Cranking Out Casements

Using a layout rod and shaper joinery to build outward-swinging windows with divided-light sashes and insulated glass

One of the loveliest houses in Irvington, New York, was built in the 1920s by a wealthy philanthropist named Ralph H. Mathiessen. The house commands a breathtaking site on the banks of the Hudson River, overlooking the Tappan Zee. It's an elegant example of the French eclectic style, characterized by decorative brickwork and a steep, slate-covered roof.

Unfortunately, by the time the present owners acquired the house, successive waves of "modernization" had spoiled much of the original detailing. Among other things, casement windows in the third-floor dormers had been traded for aluminum jalousies. I was asked to undo some of the damage by replacing the replacements with true divided-light windows. In addition, the owners wanted to upgrade the thermal efficiency as much as possible, so new glazing had to be insulated glass. None of the new windows we needed were available in stock sizes, and while some of the major window manufacturers now do custom work, the need to save time and money prompted me to build them myself. Over the course of the project, I fabricated sidelights and French doors as well as casement windows using the same basic joinery. But I'll limit the discussion here to casements.

Casement hardware—The job was a first for me, so I familiarized myself with the anatomy of casement windows by reading up on the subject in A. B. Emary's *Handbook of Carpentry and Joinery* (Sterling Publishing Co., out of print) and Antony Talbot's *Handbook of Doormaking, Windowmaking, and Staircasing* (Sterling Publishing Co. Inc., 2 Park Ave., New York, N. Y. 10016, 1980. $8.95). Then I turned to the hardware catalogs to see what kinds of fittings were available.

Casement windows can either swing in or out. Outward-swinging casements (photo right), which I built for this job, are easier to make watertight because rain driven between the sash and the frame drains out rather than in. They are also more convenient to use because they don't project into the room when open, as do inward-swinging casements.

The chief disadvantage of outward-swinging casements is a susceptibility to decay. If left open, even in a light rain, the sash will be soaked. Another problem is that the screen must be placed inside the window, blocking access to the sash. At one time screens were hinged so that you could get at the old sliding-rod hardware used to open and close the windows. Modern casements open and close by means of a worm-gear crank mounted on the stool. Only occasional access to the sash is required, so the screens can be snapped in place.

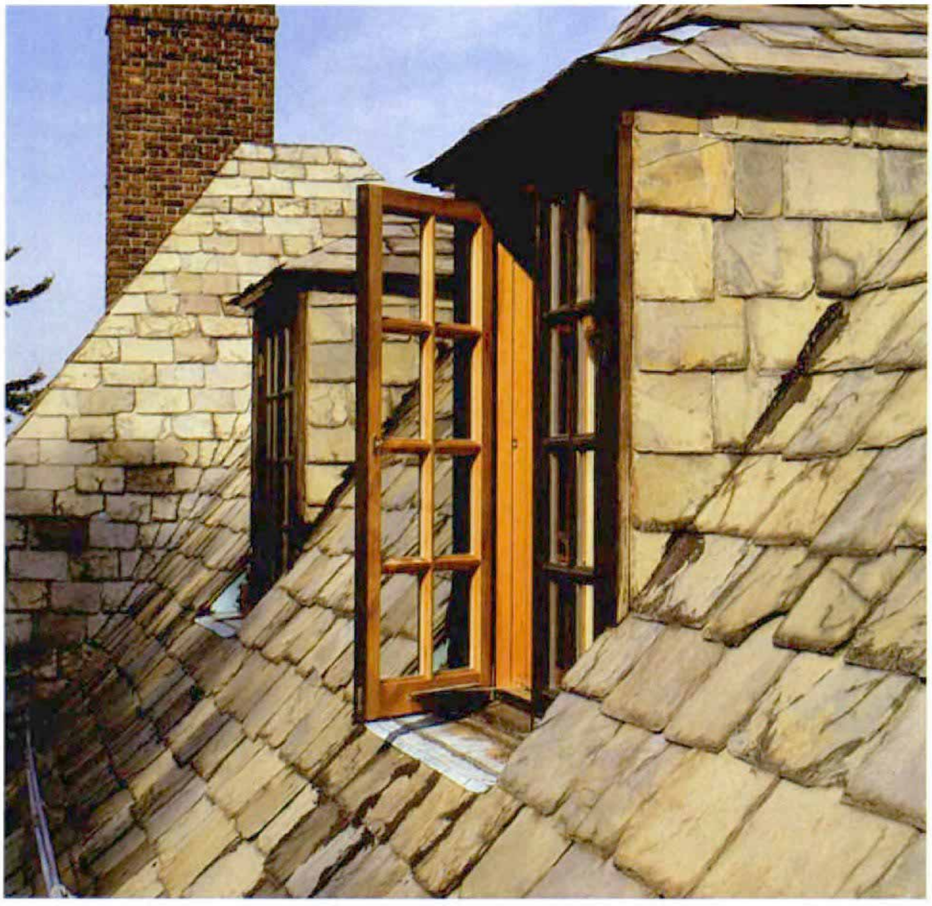
Sliding-rod and crank-type hardware (known as "casement operators") is still available from H. B. Ives (a Harrow Co., P. O. Box 1887, New Haven, Conn. 06508). The crank-type operator is by far the more practical, so I incorporated it into my design for the Mathiessen house windows. Although we wanted brass to match the rest of the hardware, Ives makes the operators only in painted steel.

Modern casements have a lever-type lock that operates with the screen in place, but my customers wanted the look of traditional brass casement locks (called "fasteners"), which were available from Ives. Since the worm gear of a crank-type casement prevents the window from being forced open, even when unlocked, the main purpose of the fastener is to provide a tight weather seal.

Casement frames—Fortunately, many of the original cypress window frames in the dormers were reusable. Most of these had simply been boxed around to make a finished opening for the aluminum jalousies. Where the frames were damaged beyond repair, I removed them and made new ones.

The new side and head jambs have two rabbets each—one on the outside for the sash

Built in the 1920s, this house suffered subsequent remodeling that saw the original casement windows in the dormers replaced by aluminum jalousies. But the wheel of architectural fashion has now come full circle and the casements are back; this time with double-pane insulated glass.



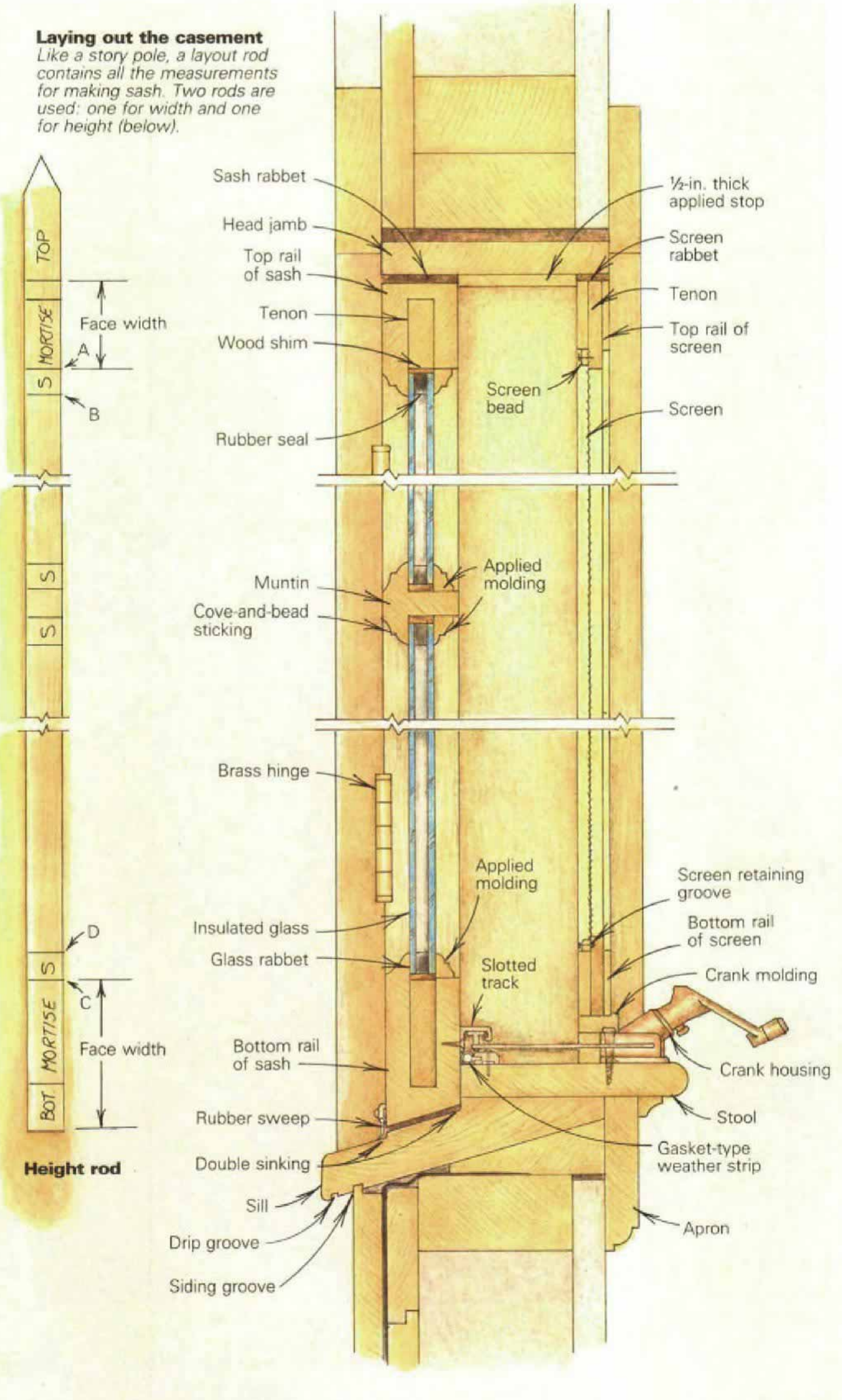
and one on the inside for the screen. These rabbets could have been cut into thick stock, but I found it easier and more economical to attach a ½-in. thick stop to ¾-in. thick jambs.

For the window sills, I decided to use cypress. Although some folks say the cypress available nowadays has grown too fast to contain the resin needed for decay resistance, I gave cypress the benefit of the doubt. The good condition of the original casement frames argued strongly in its favor. I cut a pair of shallow rabbets in the sills, known as "double sinking," to help to keep rain from blowing under the sash (drawing below). A drip groove on the bottom of the sill prevents water from being drawn under the sill by capillary action.

Designing for insulated glass—By far the trickiest part of the job was designing and building the new sash. Switching from ⅛-in. single-pane to ½-in. double-pane insulated glass required an overhaul of the original sash design. Unlike single-pane glass, which is sealed with a thin bead of putty, insulated-glass units are typically held in place by moldings because the solvents in putty will attack the rubber seal around insulated glass. Consequently, a rabbet for insulated glass must be deep enough to accommodate both the increased thickness of the glazing and the thickness of a wood molding. Although the original casement sashes in the Mathiessen house were a hefty 2¼ in. thick, the rabbet for glass was only ¾ in. deep—not enough to hold insulated glass. For this reason I made replacement sashes for some of the remaining original wood casement windows, as well as for those that had been switched to aluminum.

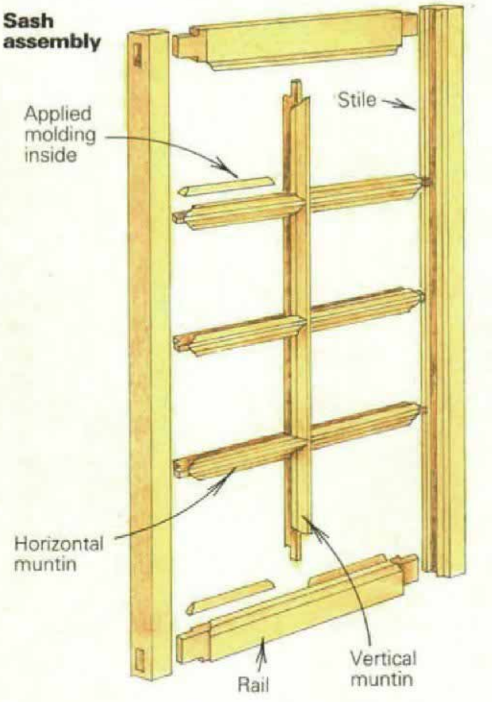
At my local supplier, I had a choice of either 8/4 or 12/4 rough stock. I decided to build the new sash from 8/4 stock planed to 1¾ in. On the outside of the sash, I cut a ⅝-in. deep cove-and-bead profile on a shaper. This profile is called *sticking* because it is worked directly on the sash—"stuck" rather than applied. The glass rabbet took up the remaining 1⅛-in. thickness of sash: ½ in. for the glass and ⅝ in. left for an applied molding similar in profile to the cove-and-bead sticking.

Muntins make up the inner framework, or grid, that holds the glazing in a divided-light sash. On this project, the width and depth of the muntins had to be carefully considered. I was doubling the weight of the glass, so stronger muntins would be needed. In addition, the applied molding had to be wide enough to hide the ½-in. deep rubber seal that separates the two panes in an insulated-glass unit. But if the muntins were too wide, the sash would look more like a dungeon grate than the delicate tracery I wanted. I set-



Laying out the casement

Like a story pole, a layout rod contains all the measurements for making sash. Two rods are used: one for width and one for height (below).



Sash assembly

tled on a muntin width of 1½ in. This would accommodate a ½-in. wide flat face down the middle, with ½ in. sticking on either side.

Choosing materials—I chose white pine for the sashes, jambs and trim. This old standby is stable and easily worked, and is fairly decay resistant. Sash work requires a lot of short pieces, so I figured I could cut around the knots in Grade 2 material without too much waste. I saved the long, vertical-grained pieces from the edge of each board for stiles and used the less stable flat-grain stock from the middle of the board for the rails and muntins. All this selective cutting took time though, and I've since found it cheaper to buy clear sugar pine in the first place.

I got my insulated glass from a local glazier, who gets it from a wholesale fabricator. Quality control was less than rigorous, however, and I returned a lot of defective units. The defects included corners out of square and ruptures in the rubber seal. I was particularly careful to root out the latter—I've no desire to be replacing fogged-up units a year or two down the road.

Rod layout—Like a story pole for a house, a rod is a layout stick containing all of the pertinent measurements for making a sash. You need two rods—one for height and one for width—and laying them out is the single most important step in sash-making. It requires the builder to think through the entire cutting and assembly process before any sawdust flies.

I began the layout of the height rod by cutting a piece of 1x2 a few inches longer than the height of the sash. I cut one end square and marked it with an arrow and the word "bottom." Starting from this end, I laid off the overall height of the sash, marking this line with an arrow and the word "top."

From the top, I measured back a distance equal to the face width of the top rail, made a mark (point A, drawing facing page), then added the sticking width and made a second mark (point B). I repeated this for the bottom rail (marking points C and D).

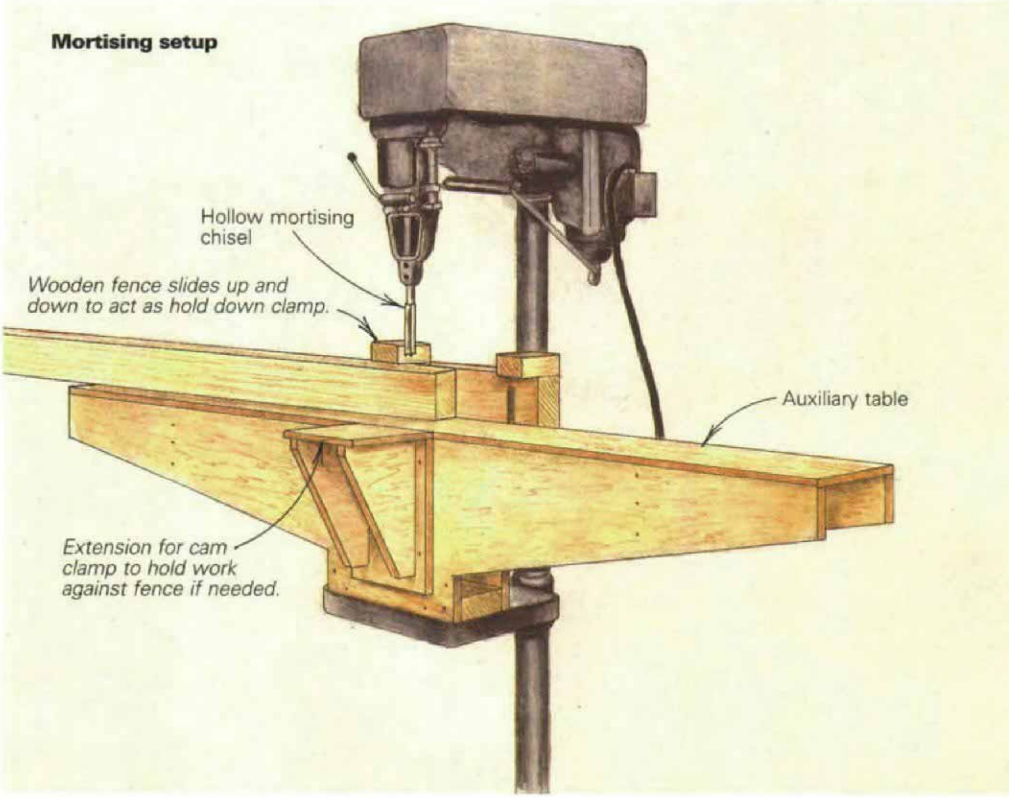
I measured the distance from C to A and deducted from this measurement the combined face width of all horizontal muntins. For the sash in this example, the combined thickness is 1½ in. (3 x ½ in.). I divided the balance by the number of lights the sash has along its length (four). The result was the distance from rail to muntin and muntin to muntin, measured on the inside of the sash. This could also be expressed as the distance from shoulder of glass rabbet to shoulder of glass rabbet. After determining the measurments, I marked them on the rod. Then I added the sticking width (½ in.) to both sides of each muntin, marking it with an "S."

Because hinged casement windows are subjected to a racking force resulting from their own weight, they are best made with mortise-and-tenon joints, rather than with the bridle joint sometimes used for double-hung sash. So the next step in preparing the height rod was to lay out the height of the mortises to be cut in the stiles. Although I wanted maximum surface area in the joint for gluing strength, I was careful to leave enough wood (½ in.) between the mortises and the ends of the stile to prevent the wood from fracturing.

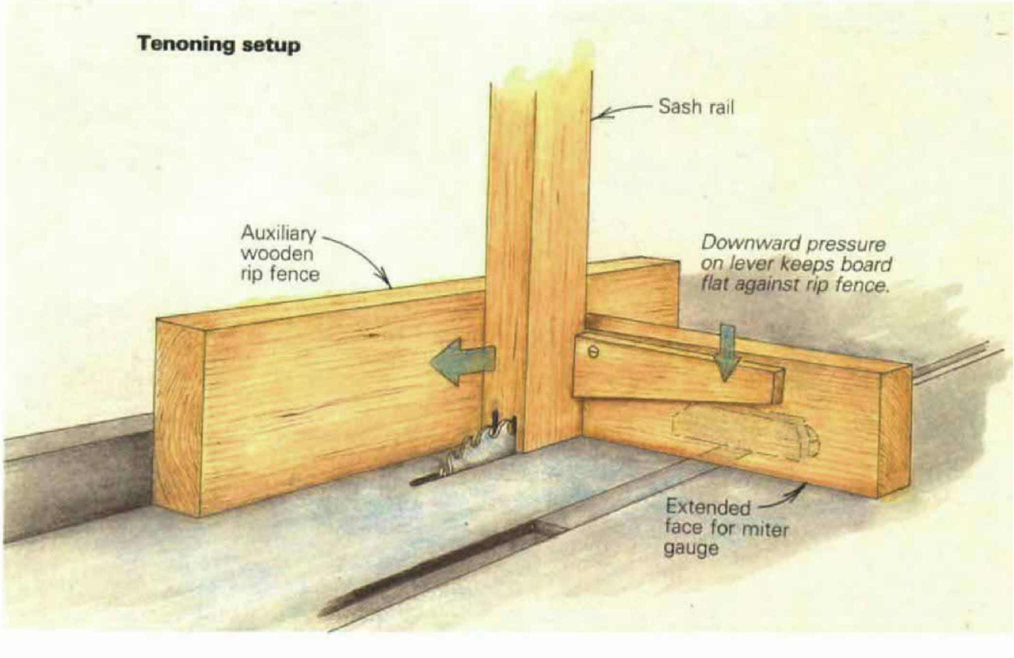
I labeled the mortise heights on both ends of the rod. The smaller mortises—those for the stub tenons in the horizontal muntins—had essentially been laid out already because their height is the same as that of the muntin face width, which I had marked earlier.

When I'm building larger casements or divided-light doors, I usually have a through-tenoned horizontal muntin in the center, tying the stiles together and making the sash more rigid. I didn't think that was necessary here. The casement sashes were small enough that the stiles and rails provided the necessary structure. The muntin configuration consists of seven pieces: one through-tenoned vertical muntin (or sash bar), and six stub-tenoned horizontal muntins (sash assembly drawing, facing page).

In traditional sash-making, the stub tenon extends only as deep as the sticking



Mortising setup



Tenoning setup

Drawings: Michael Mandarano

(for more on traditional sash-making, see *FHB* #18 pp. 72-77). Because I needed a bigger rabbet to make room for the insulated glass, I had less stock to house the stub tenons. Consequently, they had to reach somewhat further, extending into the face width of the adjoining member. At the vertical muntin, stub tenons would be reaching in from both sides. Because the face width of the vertical muntin is only ½ in., the stub tenon length had to be a little less than half that, or 3/16 in.

To finish the height rod, I labeled it with the word "height" on the top, then cut a point on this end to avoid confusing it with the squared-bottom end, which would be used to register the rod on the stock.

Layout of the width rod was essentially the same as for the height rod. I used through-tenons on the rails, so their length was determined by the overall sash width.

Fabrication—The first step in the actual making of the sashes was to size each piece to rough width and length. Then I jointed the pieces and ripped them to finish width. I saved the thin off-cut strips from the final ripping operation for shims. Varying in thickness from paper-thin to ⅛ in., they came in handy later for positioning the insulated-glass units in the sash.

After crosscutting each piece to finish length, I laid out the mortises. To speed this up, I transferred the mortise heights from the rod onto one of the sash pieces, lined that piece up with all the others like it and squared across the lot of them. Although you can cut mortises with a hand-held electric drill and clean them up with a chisel, I find it a lot faster and easier to use a ½-in. hollow mortising chisel chucked in a drill press. I didn't need to mark the width of the mortise because it was controlled by the fence setup on the mortiser. My vintage Delta home-shop drill press is a precise but willowy machine. To enable it to handle the long, heavy stiles, I built an auxiliary table out of plywood that extends about 4 ft. on both sides of the drill press (top drawing, previous page). A short wooden fence at the back of the table slides up and down on a pair of bolts, doubling as a hold-down clamp when the wing nuts are tightened. I added a small extension at the front of the table to accommodate a cam clamp for holding the work against the fence, although in most cases I found thumb pressure to be adequate for this.

I cut the tenons on a tablesaw. The combination of a high auxiliary rip fence and a miter gauge enables me to do fast, accurate tenoning without a $200 jig. Before cutting the tenon cheeks, I screwed a wood extension to the face of the miter gauge and attached a wooden lever to that (bottom drawing, previous page). The lever is made so that slight downward pressure on one end will hold the board I'm tenoning snug against the fence.

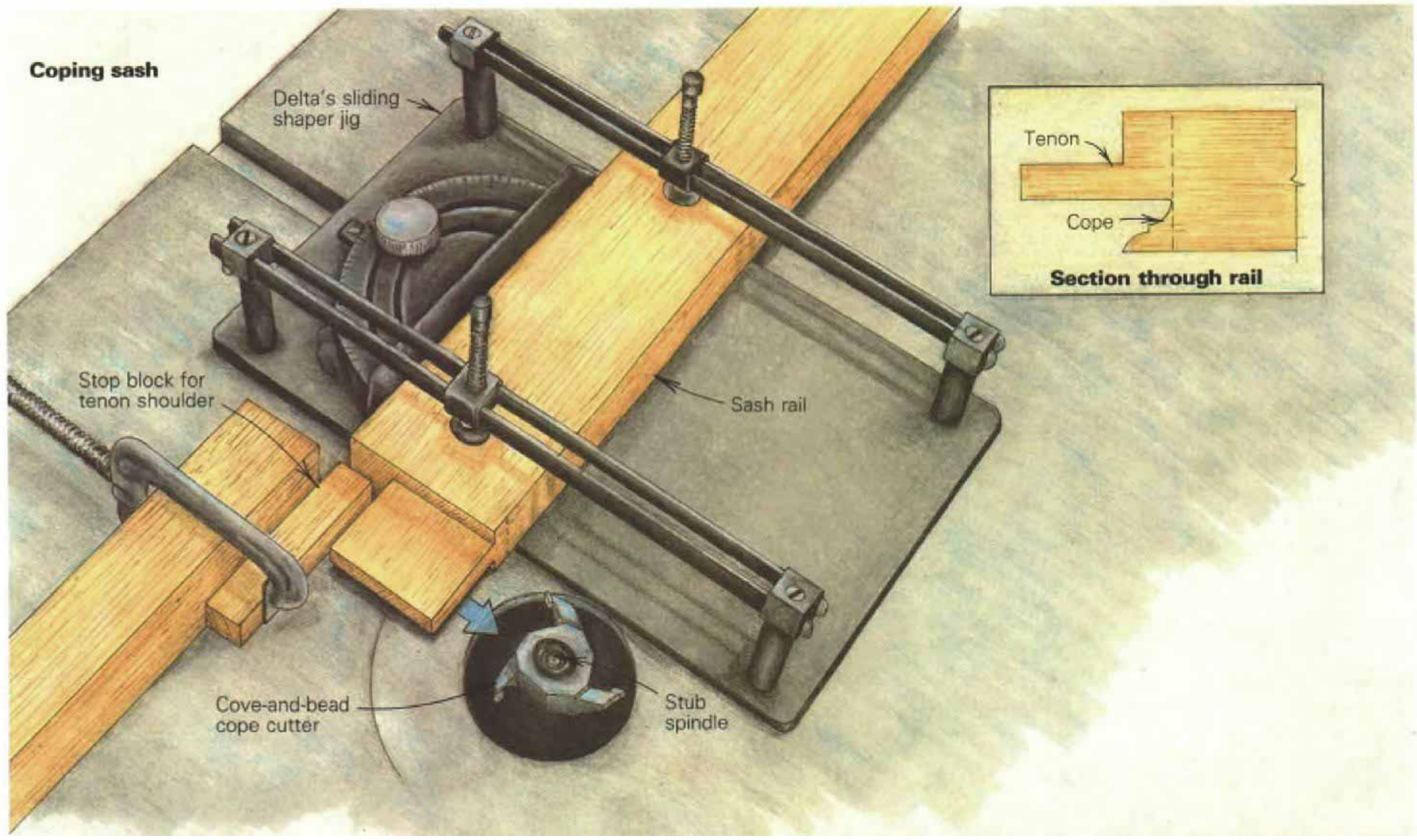
Coping and sticking—I'm lucky to have two shapers in my shop—a light-duty shaper with a ½-in. spindle and a two-speed heavy-duty shaper (both were made by Rockwell, now Delta International Machinery Corp., 246 Alpha Drive, Pittsburgh, Pa. 15238). In an old manual called *Getting the Most Out of Your Shaper* (originally published by Rockwell, reprinted by Linden Publishing Co., 3845 N. Blackstone, Fresno, Calif. 93726), I read up on the use of shapers for sash-making. Then, armed with matching cove-and-bead molding and cope cutters, I had at it.

In order for the tenoned parts of the sash to fit snugly against the mortised parts, they have to be notched to fit over the sticking (drawing below). This notching process is called coping, and it's the trickiest operation in sash-building, especially when the joinery is mortise and tenon. This is because a through-tenon on a rail or muntin won't clear the top of a standard shaper spindle sticking above the cope cutter. The solution is to use a stub spindle, which is shorter than a standard spindle and uses a countersunk machine screw instead of a nut to hold down the cutter. This allows the tenon to ride just over the cutter (drawing below).

Unfortunately, you need counterbored cutters to use with the stub spindle, and these don't seem to be available in carbide (probably because most sashes are dowelled these days, so cutting around a tenon isn't necessary). As it turned out, the Delta high-speed steel #09-137 counterbored cope cutter costs more than a similar cutter in carbide, but the carbide version isn't counterbored. A machinist counterbored my carbide cove-and-bead cope cutters (#43-915 and #43-916) so that I could mount them on the stub spindle to cope the shoulders of pieces with through tenons.

To form the stub tenons on the muntins, I used the same cutter on a regular spindle in conjunction with a spacer collar and a ½-in. straight cutter with shorter radius. This way I could cope the ends and form the tenons in a single pass.

Some sash builders cope the ends of all the muntins at once by cutting the coped shape across the end of a wide board and then ripping the individual muntins from it. I ripped each one to size first, and then coped them individually, using a sliding jig that Del-



ta makes for their shapers (drawing, facing page). This jig combines a miter gauge and a small sliding table with integral hold down clamps. I coped the ends of the muntins before molding their edges so that I would have a flat surface bearing against the miter gauge. The subsequent edge-molding operation would remove the tearout left by the cope cutter. Sizing muntins individually lets me use up a lot of otherwise useless short and narrow scrap, as well as making it easier to account for all the necessary pieces before moving on to the next step.

To ensure perfect mating of cope and sticking, I set up both operations simultaneously on separate shapers. If I only had one shaper, my first step would have been to make an accurately fitting pair of prototypes by trial and error (one stuck, the other coped). These would have been used to test the various setups. The stiles and rails were beefy enough that I felt I could run them safely on the shaper without hold-downs. For the muntins, I used Delta's nifty spring hold-downs, which held the small molding securely to the fence and table.

A wide straight cutter could have been used below the sticking cutter to do the rabbeting at the same time, but it would have meant making a heavier cut than my equipment is comfortable with. Instead, I used a narrow straight cutter along with the sticking cutter. This ploughed out part of the rabbet. I sliced off the remaining material on the tablesaw.

The slotted track and crank housing of the casement operator are simply screwed in place. The "crank molding" is the narrow stock notched to fit over the crank housing. It provides a surface for the screen to sit on. The solid-brass hinges have a small set screw in the barrel that prevents the hinge pins from being removed from the outside.

Assembly and installation—After all the shaper and saw cuts were complete, the sashes were ready to assemble. The nice thing about through-tenoning is that it allows me to start all the tenons in their respective mortises. Then all I have to do is brush a light coating of glue—resorcinol in this case—into the mortise from the opposite side and tighten the clamps. That saves a lot of frantic moments. I used clamping blocks that have a channel ploughed in one side. Centering this channel over the mortise before tightening the clamps allows the tenon to protrude slightly beyond the edge of the stile if necessary.

After laying the insulated-glass units into the sashes and shimming them into position, I was faced with the task of fitting all the moldings that would hold the glass in place. One of the rooms I worked in, for example, contained six sidelights, five casements and one 8-ft. pair of French doors. That translated into 112 panes of glass, which meant 448 moldings requiring 896 miters. There had to be a better way.

My shortcut was to cope wide stock on the shaper first, then mold the sticking on the edges and rip off individual precoped moldings. This trick saved many tedious hours hunched over a screaming miter box. Another time-saver I discovered was a pneumatic brad lacker. It came in mighty handy for the 2,688 fasteners.

Hanging the sash was no different from hanging doors. I used a router and a plywood template to cut the hinge mortises in the sash. On the new jambs that I made, I had routed mortises for the hinges before assembling and installing the frames.

Because the hinge barrels for each sash would be located on the outside, I wanted solid-brass butt hinges to resist corrosion. I also needed the security of a nonremovable pin. The ones I used were made by the Baldwin Hardware Corp. (841 E. Wyomissing Boulevard, Box 15048, Reading, Penna. 19612) and cost $50 a pair. The end caps on the barrel of the hinge unscrew, allowing removal of the hinge pin for easier installation of the sash. A tiny set screw on the indoor side of the hinge barrel secures the pin afterwards. The casement locks were simply screwed to the sash and their strike plates drilled and mortised like those for the lockset on a door.

I worked out the location for the casement operator by trial and error. If the crank was too close to the jamb, there wasn't enough room for a hand to turn it. And if the crank was too far from the jamb, the window wouldn't open very far. Once I figured out the best location, installation was straightforward—a slotted track was screwed to the inside face of the sash and the body of the casement operator was screwed to the window stool. I made a notched wooden piece, which I call a "crank molding," to fit over the casement operator (photo left). In addition to being notched for the body of the casement operator, it is rabbeted in the back to receive the retracted arm of the casement operator when the sash is closed. There's also a shallow rabbet in the top for the screen to sit in. I made all the cuts on the tablesaw, starting with the cross-grain notch for the operator.

Weatherstripping the windows was a prime concern. I chose a stainless-steel leaf-type material called Numetal, made by Macklanburg-Duncan (Box 25188, Oklahoma City, Okla. 73125). Each box of Numetal includes nails and about 30 ft. of weatherstripping. I nailed it to the side and head jambs along the sash rabbet. It is fairly easy to apply, invisible when the sash is closed and is the most durable of any system I've used.

On the bottom of the sash, I used a rubber sweep on the outside to seal the sash against the sill. Then I mounted a piece of compressible gasket-type Weatherstripping on the stool for the sash to press against. I could have run it along the sides and head as well, but the material would have interfered with the fasteners on the strike side and might have gotten pinched by the closing sash on the hinge side. It wouldn't have looked very good, either.

For the screens, I built simple frames out of ¾-in. stock. I cut a rabbet on both sides—a shallow one on the inside for decoration and a deeper one on the outside for the screen and screen bead molding. I coped the rails into the stiles, which essentially creates a shallow bridle joint, glued them together and ran a long screw through the ends. I cut a narrow screen-retaining groove in the bottom of the rabbet on the screen side and used a screening tool (which looks like a dull pizza cutter) to press in the aluminum screen. I used a utility knife to trim the screen against the corner of the rabbet and then nailed on the screen bead molding. To hold the screens in place, I installed bullet catches between the stiles and jamb—one on each side, about halfway up the stiles. A delicate brass knob, installed on the face of the frame, makes the screens easy to pop out in the fall for a clearer view. ☐

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