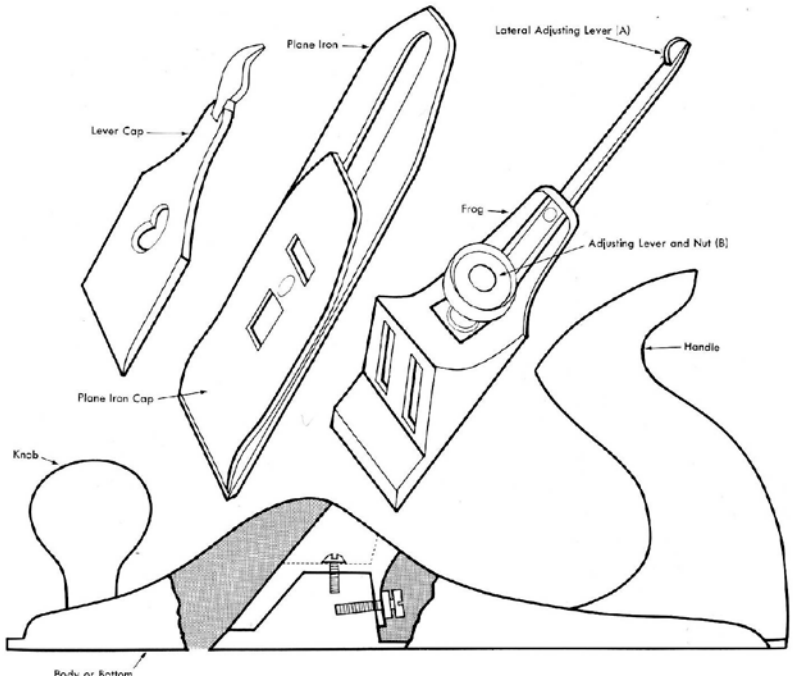
Assignment #2

The *smoothing plane* is used for planing short stock smooth and flat. Its particular purpose, as its name implies, is to make a very smooth surface. It is often used to finish plane a board after it has been rough planed with a larger plane. The smoothing plane is generally 225 mm long and 50 mm wide, and has the same construction and design as the jack plane shown in Figure 7:1.

The *jack plane* is the general-purpose plane that is used more than any other. It is light enough to be handled easily, yet long enough to plane long stock if required. It is the plane that most carpenters carry in their tool boxes because it can be used for almost any planing operation. It is made in several sizes, but the one most used is 350 mm long and 50 mm wide (see Figure 7:1).

The *fore plane*, which is almost identical in construction with the jack plane, except that it is longer and wider, is used for planing longer material. Fore planes are usually 450 mm long and 60 mm wide.

The *jointer plane* is the longest type of plane in general use and also is similar in construction to the jack plane. Because of its length, it is especially useful for truing the edges of long boards. Sizes range from 550 mm to 700 mm in length and from 58 mm to 74 mm in width.



CHAPTER SEVEN

planes and planing

The plane is one of the most useful of all woodworking tools because it is so necessary for reducing stock to the correct size, as well as for making it smooth and square. To know the type and size of plane best suited for the job at hand and to know how to use a plane well is essential to all types of woodwork.

The first planes used were merely chisels placed in a wooden block. The blade was held in place at the correct depth by a wedge. Since those days many advances have been made in the manufacture of planes, and they are now produced in many different shapes and sizes, each suitable for a specific purpose. However, the principle of the cutting action is the same in all types.

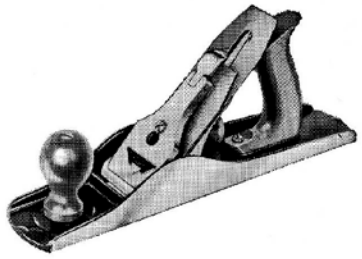


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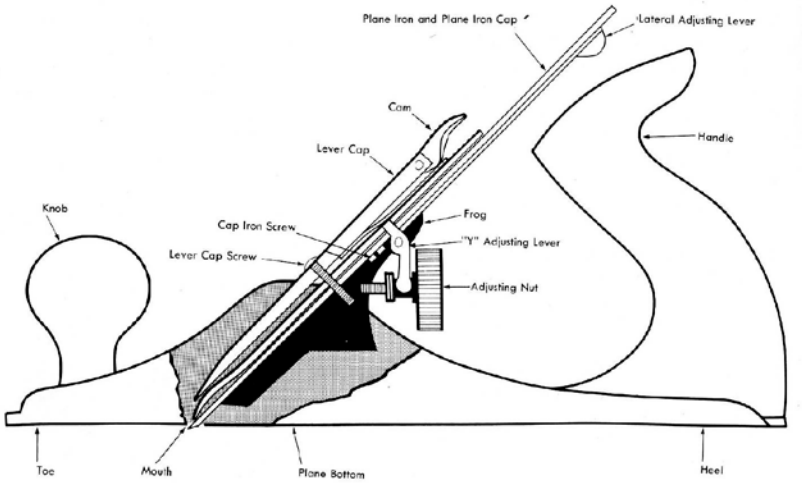
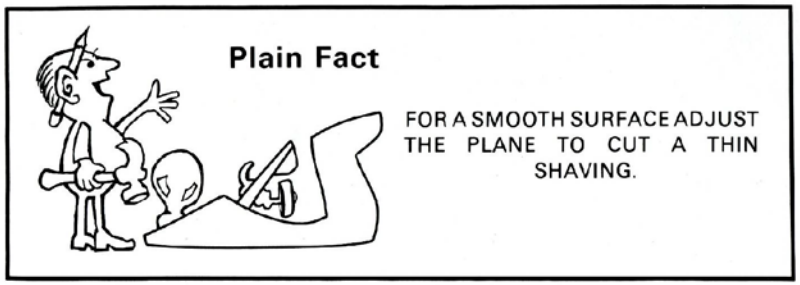
Fig. 7:1 Jack Plane

Bench planes

The planes that are most often used in general woodwork are known as *bench planes*. They include the *smoothing*, *jack*, *fore*, and *jointer planes*. This type of plane is illustrated in Figures 7:1 and 7:2.





Always plane in the direction of the grain. Cutting against the grain will result in an uneven, rough surface.

Hold the plane with the right hand on the handle and the left hand on the knob (reverse if left-handed). When beginning the cut, bear down firmly on the knob. As the plane stroke continues, place an even pressure on the handle and the knob. When finishing the stroke, lighten the pressure on the knob and bear down on the handle. This will prevent dubbing or rounding the end of the wood.

When planing the face of a board, a better cut is often produced by holding the plane at an angle to the edge of the board to make a shearing cut. This allows the plane blade to make a slicing cut that is narrower than the width of the blade. Thus we might have a 50 mm blade cutting a 30 mm shaving (see Figure 7:8). Some planes are made with the blade set in the plane in such a way that it cuts at an angle to the direction of the stroke, thus making it possible to produce a shearing cut by pushing the plane parallel to the edge of the work.

When planing the edge of the work, use as long a stroke as possible. The last few strokes should produce a shaving the full length and width of the

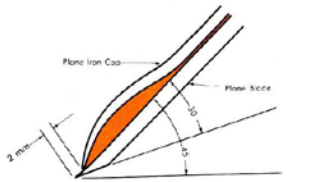


Fig. 7:6 Blade Assembly

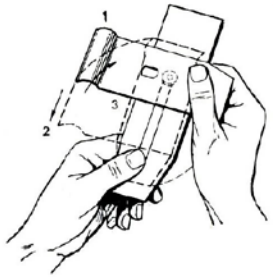


Fig. 7:7 Blade Assembly

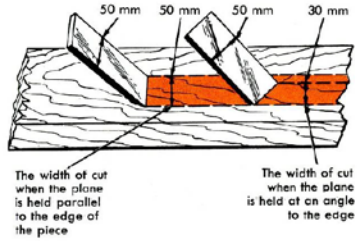


Fig. 7:8 To make a shearing cut the plane blade should be at this angle.

A cut-away view of a smoothing plane is shown in Figure 7:2, listing the parts, which are the same in almost all types of bench planes.

One of the secrets of the proper operation of a hand plane is to have it correctly adjusted for the depth of cut and the angle of the blade. There are two main blade adjustments on a hand plane: (1) the adjusting nut raises or lowers the blade and so regulates the amount of cut; (2) the lateral adjusting lever tilts the blade to the right or left. To set the plane blade, sight along the bottom of the plane and turn the adjusting nut until the sharp edge of the blade projects slightly above the sole of the plane. The lateral (sideways) adjustment of the blade can be checked at the same time by pushing the lever to the right or to the left until the blade is parallel with the plane bottom (see Figure 7:4).

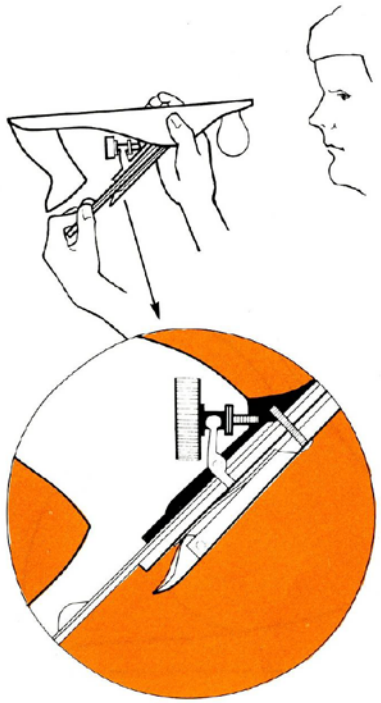


Fig. 7:4 Plane Adjustment

Figures 7:5, 7:6, and 7:7 illustrate the correct method of assembling the blade and plane iron cap after cleaning or sharpening, to avoid dulling the cutting edge of the blade. The edge of the cap should be approximately 2 mm from the cutting edge of the blade, which should fit snugly down on the frog. The cam should be tight enough to hold the assembly firmly in place.

The plane iron cap is often referred to as the chip breaker because its main purpose is to stiffen and steady the blade so that the blade will cut a smooth, continuous shaving rather than chip shavings, which would occur if the blade were not held steady.

How to use a plane

The work should be held down firmly either between the jaws of a vise or by using a bench stop. Both hands should be free to control and push the plane.

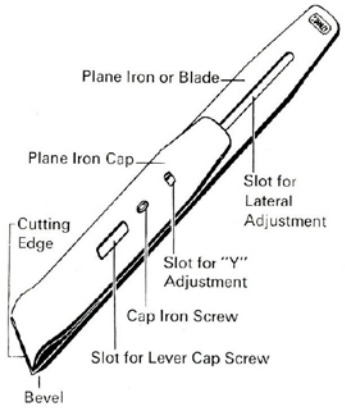


Fig. 7:5 Blade Assembly

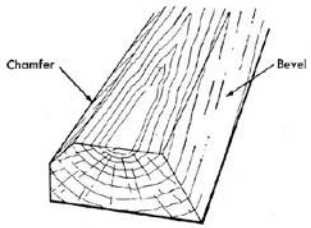


Fig. 7:11

by gauging a line with a pencil, as shown in Figure 7:12. To do this, place your second finger against the edge of the stock and hold the pencil as shown. Practise drawing lines on a piece of scrap lumber. You will be surprised how easily and accurately it can be done. This method is much faster than the one requiring the use of the marking gauge.

Special planes

There are many special planes made for specific operations, some of which are shown in the following illustrations.

The *block plane* is made in varying sizes from 100 mm to 175 mm long, the most common size being 150 mm long with a blade 40 mm wide. The block plane is used extensively for planing end grain, often by carpenters for fitting exterior and interior trim, but also for planing short pieces in the shop. This plane is made to be used with one hand, with the palm over the lever cap and the forefinger in the hollow of the finger rest. As shown in Figure 7:13, most block planes have an adjustable mouth.

A *rabbet plane* is used for cutting a recessed section out of the edge of a piece of stock. It is equipped with an adjustable depth gauge and a fence so that any desired size of rabbet can be cut.

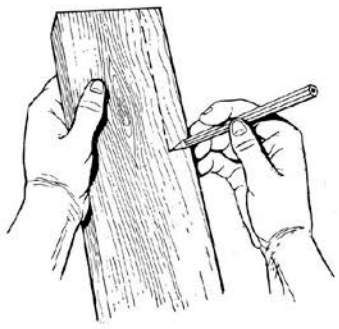


Fig. 7:12 Finger Gauging a Line

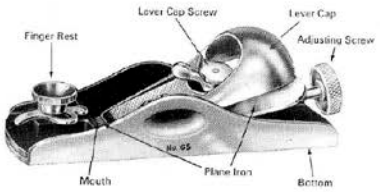


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Fig. 7:13 Block Plane

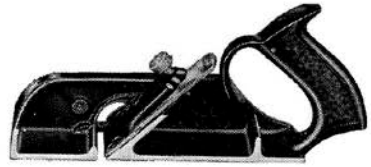

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Fig. 7:14 Rabbet Plane

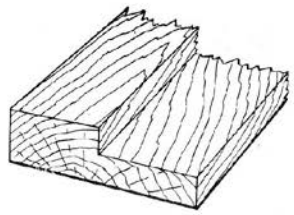

Fig. 7:15 Rabbet Cut

General Brock Secondary School, Burlington *James C. Fish Photography*

Fig. 7:9

piece. This will ensure a straight and true edge. If the piece is long, it is much better to use a long plane that will bridge the low spots and cut the high points until the edge is straight. Figures 7:9 and 7:10 illustrate this principle.

When planing end grain, make fine cuts with a sharp plane. See page 45 for three methods of planing end grain.

It is often necessary to cut a chamfer or a bevel on a board. The difference between these two terms, which are often confused, is illustrated in Figure 7:11. A *chamfer* is generally a 45° angle cut at the *arris* (the line where two surfaces meet at a 90° angle), and is generally made for decorative purposes. A *bevel* is cut the full thickness of the piece and at any angle. It is generally made for some purpose other than decoration.

Both the chamfer and the bevel can best be cut with a plane after they have been laid out with a marking gauge or

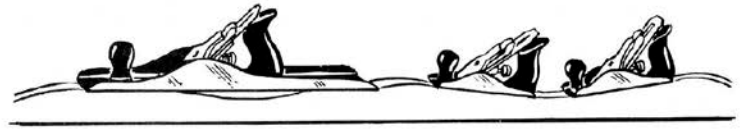

Fig. 7:10

A *spokeshave* (Figure 7:20) can be considered as belonging to the plane family. The principle of the cutting action is the same; it is really a short-bottomed plane with a handle on each side, which makes it easy to push over curved surfaces. The spokeshave should be pushed away from the operator, so that it cuts on the downstroke, as illustrated in Figure 7:21. If this is not done, the blade tends to dig in or chatter. Spokeshaves are made with convex and concave bottoms, as well as with straight ones. The blade is adjusted by thumbscrews on the type shown, while on other types the blade must be tapped down to the correct setting.

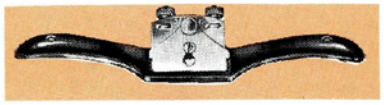

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Fig. 7:20 Spokeshave

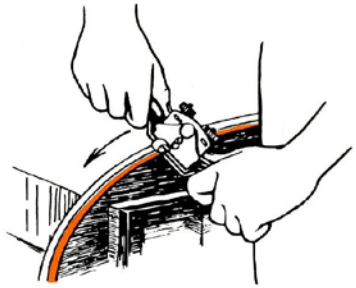

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Fig. 7:21 Use of a Spokeshave to Cut a Chamfer on an Outside Curve

Squaring stock

One of the chief purposes of a plane is to reduce stock to the correct size and shape, an operation often referred to as *squaring stock*, or *truing up stock*. More specifically, these terms mean to make a true rectangular shape with all surfaces flat, all corners square, all opposite sides parallel, and of the correct thickness, width, and length. To produce such a piece of stock simply requires the standard planing operations with which you may be quite familiar. However, to perform them well and in the proper sequence, testing each operation as it is completed, is an important step that you should learn to do automatically in the construction of most projects made from wood.

It is important that you plane the sides, edges, and ends of the board in order and at right angles to each other. Not all tradespeople perform the steps in the same sequence, but the same results must be achieved. The order of operations often used is as follows:

1. *Plane the face side.* After cutting the stock to rough length and width, select the better of the two broad surfaces (the one with the fewest blemishes or defects) and plane this surface flat and smooth. It can best be held in place for planing by using a vise, as shown in Figure 7:22. Plane always in the direction of the grain.

Test the surface for flatness with a try square or straightedge, as shown in Figure 7:23. Test the surface from edge to edge, from end to end, and diagonally from corner to corner. Mark this surface for the face side.

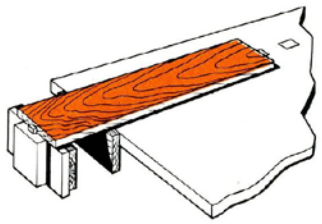

Fig. 7:22 Plane this face flat and smooth.

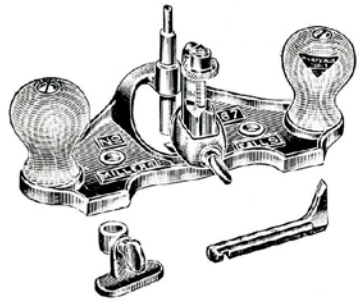

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Fig. 7:16 Router Plane

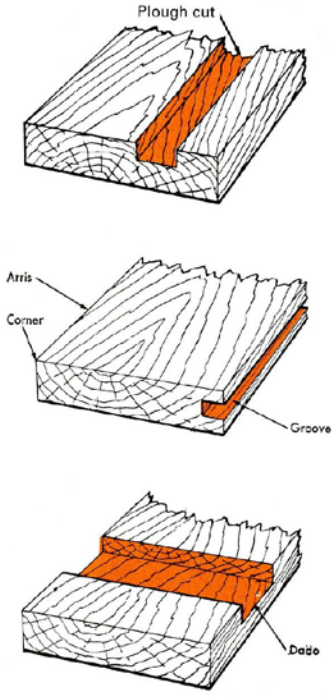

Fig. 7:17 These cuts can be made with a router plane.

The *router plane* is used to remove the waste material when making a groove, plough, or dado cut in a piece of stock. If the wide cut is parallel to the grain and on the side or face of the piece, it is called a *plough cut*. If it is on the edge of the stock, it is referred to as a *groove*. When the cut is at a right angle to the wood, it is a *dado* (see Figure 7:17). A saw or chisel is used to cut the boundary lines, while the router plane is used to take out the centre of the cut.

A new type of forming tool is shown in Figure 7:18. The cutting is done by a piece of steel mesh with sharp edges, which forms the bottom of the plane. The cutting surface is similar to that of a wood rasp. The blades are replaceable (Figure 7:19).

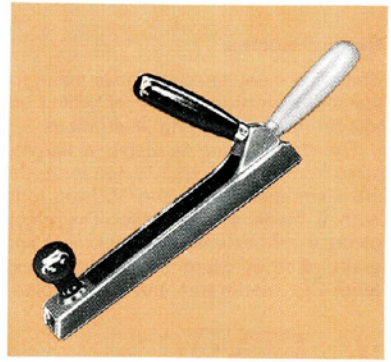

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Fig. 7:18 Surform Tool

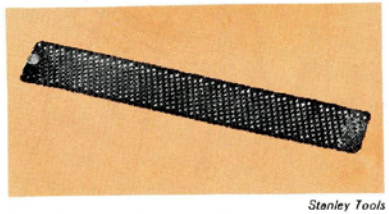

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Fig. 7:19 Replaceable Blade

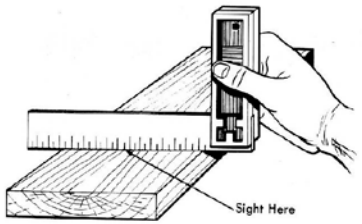


Fig. 7:23 Testing for Flatness

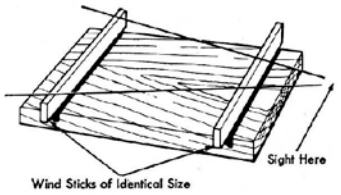


Fig. 7:24 Testing for Wind

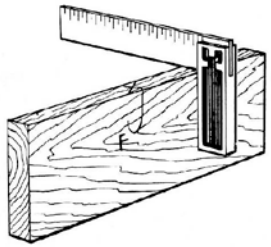


Fig. 7:25 Testing an Edge to the Face

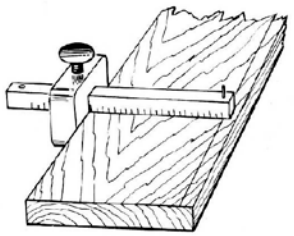


Fig. 7:26 Scribing Stock to Width

In some cases it is necessary to test the face surface of a board for *wind* (*twist* or *propeller shape*). This can be done by placing two straight-edged sticks of identical widths on the face of the piece, as shown in Figure 7:24. Sight over the tops of the wind sticks. If they are in line with each other, the piece is true and free from wind or twist.

2. *Plane the face edge*. Choose the better edge and place the piece in the vise with this edge up. Plane the edge straight and smooth by taking full-length cuts. Use a straightedge to test from end to end for straightness and a try square to determine if the edge is square to the face side.

Identifying check marks are sometimes used to indicate the face side and face edge. They generally consist of a mark with a loop on the face side and an X on the face edge, one end of which joins up with the loop on the face (see Figure 7:25).

3. *Cut and plane to width*. Set the mark-gauge to the required width of the stock. From the face edge just planed, scribe a line on the face side the full length of the stock, as shown in Figure 7:26. If there is more than 8 mm of stock to be removed, it may be necessary to cut off some of the surplus with a rip saw before planing. Plane the edge smooth, straight, square, and to the gauge line. Test with a try square from the face side.

4. *Plane to thickness*. With the marking gauge set to the required thickness, scribe a line on both edges and both ends (Figure 7:27). Be sure to scribe from the face side. Plane to this scribed

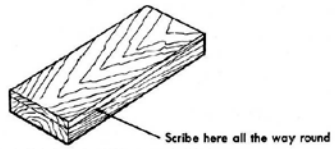


Fig. 7:27 Scribing to Thickness

line, and test for flatness and smoothness in the same manner as for the face side.

5. *Square one end*. Before measuring a piece of stock to its correct length, check one end to see that it is square with the face side and the face edge, and that it is straight and smooth. If this is not the case, it should be planed. Care must be taken when planing end grain or it will splinter at the edge. There are three methods of avoiding this splintering:

(a) A scrap piece of wood may be placed at the edge as shown in Figure 7:28.

(b) Plane halfway across the piece from each edge. This will prevent the edge from splitting if the plane is lifted slightly before the blade passes over the far edge. Test the end from the face side and edge.

(c) Cut a chamfer on the waste edge of the board and plane towards the chamfer (see Figure 7:31). If this method is used the end must be squared before the stock is reduced to the finished width.

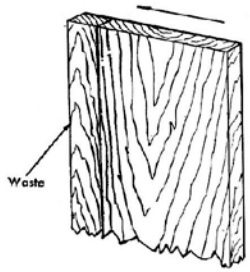


Fig. 7:28 Scrap Wood Placed at the Edge

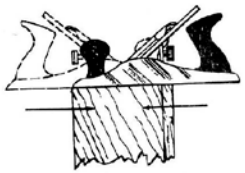


Fig. 7:29 Planing Halfway from Each Edge

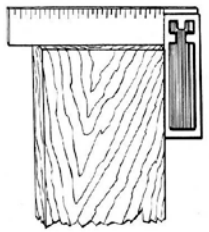


Fig. 7:30 End should be square with face edge

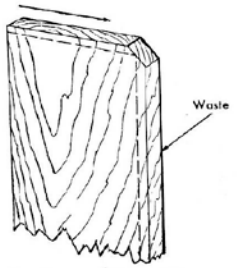


Fig. 7:31 Chamfer Cut on Waste Edge

6. *Measure and cut to length*. Mark the board to the exact length by measuring the desired distance from the finished end. Square a line across the piece to this point. Either plane or saw the piece to this line. If more than 6 mm is to be removed, it should be sawn with a back saw on a bench hook, as shown in Figure 7:32.

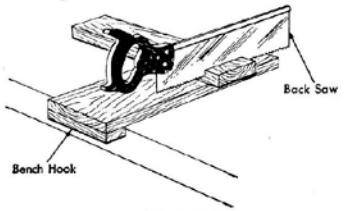


Fig. 7:32

CHAPTER EIGHT

hand saws and their uses

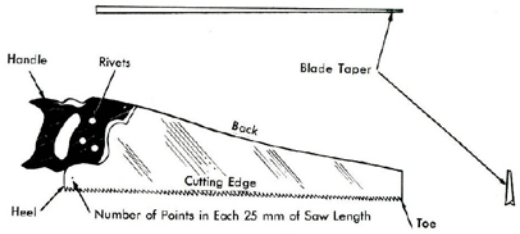


Fig. 8:1

Hand saws, which are so necessary for the cutting and shaping of wood and appear so easy to use, are, nevertheless, probably the most misused of all tools. Why is this so? Lack of knowledge about the proper way to use hand saws and inexperience account for much of the mistreatment of these tools. Below are some of the common ways in which they are incorrectly used and abused.

(a) The wrong type of saw is often used for the cut required.

(b) The wood being cut is not firmly held or supported.

(c) Cuts are made freehand without the use of proper layout lines.

(d) Hand saws are used that are not sharp.

(e) Inexperience and overconfidence result in a poor job; hand sawing requires more skill than is at first apparent.

In order to avoid these mistakes, you should become familiar with the various kinds of saws, their construction and their uses.

The essential parts of the hand saw are shown in Figure 8:1.

There are many types, sizes, and shapes of hand saws, each manufactured for a different purpose. The term *hand saw* usually refers to the general-purpose *cross-cut* or *rip saw* shown in Figure 8:1.

A number stamped on most saw blades near the heel indicates the number of points per 25 mm. There is always one tooth less than there are points for each 25 mm of saw blade, as is illustrated in Figure 8:2.

Cross-cut saws vary in coarseness from 7 points to 13 points per 25 mm. Rip saws as a rule are somewhat coarser and may have as few as 5 points per 25 mm of saw length.

Hand saws are ground so that the blade tapers along the back from the

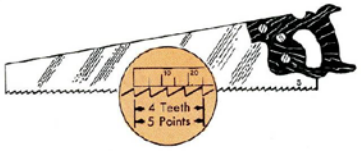


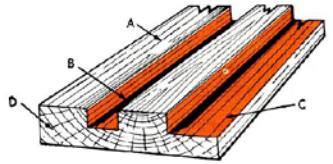
Fig. 8:2

Cut on the waste side of the line and lightly plane, using one of the methods just described for planing end grain.

This may appear to be a lengthy procedure to bring one piece of stock to the correct size and shape. However, you will find that you will save time in the long run by having pieces that fit properly. You will also gain valuable experience by performing these operations correctly.

In some cases when curves or special shapes must be cut from a pattern or layout, some of the steps just described here may be omitted and others substituted.

6. What type of plane would be used to plane surfaces A, B, C, and D in the piece of stock shown here?



7. Illustrate by a sketch (a) an arris, (b) a chamfer, and (c) a bevel.

ASSIGNMENT

Planes and planing

1. List four types of bench planes. Give their purpose and their size.
2. Make a drawing of a jack plane and name the parts.
3. Explain why it is better to use a jointer plane to straighten the edge of a long piece of stock rather than a smoothing plane.
4. What is the special purpose of (a) a rabbet plane? (b) a router plane?
5. Show by arrows the direction in which the spokeshave should be pushed to smooth the curved edge of the piece of stock shown at the top of the next column.

Squaring stock

8. What is meant by "squaring stock"?
9. List the first three steps in the operation of squaring stock.
10. How should the face side of a board be tested to make certain that it is true?
11. Describe three methods of planing the end grain of a piece of stock.
12. Explain how a piece of stock is tested for wind.
13. Must the steps in squaring stock always be performed in the same order? If not, what other order could be suggested?

across the grain, and, if necessary, for ripping when a fine cut is required, although in this case it cuts more slowly than the rip saw.

Back saw

The back saw, with 12 to 14 points per 25 mm of saw length, is a fine cross-cut saw that is used for fine work. It generally has little set.

The blade has a stiffening rib at the back that holds the blade firm and tends to make it easier to make a straight and square cut. The common length of these saws is from 300 mm to 400 mm. Such a saw is shown in Figure 7:32.

Coping saw

The coping saw, sometimes referred to as a *fret saw*, is used for making curved cuts in thin stock. The blade is held tight by the tension placed on it by the steel frame. The blades are narrow and are held in place by either a loop or a pin in the ends of the blade, which fits into the frame and handle.

When you use a coping saw, the work must be held firmly in a vise. If the work is thin, a piece of stock should be placed behind the wood being cut in order to stiffen it. A V block is often used when cutting small layouts, as shown in Figure 8:5. When inside designs are cut, a hole must be bored in the waste stock so that the blade can be inserted and the saw reassembled to cut out the design.

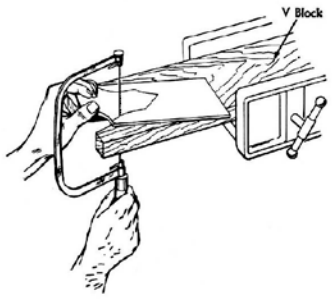


Fig. 8:5 When using a coping saw, cut on the down stroke.

Compass saw

As the name implies, the compass saw was designed to cut circles. The blade is ground to a point at the end and with the back thinner than the cutting edge. This gives the blade clearance when cutting a sharp radius. This saw can be used for cutting with the grain or across it.

Keyhole saw

The keyhole saw is similar to the compass saw; in fact, they are often confused, so that the name keyhole saw is frequently used for both of these saws. However, the properly named keyhole saw, as shown in Figure 8:7, is smaller and is used for cutting smaller arcs. The blade is made so that it will slide into the handle in order for it to be used in more restricted areas. This saw is sometimes called a *pad saw*.

Fig. 8:6 Compass Saw

Fig. 8:7 Keyhole Saw

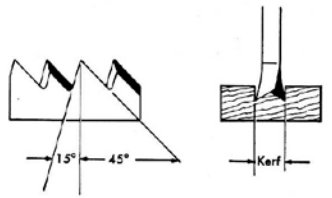


Fig. 8:3

handle to the toe and from the cutting edge to the back. This double taper of the blade makes the saw lighter to handle, stiffens the blade to prevent bending or buckling, and as well provides clearance for the saw blade as it cuts into the wood so that it will be less likely to bind or pinch.

Cross-cut saw

The purpose of this saw is to cut at a right angle to the grain of the wood. The teeth are so shaped that they cut the fibres evenly and smoothly. The shape of the teeth is shown in Figure 8:3.

So that the saw blade will have additional clearance to prevent it from binding, every other tooth is bent outward in the opposite direction. This is called the *set* of the saw. The amount of the set of a saw determines the width of the cut (*kerf*) the saw will make. In general, coarse saws that are used for heavy work have more set than fine saws

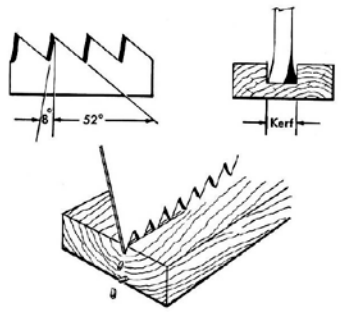


Fig. 8:4 Cutting Action of a Rip Saw

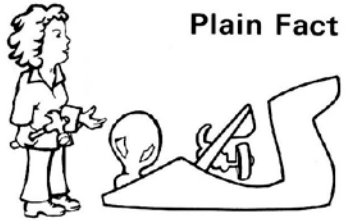
that may be used for lighter and finer work.

The length of a hand saw blade may vary from 500 mm to 700 mm, the most-used lengths being 600 mm and 650 mm.

Rip saw

The rip saw is used to cut parallel to the grain of the wood. It differs from the cross-cut saw only in the shape of the teeth, which are like a series of chisels. Figure 8:4 illustrates the shape of the teeth and their cutting action through the fibres.

Although rip saws and cross-cut saws are made in identical sizes, the cross-cut saw is better adapted for general work because it can be used not only for cross-cutting but also for cutting diagonally



Plain Fact

IF LUMBER IS DAMP USE A SAW WITH SUFFICIENT SET TO PREVENT IT FROM BINDING.

Fig. 8:12 Testing the Saw for Vertical Position

4. Hold the saw so that the blade is at right angles to the face of the board. It may be necessary at first to test the blade with a try square, as shown in Figure 8:12. However, with practice, you will be able to hold the saw automatically at the correct angle.
5. Finish the saw cut with short, easy strokes. To prevent the wood from splitting or breaking unevenly from its own weight, support the part to be cut off with the other hand.

James C. Fish Photography

Fig. 8:13 Use double layout lines when cutting plywood.

Fig. 8:8 Dovetail Saw Used for Fine Work on Thin Stock

How to use a hand saw

Since the use of a hand saw is so essential in woodwork, it is very important that you not only be familiar with the various types of hand saws but also that you learn how to use them correctly. To be proficient in woodwork, you must be able to square the end of a board with a hand saw so that the cut is perfectly square with the face side and the face edge, and so that the cut is made on the waste edge of the line.

Only through practice can one acquire the ability to use a hand saw skilfully. However, here are some pointers that may make your practice more effective:

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Fig. 8:9 Cross-cutting

Fig. 8:10 Rip Sawing

1. Make sure the work is held firmly. If the piece is short, it should be placed in a vise or on a bench hook. If the stock is long, it can be placed on two saw-horses. Hold the board steady with the knee.
2. Use the correct saw for the job you are doing.
3. Start the saw kerf on the waste edge of the line by drawing the saw lightly over the edge of the board at the correct angle (see Figure 8:11).

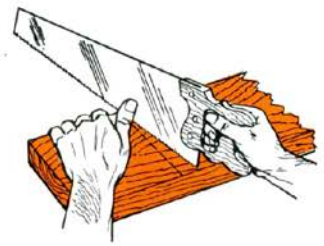


Fig. 8:11 Starting the Cut on the Waste Side of the Line

CHAPTER TWENTY-TWO

wood joints

The construction of good joints is an important part of woodwork. Very few objects of wood can be made from one single piece. We do not consider two pieces of wood that have simply been nailed or screwed together as forming a wood joint in the true sense. However, when two pieces are cut or shaped to fit each other so that with the aid of glue they are as strong as, or stronger than, one single piece and have a neat appearance, they can be considered to make a good wood joint. There are a great number of joints used in all branches of the woodworking trade; only the ones most frequently used are described here.

Edge-to-edge joint

One of the joints you may be called upon to make first is the edge-to-edge joint. This joint is used when making many articles of wood that require parts wider than one piece of lumber. This makes it necessary to glue two or more boards edge to edge to make one wide section. It is seldom possible to get a board wide enough for the larger sections of most furniture; even if it were, it is more advisable to make the part by gluing narrow boards together, as it will keep its shape better. Lumber more than 150 mm wide should not be used for good cabinetmaking, as the wider the piece the greater the warpage that will take place. It is important that warpage be kept to a minimum. One of the ways this can be done is to use narrow stock.

In preparing the pieces for gluing, you must take several factors into consideration:

1. The grain of the wood should run in the same direction in each piece.
2. Place the face side of all boards up; the better of the two sides should be considered the face. Mark this side with the letter *F* or some other indicating check mark.
3. Try to position the pieces so that their colour, grain, and texture match.
4. Reverse the direction of the annual ring on alternate boards.

Lumber tends to warp in the direction of the annual rings. That is, the rings tend to straighten out, warping the piece into a cup shape. This warpage can be reduced if the direction of the annual rings is alternated in consecutive pieces. Thus the warpage of one piece counteracts the warpage of the next.

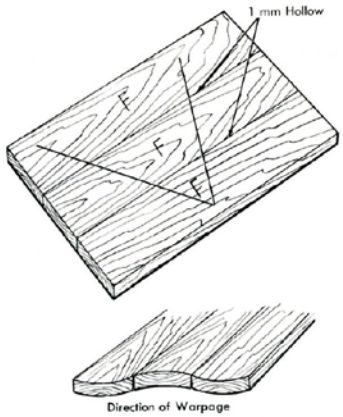
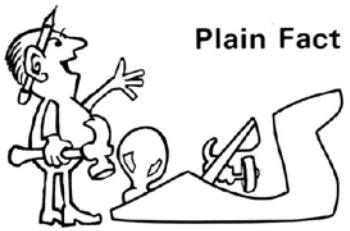


Fig. 22:1 Edge-to-Edge Glue Joint



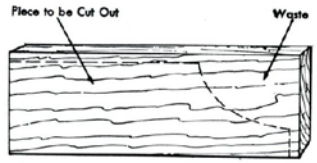
Plain Fact

A PROPERLY USED SHARP SAW IS MORE ESSENTIAL THAN BRUTE STRENGTH IN MAKING A GOOD SAW CUT.

6. Always cut to a line, never freehand.
7. When cutting plywood sheet stock, use a cross-cut saw that is 10 points per 25 mm of saw length or finer. Work carefully, with the sheet well supported to prevent splintering on the under side. It helps if the pencil line is scored with a knife or chisel before cutting. This will prevent the fibres from being torn. When several pieces are to be cut from one sheet, it is a good idea to make double layout lines to indicate the edge of the saw kerf, as shown in Figure 8:13.
8. Hand saws are very useful tools; take proper care of them. Keep them sharp. Do not drop them or handle the blade with perspiring hands. Oil the blade occasionally to prevent rust.

ASSIGNMENT

1. Show, by means of a drawing, the difference between the teeth of a cross-cut saw and those of a rip saw. Show the angle of the teeth.
2. What does the number 10 stamped on the heel of a hand saw indicate?
3. What determines the width of a saw kerf?
4. What is meant by the set of a hand saw? Why must a hand saw have set?
5. Are there more or fewer points than teeth per 25 mm of saw length on a hand saw?
6. Explain how you finish the cut when using a cross-cut hand saw.
7. What is the special purpose of (a) the back saw? (b) the coping saw? and (c) the compass saw?
8. Make a drawing of a hand saw and name the parts.
9. Where should the saw kerf be in relation to the line?
10. What two factors will help you master the skill of making a perfectly square cut with a hand saw?
11. State three rules for the care of a hand saw.
12. In what order would you make the cuts required to produce the piece shown here? Name the type of saw you would use for each cut.



slight lead or bevel on the end so that the glue will not be scraped off the side of the hole as it enters.

Dowels are seldom used singly; two should be used to prevent any pivot action that might take place. If the joint is wide, three should be used.

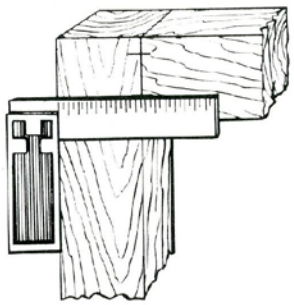


Fig. 22:4 Locating the Dowels on the Face of the Work

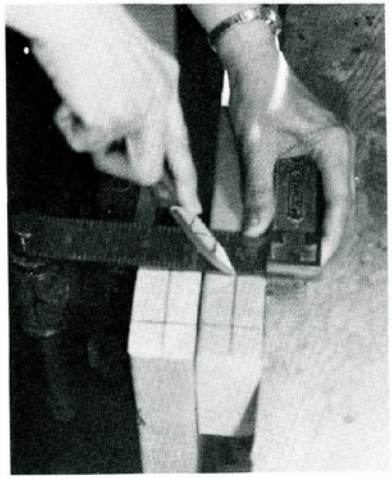


Fig. 22:5 Laying Out a Dowel Joint

How to lay out a dowel joint

1. If an end of one piece is to be butted to the edge of another, the location of the dowels should be marked on the face of the work, as shown in Figure 22:4.
2. Place the two surfaces to be butted together side by side and in an upright position in the vise, as shown in Figure 22:5 and 22:6.
3. Square lines across both pieces at the correct locations using a sharp pencil or knife (see Figure 22:5).
4. Set the marking gauge to exactly half the thickness of the stock and scribe a line from the face side of the work.
5. Make a punch mark where these two lines intersect. This will be the exact centre for the dowel location.

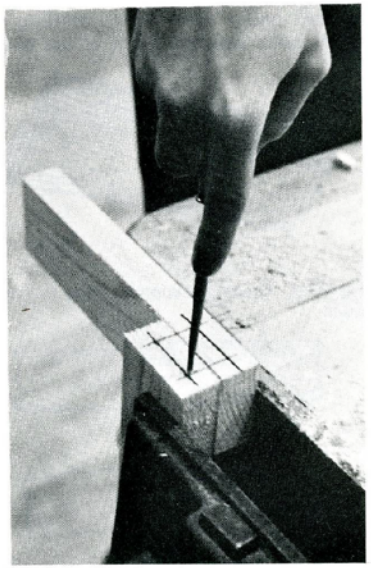


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Fig. 22:6 Laying Out an End-to-Edge Dowel Joint

Lay out the pieces, as shown in Figure 22:1, and make a large pencilled "V" across the pieces so they will be glued together in the correct order. The edges of the pieces must now be planed to fit each other. Each piece should be planed so that the edge is straight and square with the face. If the pieces are long, the joint should be planed so that it will be open 0.5 mm to 1 mm in the centre. This is called a *hollow glue* or *spring joint*. The reason for the slight hollow is that most wood contains an excess of moisture at the time the joint is made. The wood tends to dry out more at the ends, causing it to shrink more there. To compensate for this, the centre is left slightly hollow so that when the shrinkage takes place there will be equal pressure along the full length of the joint. This tends to prevent the joints from opening up at the ends. This hollow is invisible when the work has been glued and clamped. A hollow need not be left in short stock.

When the edges have all been fitted, place the work in two or more bar clamps. Check the joints before applying the glue. When the pressure is applied, the joints should be almost invisible.

Dowel joint

The dowel joint was probably the first type of wood joint used by man, as wooden pegs (dowels) were the first method of fastening two pieces together. Dowels are still used extensively, although not quite in the same form. Many fine pieces of well-preserved furniture that were made many centuries ago and are now found in our museums are held together entirely with wooden pegs or dowels, with no glue, nails, or screws. This furniture is still serviceable today and in excellent condition.

Dowel joints are relatively easy to construct. They may be used in conjunction with such joints as the edge-to-edge joint just described or the mitre or butt joints, shown in Figure 22:2, to give extra strength.

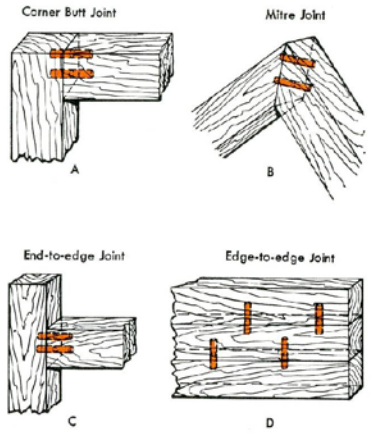


Fig. 22:2 Dowel Joints

The dowels are generally made in long lengths from a hard wood such as maple or birch. They are made in diameters from 6 mm to 20 mm. The size depends on the thickness of the wood to be joined, the 9.5 mm being the most common size used. A general rule for the length of the dowel is that it should be approximately seven times the diameter. The diameter of the dowel should be approximately one-third the thickness of the wood being joined.

A groove 3 mm deep should be cut the full length of the dowel to allow the excess air and glue to be forced out of the bottom of the hole. A more effective means of distributing the glue is to cut a spiral groove in the dowel, as shown in Figure 22:3. The dowels should have a

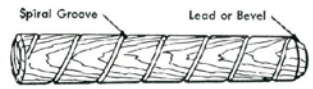


Fig. 22:3 Dowel

Dowel centres are shown in Figure 22:11.

Assembling a dowel joint
The dowels should be cut slightly shorter than the combined depth of the two holes. Insert the dowels and fit the two members together dry, before final gluing.

Mortise-and-tenon joint

The mortise-and-tenon joint may be considered one of the stronger, although more difficult, joints to make. There are many variations of this useful joint, but we will only describe the *blind mortise-and-tenon joint*, because it is the one most often used. This joint is shown in Figure 22:12.

The mortise-and-tenon joint is used extensively for furniture, window sashes, and doors.

The *tenon* is the projecting part of one section of the joint, and the *mortise* the corresponding recess into which the tenon fits. The thickness of the tenon should be approximately one-third of the total thickness of the stock. The type of mortise-and-tenon joint and the length of the tenon will depend on the width of the stock.

To lay out the tenon

1. From the end of the stock, measure the length of the tenon, and square a line all the way round the piece (see line A in Figure 22:13). This is called the *shoulder* of the tenon.
2. On the shoulder of the tenon lay out the thickness of the tenon (points B in Figure 22:13). From these two points, scribe lines on the two edges and the end of the piece as shown. A marking gauge can be used for this. However, it is faster and more accurate to use a mortise gauge that has two scriber points, so that both sides

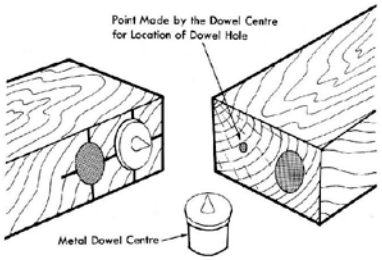


Fig. 22:11 Locating Dowel Holes Using Dowel Centres

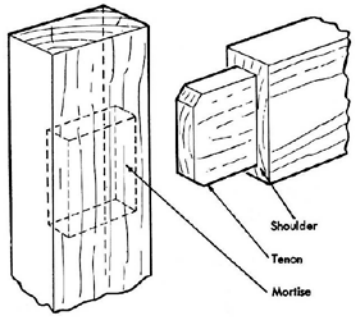


Fig. 22:12 Blind Mortise-and-Tenon Joint

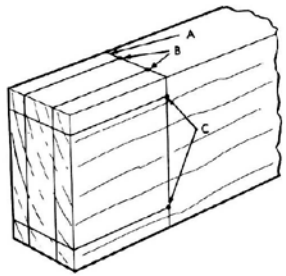


Fig. 22:13 Layout of a Tenon

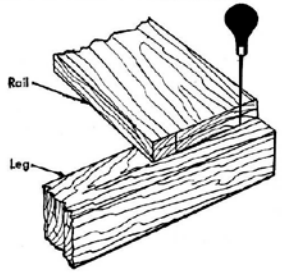


Fig. 22:7 Rail-to-Leg Dowel Joint

If one of the pieces is thicker than the other, as is the case when attaching a rail to a table leg, the dowel centres can be located as shown in Figure 22:7.

If dowels are to be used in an edge-to-edge joint, they can be laid out as shown in Figure 22:8.

Select the correct-size auger bit for the dowels being used. When starting to bore, make sure the point of the bit is in the hole made by the scratch awl at the intersection of the lines. Keep the bit perpendicular to the surface of the wood. If the holes are not straight, or are not started correctly, the two pieces will not be properly aligned (see Figure 22:9).

A better job can be made by using a dowelling jig, which, if properly set on the work, ensures that the holes will be correctly located and bored at a right angle to the face of the work. Figure 22:10 illustrates one of these dowelling jigs.

A fast and accurate method of locating the centre for dowel holes is by using metal dowel centres. These are flanged cylindrical metal plugs (made in sizes ranging from 6 mm to 20 mm, with 9.5 mm the most popular) which fit into the bored hole leaving a sharp point projecting. Thus, when the holes in one piece are laid out and bored, and when the dowel centres are inserted and the mating parts pressed together, the dowel centre points will accurately locate the centres for the holes in the second piece.

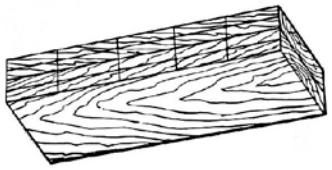


Fig. 22:8 Dowel Location for Edge-to-Edge Joint

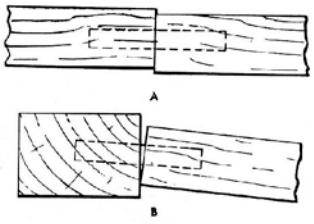


Fig. 22:9 The Result of Poor Alignment of Dowels

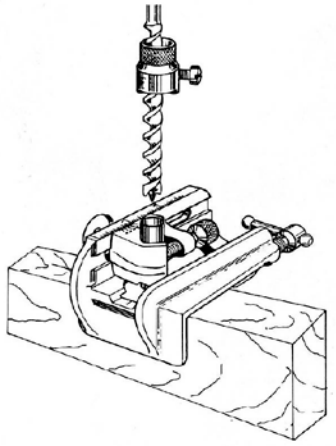


Fig. 22:10 Dowelling Jig

of the tenon can be laid out at one time. Such a gauge is shown in Figure 3:25. Always scribe from the face side of the work.

3. Locate points C of Figure 22:13, which represent the width of the tenon, and scribe lines from these points on the sides and end of the piece in the same manner as for the thickness of the tenon.

To cut the tenon

1. With the work upright in the vise and using the back saw, cut along the lines representing the width and the thickness of the tenon, remembering to cut on the waste side of the lines (see Figure 22:14).
2. With the work on its side in the vise or on a bench hook, make the shoulder cuts (line A, Figure 22:13) until the waste stock falls free. Care should be taken not to cut into the tenon and so weaken it.

To lay out the mortise

1. With a try square, lay out lines A and B, as in Figure 22:15. These lines represent the length of the mortise, which should be slightly larger than the width of the tenon.

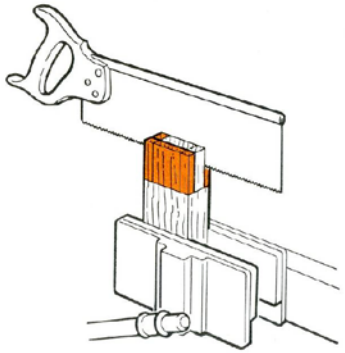


Fig. 22:14 Cutting a Tenon

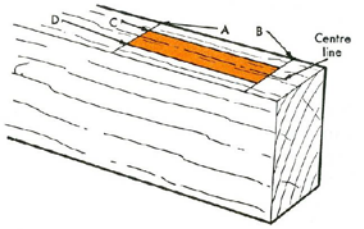


Fig. 22:15 Layout of a Mortise

2. With the mortise gauge, lay out lines C and D. Set the mortise gauge to the same width as you did for marking the thickness on the tenon.
3. Lay out a centre line midway between these two lines.

To cut the mortise

1. Fasten the stock firmly in the vise with the scribed edge up.
2. With a brace and bit the same diameter as the width of the mortise, bore a hole at either end of the mortise layout. The point of the bit must be started on the centre line. Keep the bit in a perfectly perpendicular position when boring. A depth gauge should be used so that the mortise will be cut slightly deeper than the length of the tenon.
3. Bore as many holes as are required between the two end holes. Each hole should slightly overlap the next (see Figure 22:16).
4. When all the holes have been bored, cut out the remaining material, using a mortise chisel and a mallet.

The mortise may be cut by using only a mortise chisel and a mallet without first using the brace and bit. This method works very well with soft wood. A mortise chisel the same width as the thickness of the tenon should be used. Do not attempt to remove too much stock with the chisel at one time (see Figure 22:18).

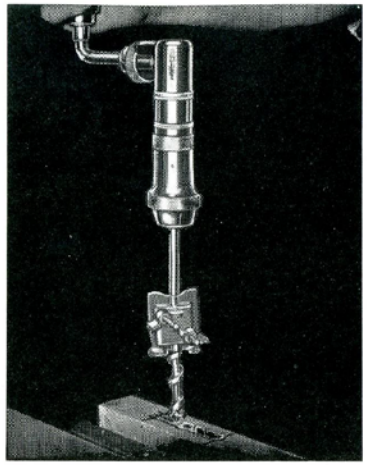


Fig. 22:16 Boring the Holes for a Mortise

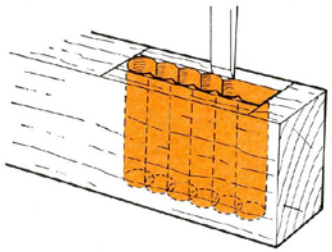


Fig. 22:17 Cutting Out Remaining Material with a Mortise Chisel

Some final fitting may be necessary to make the joint fit snugly. Smear glue liberally on the tenon before clamping.

Other types of mortise-and-tenon joints are the *through mortise-and-tenon,* where the tenon goes all the way through the piece, the *haunch mortise-and-tenon,* the *stub mortise-and-tenon,*

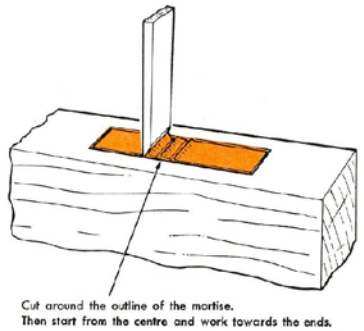


Fig. 22:18 Cutting a Mortise with a Mortise Chisel

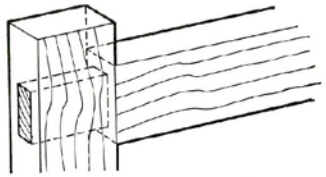


Fig. 22:19 Through Mortise-and-Tenon Joint

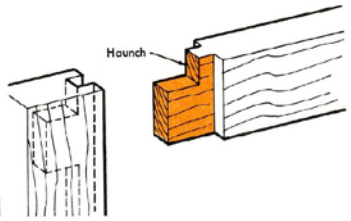


Fig. 22:20 Haunch Mortise-and-Tenon Joint

the *open mortise-and-tenon,* the *double mortise-and-tenon,* and the *mortise-and-tenon with a key.* These joints are shown in Figures 22:19 to 22:24.

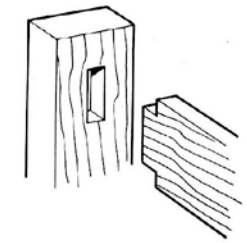


Fig. 22:21 Stub Mortise-and-Tenon Joint

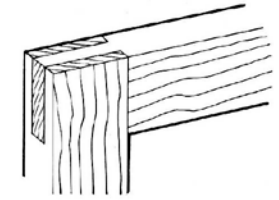


Fig. 22:22 Open Mortise-and-Tenon Joint

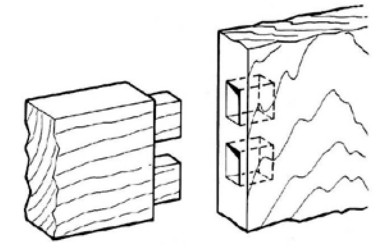


Fig. 22:23 Double Mortise-and-Tenon Joint Used in Door Construction

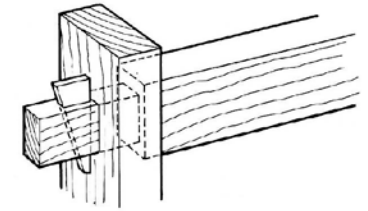


Fig. 22:24 Mortise and Tenon with a Key Used Where Joint Must Be Taken Apart

Cross-lap joint

The cross-lap joint is often called the *half-lap joint* because an equal amount of material is removed from each piece, making the surfaces of the two pieces flush or even. There are several variations of this joint. Four of these are shown in Figures 22:25 to 22:28.

How to lay out a centre cross-lap joint

1. Set one piece over the other at the position of the joint, as shown in Figure 22:29, and mark the cross-lines at both edges of the pieces as shown.
2. Square the lines across the surface of both pieces, using a try square and a knife or a sharp pencil.
3. Scribe a line for the depth of the notch with a marking gauge. This depth should be one-half the thickness of the pieces.
4. Extend the lines from the surface of the pieces on both edges down to the depth mark just made.

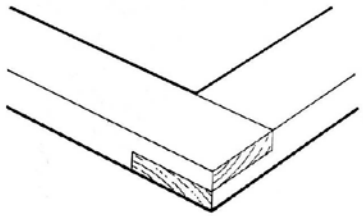


Fig. 22:25 Corner Lap Joint

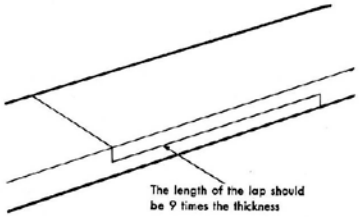


Fig. 22:26 End Lap Joint

How to cut a lap joint

1. With a back saw, make a cut to the correct depth just inside the cross-lines on both pieces.
2. Make several cuts between the lines down to the same depth, as shown in Figure 22:30.
3. With a socket chisel and mallet, remove the waste stock, chiselling from both sides of the piece to prevent the wood from splitting out below the depth mark (see Figure 22:31).
4. Fit the two pieces together for a trial assembly. Some fitting may be necessary. The pieces should fit snugly, but it should not be necessary to drive them together.

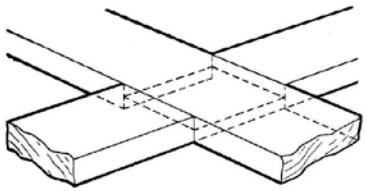


Fig. 22:27 Centre Lap Joint

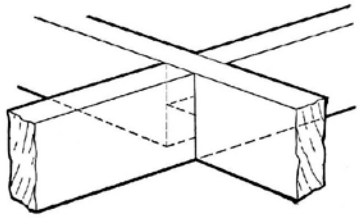


Fig. 22:28 Edge Lap Joint

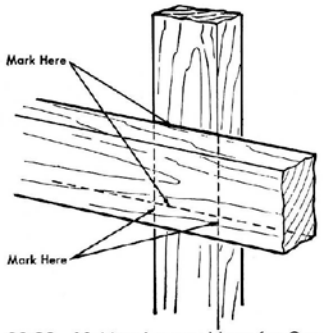


Fig. 22:29 Making Layout Lines for Cross-Lap Joint

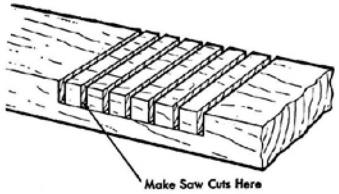


Fig. 22:30

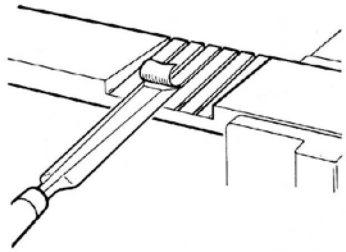


Fig. 22:31 Removing Waste Stock with a Chisel

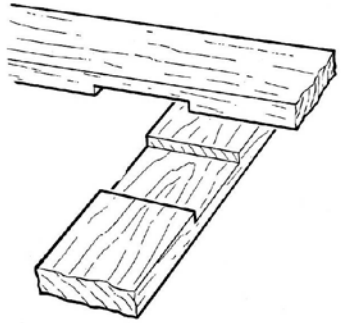


Fig. 22:32 All Wood Removed

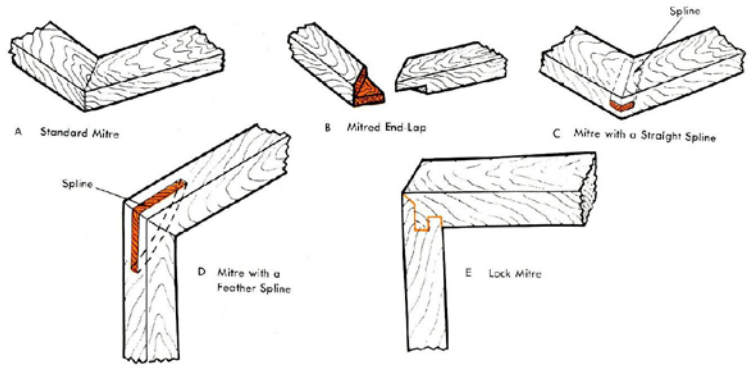


Fig. 22:33 Mitre Joints

Mitre joint

The mitre joint is essentially a butt joint that has been cut to 45° so that when the two pieces are placed together they will form a right angle, or a 90° corner, with no end grain exposed. Mitre cuts may be made at other angles, such as 30° to make a six-sided figure. However, the 45° mitre is the one most frequently cut because it is required for making all manner of small frames. Several types of mitre joints are shown in Figure 22:33.

The best method of cutting a mitre joint is to use a *mitre box*, which may be either the hand-made type illustrated in Figure 22:34, or the metal mitre box, which requires a special back saw, shown in Figure 22:35. A more accurate cut can be made with the metal mitre box, and it may be set to cut any desired angle. It is equipped with an adjustable stop that can be set when you wish to cut duplicate pieces of exactly the same length.

In laying out and cutting a mitre it is important that the piece be measured accurately to length and that the saw cut be made on the waste side of the line. The mitre box will determine the

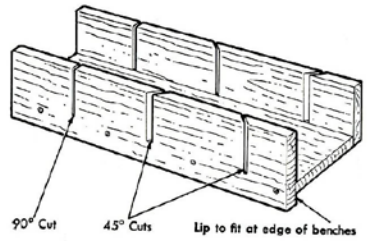
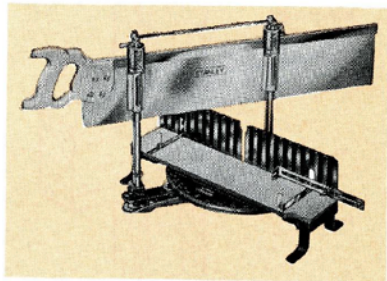


Fig. 22:34 Wooden Mitre Box



Stanley Tools

Fig. 22:35 Metal Mitre Box and Saw

correct angle if the work is held securely against the back of the box.

Mitre joints are generally held with glue and nails, although dowels are sometimes used for extra strength.

Dado joint

A *dado* is a groove cut across the grain of the wood. When another piece is fitted into this groove it is called a *dado joint* (see Figure 22:36). The dado joint is a strong, neat method of joining the end of one piece to the side of another. You probably have often seen cupboards or bookcases where grooves have been cut in the upright end section and the shelves set into them. This is a good example of a dado joint. Dado joints are also used in stepladders. In general the depth of a dado should be one-third the thickness of the stock.

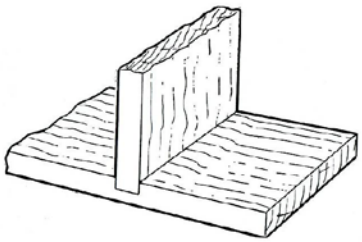


Fig. 22:36 Dado Joint

To lay out and cut a dado joint

Square the end of one piece. Place this piece in the desired position and mark on either side with a knife or a sharp pencil for the dado joint, as shown in Figure 22:37. Extend the lines down both edges of the piece. With the marking gauge, mark the depth of the dado. Using a back saw, cut just inside the two lines to the correct depth.

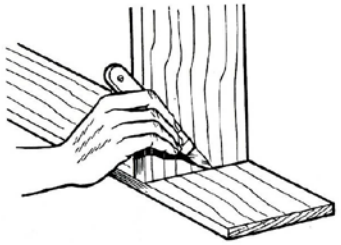


Fig. 22:37 Marking the Layout for a Dado Joint

Remove the wood between the lines with a mallet and a socket chisel. Fit the two pieces together for a trial assembly. Some final fitting may be necessary to make the joint fit snugly. The pieces should not have to be driven together.

If the dado is too snug, do not attempt to widen it by chiselling or filing. The use of sandpaper or a finely adjusted block plane on the insert will ensure a neater fit. Where it is not desirable to have the dado exposed on the face edge of the work a *stopped dado joint* is used. The dado does not run the full width of the stock (see Figure 22:38).

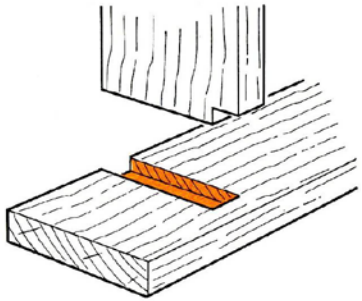
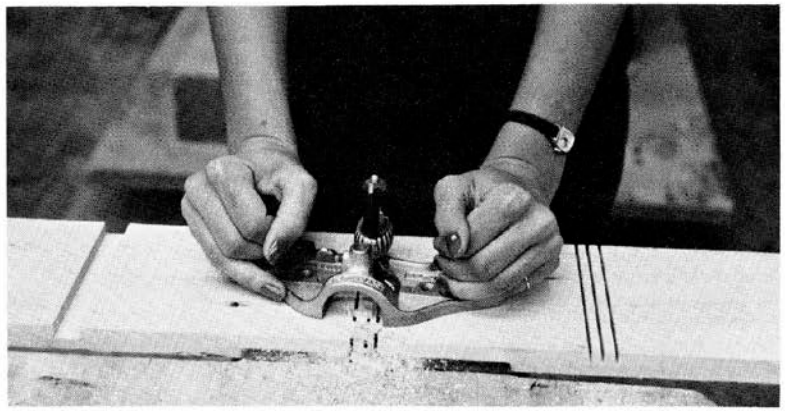
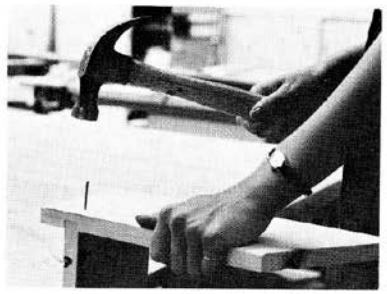


Fig. 22:38 Stopped Dado Joint



Central Technical School, Toronto

Fig. 22:39 Making a Dado Cut Using a Router



Central Technical School, Toronto

Fig. 22:40 Assembling a Dado Joint

Rabbet joint

The rabbet joint is actually a dado joint that is made at the end of the piece (see Figures 22:41 and 22:42). It is used mainly for corner construction. The front of a drawer is often fastened to the sides in this manner.

A rabbet cut may also be made the full length of a piece.

To lay out and cut a rabbet joint

Square the end of the pieces and place them together in the correct location. As shown in Figure 22:43, mark along the edge of piece number 1 with a knife or

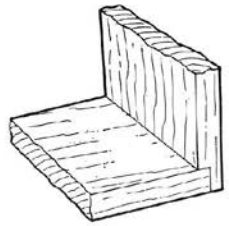


Fig. 22:41 Rabbet Joint

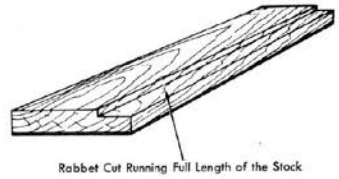


Fig. 22:42

a sharp pencil. Continue this line down the edge of the piece. Scribe a line to the correct depth on both edges and on the end of piece number 2. With the back saw, cut just inside the line to the required depth. Remove the waste wood with a socket chisel and mallet. Do any necessary trimming with a sharp chisel to make the pieces fit properly. Both the rabbet and the dado joints can be nailed, screwed, or glued together.

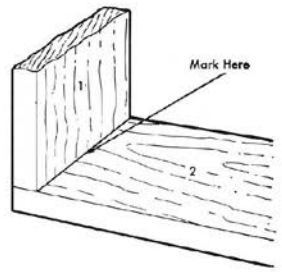


Fig. 22:43 Layout of a Rabbet Joint

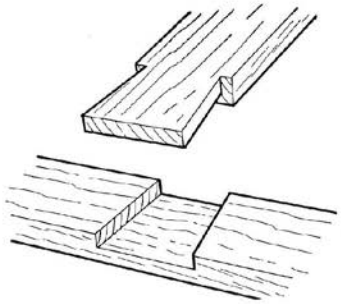


Fig. 22:44 Dovetail Half-Lap Joint

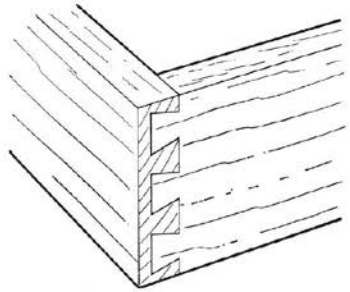


Fig. 22:45 Multiple Dovetail Joint—As Used for Drawer Construction

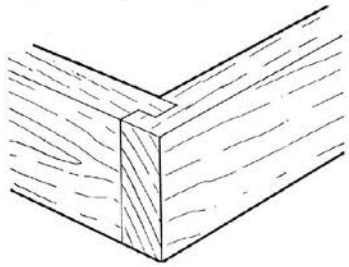


Fig. 22:46 Dado and Rabbet Joint

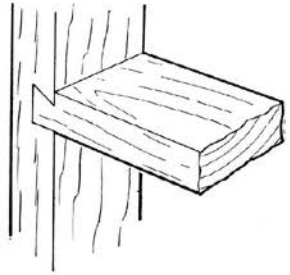


Fig. 22:47 Dovetail Dado Joint

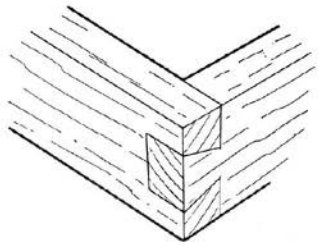
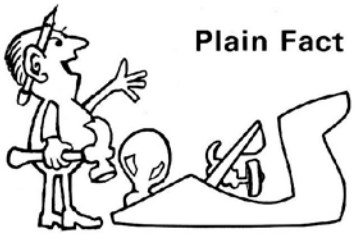


Fig. 22:48 Through Single Dovetail

Dado and rabbet joints

23. What is a dado cut?
24. List four wooden articles in which you might use dado joints.
25. What is the difference between a dado and a rabbet joint?
26. List the steps in making a rabbet joint.
27. How are dado and rabbet joints held together?
28. How would you lay out and cut the joints shown in Figure 22:46?



Plain Fact

THE HOLDING POWER OF A WOOD JOINT DEPENDS ON HOW WELL THE PIECES FIT. NO AMOUNT OF GLUE WILL MAKE A POOR-FITTING JOINT SECURE.

There are a great many other joints that are used in woodwork. Some of these are shown in Figures 22:44 to 22:48.

ASSIGNMENT

1. What are the requirements of a good wood joint?

Edge-to-edge joints

2. Why is it more advisable to use two narrow boards glued edge to edge than one wide piece?
3. Make a drawing of three boards ready for gluing. Show all the markings that indicate their correct position.

Dowel joints

4. Why were dowel joints the first type of wood joints used?
5. In what general types of wood joints are dowels used?
6. (a) From which species of wood are dowels generally made?
   (b) In what sizes are dowels made?
   (c) What is the common length for individual dowels?
7. Why is a groove cut in the side of a dowel? Why do they have a lead?
8. Explain how end-to-edge dowel joints are laid out. (You may use diagrams for your explanation.)
9. How is a dowelling jig used?

Mortise-and-tenon joints

10. List three types of mortise-and-tenon joints, and three places in which they are used.
11. What should be the thickness of a tenon on a piece of stock 30 mm thick?
12. What is the difference between a marking gauge and a mortise gauge?
13. Why is a centre line drawn on the mortise layout?
14. Describe how the mortise is cut.

Cross-lap joints

15. Why is a cross-lap joint often referred to as a half-lap joint?
16. Make a sketch of three types of lap joints.
17. Describe how to lay out a centre cross-lap joint.
18. Why should the wood be chiselled from both edges of the piece when making a cross-lap joint?

Mitre joints

19. What is meant by a mitre cut?
20. List the advantages and disadvantages of the metal and the wooden mitre boxes.
21. If you wish to make an eight-sided frame using eight individual pieces, at what angle would you make the cut at each end of them? at each end of the twelve pieces for a twelve-sided figure?
22. How are mitre joints held together?