FINE HOMEBUILDING
DECEMBER 1982/JANUARY 1983 No. 12

An Introduction to Timber Framing

Learning this traditional method begins with the mortise-and-tenon joint

by Tedd Benson

The standards of work in timber-frame structures aren't new; we have inherited them from a 2,000-year-old tradition of craftsmanship. The evolution of this building method (which throughout much of history was just about all there was to carpentry) resulted from pursuing a very simple goal: to put together better and stronger buildings. The proof of the success of this development can be found in the barns, houses, churches, temples and cathedrals that have become architectural treasures in all parts of the world. It wasn't until the advent of nails, joinery hardware and dimensioned lumber that true timber framing went into decline.

In reviving the craft today, we pay careful attention to the lessons and the standards evinced by these old buildings. Indeed, the thrill of practicing timber framing today lies in knowing that there is much left to learn, and in believing that each improvement brings us closer to the day when we can feel we are no longer journeymen. At the same time, we are working toward continued refinement and development. Timber-frame buildings are finding renewed acceptance for many reasons, but the integrity of the structure and the rewards to the craftsman and home owner are preserved only when high standards are maintained.

In our own shop we have learned this obvious truth the hard way—good timber frames happen only as a result of good joinery. Precise work is as important in timber framing as it is in cabinetry, so joint-making is the first thing an aspiring timber-framer needs to learn.

Mortise and tenon—This joint is practically the definition of a timber frame. Most of the joints that go into a frame are variations on the basic mortise-and-tenon joint. Once you've mastered the skills for making this joint, you should be able to execute just about any other joint in the frame. And since there are several hundred joints in the average timber frame, speed and precision are equally important.

The joint we will be working on is the shouldered mortise-and-tenon (above). It's a good example of a slightly modified mortise-and-tenon. We use this type of joint where major girts or connector beams join a post. The full width of the horizontal timber is held by the bottom shoulder on the post, and this extra bearing surface makes the joint far stronger than a straight mortise-and-tenon.

Squaring up—Before you can lay out the joint, the timber must be square at the joint area. Each face of the joint must be square if you're going to achieve a precise fit. One way to square and flatten timbers is to run them through a large thickness planer. With pine,

What makes a good framing chisel?

The framing chisel is to the timber framer what the racket is to the tennis player: You can't play the game without it. Since every phase of timber framing requires work with the chisel, you will want to own the best possible tool. A good chisel will not make you a good timber framer, but like a good racket, it will immediately improve your game and make you much happier as you learn. Those of us who work with timbers a lot look for the perfect chisel the way that King Arthur's knights used to search for the Holy Grail. It's just that elusive.

Let me describe the perfect framing chisel, sometimes called a firmer chisel or a beamer's chisel. The blade should be stout and strong, but not too long because it's difficult to control the cutting edge if your hand is a foot away. The blade should be 6 in. to 8 in. long, $^3/_8$ in. thick at the shoulder, and $^3/_{16}$ in. thick at the bevel. The steel must have a Rockwell hardness in the range of 60 (C) if it's going to hold a good edge, especially in oak or other hardwoods. The back of the blade must be honed perfectly flat if it's to cut true. To reduce friction and to enable the cutting edge to get into tight places, it's better if the side edges are bevel ground. The handle itself should be hickory or ash, and it should be fitted with a steel ring just below its striking surface. To prevent the handle from splitting, it should fit into a socket rather than over a tang. You'd order the tool as a bevel-edged socket framing chisel. Old or new, I have yet to see an unmodified tool that fits this description. The chisel you will get will probably be a compromise.

If you are lucky enough to find an old framing chisel that is still in good condition, buy it. Most of these are socket types (the old-timers were very practical) and you might well find one of the better-known brands like Buck, Witherby or White. Be careful, though. Many of these old chisels have lost their temper or have been used as a pry bar once too often.

If you're buying a new chisel, you'll probably have to choose between a Marples (heavy-duty tang), Sorby (heavy-duty tang), or Greenlee, and several brands of Japanese temple carpenter's chisels (see tool retailers list below). Almost everyone in our shop uses either Marples or Sorby chisels. They have excellent blades and are nicely balanced. Most of us have modified them by having the edges beveled at a local machine shop. All of us are frustrated by the frequency with which we have to replace split handles.

The most disappointing chisel in the group is the Greenlee. Though they do have sockets for the handles, my experience with them shows that their blades are poorly ground, and their backs are anything but flat. We've cut at least 1 in. off the tip and completely reground the back of several Greenlees to make them useful. On some, the tang is slightly off center, which makes the tool feel very unbalanced.

The newest tool on the market is the Sorby framing chisel, which is made specially for Lee Valley Tools. It's a well-made tool and is rugged enough to take demanding use. Its problems are that it is still a tang chisel, and with a length of more than 19 in., it's just too long for fine work. With such a long tool, the timber being worked must be very low so you can strike the chisel at a comfortable level. Still, it is pleasing to see a tool that is so well made, and if you don't work your beams up on sawhorses like we do, it might be just right.

We are just becoming familiar with Japanese chisels. These tools fulfill most of the requirements I mentioned earlier, and with their laminated steel blades, they have a harder cutting edge than any Western chisels. The problems are that the blade is quite short (about 3½ in.) and the metal at the socket seems to be made from softer steel, which can bend too easily. These chisels work very well as long as they're not struck, so we use them for paring.

Most chisels are bought with a factory bevel of between 25° and 30°. This angle is fine for mortising softwoods such as pine, spruce, fir or hemlock. For work in hardwood, it's better to change the angle to between 35° and 40°. Too blunt a bevel angle will crush the wood fibers in softwoods, while too shallow an angle can cause the chisel to chip if you're working in hardwood.

In either case, the honing angle should be about 5° greater than the angle of the bevel. This makes the cutting edge stronger by eliminating the feathering at the tip. It also allows you to touch up the edge quickly since there is so little surface area on the honed edge.

For honing, we use two stones: a soft and a hard Arkansas. Though we've started to experiment with Japanese waterstones in the shop, the Arkansas stones are the ones we take to the site. There are a few jigs available that clamp to the chisel, guiding it across the stone to maintain a consistent honing angle, but we haven't found much use for them. If you spend enough time using your chisel, you should be able to hone by eye, and by feel. Be sure to back off (hone the back of the blade) only on the finer stone. After a chisel has been honed four or five times, we regrind the basic bevel.

The slick—This tool is just a chisel with a wide blade and a long handle that is not meant to be struck with a mallet; it's designed to be pushed by hand. The slick is used for paring large surfaces, and it's especially good for slicing across the grain to finish the sides of mortises and tenons. Of course a chisel can be used for final paring as well, but most professional timber framers prefer a slick because its wide blade makes for quick, accurate work on broad surfaces, and its long handle provides extra leverage and control.

Since this tool is used only for paring, its bevel should be ground to a shallow angle—about 20° to 25°. There aren't many brands of slicks. Most people in our shop use the slick sold by Woodcraft; it's well made and moderately priced. However, for the quality of steel, light weight and balance, I would have to say that the best are made by the Japanese. If I can save enough money, I'll buy one.
—*T.B.*

Where to get them

The following companies sell framing chisels:

Frog Tool Co.
548 N. Wells St., Chicago, Ill. 60610.

Garrett Wade Co.
161 Ave. of Americas, New York, N.Y. 10013.

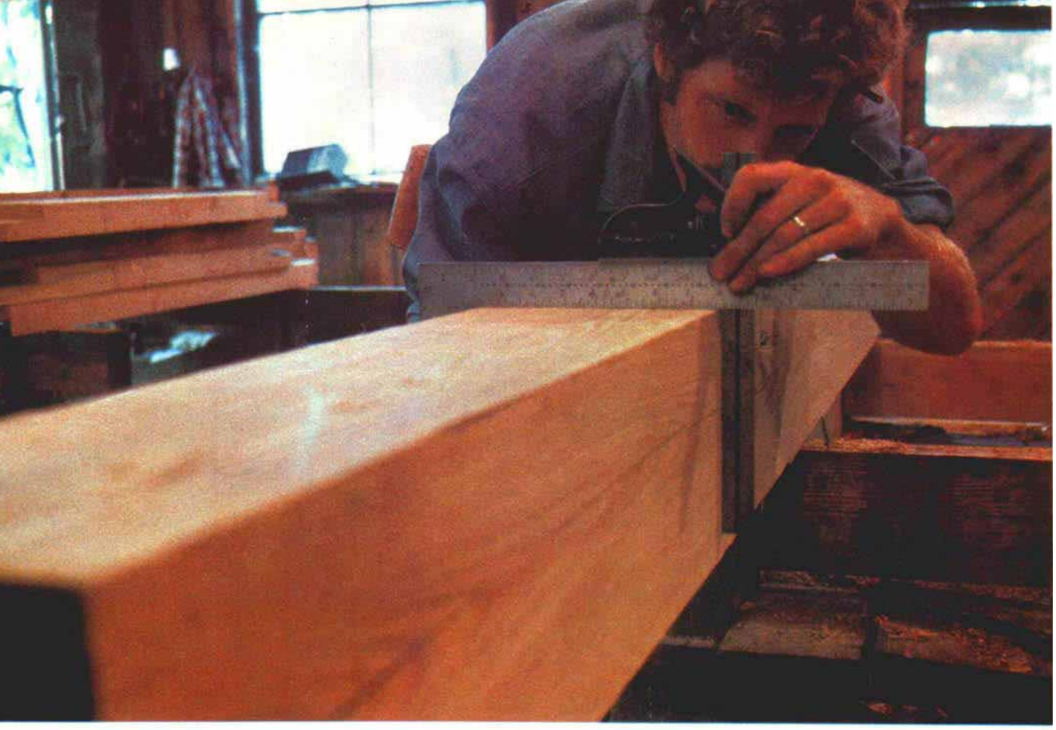
Lee Valley Tools Ltd.
Box 6295, Ottawa, Ontario, Canada K2A 1T4.

The Tool Works
76 9th Ave., New York, N.Y. 10011.

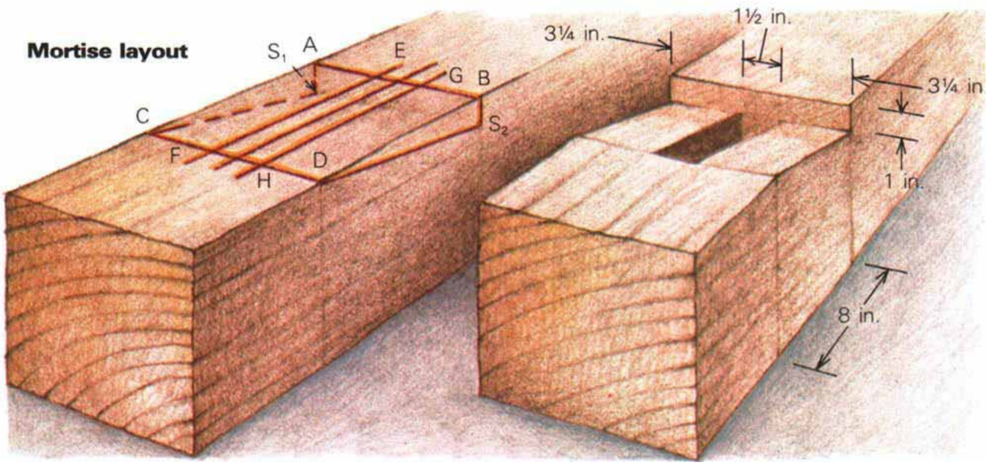
Woodcraft Supply
Box 4000, 41 Atlantic Ave., Woburn, Mass. 01888.

Woodline—The Japan Woodworker
1731 Clement Ave., Alameda, Calif. 94501.

Illustrations: Frances Ashforth



***Squaring up.* Using a flat outside face of the timber as a reference, check the other three faces around the joint area for square. The surest way to do this is to use a framing square and a combination square together, as shown at left. A small plane is fine for trimming high spots, and a tolerance of 1/32 in. is acceptable.**



hemlock, fir and other softwoods, this works well. But with oak, we've had no luck. There just doesn't seem to be a planer that has enough power to get the job done without driving the operator nuts. Therefore, we take a big power hand planer to the timber for rough squaring (we've had good results with the 6⅛-in. wide Makita 1805B), and then finish the job around the joint area with a hand plane.

Use a straight, flat outside face of the timber as a reference to square up the other three faces. The outside face is least likely to be worked or otherwise altered when you cut the joint. If there is no outside face (as on an interior post), then square up from a designated side to keep all the adjacent faces perpendicular, and opposite faces parallel. Interior beams such as floor joists and summer beams should always be squared from the top face. Use a framing square to check the joint area as you trim each face with a plane. By resting a combination square on the blade of your framing square, as shown in the photo above, you can check three faces of the timber at once.

The mortise—With the timber square to a tolerance of 1/32 in., you're ready to lay out the joint. Whether you measure from the side of the timber or from its center depends on the relationship between the timbers that are being joined. For example, both timbers might need to be flush with an outside face, as is the case with a post and girt. Or you may have an interior timber that is smaller in section and needs to be centered on a post or beam.

There are a number of ways to do layout. Except for very repetitious details, I favor methods that require the worker to keep thinking about how timbers relate to each other in the frame. Too many templates or marking shortcuts can lead to the belief that layout is an automatic process. When you fall into this pit, strange things begin to happen—the wrong template is used; the marking gauge doesn't get reset; you forget that this is the one layout that is different because of a sizing adjustment (a timber slightly larger or smaller than its blueprinted dimensions)—and you can't just throw timbers away when you make errors like these. For most of our work, we use the framing square. It's a simple tool that can be used to lay out any joint as long as you think while you use it.

With the blade of the square held against a side of the timber, scribe or draw the shoulder line at the bottom of the mortise (line AB in the drawing above). At this point you may choose to make all layout lines with a sharp pencil and light touch, but be sure to scribe the joint before cutting it, using a sharp awl along the grain and a utility knife across the grain. The advantage of the scribed or scored line is that it cuts the surface fibers of the wood and gives you a notch into which you can set your chisel.

Measure to the top of the mortise (the height of the tenon) and scribe line CD. Now, from the outside face of the timber, measure to the outside edge of the mortise and make two marks that can be connected by using the framing square as a straightedge. Scribing with the grain is difficult in a coarse-grained wood, so take care that lines don't wander. This gives you line EF. Measure from E and F the width of the mortise and make line GH. Then make a line down the exact center of the mortise to guide the drill bit. Mark this centerline at both ends of the mortise, measuring in half the diameter of the drill bit plus 1/16 in. from AB and CD. This extra 1/16 in. gives room for error and lets you to work up to the line with your chisel.

The mortise is now ready for drilling, but you should lay out the shoulder first. With the blade of the square held on the mortise side of the timber, scribe a line exactly 1 in. down from A and B to S_1 and S_2. Connect S_1 to C and S_2 to D.

The goal of drilling is to remove wood quickly, roughly excavating the mortise to its full depth and staying away from the scribed edges of the joint. We use power tools for this part of the job. I think that as we work toward the revival of the craft of timber framing in the 20th century, we should use the tools, techniques and knowledge that are available in our age. Throughout the history of timber framing, as the tools improved and as the knowledge about wood became more complete, the joints became more sophisticated and stronger; buildings became better.

C.A. Hewett, the English building historian, documents tremendous changes that took place in the evolution of timber framing as the tools became more highly evolved and easier to use. When it was a great struggle to drill one hole to remove the wood for a mortise, only one hole was drilled and the mortise was therefore approximately square and contained no housing or shouldering that might have improved its strength. It was simply too difficult to remove the wood. In the 11th century, there was a marked improvement in the quality of the mortises, which seems to have been tied to the ability to drill holes more easily. As a result, the joints became more elongated, using more of the surface area of the pieces being joined.

It is in gross wood removal that we have the greatest advantage over our predecessors. With power tools we can remove wood extremely quickly and therefore make strong, beautiful joints more efficiently than ever.

Use a drill bit that is at least ⅛ in. smaller than the width of the mortise, so you can work up to the finished surface with your chisel. If you're using a portable electric drill and you don't have a positive stop, file a mark into the drill bit to gauge your depth. In our frames, major tenons are usually $3\frac{3}{4}$ in. long, so we drill to a depth of 4 in. Bore the holes at either end of the mortise first, as shown in the photo at right. Then, using the centerline as a guide, bore a series of overlapping holes.

Now you're ready to work with the chisel. Use a good framing chisel (see p.23) with a blade slightly narrower than the width of the mortise. Just as boring the mortise was part of the rough work, your first work with the chisel also involves removing lots of waste. So don't spend a lot of time being fussy when it isn't necessary. Get the waste wood out quickly so you'll have the time and concentration to be precise as you work toward the line of the finished mortise.

Roughing-out should take you to between $\frac{1}{8}$ in. and $\frac{1}{16}$ in. of the line. Strike your chisel with heavy blows from the mallet and hog off reasonably large slices of wood (photo below left), but be careful in this rough stage not to attempt too large a bite. Make sure that you are in control, not the grain of the wood. Attempting to take out too much wood usually results in back-chiseling (going beyond true) or in a stuck chisel. Make your cuts across the grain before turning the chisel with the grain so you don't run the risk of splitting the wood. This will also break pieces of wood loose more easily. A corner chisel can be used at this stage, but don't take the whole corner out at once; let the chisel drift toward the center of the mortise.

Tap the chisel more lightly as you get closer to the line. Finally, you can pare the remaining slices off by pushing the chisel or a slick with your hand (photo below right). As you work, keep checking the inside of the mortise with a combination square to make sure that the walls are straight and square.

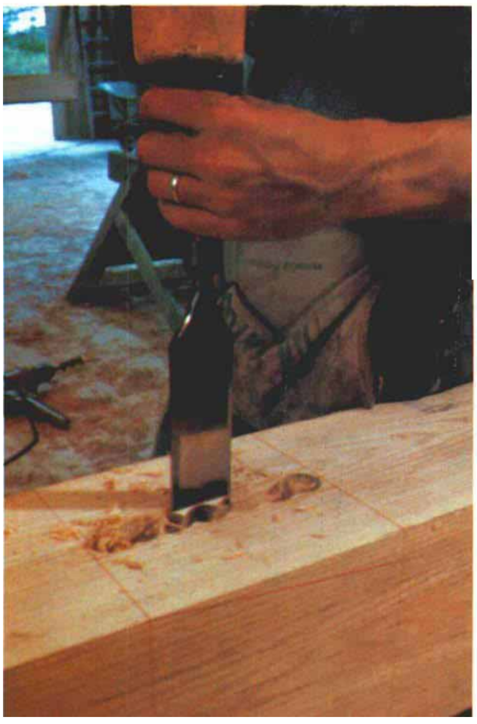
When the mortise is complete, it's time to cut the shoulder. Set the blade of your circular saw $\frac{1}{16}$ in. less than the depth of the finished shoulder—$\frac{15}{16}$ in. in this case. We use worm-drive saws because their extra power makes a difference in oak. When you cut across the shoulder (line AB), stay about $\frac{1}{16}$ in. shy of the line. Then set the saw at full depth and turn the timber to each side for the two side cuts into the shoulder (S_1C and S_2D). Again, stay away from the line by about $\frac{1}{16}$ in. You can break out the two waste pieces on either side of the completed mortise quite easily by driving a chisel into the kerf at line CD.

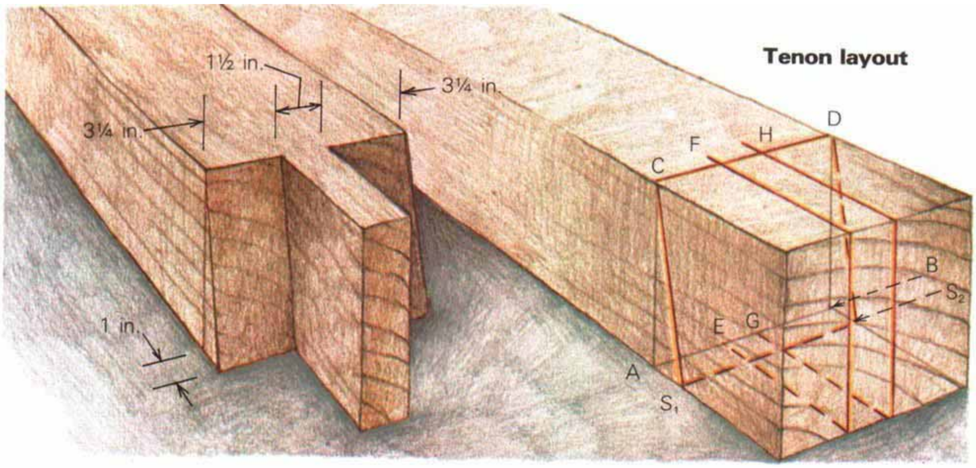
Staying away from the lines on these cuts means that the joint is actually finished with a chisel and a slick. The theory is the same as for the mortise—do the rough wood removal rapidly with power tools and then work up to the line with more control.

Making the tenon—Begin once again by squaring the timber at the joint area, working from a designated face as you did when you laid out the mortise timber. If necessary, square off the end of the timber so that the end of the

***Drilling the mortise*. The bit diameter should be about $\frac{1}{8}$ in. less than the width of the mortise. Set the bit point on the mortise centerline, drill the two outside holes first (above) and make a series of overlapping holes to open the slot.**

***Cleanout*. Next come wood removal, left, and paring to the line, below. Strong blows with the mallet help the framing chisel to slice out large pieces of waste to within about $\frac{1}{16}$ in. of the line. Then more careful paring removes this last narrow section of waste.**





tenon will be square. Then measure 3¾ in. (or ¼ in. less than the depth of your mortise) back from this edge and square a line all the way around the timber.

Now you are ready to lay out the beveled shoulder of the tenon to match the angled cheek of the mortise. Mark its 1-in. depth from the squared line (AB in the drawing at left) at the bottom of the timber. This will give you line S_1S_2. Connect S_1 and S_2 with points at C and D, which correspond to the measurements used to mark the cheeks of the mortise. Remember that although the timber dimension may vary, you have to keep the measurements constant. Complete the layout by marking both sides and the end of the tenon, as shown in the drawing. To ensure that the tenon will be perpendicular to its shoulders and properly aligned with its mortise, use a single outside face of the timber as a measuring edge.

Cut along the beveled shoulder lines (CS_1 and DS_2) first. Set the saw depth to leave ¹⁄₁₆ in. of waste outside the tenon line, and stay about the same distance from the shoulder line when you make the cut. Make the next cuts—four in all—from the end of the timber, sawing in on the top and bottom of the tenon with the blade at full depth. Again, stay shy of the line. Then use these saw kerfs and the twin vertical lines on the end of the timber to guide the blade as you make drop cuts on either side of the tenon (photo far left). Now you can remove the waste wood by driving the chisel into the kerfs at the end of the timber. This completes the rough wood removal.

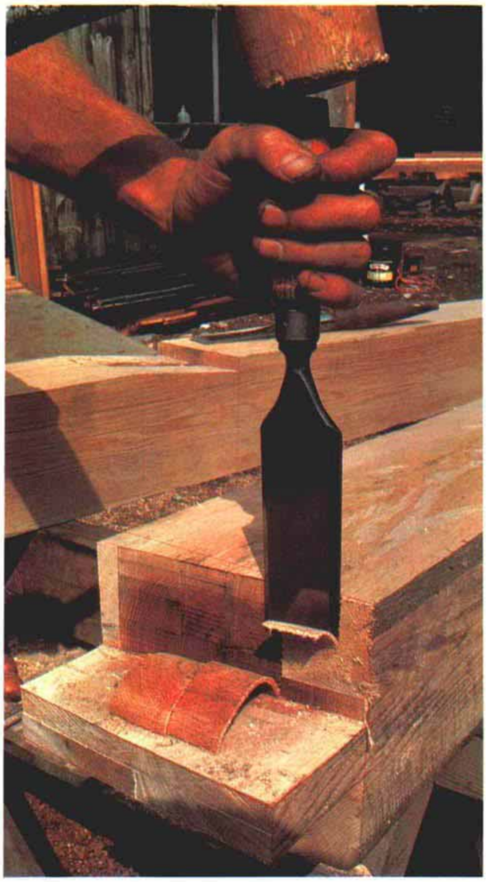
Working with the tenon on its side, chisel to the beveled shoulder line first. Start by establishing the line with a series of shallow chisel cuts and then work the rest of the surface to this edge (photo left). It's always a good idea to cut across the grain like this before cutting with the grain to remove wood. It doesn't hurt to back-chisel about ¹⁄₃₂ in. from the edge to ensure a tight edge joint and to compensate for possible shrinkage near the surface of the wood. Check the accuracy of your work with a combination square.

Pare the surface of the tenon to the line with a slick (photo bottom left) or a rabbeting plane. You can use calipers to check the tenon thickness, or sight beneath the blade of your combination square by eye. To finish, bevel the end of the tenon slightly so that it will start easily in the mortise.

The last step is assembly and pegging. When the timbers meet, the tenon will fit tightly into its mortise, the beam will rest squarely on the full surface of the shoulder, all face edges will meet precisely, and both timbers will be in proper alignment with the rest of the timber frame. We usually use a come-along and rope to pull joints tight and square; then we hold them that way until the hardwood pegs are driven. For this shouldered mortise and tenon, we'll drill out a pair of 1-in. dia. holes 2 in. from the top and bottom of the mortise and 1¼ in. from the beveled face on the post. ❑

Tedd Benson's timber-framing company is based in Alstead, N.H.

Roughing out the tenon. **Shoulder and side cuts have already been made to within ¹⁄₁₆ in. of the joint line. The drop cuts at the end of the tenon, shown above, are the last ones to be made, using the kerfs from the side cuts and the penciled joint lines as guides.**



Paring to the line. **Set the chisel edge in the razored scribe line and make shallow finish cuts all the way across the face of the shoulder (right). Below, the easiest way to complete the tenon is with a slick. Work the blade across the grain until the surface is flat and true.**