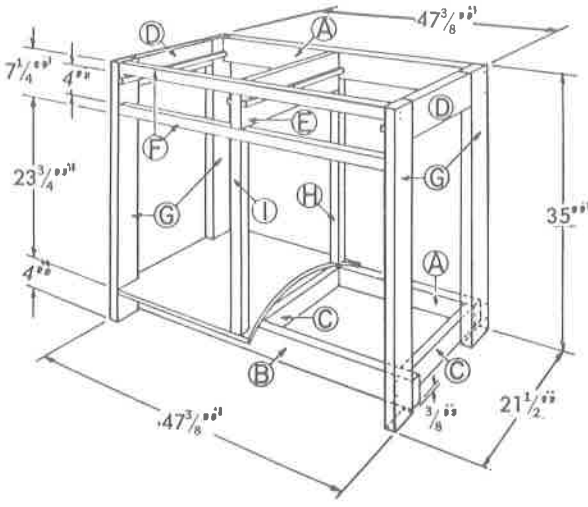
1. Determine height.
2. Make changes in dimension on plan to suit selected height. Make calculations for specific material lengths.
3. Cut pieces A through G.
4. Assemble front legs and pieces B and F.
5. Assemble back legs and pieces A.
6. Add pieces C, D, and E to back assembly.
7. Cut and insert bottom.
8. Attach front assembly to rear assembly.
9. Cut and add pieces H and I.
10. Brace inside for squareness.
11. Cut and attach ¼" plywood to back and ends.
12. Cut and attach trim to front.
13. Cut, fit, and hang doors (1/32" clearance on hinge side and 1/16" on opposite side and top).
14. Make drawers
15. Attach top—drill shallow holes so screw heads can be set below table surface. Plug with a section of dowel or plastic wood after screws are set.
16. Finish with penetrating wood sealer.

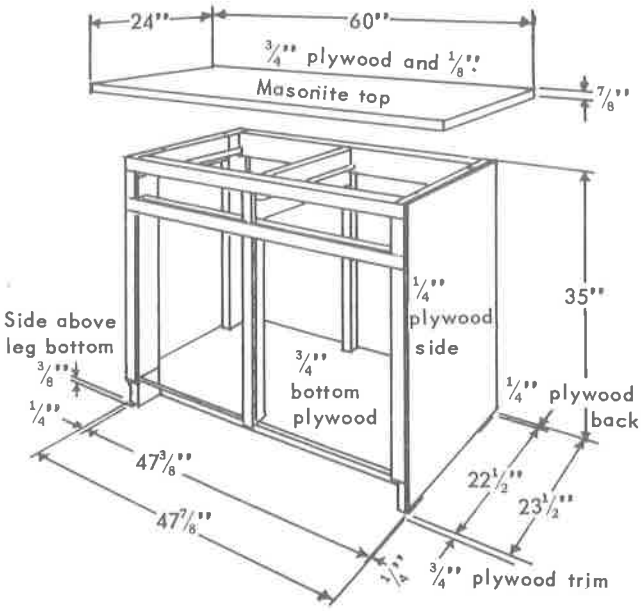
WORK BENCH - PLAN A Continued





See inside back cover for drawer detail.

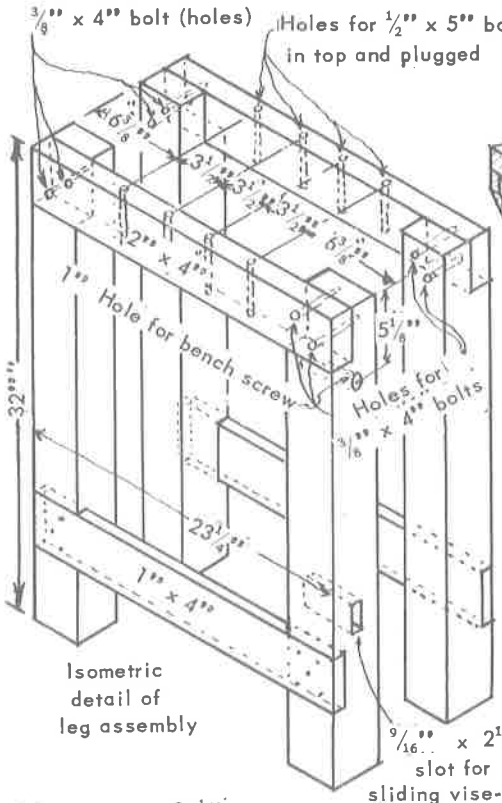




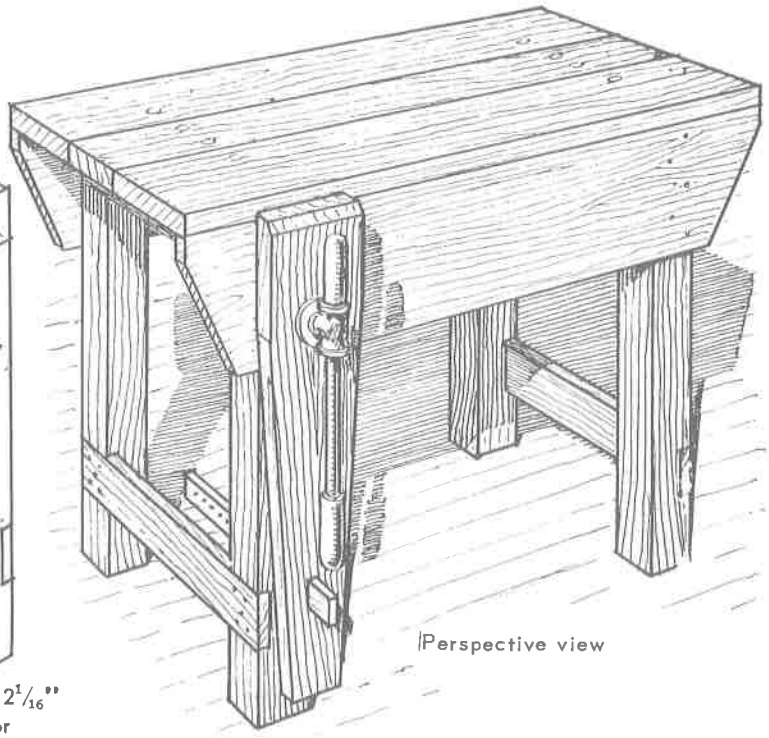
WORK BENCH -PLAN B

Materials:

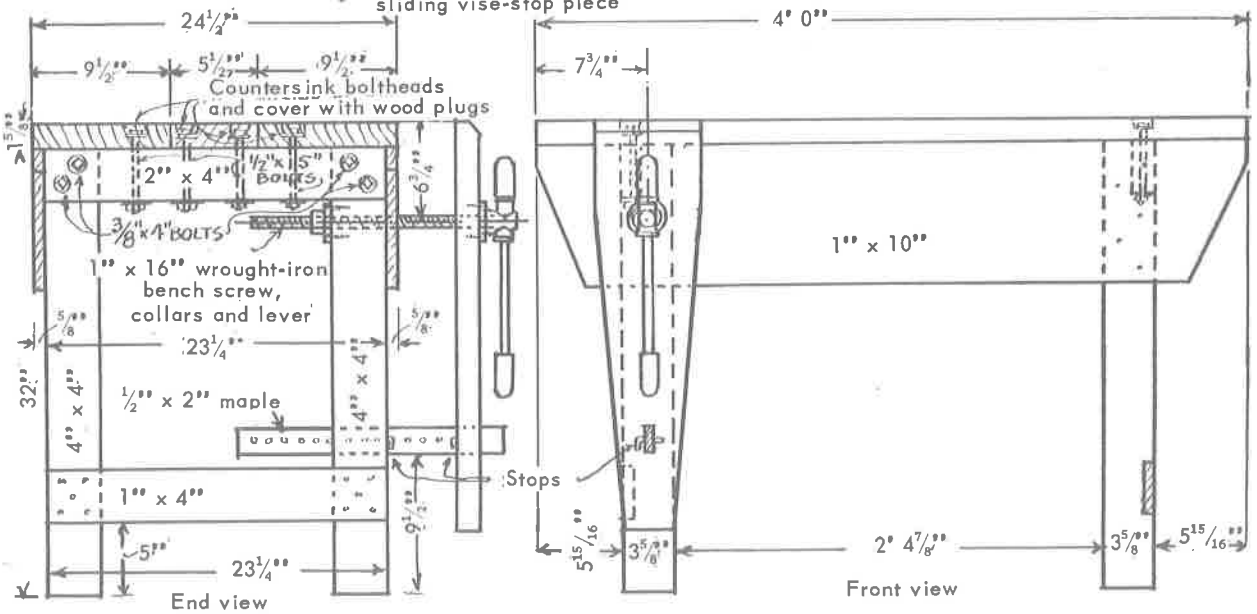
1 pc 2'' x 10'' x 8' } edge-grained pine or
1 pc 2'' x 6'' x 4' } fir for top
1 pc 1'' x 10'' x 8' pine – sides
1 pc 4'' x 4'' x 11' }
1 pc 2'' x 4'' x 4' } pine for leg frames
1 pc 1'' x 4'' x 4' }
1 pc 2'' x 8'' x 2'6'' oak or birch for clamp vise
1 pc ½'' x 2'' x 18'' maple for vice-stop piece
8 – ½'' x 5'' bolts
16 washers to fit
8 – ⅜'' x 4'' bolts
16 washers to fit
Nails and spikes as needed
1 – 1'' x 16'' wrought-iron bench screw



Isometric detail of leg assembly



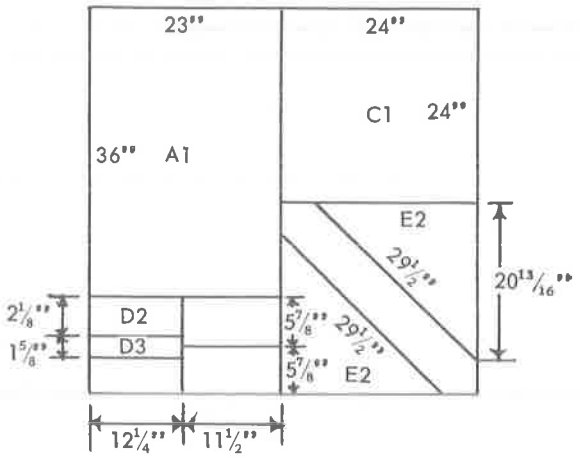
Perspective view

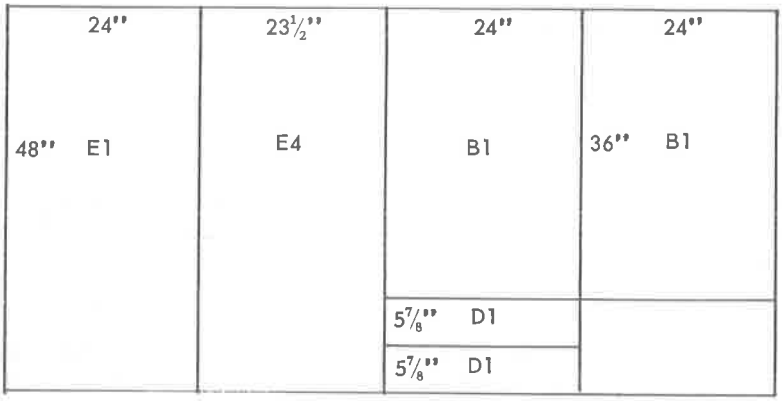


DOGHOUSE

Materials:

1 pc 4' x 8' x ½'' exterior grade fir plywood
1 pc 4' x 4' x ½'' exterior grade fir plywood
5 pc 1'' x 2'' x 10' pine s4s





Parts Identification:

A2	–	1'' x 2'' x 36''	(2)
A3	–	1'' x 2'' x 21½''	(2)
B2	–	1'' x 2'' x 32¾''	(2)
B3	–	1'' x 2'' x 21⅞''	(4)
C3	–	1'' x 2'' x 21½''	(1)
D5	–	1'' x 2'' x 23½''	(2)
D6	–	1'' x 2'' x 12¼''	(2)
D7	–	1'' x 2'' x 21½''	(1)
E5	–	1'' x 2'' x 23½''	(3)
E6	–	1'' x 2'' x 24''	(2)
E7	–	1'' x 2'' x 21⅞''	(3)

Construction:

1. Cut all pieces to exact measurements or to fit your own requirements.

2. When assembling parts, fasten with water-resistant glue and finish nails.

3. Assemble all A parts to form bottom of doghouse.

4. Assemble all B parts to form the sides of the house.

5. Assemble all C parts to form the back of the house.

6. Fasten the sides to the bottom.

7. Fasten the back to the bottom and sides.

8. Fasten the D parts to the sides and bottom in the following order: D7, D1's, D2, D3, D5's, D6's, D4.

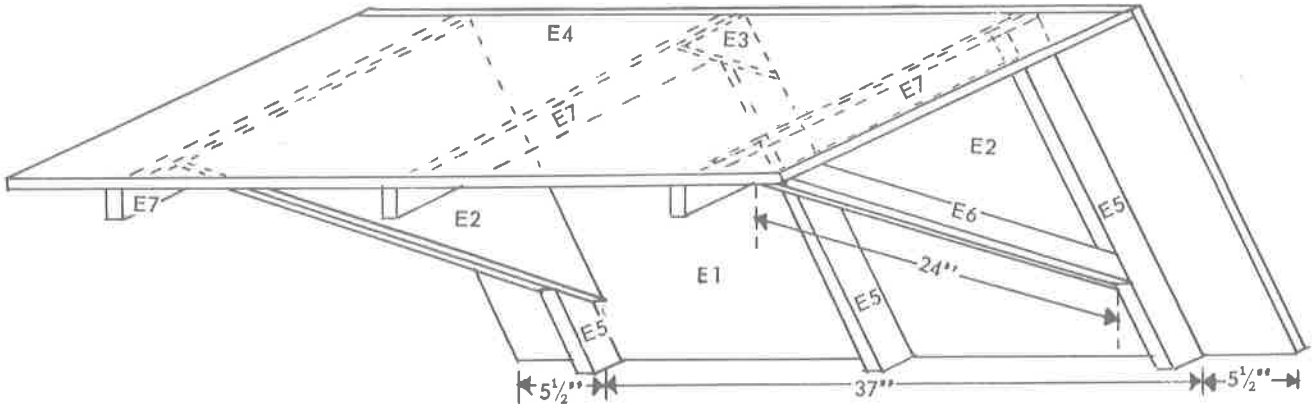
9. Assemble the E parts to form the detachable roof.

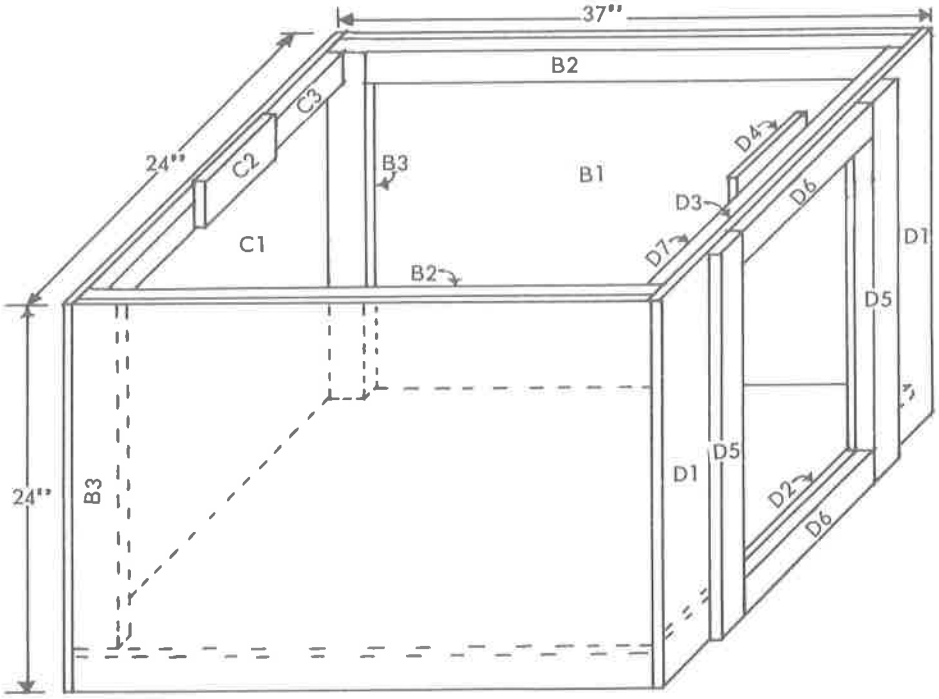
   Note that the rafters meet at right angles at the peak of the roof, and that pieces E6 are cut at a 45° angle.

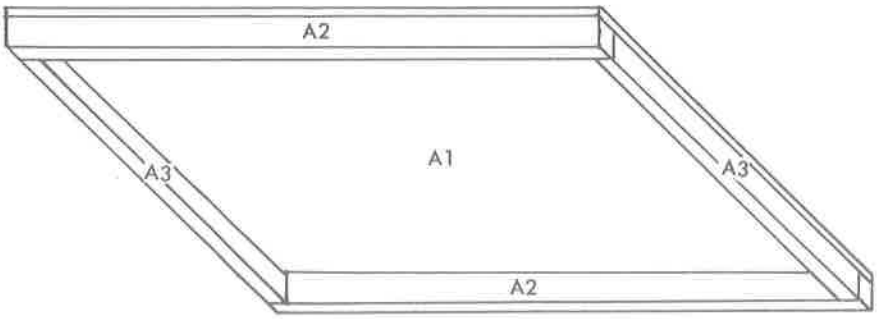
10. The roof is held in place by cleats C2 and D4, and should be left loose to permit easy removal when cleaning or painting the house.

11. Round off exposed edges of plywood to prevent splintering, and sand all joints to a smooth finish.

DOGHOUSE


E4
E3
E7
E7
E7
E2
E2
E6
E5
E1
24"
E5
E5
5½"
37"
5½"


37"
B2
C3
24"
C2
B3
B1
D4
D3
D6
D1
C1
D7
B2
D5
24"
B3
D1
D5
D2
D6


A2
A1
A3
A3
A2

COMBINATION PICNIC TABLE AND BENCHES

This table-bench plan consists of two separate halves, and can be used either as a table or two benches. It also can be used as a half table and a bench.

Redwood, cedar, white pine, or Douglas-fir can be used in the construction. All bolt holes, joint areas, and end grain should be treated with a water-repellent wood preservative before assembling.

You can finish it with either a natural finish or a paint finish. For the natural finish use a wood stain. For a paint finish, treat all surfaces with a water-repellent wood preservative. Apply one coat of a good (nonchalking) exterior enamel.

Materials:

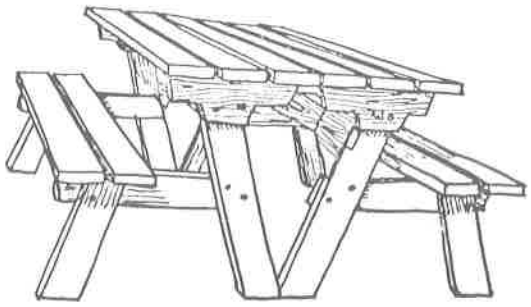
5 pc 2" x 6" x 12' for tops and seats
4 pc 2" x 6" x 8' for endpieces A, B, C, and D
1 pc 2" x 4" x 12' for pc G and E
1 pc 1' x 4' x ¼" exterior plywood for pc F
20 – ⅜" x 3½" machine or carriage bolts with washers and nuts
4 – ¼" x 6" carriage bolts with washers and nuts
4 – ⅜" x 3" eyebolts
4 – 8" lengths small-link chain
5 lb 16d flathead nails
¼ lb 4d flathead nails
Water-repellent wood preservative
Finishing materials

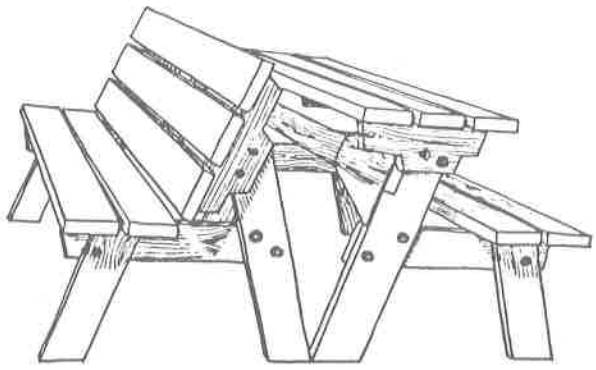
Construction:

1. Carefully study the various views and general information.

2. Make and assemble the end frames first. See the end view, side view, and piece detail. Cut the end frame pieces A, B, C, and D, and the seat and top pieces. Assemble pieces B, C, and D as end units. Assemble two end units with piece G, and seat pieces to form a base.

3. To make the top, assemble three top pieces to the end cleats A and center cleat E.

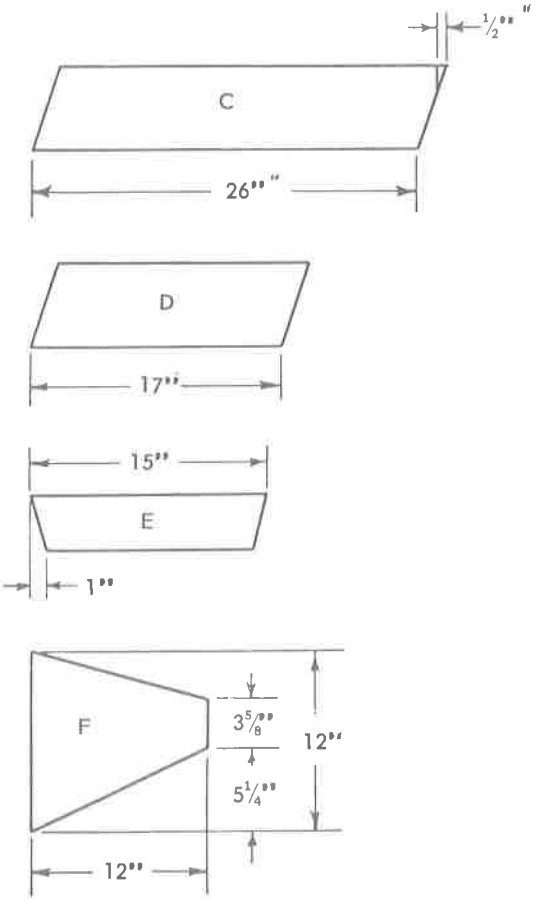


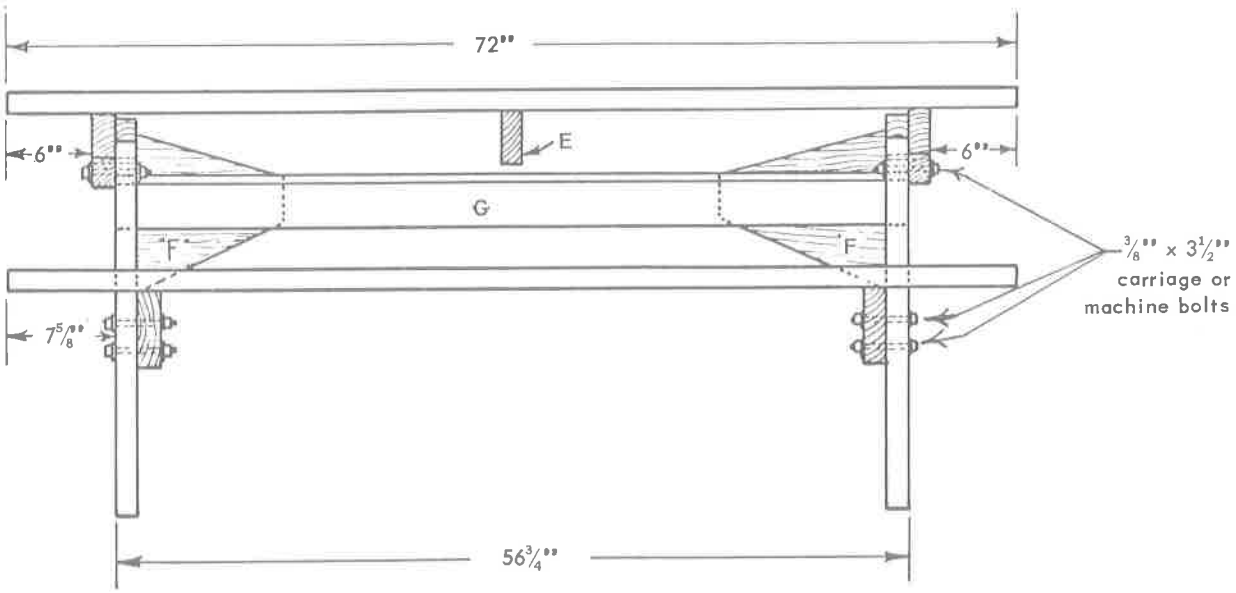


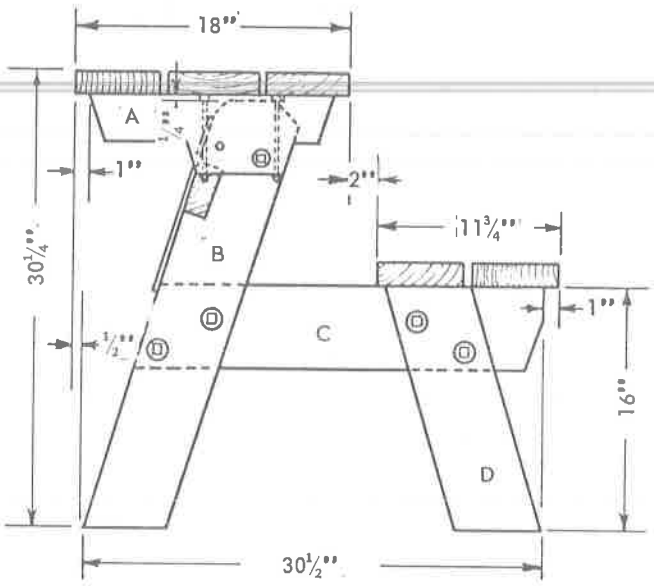
4. Assemble one unit by attaching top to base by inserting bolts through pieces A and B. Level the base and top unit. Drill the ⅜'' hole in piece B for the eyebolt lock. Rotate the top into the backrest position. Drill the ⅜'' hole in piece B for the eyebolt lock.

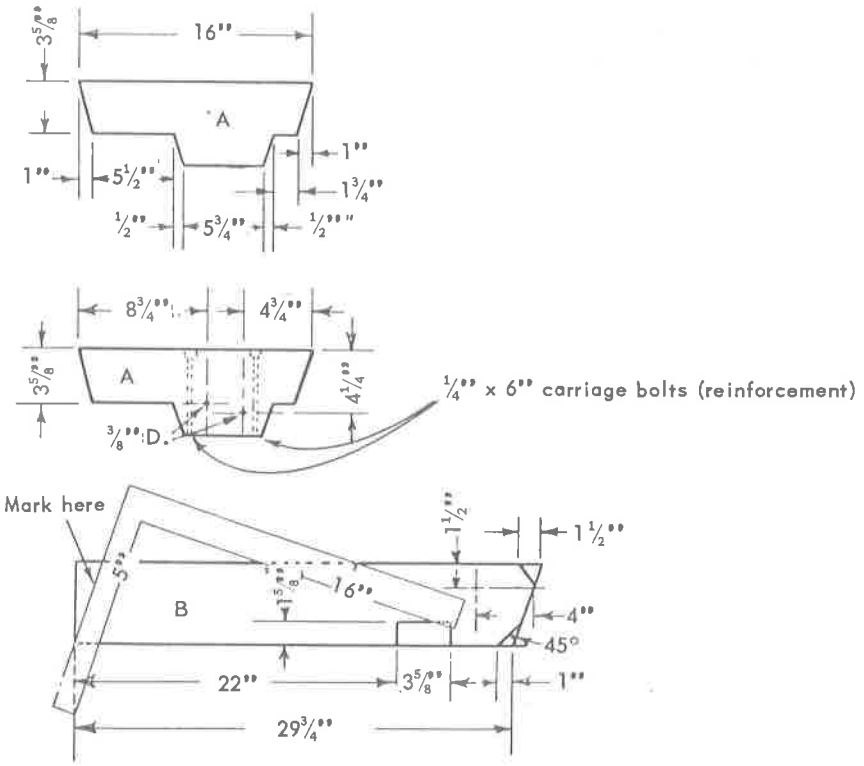
5. Fasten one end of the 8'' chain to the eyebolt, and the other end to piece A with a nail or screw.

Position the square as indicated, and mark. Measure the length, and reposition the square with the same readings for the other end cut. If you are near the end of the plank, position the square on the opposite edge. Be sure the cuts are parallel. Use the same square settings to cut pieces C and D.

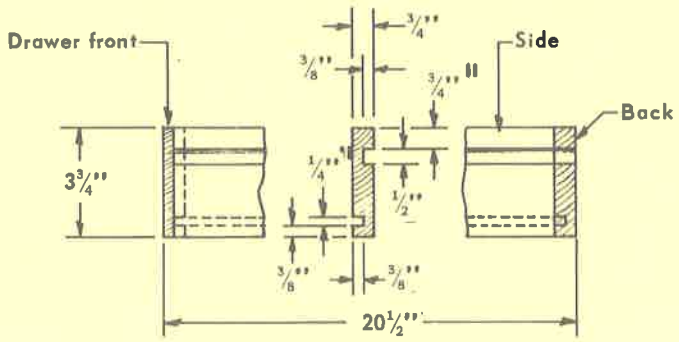


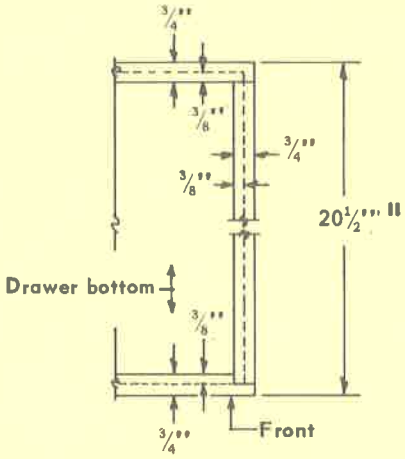


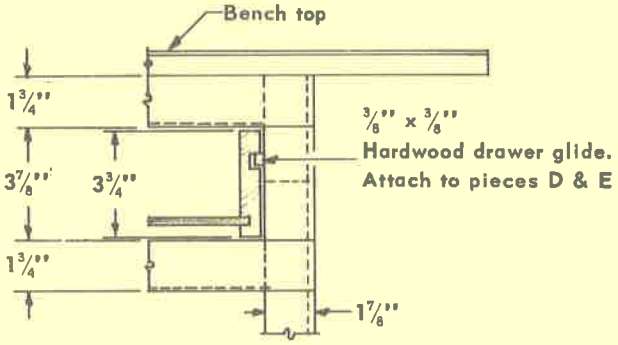

18"
A
1"
2"
11¾"
B
30¼"
C
1"
½"
16"
D
30½"


3⅝"
16"
A
1"
1"
5½"
1¾"
½"
5¾"
½"
8¾"
4¾"
3⅝"
A
4¼"
¼" x 6" carriage bolts (reinforcement)
⅜" D.
Mark here
1½"
1½"
5"
B
15⅛"
16"
4"
45°
22"
3⅝"
1"
29¾"

Drawer detail for work bench page 22.

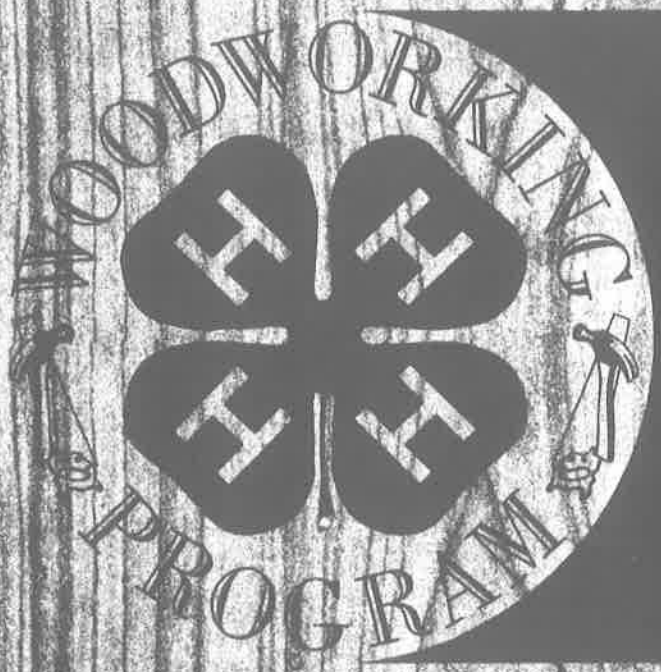






Members' Manual

UNIT 4



THE CRAFTSMAN

4-H Engineering Woodworking Program
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA
4-H-20040

TABLE OF CONTENTS

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A Look Ahead

National 4-H Engineering Woodworking Committee

Introduction

This is your book for the fourth unit of the 4-H Woodworking Project. It contains information on using and sharpening tools, gluing, finishing and other information. It also includes drawings for several articles you can make. However, in deciding what you are going to make you should consider what you or some other member of the family need. Then find or develop a plan for it rather than making something just because it is in the 4-H plans. This practical approach is very important because you are now enrolled as a Craftsman. Your woodworking project leader, Extension Agent, the agricultural engineering department of your state University and the library may help you find plans.

The use of several power tools is included in this unit. If you have these and others, learn to use them safely. However, many things can be made without such tools.

The woodworking project is planned so you will learn practical and useful things for now and the future when you become a home owner. In addition, many people follow woodworking as a hobby or career.

While working in this unit, investigate career possibilities in this and related areas. If you like to build things from plans you may consider an area in carpentry. If you enjoy planning and drawing your own items, you might consider study in the area of agricultural engineering, engineering, drafting, or architecture. Other possibilities include industrial arts teaching, wood technologist, wood utilization specialist, etc. If possible, visit manufacturing plants and talk to the employees and the personnel director.

Work Safely

Review the safety rules in Units One to Three.

The following safety rules apply to nearly all power woodworking machines. Special safety rules will be included in information pertaining to a specific tool in this circular. In addition, most manufacturers supply safety information in their literature.

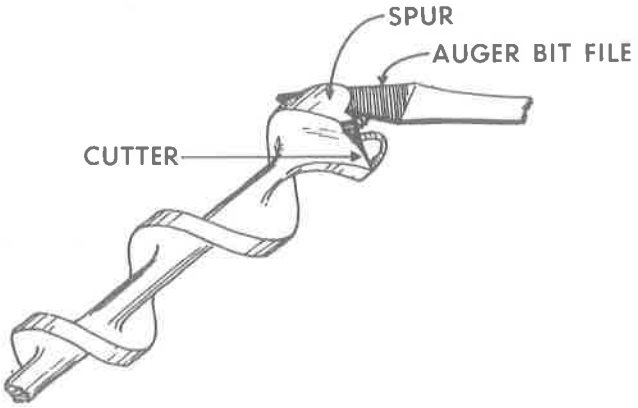
- When working in the shop wear tight fitting clothes. Loose or dangling clothing or long hair may get caught in a machine.
- Do not operate power machines when you are overtired or emotionally upset.
- Study the safety and operation rules in the instruction book for each machine.
- Keep proper guards and protective shields on all machines.
- Make certain that all machines have ON and OFF switches located on or near the machine.
- Make all necessary settings and adjustments on each machine before turning on the power.
- Stop the machine as soon as the job is finished or when an adjustment needs to be made.
- Do not force a tool or machine. It is designed to work at a certain speed depending upon the material and type of cut being made.
- As a tool operator, give your undivided attention to the task at hand. Do not visit with anyone when you are operating a power tool.
- If you must attract the attention of a machine operator, approach him slowly from the front.
- Be sure the machine is properly grounded or constructed to prevent electrical shock. See Woodworking Unit 2 *Learning and Building* for details.

Care and Sharpening of Tools

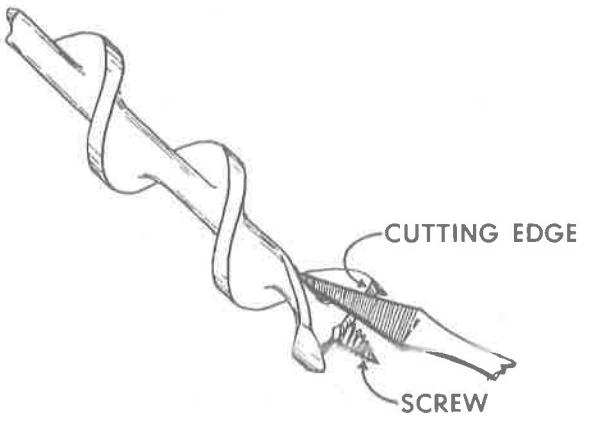
Auger Bits

An auger bit file or an extra slim taper file should be used to sharpen auger bits.

To sharpen the auger bit spur, rest the bit on the edge of the work bench with the screw pointing up. A vise may also be used to hold the bit in position. File lightly on the inside face of the spur; be careful to maintain the original angles. Never file a spur on the outside. To do so would reduce the bit clearance. Holes that are bored by a bit which lacks clearance will be undersized and will have rough walls.



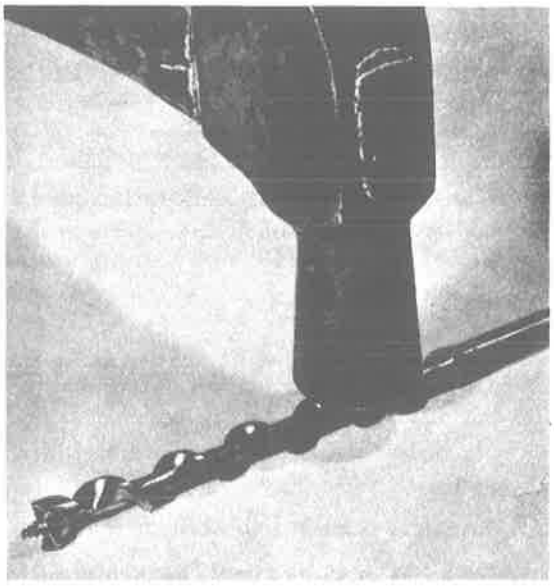
To sharpen the cutters, rest the bit on a board or work-bench with the screw down. A vise may also be used to hold the bit in this position. File only the upper edge of the cutters. File well back into the throat to maintain a gradual taper from the cutting edge. Remove the same amount of material from each cutting edge to keep them level, so they will cut chips of equal thickness.



It is important to store auger bits properly. If they are kept loose in a tool box or drawer, other metal tools may strike or rub against them. This may dull or damage the feed screw or cutting edge. A rack is the most desirable means of storage. If the bits cannot be stored in a rack, each should be protected with a cap.

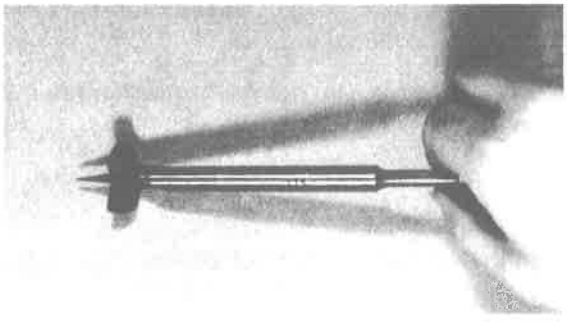
Moisture from the hands or sap from green lumber may cause the bits to rust. To prevent rusting, wipe them occasionally with an oily rag.

If a bit becomes sprung by some abuse, it can usually be straightened. To do this, roll the bit on a level wood surface until the bend is up. Then on the high side tap it lightly with a hammer.



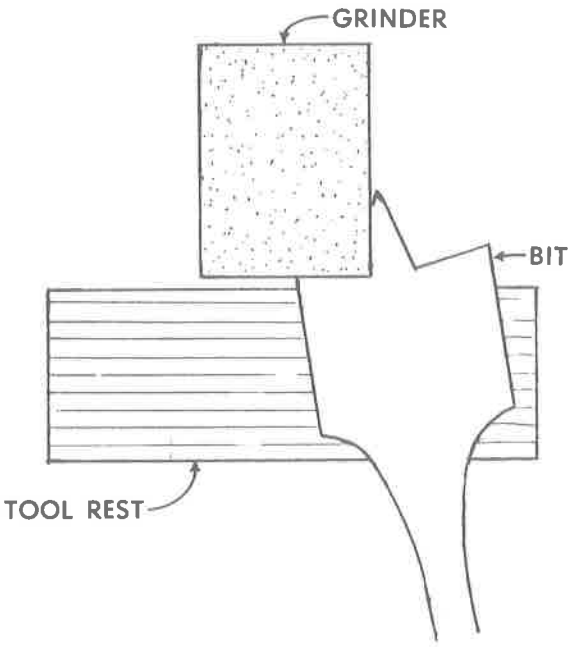
Power Wood Boring Bits

The cutter and spurs of power wood boring bits are sharpened in a manner similar to auger bits.



Power wood boring bits can be sharpened on the corner of a bench grinder wheel.

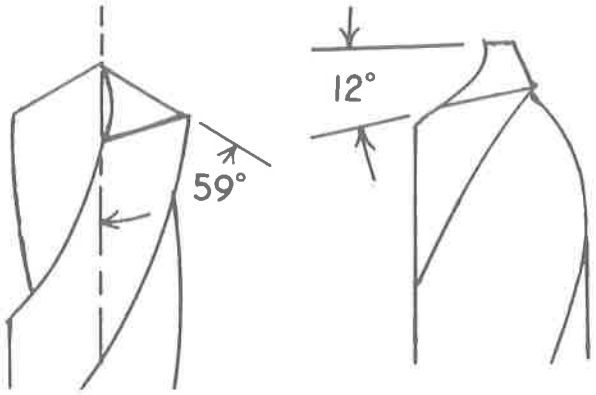
Determine the clearance angle before doing any grinding. Hold the bit as illustrated.



There may be other types of wood boring bits. Examine them for characteristics similar to those described in bit sharpening. Determine the original angles and develop a method to sharpen them.

Twist Drills

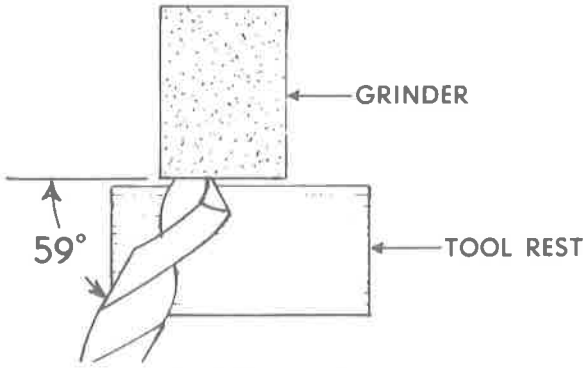
Twist drills are sharpened by grinding. The cutting lips should be exactly the same length and make exactly the same angle with the center line of the drill. The angle varies for special use of the drill, but 59 degrees is recommended for general use. Twist drills sharpened for special use in wood have a 45 degree angle. This gives a much longer point than when it is sharpened for general use. In addition, material must be removed behind the cutting edge to give the cutting lips clearance to allow the drill to bite into the metal. This clearance angle should be from 8 to 12 degrees for general use, and 12 degrees for special use in wood.



Correct angles for grinding a twist drill for general use.

To grind a twist drill the tool rest should be adjusted so it is almost to the same level as the wheel shaft, parallel to the face of the grinding wheel, and as close as possible to it without rubbing.

After the tool rest is adjusted, place the drill on the tool rest with the cutting end and shank end level. Have the lip to be ground horizontal. The axis of the drill should make an angle of 59 degrees with the cutting face of the wheel.

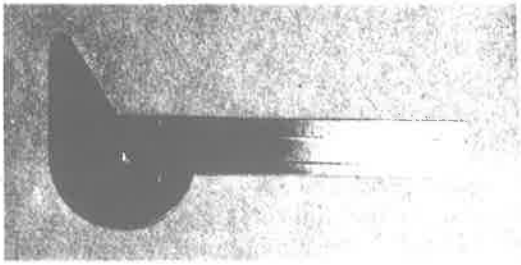


A twist drill in position

With the grinder running, the drill should be slowly, but firmly forced against the grinding wheel. The cutting edge should be slowly elevated by lowering the shank end until the clearance angle is reached. As the point is elevated, it must be pushed forward somewhat to keep it in contact with the wheel. After the clearance angle has been reached, remove the drill from contact with the grinder, return to starting position, and repeat the operation until the lip is properly ground.

The second lip is ground by turning the drill half around and grinding it exactly as the first one.

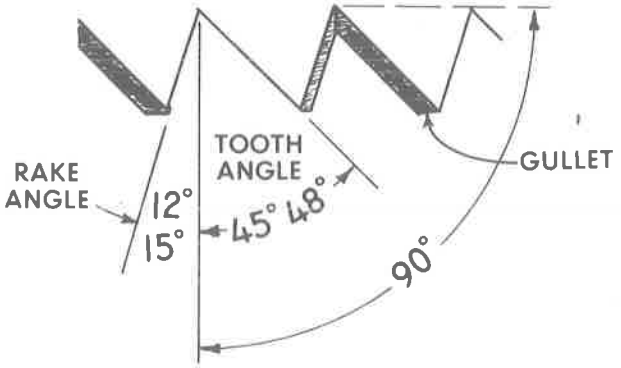
A drill point gauge is a convenient and useful tool for twist drill sharpening.



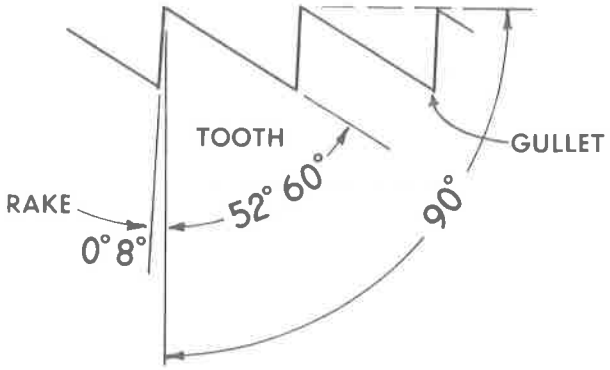
A drill point gauge

Hand Saws

Saw filing is necessary to keep a saw in good condition. The procedure is similar for all hand saws, but the shape of the teeth is different on various kinds of saws.



Side view of cross cut saw



Side view of rip saw

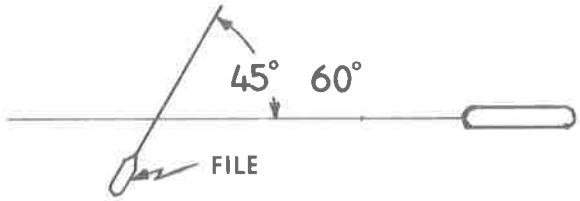
Jointing

The first step in sharpening all saws is the process of making all the teeth the same height. This is called jointing. It is done with a flat file. The saw is clamped in a vise or saw clamp. Then the file is run lengthwise along the teeth until a small flat spot is visible at the point of each tooth. The file should be held level so the teeth will all be the same length. A jointer (device to hold the file) may be used. Jointing may be omitted if the saw is in good condition and is receiving only a touchup filing.

Shaping the Teeth

To file or shape the teeth of a crosscut saw, the following procedure is recommended:

1. Clamp the saw in a clamp or vise with the bottom of the gullets about 1/8" above the clamp and with the handle to the right.
2. Start at the point or toe of saw (end away from the handle).
3. Pick out first tooth that is set toward you.
4. Place file in the gullet to the left of this tooth.
5. Hold file at 45 to 60 degree angle with respect to the blade to produce the bevel angle. The file should be held level but rotated to give the 12 to 15 degree rake angle. See side view of cross cut saw.



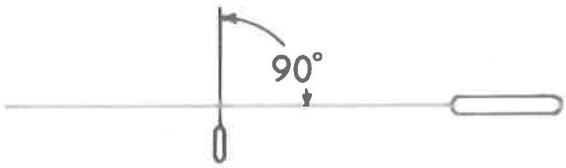
Position of file for obtaining cross cut bevel

6. The file should cut only on the push stroke.
7. File the back of the tooth at the left and the front of the tooth (cutting edge) at the right at the same time. File until one half of the flat spot produced by jointing has been removed from each tooth.
8. Proceed toward the handle, filing every second gullet in the same way as outlined above.
9. Remove the saw from the clamp and reverse it, then file the gullets which were skipped. Change position to keep the file at the proper angle. Start at the toe and work toward the handle.

When filing back saws or other crosscut saws with small teeth, it may be necessary to depress the file handle a little so that the file does not run level. The six inch slim taper file is desirable for use on saws with seven or eight points to the inch. A five or six inch slim taper is desirable for a nine to ten point saw. For saws with eleven to fifteen points to the inch, the four and a half inch slim taper file is the most satisfactory.

Except for the file angles the same procedures are followed to file or sharpen the teeth of a rip saw.

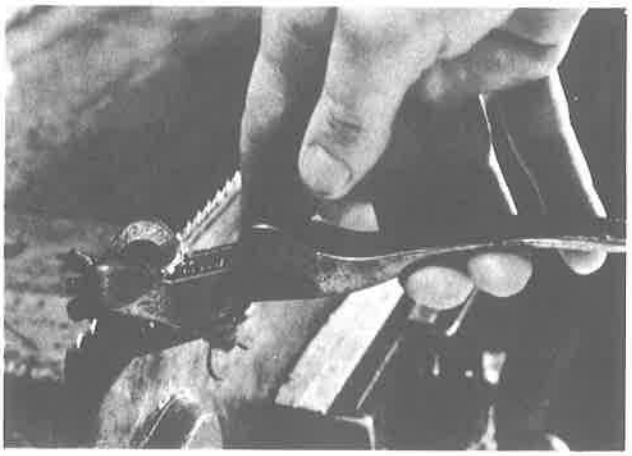
1. Hold the file directly across the blade (90 degree angle) and level.
2. Rotate the file to give a 0 to 8 degree rake angle. See side view of rip saw.



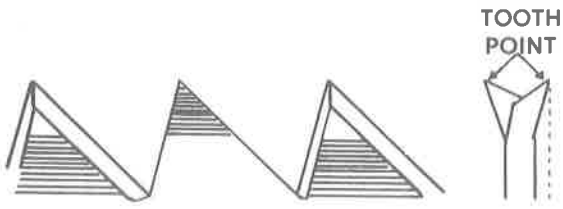
Position of file when filing a rip saw

Setting a Saw

The purpose of setting a saw is to make it cut a kerf slightly wider than the thickness of the blade. This reduces friction and lets the saw operate freely. It is done by springing the upper 1/3 or 1/2 of each tooth outward (toward point). The teeth should be set so the outer edge projects beyond the line of the blade about 1/3 the thickness of the blade. Care must be taken to see that the set is regular and equal on both sides or the saw will not cut true. Taper saws require very little set, because the blade tapers thinner to the back and from the point to the butt. The teeth are set with a special tool called a saw set. The set may be regulated to adjust the amount of tooth that is bent. On most sets, the angle to which a tooth is bent can also be adjusted. Begin the setting operation from either end. Bend every other tooth. When setting a crosscut saw be sure the cutting edges or points are being bent outward. When one side has been finished, turn the saw around and set the teeth on the other side.



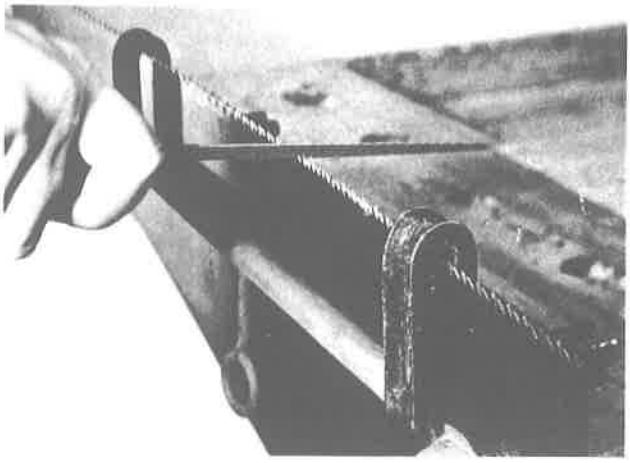
Hand set being used on saw



Set of crosscut saw

Pointing the Saw

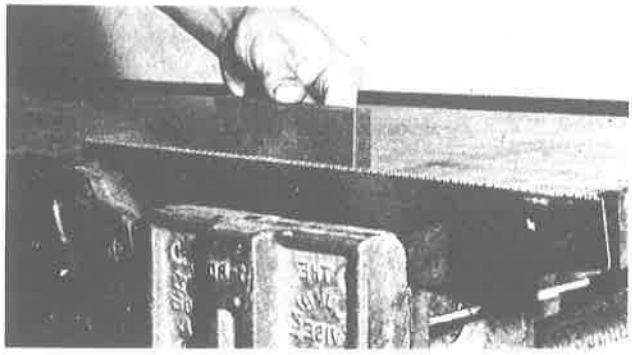
This is a process of finish filing to take care of any irregularities produced by setting. Usually one or two strokes of the file is sufficient.



Pointing the saw

Side Dressing or Side Jointing

Side jointing puts a final touch to the job after the saw has been filed and set. It is done by running a worn file or whetstone lightly along each side of the saw a few times. This removes the wire edge and slight unevenness of the points, insures smooth cutting and prolongs the length of service between filings.

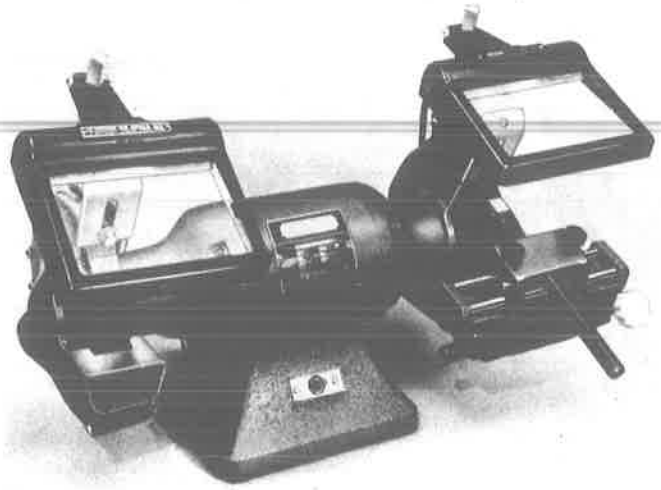


Side dressing the saw

Bench Grinder

The grinder is not a woodworking tool, but it is a necessity in all well equipped woodworking shops. Equipped with the proper grinding wheels, a wire brush wheel and a buffing wheel, it is very useful in keeping tools sharp and in good condition.

There are two types of high speed bench grinders. The self contained unit with the grinding wheels mounted on the motor shaft, and the unit consisting of a motor belted to a separate arbor for the grinding wheels. Both types are available with either bronze or sealed ball bearings.



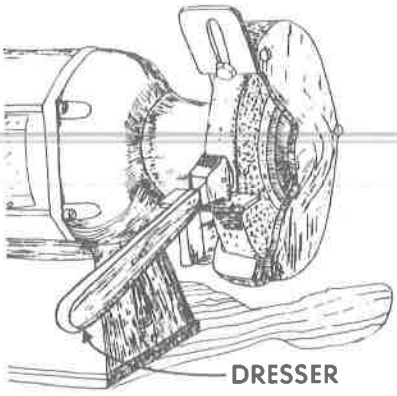
Bench grinder self-contained

The grinder should be designed for 7 inch diameter by 1 inch face wheels or larger. If the grinder will be used only for sharpening woodworking tools, a smaller grinder would be satisfactory.

Before purchasing a grinder, compare the cost, size and quality of the various types. Look for general sturdy construction combined with guards for the grinding wheels, adjustable tool rests, and safety glass eye shields.

Grinder Wheel Dressing

The grinding wheels should be dressed regularly to keep them round and to remove the glaze. Support the dresser on the tool rest and hold it firmly against the grinding wheel, while it is operating at full speed. Move the dresser back and forth across the surface. Do not remove more of the grinding wheel than is necessary. Exert just enough pressure on the dresser so that the dresser is cutting the wheel. When sparks are present, apply slightly more pressure.



Dressing a grinding wheel

Grinder Operation and Safety

- It is important to protect your eyes when operating a high speed grinder. Pieces of metal and abrasive wheel particles fly from the grinding wheel when it is in use. These particles may injure unprotected eyes. Provide yourself with a pair of safety goggles and use them.
- Do not operate the wheel at a speed that exceeds the manufacturer's recommendations.
- Keep the tool rest adjusted and close to the grinding wheel. The distance from the wheel should not exceed 1/8".
- Keep the grinding wheel round with the proper shaped working face by frequent dressing.
- Do not exert a side pressure on the grinding wheel by making a heavy cut on the side of the wheel.
- Do not grind with the wheel before it has reached operating speed or while it is coasting to a stop.
- Whenever possible, avoid standing directly in line of the grinding wheel rotation.

Power Tools

Very few woodworkers, professional or amateur, use only hand tools. Most of the cutting, shaping, jointing and sanding is done by machine. This makes the work easier and faster.

The use of power tools increases the accident hazard. However, power tools can be used safely if the operator knows the jobs for which the machine was designed, and follows the recommended safety rules.

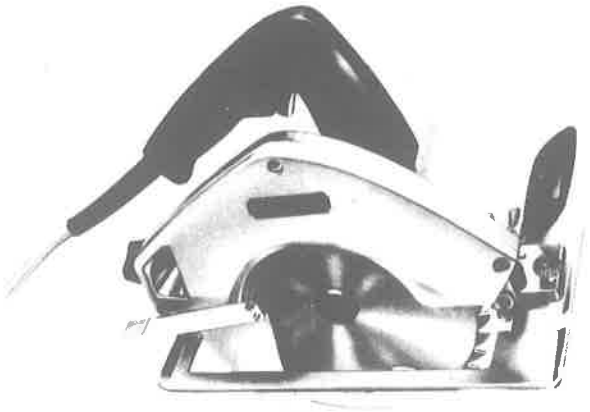
Information pertaining to the use and selection of some of the more common power tools is included in this unit. Obtain and study the operator's manual or instruction book before using the equipment.

Portable Electric Tools

Portable electric tools are very useful power tools. They are light in weight and compact in design. These characteristics make them very desirable for use on many construction and repair jobs. From the standpoint of electrical safety, it is important to have a tool bearing the (UL) Underwriters Laboratories label on the unit rather than just on the cord. Such tools are now available with (1) the three wire grounding type cord and attachment plug or (2) with a specially insulated motor and switch housing and a two wire cord.

Portable Electric Saw

The portable electric hand saw will do many of the sawing operations mentioned in the section on circular saws. Because it can be easily carried around, it can be used for many tasks on the construction job. This same ease of carrying it around also makes it potentially dangerous. If carelessly handled, it could come in contact with most any part of the body and cause injury.



An electric hand saw

SAW USE

To start a cut, rest the front edge of the saw foot on the stock, and line up the blade with the cutting line. Before starting the motor be sure the blade teeth are not in contact with the wood and the lower blade guard is free and in position. Press the trigger to start the saw. Guide the saw through its cut with firm pressure. Do not force the saw. Too much force will actually slow down the sawing operation and overload the motor.

If the motor should stall, do not release the switch but pull back the saw until the blade regains its normal speed. Then, either shut off the motor or start the cut again. This procedure will reduce the burning of the switch contact points, and in that way will increase the life of the switch.

A rip fence is desirable if one has a lot of stock that is to be ripped to a uniform width.

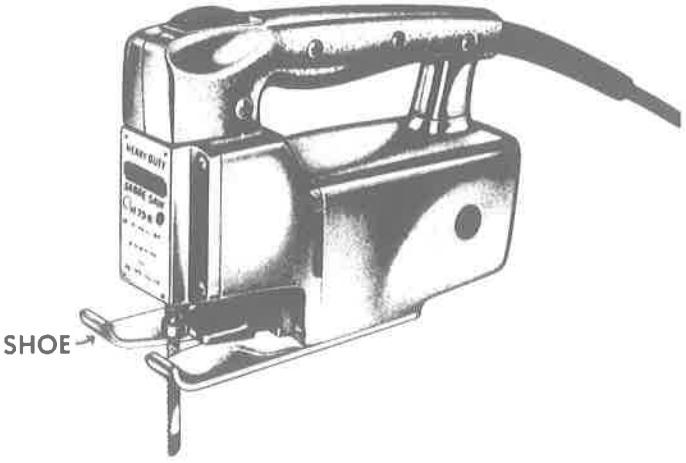
Follow the manufacturer's recommendations for lubrication and maintenance.

SAW SAFETY

- Disconnect the saw cord plug from the socket before making adjustments, changing blades, lubricating or inspecting the saw. Always disconnect the plug when the saw is not in active use.
- Never carry or drag the saw around by the cord. Keep the cord clean and free of grease and oil.
- Use the proper blade for the material to be sawed. Use only sharp blades. Check for saw wobble by spinning the blade by hand before plugging in.
- Never lay the saw down when the blade is still in motion.
- Don't cut the cord.

Portable Jig or Saber Saw

The portable electric jig saw will cut straight lines, curves, short radius circles and irregular shapes in wood up to 1 inch thick or more depending upon the tool. Saw blades are available, so they can be used on metal, plastics, composition board, rubber, etc.



Saber saw

SAW OPERATION

Grasp the tool firmly. See that the blade is free before turning on the switch. Rest the front of the shoe on the wood and then line up the blade with the cutting line. Advance the saw through the cut with firm, downward pressure on the shoe and feed with enough forward pressure to permit the blade to cut freely.

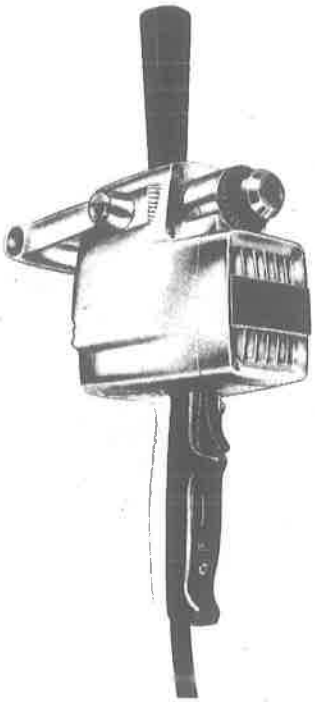
To make a pocket cut in wood, tilt the tool forward on its nose and gently but firmly draw the blade forward in a succession of strokes about 1 1/2" long. Cut a little deeper with each stroke. After cutting through the material, operate the tool in the normal position.

Portable Electric Drills

The 1/4" drill was discussed in Unit Two, *Learning and Building*. Drills are also available in 3/8" and 1/2" size. Generally speaking, the larger the drill, the slower it runs, the more torque or twist it develops and the more expensive it is. For example, if a bit in a 1/2" heavy duty drill would suddenly become stuck, the torque could jerk your arms enough to sprain a muscle.

The 1/4" drills develop from 1/8 to 1/4 horsepower depending upon quality and design. The 3/8" drills range from about 1/4 to 1/3 horsepower. The power of 1/2" drills varies from 1/3 to 3/4 horsepower.

Drill stands and many other accessories are available for use with the drills.



Heavy duty drill

Portable Electric Sanders

The use and characteristics of the oscillating sander were discussed in Unit Two *Learning and Building*.

The disc sander is suitable for rough sanding, paint removal, etc. It does not work well for fine finish sanding, because it tends to leave circular marks on the finished product.

The belt sander is usually the most expensive, the heaviest, and contacts the most area. The cutting action is done by a sanding belt which runs over two pulleys. This belt runs at the rate of 800 to 1100 feet per minute. The size of the machine is indicated by the width of the sanding belt used. A belt sander that uses a belt 4" wide is called a 4-inch belt sander.

A belt sander

USING THE SANDER

Be sure the switch is in the OFF position before connecting the electric plug to the outlet. Lift the sander off the wood before starting or stopping the sander. Allow the sander time to reach operating speed before bringing it in contact with the wood. Hold the tool firmly and use the tool freely without exerting downward pressure. The weight of the tool itself is enough in most cases.

To smooth a very rough surface, use a coarse abrasive and run the sander diagonally across the grain of the wood. Then, before changing to the fine abrasive finishing operation, smooth the surface by guiding the sander back and forth with the grain. In the finishing operation, be sure to sand with the grain of the wood.

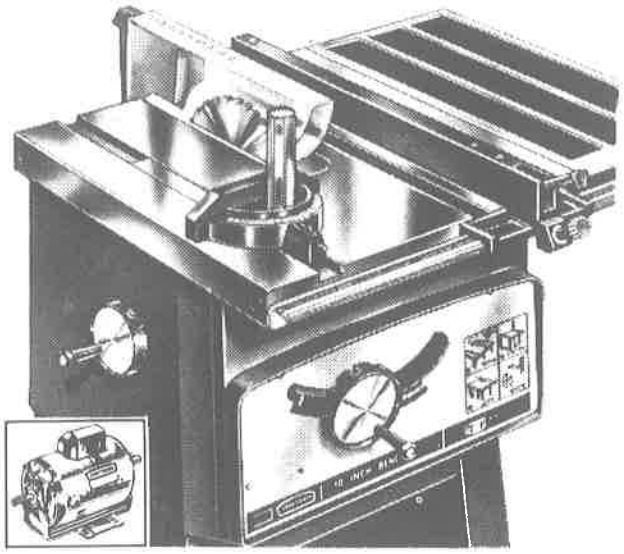
Always use the proper abrasive material for the job at hand.

Lubricate and service the sander as recommended by the manufacturer.

Circular Saws

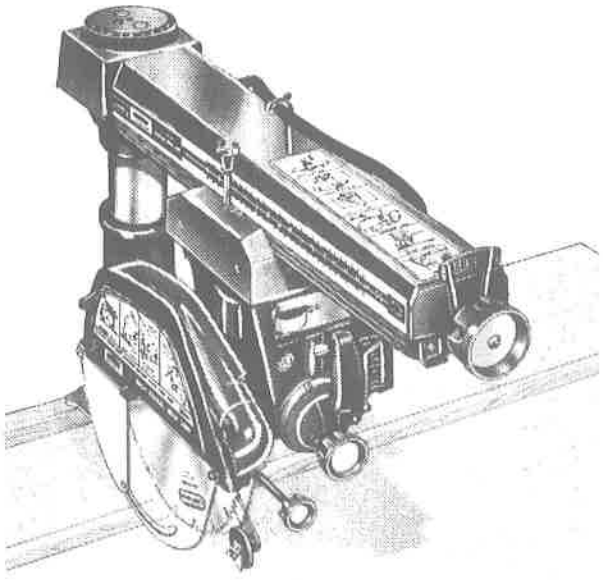
The circular saw is one of the most useful machines in the woodworking shop. There are three primary types of circular saws: the tilting table saw, the tilting arbor saw and the radial arm saw.

The tilting arbor and the tilting table saws are both used to cut bevels, a small portion of the total sawing these power tools do. As their names indicate, the arbor and the table tilt to achieve the desired angle for the bevel. Of the two, the tilting arbor saw is easier to operate but is more expensive.



Tilting arbor saw

The radial arm saw is the most expensive of the group. It is adaptable and adjustable, and very accurate for making bevel, miter, and compound cuts.



Radial arm saw

SELECTING A CIRCULAR SAW

The following should be considered when selecting a circular saw:

- The size is indicated by the diameter of the largest blade that can be used on the machine. A 7" saw will make a 2" right angle cut; an 8" will make a 2 1/2" cut; and a 10" will make a 3 1/4" cut.

  The motor size also affects the price. The motor should be at least 1/3 horsepower for the 7" saw; 1/2 horsepower for the 8" saw; and 3/4 horsepower for the 10" saw.

- Safety features of the machine are very important. Be sure the saw has a well made useable guard. Belts and pulleys should be protected with a guard.

- Table size is important, but table extensions can be obtained.

- Switch, handles, and cranks for various saw adjustments should be conveniently located.

- Before making a final decision, consider the general quality of the machine's material and workmanship.

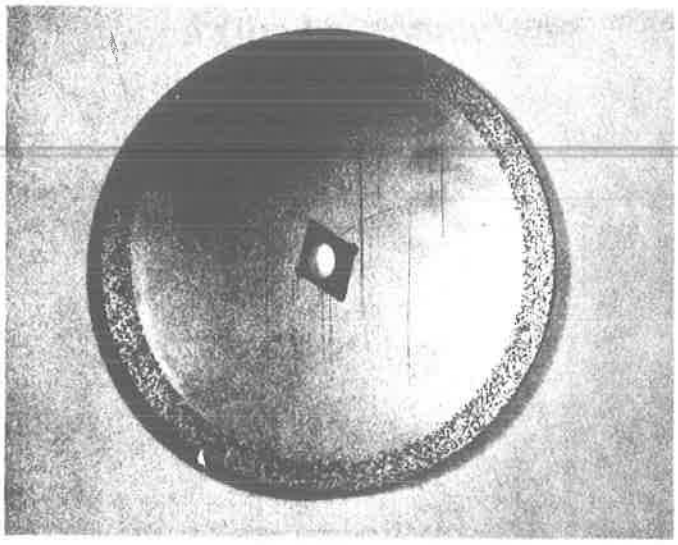
SAW BLADES

There are many kinds of circular saw blades. In the average shop, most of the work can be done with a flat combination blade and a hollow ground combination or planer blade. The latter will make a very smooth saw cut edge, but is rather expensive. The flat combination is cheaper, but leaves a rougher edge. It can be used for crosscutting, ripping or mitering.

A combination blade with tungsten-carbide tipped teeth is also available. This is a very long lasting blade under normal conditions, but is rather expensive.

The rip and crosscut blades will perform their special cuts more rapidly and efficiently than the combination blades.

The fine tooth plywood blade is desirable if cutting a large amount of plywood, veneer, etc.



Tungsten carbide abrasive cut-off blade

The safest addition to the list of circular saw blades is the tungsten carbide abrasive blade. These resemble the disc sanding blades for use on a table or bench saw. The blades have tungsten carbide particles or grits fused to the rim of the saw in place of conventional teeth. The same material is also on part of each side of the blade to cut a kerf wide enough to prevent binding or pinching. This type of a blade requires more horsepower than a toothed blade.

These blades tend to gum up when used in resinous or pitchy material. They can be cleaned with a solution of baking soda and water. Place the blade in a flat pan. Add an inch of water to cover it. Add baking soda at the rate of about one rounded teaspoon per pint of water. Place the pan on a heating unit, and allow the mixture to boil for 10 or 15 minutes. Allow the tools to soak in the solution as it cools for 45 minutes or more. Remove the blade and rinse under a faucet. If some particles stick, brush lightly with a wire brush, and rinse again. After the last rinsing, wipe the tool dry to prevent rusting.

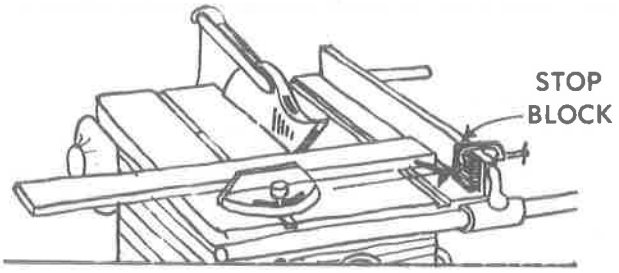
Saw Operations

The saw should be sharp and properly adjusted before it is used. It should be checked for squareness of the saw blade to the table, for rip fence alignment and for miter gauge accuracy. The accuracy of the depth of cut and saw or table tilt scales should also be checked. Follow the manufacturer's recommendations given in the operator's guide book to make these adjustments and for car and maintenance.

Cross cutting, ripping, sawing miters and bevels, rabbeting and dado cutting are the common sawing operations. There are special things to consider in each of the operations.

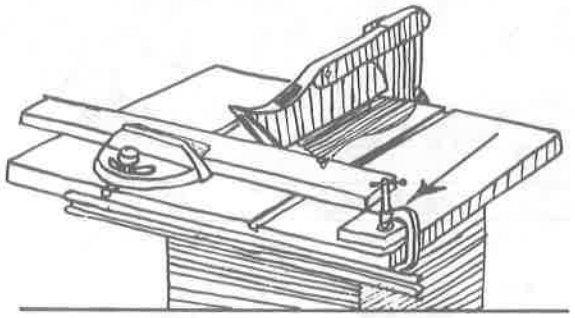
Cross Cutting

When cross cutting (sawing across the grain), use the miter gauge for all cuts. Never allow the free end of the stock to bind between the saw blade and the rip fence or any other form of a stop.

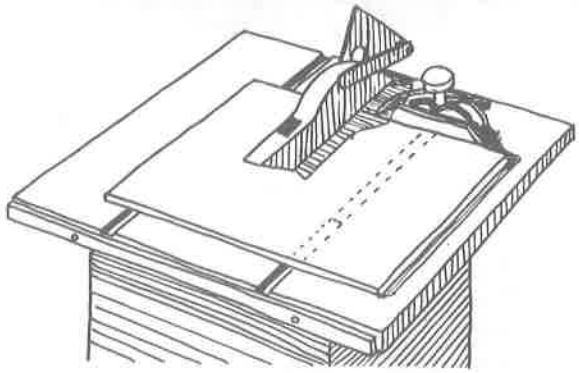


Stop block attached to rip fence

If a number of pieces are to be cut the same length, attach a stop block to the rip fence or to the table itself, at the front of the table. Make the stop narrow so the work piece will be sliding free before reaching the saw.

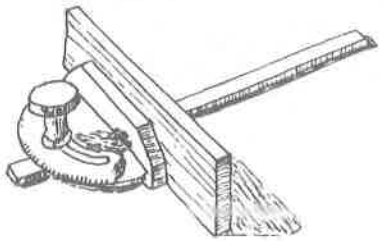


Stop block attached to table



Reversed miter gauge

When a wide board will not fit between the saw blade and the miter gauge, remove the gauge and reverse it so the slide is to the rear. Check to be sure the gauge will not strike the saw in this position.

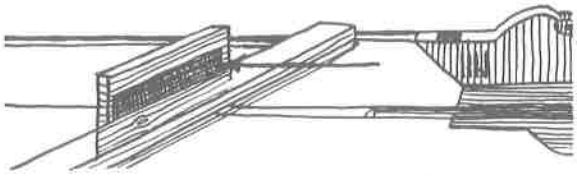


Miter gauge auxiliary extension

The miter gauge will work better if an auxiliary extension is attached. Such an extension can be made by bolting or screwing a piece of board or plywood to the face side of the miter gauge.

Miter Cutting

Miter cutting is much like cross cutting, because miters are cross cuts at an angle to the edge of the wood. The miter gauge is set at the required angle for the cut. To cut an equilateral triangle, set the miter at 30 degrees; for a square 45 degrees; and for a hexagon or six angled figure, set the miter gauge at 60 degrees.



Sandpaper glued to work face

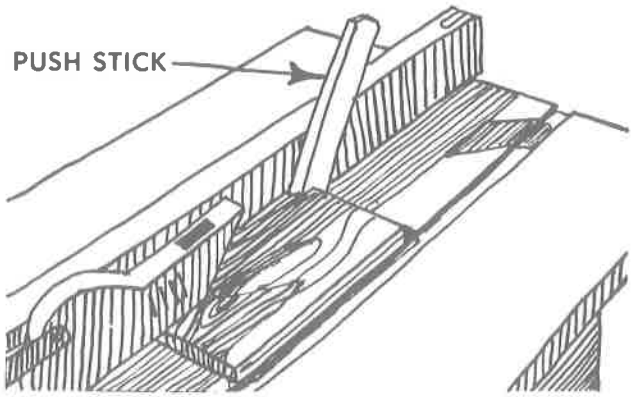
The miter gauge auxiliary extension is very desirable for this work. There is a tendency for the work piece to creep into the saw, therefore, it must be held securely. Gluing sandpaper to the contact face of the miter gauge or auxiliary extension will help to hold the work piece in position.

Ripping

Ripping is sawing wood with the grain. The first step in the operation is to set the rip fence in the proper position. If the ripping scale is not accurate, measure the required distance from inside the saw tooth points to the fence. For an exact dimension, test the setting with a piece of scrap lumber before ripping your work piece.

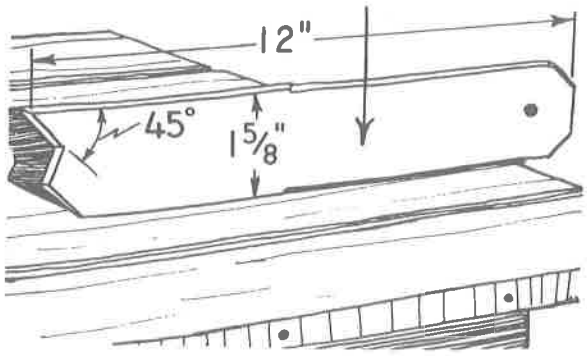
The stock should be fed into the saw at a smooth uniform rate. A sliding contact with the rip fence should be maintained. The stock should also make a solid contact with the table top.

Always use a push stick to push the final end of the board past the saw. This is especially important when the distance between the fence and the blade is less than the width of your hand.



Use of push stick

Board supports should be provided when ripping a long board. Ordinary wooden horses of the proper height are satisfactory. A roller support may be used.



Simple push stick made of scrap

Cutting Bevels

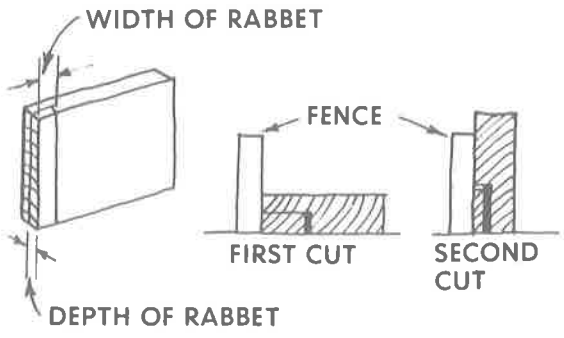
Bevels from 1 to 45 degrees may be cut on the tilting table, tilting arbor and radial arm saw. Bevel cutting with the tilting arbor saw is very similar to cross cutting or ripping. It is a little more difficult with the tilting table saw. There is a tendency for the work to slide down the table slope as it is fed into the saw.

The fence or miter gauge should always be placed on the low side of the blade, when using a tilting table saw. Sandpaper on the miter gauge face will help hold the material in place.

Cutting A Rabbet

A rabbet is a rectangular recess cut on the edge or end of a piece of wood. This is done by making two saw cuts at right angles to each other.

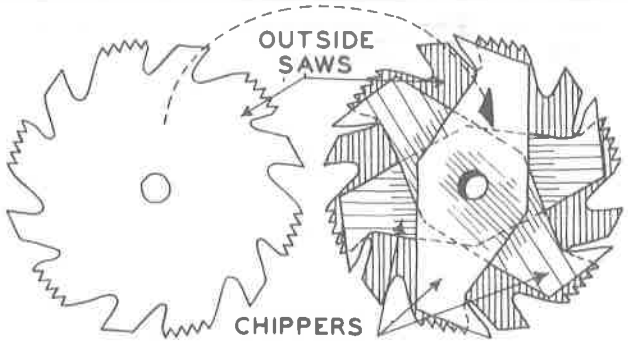
Mark the size of the rabbet on one end of the work as a guide for setting the saw. Set the blade so the top of the teeth just touch the mark, when the stock is lying flat on the table. Make this cut using the miter gauge or fence as a guide. Reset the saw for the second cut.



Cutting a rabbet

Dado Cutting

A dado is a rectangular recess across a board. If the recess is parallel to the grain of the wood, it is usually called a groove. Either may be cut with a dado saw or by making several cuts with the ordinary blade.



Typical dado set

A typical dado set consists of two solid full circle outside blades and a number of two-tooth chipper blades for use between the outside blades. The outside blades cut like a combination blade, and the chippers act as planers to smooth out the area between the two outside blades. The chippers cannot be used alone.

When two or more chipper blades are used, space the swaged ends of chippers evenly around the circumference of the assembled head. The chipper ends must be opposite the gullet of the adjacent outer blade.

The dado saw or head may be used to cut dados, grooves, rabbets and tenons. Dado heads are smaller in diameter than standard saw blades. Thus the depth of cut gauge will not be accurate. Each setting must be made by aligning the top of the blades with the mark on the work.

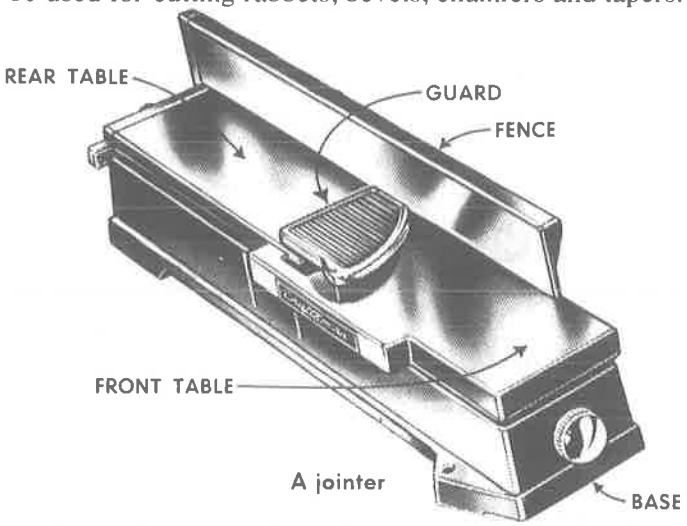
Saw Safety

Safety rules given in the section devoted to the safe use of woodworking power equipment apply to the saw. In addition the following rules apply specifically to the saw:

- Stand to one side of the rotating saw blade, never directly in line with the blade. Then, if a piece does kick back it will not strike you.
- Use a push stick between the fence and the saw for all narrow ripping.
- When using the tilting table or tilting arbor saw, do not allow the saw to project more than 1/8 to 1/4 inch higher than the thickness of the piece to be cut.
- When operating the radial arm saw, be sure all clamp handles are properly tightened before starting machine.
- When ripping with the radial arm saw, be sure to feed the stock from the proper direction. Stock must be pushed against the rotating direction of the saw teeth.

The Jointer

The jointer is a power tool designed to do part of the work formerly done with a hand plane. It is used to plane or finish edges and surfaces of lumber. The jointer straightens and dresses a surface in one operation. It will do the work much faster and better than the hand plane. In addition to planing edges and surfaces, it may be used for cutting rabbets, bevels, chamfers and tapers.



A jointer

The main parts of a jointer are the guards, base, front table, rear table, cutting head and fence. The only working part is the cutter head which consists of a heavy steel cylinder and the knives.

Selecting a Jointer

Jointers are made in a variety of sizes for light, heavy and special duty work. The size of a jointer is determined by the length of the knives on the cutter head. The most common jointers are the four- and six-inch sizes.

Most good quality jointers are equipped with three or four knives.

The cutter head revolves in two bearings which are fastened to the main casting. The bearings may be bronze, ball or roller. The ball bearings, enclosed in dust-proof housings, are more expensive, but are desired especially when the machine will be used for rabbeting.

The longer the tables on the jointer, the more costly the machine. The longer table increases the ease of straightening longer pieces of lumber.

The machine should be equipped with a cutter guard that will automatically swing into position to cover the cutter head. It should also be equipped with a sliding guard that will move with the fence, so no portion of the cutter head will be unguarded when the fence is moved toward the center of the table.

The jointer should be operated at the speed recommended by the manufacturer, which is usually 3600 to 4500 rpm. Satisfactory work cannot be done at slower than recommended cutter head speeds. A 1/3 or 1/2 HP motor should be used for a four-inch jointer and a 1/2 or 3/4 HP motor for a six-inch jointer.

Jointer Adjustments

Most jointers are properly adjusted when shipped from the manufacturer. However, they should be checked before being used. Exact adjustments are absolutely necessary if the jointer is to do accurate work. Check to see that the cutter head knives and the rear table are level. The rear table should not be moved after it is properly adjusted.

Follow the manufacturer's recommendations in making adjustments.

Resetting The Cutter Knives

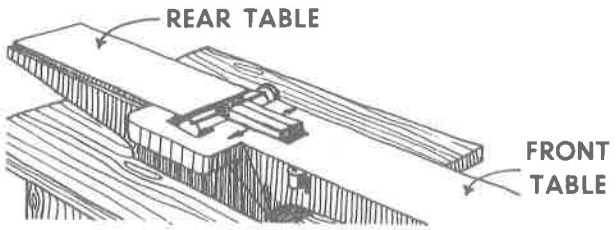
It is necessary to reset the knives after they have been removed for sharpening. This must be done accurately and carefully. Follow the manufacturers directions.

Honing Jointer Knives

The length of service between grindings can be greatly extended by properly honing the jointer knives. This can be done by covering a fine rectangular shaped abrasive stone with a piece of paper. By leaving one end of the stone exposed, it can cut the knife, but will not damage the jointer table.

Rotate the cutter head so the bevel edge of the knife is exactly parallel to the front table. Hold the head in this position by wedging or clamping the belt. Stroke the knife from end to end with the exposed portion of the stone. Keep the stone flat on the front jointer table. Stroke each knife in turn and give each knife the same number of strokes.

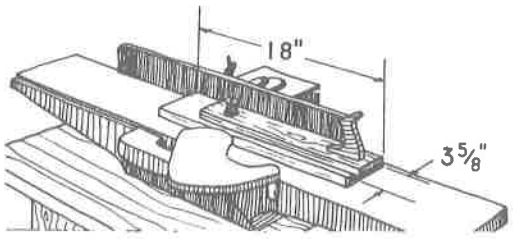
A small abrasive stone can be used on the cutting edge side of the knives to remove any burr turned over by the honing action. Check rear table elevation.



Honing jointer knives

Jointer Operations

The jointer is a dangerous tool if it is not used correctly. Extreme care must be taken so the hands or fingers do not get into the knives. The fingers should be kept as far from the revolving knives as possible. A push block should be used for most jointer operations. Work with the grain of the wood, not against it.



A push block in use

Surface Planing

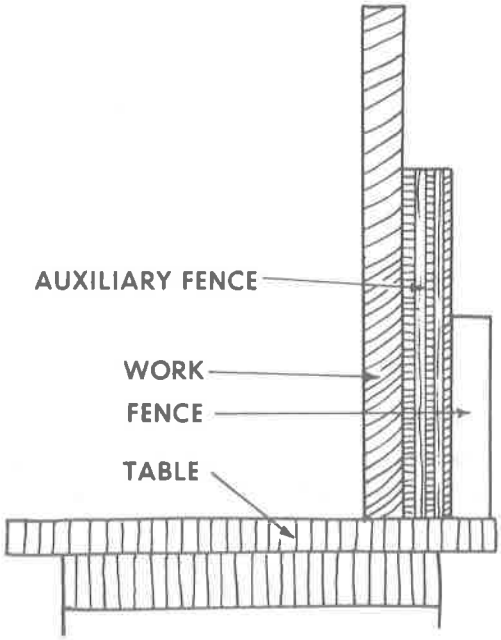
Surface planing or smoothing board surfaces is a simple operation. Adjust the front table for a thin cut, 1/16" or less.

It is usually not practical to surface boards under 12 inches in length. Shorter boards do not provide enough hand-hold leverage to offset the thrust of the cutter head.

Edge Jointing

Edge jointing is the simplest and most common operation done on the jointer. Usually the cut should be 1/8" or less.

When the edges of wide boards are jointed, it is best to attach an auxiliary fence to the regular fence. This fence should be high enough so the work piece can be pressed firmly against it.

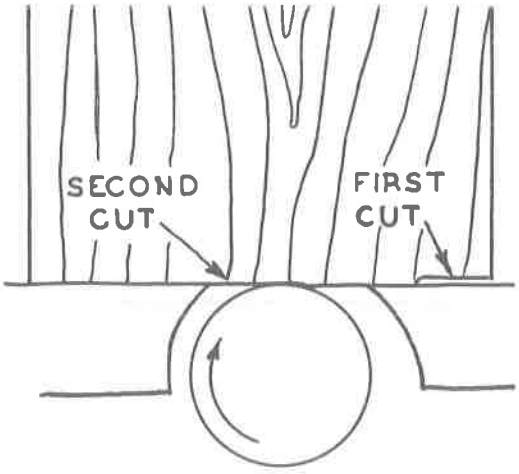


Using an auxiliary fence

End Jointing and Plywood Edge Jointing

End jointing is similar to edge jointing. However, there is a greater tendency for the wood to split at the back end as it is passed over the cutter head. This tendency to split can be overcome by making two partial cuts in jointing the end. The first cut is long enough to carry past the second or third grain or annual ring of the wood at one edge. The board is then turned around, and the second cut is made to join the first cut for a straight edge.

Do not attempt this on pieces less than 6 inches wide or pieces that are too long to handle with ease.



End jointing

Cutting Bevels and Chamfers

The fence on most jointers can be tilted to the desired angle for bevel cutting. The angle is indicated by the fence angle pointer and protractor scale. After the fence is set in the desired position, a number of cuts are made to get the desired chamfer or bevel depth.

Rabbeting

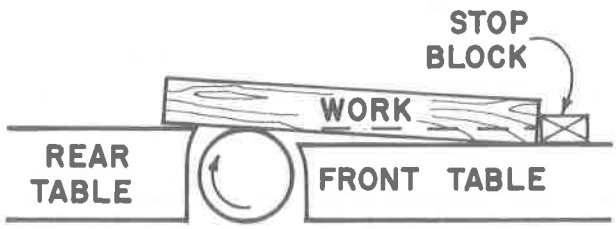
Rabbets or edge grooves are easily cut on the jointer. However, for accurate rabbeting it is desirable to have a jointer with ball bearings.

To set up for cutting rabbets, remove the guard. Move the fence over to the edge of the jointer so you will obtain the desired width of cut when the work piece is pressed against the fence. Lower the front table 1/4" or less. Make as many cuts as are necessary to obtain the desired depth of cut.

Cutting Tapers

A simple taper, shorter than the length of the front table can be cut on a jointer in the following manner: First, lower the front table the amount the board is to be tapered, minus a small amount for a finishing cut.

Then with the jointer stopped move the guard to the side and place the workpiece over the cutter head with the forward end resting on the rear table. The start of the taper should be over the center of the cutter head. With the workpiece in this position clamp a stop block to the front table at the rear of the work piece. (The stop block will prevent the workpiece from being thrown to the rear at the start of the cutting operation.) Remove the work piece and start the jointer. Rest the rear of the work pieces against the stop block; slide the guard to the side; and lower the work piece onto the front table and cutting head. KEEP YOUR FINGERS AWAY FROM THE KNIVES: Use a push block to feed the work piece through the jointer. After this cut is complete, raise the front table to a position for making a light cut. Then make the finishing cut.



Cutting a short taper

Jointer Safety

- Use the cutter head guard at all times on jobs that will permit its use.
- Use the push block, especially when surfacing thin or short stock.
- Do not let your fingers extend over either end or edge of a board that is being surfaced.
- Do not attempt to surface a block that is less than 12 inches long.
- Do not attempt to make too heavy a cut.
- Do not use a jointer if the knives are dull.
- See that the material run over the jointer is sound and and free of loose knots.
- Open the main power switch and remove the fuse or disconnect the cord when installing or adjusting knives.
- Do not move the fence while the machine is in operation.

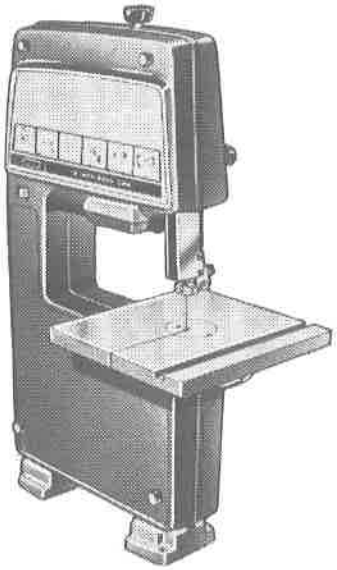
Jig Saw and Band Saw

The jig saw is discussed in Unit Two *Learning and Building.*

It would take many pages to explain the operations and adjustments of the band saw. If you have one, obtain a book pertaining to band saw operation techniques.

The band saw cuts more rapidly than the jig saw and will cut thicker material. Most band saws can be used on material up to four or six inches thick. The table can generally be tilted for bevel cuts. The saw blade is a continuous flexible band of steel, with cutting teeth on one edge. This operates over two or three wheels. When running it provides a continuous row of teeth moving downward through the material being cut.

A band saw should have sealed, smooth running bearings. The guide for the blade should be rigid and easily set. The machine should be so constructed that it is easy to change the blades.



A band saw

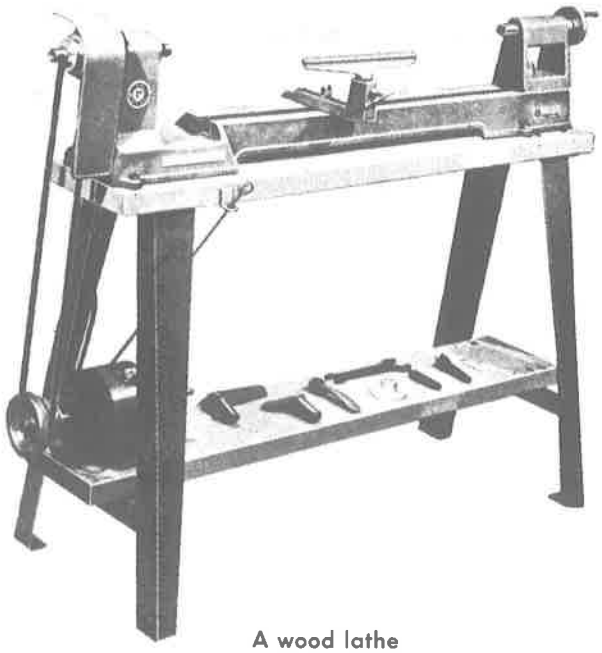
BAND SAW SAFETY

- Keep the fingers of each hand close together, and watch the saw at all times.
- The band saw guide must be adjusted within one-quarter of an inch of the top of the work.
- The machine must reach its full operating speed before cutting is started.

Wood Lathe

Of all the power tools used by the home craftsman, the wood lathe is the most enjoyable to operate. However, it must be considered as a hobby or special interest tool. Many operations can be performed on the lathe. If you have access to one be sure you read and study an operation manual before using it.

The wood lathe consists of four essential parts: the bed, a headstock fixed on the bed, a tailstock, and a tool rest. Both the tailstock and tool rest can be moved on the bed.



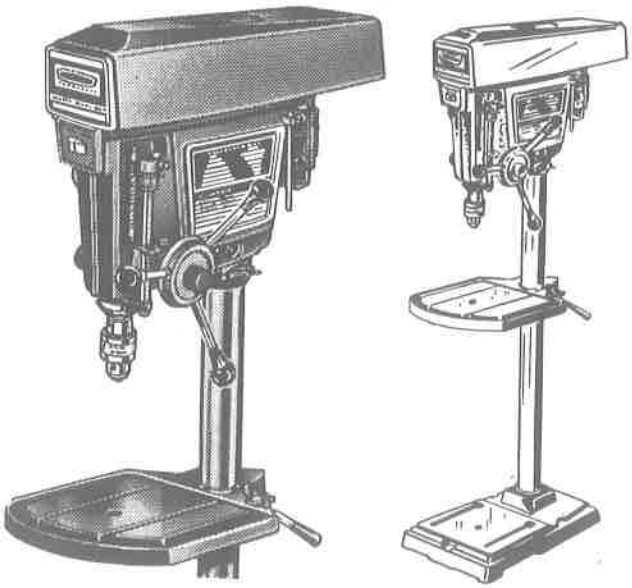
A wood lathe

The lathe size is expressed in terms of swing and capacity. Capacity refers to the longest piece which can be inserted between the headstock and tailstock. Swing refers to the largest diameter workpiece that can be rotated without striking the bed. In most instances, lathe bed extensions can be purchased to increase the capacity.

Drill Press

The drill press has many uses. With the various attachments it can be used for drilling, routing, sanding, mortising, shaping, carving, cutting dovetails, buffing, wire brushing, and grinding.

If you have the machine, study the operator's manual and instruction book.



A drill press

Wood Stabilized With Polyethylene Glycol - 1000

A process of impregnating wood with a polyethylene glycol compound can be used to reduce checking of the wood during drying. It can also be used to give a high degree of dimensional stability to wood in relation to moisture change. This process has been used in gun stocks production, bowl turning, wood carving and protection of imported wood carvings.

Further information pertaining to the use of polyethylene glycol - 1000 may be obtained from the Forest Products Laboratory, Madison, Wisconsin 53705.

Gluing Wood

Gluing is an important part of wood construction and the woodworking craft. In many instances, durability, strength and appearance of the finished product depend upon the proper selection of the glue and following good gluing techniques.

There are many kinds and manufacturers of commercially prepared glues. Most manufacturers make more than one type of glue, therefore, one must determine the specific product rather than refer loosely to a trade name.

The following chart gives the main characteristics of most common glues. Use this as a basis for your glue selection. However, follow the manufacturers recommendations pertaining to specific mixing, use, temperature, clamp pressure and curing time.

Glues for the Home Shop

Form	Properties	Preparation and Application	Uses
		ADHESIVES COMMONLY USED TO GLUE WOOD TO WOOD	
		Animal and Fish	
Both dry powder form and liquid form.	Low resistance to moisture and damp conditions; stain wood very slightly if at all; good joint filling qualities.	Dry form mixed with water, soaked and melted; solution kept warm during application.	Furniture assembly, cabinet making and shopwork for interior use; not subject to damp conditions.
		Polyvinyl Resin Emulsion	
White liquid	Low resistance to moisture and damp conditions, joints tend to yield under continued stress; stains wood little if at all; dries fast. Not HEAT resistant.	Ready to use; minimum temperature 60° F.	Furniture assembly, cabinet and shop work for interior use; not subject to damp conditions, continued stress, or excessive heat.
		Casein	
Powder	Moderately durable under damp conditions; dulling effect on tools; stains some woods badly; good joint gap filling quality.	Mixed with cold water and applied cold; minimum 70° F.	Furniture assembly, shop work and cabinet making requiring low to moderate moisture resistance.
		Urea or Plastic Resin	
Usually powder	Moderately durable under damp conditions; stains wood slightly if at all; poor joint filling qualities.	Dry form mixed with water; minimum, 70° F.	Furniture assembly, cabinet making and shop work for interior use.
		Resorcinol Resin	
Liquid form with catalyst packaged separately.	Very resistant to moisture and damp conditions; stains wood slightly; dark red in color; poor joint filling qualities.	Mix with catalyst; minimum temperature 70° F.; 110 to 150° preferred for dense wood.	For use wherever moisture is a hazard or all outside construction; outdoor furniture, boats, animal shelters, etc.
		SPECIAL ADHESIVES TO BOND OTHER MATERIALS TO WOOD	
		Contact Adhesives	
Liquid	Moderately water resistant. At present not considered suitable for purposes requiring very strong and durable bonds.	Ready to use; minimum usually 70° F. Adheres immediately on contact.	Covering counters, cabinets, etc., with linoleum, plastic laminates, leather, etc.
		Epoxy Glue or Cement	
Liquid or paste form; one container of resin and another of hardener.	Probably durable but not definitely established; very resistant to moisture and damp conditions; high in cost. Good joint gap filling qualities.	Mix resin and hardener; minimum generally 70° F	Excellent for bonding metal or fiberglas, cloth, etc., to wood. No practical advantages on wood to wood gluing over resorcinol glue except it has good joint gap filling qualities and more effective for end grain butt joints.

Conditioning Wood for Gluing

When gluing, it's important the wood, depending upon its intended use, be of the correct moisture content.

If the wood is to be used inside, its moisture content at gluing should be five to six percent. On the other hand, if the ultimate use of the wood product is outside, then its moisture content should be 12 percent when being glued. This percent can be obtained by air drying during the summer months.

Lumber having five to six percent moisture is generally satisfactory for gluing into furniture, cabinet work, etc. This moisture level can be obtained by kiln drying or by drying in the house during the winter. In summer, the moisture can be lowered by drying the wood in a ventilated attic for several days or weeks.

Wood surfaces to be glued should be flat and smooth, free from machine marks, torn fibers or other surface irregularities.

Directions for Gluing

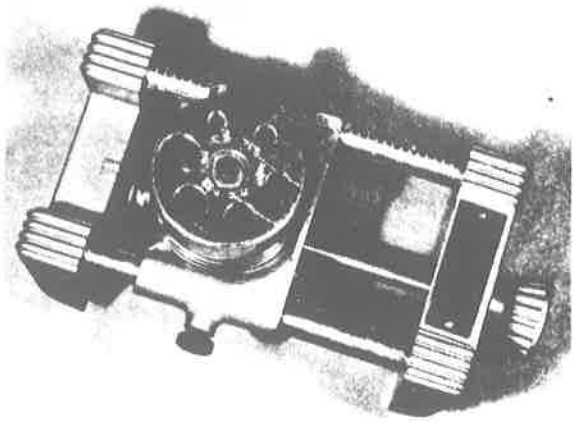
- Select the proper glue for the probable service conditions to which the glued item is to be exposed.
- Have the lumber conditioned to proper moisture content for intended use.
- Read and follow the manufacturer's instructions for the type of glue being used.
- Make certain that all tool operations on the various parts of the assembly have been completed before gluing. This machining should be done as shortly before gluing as possible.
- Before applying the glue, decide how you are going to apply clamps or other fasteners to hold the assembly together.
- Have at hand all materials needed in the operation before applying any glue.
- Apply glue to one or both surfaces as recommended by the manufacturer; follow recommendations pertaining to interval between spreading the glue and clamping or applying pressure; and apply adequate and uniform pressure.
- Remove surplus glue squeezed out of the joint before it is dry. For light finishing sand after the glue has dried.
- Allow enough time for glue to set or dry before removing the clamps.
- In some instances, further moisture condition the wood before machining. When edge-to-edge joints are glued, the wood at the joint edges of the boards absorbs water from the glue and swells. If the work is surfaced before the excess moisture is dried out or distributed, more wood is removed along the swollen joints than elsewhere. When the joints dry, the shrinking causes permanent depressions along the glued joints. Therefore, several days' time should be allowed for drying or moisture distribution before surfacing.

Using Dowels When Gluing

With most woods, a well made glued joint between two flat, side grain surfaces is about as strong as the wood itself. Therefore, the use of dowels, tongue and groove joints and other shaped joints do not add materially to the strength of the joint. However, when an end-to-side grain joint or end-butt joint is made, it is necessary to use irregular shapes of joints, dowels, tenons or other devices to bring side grain in contact with side grain or to secure larger gluing surfaces.

When dowels are used, exacting care must be taken in laying out the accurate location of the holes for the dowels. The holes should be drilled with a sharp tool so the surface is smooth and free of torn fibers. The drill feed rate and withdrawal rate should be as high as possible to avoid polishing the hole wall, which could prevent the formation of a satisfactory glue bond.

If the holes cannot be drilled with a drill press, a doweling jig will aid in guiding the hand boring operation.



Doweling jig

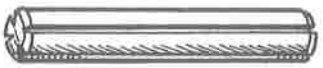
Each dowel hole should be about 1 1/2" deep, when material dimension allows. The dowels should be nearly the full length of both holes so the glue in the hole is forced up the grooves of the dowel rather than collecting in the bottom of the holes. Caution and dry trial assembly is urged to be sure the dowels are not too long.

Generally, the diameter of the dowel used is about equal to one-half the thickness of the thinnest of the two pieces being joined. For example, if you are using a dowel joint between a 3/4" chair rail and a 1 1/2" leg, a 3/8" dowel would be workable.

Ideally, the dowel and the hole should be the exact same size. The Furniture Industry Research Association of Herefordshire, England recommends the dowel should be the same size or .005 inch smaller than the hole. This tolerance can be achieved in the home workshop by drilling the holes with a metal boring bit. Then use the same bit to drill the threads out of a standard size nut for a metal bolt. Locate dowels that bind or do not go through the hole in the nut. Clamp the nut in a vise and drive dowel sections through the nut for sizing. Lightly sand any glossy areas formed on the dowel with fine sandpaper.

The Furniture Industry Association reports that for tight joints grooved dowels must be used to allow air and excess glue to escape. They indicate that dowels with multi grooves running lengthwise are slightly more effective than single or double grooved dowels. However, they report a reduction of strength when spiral grooved dowels are used. This may be caused by the grooves cutting the surface fiber and weakening the dowel. Dowels should be straight grained and free of defects. Slightly bevel the ends of the dowel for easier insertion into the dowel hole.

Plain dowel



Grooved dowel

The Association reports that glue application to both the dowel and the hole is preferred to an application on only one or the other.

The dowels are usually cut from dowel rods. These are available at lumberyards and hardware stores in two or three foot lengths. Dowel rods are usually stocked in various diameters from 3/16" upward to an inch.

Painting and Finishing Wood

A knowledge of painting and finishing wood is an important part of the advanced woodworking projects. For example, in this unit your project work for a year might consist of painting, repainting, staining or applying water repellent preservative to the house and garage or other buildings.

Painting and wood finishing is a large and complex topic. This section will provide some basic information and suggest sources of additional material. The subject is divided into sections on interior and exterior finishes.

Exterior Wood Finishing

Surface film coating and penetrating finishes are the two groups of exterior wood finishes. Paint, enamel, varnish, etc. are examples of the surface coating finishes. Oil base and latex base penetrating stains such as redwood and cedar stain and water repellent preservative are examples of penetrating finishes.

A natural type finish can be obtained by the use of water repellent preservative. For futher information obtain a copy of Forest Products Laboratory Report - 0124.

The stains penetrate into the wood without forming a surface film. Therefore, they do not crack, peel or scale. The stains are especially suitable for rough and weathered wood and plywood. However, they serve well on smooth lumber, too. They are frequently used on smooth cedar or redwood siding to preserve the natural color of the wood. One coat of the oil base stain should last three years on smooth surfaces and six years on rough surfaces.

Generally speaking, the commercially available clear surface film forming finishes such as varnish, have been short lived, requiring finish renewal every year or two.

For additional information pertaining to stains obtain a copy of Forest Products Laboratory Report-046.

Surface coating finishes often fail by cracking, curling, flaking, checking, crumbling, blistering or peeling. Paints that fail by checking and crumbling generally leave a good surface for repainting with little preparatory work. Paints with advanced forms of other types of failure require a great deal of work prior to repainting.

Exterior house paint has been the most widely used paint for wood siding on homes. A good white house paint should last at least four to five years before it must be renewed and a tinted paint should last five or six years. Obtain a copy of Forest Products Laboratory Report - 0123, How To Paint Wood.

House paints consist of two parts, a solid part (pigments) and a liquid part (the vehicle). For many years, the vehicle consisted essentially of a drying oil — usually linseed oil, a thinner and a small amount of drier. The kind and quality of this paint was determined by the nature and proportion of pigment and the kind of vehicle. Classifications, advantages and disadvantages of these paints are given in the USDA Home and Garden Bulletin No. 52, Wood Siding.

Latex paints for exterior use have been recently developed. Latex paints are made by combining the pigments with resin particles which have been dispersed or emulsified in water. Such paints are often called emulsion, rubber-base, water-thinned or water-base paints.

Interior Wood Finishing

Interior finishing has more exacting standards of appearance than exterior finishing. There is also a greater variety of effects. Both opaque and transparent finishes are commonly used.

Preparation for Finish

Inexperienced workers sometimes feel that stain and varnish will hide defects. This is not true, for every flaw will be exaggerated and made more prominent when the finish is applied, especially if the finish has high gloss.

Before applying the finish:

1. See that all mill marks have been removed. They should be removed before the project is assembled.
2. Check to see that all tool marks, pencil marks, grease spots, fingerprints, glue or other blemishes have been removed.
3. Try to remove all dents or impressions in the wood before starting the finishing operation. Many dents can be removed by placing a pad dampened with water over the dent and heating it with a flat iron or soldering iron. The steam expands the compressed pores.
4. Sponge softwoods with water and allow them to dry thoroughly. Then sand lightly with sharp sandpaper before finishing. This decreases the problem of raised grain on flat grained surfaces. In the planing operations, the hard bands of summerwood are sometimes crushed into the spring softwood. These bands sometimes raise again when the moisture content of the wood changes.
5. Give the article a final sanding with a fine or very fine grit sandpaper.
6. Wipe off the sanding dust with a tack cloth or a cloth slightly moistened with thinner used in the finish to be applied.
7. It is generally recommended to sand lightly with very fine sandpaper between each coat in the finishing operation.

Transparent Finishes

The application of most transparent finishes consists of one or more of the following fundamental operations: staining, filling, sealing, surface coating, rubbing and polishing.

Transparent finishes can be divided into the surface coating finishes and penetrating finishes.

Application of the easy to apply penetrating finishes was described in Unit I. Information pertaining to surface coating finishes follows:

Staining

Stain is any material used to color wood, but not to conceal the grain.

In the penetrating finish process for both hardwoods and softwoods; the stain is added to the penetrating seal or purchased in colored form.

Before staining something you have made, you may desire to try the process on a piece of scrap wood to check the color and your total finishing process. It is important to remember that the same stain will produce different shades on different woods. In addition, different manufacturers have different names for very similar colors.

Either water stain, penetrating oil stain or pigmented stain may be used on hardwoods as a part of the surface coating process. The oil stains should be applied evenly and thinly. Allow a short time for the stain to partially soak into the wood, then wipe the surplus stain from the surface. The quicker the stain is wiped off, the lighter will be the resulting color. It is generally wise to seal the oil stain with a coat of shellac before applying any other finish.

When oil stain is applied to softwoods, the springwood absorbs more stain than summerwood. This reverses the color variation and in some, such as Douglas-fir, the wood often is given a harsh and glaring appearance. Frequently this can be prevented by applying a special shellac before the staining operation. This shellac is prepared by mixing four parts by volume of alcohol or shellac thinner to one part of four pound cut shellac. Often the end grain of both hardwoods and softwoods is treated with such a shellac or sealer coat before applying the stain.

The pigmented stains, which are similar in nature to paint highly diluted with thinner, are less likely to produce this color reversal effect. However, in some instances it is recommended to use the shellac coat described in the preceding paragraph.

When applying pigmented stains do not allow them to "run" or "sag." These stains may be applied as either a light or heavy coat and may be wiped off or allowed to dry depending upon the manufacturer's recommendations and the desired effect.

Filling

The purpose of wood filling is to fill the open pores and cavities of the wood cells. This leaves the surface smooth and level for the next coats of finish. There has been a tendency, in recent years, to omit filling. Before you decide to do this, examine articles on which filler has and has not been used.

Pastewood filler is generally used to fill the pores of open-grained woods such as red oak. The commercial paste wood filler is usually combined with a wood sealer. As a result, the penetrating seal finish can be developed during the filling operation. Directions on the container generally describe the procedure which includes application, short drying time and wiping off of the excess before hardening.

If the wood is stained with oil stain and filled, it should be stained first, then sealed and filled with a filler that is colored with stain, unless some special effect is desired.

Sealing

Sealer is used to prevent the 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 are available.

Surface Coatings

Varnish, lacquer and various other synthetic compounds are used for surface finishes.

Varnish has had the reputation of yellowing with age. This was rather typical of the oleo resin varnish. However, this has been partly overcome with the use of the alkyd resin varnishes. Varnish can be made to dry dull (satiny) to resemble rubbed varnish.

Lacquers have the advantage of drying rapidly and forming a hard protective surface but require more coats than varnish to build a coating of the same thickness.

Shellac dries quickly, also, but the resulting coating is easily marred by water.

Many paint and chemical companies have on going research programs to develop new finishes and improve the old. New products of nitrocellulose-acrylic, polyurethanes and other synthetics have been developed as a result. Many of these newer finishes are more expensive, faster drying and more resistant to the action of weak caustics and dilute acids, and tougher than the older type finishes.

Select these finishes on the basis of what you desire in the finish and follow the manufacturer's directions.

Rubbing and Polishing

Various degrees of satin or luster effect can be obtained by further treatment of a high quality gloss surface coating.

A high sheen satin finish can be obtained by rubbing the final coat with grade 500 paper. Then hand rub with cloth or felt and a slurry of fine pumice. Follow this with furniture cleaner and polish.

A dull satin finish can be obtained by a final hand sanding using grade 360 or 400 paper. Follow this with an application of a furniture cleaner and polish.

Opaque Finishes

Both enamels and paints are generally used for opaque finishes on interior woodwork. Enamels differ from paints in that linseed oil is partly or entirely replaced by bodied oils, varnishes or lacquers. This gives a coating that does not show brush marks, gives a harder surface, and a more lasting sheen than regular paint.

Wood to be enameled or painted should be prepared as indicated in the section devoted to preparation for finishing.

Wood to be finished with paint or enamel should be smooth, dust free and free from oil or grease. Nail holes and other defects should be filled before or after the prime coat as recommended by the finish manufacturer. Use the primer and application procedures recommended by the manufacturer.

The knots in white pine, ponderosa pine or southern yellow pine should be sealed with a special knot sealer or shellac after the priming coat is dry. If you are using light-colored enamel on white pine or ponderosa pine, a coat of knot sealer should be put over all the heartwood material. This will help to prevent discoloration of the paint or enamel by the resin present in the heartwood.

After the priming coat and knot sealer have been applied, put on the enamel undercoating. One or two coats may be needed to completely cover the wood. For best results the surface of the enamel undercoating should be sandpapered lightly before applying the finishing enamel. The finishing enamel may be left with its natural gloss or it may be rubbed to a dull finish.

Selecting Drawings

On this and the following pages you will find plans for items to make in your woodworking project. You may make other items besides the ones shown in this book.

Work Bench

This is a basic plan to be altered in relations to material, height and vise. Hip height is very comfortable unless you plan to do a great deal of hand planing. Then it may be desirable to lower it a couple of inches.

Materials:

Hardware:

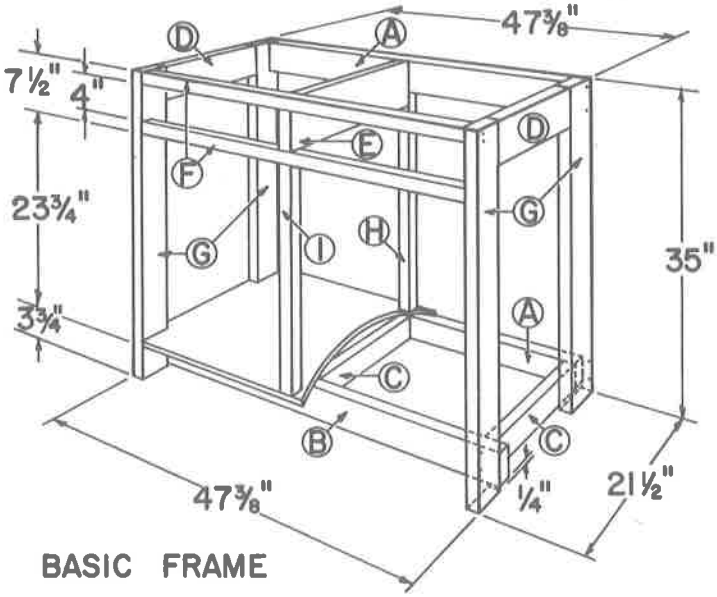
2 pr. 2" x 2" butt hinges with screws
4 ea. door or drawer pulls with screws
2 ea. door catch
12 - 1 1/2" #10 flat head wood screws (attach top)
Penetrating wood sealer for finish
3/4" wire nails
6d finish nails
6d common nails
8d common nails
10d common nails
16d common nails
40d common nails

35" leg height & 24" x 60" plywood top

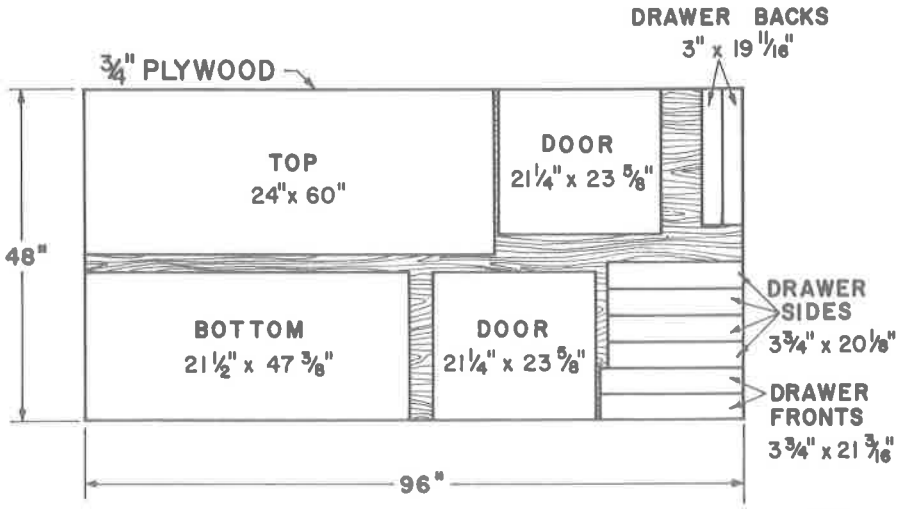
1 pc. 3/4" exterior grade plywood 4' x 8'
1 pc. 1/4" exterior grade plywood 4' x 8'
1 pc. 2" x 6" x 2' (E)
4 pc. 2" x 4" x 8' (A, B, C, D & G)
1 pc. 2" x 2" x 12' (F, H, I)
1 pc. 1" x 2" x 12' (drawer guides and runners)
1 pc. 1' x 4" x 4' (drawer guides)
1 pc. 2' x 4', 1/4" plywood or hardboard (drawer bottoms)
2 pc. actual dimension pine trim material 3/4" x 1 3/4" x 8'

Optional:

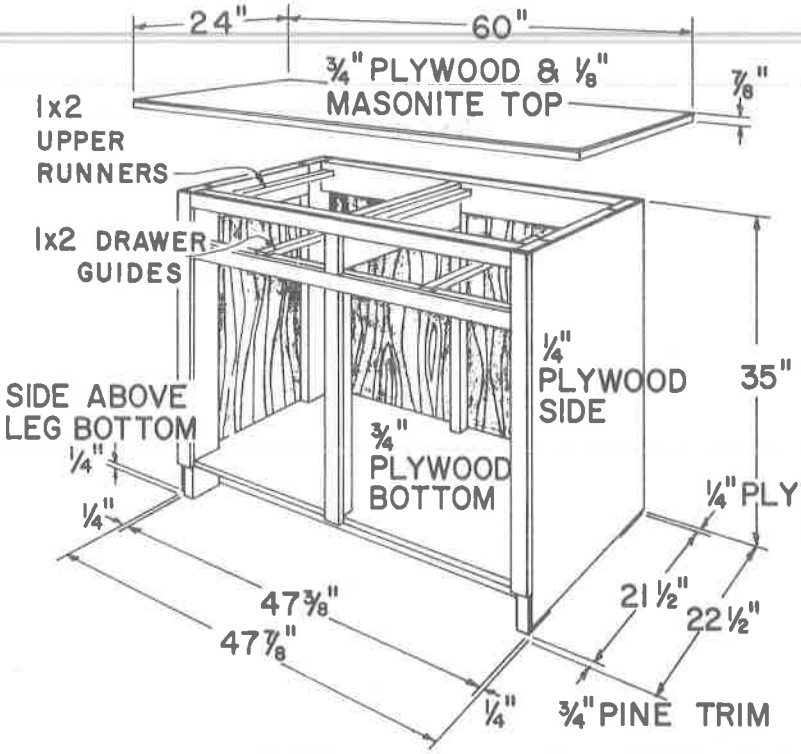
1 pc. 2' x 5', 1/8" - 1/4" Masonite or equivalent to cover plywood top

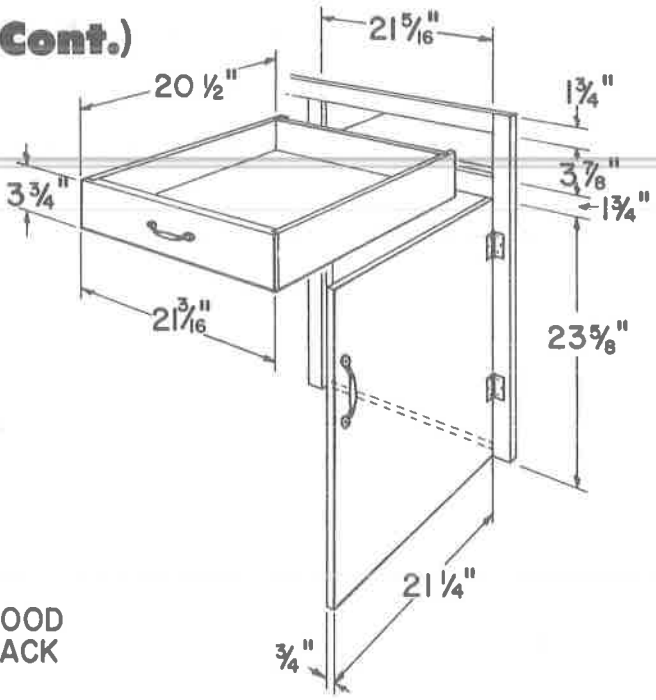


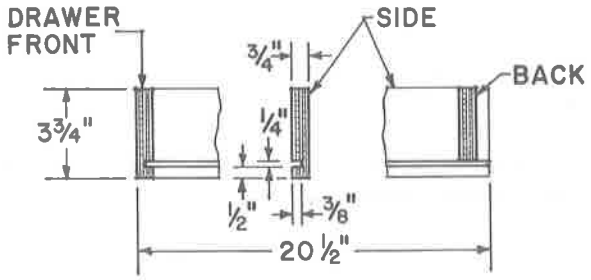
BASIC FRAME



Work Bench (Cont.)



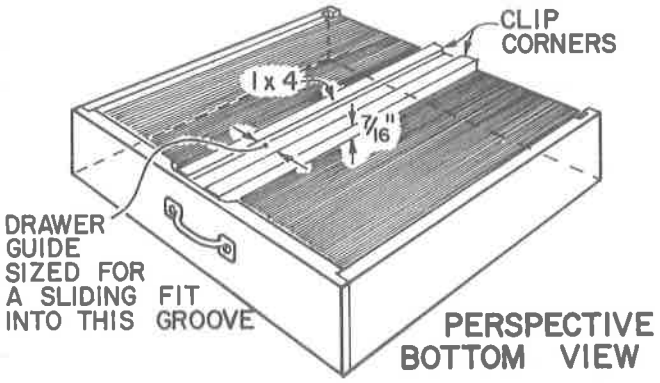




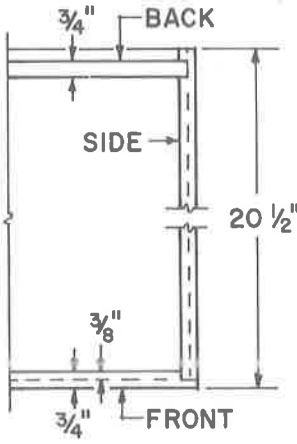
SECTION DETAILS

Construction Procedure:

1. Determine height.
2. Make changes in dimension on plan as necessitated by selected height. Make calculations for specific material lengths.
3. Purchase materials.
4. Cut pieces A through G.
5. Assemble front legs and pieces B and F.
6. Assemble back legs and pieces A.
7. Add pieces C, D and E to back assembly.
8. Cut and insert bottom.
9. Attach front assembly to rear assembly.
10. Cut and add pieces H and I.
11. Brace inside for squareness.
12. Cut and attach 1/4" plywood to back and ends.
13. Cut and attach trim to front.
14. Cut, fit and hang doors. (1/32" clearance on hinge side and 1/16" on opposite side and top)
15. Make drawers.
16. Attach top—drill shallow holes so screw heads can be set below table surface. Plug with a section of dowel or plastic wood after screws are set.
17. Finish with penetrating wood sealer.



PERSPECTIVE BOTTOM VIEW

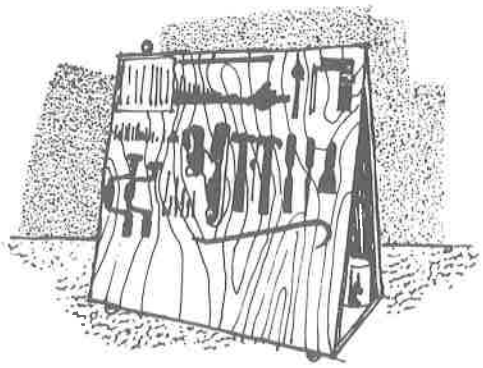


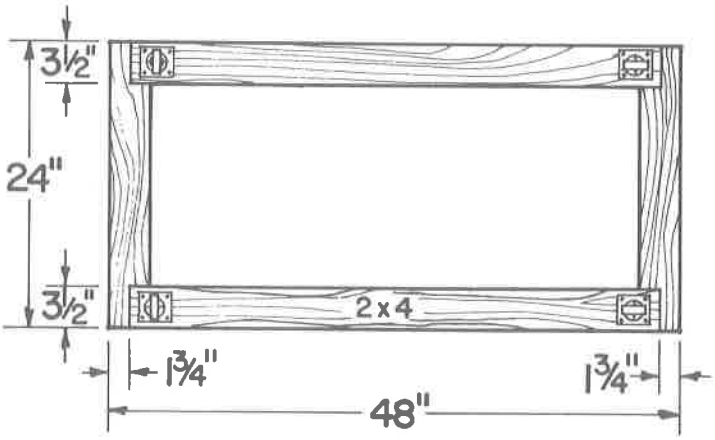
TOP VIEW

Roll Away Tool Rack

Material List:

1 piece 4' x 8' x 1/2" plywood
1 piece 2' x 4' x 1/4" plywood
1 piece 2" x 4" x 12'
2 pieces 2" x 2" x 8'
1 piece 1" x 6" x 4'
1 pair heavy duty 2" casters (swivel)
1 pair heavy duty 2" casters (rigid)
16 - 1" - 1 1/2" screws for casters
8 - 3" wood screws or lag screws
(for base frame)
Nails and glue to attach plywood



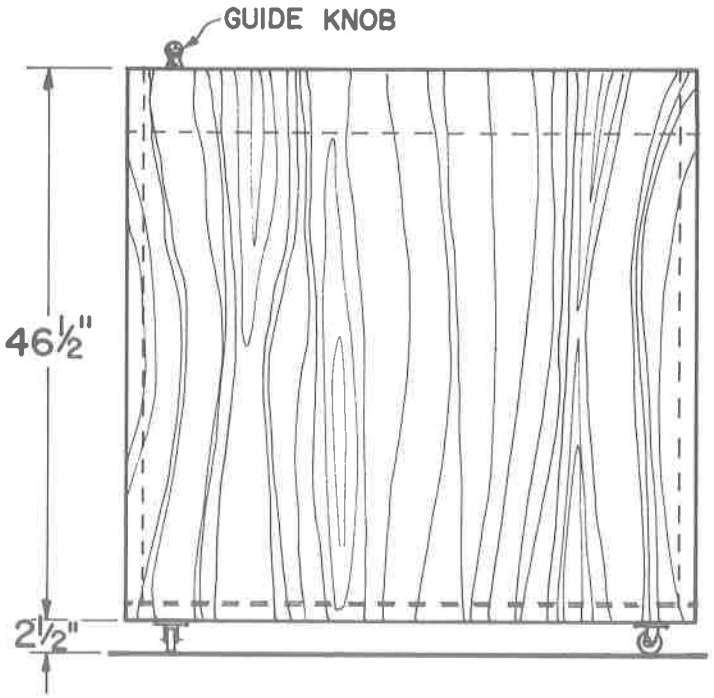


BOTTOM VIEW

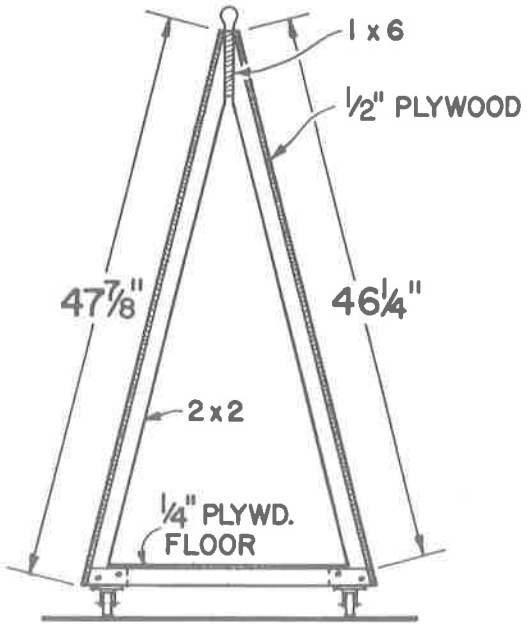
Note: Ends of tool rack may be closed in to provide storage.

Note: Casters on guide end should swivel, casters on other end should be rigid to facilitate guiding.

Note: Tools may be supported by screw hook, wooden brackets, metal brackets, and clasps.



SIDE VIEW



END VIEW

Knife Rack

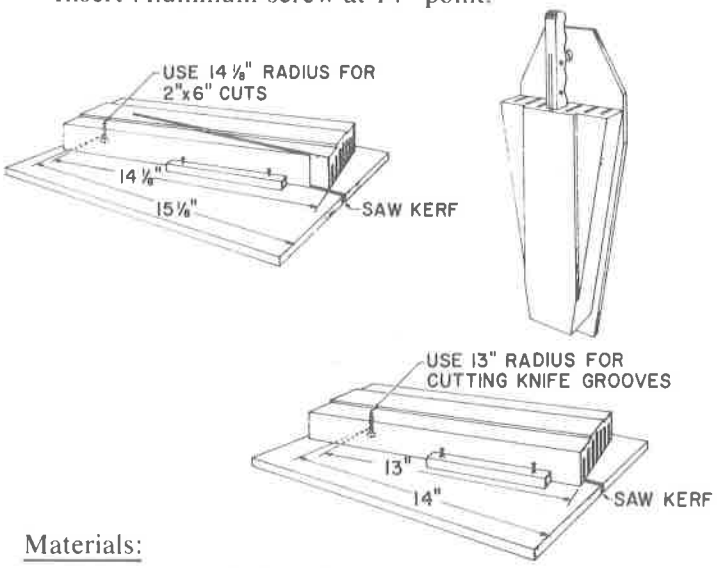
Suggested cutting procedure for 2" x 6" block:

1. Cut 2" x 6" to 15" length with square ends.
2. Mark center line of 2" x 6" on each end. Mark center lines of knife blade grooves on end of 2" x 6".

3. Cut 1/8" x 1 1/2" rabbets on jointer or table saw.

4. Cut out 11 1/2" x 16" rectangular piece for sawing jig from 1/4" or 3/8" plywood. Mark center line lengthwise on both sides of this piece. On the back side measure from top or leading edge along center line and mark a point at 14" and one at 15 1/8". These will later serve as points of pivot for saw cuts. Note this measurement is 1" greater than the radius points shown on the drawing because the top of the 2" x 6" will be 1" below the top of the plywood.

5. Lightly nail plywood jig to back side of 2" x 6" piece with pivot points marks visible, center lines matching and flush at the bottom. Leave nail heads protruding for easy pulling. Drill countersunk holes for 3/4" or 1" #8 Aluminum flat head screw at pivot points. Insert Aluminum screw at 14" point.



Materials:

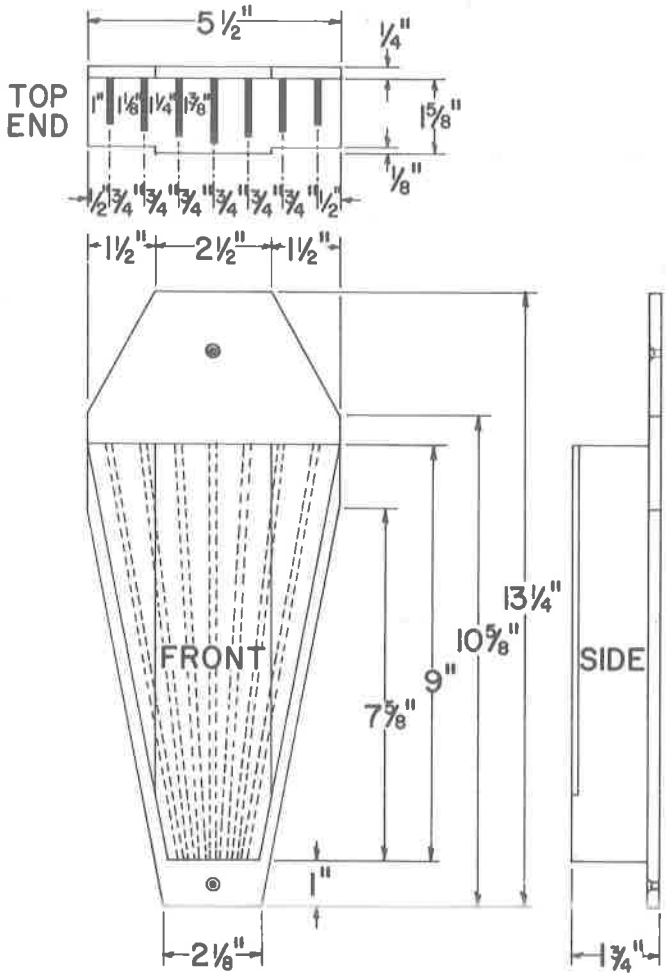
1 pc. 2" x 6" x 15", actual dressed dimensions about 1 1/2" x 5 1/2"
1 pc. 1/4" plywood 5 1/2" x 13 1/2"
Water resistant glue
5/8" wire nails
Finishing materials
For cut out jig - 1 pc. 11 1/2" x 16" 1/4" or 3/8" plywood, 1 3/4" - 1" Aluminum #8 flat head wood screw, 2 pc. 3/4" x 3/4" x 5" & 1 1/4" wire nails

6. Nail a 3/4" x 3/4" x 5" holding block on each side of 2" x 6" near upper end to hold it in position. Remove nails from bottom.

7. Raise saw to desired level for saw kerf. Position rip fence so saw will cut out centerline. Determine point of leading edge advance necessary to cut 9" kerfs but not saw into pivot screw. Attach a stop block to saw table at this point.
8. Make center cut. Stop saw. Remove side holding blocks. Rotate 2" x 6" to a different saw kerf center line. Attach side holding blocks. Adjust saw height. Proceed as above for remainder of cuts for knife holding kerfs.

9. To cut outside of 2" x 6" to width and shape, change screw to pivot point at 15 1/8" and proceed as above, except raise the saw to cut through the 2" x 6". Remember to keep the stop block in place to avoid cutting into the pivot screw.

10. Remove 2" x 6" from sawing jig to cut to 9" length.



Camping Kitchen

This camping kitchen is planned as a durable, light weight container for the camp stove, silverware, kitchen tools, condiments, nesting cooking kit, wax paper, aluminum foil, etc. One-quarter inch plywood was used to keep weight at a minimum. The exterior corners are reinforced with fiberglas cloth for maximum strength with smooth surfaces.

The unit may be placed on a picnic table or be used with its removable legs.

This is only a suggested size. Alter to fit your equipment, etc.

Material List:
1 pc. 4' x 6' x 1/4" exterior grade plywood
2 pc. 3/8" x 4 1/4" (actual dimensions) strips.
Box lumber 1/8" thick for knife holder
1 pc. 1/2" x 3/4" x 4' parting stop
1 pc. 6" x 12" x 3/8" exterior grade plywood
1 pc. 1/4" x 1/4" x 62" (actual dimensions)

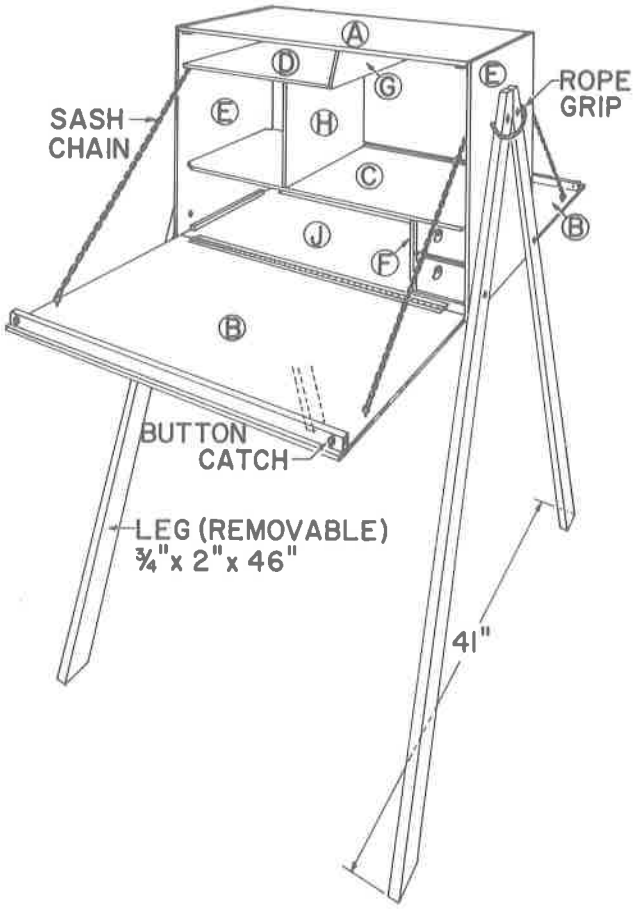
1/2" wire brads
3/4" wire brads
2 ea. 1 1/16" (open) x 24" continuous hinge or
1 - 48" long with 3/8" screws
4 ea. bullet catch
8 ea. 3/16" x 5/8" round head stovebolt with nut

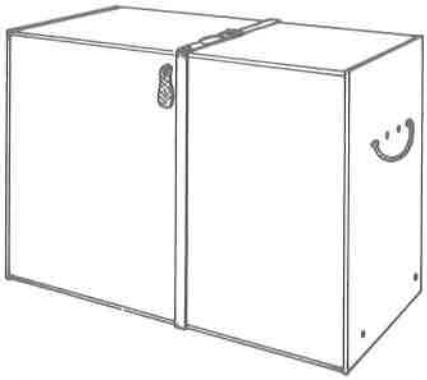
4 ea. 3/16" x 5/8" flat head stovebolt with nut
16 ea. 3/16" or 1/4" steel washers
8 ea. 3/16" lock washers
6 - 1/2' chain
48 ea. 5/8" #3 or 4 flat head wood screws

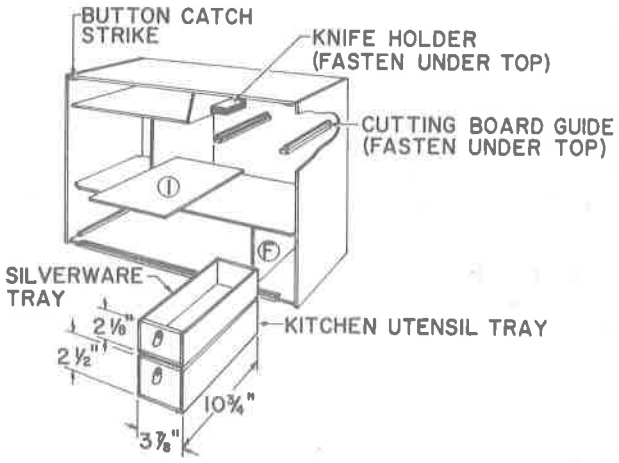
2' 1/4" rope or sash cord
Waterproof resorcinol glue
1 pc. 1" x 8" leather for door, silverware and drawer pulls
Fiberglas cloth and epoxy resin to reinforce 4 exterior joints (4 strips 4" x 12")
1 ea. 1" x 60" luggage or boat strap
Wire staples to hold fiberglas cloth while resin is setting

Legs:

4 pc. 3/4" x 2" x 46" (actual dimensions)
8 ea. 1/4" x 1 1/4" machine bolts with wing nuts
16 ea. 1/4" steel washers





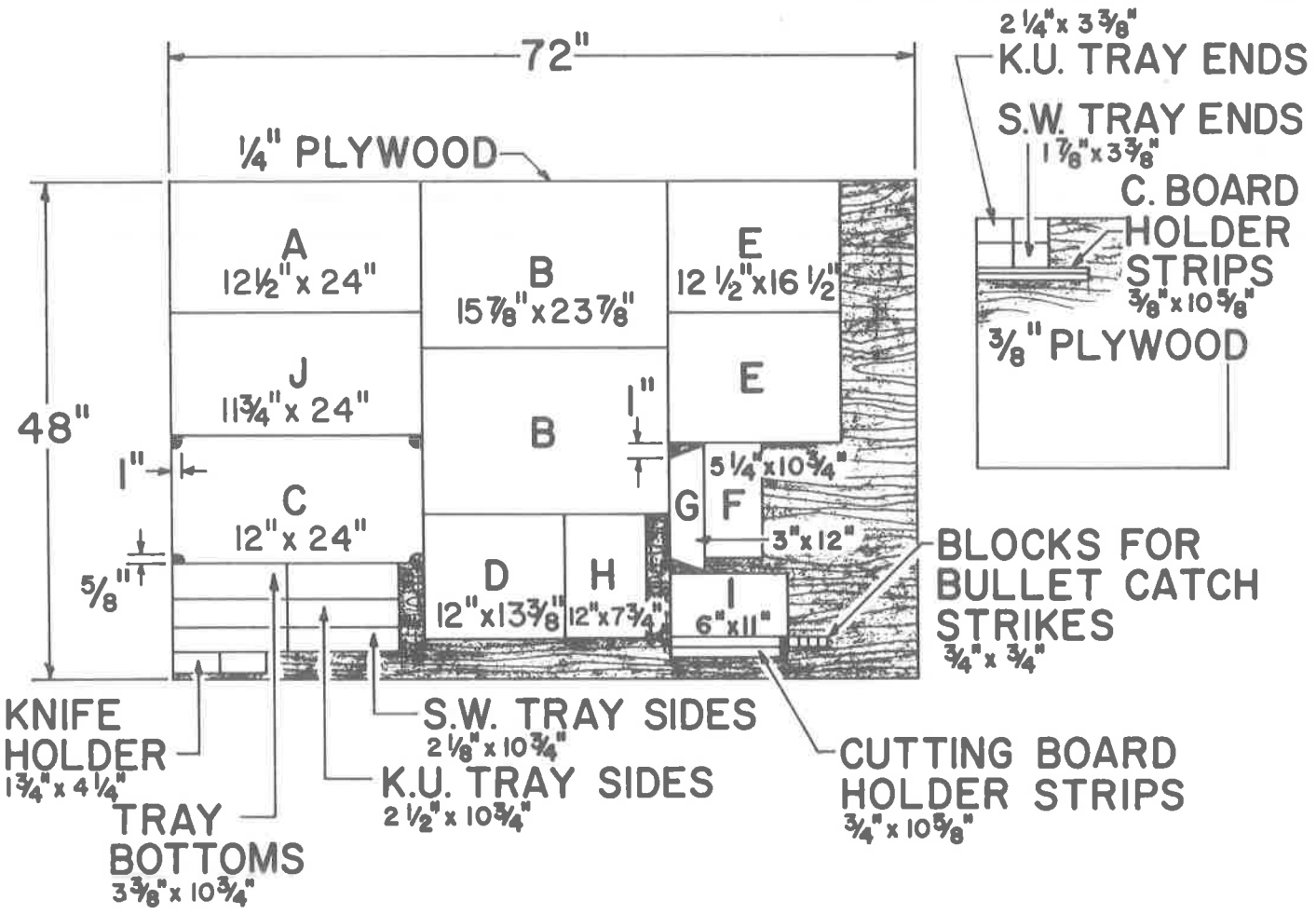


Camping Kitchen (Cont.)

Construction Procedure:

1. Determine if your equipment will fit into the unit as dimensioned. Alter dimensions and plan as necessary.
2. Layout cutting plan.
3. Cut pieces for top, bottom, ends and label.
4. Assemble outer frame. Use 1/4" x 1/4" x 10" reinforcing blocks with 1/2" brads and glue, and 3/4" brads through end pieces into top and bottom pieces plus glue.
5. Attach shelf and partitions with glue at butt joints plus 5/8" screws placed about 3" apart.
6. Cut and attach doors. File off protruding hinge screw tips. Attach door stiffener with bullet catches using 4 - 5/8" screws. Fasten bullet catch steel strike to 3/4" x 3/4" piece of 1/4" plywood to top with glue and nail provided. Attach door support chains. Attach leather pulls.
7. Make trays. Put 1/4" x 1/4" x 10 3/4" runners under the kitchen tool tray, and leather pull on end of silverware tray.
8. Assemble knife holder and cutting board holders. Attach to top with 5/8" screws.
9. Drill for and attach rope handles.
10. Make legs and drill holes in sides of kitchen.
11. Slightly round all corners and edges.
12. Reinforce end joints at top and bottom by applying a 4" x 12" strip of fiberglas cloth to the outside of each joint. Follow manufacturer's directions.

Note: To prevent glass cloth from buckling crosswise, staple about 2" apart in a line about 1" from the edge. Remove staples before applying second application of resin.



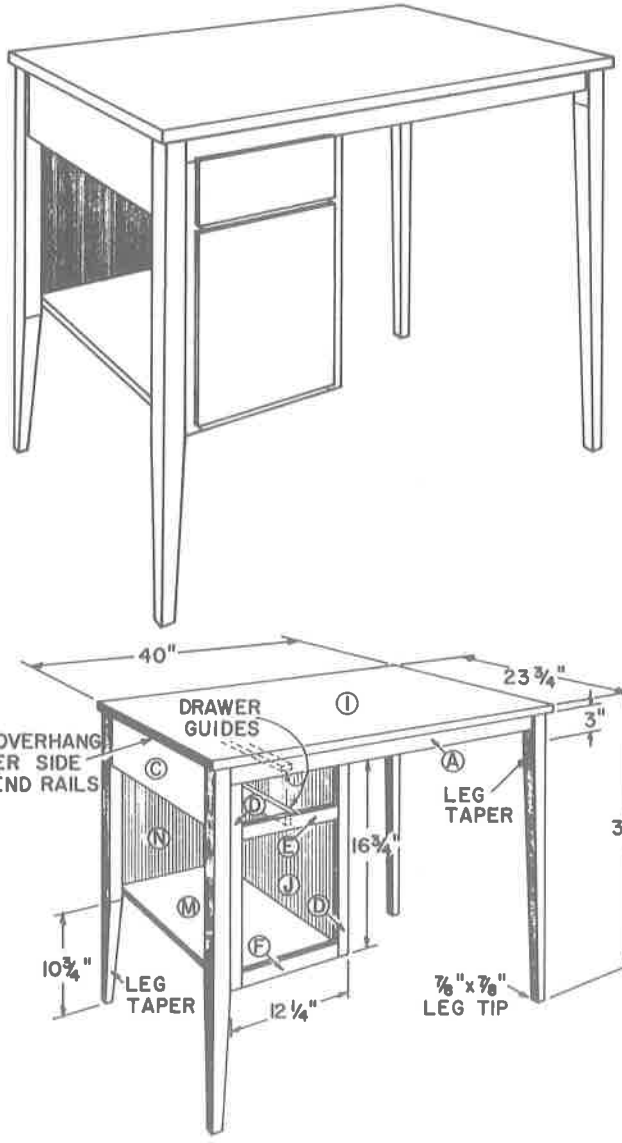
Study Desk

There are certain minimum dimensions for a study desk or table and chair.

The desk top should be at least 22 inches wide and 40 inches long, and 28 to 30 inches high. The desk should have at least one drawer which is deep enough to hold ink bottles. Book storage below desk top may be desirable if the room is too small to accommodate a book case.

The chair should have a rather straight back. The seat should be fairly soft and 17 to 18 1/2 inches above the floor.

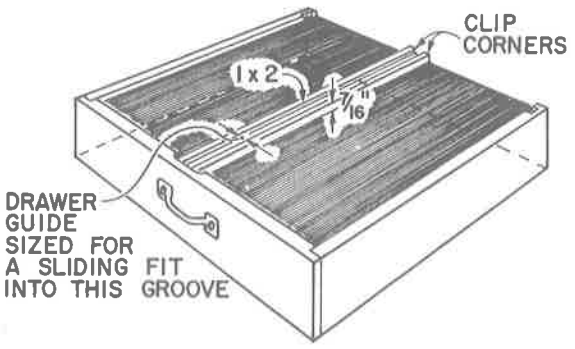
Chairs and desks of these dimensions are adapted to most people who are at least five feet tall. However, shorter people, such as many fifth and sixth graders, can use this standard size furniture with some inexpensive adaptations. To do this, provide a firm cushion for the chair seat so the table top is about level with the bottom of the youngster's ribcage. Then provide a footstool high enough to be a comfortable foot rest.



Material List:

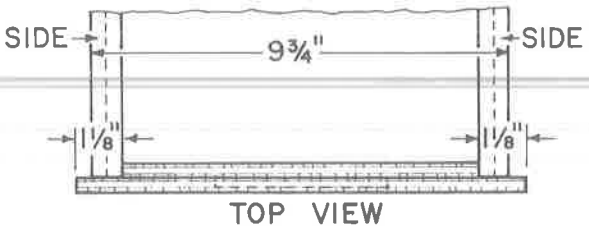
Plan A (Solid Lumber Rails) 23 3/4" x 40" top

2" nominal dimension solid stock for:
4 legs 1 1/2" x 1 1/2" x 29 1/4" (actual dimensions)
1" nominal dimension solid stock for:
2 pc. 3/4" x 1 5/8" x 36" side rails (A)
1 pc. 3/4" x 1 5/8" x 19 3/4" end rail (B)
(Not illustrated)
1 pc. 3/4" x 5 1/4" x 19 3/4" end rail (C)
2 pc. 3/4" x 1 1/8" x 16 3/4" trim (D)
1 pc. 3/4" x 1 1/4" x 10" trim (E)
1 pc. 3/4" x 1 1/4" x 10" trim (F)
1 pc. 3/4" x 1 1/2" x 16" four corner braces (G)
1 pc. 3/4" x 3/4" x 24" six attachment blocks (H)
1 pc. 3/4" x 3 1/2" x 60" drawer sides and back (Note: May be lower grade stock)
2 pc. 3/8" x 3/4" x 21" drawer glides
3/4" plywood
1 pc. 23 3/4" x 40" top (I)
1 pc. 18 3/8" x 21" (J)
1 pc. 10 1/2" x 11 1/4" (K)
1 pc. 4" x 10 1/2" (L)
1 pc. 11 1/2" x 21" (M)
1 pc. 12 1/4" x 16 3/4" (N)
1/4" plywood
1 pc. 8 7/8" x 21" drawer bottom
Wood tape to cover edges of table top and exposed edge of piece (M)
1 pc. 3/8" x 36" dowel
4 ea. 1/4" x 2" lag screws
8 ea. 1" #8 flat head wood screws
18 ea. 1 1/4" #10 flat head wood screws
4 ea. 1/4" steel washers
Glue
6d finishing nails
7/8" wire brads
1 1/4" wire brads
Finish materials appropriate for wood selected



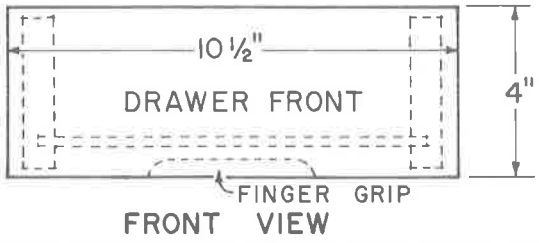
BOTTOM VIEW

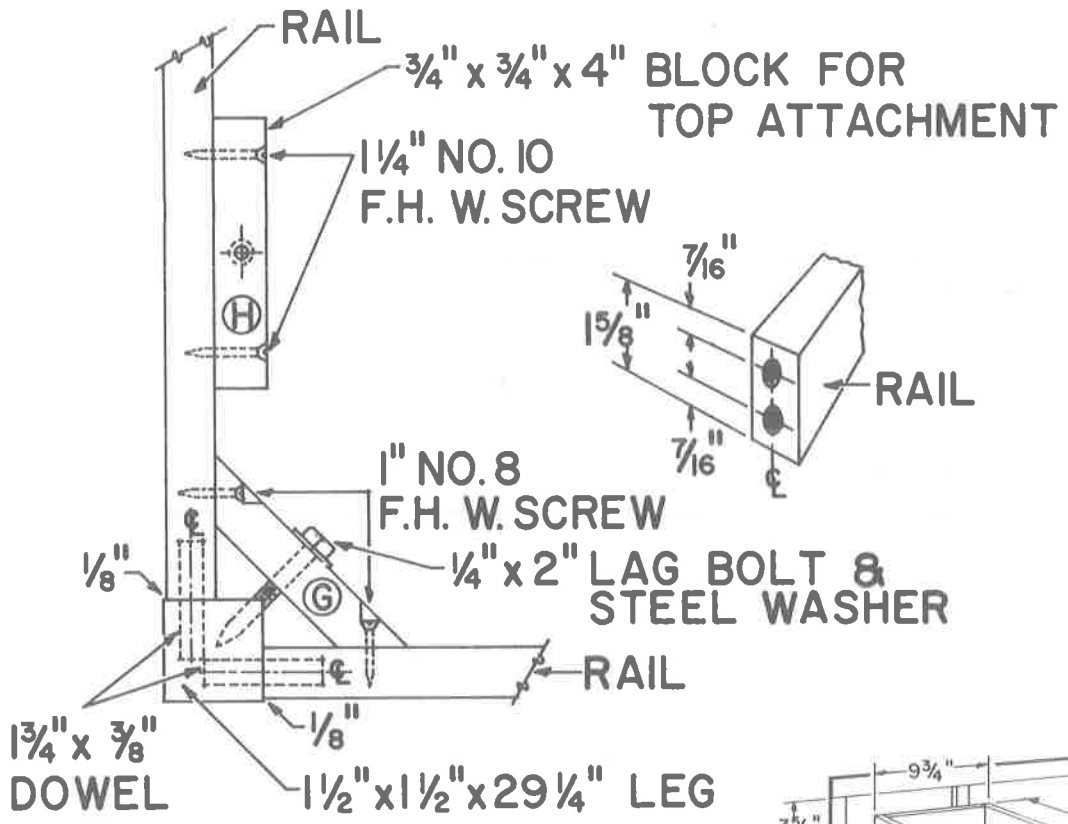
Study Desk (Cont.)

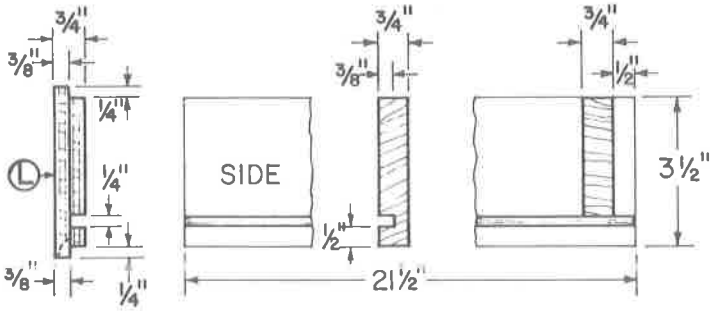


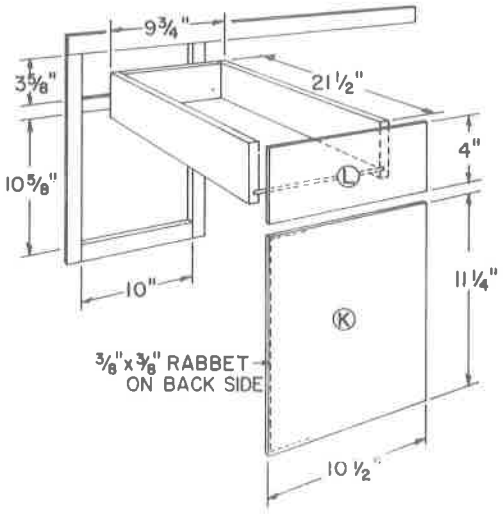
Plan B

Same as Plan A except all pieces listed under one inch nominal dimension stock are also cut from 3/4" plywood. Add four more attachment blocks near the corners to stiffen rails.

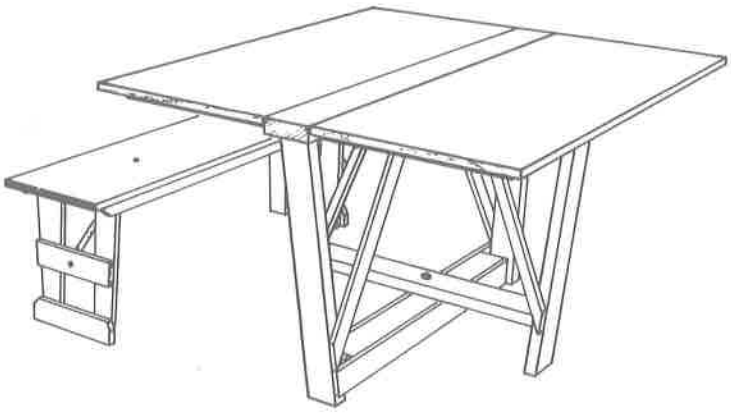








Folding Picnic Table and Benches



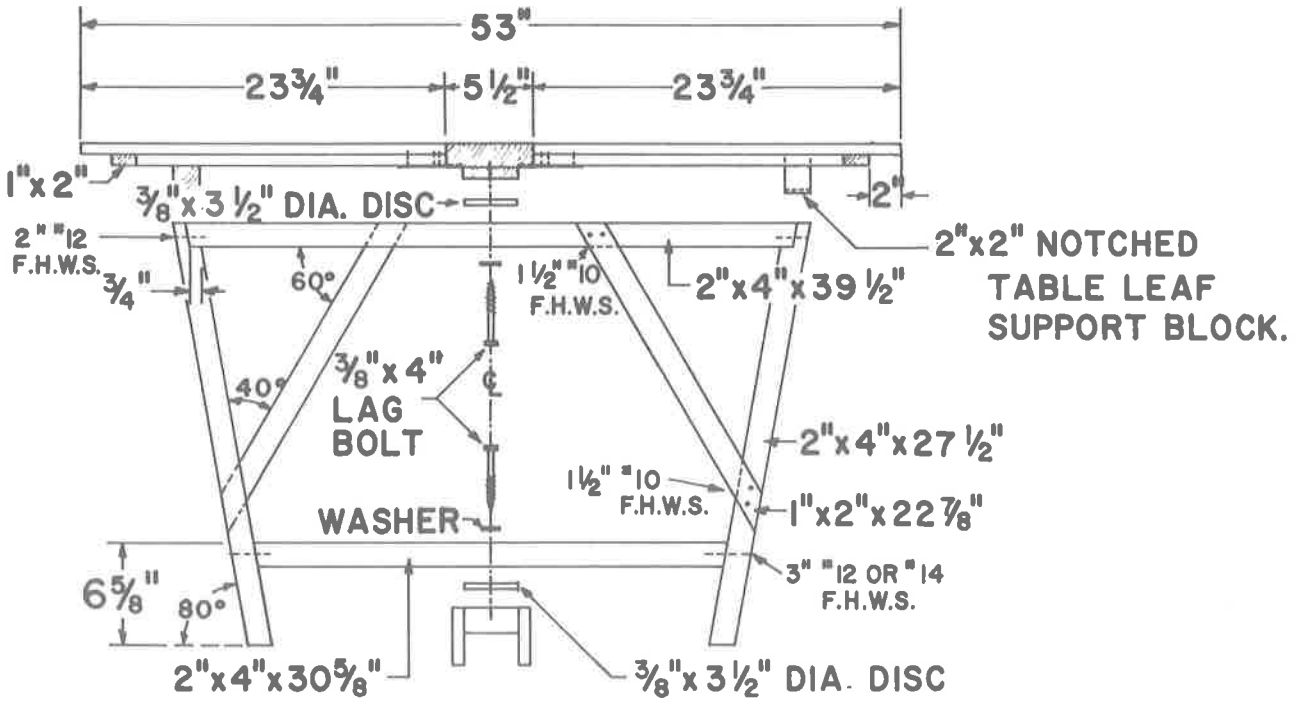
This table and the benches are designed so they can be folded for storage. Both the table and benches have solid plywood tops. One 4' x 8' sheet of 3/4" plywood will make the table top and tops for 2 - 4' benches and 2 - 2' benches.

The table plan may be changed to a 1" x 4" slatted top by replacing the 1" x 2" reinforcing strips under the drop leaves with 1" x 4" material. The bench plans may be modified to a slatted top design by adding a 2" x 2" piece crosswise outside of the legs and at the center line.

Material List:

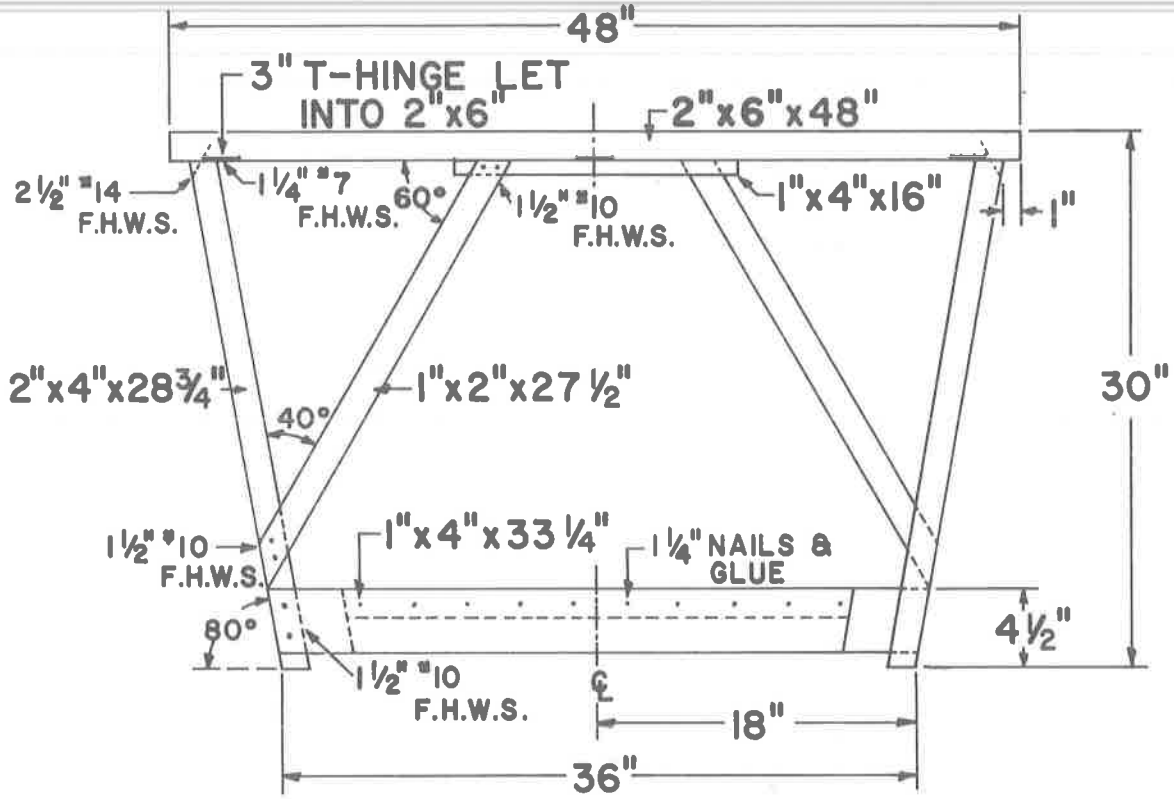
1 pc. 4' x 4' x 3/4" exterior grade plywood (4' x 8' for table and 2 - 4' benches and 2 - 2' benches or 3 - 4' benches)
1 pc. 4" x 8" x 3/4" exterior grade plywood (Discs)
1 pc. 2" x 6" x 4' Douglas fir preferred (Main Center Support)
2 pc. 2" x 4" x 10' Douglas fir preferred (Legs and Cross Members)
1 pc. 1" x 4" x 8' redwood preferred (Lower connecting members for main legs and brace nailing support)
3 pc. 1" x 2" x 10' redwood preferred (Braces)

Waterproof resorcinol glue
2 ea. 3/8" x 4" lag screws
2 ea. 3/8" flat washers
1 1/4" wire nails
3 pair 3" T hinges with 3/4" - 1 1/4" screws
4 ea. 3" #12 or 14 F.H.W.S.
6 ea. 2 1/2" #14 F.H.W.S.
4 ea. 2" #12 F.H.W.S.
20 ea. 1 1/2" #10 F.H.W.S.

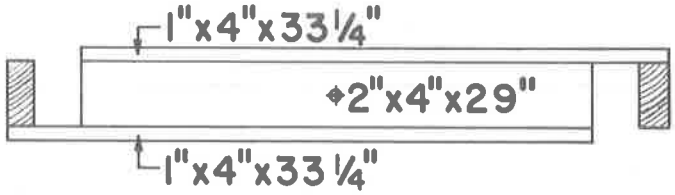


SIDE VIEW - FOLDING LEG ASSEMBLY

Picnic Table & Benches Cont.



SIDE VIEW - MAIN LEG ASSEMBLY



TOP VIEW - LOWER MEMBER OF MAIN LEGS

Material List for 2 - 4' & 2 - 2' benches

3/4" plywood and glue (See material list for table.)
2 ea. 1" x 4" x 12' redwood preferred
2 ea. 1" x 3" x 8' redwood preferred
3 ea. 1" x 2" x 8' or 2 - 12' redwood preferred

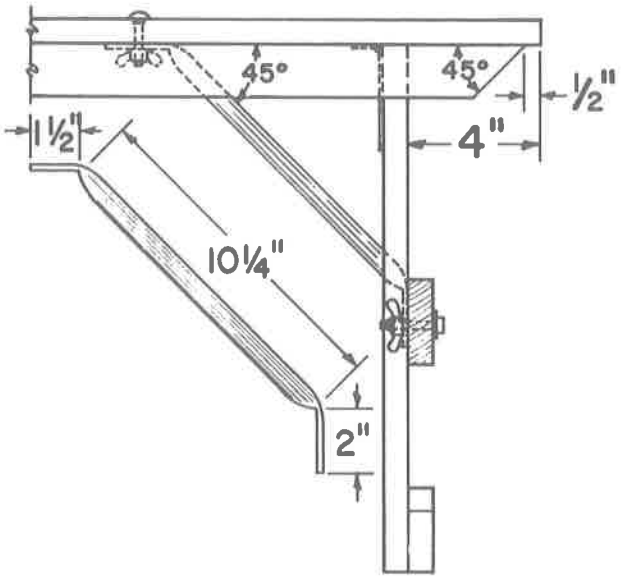
8 pairs 3" T hinges with 5/8" screws
1/2" thin - wall conduit for 8 pieces 13 3/4" long
8 ea. 5/16" x 1 1/4" or 1 1/2" carriage bolt
8 ea. 5/16" x 1 1/4" or 1 1/2" machine bolt
16 ea. 5/16" wing nuts
8 ea. 5/16" flat washers
Rope or strap material to tie braces in place when folded
Water repellent wood preservative

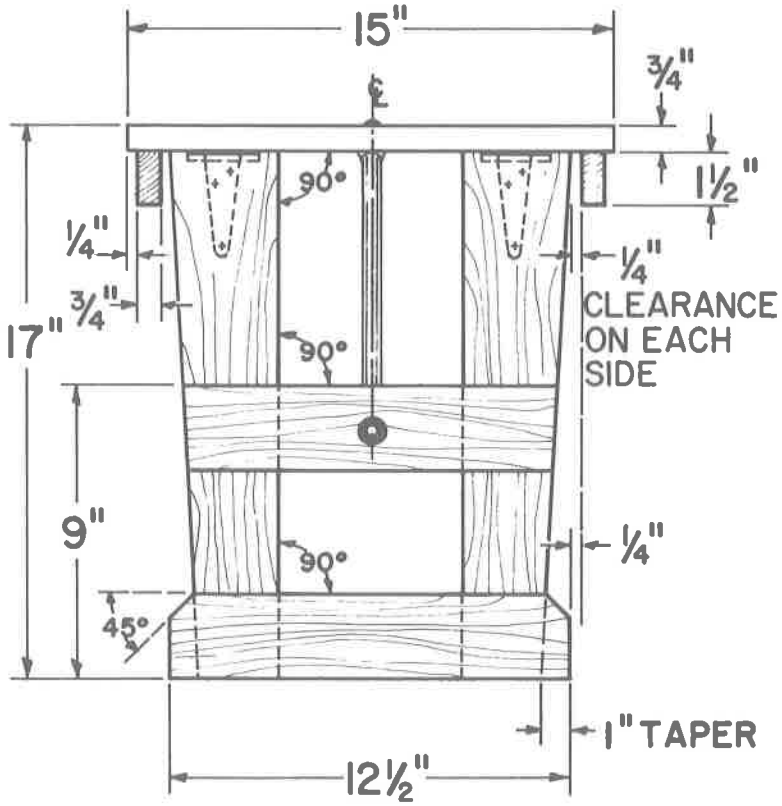
Finishing materials

When constructing the benches which are 2' long, change the dimension from the end of the bench to the outside of the leg from 4" to 2". Note: The legs will not fold flat on these units as they will overlap.

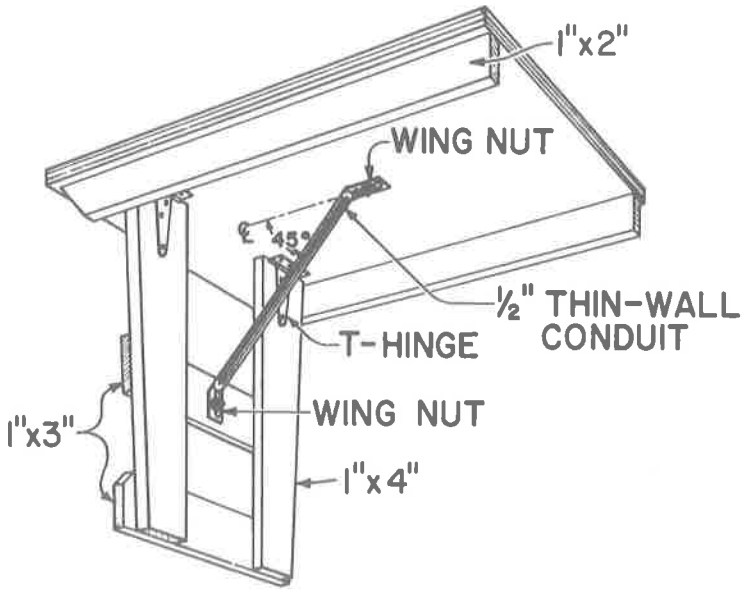
Finish with an oil base, latex stain or paint. If you use a paint finish, prime the wood with a high grade exterior house paint primer. Then complete the job with good exterior enamel (nonchalking).

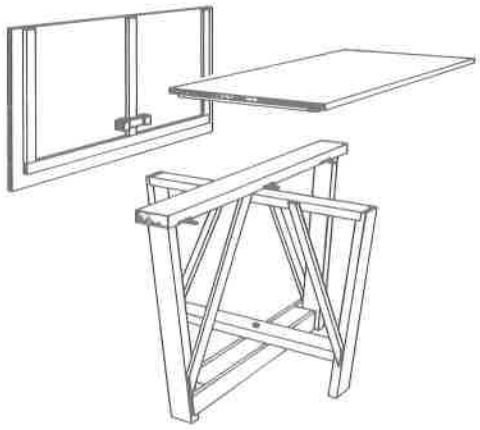
Picnic Table & Benches Cont.





END VIEW

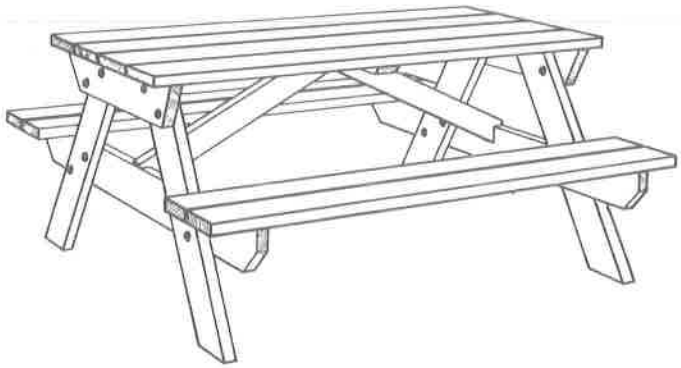




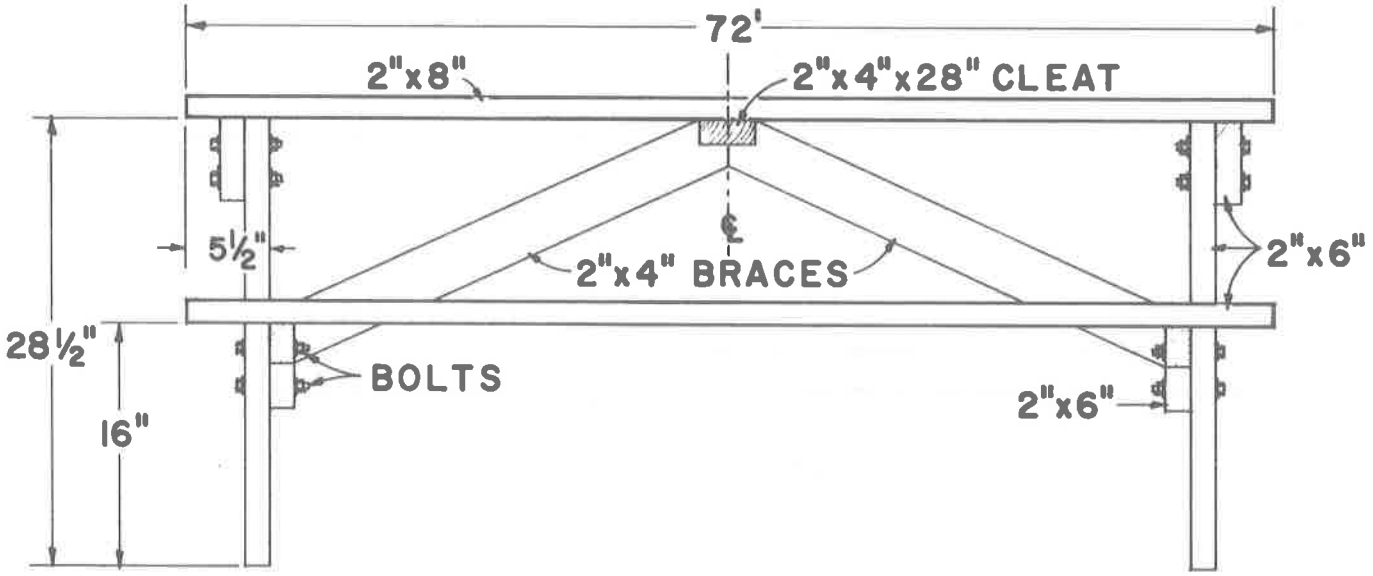
Nonfolding Picnic Table

Material List:

2 pcs. 2" x 8" x 12'
3 pcs. 2" x 6" x 12'
2 pcs. 2" x 6" x 8' or 1 pc. 16'
1 pc. 2" x 4" x 8'
16 bolts 3/8" x 3 1/2" or 4" zinc coated, depending on thickness of 2" material (Machine with washers.)
10d nails for cleat and braces
1 1/2 lbs. 20d spikes for top and seats
Water repellent wood preservative containing penta



Note: The table will have a streamlined appearance if you taper the legs and cross pieces supporting the seats and table top. Taper the legs on the inside about 1" from top to bottom. Taper the cross pieces about 1" from the center to the ends.



Materials for Finish:

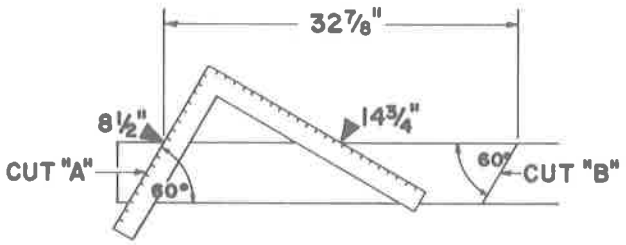
Paint or Stain

If you use a linseed oil base penetrating stain such as redwood or cedar stain allow the table to weather several months before applying the stain. If you use latex stain apply it immediately and apply two coats about 30-45 minutes apart.

Instructions:

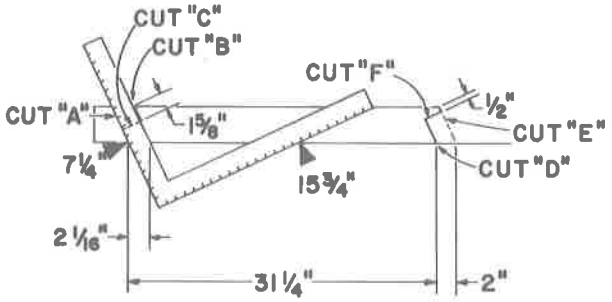
1. Heartwood of Douglas Fir may be the most practical wood. However, the heartwoods of redwood and cedar are more durable.
2. Treat all ends, surfaces and bolt holes of each piece with water repellent wood preservative before assembling. Dip the ends of each piece and apply preservatives to the undipped portion with a brush.
3. Cut the seat and table top pieces to length.
4. Make the end frames. To assemble, lightly nail the pieces of one end frame together. Locate the bolt holes and drill through the legs and end pieces at one time. Treat, then fasten securely with bolts.
5. Make the 2" x 4" cleat braces.
6. To assemble top, legs and seats:
   a. Lay the table top upside down on a smooth surface.
   b. Nail the 2" x 4" cleat to the table top plank.
   c. Position one end section square with the table top and locate so the brace fits snugly. Nail the brace in place. Toe nail end section to table top plank to hold it when the bench is turned over. Repeat with the other end section.
   d. Turn bench to upright position. Check for squareness. Spike seat and table top in place. Drill pilot holes for spikes.

Nonfolding Picnic Table Cont.



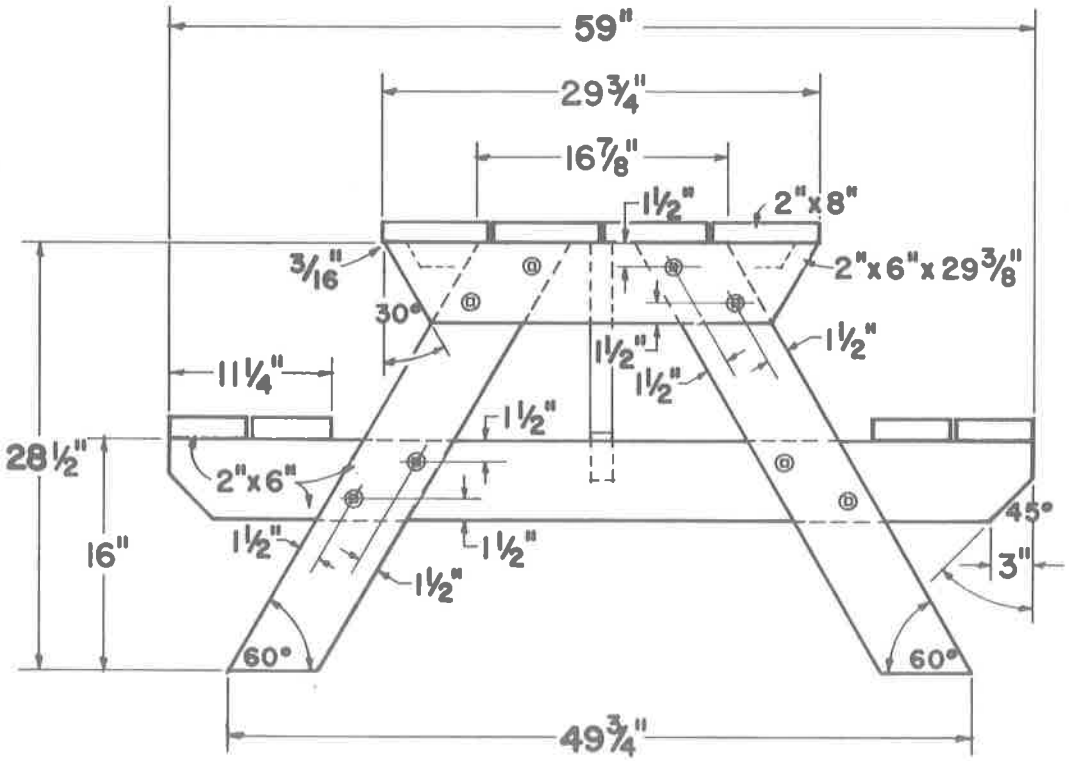
Layout Procedure for the Legs:

1. Position the square on the 2 x 6 as indicated. Mark along the tongue for cut "A".
2. Repeat for cut "B". If the mark B will be too close to the end of the 2 x 6 for this position, position the square on the opposite edge of the same face. Cuts are to be parallel.

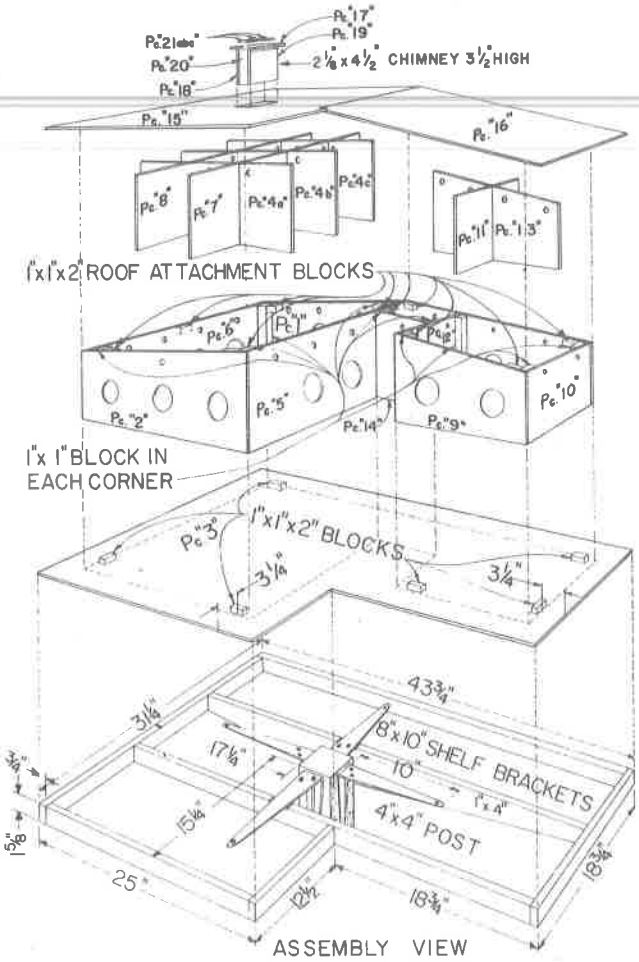


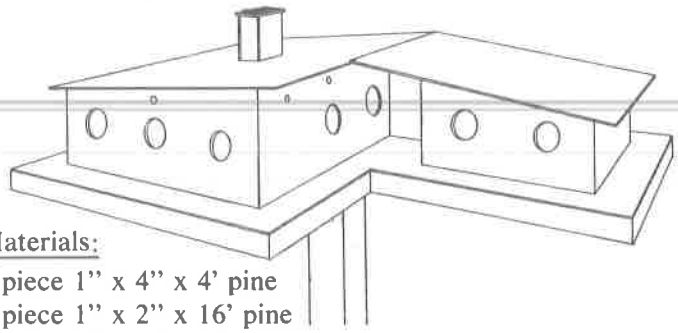
Layout Procedure for the Braces:

1. Position the square as indicated for Cut "A" - 60°.
2. Repeat step one for cuts "B", "D" and "E".
3. Cut "C" is at right angles to "A" and "B".
4. Cut "F" is at right angles to "D" and "E".



Ranch Style Martin House



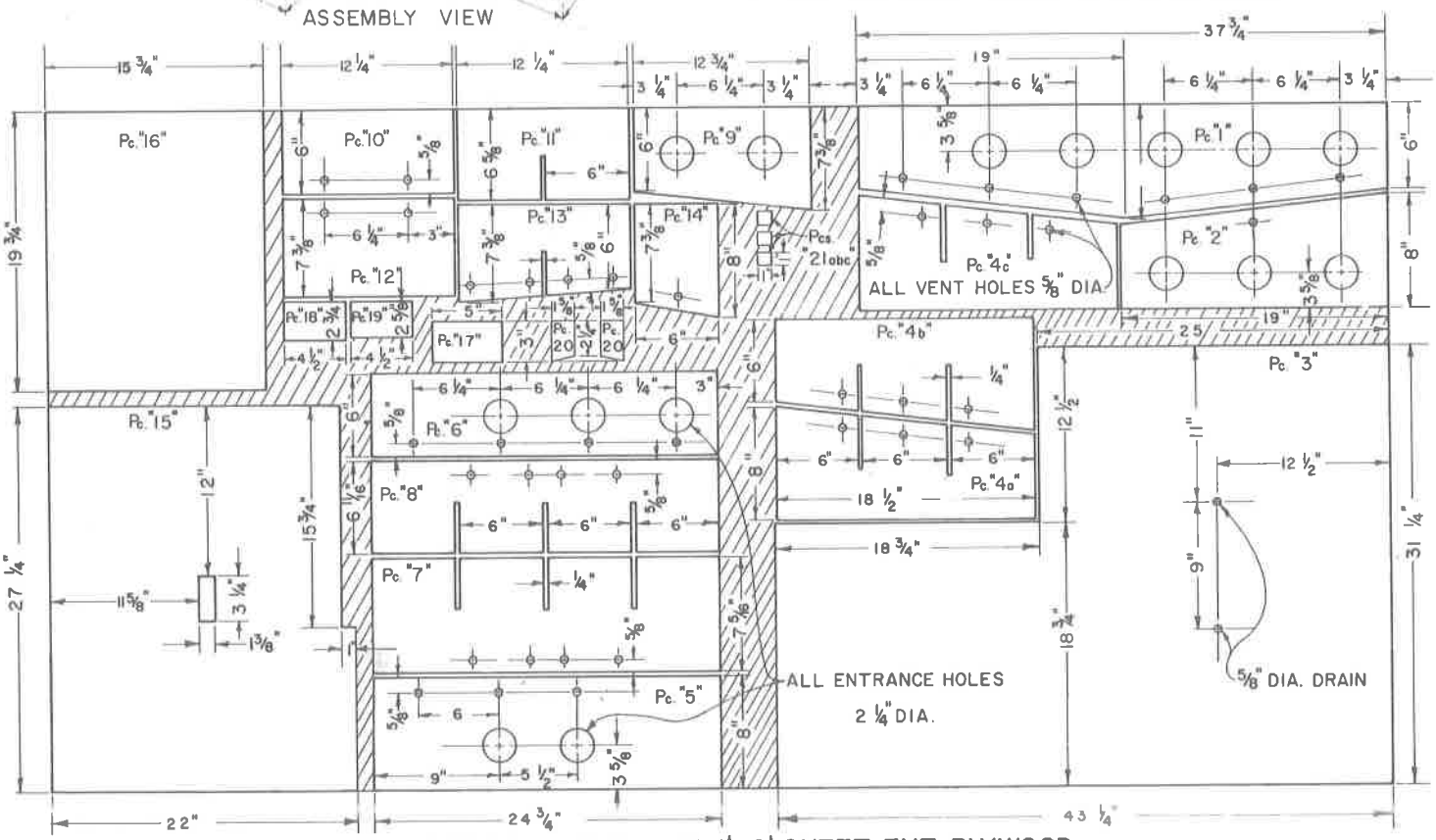


Materials:

1 piece 1" x 4" x 4' pine
1 piece 1" x 2" x 16' pine
1 piece 1" x 1" x 10' pine
1 sheet 4' x 8' exterior type 1/4" plywood
4 - 8" x 10" shelf brackets
12 - 1/4" x 1/2" flat head stove bolts
12 - 1 1/4" #10 flat head wood screws
10 - 3/4" #8 round head wood screws to attach roof - brass, zinc or cadium plated
1 3/4" - 2 1/4" nails (galvanized or aluminum preferred)
1" wire nails (galvanized or aluminum preferred)
Resorcinol glue
Water repellent wood preservative, Paint

House Assembly:

1. Use Resorcinol glue and nails for all joints. Nails are used to exert pressure while the glue is setting. If you have adequate clamps, omit nails.
2. Treat all wood parts with a water repellent wood preservative.
3. Paint with a good exterior type house paint.

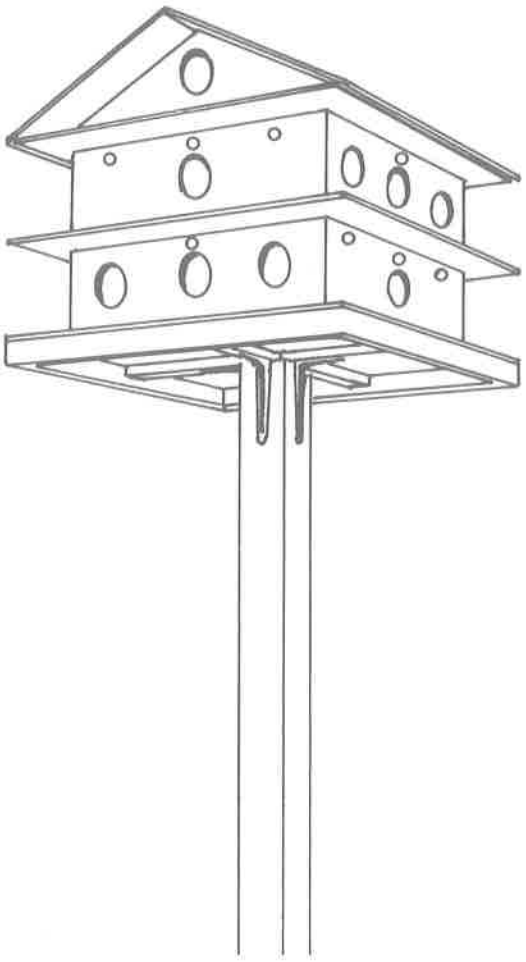


SUGGESTED LAYOUT ON 4'x8' SHEET EXT. PLYWOOD

Two-Story Martin House

Materials:

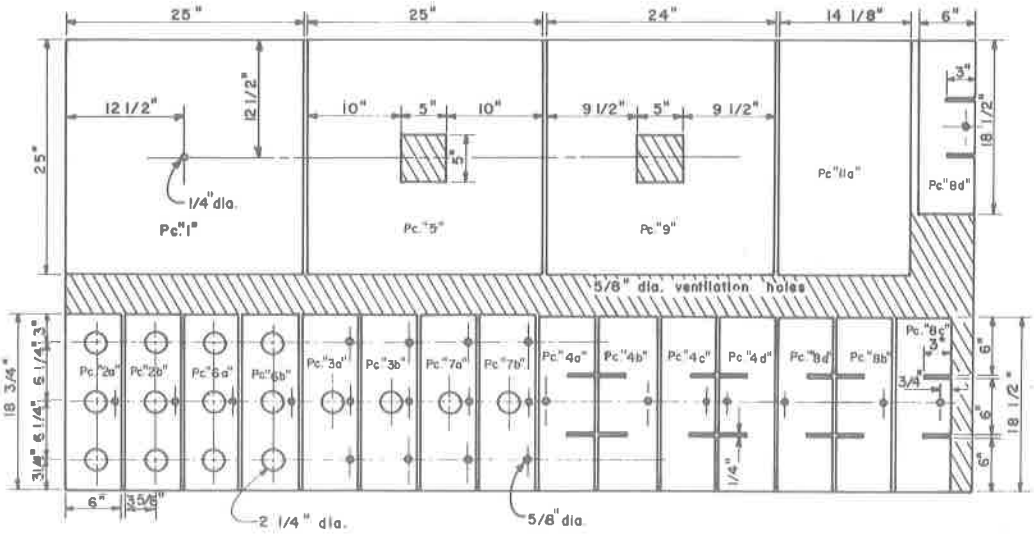
1 sheet 4' x 8' exterior type 1/4" plywood
1 sheet 2' x 4' exterior plywood (with face grain in 2' direction)
1 piece 2" x 2" x 6" for chimney
1 piece 1" x 2" x 14' pine or spruce
1 piece 1" x 1" x 8' pine or spruce
1 piece 4" x 8" aluminum or copper window screen
Wire cloth staples
2" or 2 1/4" nails (galvanized or aluminum preferred)
1" wire nails (galvanized or aluminum preferred) or 3/4" #6 flat head screws (rust resistant)
Resorcinal glue (waterproof)
1 each 1/4" x 24" or 30" thread rod with 2 nuts and 2 washers.



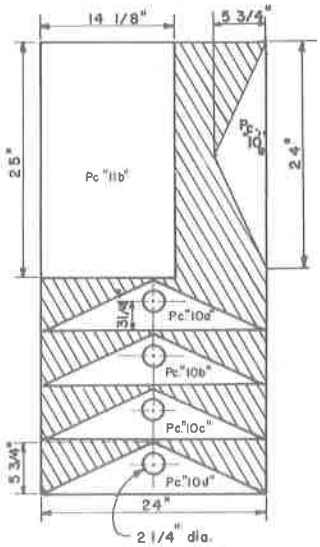
Mounting:

Use 4 - 4" x 5" shelf brackets with 1/4" or 3/16" x 1 1/2" round head stove bolts and 1" #8 flat head wood screws to attach to pole. See plans for ranch style martin house for pole detail and location.

NOTE: Additional stories may be added if desired.



LAYOUT FOR 4'x8' SHEET



LAYOUT FOR 2'x4' SHEET

Two-Story Martin House Cont.

Construction:

NOTE: This unit is held together by a thread rod extending from underside of 1" x 2" base frame through the center of the chimney.

1. Lay out all pieces on plywood sheets. Cut out. Make 8 - 1" x 1" x 5 7/8" corner blocks and 16 - 1" x 1" x 2" blocks to position the parts.

2. Cut out and assemble base from 1" x 2". Use 7d galvanized siding nails. Attach piece "1" with glue and 1" or 1 1/4" nails (rust resistant preferred).

3. Assemble sidewalls for first story pieces 2a, 2b, 3a and 3b; and pieces 6a, 6b, 7a and 7b for second story. Use glue and 1" nails or 3/4" #6 flat head wood screws (rust resistant preferred). Use 3 at each end of each piece.

4. Position first-story sidewalls on base piece. Mark position for each 1" x 1" x 2" block to hold sidewall in position. Attach blocks to piece 1 with glue and 2 - 1" nails or 3/4" #6 flat head wood screws. Place sidewall in position on piece 1. Insert partitions. Position piece 5 and mark for the location of 1" x 1" x 2" blocks near corners on the underside. Attach the blocks.

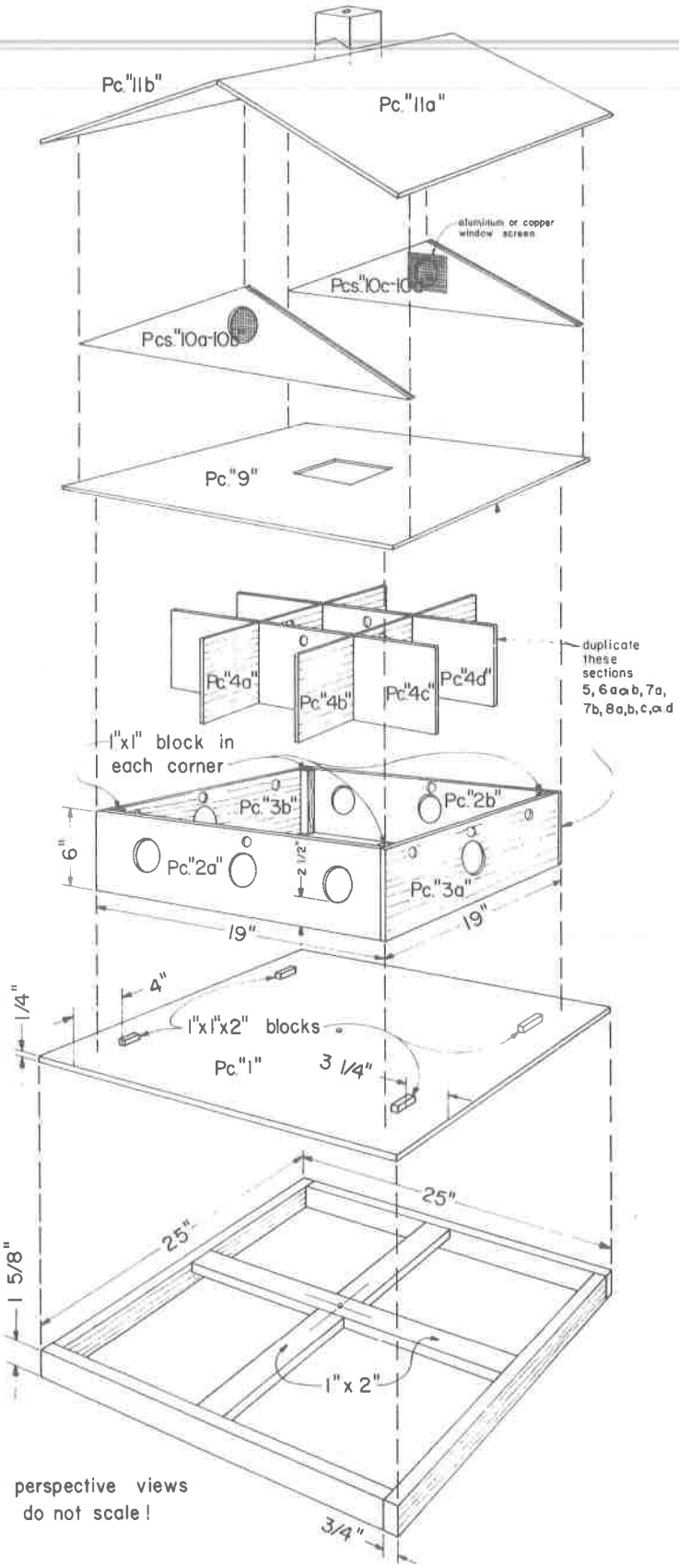
5. Place piece 5 in position. Position the second-story sidewalls on piece 5, and mark for the location of the 1" x 1" x 2" blocks. Move them to the opposite side of the corner from the blocks underneath for convenience in attachment to piece 5. Attach blocks. Position sidewalls. Insert partitions.

6. Position piece 9. Mark location for 1" x 1" x 2" positioning blocks on underside. Attach blocks.

7. Glue pieces 10a and 10b and 10c and 10d together to form gable ends 1/2" thick. Attach screen. Position and mark. Glue scrap pieces to piece 10e to make it 1/2" thick. It will be positioned adjacent to the center threaded rod going up through the exact center of the house. Attach these pieces with glue and nails or flat head wood screws from the underside. Attach roof pieces with glue and nails or screws.

8. Make chimney from a piece of 2" x 2". Cut V-notch on end to fit roof. Have it extend 2 1/2" above roof peak. Drill 1/4" hole in chimney and roof for rod. Nail chimney in place. Insert rod and tighten up.

9. Drill hole in top of pole to accommodate nut on lower end of threaded rod.



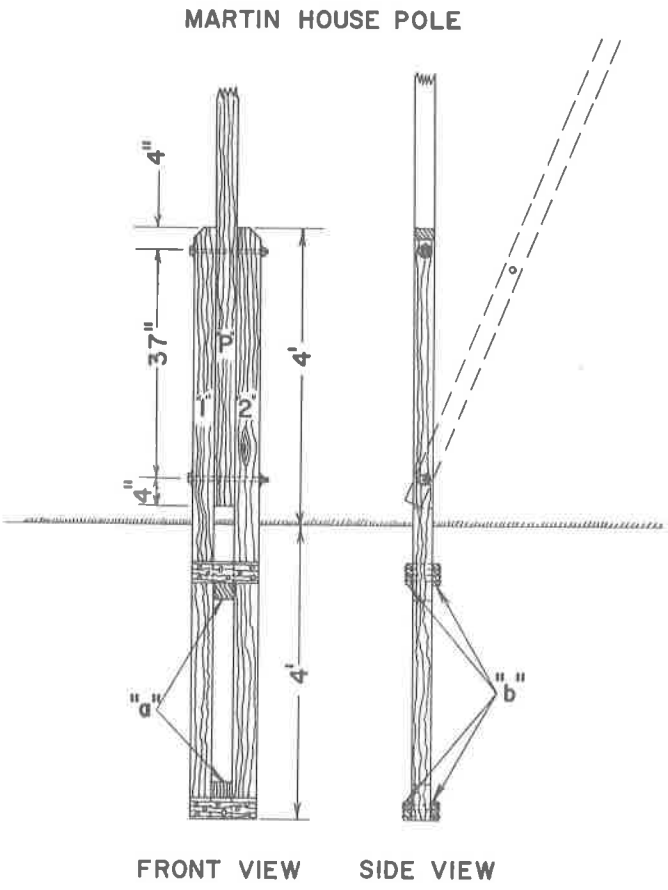
ASSEMBLY VIEW

Martin House Pole

Materials for Martin House Pole:
1 piece 4" x 4" x 8'
1 piece 4" x 4" x 10'
1 piece 4" x 4" x 12' - 18'
(Treated poles may be used as an alternative)
1 piece 1" x 4" x 4'
1 - 1/2" x 24" or 36" threaded rod
4 - 1/2" steel washers
4 - 1/2" nuts
7d galvanized nails

Pole Assembly:

1. The pole supports, pieces, number 1 and 2, are 4" x 4" x 8'. They are held in a spread position by pieces (a) (4" x 4" x 6"), and nailed in place with pieces (B). The pole supports are set 4' in the ground.
2. The pole is hinged on the lower bolt.
3. A similar construction pattern can be followed by using treated poles.
4. It is also possible to build a 4 3/8" x 4 3/8" pole of 4 - 1" x 4" boards.
5. Pieces that will be in contact with the ground should be made from material pressure-treated with a wood preservative.



NOTES

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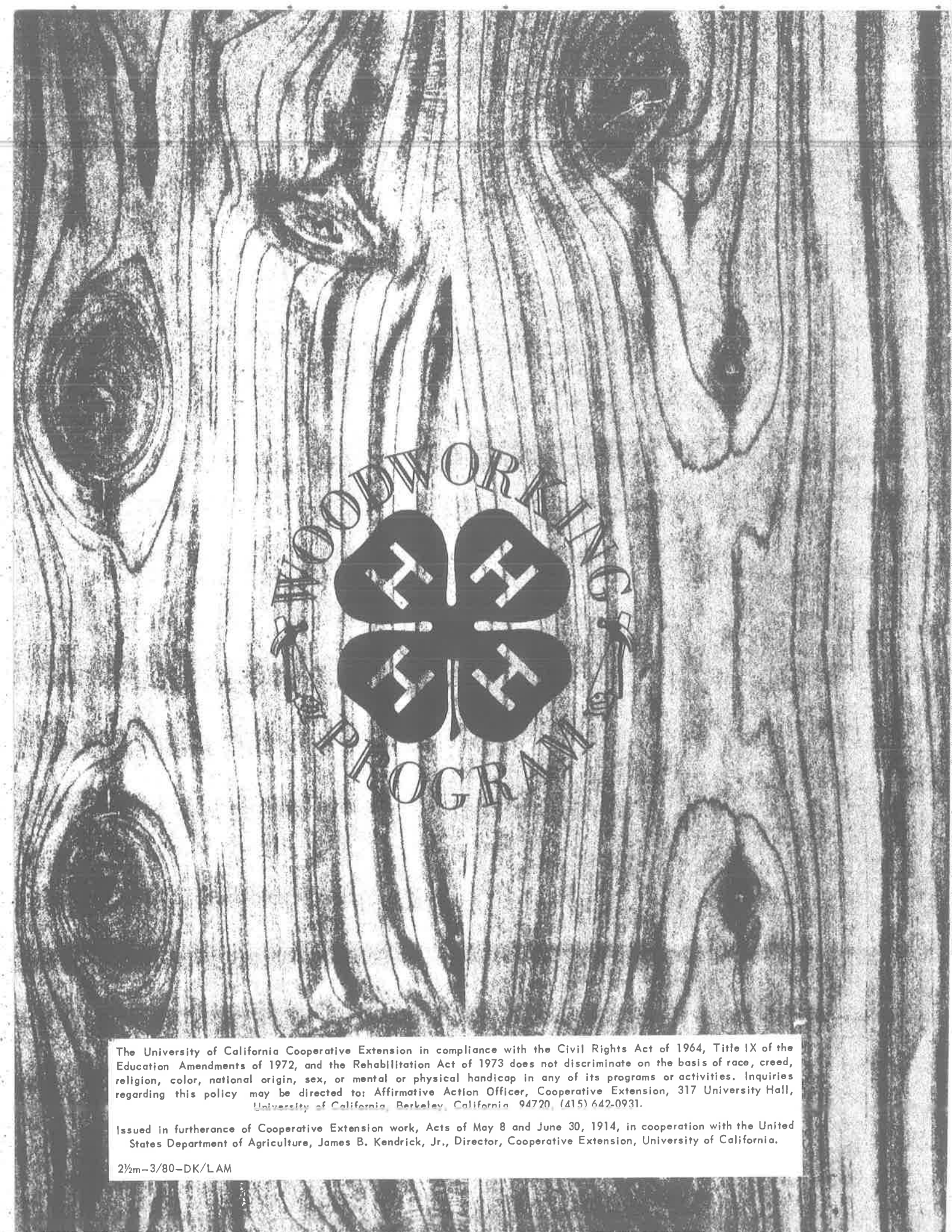

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture, James B. Kendrick, Jr., Director, Cooperative Extension, University of California.

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Members' Manual

UNIT 2

LEARNING AND BUILDING

4-H Engineering Woodworking Program

CO 101

A Note to Parents

You as a parent are the most important and influential person in your child's life. You can nurture and cultivate his interest in this project by guiding him in his planning, assisting him in carrying out his project and by recognizing him for a job well done.

The information in this manual can provide significant learning experiences for your child. Helping your child plan the things he will learn and do and assessing his progress based on these plans will help make his experience more worthwhile. This individual planning and evaluating with your child may be done by his project leader. However, if this is not possible, you can fulfill this need.

Following are some things you as a parent can do to help your child get the most out of this project:

- Become familiar with the material in this manual.
- Use the lists of "things you may wish to learn" and "things you may wish to do," listed under Opportunities for Learning and Doing. Help your child select goals he can likely achieve.
- Help him decide what tools, equipment and supplies he will need and what he can realistically expect to have.
- Help him understand and learn how to do the tasks he is expected to complete. Do not do his work for him.
- Assist him in scheduling his time.
- Discuss his progress with him from time to time.
- Help him recognize a good job from a poor one.
- Commend him for his efforts.
- Help him understand where he needs to improve.
- Help him to know himself, his strengths and weaknesses, and to improve his own abilities.
- Help him to evaluate what he has done and what he has learned on the basis of the goals he has set for himself. Avoid comparing his progress with others. Other members may have different goals, tools and equipment.

Acknowledgment

This educational material has been prepared for use in connection with official 4-H projects by the National 4-H Engineering Woodworking Development Committee, comprised of representatives of the Cooperative Extension Service and the National 4-H Council. Special acknowledgment is given to the University of Wisconsin Extension Service for developing the original project material. Grateful appreciation is expressed to The Stanley Works for financial and technical assistance in helping to make possible the publication of this educational material.

The materials for the 4-H Engineering Woodworking program are published by the National 4-H Council, 150 N. Wacker Drive, Chicago 60606 in behalf of the Cooperative Extension Services of the State Land-Grant Universities with the U. S. Department of Agriculture cooperating.

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Litho In U.S.A.

Table of Contents

Planning Ahead

Introduction

This is the second in a series of woodworking publications. It contains information on reading drawings and using some of the common hand and power tools. There are drawings of some articles you may want to make in the back of the publication. However, you are free to make other things that are not too difficult. Be sure you can obtain the necessary materials, have or can use the necessary tools and the necessary help is available. Discuss it with your leader or parents.

You may also use drawings from other publications in the woodworking series. You should enroll in the unit in which you will be the most satisfied.

Your woodworking project leader may ask you to come to his home or shop to do some of the project work. You may have to do all the work at home. You will enjoy the project more if you have a work area in the shop, basement or garage. Be sure to provide storage of some kind for your collection of woodworking tools. The tools described in Woodworking Unit 1 will make a good start on a tool set.

Opportunities for Learning and Doing

In Woodworking, there are many different things you can do and things you can make. There are also many opportunities to learn while doing.

Following are lists of "things you may wish to learn" and "things you may wish to do." These are merely suggestions. There may be other things in addition to those listed that you may wish to add. Likewise, there may be things on the lists which you may not want to include depending upon your interests and past experience.

Things you may wish to learn:

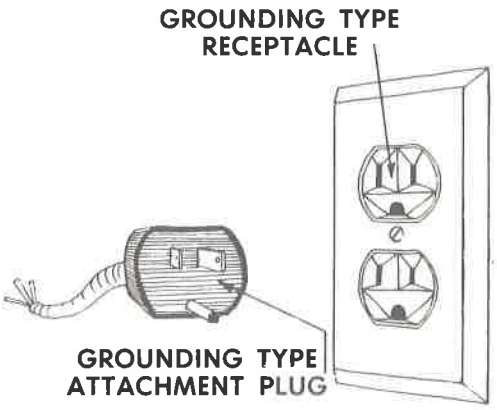
1. To read and use grid system and pictorial drawings.
2. To read and make a three-view orthographic drawing.
3. How to use a hand drill.
4. The difference between crosscut and rip saws.
5. How to use screws in woodworking
   - Pilot hole
   - Shank hole
   - Countersink
   - Proper size screwdriver.
6. How to bore holes with a bit brace and auger bits.
7. How to cut wood with a jig saw
   - Blade selection
   - Inside cuts
   - Characteristics of jig saws.
8. How to drill holes in wood with an electric drill
   - Headless nails for small holes
   - Wood screw pilot bits
   - Twist drills
   - Large wood boring bits.
9. How to mark a uniform width section along the edge of the board
   - Marking gauge
   - Steel combination square.
10. How to use an oscillating sander.

Things you may wish to do:

1. Make a pig shaped cutting board.
2. Give a demonstration on correct use of a hand drill.
3. Make a birdhouse.
4. Make a collection of different types and sizes of wood screws.
5. Visit a lumber yard.
6. Replace a window I broke with a baseball.
7. Make a toy as a Christmas gift for my brother.
8. Build a tool box.
9. Buy a jig saw or electric drill or ask my parents for one for my birthday or Christmas.
10. Make a bookcase in my room from boards and bricks. The bricks will be used as spacers between the boards.

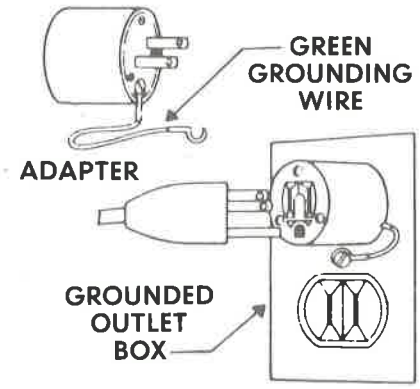
Work Safely

1. Review the safety rules in Unit 1.
2. When working in the shop area wear tight fitting clothes. Avoid loose or dangling clothing which might get entangled in a machine.
3. Avoid carrying sharp or pointed tools in your pocket. They may cut or scratch you or somebody else, or tear chair or auto cushions.
4. Be sure every electric tool you use such as a jig saw, electric drill or sander is properly grounded to protect you from electrical shock. This can be done by connecting the tools to the power source with a cable or cord that has three conductors. The third wire, which is green, and attaches to a third blade of the attachment plug safely grounds the tool when used with grounding type receptacles connected into an electrical circuit that has a safety ground.



A grounding type attachment plug and grounding type receptacle.

Adapters are available for use with two prong or two wire receptacles until the grounding type receptacles are installed. The green grounding wire which extends from the side of the adapter must be connected to a permanent ground. Have a qualified electrician install a permanent ground where two prong adapters must be used with power tools.



A grounding adapter used with a grounded outlet box.

If your tool is equipped with a two-blade attachment plug, have it replaced with a three-blade grounding type attachment plug. The cord may have a third wire in it. If not, have the cord replaced with a three-wire cord. If this is done, one end of the green wire must be permanently attached to the tool housing and the other end to the grounding blade of the attachment plug.

Some manufacturers are now making portable electric tools with a specially insulated motor and switch housing. These units have a two wire cord and are approved by Underwriters Laboratories. It is important to have a tool bearing the (UL) label on the unit rather than just on the cord.

How To Read and Use Drawings

Reading drawings is as important to the builder and engineer as the road map is to the traveler. You learned how to use trace patterns and read pictorial drawings as part of Unit 1. Now you will learn how to use the grid system to make drawings of irregular shaped articles. You will also learn more about pictorial drawings.

The grid system is used when the article is too large for a trace pattern.

Do the following and your grid system pattern will be successful:

1. Determine the size of the squares or rectangles. By changing the size you can change the size and shape of the article.
2. Determine the size of board or paper for the pattern. You may draw directly on the wood or on paper.
3. Mark the right sized squares or rectangles.
4. Mark where the object outline crosses the grid lines.
5. Connect these marks to form the shape.

Grid system for hobby horse head. A 1" x 1" grid gives 7½" x 8" head. A ½" x ½" grid gives a head 3¾" x 4".

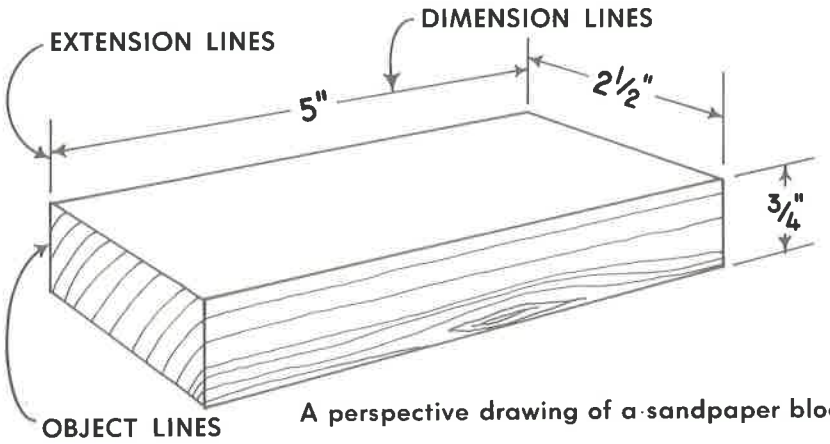
This system works well to draw a map for your geography or social studies. It will also work for designing a woodworking pattern.

PICTORIAL DRAWINGS

Perspectives and isometrics are the common pictorial drawings you will see and use.

Perspective Drawings

The perspective drawing is made so that it looks like a camera took a picture of the object. In this type of a drawing the lines going in the same direction tend to come together as they go away from you. The same thing happens when you look at the world around you. Remember how the railroad tracks seem to go together in the distance. The road appears to get narrower off in the distance. Houses far away seem smaller than those nearby. The following drawing is a perspective of a sandpaper block. Measure the length of the lines indicating the front and back edge of the block. Are they the same or different length?



A perspective drawing of a sandpaper block.

Isometric Drawings

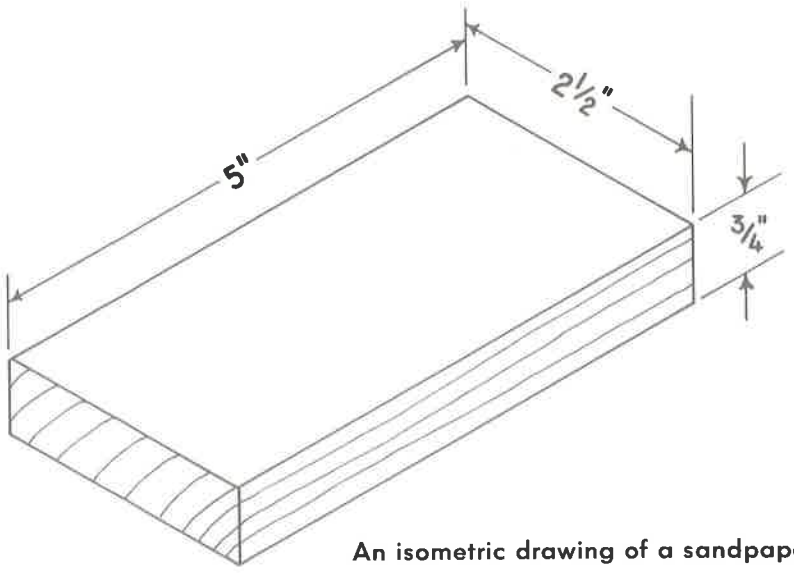
An isometric drawing is a form of pictorial drawing similar to the perspective. However, the lines going in the same direction do not come together as they move away from you. This usually makes the part or pieces in the back of the drawing look larger than those in front.

Exploded Pictorials

Exploded pictorials have the various pieces set apart. If the pieces were moved together, they would form a normal pictorial drawing.

Lines Used in Drawings

Each line in a drawing has a definite job. Notice how the lines that show the outline, corners and edges of the object are very heavy dark lines. These are called object lines. Look at both the isometric and perspective drawings of the sandpaper block. Notice the fine solid lines with an arrowhead on each end. These are called dimension lines. The number near the center of the line indicates the distance desired between the arrow tips. The extension lines make it possible to move the dimension lines away from the object lines. The extension lines are thin solid lines.



An isometric drawing of a sandpaper block.

THREE-VIEW ORTHOGRAPHIC DRAWING

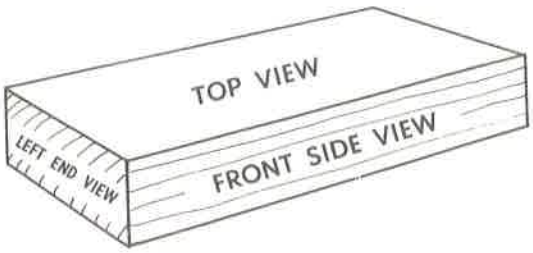
Sometimes it is necessary to have more than one view of the object. This method is usually called orthographic drawing. Your drawings will usually have a top view or side or front view and an edge or end view.

The top view will show you what you would see by looking directly at the top of the article. You can determine length and width, but not height, from the top view.

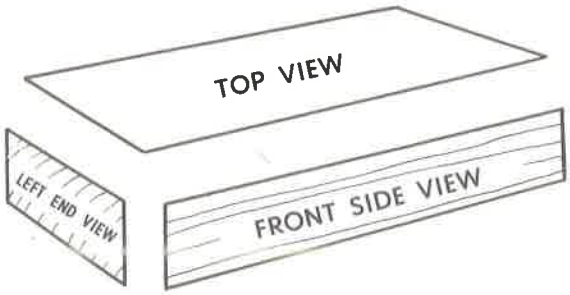
The front or side view will show what you would see by looking directly at the side. You can determine length and height, but not width, from this view.

The end or edge view will give you width and thickness but not length. Let us make an orthographic drawing of the sandpaper block.

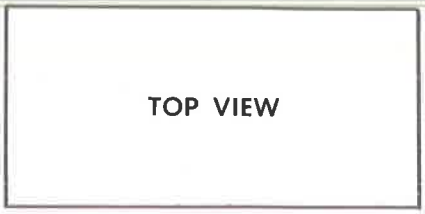
First we will draw the perspective. Then we will label the top, front side and end.



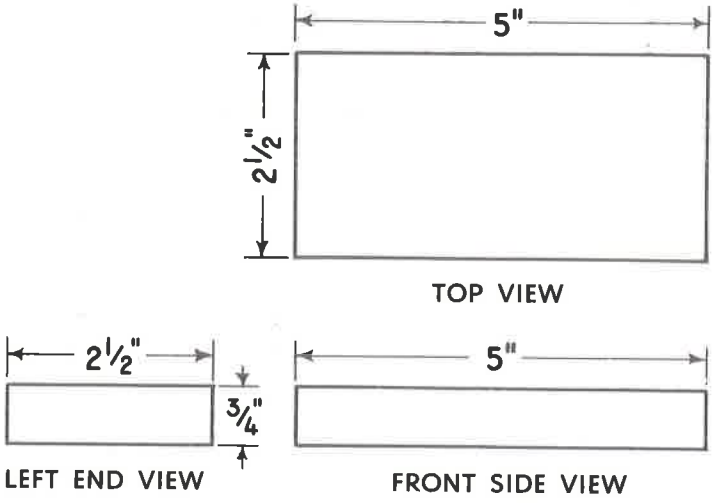
Now we will move the various sections apart as we would in an exploded perspective. We will then label them as views.



Now we will square the top, front and end as you made your sandpaper block.



Now we will move the squared views into their normal positions in a three-view drawing.



If our perspective had been pointing to the left rather than to the right we would have had a right end view in a position to the right of the front side view.

These steps were presented to help you understand the three-view drawing. When a drawing of this type is made, each view is drawn to scale in its own position.

Try drawing the front, side or end and top views of your house with the end view to the right of the front view. Can you get the chimney in the right place in all three views?

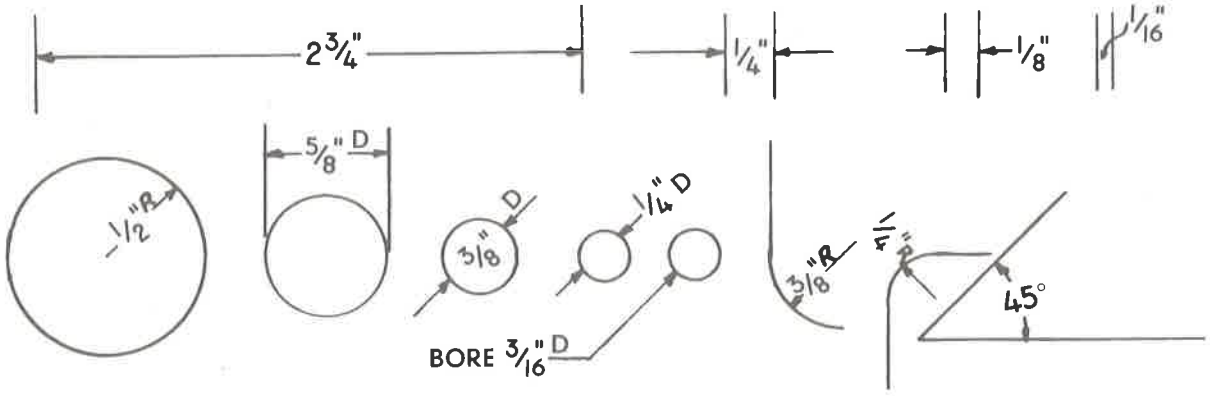
Draw three views of a 6" piece of 2" x 4" wood with another small block on top of it. Make these drawings on clean white paper and put them in your record book.

You may desire to make drawings of the articles you make.

METHODS OF TELLING SIZE

It is usually impossible or impractical to make drawings as large as the articles to be made. Therefore, scale drawings, which are smaller than actual size of the objects are very common. The full size dimensions are given, even though the drawing has been made smaller. The scale system is used with grid system, dimensioned pictorials and exploded pictorials and the three-view orthographic. Usually a certain exact measurement on the isometric or three-view orthographic drawing indicates the exact measurements on the object. For example, ¼" might equal 1'. Many floor plans for houses are drawn at the scale of ¼" equals 1'.

The following illustration indicates different methods used in dimensioning lines, arcs and circles. R indicates radius, D indicates diameter, and ° means degree.



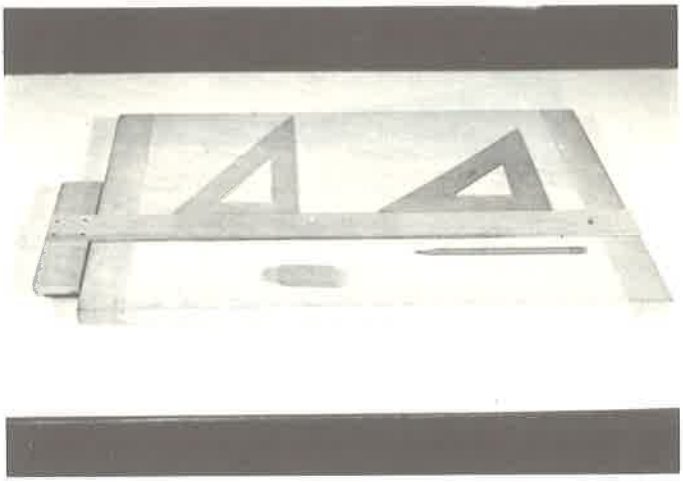
DRAWING EQUIPMENT

If you enjoy drawing of this type, you may purchase some inexpensive drawing equipment.

The following is suggested as a basic set and may be obtained at many hobby and art stores:

- A drawing board about 17" x 23"
- A 24" T-square
- An 8" 30° -60° -90° triangle
- A 6" 45° -90° triangle
- A number 2H drawing pencil/or a number 3 common pencil
- An eraser
- A 12" ruler or some other rule

If you become especially interested in this, you may purchase a reference book for further study.



A beginning drawing set.

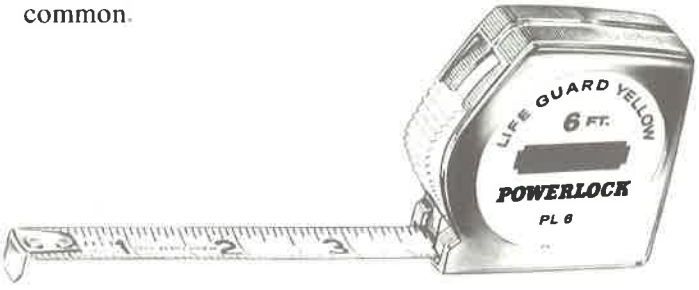
Your Tools

Woodworking Unit 1 contains information about a group of tools and some equipment you should have for your use. This unit contains information about more tools. You may want to add some of them to your tool set.

STEEL TAPE AND FOLDING RULE

In this unit, you will be making bigger things than before. Therefore, you may desire a steel tape rule or a folding rule. Both are available in similar price ranges. For your use, consider the lower cost range and either the steel tape rule or folding rule as suggested by your leader.

The steel tape rule is available in 6-, 8-, 10-, and 12-foot lengths. The 6-foot length is the most common.



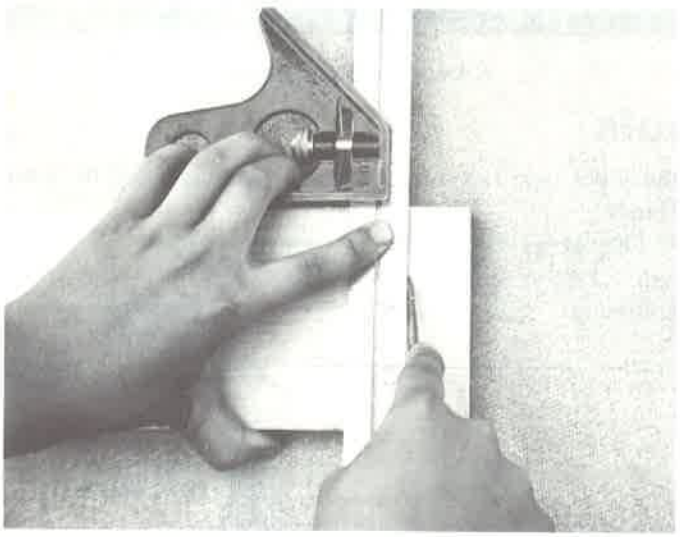
The most common folding rule is six feet long. It is available with either standard or outside reading or inside reading. The numbers on the inside reading rule begin on the inside face. Thus, the markings are close to the work when the rule lies on the work with the unfolded portion up.

Inside reading rule.

Outside reading rule.

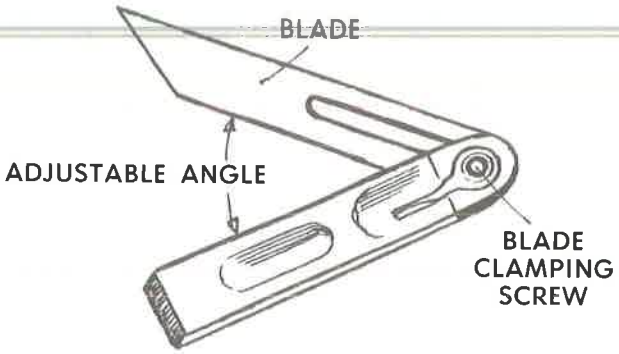
SCRATCH AWL

Now that you are doing more exact and accurate work than before, you may desire a scratch awl for marking. It gives a very clean, sharp distinct line for accurate cutting. It can be used to make a center point in wood for drilling.

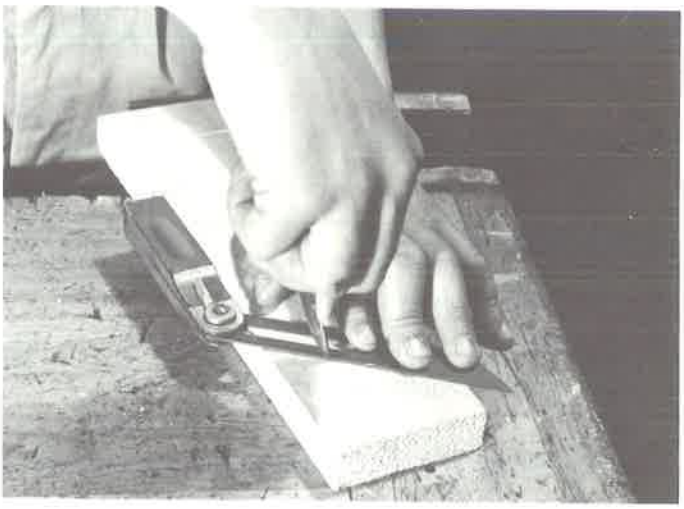


Making a clean sharp line with a scratch awl.

T BEVEL



You may desire a T bevel for laying out miters, testing mitered ends, beveled or chamfered edges, or duplicating lines drawn at some angle.

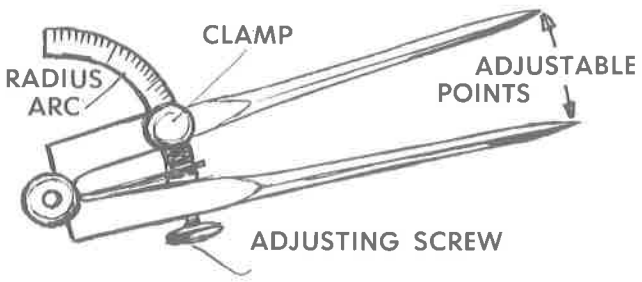


Miter corners and other angles may be marked with a T bevel.

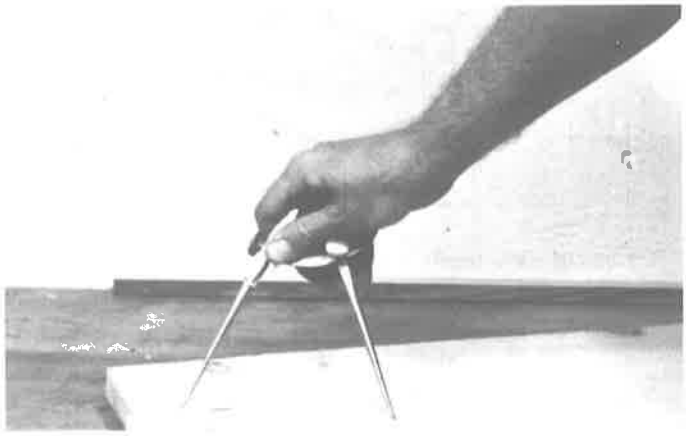
Chamfers, as illustrated above, and bevels may be tested with a T bevel.

Picture frame corners are examples of the miter corner.

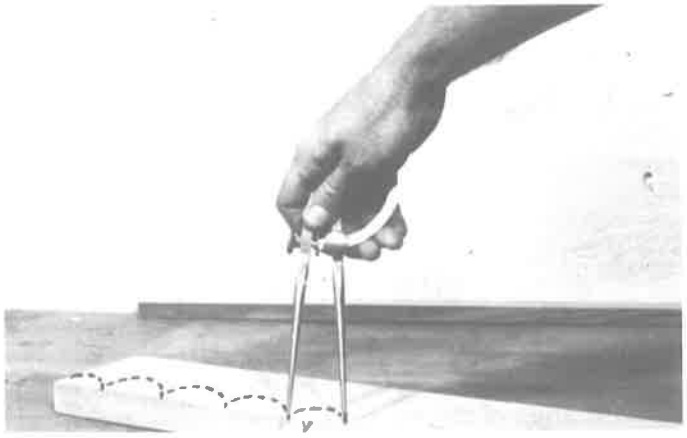
WING DIVIDERS



To use the wing dividers loosen the set screw and place points of dividers on a graduated scale or ruler. Adjust to approximate dimension and tighten the set screw. Fine adjustment may then be made with the thumb nut. Dividers measure radius which is one-half the diameter.

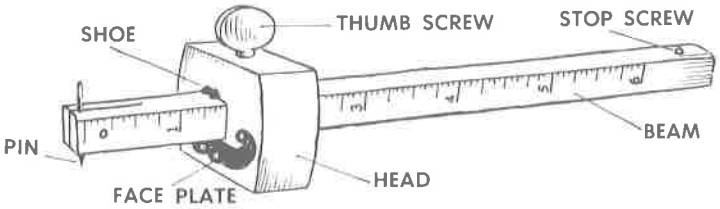


Place the point of the dividers at the center of the desired circle and hold the dividers tightly at the top between the thumb and index fingers. Lean the dividers slightly in the direction they are to be turned and draw a circle.

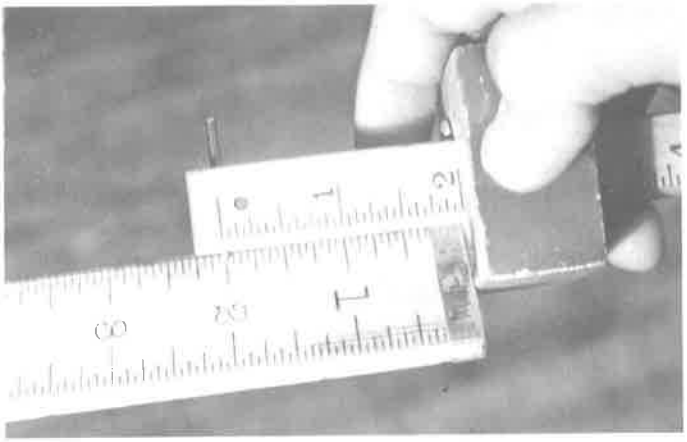


"Step off" with the dividers by turning the dividers first upon one point and then the other. Do not press the point into the wood as it will mar the surface.

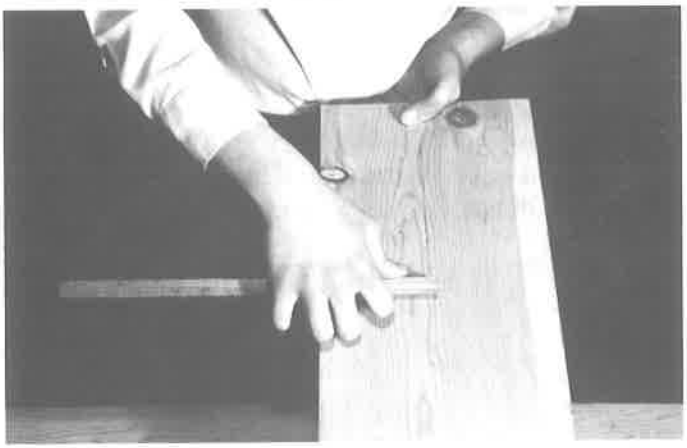
MARKING GAUGE



A marking gauge is used to mark a uniform width on a board. A steel combination square can be used for the same purpose.

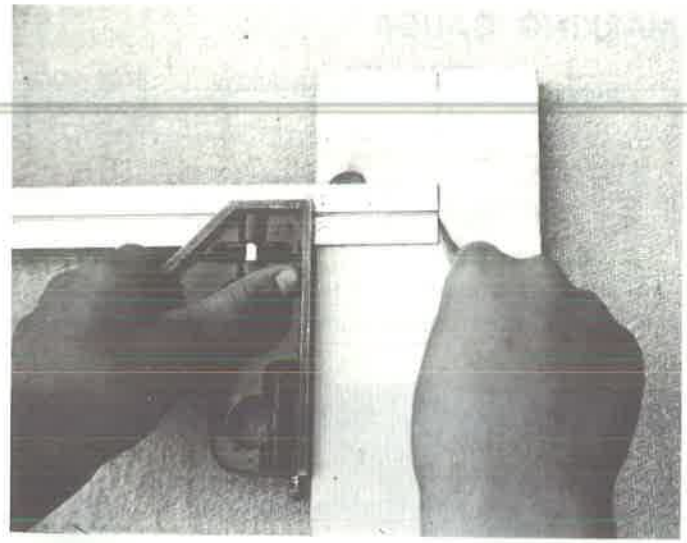


In using the marking gauge, set the pin the desired distance from the face of the head and check with a rule. It is better not to rely upon the measurements on the gauge because the pin may become bent which will upset the measurement. When the correct dimension is found tighten the thumb screw and measure again. The pin must be kept sharp.



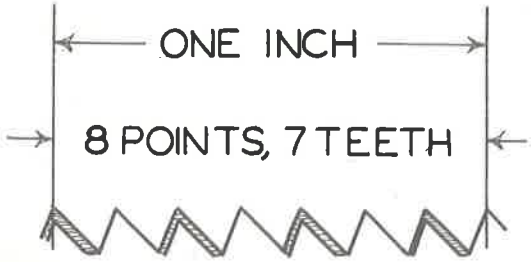
When marking, push the gauge forward. Roll the gauge slightly clockwise so both the beam and pin point touch the wood. Held in this manner, you can observe the point at all times. The head must be held tightly against the work edge of the wood. Hold the gauge as you would a ball, then move the thumb toward the pin to distribute the pressure between the pin and head.

Some people use the gauge by drawing it toward the operator. In this case the head must be tipped toward the operator. In either case be careful to keep the face firmly against the edge of the stock.

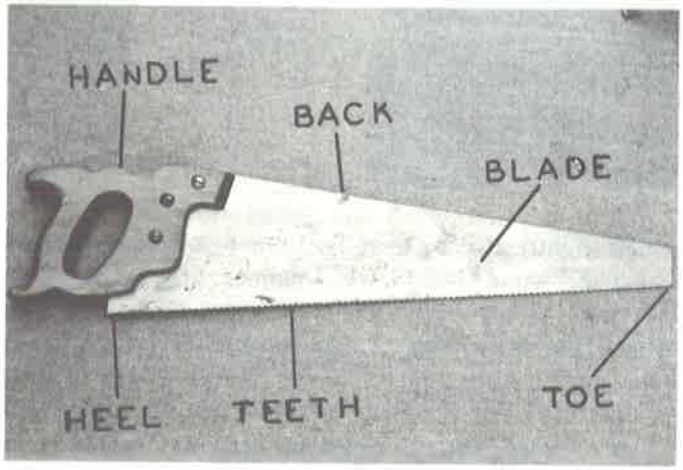


A steel combination square and marker can be used for the same purpose. Slant the marker in the direction of movement.

HAND SAWS

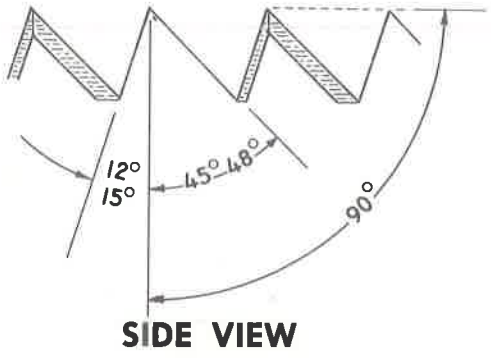


Saw size is determined by the length of the blade in inches. Some popular sizes are 20", 22", 24", and 26". The coarseness or fineness of a saw is determined by the number of teeth points per inch.



A coarse, crosscut, 8-point saw works well for fast work and for green wood. A fine saw, 10 to 14 points, is better for smooth accurate cutting and for dry seasoned wood. Rip saws usually have 5½ or 6 points per inch. Saw teeth are set to make the kerf, or saw cut, wider than the thickness of the saw blade. This allows free, easy movements of the saw. In setting, the tip portion of every other saw tooth is bent to the right and those between to the left. High quality expensive saws are taper ground to make the blade thinner at the back than at the toothed edge.

Crosscut Saw

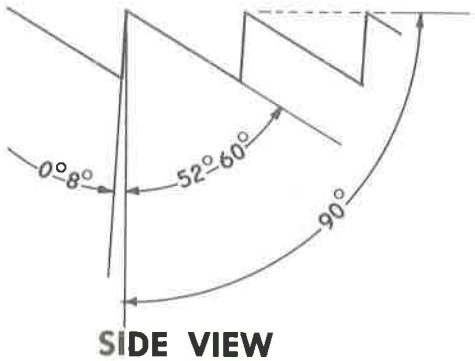


SIDE VIEW

Crosscut saw teeth are like two rows of knife points. The points cut the wood on each side of the kerf, or saw cut, and the wood crumples out between the cuts. The crosscut saw is used to cut across the grain of the wood.

You may want a 24" or 26" 8-point saw for fast work and cutting two-inch material.

Rip Saw



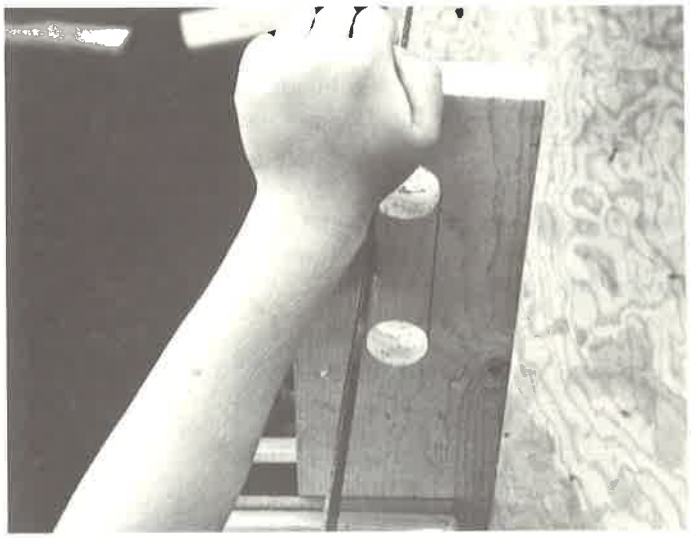
SIDE VIEW

Rip saw teeth are shaped like chisels. They cut like a gang of chisels in a row. The rip saw is used to saw with the grain of the wood.

The rip saw is held at a steeper angle than the crosscut saw. The correct angle between the rip saw and the board is 60 degrees. The correct angle for the crosscut saw is 45° with lumber and 15° with plywood.

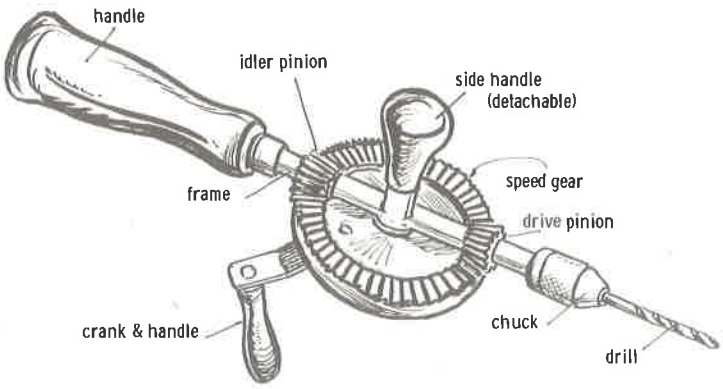
Compass Saw

The compass saw is a small saw with a short narrow blade. It is used to saw inside or outside curves on stock too heavy for a coping saw.



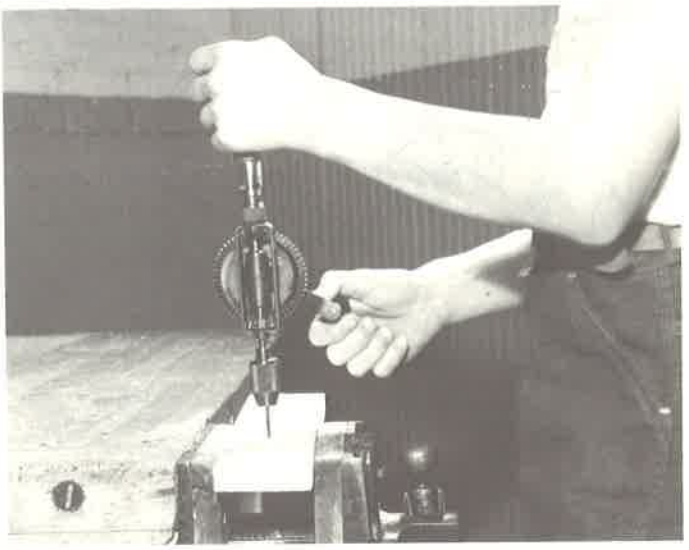
To start an inside cut with a compass saw, bore one or more holes, large enough to admit the point of the saw. Insert the saw and cut with smooth even strokes.

HAND DRILL



The hand drill is used to make small holes for nails and screws. This prevents splitting the board. Use it also to drill a starting hole for the coping saw blade.

Punch a small starting hole in the wood with the scratch awl or nail and hammer. The hole prevents sliding of the drill point.



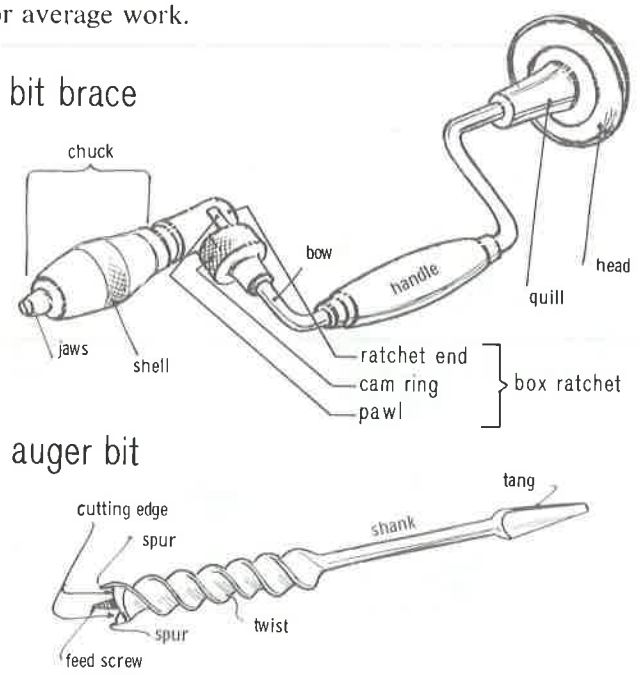
To put the drill in the chuck, hold the crank handle and frame with the right hand and turn the chuck to the left. Open the jaws only a little more than the size of the drill. This helps to center the drill. To tighten, hold the crank, handle and frame with the right hand, and turn the chuck to the right.

The drill may be held straight up or down or it may be held flatwise.

Nails and brads with heads cut off may be used for drilling small holes.

BIT BRACE AND AUGER BITS

To bore large holes use your bit brace and auger bit or electric drill and appropriate bit. The bit brace is used for turning such tools as wood auger bits, twist drills, screwdriver bits and countersinks. Braces are made either with or without the ratchet device. The ratchet makes it possible to bore holes where the handle cannot be turned all the way around, as in corners. It is also very useful when driving screws with a screwdriver bit. The size of a bit brace is designated by its sweep, or the diameter of the circle through which the handle swings. A brace with an 8-inch sweep is suitable for average work.

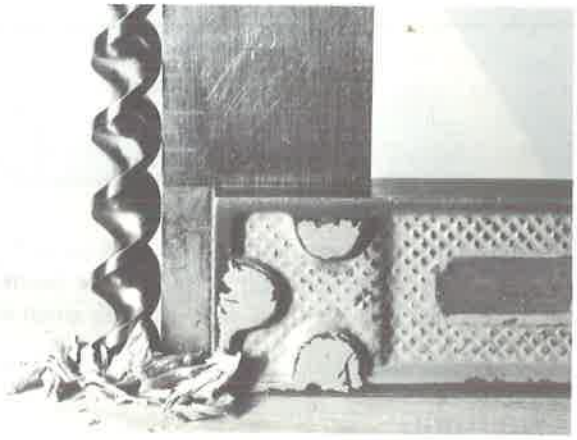


Most hardware stores sell auger bits individually or in sets of 5 or 6 or more bits. In these sets the smallest bit is usually ¼" and the largest 1". The number usually stamped on the tang or shank of the auger bit indicates the size of the bit by 16ths of an inch. For example, 4 indicates 4/16" or ¼".

To place the bit in the brace chuck, hold the chuck and turn the handle to the left until the jaws are open.

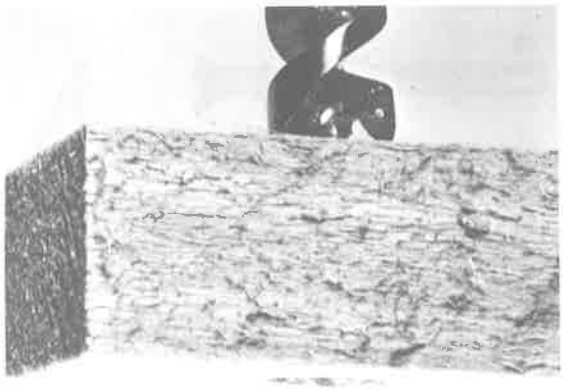
Put the bit tang into the square socket at the bottom of the open jaws. Turn the handle to the right until the jaws are tight on the bit. Be sure the bit is straight.

Hold your bit straight and turn until it starts cutting. Then check with a square for straightness. Bore part way, then check again with the square. Push a little on the brace head, at the same time let the feed screw pull the bit into the wood.

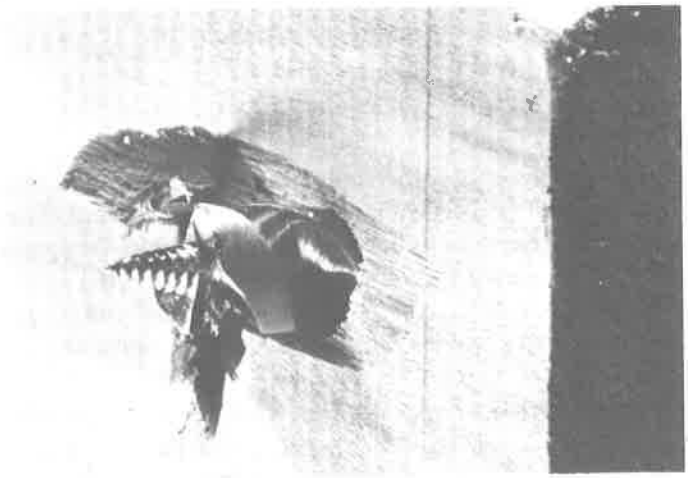


Bore until the point of the feed screw comes through the wood. Then turn the bit backwards until it is out of the hole.

Turn the board over. Start the screw in the hole made by the bit from the starting side and finish boring the hole.



Clamping a scrap board on the back of the good piece will also prevent the breaking. Bore through the good piece into the scrap.



Don't break the wood by boring through the board.

This is an expansion bit for boring holes of various diameters. It may be adjusted to make a hole of the size that is needed.

USING WOOD SCREWS

There are various kinds and sizes of screws. The flat head screw is most commonly used in woodworking, although the oval head and round head screws are sometimes used, mainly for ornamental effect.

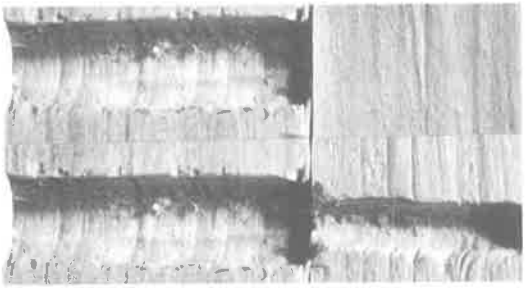
The size of wood screws is designated by:
(1) the size of the shank
(2) length.

You may use screws to assemble some of the things in this woodworking project.

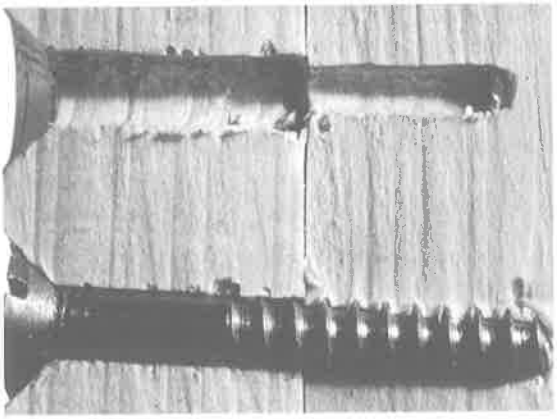
Round head, oval head, and flat head wood screws.

Drill pilot holes to prevent splitting and to make the screws turn easier. Bore a small hole in the piece holding the point. This hole should be a little smaller than the solid portion of the screw inside the threads. It is called a pilot or anchor hole.

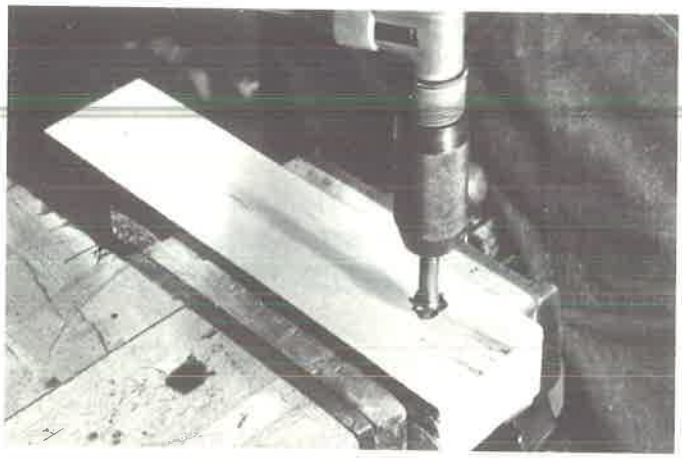
Bore a hole for the shank in the piece touching the head. This hole should be large enough so the screw will slip easily, but snugly into the hole.



The larger part of the hole is the shank hole. The smaller part is the anchor hole.

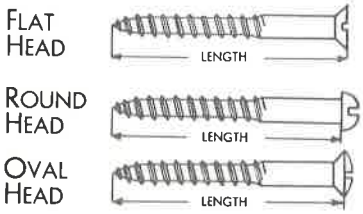


Ream the top of the shank hole with a countersink for flat or oval head screws.

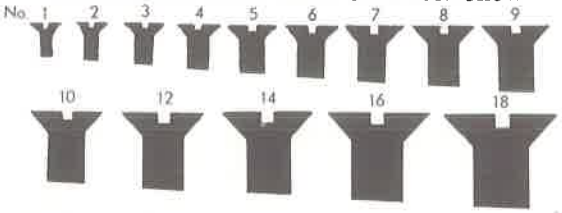


The flat head screw should be flush with the surface of the wood. Test by turning the screw upside down and holding it against the reamed surface.

Wood screw pilot bits are available for electric drills. They are available for most screw sizes and drill the pilot hole, anchor hole, and countersink all at one time.



DETERMINE SCREW SHANK SIZES BY COMPARISON BELOW



SIZES OF BITS OR DRILLS TO BORE HOLES FOR WOOD SCREWS

NUMBER OF SCREW		1	2	3	4	5	6	7	8	9	10	12	14	16	18
BODY DIAMETER OF SCREW		.073	.086	.099	.112	.125	.138	.151	.164	.177	.190	.216	.242	.268	.294
		5/64 -	3/32 -	3/32 +	7/64 +	1/8	9/64 -	5/32 -	11/64 -	11/64 +	3/16 +	7/32 -	15/64 +	17/64 +	19/64 -
FIRST HOLE	TWIST DRILL SIZE	5/64	3/32	7/64	7/64	1/8	9/64	5/32	11/64	3/16	3/16	7/32	1/4	17/64	19/64
	AUGER BIT NUMBER							3	3	3	3	4	4	5	5
SECOND HOLE	TWIST DRILL SIZE		1/16	1/16	5/64	5/64	3/32	7/64	7/64	1/8	1/8	9/64	5/32	3/16	13/64
	AUGER BIT NUMBER												3	3	4

USING THE SCREWDRIVER

Turn the screw in until the two pieces of wood fit tightly together. If you turn the screw too much the wood around the screw threads will break out. Then the strength of the screw is lost.

The screwdriver should be the same width as the screw slot is at its base. It should be thick enough so it fits snugly into the slot.

C-CLAMPS

Use your C-clamps to hold pieces of wood together for gluing, to clamp boards together when boring holes, and to clamp a guide board on a board for a straight saw cut.

Use a piece of scrap material between your good board and the clamp to prevent dents.

JIG SAW

The jig saw is usually used to make curved or irregular cuts. However, it can be used for regular rip and cross cuts. It can be used to make inside cuts within the center section of a piece. A start hole is drilled in the work. The blade is inserted through the hole and put in the jig saw. Fine, narrow blades make very intricate cuts possible.

Many different types of saw blades make it possible to cut wood, metals, plastics, etc. The down stroke is the power and cutting stroke on most jig saws.

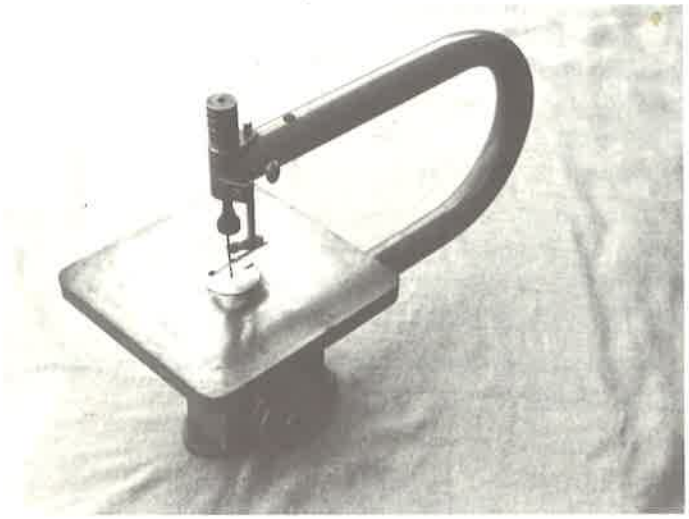
Selecting a Jig Saw

A jig saw should be sturdily constructed and free of severe vibration to stand up over a long period of time. The capacity of a jig saw is indicated by the distance between the blade and the rear of the frame.

There are three common types of table model jig saws. Each type may appear in more than one price range, depending upon the built-in refinements.

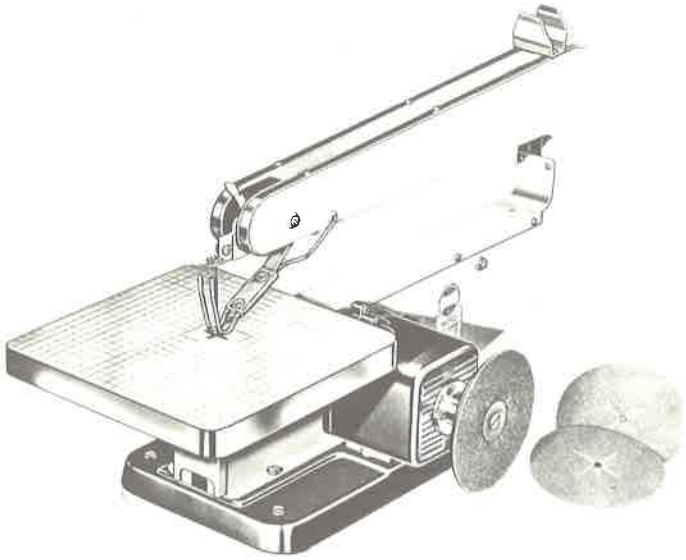
Magnetic Jig Saw

The magnetic type uses a self-contained magnetic power unit which operates the blade at a very high speed by means of a diaphragm.



Spring-located type Jig Saw

The blade of the spring-located jig saw is pulled downward by some eccentric system such as a crankshaft. During this down stroke, the spring located in the upper tube of the saw is tensioned. This spring helps pull the blade on the upward stroke.



A Walking-beam or rocker arm action Jig Saw

In this type of saw, the blade is held firmly at both ends by a rectangular rigid frame. This frame is pivoted at one point to allow up and down motion. Some motor driven eccentric device at another point on the rigid saw frame gives it the up and down action. The rocking frame is enclosed within the jig saw housing. This type of saw operates with the least vibration.

Operating a Jig Saw

It would take many pages to explain in detail the operations of a jig saw. If you have a jig saw, study the instruction book you received with the saw.

ELECTRIC DRILL

A ¼" electric drill is a very handy tool for predrilling nail holes to prevent splitting, pilot holes for screws and other holes in wood. It is available in the light-duty inexpensive range, medium-duty, and heavy-duty, or industrial class.

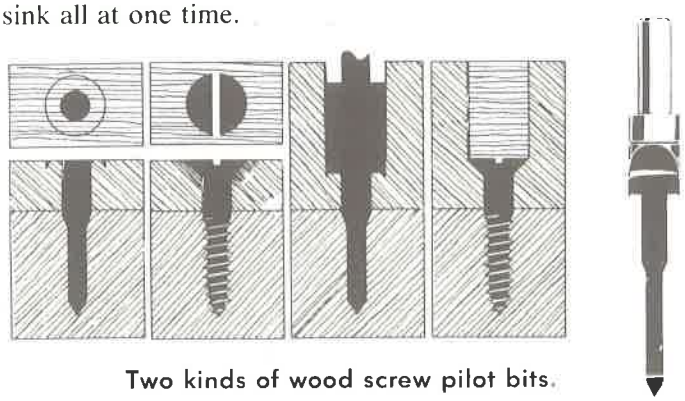
The light-duty drills generally have a light-duty motor and bronze bearings. The heavy-duty or industrial drills are designed for heavy continuous work. They have a heavy-duty motor and ball or needle bearings. Electric drills are also available with variable speed and reversing capabilities.

Using the Electric Drill

When using the electric drill grasp it firmly. The drill develops twist power or torque. If the bit would suddenly become stuck, the torque of the drill could jerk your arm enough to sprain a muscle.

Fine drill bits or nails with the head cut off may be used for predrilling for nails. These drills run at a very high speed. Therefore, carbon steel drill bits will work in wood, but high-speed drills are necessary for drilling in metal.

Wood screw pilot bits are available for most screw sizes which drill the pilot hole, anchor hole and countersink all at one time.



Two kinds of wood screw pilot bits.

For larger holes, in wood, the drill bit with ¼" shank or power wood boring bits may be used.

Power-bore Wood Bit

Whenever you use an electric drill:

- Be sure it is properly grounded.
- Be sure the bit is tight in the chuck.
- Hold the drill securely.
- Keep your fingers away from the turning chuck.
- Unplug the drill when changing or tightening drill bits.
- Lubricate according to manufacturer's directions.

OSCILLATING SANDER

One kind of oscillating sander

Oscillating electric sanders can be used to advantage in the shop and home. They can be used for paint removal, refinishing furniture, finishing wood, and smoothing wood, wallboard or plaster wall joints. The sanding action is provided by a rectangular piece of sanding paper attached to the sanding pad. The pad oscillates either back and forth or in a small orbit.

Use open coat aluminum-oxide or silicon carbide paper for sanding. Tungsten carbide brazed onto a metal backing will last much longer but is more expensive.

Using the Sander

Be sure the sander is properly grounded through a three-wire grounding cord. Check to see if the switch is in the OFF position before connecting the electric plug to the outlet. Lift the sander off the work before starting or stopping it. Hold the sander firmly with little or no downward pressure. The weight of the sander is enough in most cases.

To smooth a rough surface, use a coarse abrasive and sand diagonally across the grain of wood then sand lengthwise of the grain. To complete the job, sand lengthwise with medium and fine sandpaper.

Lubricate the sander according to recommendations of the manufacturer.

Lumber Sizes

The chart following indicates lumber sizes of material commonly available at the lumber yard. The lumber may vary from these dimensions due to moisture content. The dimensions are subject to change because the lumber manufacturers in cooperation with the U. S. Department of Commerce are in the process of developing a new national standard on grades and specifications.

Nominal size indicates the size of the material when it was cut from the log. The dressed dimension is the minimum actual size of the lumber after drying and smoothing by machinery on all four sides.

SOFTWOODS

Dimensions: nominal, dressed, dry

Nominal Size		Dressed Dimensions* Surfaced 4 Sides	
Thickness In.	Width In.	Thickness In.	Width In.
Boards – Common & Finish			
1	4	¾	3½"
1	6	¾	5½
1	8	¾	7¼
1	10	¾	9¼
1	12	¾	11¼
2" Dimension			
2	2	1⅝	1½
2	4	1⅝	3½
2	6	1⅝	5½
2	8	1⅝	7¼
2	10	1⅝	9¼

*Lumber which is high in moisture or green may be slightly thicker and wider.

HARDWOODS

Dimensions: nominal, dressed

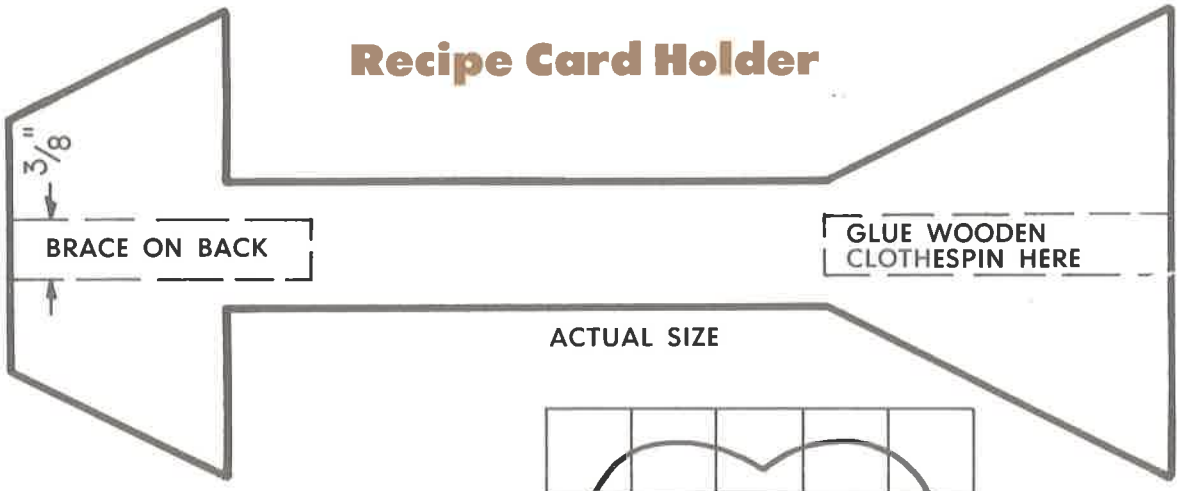
Nominal Size		Dressed Dimensions* Surfaced 4 sides	
Thickness In.	Width In.	Thickness In.	Width In.
		Boards	
1	4	13/16	3⅝
1	5	13/16	4⅝
1	6	13/16	5⅝
1	7	13/16	6⅝
1	8	13/16	7½
1	9	13/16	8½
1	10	13/16	9½
1	11	13/16	10½
1	12	13/16	11½

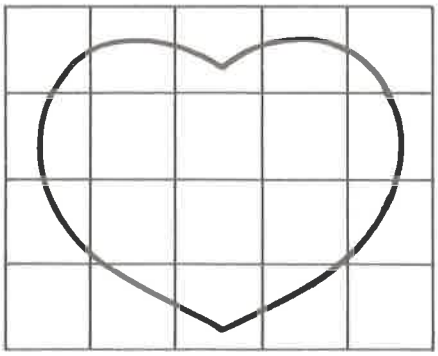
*Also sold surfaced on two sides only. The width is then nonstandard and referred to as random width.

SELECTING DRAWINGS

On the following pages you will find plans for items to make in your woodworking project. You are encouraged to make other items besides the ones shown in this book. Make minor alterations in the plans to accommodate variations in lumber sizes.

Recipe Card Holder





Material:

Base - 1 pc. 1" x 4" x 6" or ⅝" - ¾" plywood

Arrow - Fruit crate lumber or ¼" plywood

Brace - ⅜" crate lumber or plywood

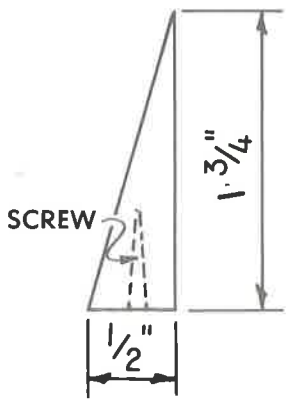
1 Spring type clothes pin

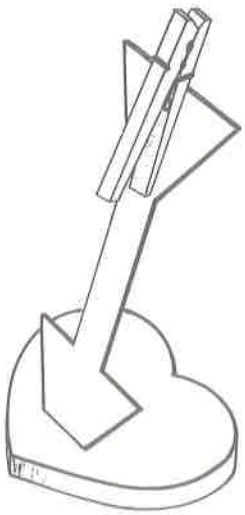
1 Flat head wood screw - thickness of base plus ½" long

Glue

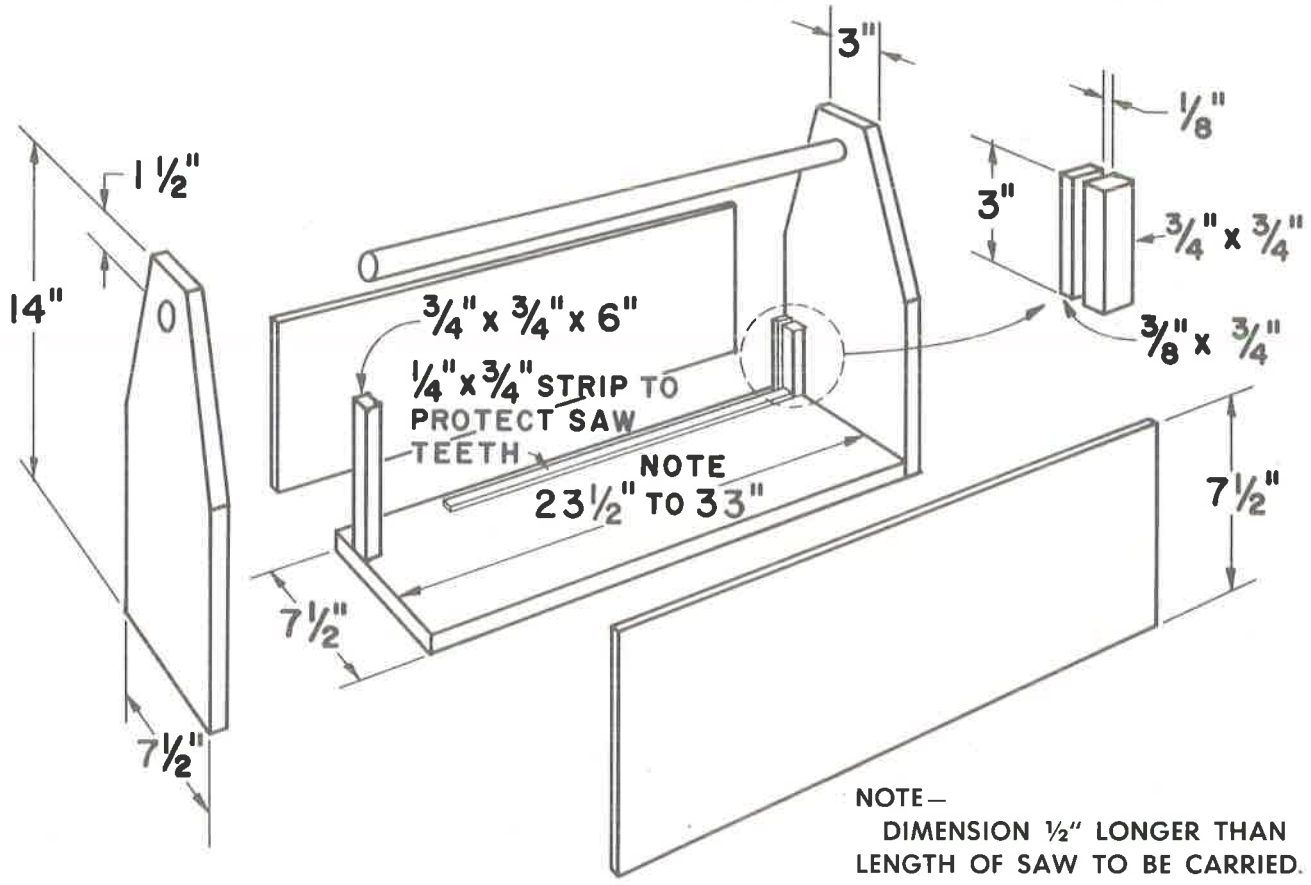
Finish:

Apply penetrating type finish or enamel.





Tool Box



Material:

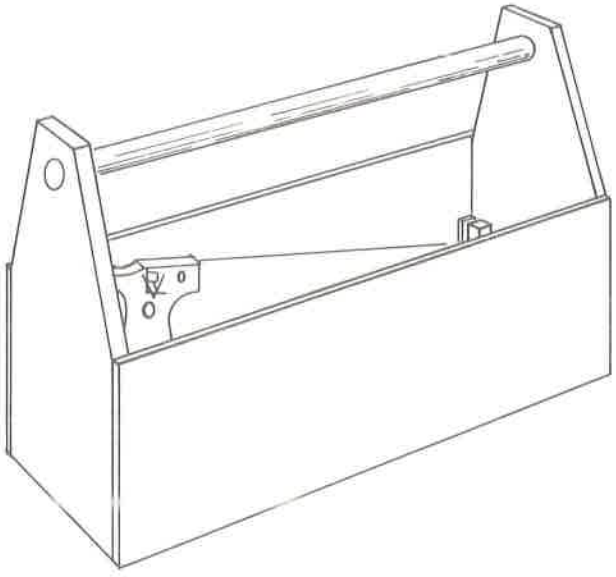
1 pc. 1" x 8" for end and bottom

1 pc. ¼" exterior type plywood, or ⅛" or ¼" tempered hardboard for sides

1 pc. 1" dowel or broomstick

1 pc. ¾" x ¾" x 9"
1 pc. ⅜" x ¾" x 3"
1 pc. ¼" x ¾"

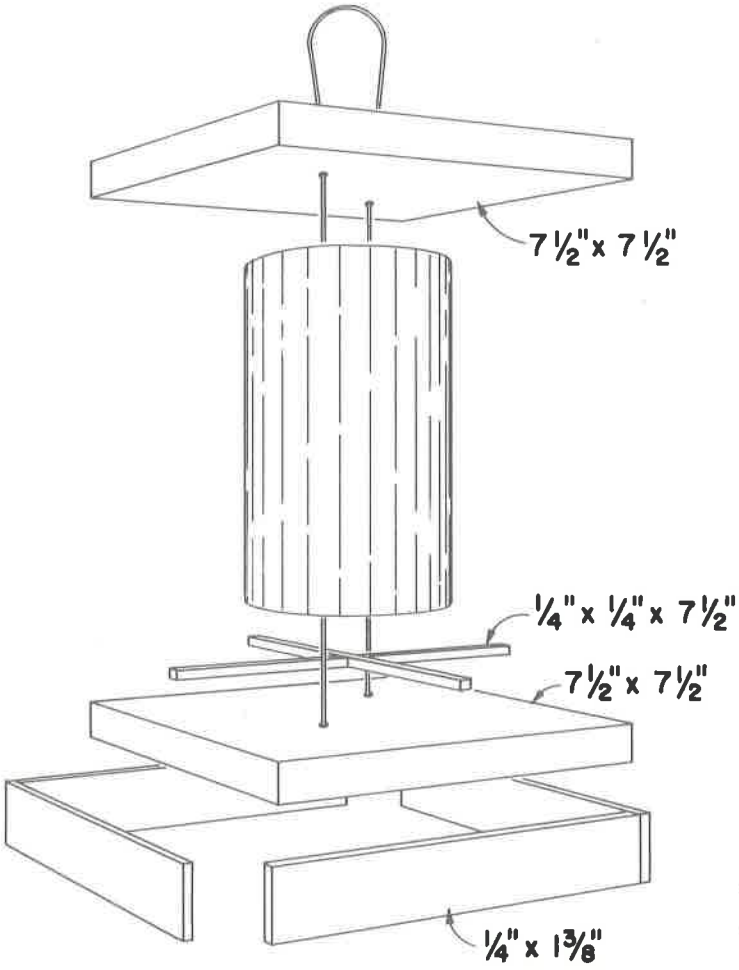
¾" Flat head wood screws



Finish.

Apply penetrating type finish, paint or enamel.

Bird Feeder



Material:

1 pc. 1" x 8" x 16" top and bottom or ¾" x 8" x 16" exterior plywood

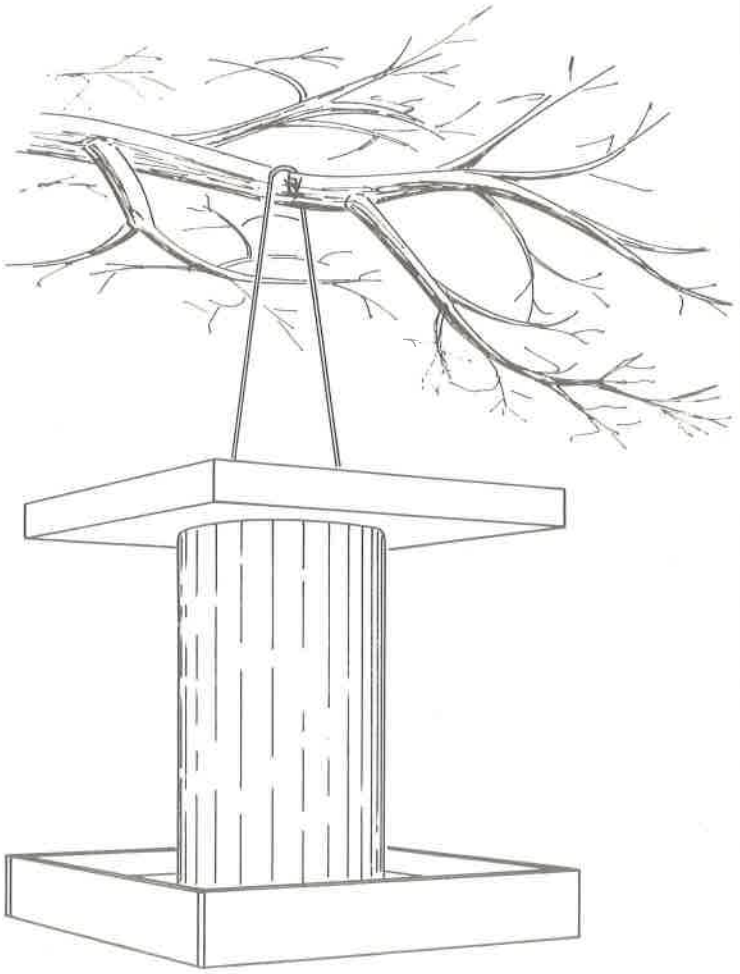
1 pc. ¼" x ¼" x 16" (actual dimensions)

1 pc. ¼" x 1⅜" x 33" lattice (actual dimensions)

1 - Fruit juice can about 4¼" x 7"

42" #16, 17 or 18 wire (galvanized or aluminum preferred)

¾" wire nails (galvanized or aluminum preferred)



Finish:

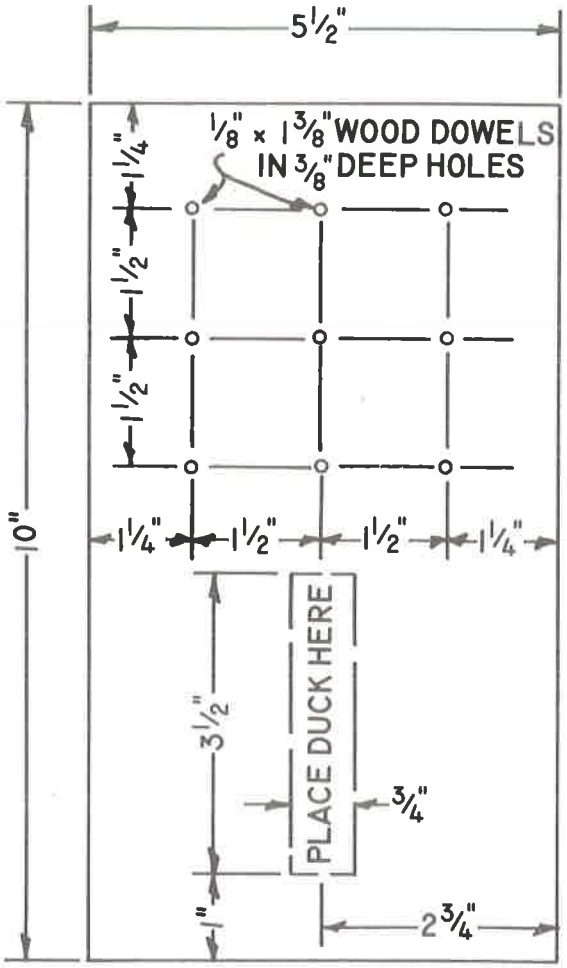
Wash the can. Allow it to dry. Paint with a good grade of exterior house paint or metal paint or enamel.

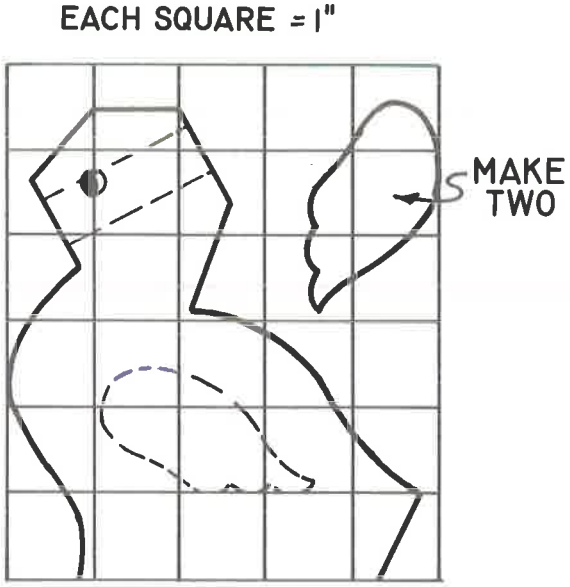
Finish the wood portions in either exterior house paint or exterior stain.

Mounting:

Hang from a low branch of a tree so it can be reached for easy refilling.

Thread and Scissors Holder





Finish:

Apply penetrating type finish or enamel.

Material:

1 pc. 1" x 6" x 10" or ¾" plywood of the same size for base

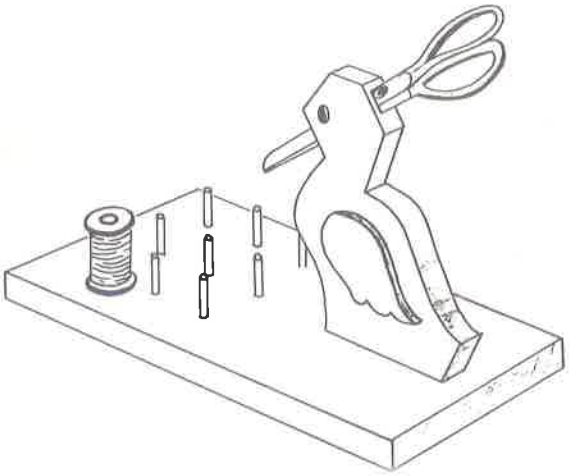
1 pc. 5" x 6" x ¾" plywood or hardwood lumber for body

1 pc. 3" x 4" x ¼" plywood, box lumber, or lattice material for wings

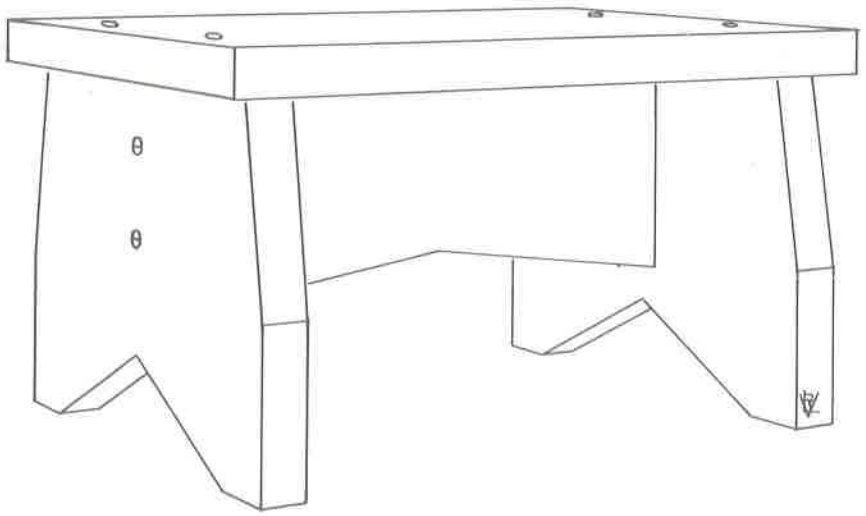
1 pc. ¼" dowel 15" long

2 - 1½" #8 flat head wood screws to attach body to base

Glue for pegs



Foot Stool



Material:

1 pc. 1" x 8" x 24" for top and legs

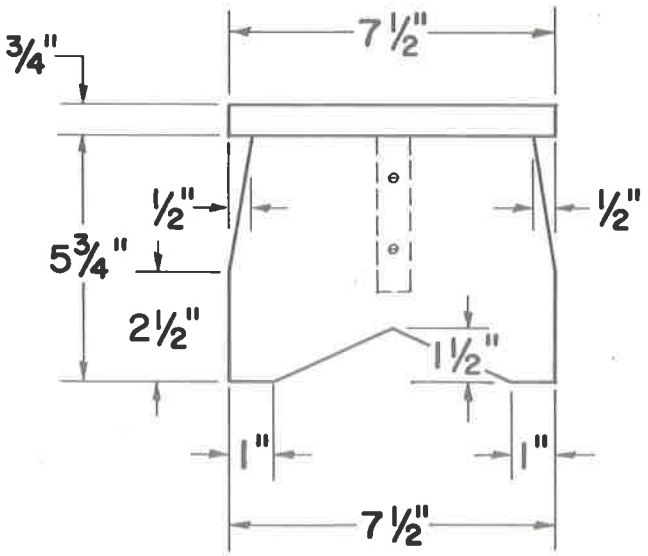
1 pc. 1" x 4" x 12" for stretcher

8 – 1½" #8 flat head wood screws

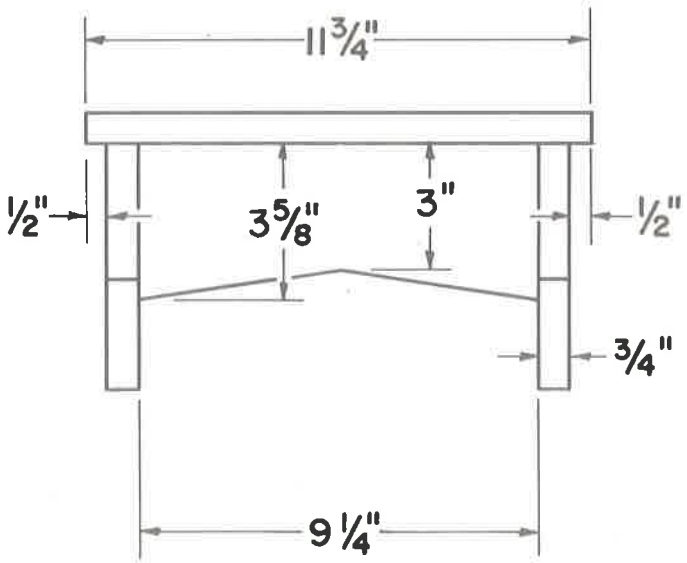
Finish:

Apply penetrating type finish or enamel.

END VIEW



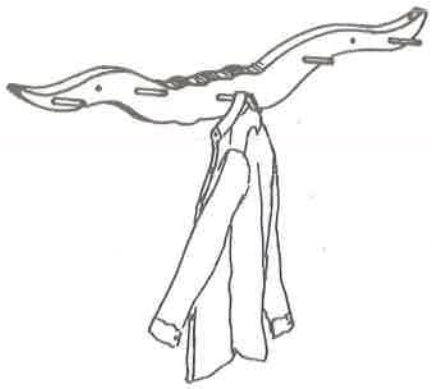
SIDE VIEW



"Steer-Horn" Clothes Hanger

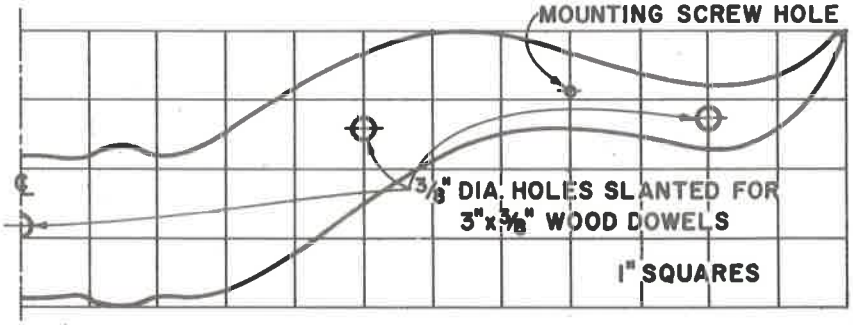
Material:

1 pc. ¾" lumber or plywood about 4" x 24"
1 pc. ⅜" x 20" dowel.
Glue
Penetrating wood finish or other appropriate finish materials



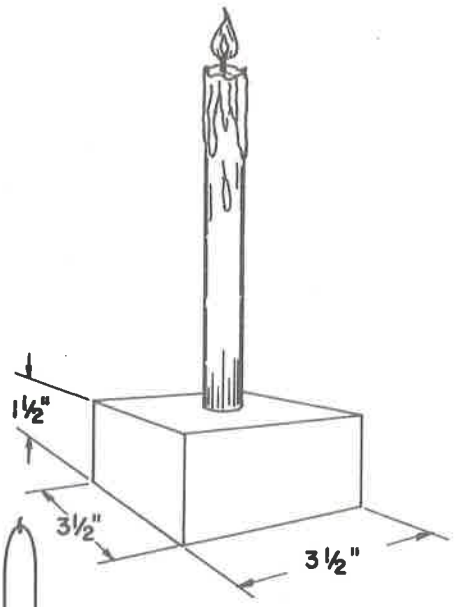
Procedure:

1. Fold a sheet of paper at least 24" long squarely in half. Lay out squares for grid system on one side. Draw the half of the horn shown. Cut out with the paper folded for the complete pattern.
2. Cut out horn piece and dowels.
3. Mark centers for holes for dowels.
4. Drill holes for dowels. Slant them downward so dowel points upward 10° from the horizontal.
5. Drill holes for screws to be used in fastening to the wall or fasten screw eyes into the top. Sandpaper smooth.
6. Round one end of each dowel. Spread glue on the sides of each dowel hole. Insert dowels.
7. Apply finish after glue is dry.



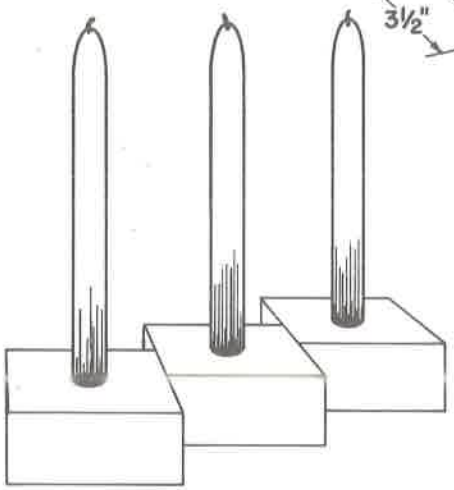
Candle Holder

(Single or Multiple)



Material:

About 4" of 2" x 4" for each unit
Contact or quick drying glue for multiple units
Finishing materials as you desire



Procedure:

1. Cut out blocks.
2. Drill holes for candles.
3. Sand smooth. Caution, do not round edges or corners of units to be glued together.
4. Glue blocks into units if desired.
5. Complete sanding.
6. Finish as desired.

Wren House

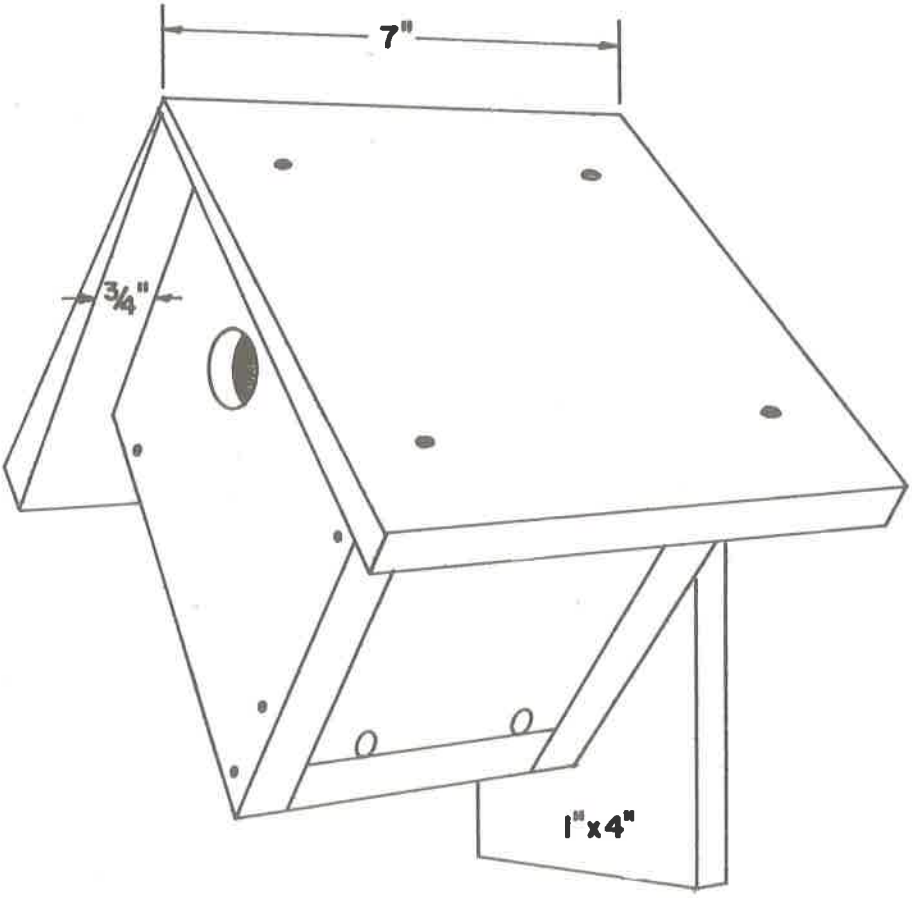
NOTE: Attach one side of roof with wood screws, so it can be removed for annual house cleaning.

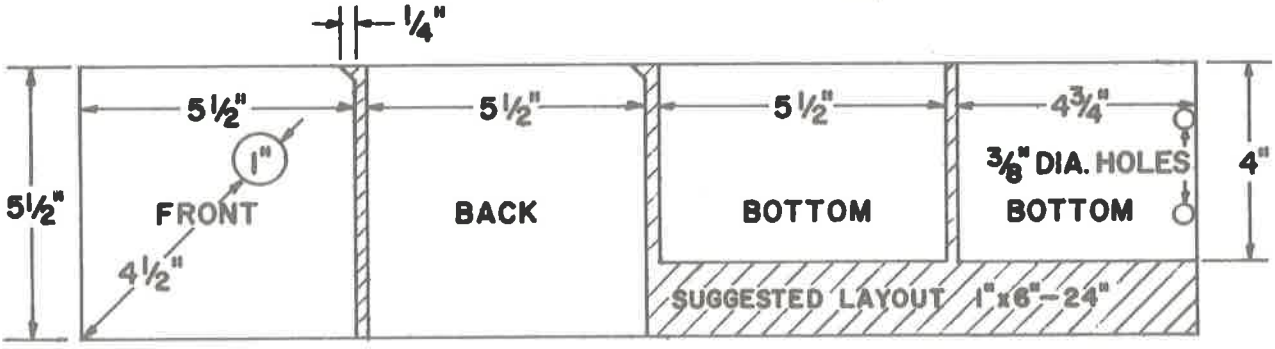
Mounting:

Attach to a tree or post 5' or 6' above ground with round head or lag screws. Wrens seek shade and protection of thick bushes.

Material:

1 pc. 1" x 6" x 24"
1 pc. 1" x 4" x 12"
Use box lumber, bevel siding, exterior plywood, heavy asphalt roofing or tin for roof
4 – round head wood screws to attach one side of roof
9 – 1¾" - 2¼" nails (galvanized or aluminum preferred)
8 – 1¼" nails (galvanized or aluminum preferred)
Water repellent wood preservative or penetrating exterior stain for finish

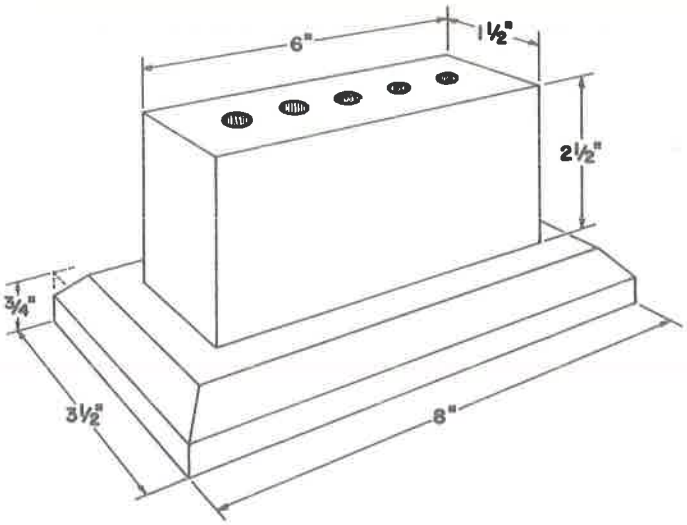




Pencil Holder

Material:

1 pc. 2" x 4" x 6"
1 pc. 1" x 4" x 8"
2 – 1½" wire nails
Glue
Penetrating wood finish or other appropriate finish materials



Procedure:

1. Cut pieces to size.
2. Bevel edges of base piece.
3. Drill holes for pencils.
4. Sandpaper smooth.
5. Fasten top piece to base with glue and two nails.
6. Apply finish after glue is dry.

Boot Jack

(To use place one foot on jack to the rear of the support and hook the heel of the boot of the other foot in the notch.)

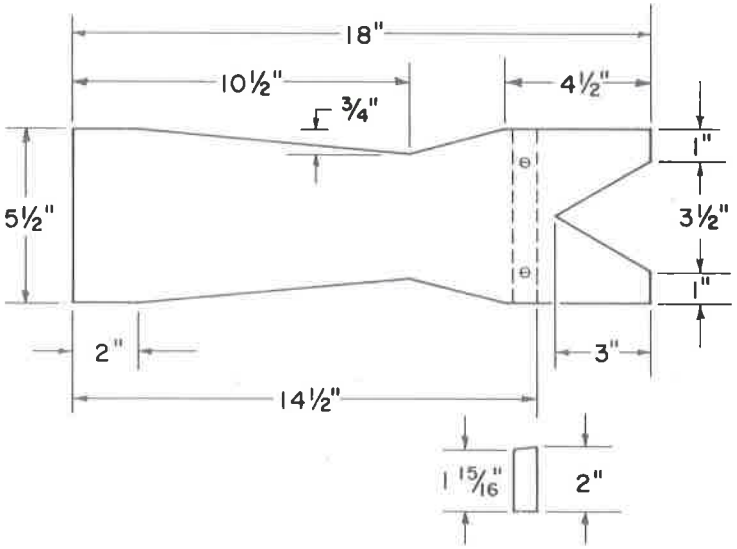
Material:

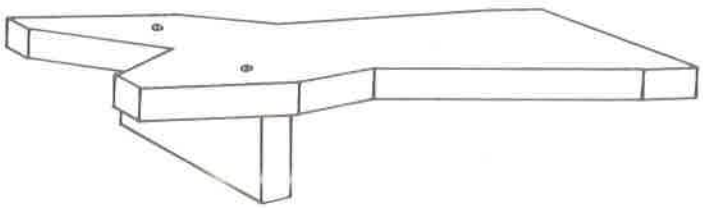
1 pc. 1" x 6" x 24"

2 each – 2" #10 flat head screws

Penetrating wood finish such as linseed oil

NOTE: If you desire a wider boot jack, make it from 26" of 1" x 8". If you desire a more trimline effect, taper all the way from the front to the back by removing 1¼" on each side.





Salt & Pepper Shakers

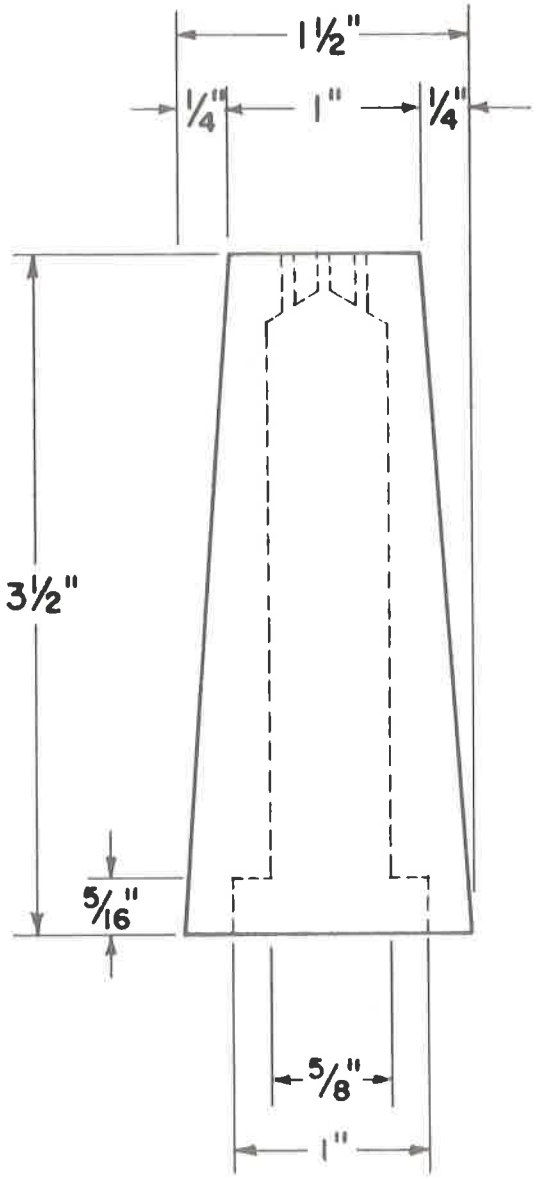
Material:

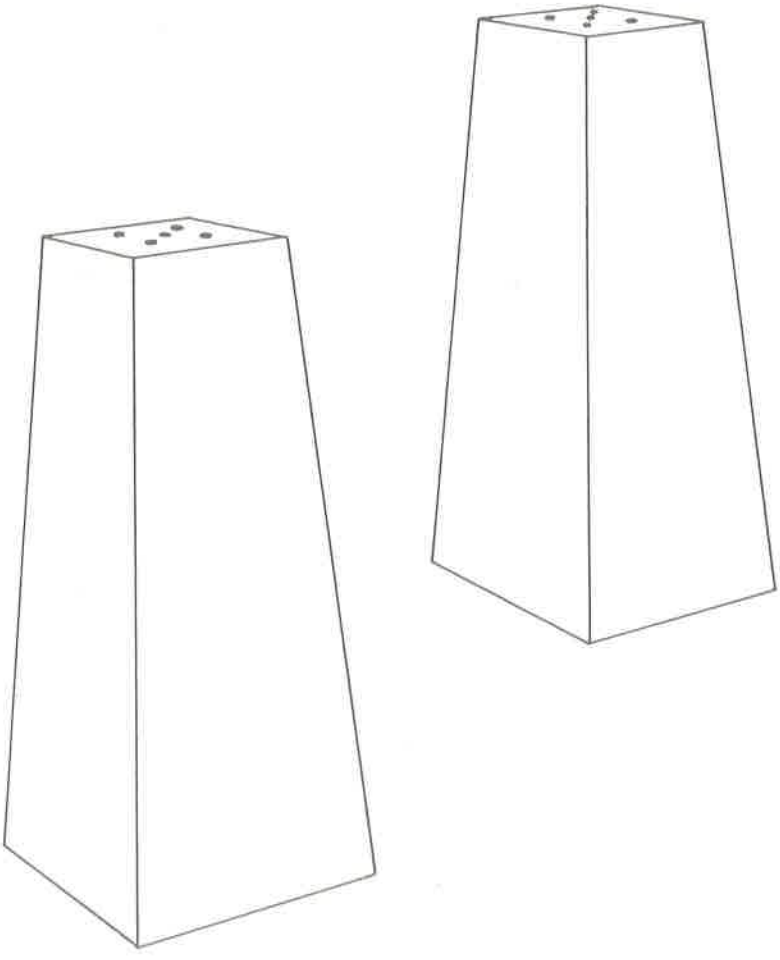
1 pc. 2" x 2" - 3½" for each shaker
Hardwood preferred

One cork or rubber stopper for each (⅝" x 1" – cut off)

Penetrating wood finish or other appropriate wood finish materials

NOTE: Drill 1/16" or smaller holes and try with the salt and pepper you are using. If the holes are too small, use larger size drills or nail bits until you have a workable size. The holes may be drilled in a letter "S" and "P" shape for identification or plan some other means of identification. In construction drill the large shallow hole first. (If you have a 1⅛" bit use that instead of your 1" bit.) Then drill the deep ⅝" hole.





Note Pad Dispenser

Material:

1 pc. ¼" plywood about 12" x 12"

1 pc. ⅜" dowel 3" long

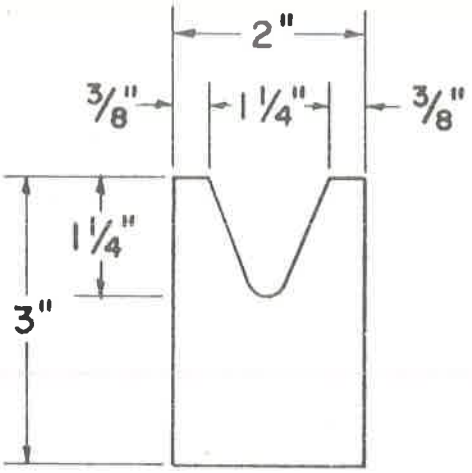
Glue

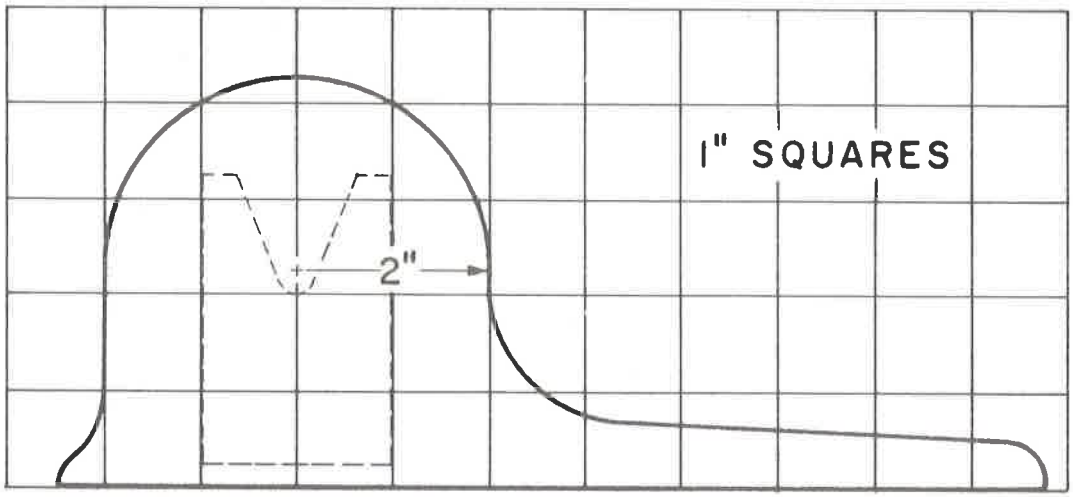
¾" and ½" wire brads

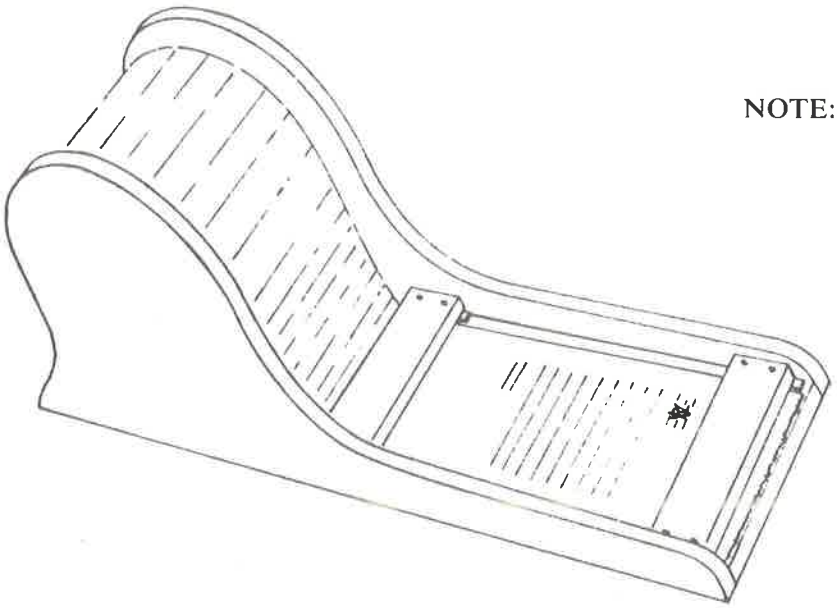
Thin cardboard – about the thickness of a blotter paper to use as a spacer under the cross pieces

1 roll 2¼" adding machine tape

Penetrating wood finish or other appropriate finish materials







NOTE: If you desire to hang this unit on the wall, change the notch direction on the dowel holders. For uniformity you can nail the two side pieces together, inside to inside, and cut both at once.

Bird House

Material:

1 pc. 1" x 6" x 54"
1 pc. ¾" x 10" x 8" bevel siding or other material for roof
1 pc. 1" x 4" x 4" for coon or starling guard
3 - 1½" #10 round head wood screws
1¼" nails - roof and guard (galvanized or aluminum preferred)
1¾" - 2¼" nails (galvanized or aluminum preferred)
Water repellent wood preservative or penetrating exterior stain for finish

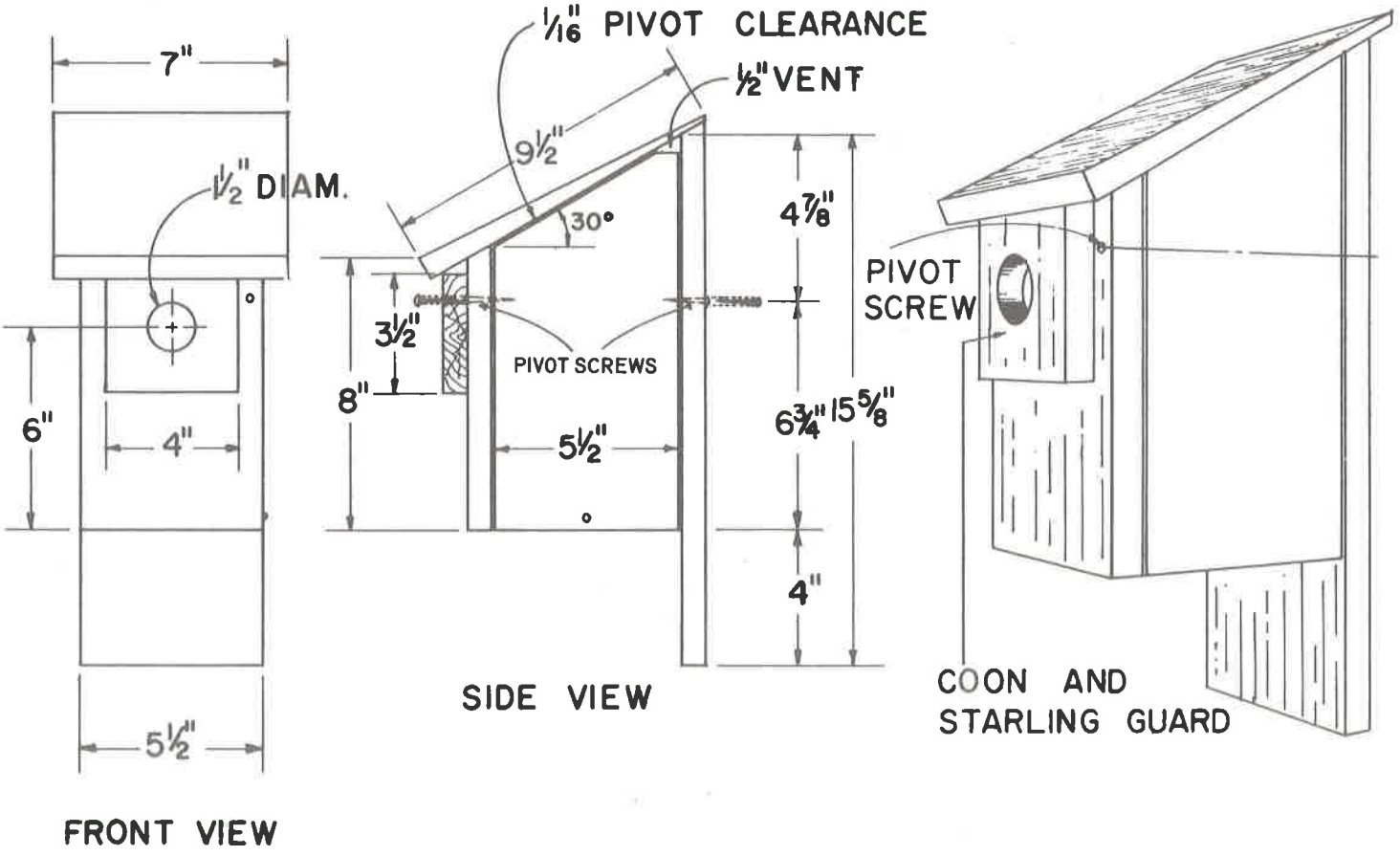
Construction Notes:

1. Drill ⅜" diameter drain hole in each corner of the bottom.
2. Note, one side of the house is hinged with two pivot screws for easy access for annual cleaning. Removal of the screw at the bottom of the side allows the top of the side to be pushed inward. The hinged side should be 1/16" shorter than the other side.
3. Drill holes in front and back pieces slightly larger than shank of pivot screws.

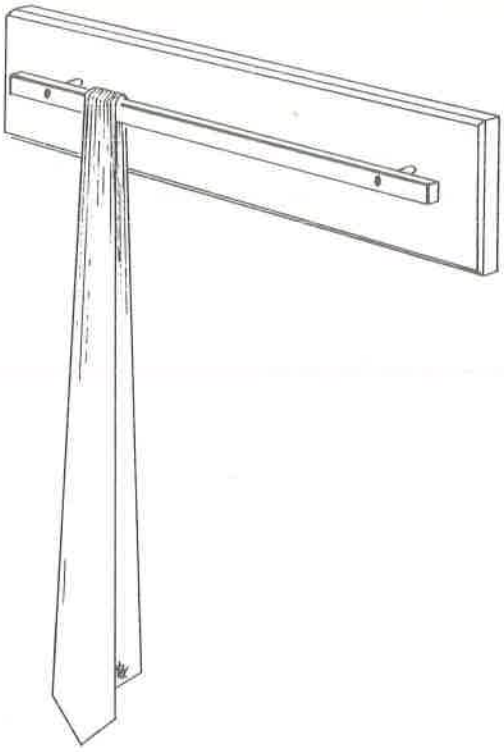
Mounting:

Attach to a tree or post 5' or 6' above ground with round head or lag screws through the bottom of the back piece.

HOUSE FOR WRENS, BLUEBIRDS, OR TREE SWALLOWS



Tie Rack



Material:

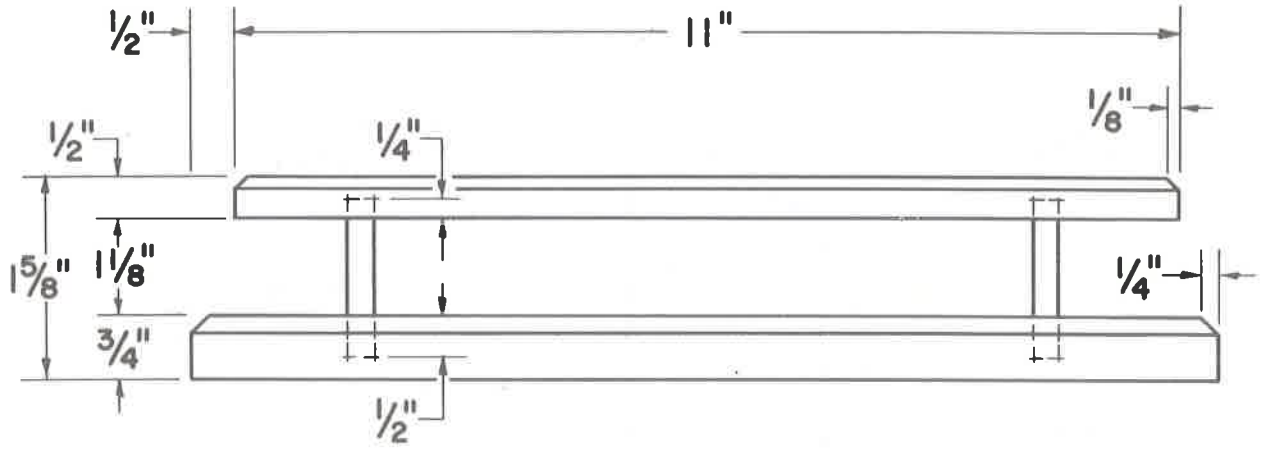
1 pc. 1" x 4" x 12" for back

2 pcs. ⅜" dowel 1⅞" long

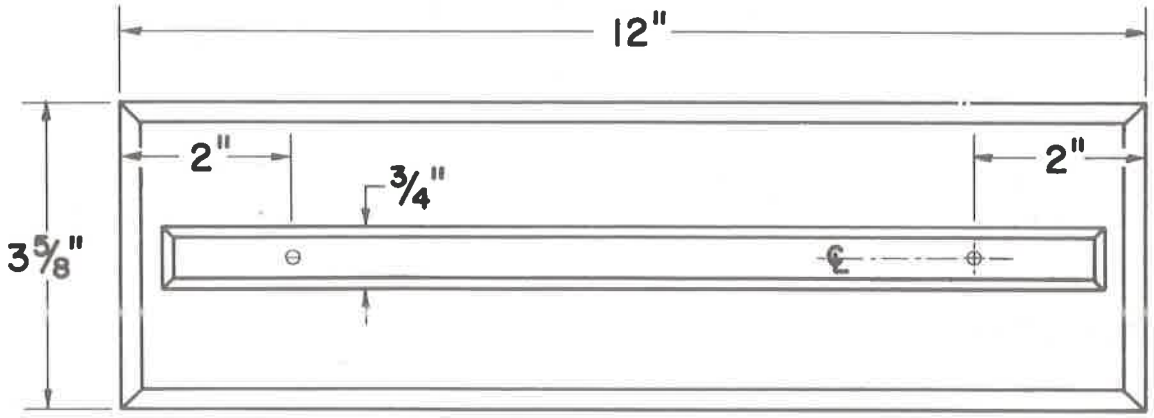
Glue if desired

Penetrating wood finish or other appropriate finish materials

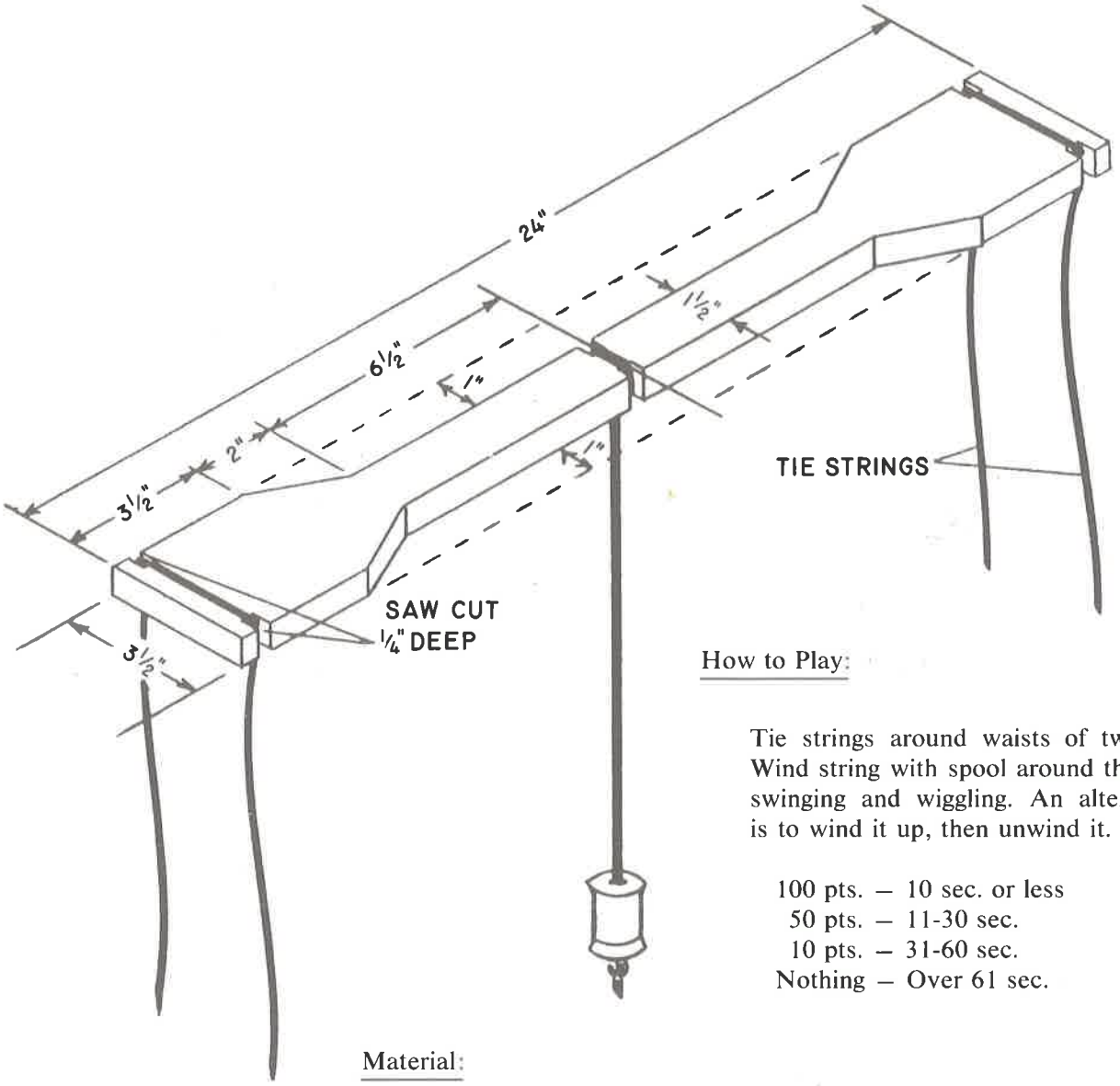
TOP VIEW



FRONT VIEW



Swiggle Stick



How to Play:

Tie strings around waists of two people. Wind string with spool around the stick by swinging and wiggling. An alternate play is to wind it up, then unwind it.

100 pts. – 10 sec. or less
50 pts. – 11-30 sec.
10 pts. – 31-60 sec.
Nothing – Over 61 sec.

Material:

1 pc. soft wood or plywood, ¼" to ¾" thick
1 spool, or small wood block, or old ball
4 pcs. of heavy string or cord 3 feet long for ties
1 pc. string 3 feet long to attach spool

Procedure:

1. Mark out on piece of material.
2. Cut out.
3. Make a cut with the saw ¼" deep on both edges at both ends and at the center. Tie the strings around the ends so they fit in the cut made by the saw. First tie one so that the knot is on one edge, then the other so it is on the opposite edge.
4. Tie another string at the notches at the center and attach a spool.


WOODWORKING
PROGRAM

Out of print - reference only

Members' Manual

UNIT 3

BUILDING BIGGER THINGS

4-H Engineering Woodworking Program

Table of Contents

Acknowledgment

This educational material has been prepared for use in connection with official 4-H projects by the National 4-H Engineering Woodworking Development Committee. The development committee of Cooperative Extension Service personnel included – Chairman Robert O. Gilden and Dr. Kemp L. Swiney of the Extension Service, USDA; J. M. Nicholls, University of Wyoming; Dr. Glenn Barquest, University of Wisconsin; Edward L. Palmer, University of Connecticut; Dr. Paul Crawford, University of Georgia; and E. A. Olson, University of Nebraska.

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A Look Ahead

Introduction

This is your book for the third unit of the 4-H Engineering Woodworking Program. It contains information on types of wood, additional woodworking tools and drawings for articles. Your leader and parents may have ideas for other things. It is important to make articles useful to you or other members of your family. Next year you will receive another book with more information and drawings. However, you should keep this book and the books of previous years for reference material.

Your woodworking project leader may ask you to come to his home or shop to do some of your project-work or you may have to do it all at home. You will enjoy the project more if you have a work area in the shop, basement or garage. Be sure to provide storage of some kind for your woodworking tools. The tools described in Units One and Two will make a good start on a tool set.

Work Safely

1. Review the safety rules in Units One and Two.
2. Have your leader or parents destroy the rags or cloths you use to apply wood finish. Rags containing wood finishing oils may start burning by spontaneous combustion.
3. Read the labels on the glue, wood finish and paint or varnish remover containers. Some list precautions about inhaling vapors and prolonged contact with the skin.

Materials

You may use lumber, plywood, building fiber-boards and particle boards in your project work.

Ask your parents or leader to help you select the right material.

use dry lumber

Make sure your lumber is dry before you start working with it. Wet or green lumber may warp, twist and crack as it dries. You can decrease the amount of warping by stacking the lumber above ground on a frame that is level with other heavy pieces on top of it. Extra drying is especially important if the articles you make will be used indoors.

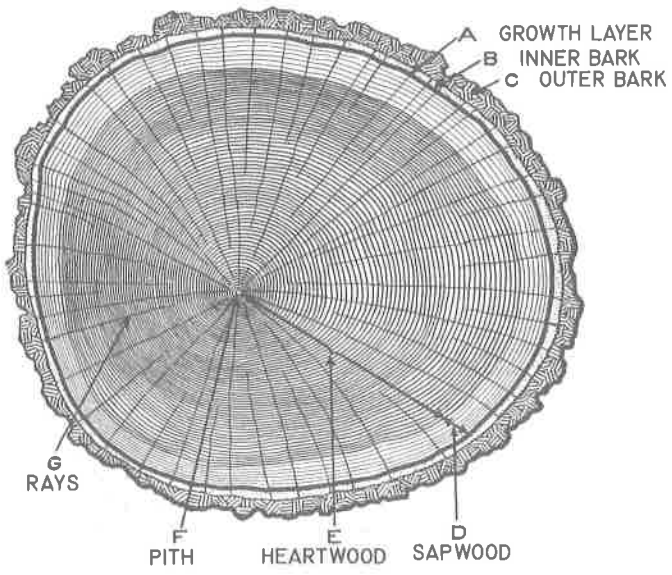
Lumber freshly sawed from logs must dry all summer to be ready for outdoor use. This is called air-dried lumber. Lumber for outdoor use can be stored in the garage, or other building.

Lumber you use for indoor articles should be drier. Place air-dried lumber in a heated room of the house for two or three weeks in the winter. Place it in a ventilated attic for one to three weeks in the summer. In hot dry weather, one week will probably be enough. Keep it there three weeks in cool, damp weather.

If your attic is not ventilated or too hard to get the lumber into, put the lumber up close to the roof boards of the garage for the extra heat for better drying.

Structure of Wood

When people talk about trees and lumber, they often speak of bark, heartwood and annual rings. Let's look at a picture to learn the meaning of these words.



When looking at the end of a log or the top of a tree stump, you will notice light and dark circles. The circles are annual rings or the amount of growth for each year. The light ring was formed in the spring of the year when the tree was growing rapidly. The darker ring was formed when the tree was growing slower in the summer. One light colored ring and one dark colored ring show how much the tree grew in one year. You can tell the age of a tree by counting the rings on the log or stump.

A *Growth layer* (cambium) is a thin layer in which all the growth of wood and bark takes place. It is located between the sapwood and bark. This layer is so thin you need a miscroscope to see it.

B *Inner bark* is soft and moist. It carries food from the leaves to all growing parts of the tree. Years ago boys used to chew the inner bark of slippery elm as gum.

C *Outer bark* consists of dry dead cells. It protects the growing areas from outside injuries.

D *Sapwood,* or outer layer of wood next to the bark, is usually lighter colored than the rest of the wood. The sapwood contains living cells and acts as a storehouse for the tree's food.

E *Heartwood* is generally darker in color than sapwood. Early in the life of the tree it was sapwood, too. But as the tree grew the cells of the inner layers of sapwood died and turned into heartwood. Heartwood is strong and helps hold up the weight of the tree.

F *Pith* is a soft center in the tree. It may be round, oval, three cornered or star shaped. It is usually less than ¼" across. It is the soft tissue about which the first wood growth takes place in newly formed twigs.

G *Rays* are strips of cells extending from the center of the tree to the bark. They carry sap across the grain of the tree. In some woods the rays are extremely small, and in others very large.

Resin is the sticky reddish-brown gum that some times oozes from wet lumber. It was sap which is now becoming dry and hard.

Kinds of Wood

Wood is probably the most commonly used building material in the world today. When our forefathers landed in America the whole continent was nearly covered with virgin forests. But, unwise logging and the destruction by insects, fires and storms have removed many of these forests.

Now second-growth forests are being grown as a tree crop in many areas. They will help furnish our wood in the future.

Hardwood and Softwood

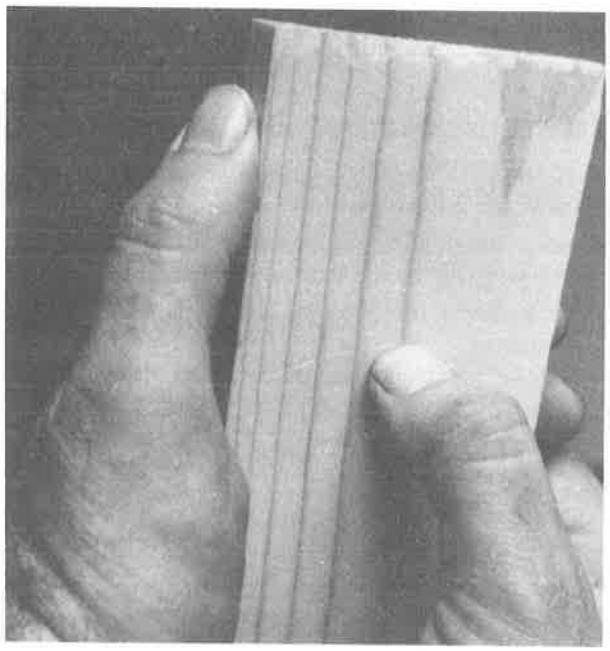
When people talk about kinds of wood, they usually mention hardwood and softwood. These terms also provide the basis for classification of all woods. As such they do not actually indicate the hardness or softness of the wood.

The softwood (coniferous) group includes trees that have needle-like or scale-like leaves and produce seed in some kind of a cone. Examples of such trees are the pine, tamarack, cedar and fir.

The hardwood (deciduous) group includes the trees that have broad leaves such as the oaks, maples and basswood. The name has no reference to the hardness of the wood.

You can easily tell the trees apart when the leaves are visible. But, it is more difficult to tell the kind of wood when working with a piece of lumber.

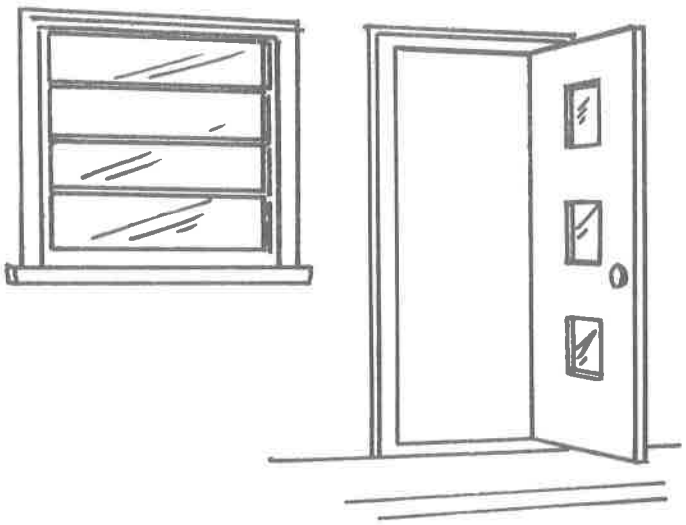
Often a thumbnail test is used to separate the hardwoods and softwoods. Push down hard with your thumbnail and pull it across the grain of a smooth piece of wood.



Running the thumbnail across the grain of the wood

The alternate layers of soft spring wood and hard summer wood of most softwoods will give a bumpy feeling to your fingernail. It will remind you of riding your bicycle across railroad ties. Your thumbnail will glide smoothly across the grain of the hardwood like riding your bicycle on smooth pavement. Try separating pieces of wood into hardwood and softwood groups.

The following are short descriptions of some of the woods available.



White Pine - A Softwood

White pine is the nicest wood for you to use, but it is rather expensive. It is easily worked with sharp tools. It doesn't split easily and is lightweight and soft.

The wood is cream-colored to light reddish-brown.

White pine is more in demand for carpentry and building than any other kind of wood. The best of this wood is used for building siding, paneling, exterior and interior building trim, sash and doors, cabinet work and foundry patterns. It is even preferred for wooden matches because the wood burns evenly and without sputtering.

Because of its general all-around usefulness, the lumber industry of this country was founded on this tree. The eastern white pine, western white pine and sugar pine are included in the white pine group.

Red Pine — A Softwood

Red pine, commonly called Norway pine, is a good second-choice wood for you to use. It is a little heavier and harder than white pine. It splits easier. It is darker in color and more resinous.

Red pine is often used for the same purposes as white pine. It is used as siding, flooring, general millwork and construction lumber. It is also used for piling, poles, pulpwood and cabin logs.

Red pine grows in the New England and lake states regions. It is a very important tree in the reforestation program, because it can grow on poor soil and has few natural enemies.

Ponderosa Pine — A Softwood

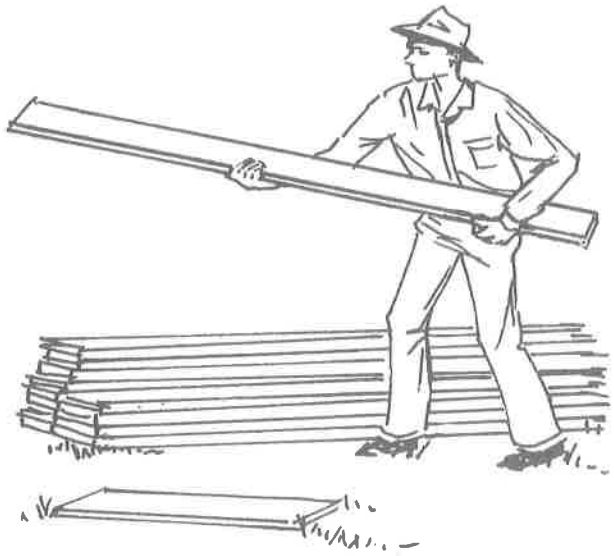
Ponderosa pine is also a good choice wood. It is a little harder to work than white pine, but a little easier than red pine. It is available at most lumber yards. Ponderosa pine grows in the western United States.

Spruce — A Softwood

Spruce wood is another wood which is rather easy to work with. It is light, soft, straight grained and non-resinous, but decays easily.

This group includes the eastern or Great Lakes' white and black spruces, the red spruce of New England and the Appalachian mountains. Sitka spruce from the northwestern part of the United States and Engelmann spruce from the high Rocky Mountains are also included.

Spruce is used principally for pulpwood, general construction lumber and box lumber.

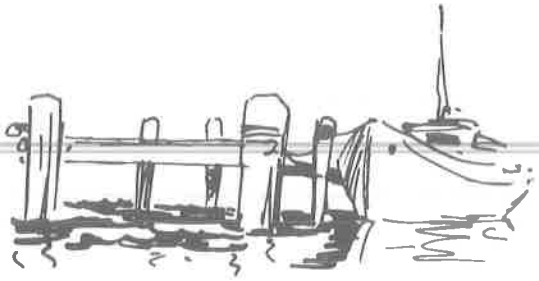


Jack Pine — A Softwood

Jack pine lumber has a rather coarse texture and is generally knotty. It is cream to pale orange-brown in color, hard and somewhat resinous. It is more apt to split from nailing than red or white pine.

Jack pine is used principally for pulpwood, poles, piling and lumber.

It grows in the lake states region and a large part of Canada. This tree matures in about 60 years. It can not grow in dense shade but grows well in the sun. It can grow on poor, sandy soils. It is a heavy seed producer. Because of these characteristics, it has seeded itself in thousands of acres of cut-over and burned forest land.

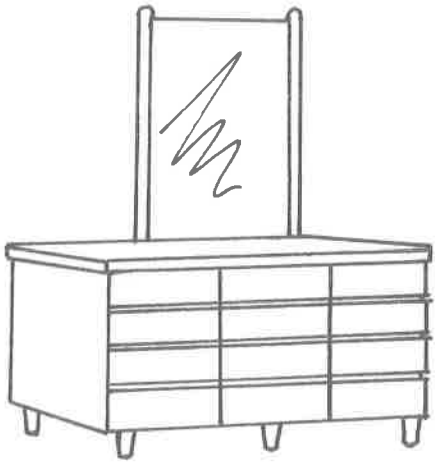


Southern Yellow Pine — A Softwood

Ten species of pine growing in southeastern United States are referred to as yellow pine. Only four of these are important. Longleaf and slash pines are generally heavy, hard and resinous. They are the major source of our resins and turpentine. Shortleaf and loblolly pine are generally light, soft and only moderately resinous.

The yellow pine wood is characterized by a dark summerwood band in the annual ring. The wood color varies from yellow-orange to reddish-brown. Yellow pine has a tendency to split during nailing.

The wood of yellow pine is used in heavy structures such as bridges, warves, docks and ship frames. It is also used for construction and box lumber, poles, piling, veneer and pulpwood.



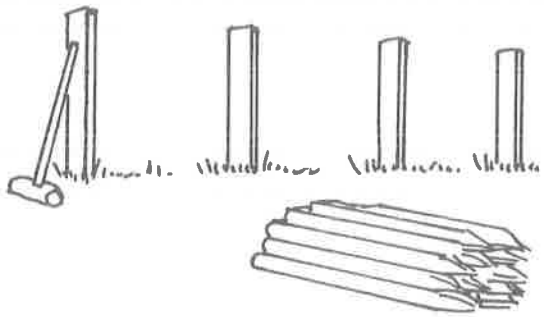
Douglas-fir — A Softwood

Douglas-fir is strong, moderately hard and heavy, and very stiff. It is rather difficult to work with using hand tools because it splits easily. Probably your first use of Douglas-fir will be as plywood or 2"x6" material.

Douglas-fir is used for structural timbers, piling, plywood, lumber, furniture and pulpwood.

The sapwood is white and the freshly cut heartwood is light reddish-yellow in color. Exposure to light and air changes the heartwood to a reddish color and sometimes to cherry-red or reddish-brown. Most Douglas-fir has a distinct odor.

Douglas-fir is one of the largest and most important trees native to North America. Some trees have been found to be 1,000 years old, 300 feet tall and 10 feet in diameter. They grown in western United States and Canada.



Aspen (Quaking and Big Tooth) and Cottonwood — Hardwoods

The aspens grow in northern United States and Canada. The cottonwoods grow in the eastern and north western United States. The cottonwoods usually grow in areas that are warmer than the areas where aspens are common. The heartwood of the aspens and cottonwood is grayish white to light grayish brown. The sapwood is slightly lighter in color. The wood is light in weight, weak, soft and generally straight grained. The aspens have a strong odor prior to seasoning. Aspen and cottonwood lumber when sawed has a wooly or fuzzy surface. When finished it has a silky luster.

These species are used principally for paper pulp, lumber and excelsior. The lumber or veneer goes largely into the manufacture of boxes and crates. Considerable amounts, however, are used in the manufacture of low cost furniture.

Red Oak — A Hardwood

Red oak is hard, coarse, porous, strong and heavy. Large open pores between the annual ring and the broad rays make this an attractive wood.

The heartwood is light red in color.

Red oak is used for furniture, interior trim, all types of cabinet and millwork, veneer, lumber, railroad ties and fence posts.

Some kinds of red oak grow in all the wooded areas of the United States. Old growth wood is softer, more easily worked and takes a better finish than second growth timber.

White Oak — A Hardwood

White oak is strong, tough and rather easy to work.

White oak is grayish brown, with a reddish tinge and, like red oak, has open grain. The rays running out from the center of the log are very distinct. Because the pores in annual rings are plugged with deposits, white oak can be used for barrels.

White oak is used for interior trim, cabinet work, furniture, flooring, untreated fence posts, railroad ties and heavy construction timbers.

Redwood — A Softwood

The heartwood of redwood varies in color from light cherry red to dark mahogany red. The sapwood is almost white. Redwood is light in weight, fairly strong.

The wood is easy to work, and generally straight-grained. However, you must be careful when nailing or using screws because it splits easily.

The heartwood is very resistant to decay and holds paint well. Because of these characteristics it is used a great deal for outdoor furniture, flower boxes, picket fences, water tanks, shingles, siding, etc.

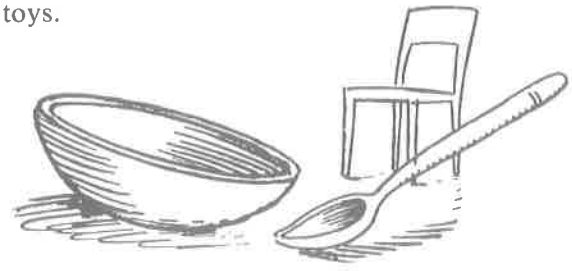
Redwood grows only in the extreme western part of the United States. It grows to enormous size. It is one of the largest growing trees known.

Birch — A Hardwood

Yellow birch has white sapwood and light reddish-brown heartwood. It is fine and uniform in texture, heavy, hard and strong. It is used for both lumber and veneer for plywood. Birch shrinks considerably in drying, works well and takes a good finish. It takes a good natural finish as well as a good stained finish, and is often stained to imitate mahogany and walnut.

Birch lumber and veneer are used in the manufacture of furniture, doors, interior finish, woodenware, boxes and baskets.

White birch is used for turned products such as spools, and toys.



Maple — A Hardwood

Maple is generally divided into two main groups: hard and soft maple. The most common hard maple is sugar maple. Its sap is used for making maple syrup and maple sugar. Soft maple is of lesser importance. Red maple and silver maple trees are classed as soft maples.

The wood of hard maple is light brown to white in color, the heartwood is the darker color. Maple is either straight or curly-grained. When hard maple contains a figure, it is called bird's eye, landscape or curly maple. It is capable of taking a high polish because of the fine, uniform texture. Although it is hard and not easy to work, it can be brought to a good surface and will turn well on a lathe.

Besides being used in millwork products such as flooring and fine interior trim, its wood is used extensively for veneering, furniture, cutting boards, musical instruments, woodenware, tool handles, ships, bowling pins, athletic equipment and school apparatus.

Walnut — A Hardwood

Black walnut, the ideal American cabinet wood, is noted for its rich color, durability and beauty. It grows mainly in the eastern half of the United States and requires a deep, rich soil. Stump and burl walnut are very valuable for veneers and panel work.

The heartwood of black walnut is rich chocolate brown. It does not warp or check when properly seasoned. The wood is heavy, brittle, hard, strong and coarse grained. The sapwood is pale brown and must be artificially darkened to match the heartwood. Walnut is used in fine furniture, cabinets, interior trim, gun stocks, musical instruments, fine boats and many other articles.

Butternut — A Hardwood

Butternut is a close relative of black walnut. The wood resembles black walnut in texture, but is lighter in color and weight, and is not as strong or hard as black walnut. The heartwood is a light chestnut brown and occasionally has a reddish tinge. The narrow sapwood varies in color from white to light brown. Butternut is very easily worked. It is used chiefly in the manufacture of furniture and for interior trim.

Black Cherry — A Hardwood

Black cherry is often called cherry, wild black cherry, wild cherry or choke cherry. It grows throughout the eastern half of the United States.

The heartwood varies in color from light to dark reddish brown; the sapwood is nearly white. Black cherry is strong, stiff and moderately heavy and hard.

Cherry is used principally for furniture, woodenware novelties and hardwood veneer for paneling, etc.

Western Redcedar — A Softwood

Western redcedar grows along the Pacific Coast of the United States and Canada. The heartwood is reddish brown in color and has the characteristic odor of cedar shingles.

The wood is light in weight, moderately soft, generally straight-grained, but has a rather coarse texture. The heartwood is very resistant to decay.

Western redcedar is used principally for shingles, exterior siding and lumber for greenhouse construction, ship and boat building. It is also used for posts, piling and poles.

Eastern Redcedar — A Softwood

Eastern redcedar is in the eastern half of the United States except in Maine and Florida. The heartwood ranges in color from dull to bright red, and the sapwood is nearly white. The wood is fairly heavy, and the heartwood is very resistant to decay. It is fine and uniform in texture.

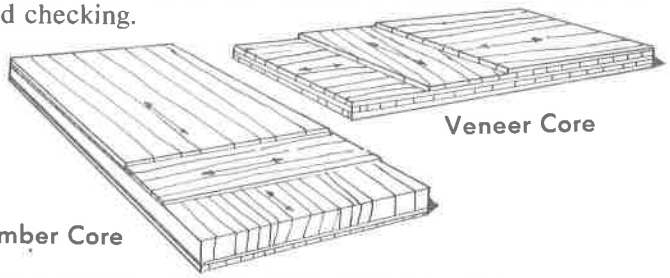
Eastern redcedar lumber is used in the manufacture of chests, closet linings, pencils and small boats.

Plywood

Thin layers or sheets of wood called veneer are used in the manufacture of plywood. The veneer is made by sawing or slicing these thin layers from a log or bolt. The veneer can be cut into almost any thickness. The most common veneers are 1/32 to 3/16 of an inch thick.

Plywood is made by gluing three, five or any odd number of layers together. The grain of the outer layers go in the same direction. The grain of each layer goes at right angles to the adjoining layer.

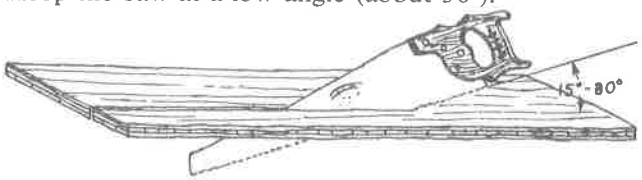
The alternating grain directions tend to reduce warping, shrinking and expanding of the plywood due to moisture change, and creates a resistance to splitting and checking.



The various veneer plies 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. In five ply construction, the plies between the core and the outer plies are called crossbands.

Different glues are used in plywoods manufactured for use indoors than in those made for outdoor use. Therefore, select exterior grade plywood for articles that will be used outdoors.

Always use a fine tooth saw for cutting plywood. To cut plywood with a handsaw, have the good side or face up. Keep the saw at a low angle (about 30°).



For Indoor Use

A-D
GROUP 1
INTERIOR
PS 1-66
TESTED DFPA QUALITY
000

For Outdoor Use

A-C
GROUP 2
EXTERIOR
PS 1-66
TESTED DFPA QUALITY
000

The registered American Plywood Association grade-trademarks shown here identify quality-tested plywood. Look for them on every panel you buy.

Particle and Fiberboard

Many materials are included in this group and are Known by various trade names.

Rigid Insulation Board

The lightest and softest of the group are the rigid insulation boards. They may be used as insulating ceiling or interior wall materials, sheathing and lathe for plaster base. You may use some of this material for bulletin board material or a backboard for a dart game.

Hardboards

The fibrous hardboards (such as masonite or the equivalent) are much harder and heavier than insulation boards. They are usually available in sheets 1/8 to 5/16 inch thick.

Hardboard may often be used as you would thin plywood. However, with moisture change it will expand and contract more than plywood. You may want to use it for sides of small boxes, drawer dividers, platter files, etc.

Some hardboards are given an additional treatment with drying oils and then baked in an oven. This is called treated or tempered hardboard. The treatment increases strength and water resistance. Therefore, use the treated or tempered hardboard if your product will be used outdoors.

Particle or Chipboards

Particle or chipboards are formed by bonding wood particles or chips into a solid sheet. The resulting boards take paint and stain finishes well and can be cut and glued as other woods. They may be used in place of plywood in many jobs. However, it is important to remember they shrink and swell more than plywood when the moisture content changes. The humidity difference in the air between summer and winter may cause moisture change in articles in the home during the year.

Board Measure

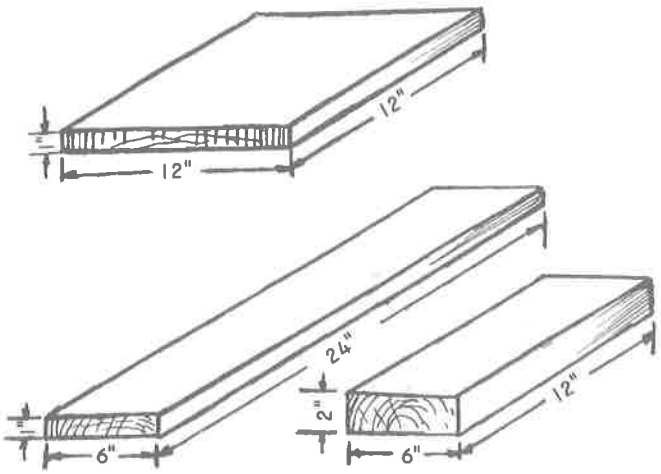
Lumber commonly cut and sold as boards and plank is rough-sawed to nominal size, and dressed to actual size. It is sold by the board foot in either nominal size or dressed form.

For example one inch pine board eight inches wide is cut approximately 1" x 8" at the saw mill. This is called its nominal dimension. As it dries, it shrinks in both width and thickness. When it is planed or surfaced on all four sides with a planer or milling machine, the size is further reduced.

Dried, it is about 3/4" thick and 7 1/4" wide. This is called the actual dimension. Two inch nominal material such as two-by-fours and two-by-sixes are usually dressed to 1 1/2" thick. The 2" x 6" is usually 5 1/2" wide.

When you buy standard dimension lumber the nominal dimension size is used in figuring board feet. For example: A board foot is a piece 1 inch thick, 12 inches wide, and 12 inches long or its equivalent. This would be the nominal dimension, but dressed it would be about 3/4" thick, 11 1/4" wide and a foot long.

Each of the following illustrations contain one board foot or 144 cubic inches on the basis of nominal dimensions.



Two simple formulas are used in figuring board feet. The first is used when the length is given in feet:

$$\frac{\text{T" (Thickness)xW" (Width)xL' (LENGTH)=Board feet}}{12}$$

When the length is given in inches the following formula is used:

$$\frac{\text{T" (Thickness)xW" (Width)xL" (Length)=Board feet}}{144}$$

Either of these formulas can be used. Remember to divide by 12 if the length is given in feet, or divide by 144 if the length is given in inches.

To find out what a piece of pine lumber 1" x 6" x 8' would cost, first determine the board feet. Then multiply this times the cost. Let's try it at $300 per thousand board feet, which is often written $300 per M. This is the same as 30 cents per board foot.

$$\frac{T" \times W" \times L' = \text{Board feet}}{12}$$

$$\frac{1" \times 6" \times 8' = 4 \text{ Board feet}}{12}$$

4 board feet x 30¢ per foot = $1.20

Can you figure out the board feet in a 1" x 8" x 12'; a 2" x 4" x 8'; and a 2" x 6" x 10'?

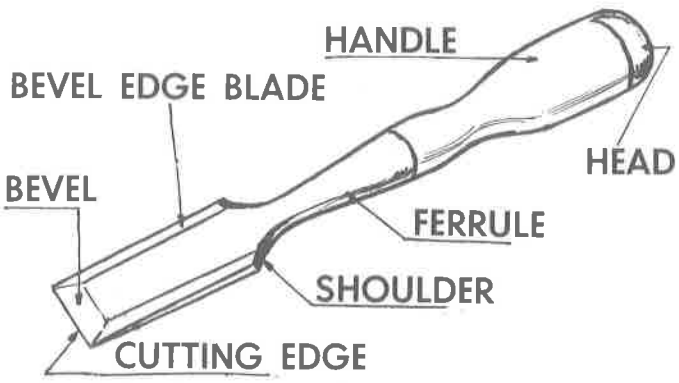
Moldings are usually sold by the lineal or running foot. Plywood, insulation board and hardboard are usually sold by the square foot.

Some lumber yards now sell dimension lumber by the lineal or running foot.

Your Tools

You were encouraged in Unit I, Adventures In Woodworking, to start a tool set of your own. Unit II gave you information on the use and care of more tools and equipment. This unit will explain how to use and care for additional tools, which you may like to add to your set.

Wood Chisel

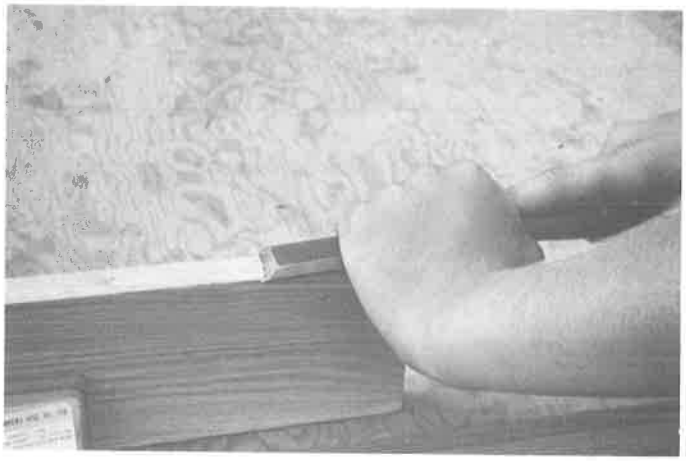


Wood chisels are made in various widths of blade, ranging from 1/8" to 2 inches.

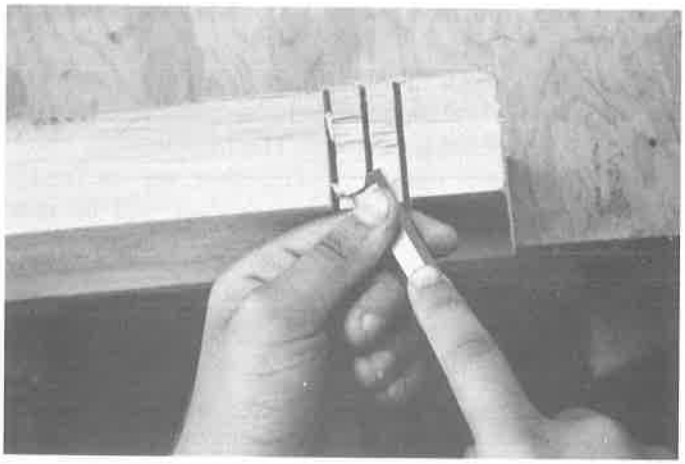
There are also several different types of chisels available at various prices. All except the thin blade paring chisels are built so they can be pounded for rough cutting. When pounding a chisel head, it is advisable to use a wood, rubber, rawhide or plastic mallet.

Using Your Wood Chisel

A right handed person will guide the chisel with the left hand and apply the moving power with the right. Always push the chisel away from you, keeping both hands behind the cutting edge.

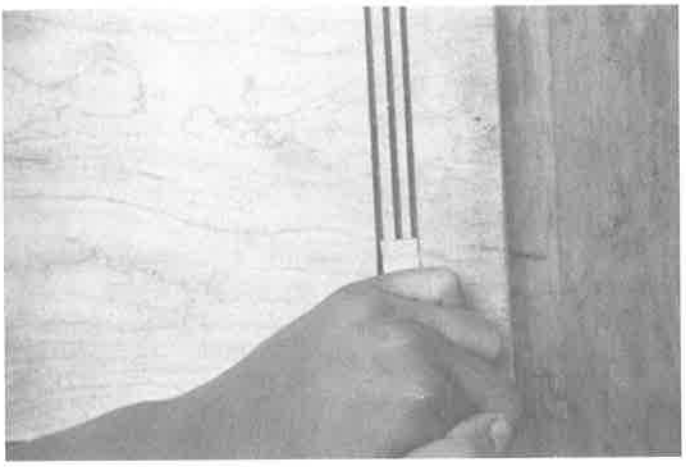


To cut with the grain, hold the chisel slightly turned to one side and push away from you. Hold with the bevel up for a fine cut and with the bevel down for a rough heavy cut.

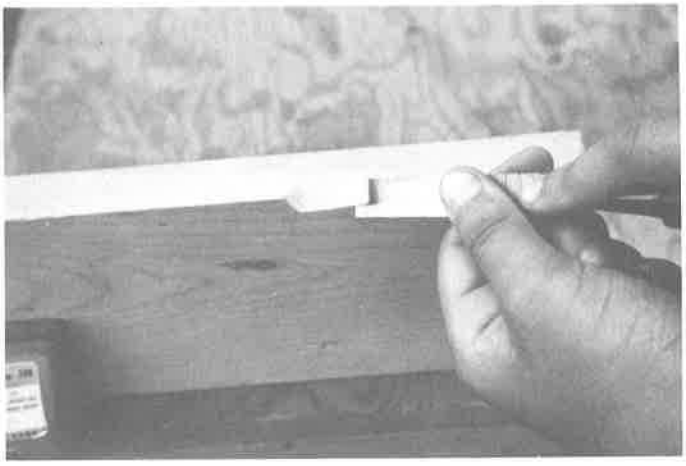


To cut across the grain of the wood, grasp the blade of the chisel between the thumb and the first two fingers of the left hand, to guide it and to act as a brake, while the pushing is done with the right hand.

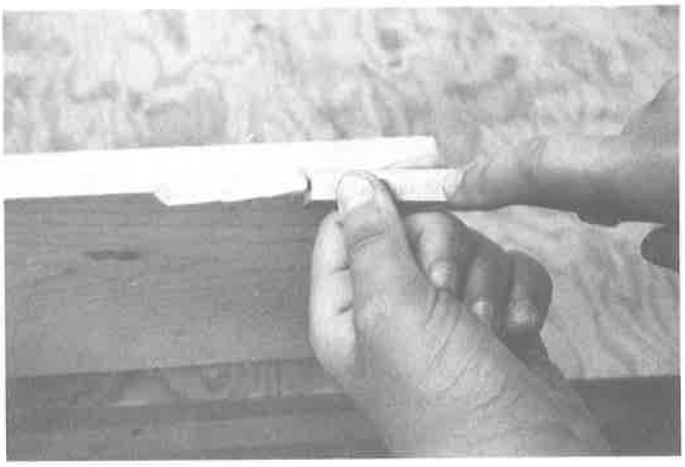
To avoid splintering the corners, cut from each edge toward the center. Remove the center portion last.



For chiseling across wide boards, hold the chisel bevel down for finger room.



To cut a chamfer, hold the handle slightly to one side, or move it back and forth slightly, as the chisel is pushed

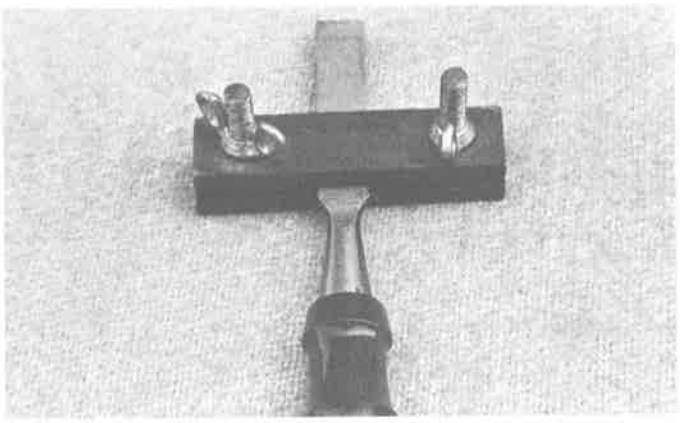


forward. This gives a sliding or slanting cutting action, which makes the chisel cut better and easier.

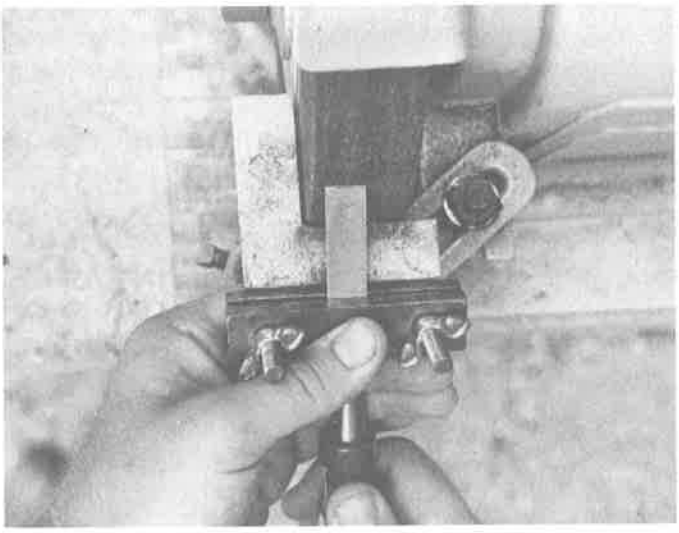
Sharpening the Wood Chisel and Plane Iron

Wood chisels and plane irons are whetted on the oil stone to give a very sharp cutting edge. When the cutting edge is nicked or the angle is incorrect, it is time to grind it. A grind stone is desired for this, but a fine grit emery wheel can be used. In either case, the grinding wheel should turn toward the chisel. The chisel or plane iron should be frequently dipped in water to prevent overheating.

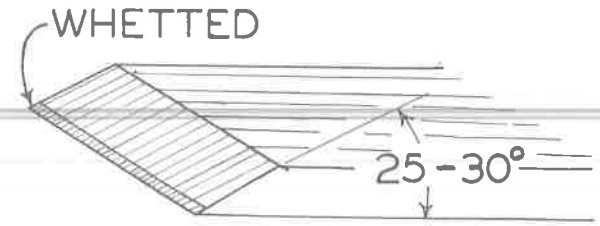
The cutting edge should be straight and square with the sides of chisel or plane iron. You may desire a clamp to grip the chisel and rest against the grinder guide for accurate positioning.



A clamp to hold the chisel or plane iron for grinding.



Chisel in position on grinder. Guide must be parallel to edge of wheel. Move chisel or plane iron across the face of the wheel from side to side. Caution: wear goggles unless the wheel is guarded with eye shields.



Both the plane iron and wood chisel should be ground to a 25° or 30° angle. This makes the bevel a little longer than twice the thickness of the chisel.

A bevel too short and thick will not enter the wood easily. A bevel too long and thin is weak and will nick easily.

After proper grinding, whet the chisel or plane iron on the oil stone for a very sharp cutting edge.

Apply enough oil to the stone surface to keep it moist. The oil prevents particles of steel from filling the pores of the stone. When the pores are filled, the stone does not cut well. Wipe off the oil before putting the stone away.

Place the chisel or plane iron on the fine grit oil stone With bevel flat on the surface. Raise handle slightly 5° or less, so you whet only the forward part of the bevel.

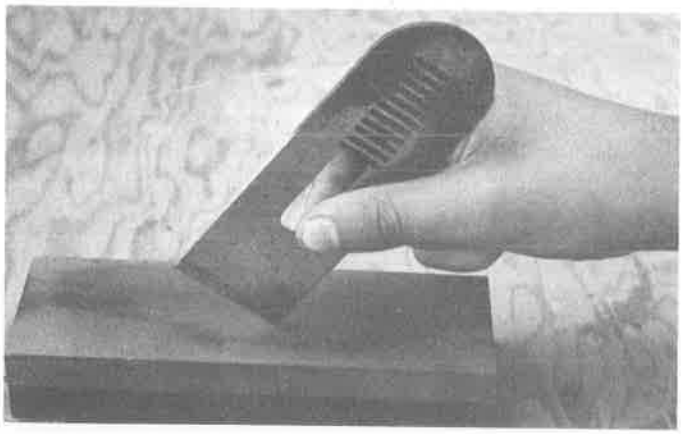
Move the chisel or plane iron with a circular motion back and forth lengthwise on the oil stone several times. The circular motion permits you to use the entire top of the stone so it wears evenly.

After whetting the bevel edge on the oil stone, remove the wire or feather edge. Turn the chisel over and hold the flat side flat on the oil stone. Move the chisel back and forth a couple of times in this position.

Now look at the cutting edge. If you see a nick or a shiny edge of bluntness, whet both sides again. Make a small cut in a piece of wood before taking a final look.

Use will dull the cutting edge. When it becomes dull, sharpen by whetting as described. The whetting process can be repeated until the bevel becomes too short and thick. Then, grind for the correct angle.

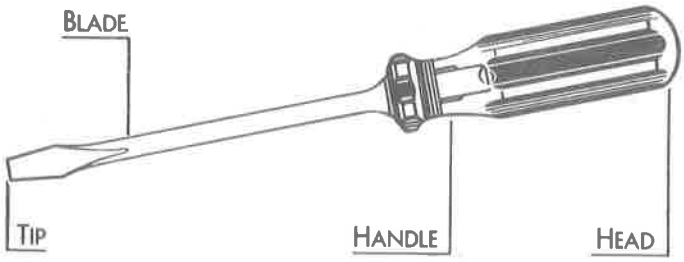
Plane marks will show less on a finished surface if the corners of the plane iron are slightly rounded. This can be accomplished by additional honing at the edges or just stroking the corner in a circular motion as illustrated.



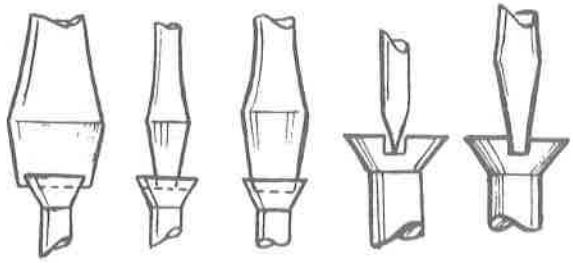
Screwdrivers

Grinding Your Worn Screwdriver

Screwdrivers are available in a large variety of sizes and shapes. The tip is usually in good condition when the screwdriver is new.



The screwdriver should fit the screw head slot as shown in the drawings below.



WRONG Too wide. Will damage wood.

WRONG Too narrow. Will damage screw.

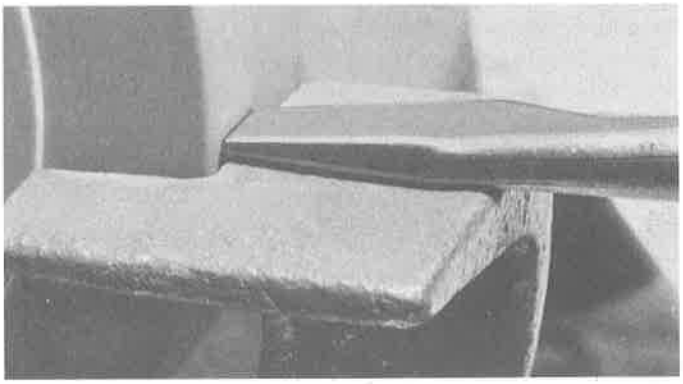
RIGHT Tip same width as slot.

WRONG Tip too sharp. May slip out.

RIGHT Sides of tip are parallel with sides of screw.

When the tip is too wide the wood around the screw will be damaged. A tip that is too narrow will slip out of the screw slot and damage the screw head. If the tip is worn to a sharp or chisel like shape it is very difficult to keep the screwdriver in the slot.

Therefore, it is often necessary to regrind the screwdriver tip. The following illustration shows the grinding action to blunt or square the tip.

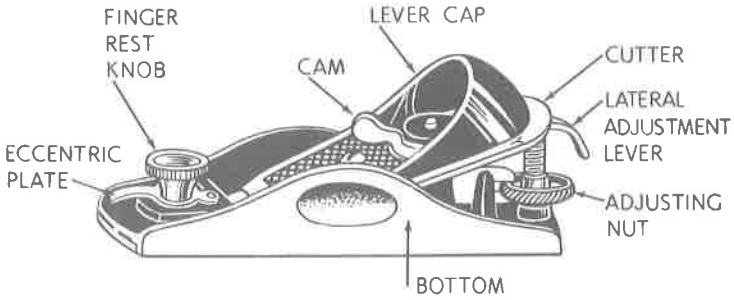


Planes

There are many different kinds of planes, the five most common ones will be discussed in this unit. These are the block, smooth, jack, fore and jointer planes.

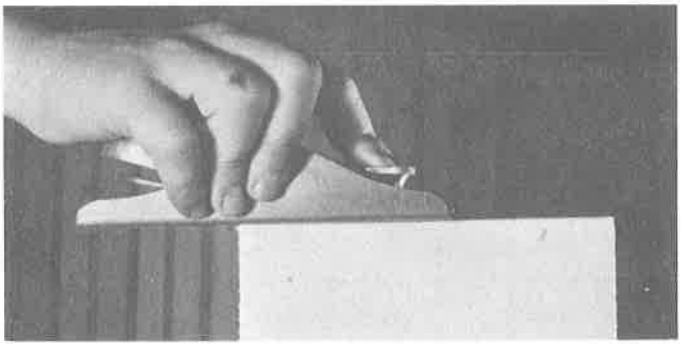
BLOCK PLANE

The block plane is the smallest and the most practical for the young woodworker. It is about six or seven inches long which makes it easy to hold and ideal for fine work and cutting across end grain. The plane iron or cutting blade is placed in the body of the plane, the bevel side up. Position the lever cap and tighten the lever cap screw.

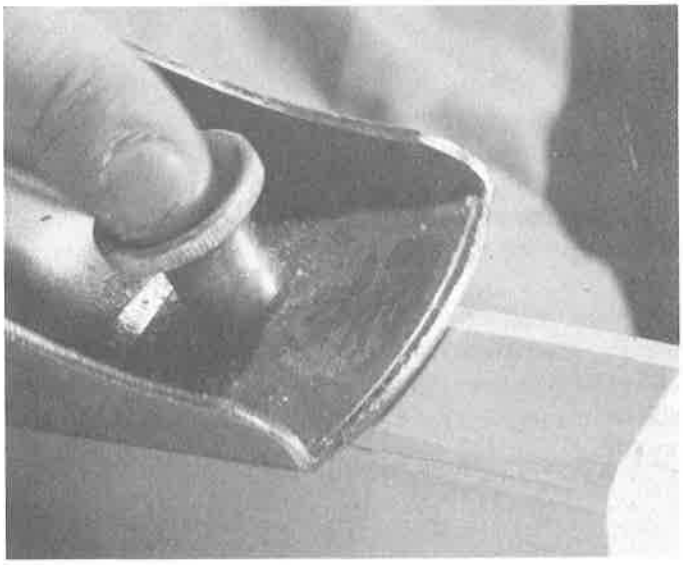


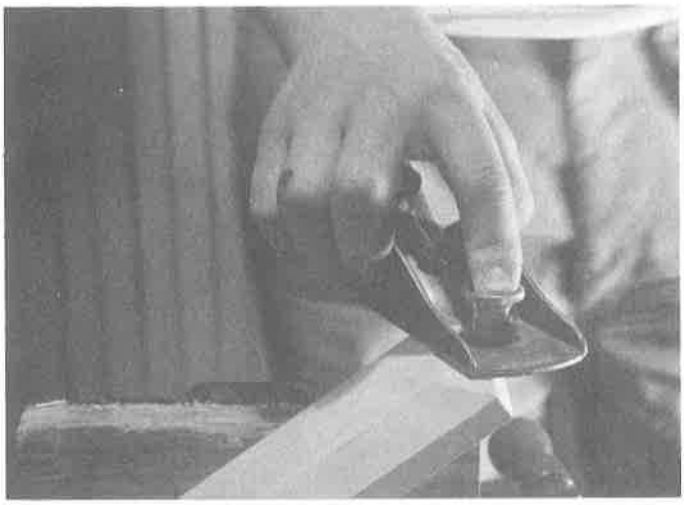
The block plane is used with the bevel side of the plane iron up.

The smooth, jack, fore and jointer planes have the blade assembled with the bevel down. They have a plane iron cap which most block planes do not have. They also have a higher blade angle than the block plane.

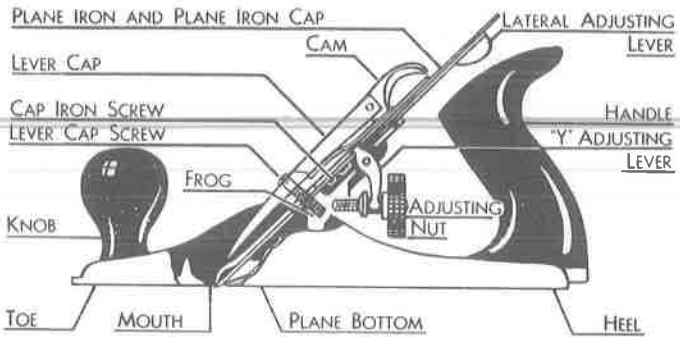


Because of the low angle, the block plane is used for fine work and end grain.





The block plane works well to cut chamfers and bevels.



SMOOTH PLANE

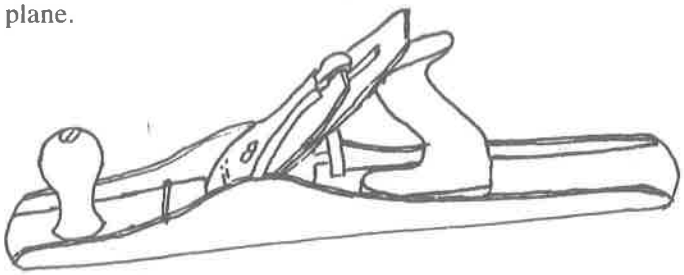
The preceding picture of a plane with the parts named is a smooth plane. Notice how the heel of the plane bottom ends at the handle. This is a characteristic of the smooth planes. The smooth planes are usually between 5 1/2" and 10" long.

It is a fine utility tool and works well for rough or preliminary planing as well as for planing end grain, chamfers and other edge shaping. However, if the board is long and a little wavy or irregular, the plane will smooth out all areas but not necessarily cut off the high spots. In other words, it will ride up and down on the irregularities like a small boat rides the crest and valley of a large wave.

A plane with a longer plane bottom, such as the jack, fore or jointer planes, will do less riding up and down on the irregularities and produce a truer surface. The top of high spots are cut off each time until the surface becomes straight.

JACK PLANE

The heel of the bottom of the jack, fore and jointer planes extend back beyond the handle. The jack planes vary in length, but are usually from 11" to 15" long. It is a fine utility tool. Because of its greater length it will true up irregular surfaces or edges better than the smooth plane.



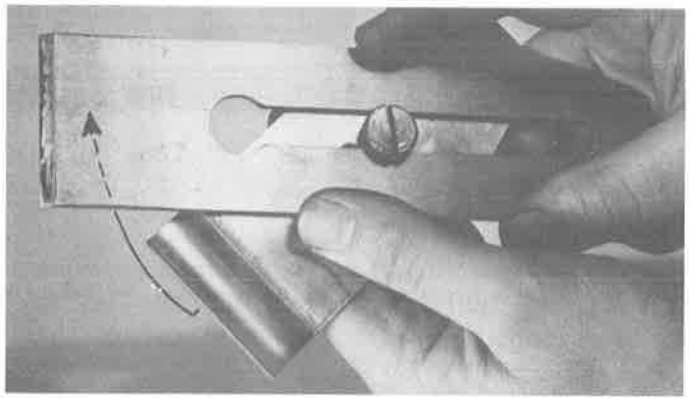
FORE PLANE AND JOINTER PLANE

The length of the plane bottoms of the fore and jointer planes are longer than the bottom of the jack plane. They are used predominantly to cut an edge or surface perfectly straight. The fore planes are usually about 18" long and the jointer plane 22" to 24".

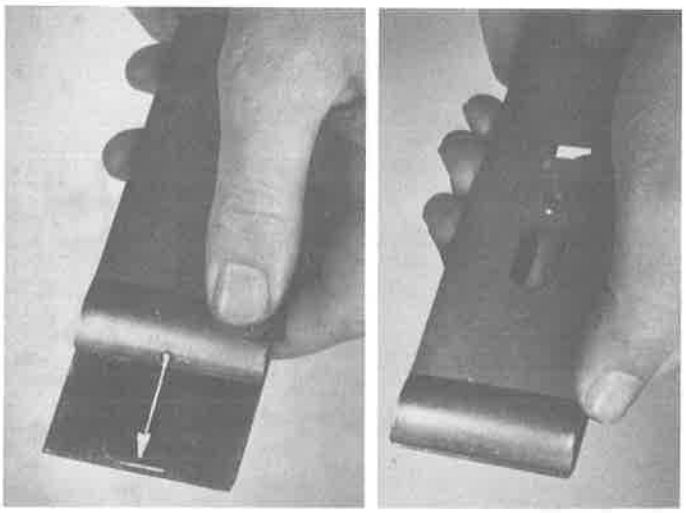
Assembling Your Other Planes

For satisfactory performance the plane iron must be sharp, properly assembled and adjusted. Plane iron and wood chisel sharpening was described earlier. Therefore, we will start with plane assembly. You will remember that when the block plane was assembled, the plane went together with the bevel up. The other 4 planes are different. They have a plane iron cap and the plane iron goes into the plane with the bevel down.

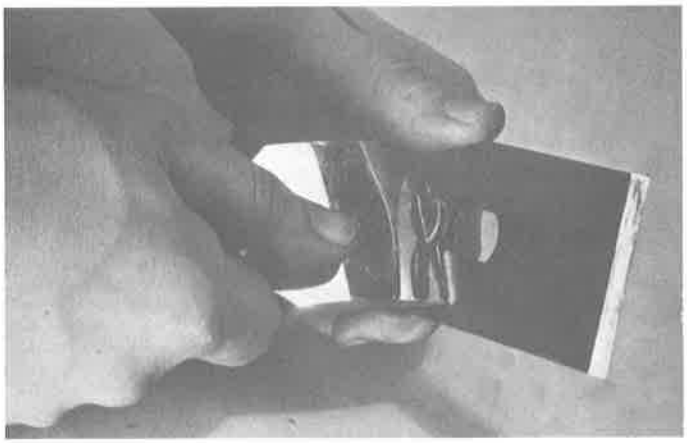
First, hold the plane iron cap crosswise with the plane iron. Slip the plane iron cap screw through the round hole in the plane iron. Slide it up the slot in the plane iron. Then rotate the plane iron cap so it is straight with the plane iron.



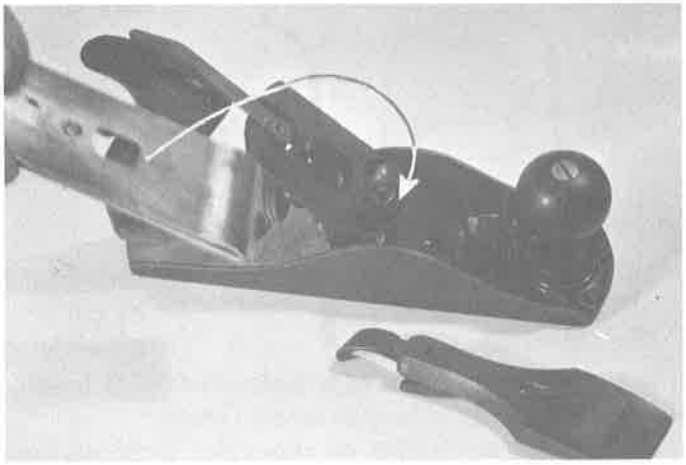
Move the plane iron cap forward to a position about 1/16 of an inch from the cutting edge. Be very careful, so the cap does not slip over the cutting edge. This would dull it.



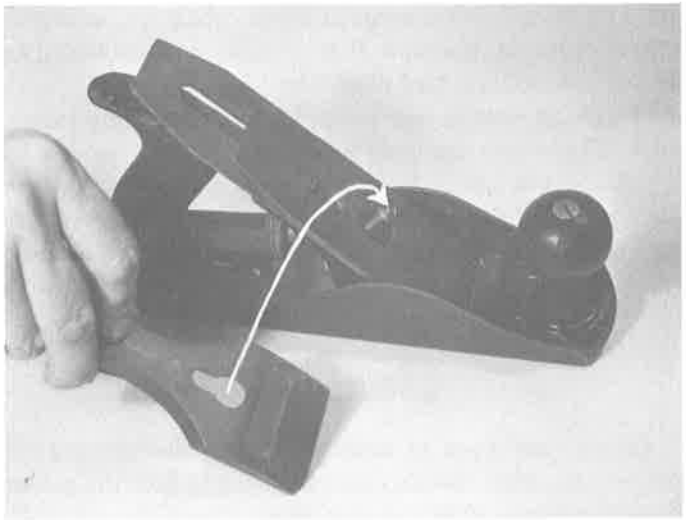
After making this adjustment use a screwdriver or lever cap to tighten the plane iron cap screw to hold the pieces together.



Carefully place the plane iron and plane iron cap, with the cap up, in position over the cap iron screw. Avoid striking the edge of the opening or mouth with the cutting edge of the plane iron.



Place the lever cap in position and lock in place with the plane iron cap cam. If it is too tight or too loose, loosen or tighten cap iron screw slightly.



Adjusting Your Planes

BLOCK PLANE

To check the adjustment, turn the plane upside down and sight along the bottom. The blade should project through evenly and just about the thickness of a sheet of paper.

Turn the adjusting knob clockwise to push the plane iron out. To pull the plane iron in, turn the knob to the left until the blade is in proper position. Then turn it clockwise until its starts to push the plane iron out. The plane iron will stay in the right place when the plane is used.

To adjust for an even blade, loosen the lever cap screw. Turn the plane over and sight along the bottom. Press the plane iron to the right or left until it is even. Tighten the lever cap screw.

SMOOTH, JACK, FORE and JOINTER PLANES

The information given pertaining to the block plane also applies to these planes. However, these planes have a lateral adjustment lever which makes for an easier even blade adjustment.

To adjust the plane, turn it over and sight along the bottom. The cutting edge of the plane iron should protrude about the thickness of a sheet of paper. The ad-

justing nut moves the blade to adjust thickness of cut. The lateral adjusting lever will move the blade sidewise to obtain equal exposure of the cutting edge.

To take the plane apart for sharpening, reverse the procedure outlined above. The plane iron cap performs two tasks in this type of a plane. It breaks and curls the shaving. This action and the metal of the toe of the plane at the mouth opening prevent the wood from splitting ahead of the cutting edge. The plane iron cap also stiffens the plane iron.

To keep the plane straight press on the finger rest at the beginning of the stroke. Press on the lever end at the end of the stroke.

Hold the plane level when planing a square edge.

Planing Flat Surfaces and Board Edges

Plane with the grain of the wood to make smooth surfaces. Remember the old saying, never rub a cat the wrong way. The grain of the wood will ruffle up just like the fur on the cat's back.

If the grain is rough and torn after the first stroke, reverse the board so you will be planing with the grain.

Hold the board being planed by clamping it securely in a vise or by placing one end against a bench stop.

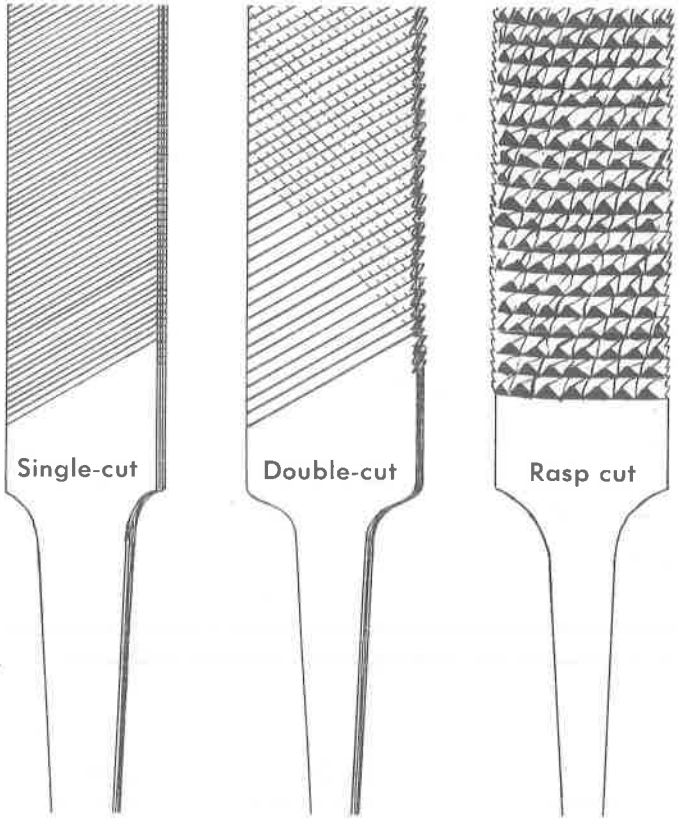
Planing End Grain

To plane end grain start at the edges and plane to the center. Then plane from the other edge to the center.

If the plane is pushed all the way across the end of the board the corner will split.

Rasps and Files

Rasps and files are useful in woodworking as well as in metal work. Many workers and hobbyists use them to smooth wood after it has been roughly cut. Most of the files on the market have teeth cut as illustrated.



The size of a file or rasp is designated by its length, measured without the tang or tapered shank.

A file with one series of chisel-like teeth running diagonally across the face is known as a single-cut file. A double-cut file has a second series crossing the first at nearly right angles. A third kind, used on rasps, consists of raised points on the surface, rather than chisel-like teeth.

The fineness or coarseness of files is commonly designated by the following series of terms, which are arranged in the order of coarsest first; rough, coarse, bastard, second cut, smooth and dead smooth.

The rough, coarse and bastard cuts are used on rough work. The others are used for finishing work.

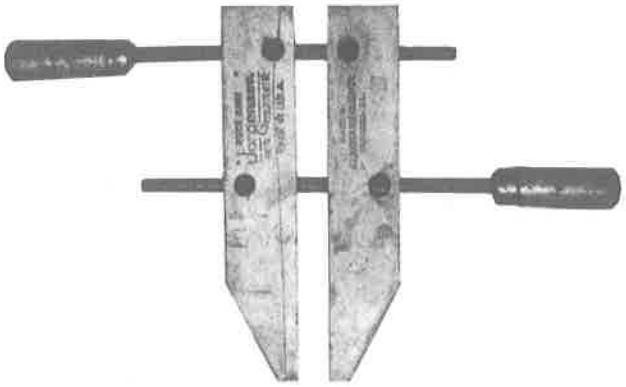
The double-cut types are usually used with heavy hand pressure for fast cutting. The single cut types are used with light pressure to produce a smooth surface finish on metal or keen edges on knives, saw teeth or other cutting implements.

Clamps

Clamps are used to hold pieces together for certain operations. They are also used in gluing to hold the pieces under pressure while the glue dries.

The C-clamp was described in Woodworking Unit 2.

HANDSCREW



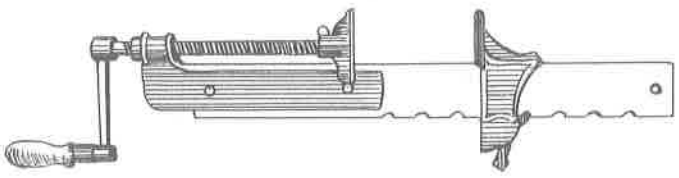
In using this clamp apply pressure with leverage from the back screw.

PIPE BAR CLAMP

Pipe forms the backbone of this clamp. Different length pipes may be used for different purposes. They are often used to glue boards together, furniture repair, etc. Pressure is applied by the crank screw. Size adjustment is made with the adjustable stop.

Similar fittings are available to make a wooden bar clamp. The wood bars are usually 1 3/8" x 2 1/2".

ADJUSTABLE BAR CLAMP



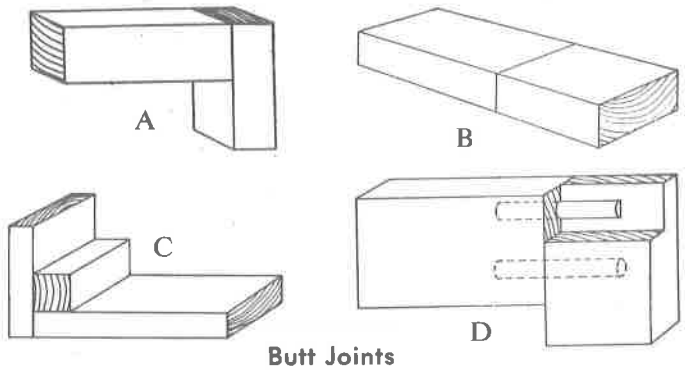
This clamp is commonly called a cabinet clamp and may be used for the same purpose as the bar clamps.

Wood Joints

Construction and repair of wood equipment and buildings require a knowledge of joints. Some of the common easy-to-make joints will be discussed in this unit.

Butt Joint

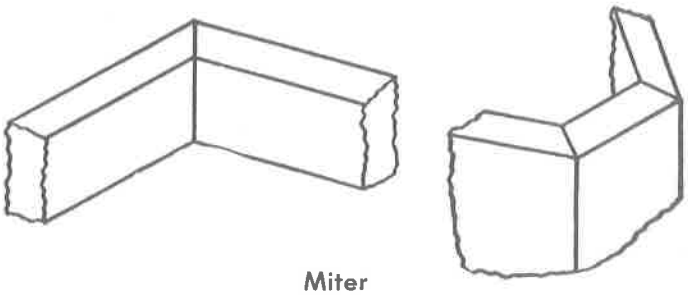
The butt joint is the simplest. It may be constructed end grain to side grain as "A"; or end to end grain as "B". The end grain to end grain butt joint must be strengthened with dowels or a piece of material attached to the side. The piece attached to the side is often called a scab, splice or gusset plate. A block may be placed in the corner of end to side grain joint for additional strength. See "C". This is called a slip or lock corner joint. The joint formed by gluing two pieces edge to edge may also be called a butt joint. The end to side grain joint may be strengthened with dowels. See "D".



Butt Joints

Miter

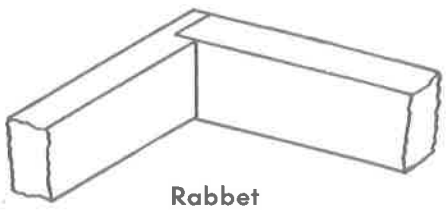
The miter joint is a form of butt joint which changes direction of the different pieces. It is often used on picture frames and other fine work. Dowels may be used in this type of a joint.



Miter

Rabbet

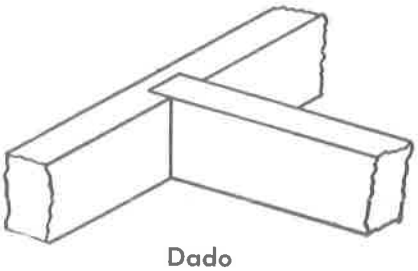
The rabbet joint is another form of butt joint. It is often used to fasten the sides of a drawer to the front piece, and in other furniture work.



Rabbet

Dado

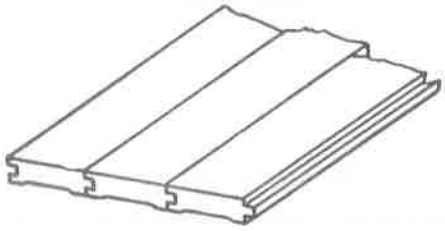
The dado joint is made by making a groove across the grain of the stock, but not at the end, allowing the second member to fit into the groove. The groove at the end of the stock makes it a rabbet joint, as the position so often determines the name. These joints are used in bookcases, step ladders and other furniture where a stronger type butt joint is required.



Dado

Tongue and Groove

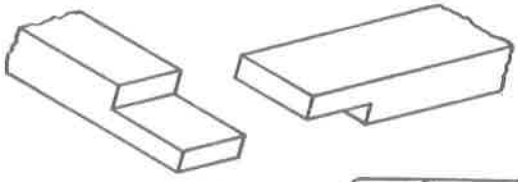
The tongue and groove joint is the familiar type used on flooring – one side containing the groove, the other the tongue that fits into the groove.



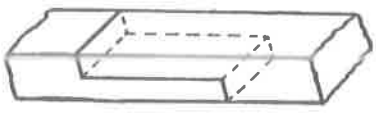
Tongue and Groove

Lap Joints

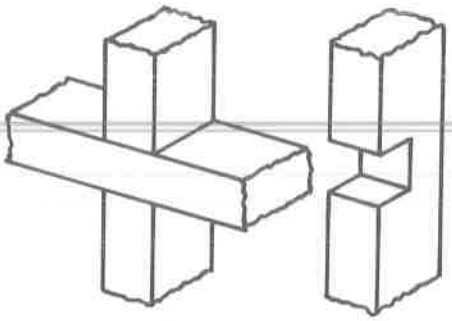
There are several types of lap joints. The names depend upon their positions. The corner or end lap joint is found in corner construction and makes a much stronger joint than the ordinary butt type joint. The middle lap joint is similar to the corner lap except that it is located elsewhere than the ends of the stock. It also forms a right angle. The cross lap joint is a more complicated form of the lap joint. The parts are grooved to one-half their width and when assembled, the grooves overlap to form a cross.



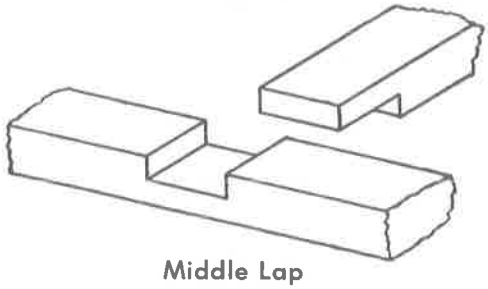
End Lap



Half Lap



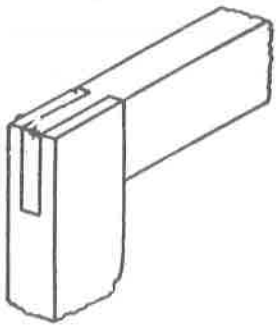
Cross Lap



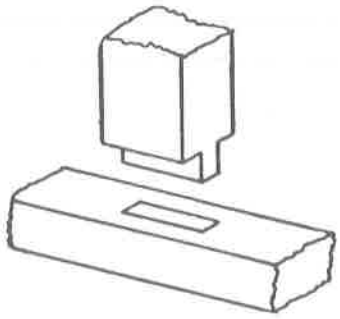
Middle Lap

Mortise and Tenon

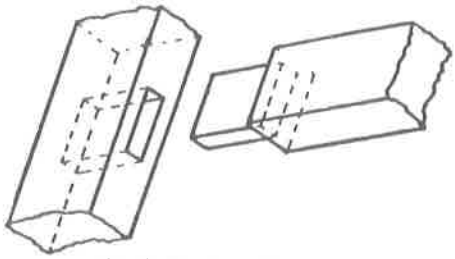
Mortise and tenon joints are most common in furniture where the rails of a table fasten into the legs. It is perhaps the strongest possible joint but like all others, it must be very carefully made and fit. There are many types of mortise and tenon joints but each has its merits. Probably the blind mortise and tenon is most used. The open type is often called the slip joint.



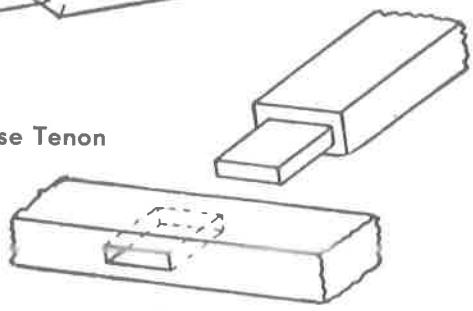
Open Mortise Tenon



Stub Mortise Tenon



Blind Mortise Tenon

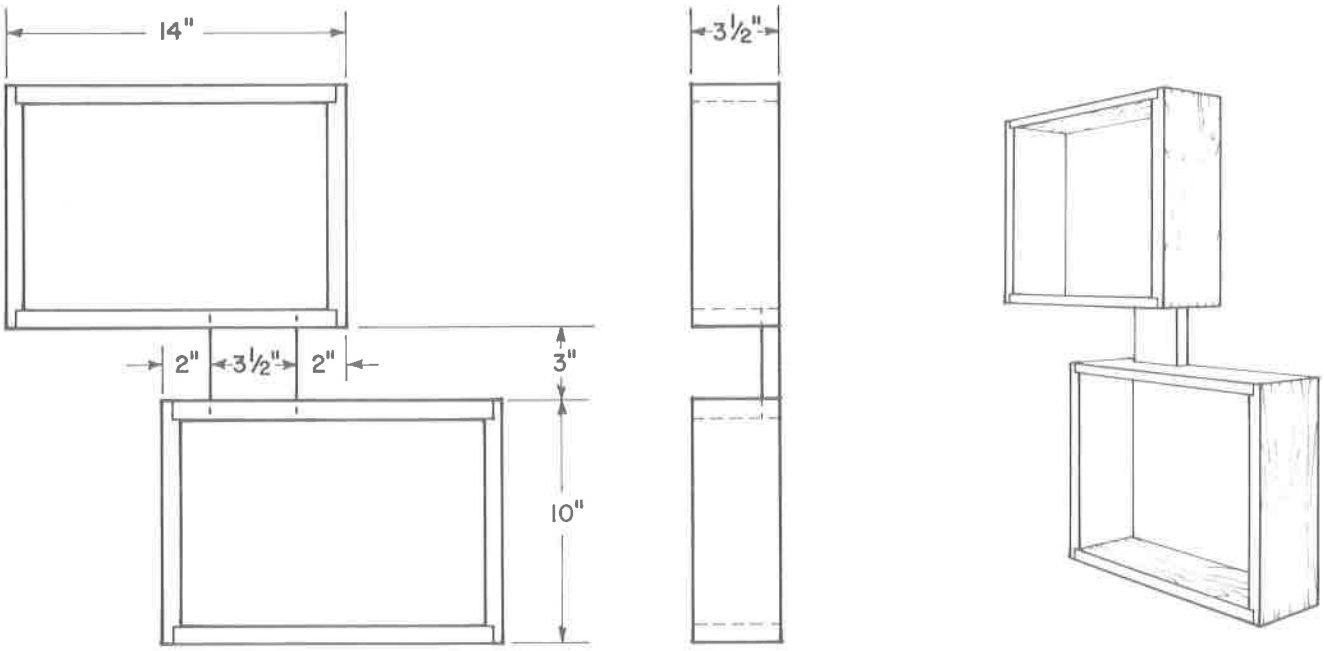


Thru Mortise Tenon

Selecting Drawings

On the following pages you will find plans for items to make in your woodworking project. You may make other items besides the ones shown in this book. Likewise, you may alter the plans shown. The material list for the individual plans gives the lumber in nominal dimension size.

Shadow Boxes



FRONT VIEW SIDE VIEW

Materials:

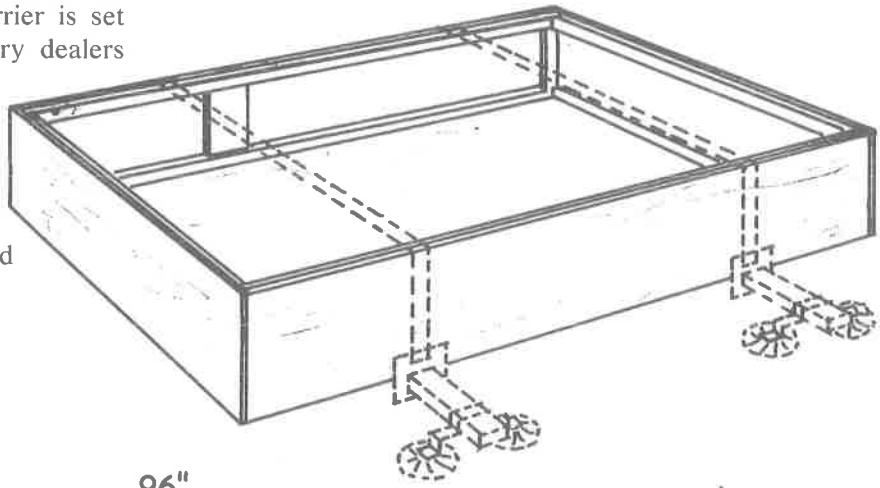
1 pc. 1" x 4" x 10' (actual dimensions about 3/4" x 3 1/2")
6d finishing nails
Penetrating wood finish or as desired

Procedure:

1. Measure, mark and cut sides of boxes.
2. Add the thickness of top and bottom pieces which contact the spacer block to 3" (The space desired between boxes). Mark and cut.
3. Cut notch for spacer in bottom board of top section and top board of bottom section.
4. Sand pieces smooth.
5. Assemble with 3 nails at each joint.

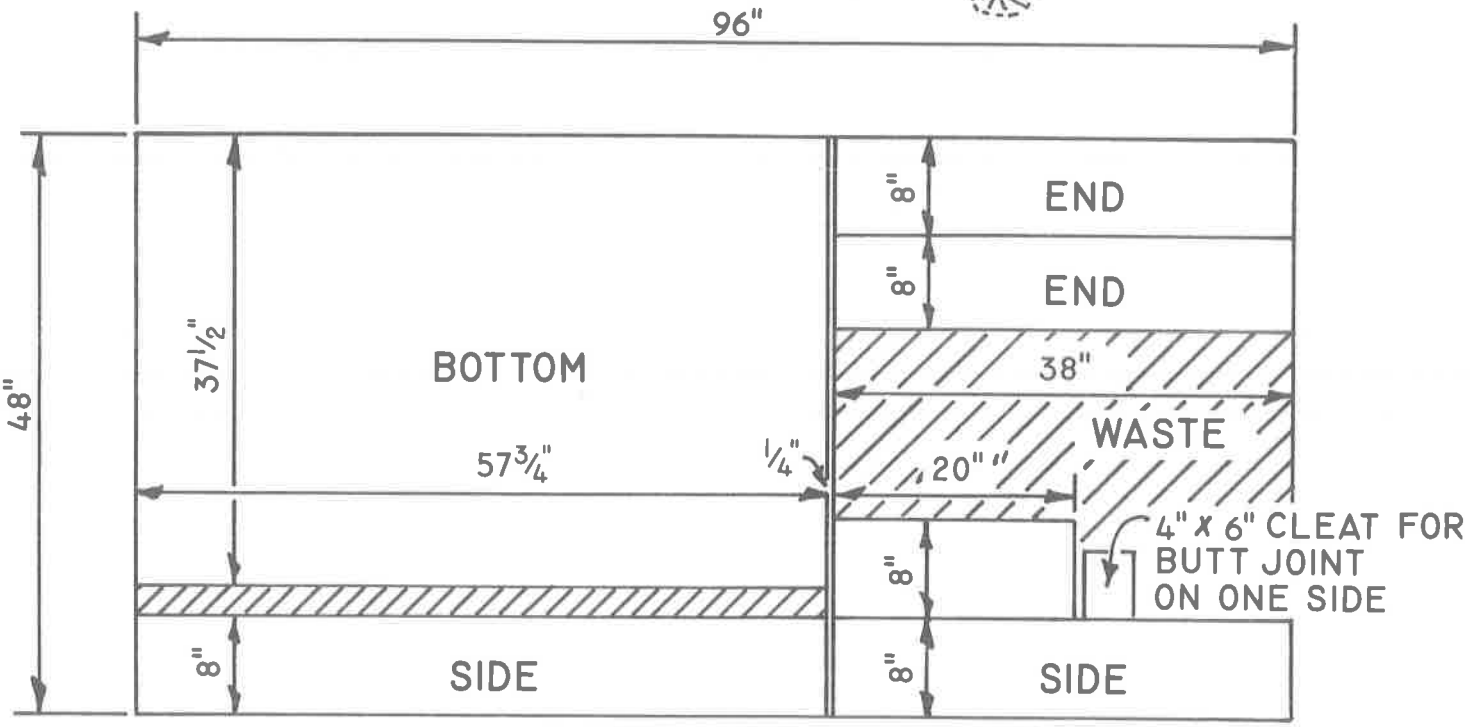
Car Top Carrier

This is a lightweight car top carrier for camping equipment or other general purpose use. It is designed to obtain maximum width and length from one sheet of plywood. However, the height may be increased two inches from that given in the plan. Top carrier is set on rack frame available from auto accessory dealers or mail order catalog.

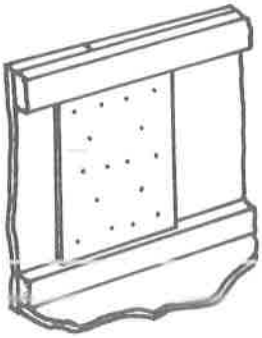


Materials:

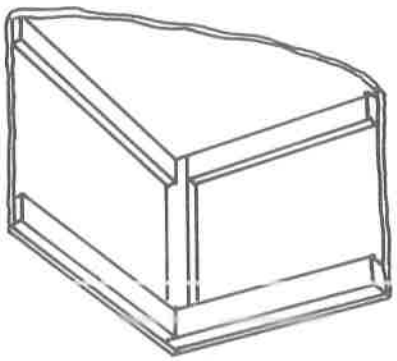
1 pc. 4' x 8' sheet 1/4" exterior grade plywood
4 - 3/8" x 3/4" strips 10' long
Resorcinol resin glue (waterproof)
5/8" wire nails
Finishing materials as desired



CUTTING DIAGRAM OF 4' x 8' x 1/4" PLYWOOD SHEET



Cleat Detail

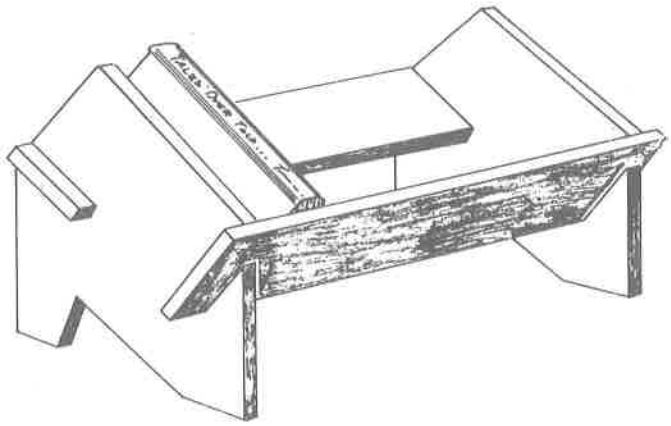


Corner Construction

Procedure:

1. Cut out pieces.
2. Assemble side pieces. Space wire nails about five inches apart to hold the pieces together while the glue dries.
3. Assemble end pieces.
4. After glue on side and end pieces is dry, assemble all pieces as a unit. Glue and nail as indicated above.

Book Rack



Materials:

1 pc. 1" x 8" x 18" (actual dimensions about 3/4" x 7 1/2" x 18") or 3/4" plywood for ends

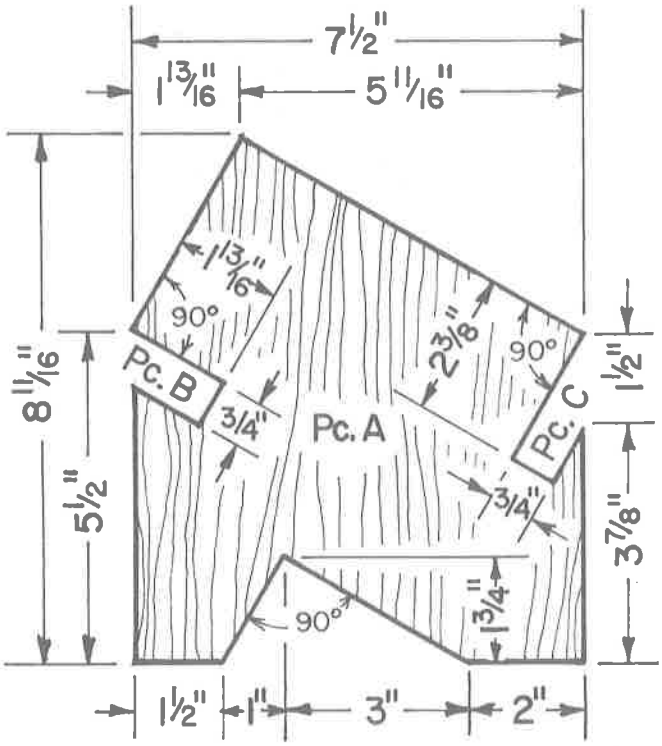
1 pc. 1" x 4" x 36" (actual dimensions about 3/4" x 3 5/8" x 36") or 3/4" plywood for strips

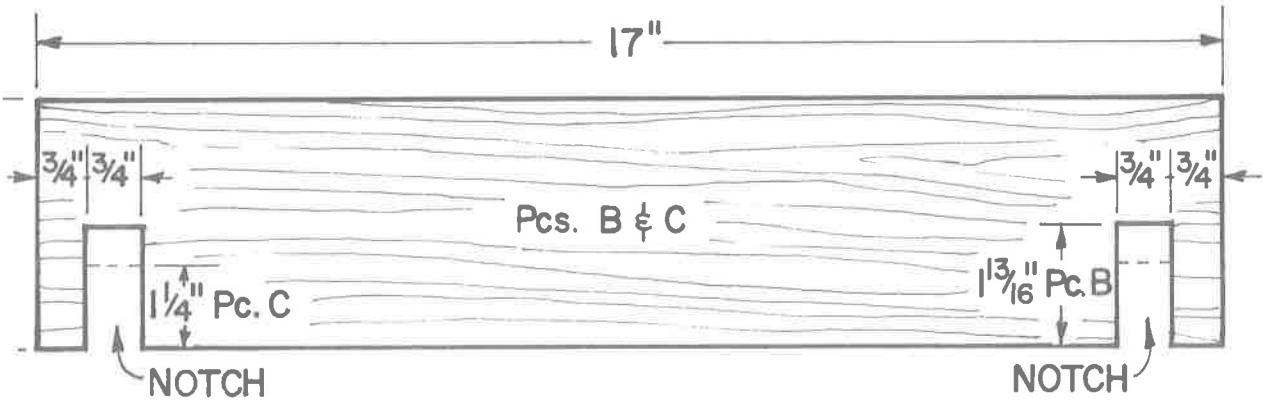
In Construction:

Note the notches in piece C are 1 1/4" deep and 1 13/16" on B. You may desire a wood screw near each end of piece C to hold the top snug against piece A.

Finish:

Apply wood seal or finish as recommended by your leader.

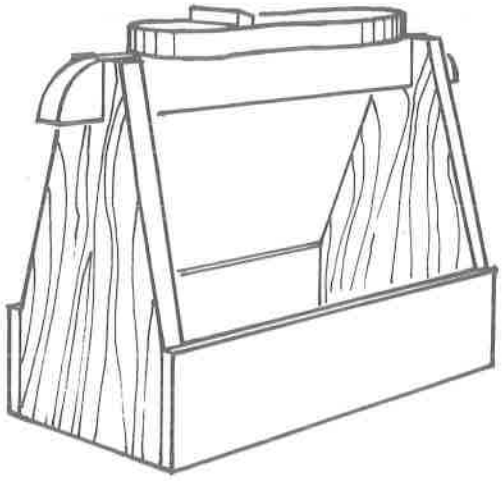


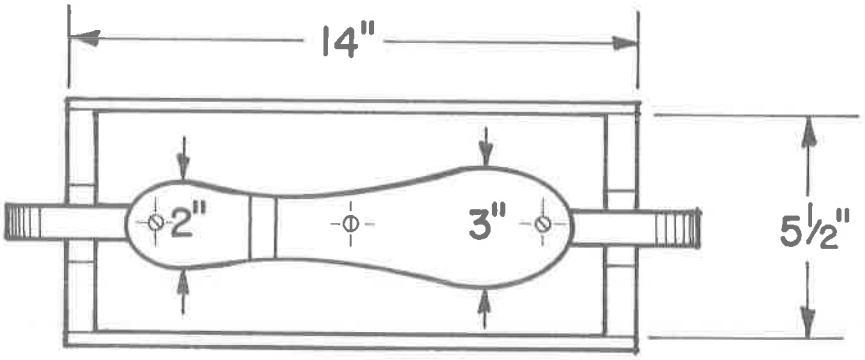


Shoe Shine Kit

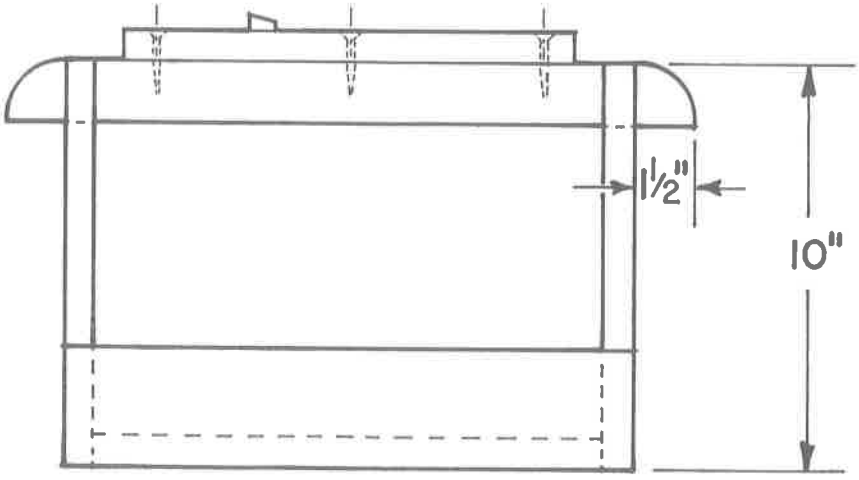
Materials:

1 pc. 1" x 6" x 4'
1 pc. 1" x 2" x 18"
Box lumber or 1/4" plywood for two pieces
3" x 14"
3 - 1 1/4" #8 flat head wood screws
1" wire brads
6d finish nails
Glue
Finish materials as desired

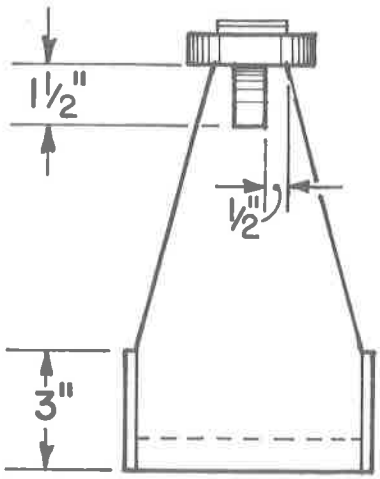




TOP VIEW

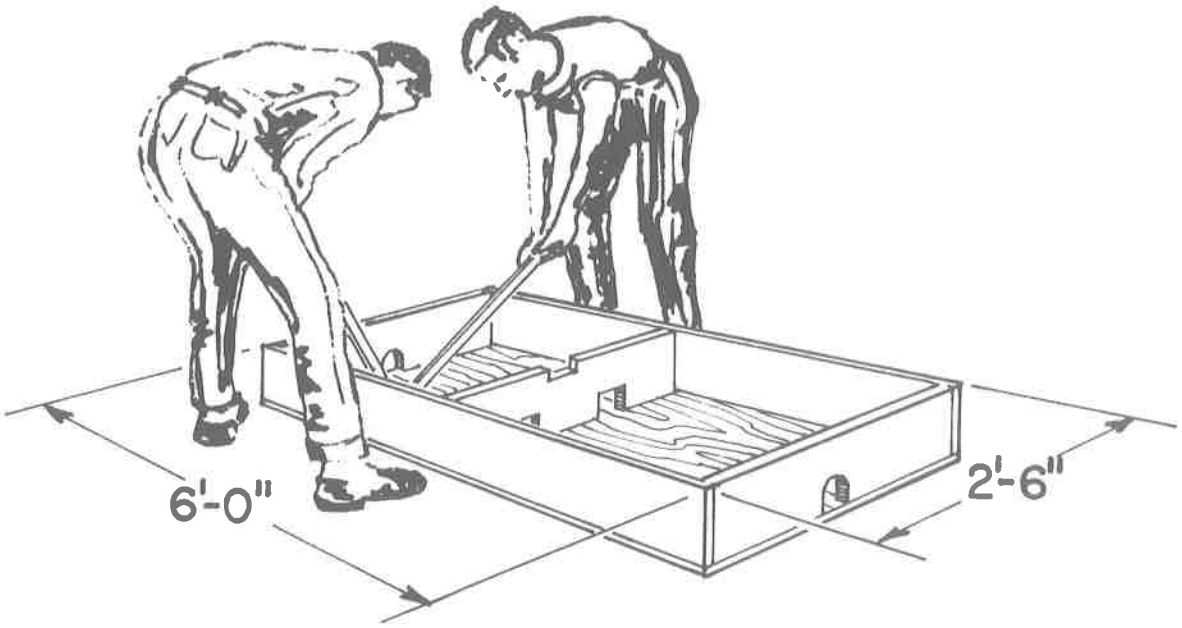


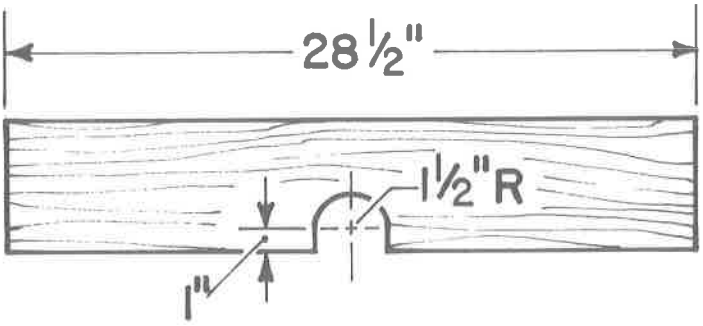
SIDE VIEW



END VIEW

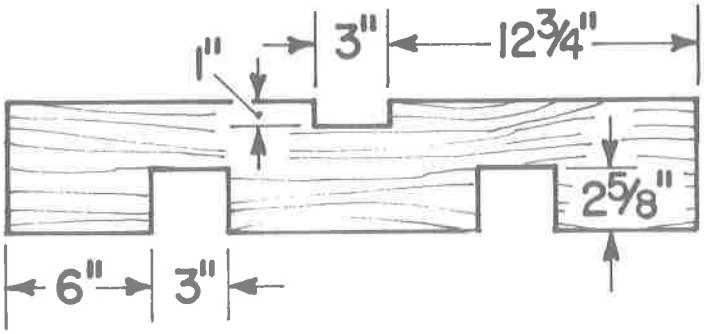
Box Hockey





Materials:

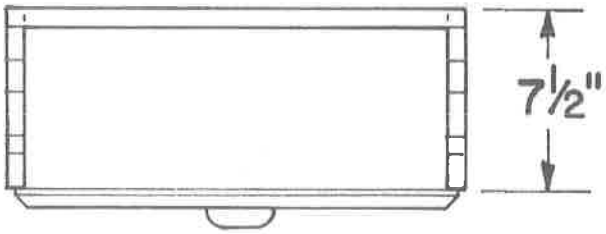
1 pc. 5/8" x 2'-6" x 6' exterior plywood for floor
1 pc. 2" x 6" x 8' ends and partition
2 pcs. 1" x 6" x 6' for sides
2 pcs. 1" x 2" x 2'-6" for sticks
1 puck 1" thick, 2" diameter, preferably rubber
Resorcinol glue (waterproof) and nails for assembly



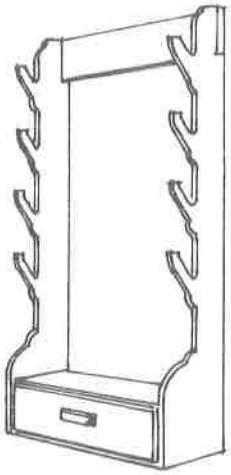
How to Play Box Hockey:

Players stand on opposite sides of box which is placed on the floor. Each player has a hockey stick and holds it at the end. The puck is placed in the notch in the center partition. To start the game, the players "shinny off." (i.e., they touch the bottom of the box and then each other's stick three times, counting 1-2-3 go.) The object of the game is to knock the puck out of the box through the end opening to the player's own left. When the puck goes through opening, the players start over. Best two out of three goals win.

A Gun Rack



TOP VIEW



Materials:

1 pc. 3/4" x 3 1/2" x 19"
(top)

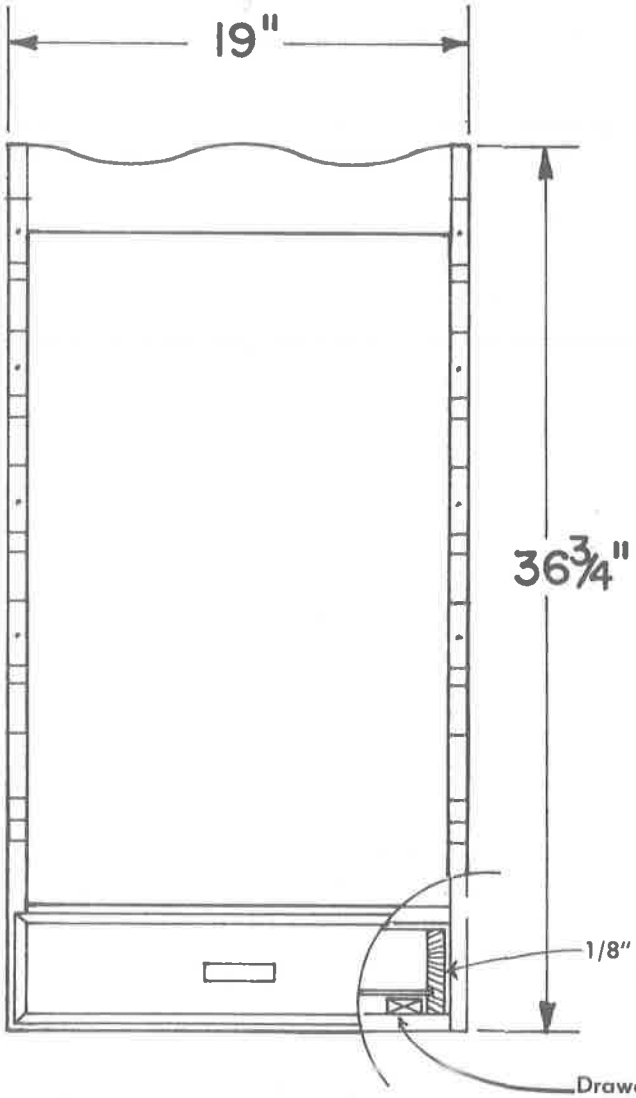
2 pc. 3/4" x 7 1/2" x 36 3/4"
(sides)

1 pc. 3/4" x 7 1/2" x 17 1/2"
(shelf)

1 pc. 3/4" x 7 1/2" x 17 1/2"
(bottom)

8 dowels 1/4" x 5"
(optional)

Nails and Expoxy glue or screws



FRONT VIEW

Drawer Parts:

1 pc. 3/4" x 4 5/8" x 18 1/2"
(front)

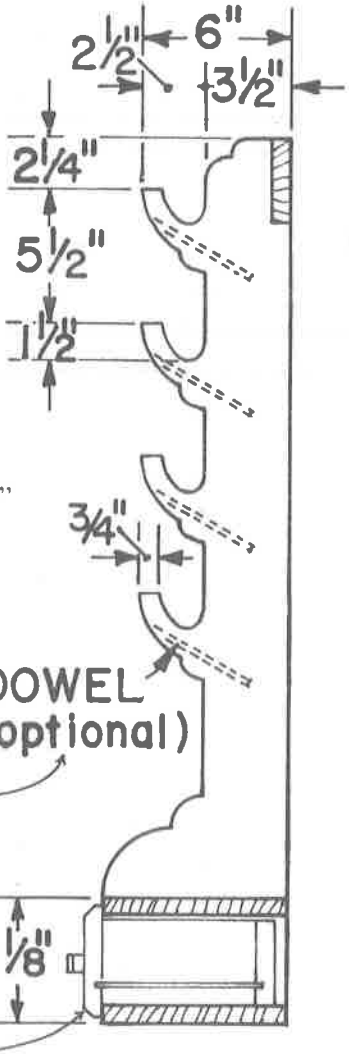
1 pc. 3/4" x 3 1/2" x 17 3/8"
(back)

2 pc. 3/4" x 3 1/2" x 6 1/4"
(sides)

1 pc. 1/8" Masonite 6 1/2" x 16 1/8"
(bottom)

2 pc. 3/4" x 1 1/2" x 1 1/2"
(guides)

1 pull, as desired



Garage Creeper

Materials:

1 pc. 16" x 40" exterior grade 1/4" plywood
1 pc. 1"x 8" x 3-1/2' hardwood to be ripped for the following actual dimension material:

2 pc. 3/4" x 2" x 40"
4 pc. 3/4" x 1-3/8" x 16"

1 set of 4 swivel caster or rollers special for creepers, etc. These are available from some mail order houses and most auto supply houses.

16-3/4" #10 flat head wood screws. (1/2" for optional plan)
8-1/4" x 2" carriage bolts with nuts
8-1/4" washers

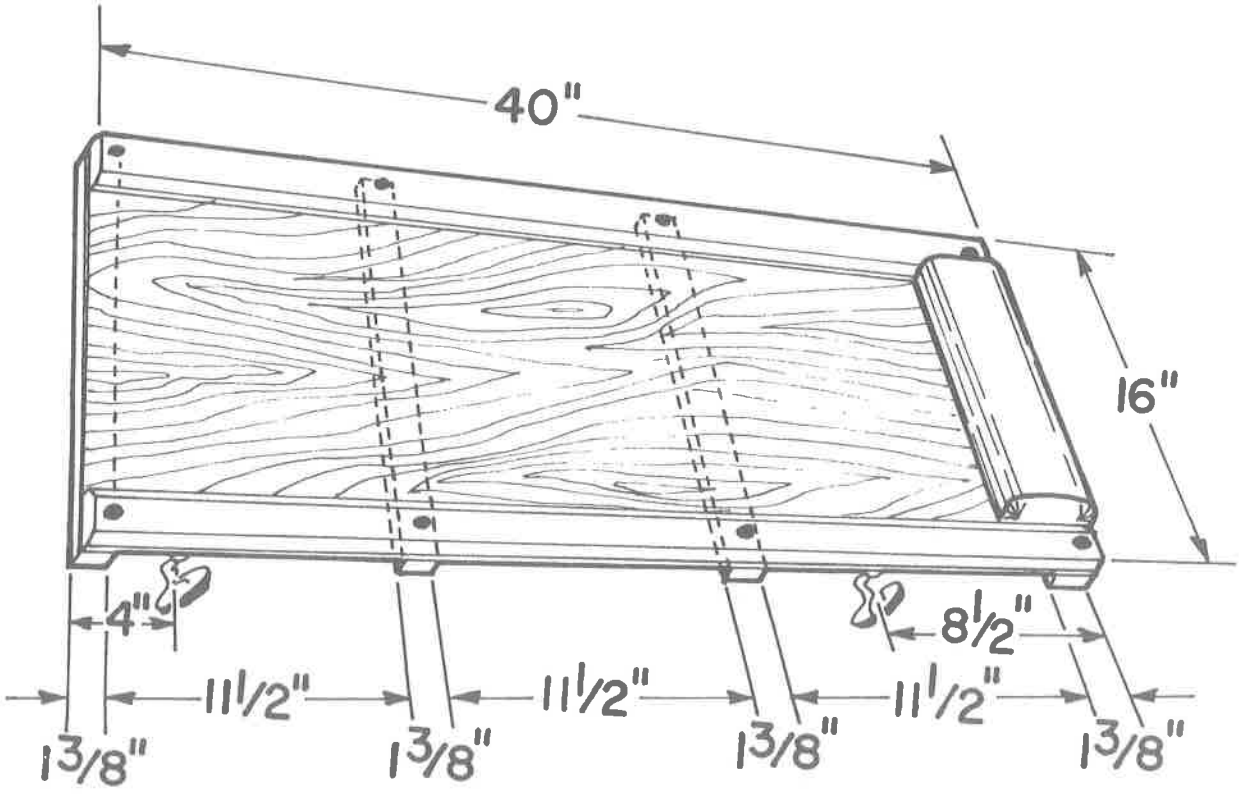
1 pc. 1" x 12" x 18" plastic foam to fold for head rest
1/3 yd. vinyl plastic upholstery for head rest covering
Upholstery nails
24 - 5/8" wire brads
Waterproof or water resistant glue
Enamel or wood sealer finishing materials

Procedure:

1. Cut plywood and hardwood strips to size.
2. Round upper inside corner of the 3/4" x 2" x 40" side pieces.
3. Glue these side pieces to plywood sheet. Use 5/8" brads about 5" apart to serve as glue clamps.
4. To attach 3/4" x 1-1/2" strips: Clamp in place, and drill bolt holes. Release clamps and apply glue. Insert bolts and tighten. Use 3 brads across plywood area to hold plywood to strip while the glue dries.
5. Attach casters. Check to see they have clearance to swing in a full circle.
6. Fold and attach head rest.

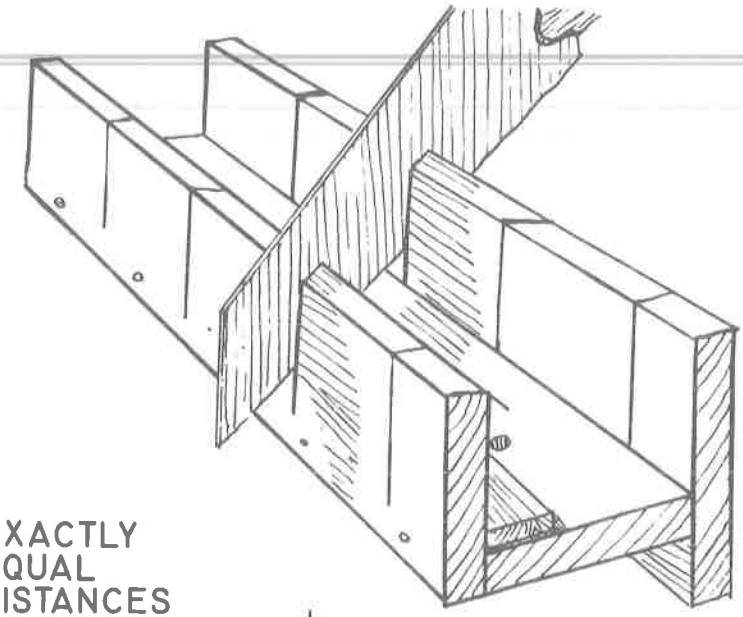
Optional Plan:

Cut a 1/4" x 3/8" rabbet on lower inside edges of hardwood sides to accommodate plywood. Cut plywood to 15 1/4" width. This will reduce overall height 1/4 inch.



Miter Box

Materials:



Plan "A"

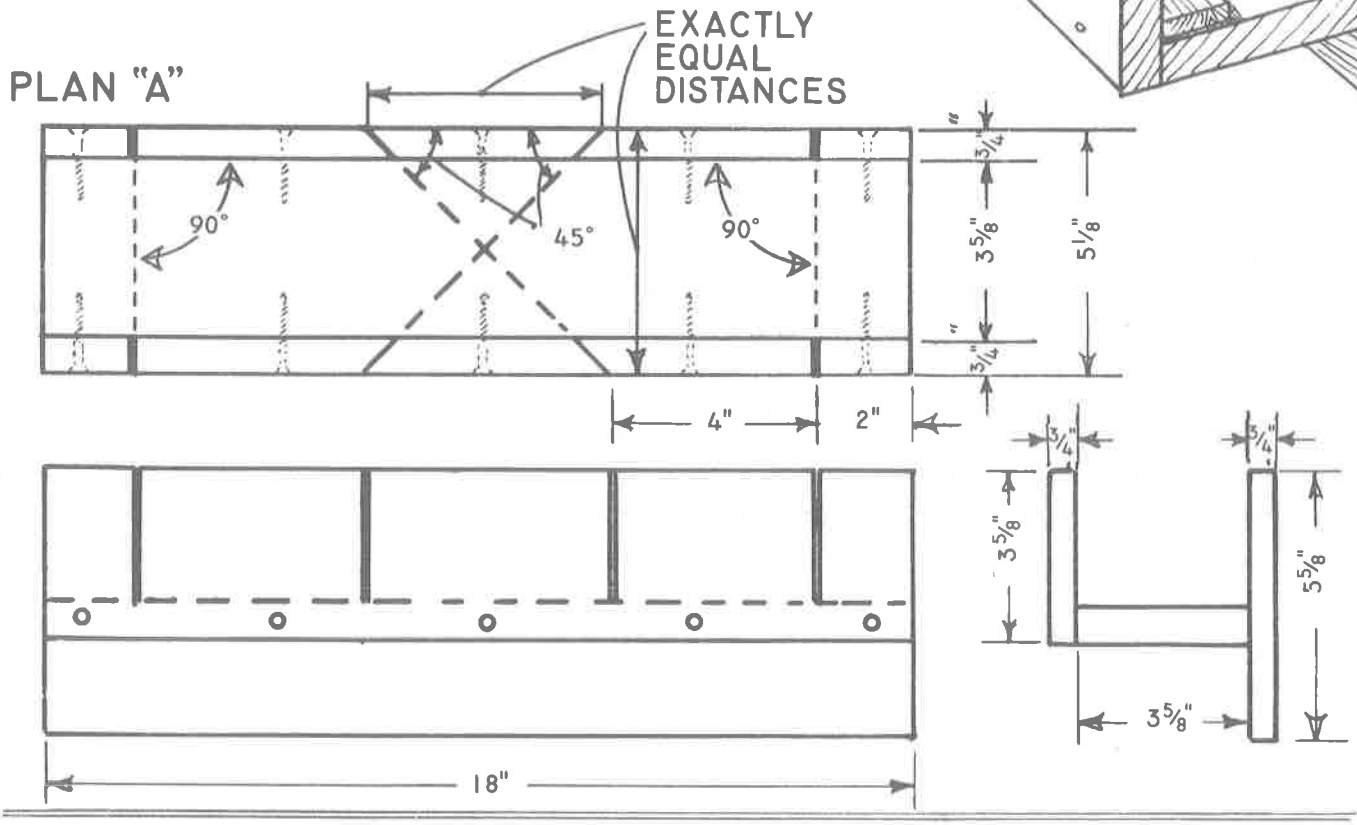
1 pc. 1"x 4" x 36" hardwood
1 pc. 1" x 6" x 18" hardwood
1 1/2" or 1 3/4" flat head screws

Plan "B"

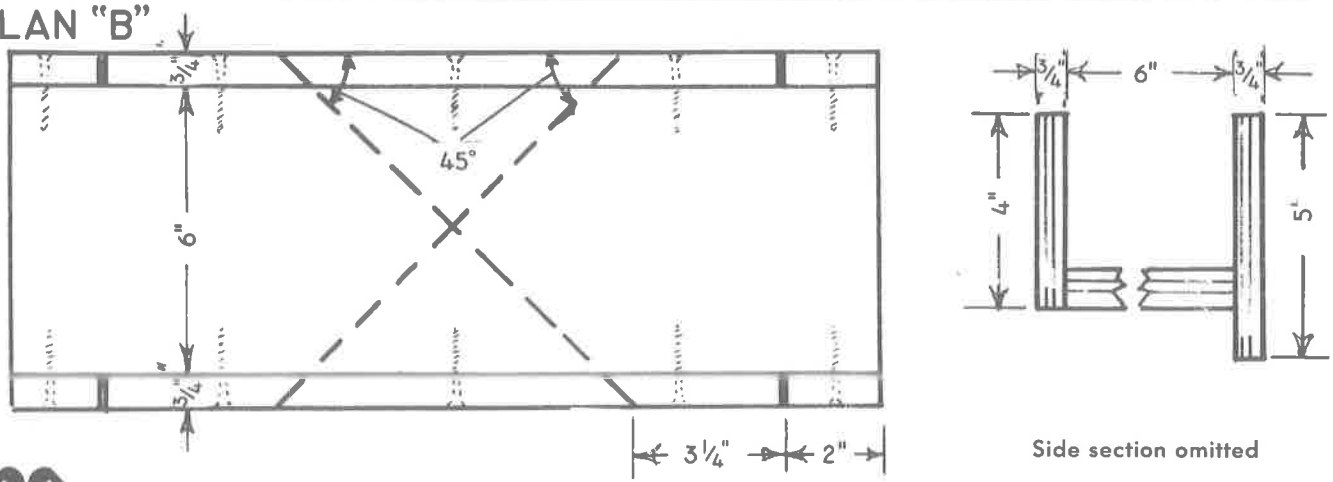
1 pc. 6" x 20"
1 pc. 5" x 20" } 3/4" plywood
1 pc. 4" x 20"

1 1/2" or 1 3/4" flat head screws

PLAN "A"



PLAN "B"



Side section omitted

Sleeve Board

Materials:

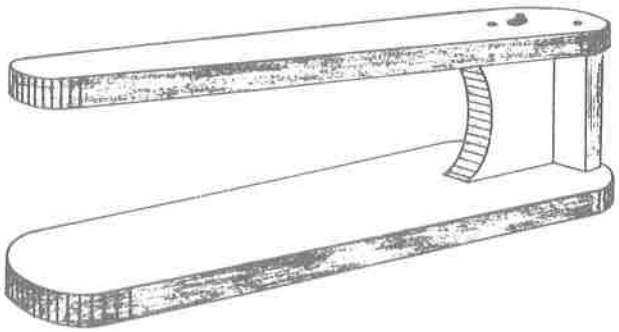
Common hardwoods, 3/4" plywood, or pine low in pitch content

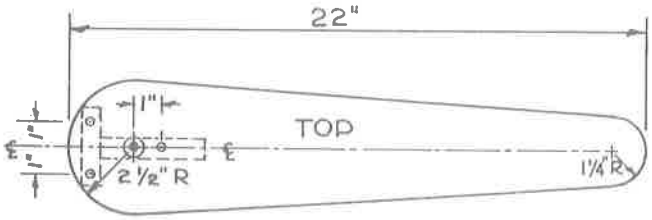
Material listed as common dimension lumber

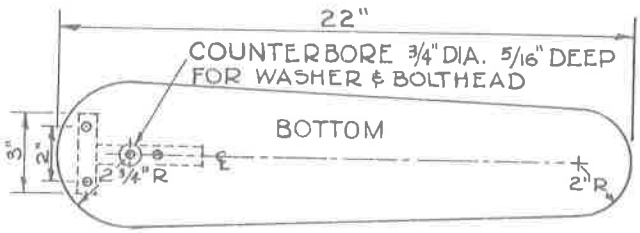
1 pc. 1" x 6" x 4'
1 pc. 1" x 4" x 8" (or 1 pc. 1" x 3 1/2" x 8")

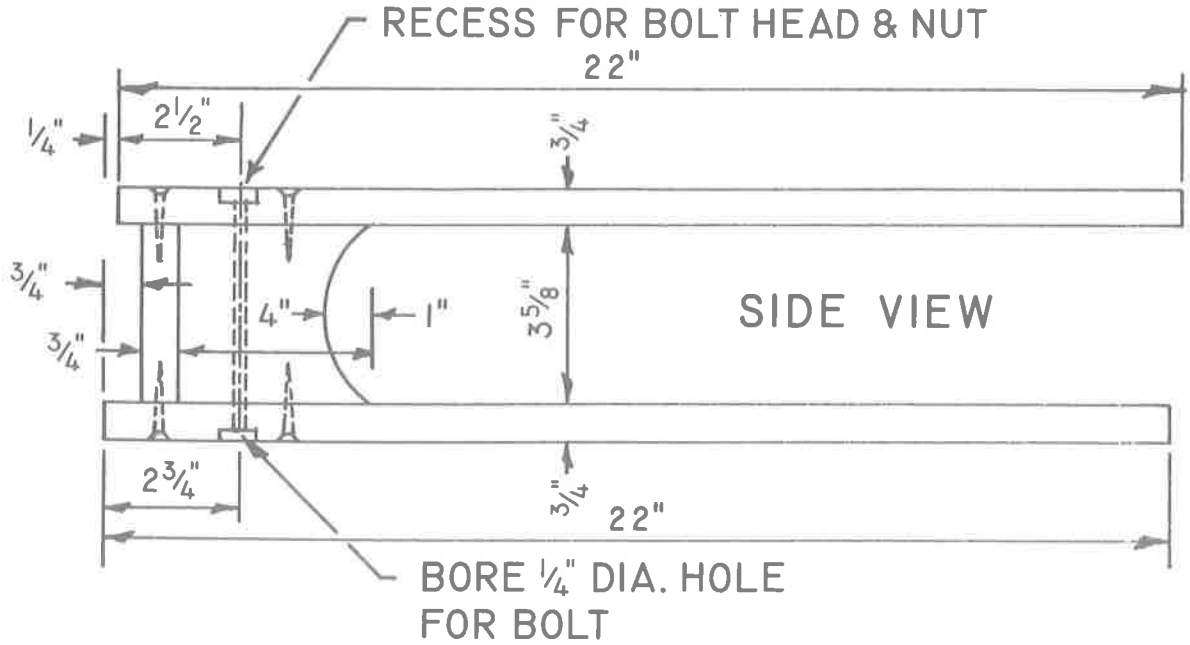
1 - 1/4" x 5" zinc-plated machine bolt
6 - 1/2" #8 zinc-plated flat head wood screws
2 - 1/4" flat washers

Floor seal or penetrating wood finish







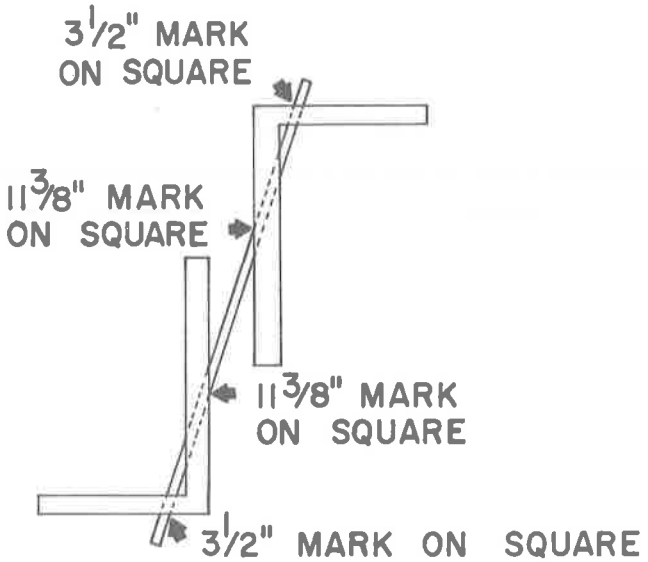


Workshop Saw Horse

This is a plan for a lightweight saw horse. It will serve for many jobs. Standard height of saw horses range from 18" to 24." A common length is 36". For a more rugged construction use 2" x 6" for crosspiece, 1' x 6" for legs, and increase the depth of the brace. This material should be split and knot free for maximum strength. Built as shown, the legs extend sidewise 1/2" for each 1-5/8" of height.

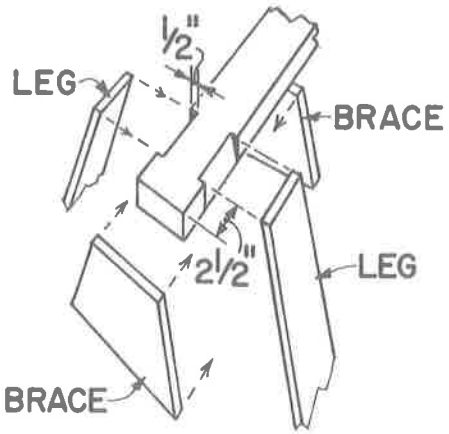
You may compute the length of the legs mathematically or use the following approximate table and process outlined in the procedure.

Horse Height	Leg Length
18"	18-7/8"
20"	20-15/16"
22"	22-1/16"
24"	25"-1/8"



Procedure:

1. Determine desired height.
2. Obtain necessary materials.
3. Mark and cut crosspiece. Before marking notches for the legs check the exact width of the leg material.
4. Mark and cut legs.
   a. Position a square as indicated on edge of leg material to mark angle of top cut.
   b. Square lines from this edge on face and back to use as guide lines in sawing.
   c. Measure length of leg on either inside or outside face. Mark this at the proper edge.
   d. Position square as indicated for bottom cut.
   e. Note: An accurate cut will serve to cut the bottom of one leg and the top of another as these lines are parallel.
5. Attach each leg with four 1-3/4" #10 flat head wood screws.
6. Cut leg braces from 1" x 8" material or 1/2"-3/4" exterior plywood.



Materials:

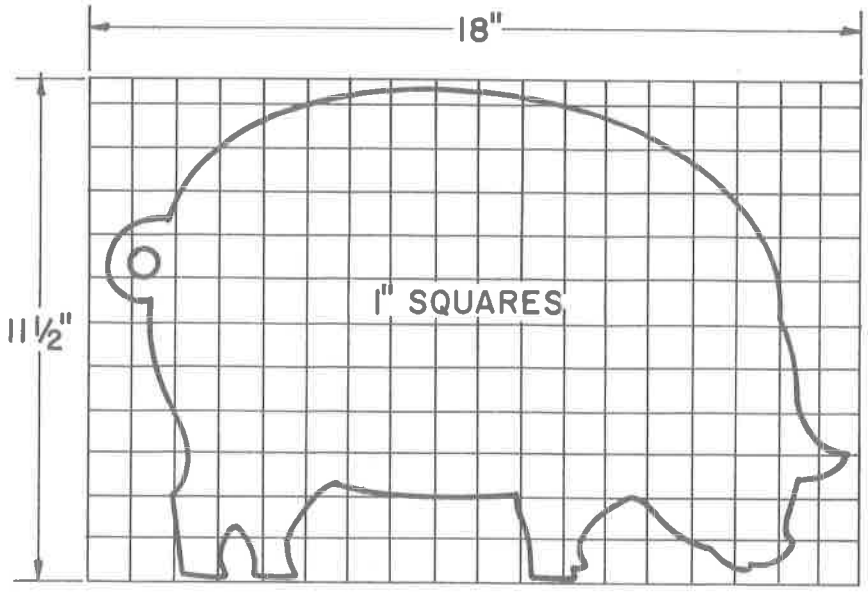
2" x 4" or 2" x 6" x 36" for crosspiece
1" x 4" or 1" x 6" as required for legs
1" x 8" or 1/2"-3/4" exterior plywood for braces
16 - 1 3/4" #10 flat head wood screws
6d nails to nail braces

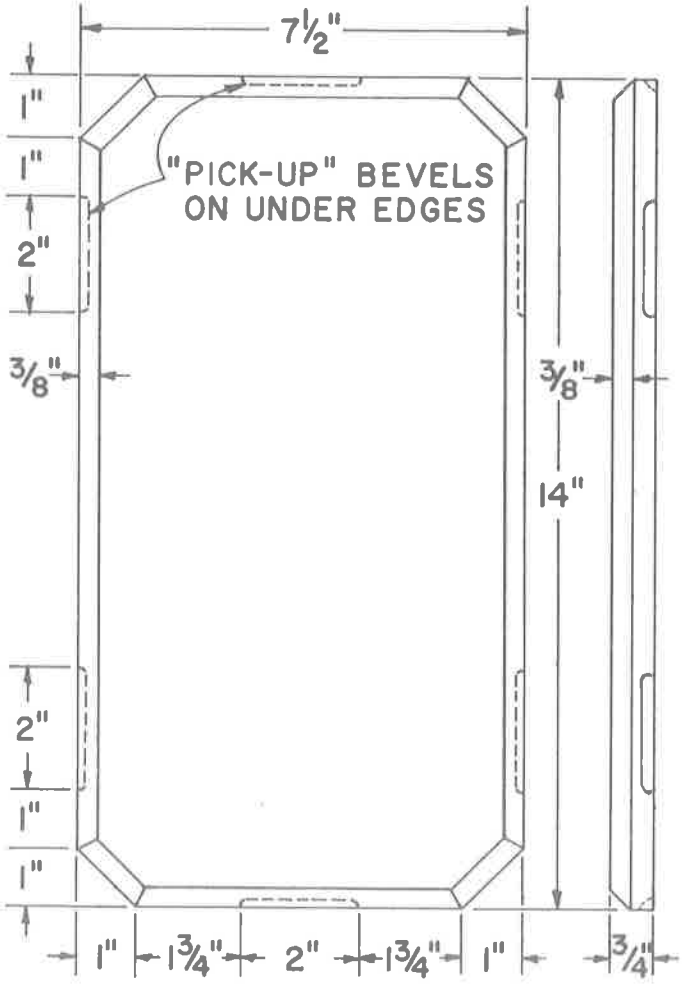
Cutting Boards

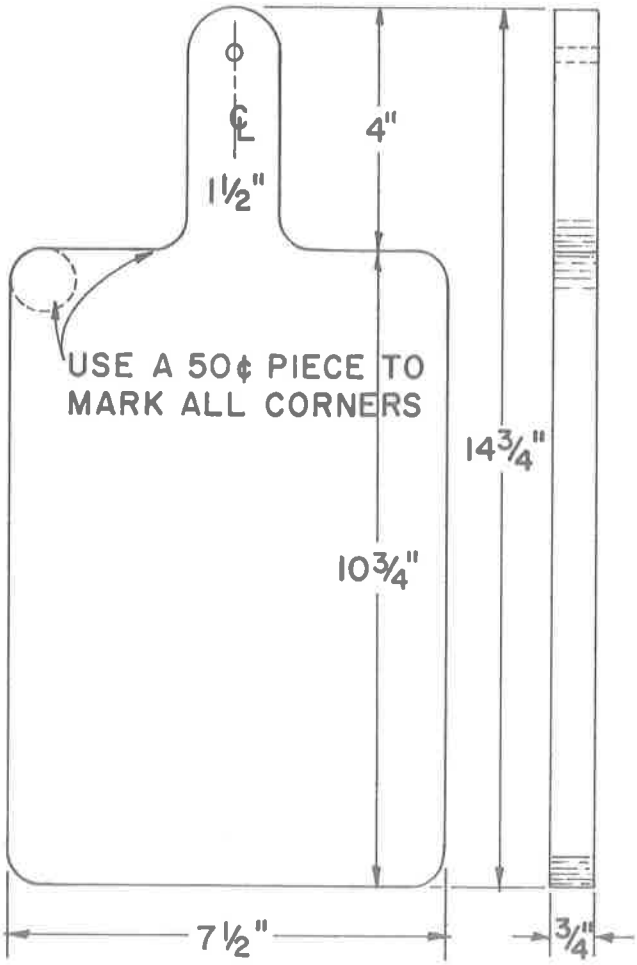
Change dimensions to fit available material or desired size.

Materials in order of preference: quarter-sawn beech, maple or birch lumber or glued stock; hardwood plywood; quarter-sawn or glued pitch free softwood; or softwood plywood.

Apply several liberal coats of vegetable salad oil or cooking oil for a finish.







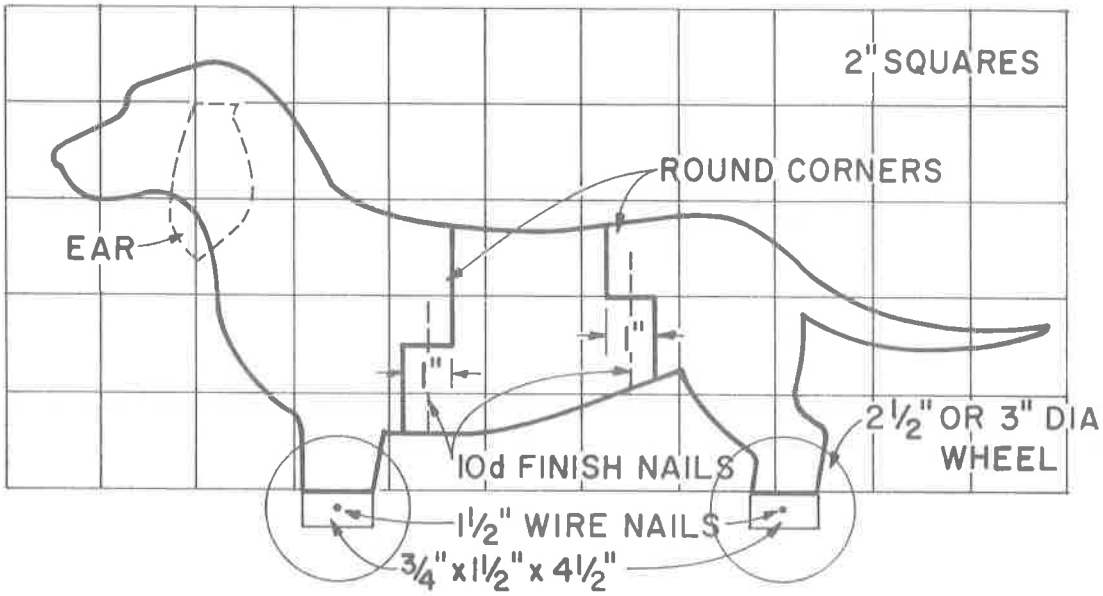
Get Along Little Doggie

Materials:

1 pc. 1" x 2" x 11" - axles (actual size about 3/4" x 1 1/2" x 11")
1pc. 10" x 22" x 3/4" plywood - body
1 pc. 6" x 8" x 3/8" or 1/2" plywood - wheels
2 - 10d finishing nails
8 - 1 1/2" wire nails
Glue
Cloth, leather, 1/8" plywood or fiber board for ears
Linseed oil or other penetrating finish material

Procedure:

1. Cut out body, wheels and axles.
2. Cut body into three sections.
3. Drill loose fitting holes for hinge nails in bottom part of center section. Drill tight pilot holes for hinge nails in end sections.
4. Round the up and down edges of the hinged joints so the dog can waggle.
5. Sandpaper smooth.
6. Drill loose fitting holes for nail hub in wheels. Attach to axles. Attach axles with nails and glue.
7. Assemble sections of dog.
8. Apply finish.



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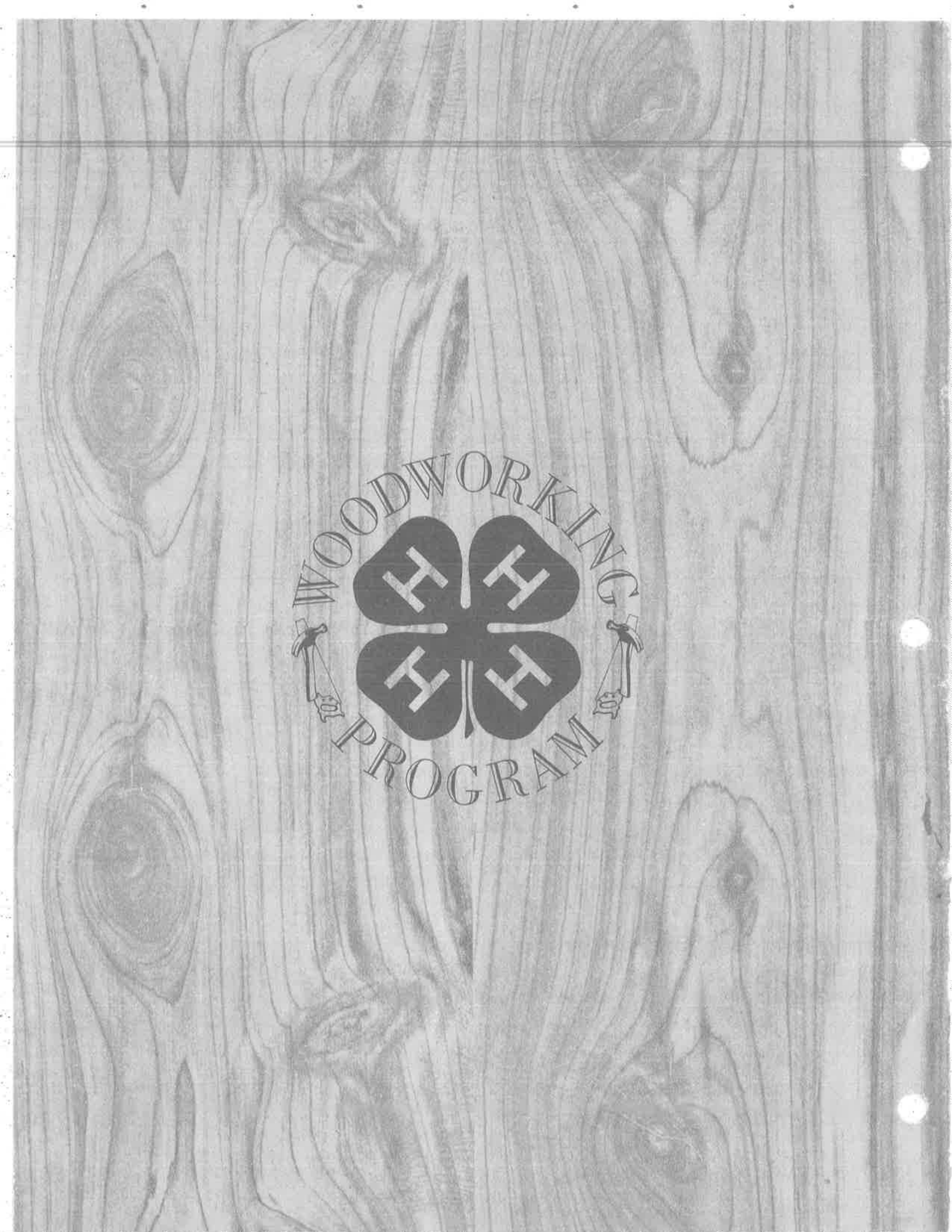
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