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- Construction drawings and related photos.
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Workbench and Tool Chest

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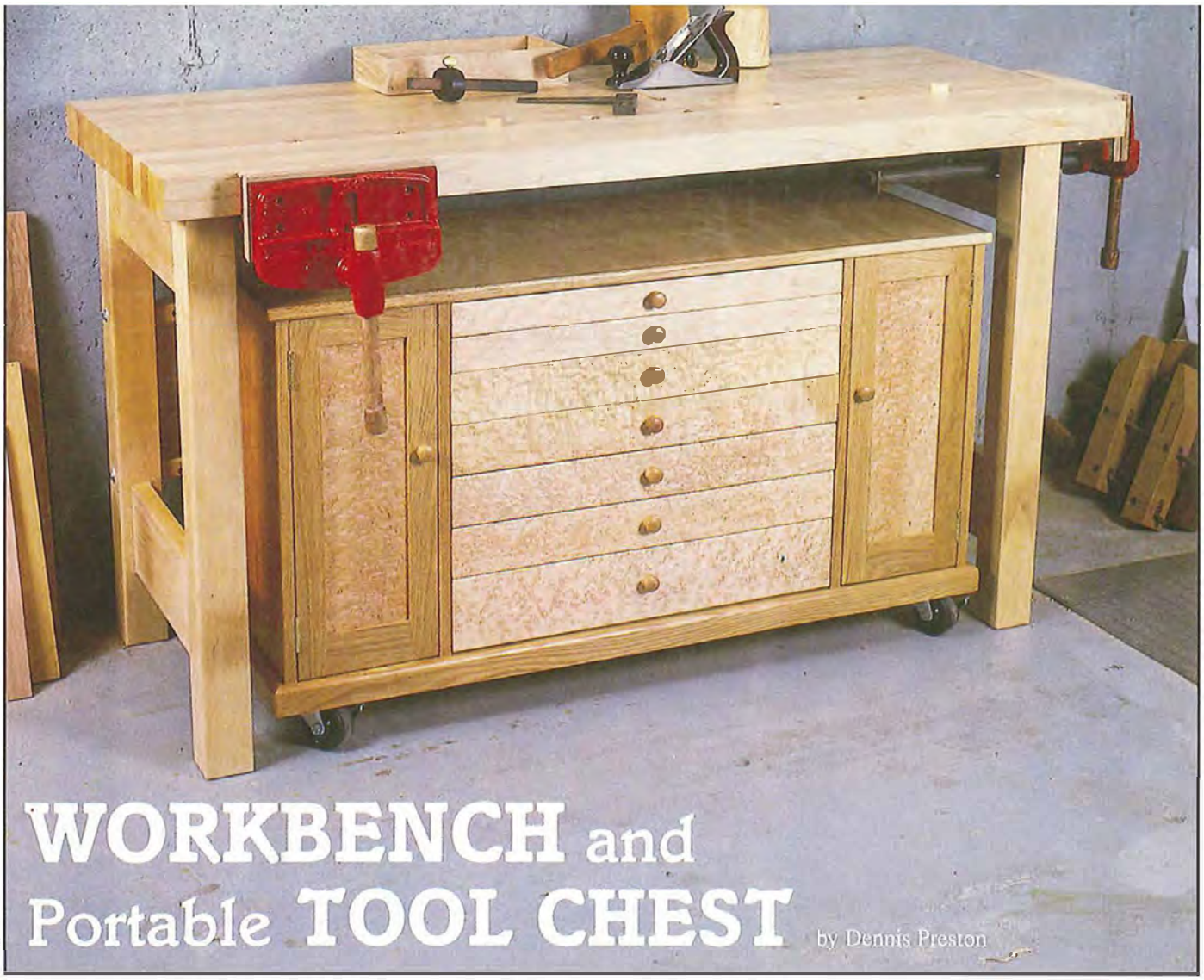


WORKBENCH and Portable TOOL CHEST

by Dennis Preston

The heart and soul of a woodshop is the workbench. A good bench is a pleasure to use. It's as steady as a rock, has large clamps, bench dogs that are centered on the clamps, and it provides a place to cut, plane, shape, sand and assemble your work. It has a flat top that is a consistent thickness throughout, which provides for convenient edge-clamping all around.

Next in importance to the workbench is tool storage. Ideally, tool storage is an arm's reach from the workbench. My mobile storage cabinet goes this concept one better; you can bring your tools right to the work, wherever it is in the shop. The tool cabinet's top also makes a handy extra work surface, set-up table, saw horse or seat to rest on.

The core of this idea was to develop a compact, robust, functional workbench that would fit into the limited space many woodworkers have available to them. Rather than build the tool storage into the bench, I opted to make the storage cabinet a separate unit, sized so it would nest conveniently under the bench. Since a good bench is like a fine piece of furniture, you'll want to take it with you when you move. The use of lag bolts and knockdown hardware makes this possible.

The Workbench

Two problems exist for many woodworkers just starting out: limited space and the lack of a good bench. It's tempting to just go out and purchase a ready-made bench, but these have several shortcomings. First, good quality European style benches (held to be the paragon of bench design) are costly at about $900 and up, and second, the vises they use are the continuous screw type, which can be frustratingly slow to use. Also, these benches usually don't include a tool storage area below, and at typically 6 ft. to 7 ft. long they may be too large for some small shops.

For woodworkers desiring to make their own bench there's the quandary of

needing a bench to build a bench, and the daunting problem of how to get the top perfectly flat after you've ripped and glued up all the stock. The use of a purchased top (A) eliminates the need to plane and flatten such a massive section. And, at 2¼ in. thick, the purchased butcher block top this bench utilizes is thicker and heavier than most of the costly European style bench tops. Overall the bench weighs in at about 220 lbs.

If you don't have a bench now, build the bench first and then use it to build the tool cabinet. The purchased top also eliminates the requirement that you must have a bench to build a bench. Mount the vises, set the top on sawhorses and you can use it as a temporary bench to construct the frame.

I have noticed both in my own work and in looking at other bench tops that most activity is centered at or near the vises. Only about the first 12 in. of depth is actually used; the rest usually becomes a temporary storage surface. European benches, with only about 16 in. of actual top width, recognize this. The remaining width is taken up by a tool well. The problem with that design, though, is that the tool well is soon overflowing with tools, shavings and chips, a problem for those times when you need the full unobstructed width of the bench top.

With this in mind my bench eliminates the tool well and utilizes a full 24 in. wide top, which I've found sufficient for most work. Any wider and the top becomes a catchall for things that should be stored elsewhere. Unless you do a lot of work on long stock, the 5 ft. bench top length should be adequate. The two vises are located in a conventional manner for a right-handed person, but could be altered. For a left-handed person, locate the top so the 4 in. overhang is on the left end, move the tail vise to that end, and switch the front vise to the right.

Making the Frame

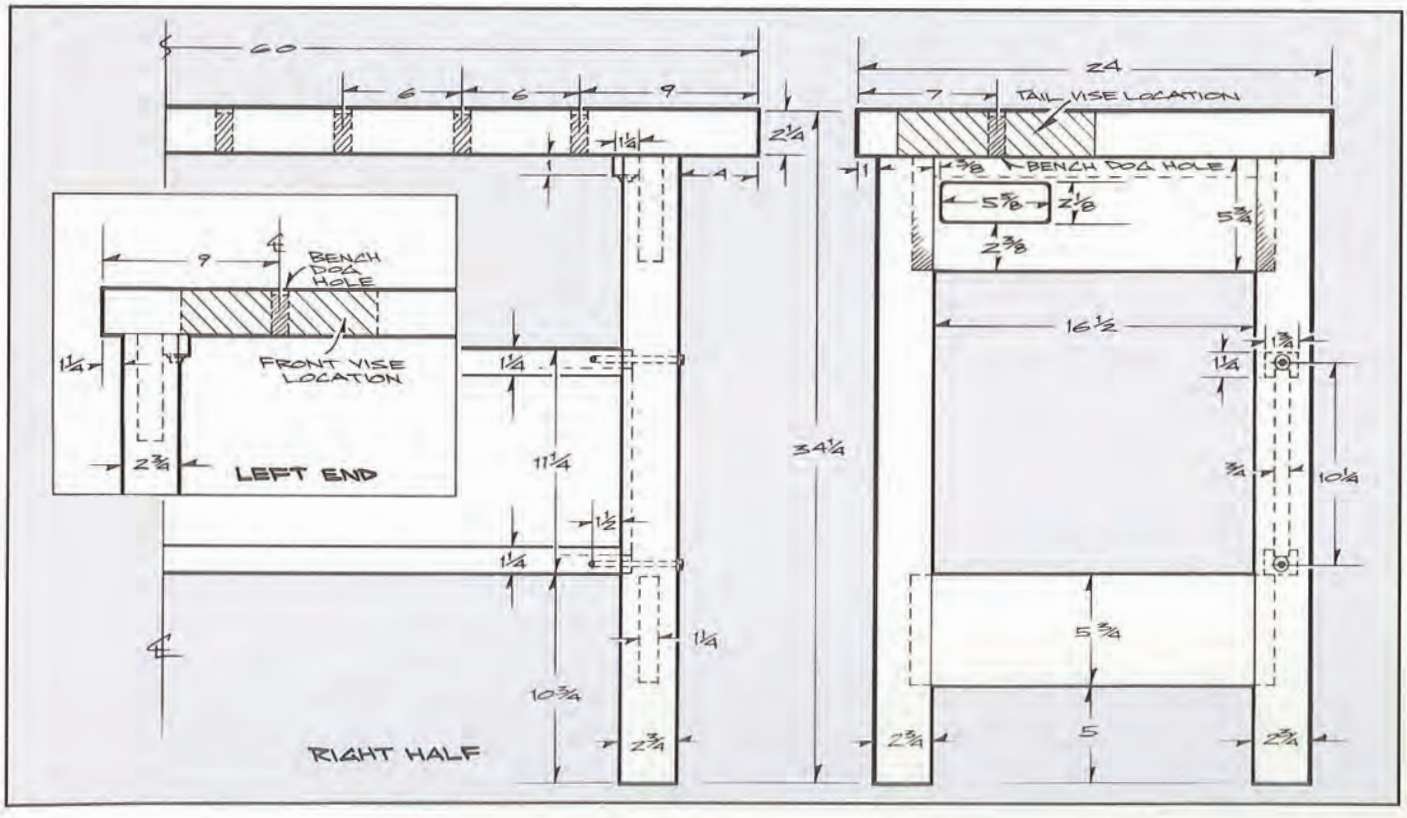
The bench frame is basically two leg assemblies (B, C) joined by a laminated back stretcher (D, E). The leg assemblies use basic mortise and tenon joinery, but the mortise and tenon joint that ties the leg assemblies together with the back stretcher uses knockdown hardware (a cross-dowel (H) and bolt) instead of glue to anchor the connection. Aprons across the front and back are not needed for strength, nor are they desired since they would prevent easy clamping of work to the top.

A good bench requires a certain amount of mass for stability. The 12/4 in. maple stock that I used for the legs is easily obtainable and provides excellent strength, but you can substitute some other hardwood, or even 4 by 4 fir construction lumber to reduce your material costs.

Before you actually cut stock for the legs, you need to determine what's a good working height for your bench. This bench is 34¼ in. high, which suits my 5 ft. 8 in. frame and the type of work I do. Examine your needs and set the bench height accordingly by adding to or shortening the bottom end of the legs. Note, though, that if you shorten the bench by more than 3 in., the tool cabinet may interfere with the vises (I). Crosscut the legs to length, then rip and plane to 2¾ in. square. Maple is very hard, so unless you've got a heavy-duty saw, you may want to use several cuts to rip the 12/4 in. stock.

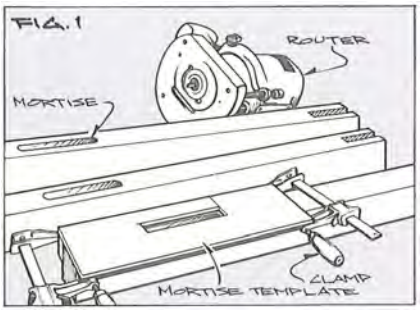
Next, rip the stretchers to 5¾ in. wide and crosscut them to 18½ in. overall, which includes the 1 in. long tenons on each end. Mark and cut the right top stretcher for the vise. All vises are not the same, so measure carefully to check that the opening is adequate for the vise you plan to use. It's a good idea to have the vise on hand before you start on the bench.

I made jigs and used the router for both the vise cutout and all the mortise work. Use straight cutters in conjunction with template guide bushings, and size



the templates with respect to the guide bushings you select. It may seem like extra work to make up templates for the various mortises, but there are actually only four different templates required. In addition to the template for the tail vise cutout, you'll need templates to cut the mortises for the stretcher, back stretcher and bench dogs (G).

As shown in Fig. 1, the templates are just sections of 1/4 in. thick luan mahog-



any plywood. Strips of hardwood fastened to the templates are used to accurately index the mortises on the legs. Using a 1/2 in. diameter bit and a 5/8 in. diameter bushing, the template cutout for the stretcher mortises should measure 1 1/8 in. by 5 7/8 in. to yield the 1 in. wide by 5 3/4 in. long mortise. Using the same bit and bushing, a 7/8 in. by 11 3/8 in. template cutout will yield the 3/4 in. wide by 11 1/4 in. long back stretcher mortises, and a 2 1/4 in. by 5 3/4 in. template cutout will produce the 2 1/8 in. wide by 5 5/8 in. long vise cutout. For the bench dog mortises, switch to a 1/4 in. diameter bit and a 3/8 in. bushing, and make the template cutout 1 in. square to get the 7/8 in. square mortise that accepts the square upper part of the bench dogs. With all the mortises, use as many passes as are needed to get the required depth. With a large router you can easily take out 1/4 in. of stock at a time, but with a smaller router limit your depth of cut to about 1/8 in. at a time.

The advantages of the template method are twofold. First, hand cutting mortises in a hardwood like maple is a real chore, and second, the router method allows you to fine-tune the fit on scrap material before making any cuts on the actual project parts. You'll really appreciate the advantages of the template method when cutting multiple mortises, such as those for the stretchers and bench dogs.

With the mortises cut, make the back stretcher lamination. Note that if you opt for the 7 ft. long top, you'll need to increase the length of the back stretcher lamination by 2 ft. As shown, the back stretcher is a sandwich of two solid maple flanges around a plywood center. Once glued up it acts as a wooden I-beam. The 3/4 in. thick plywood center section fits into 3/4 in. wide by 3/8 in. deep grooves plowed the entire length of the 1 1/4 in. thick by 1 3/4 in. wide flanges. The reason for the I-beam assembly is that since there's only one back stretcher it must be fairly wide to withstand racking. If the back stretcher were a single solid board we would have to worry about cross-grain expansion and contraction of the board within the leg mortise. The lamination of solid stock and plywood is stronger, lighter and more stable than solid stock. The overall

Bill of Materials
(all dimensions actual)

Part	Description	Size	No. Req'd.
A	Top	2 1/4 x 24 x 60	1
B	Leg	2 3/4 x 2 3/4 x 32	4
C	Stretcher	1 1/4 x 5 3/4 x 18 1/2*	4
D	Center	3/4 x 9 1/2 x 50 1/4*	1
E	Flange	1 1/4 x 1 3/4 x 50 1/4*	2
F	Cleat	1 x 1 1/4 x 16 1/2	2
G	Bench Dog	see detail	as req'd
H	Cross-dowel	3/8 dia. x 5/8 long (1/4-20)*	4
I	Vise	4 high x 10 wide	2

* Length include tenons.

length of the I-beam assembly for use with the 5 ft. long top is 50 1/4 in., which includes 1/2 in. at each end for the tenons. Round the edges of the flanges and glue up the back stretcher assembly. When dry, cut 1/2 in. by 1/2 in. notches on the flange ends to create the 1/2 in. long by 3/4 in. thick tenon that runs the full 11 1/4 in. width of the back stretcher assembly. Round the corners of the tenon to match the radius of the router bit that you used for the mortises.

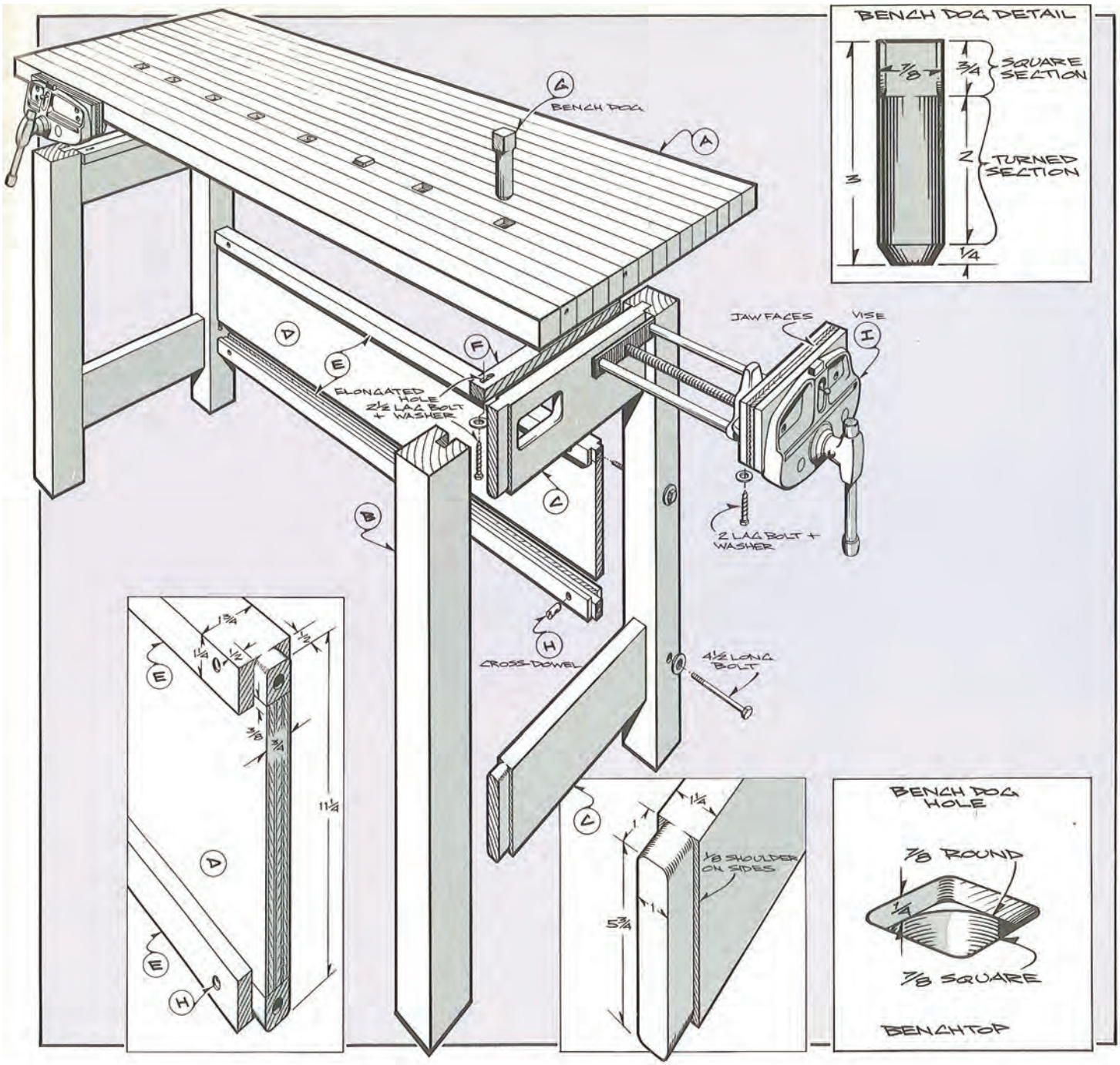
Test-fit the back stretcher tenons to the appropriate mortises, then locate and drill the holes for the bolts and cross dowels that anchor the joints. Cut the tenons on the stretcher ends, round the corners, test-fit the stretchers in their mortises, and if everything fits, glue and clamp the legs and stretchers. When dry, join the leg and stretcher assemblies with the I-beam back stretcher. Cleats (F) and lag bolts are used to mount the top to the frame.

Cut the cleats to size and bore through for the lag bolts. Note that the two outside holes in the cleats are elongated to allow for seasonal movement in the top. The cleats are glued to the inside edge of the top stretchers, a good long grain-to-long grain glue joint. At final assembly be sure to include washers under all the bolt heads to protect the wood against gouging as the bolts are tightened.

The Bench Dogs

The bench dog system is simple and unique. It combines the ease of boring a 7/8 in. diameter hole with the non-rotating feature of the more difficult to cut rectangular through-mortise. As shown in the detail, the square mortise circumscribing the 7/8 in. diameter hole is only 1/4 in. deep. There's nothing sacred about the 7/8 in. hole diameter. I just find that size handy since I can fit my small bar clamp through the hole and use it as a holdfast when I need to clamp something in the middle of the bench. But the primary advantage of using shopmade wooden bench dogs as opposed to the purchased steel variety is that you'll never risk ruining a cutting edge should the tool accidently hit the dog.

Locate the holes for the bench dogs and carefully bore through the top. But first make certain that the line of holes is centered on the tail vise, and that the last hole in the line is centered on the front vise. This may seem like a small point, but without this on-center feature you'll find it difficult to use the bench dog system as it's intended, in conjunction with the vises for holding boards. For the 10 in. wide Sears vises I used, the bench dog holes are centered 7 in. back from the front edge of the top, spaced 6 in. apart, and the first and last holes are



located on center 9 in. from the end of the bench. I use a freshly sharpened 7/8 in. diameter spade bit chucked in my 3/8 in. variable-speed reversible drill to bore the holes, but take care to keep the drill vertical. Back up the holes to prevent chip out as the bit exits. The router and template are used to cut the 1/4 in. deep by 7/8 in. square bench dog mortises.

I turn my bench dogs on the lathe, and make them in several different heights so they can later be customized for unusual holding operations. Size the square end of the dogs for a friction fit. The dogs should be long enough so they protrude through the bottom of the bench top. That way you can just give them a little tap with your palm at the bottom to pop them free.

Mounting the Top and Vises

After final sanding all parts, turn the top upside down on the floor, with a blanket or some cardboard beneath to protect it. Locate the frame, drill the holes for the 2 1/2 in. long lag bolts, and fasten the frame to the top. Don't undersize the holes for the lag bolts. Maple is very hard and you could split the wood or twist the head off the bolt if you try to torque a lag bolt into a hole that's too small.

The Sears vises are sized to mount perfectly onto a 2 1/4 in. thick top, no shimming required. Add wooden jaw faces to the vises to protect the work that's held within.

The Finish

I finished the bench with a coat of sanding sealer followed by two coats of polyurethane varnish. The top comes pre-finished, but it's important to use the sanding sealer and polyurethane on the bench dog holes, where the wood has been exposed.

Recruit some strong friends to help you move the finished bench into place. After a brief rest you'll be ready to put the bench to good use building the accompanying tool cabinet.

Portable TOOL CHEST

I find that drawers make the most convenient tool storage. And to get maximum storage, the drawers should be fairly shallow. This cabinet's seven drawers will accommodate most common woodworking tools. The two shallow top drawers are for chisels and layout tools, the middle drawers will hold everything from bits and a brace to spokeshaves and sharpening stones, and the deep bottom drawer is for planes. The two cupboard compartments are for larger items such as electric drills and routers.

The cabinet is basically just a box made of birch veneer plywood edge-banded in oak. A hardwood plywood is recommended because it's more stable, easier to work and has fewer voids than a fir plywood. You'll need two 4 ft. by 8 ft. sheets of plywood altogether: a sheet of 3/4 in. thick plywood for the case and shelf parts, and a sheet of 1/4 in. plywood for the case back and drawer bottoms. All the remaining parts except the door panels and drawer faces are oak. I used bird's-eye maple for the panels and drawer faces to add some interest. With the bird's-eye the chest can even stand alone as a piece of furniture, perhaps a collector's case or a small credenza.

Start by making the plywood box. Cut the sides (A), top/bottom (B), and dividers (C) to length and width. Note that the overall length of the sides and dividers includes the 1/4 in. wide by 3/8 in. long tongues on each end. The dividers must be sized 1/4 in. less in width than the sides, top, and bottom, but for the moment cut parts A, B and C to the same 17 in. width. This yields greater accuracy and minimizes additional rip fence settings.

Again grouping the parts, cut the tongues and grooves. I find it best to use a piece of scrap to check the settings prior to cutting the actual pieces. Be careful to orient the tongues on the dividers so they're on the side facing the drawers. You could use a fixed shelf system, but the commercial shelf supports (F) I use allow a wide range of adjustment so you can customize the shelves to meet your needs.

Lay out and cut the dadoes in the sides and dividers for the shelf supports and drawer runners (E). For the drawers to operate properly, it's important that the opposing runners in the two dividers be perfectly aligned. Cut each pair of runner dadoes with the same fence setting to insure accuracy. Then reposition the fence for the shelf support dadoes, which are all located on-center 2 1/2 in. from the edge. Set up the dado head for a 5 mm deep by 14 mm wide cut. This measurement is important since the shelf support strips are press-fit into place. Like much of the furniture hardware sold today, the strips are European made and sized in millimeters. If you don't already have one, steel rules with millimeter gradations are sold at most stationery stores. Use the same fence setting for all eight shelf support dado cuts. With the dado cuts made, now reposition the rip fence, identify the left and right side dividers, and rip 1/4 in. off the back edge of both dividers. This enables the dividers to fit inside the back. Next, set up the table saw for a 1/4 in. wide by 3/8 in. deep rabbet, and cut the rabbets in the sides, top, and bottom for the back.

Assemble the carcase, consisting of the sides, dividers, top, bottom, and back. All edges are flush at the front, so the dividers will be inset 1/4 in. at the back. Once the carcase is dry and out of clamps, add the oak base front and back (G), the base sides (H), the glueblocks

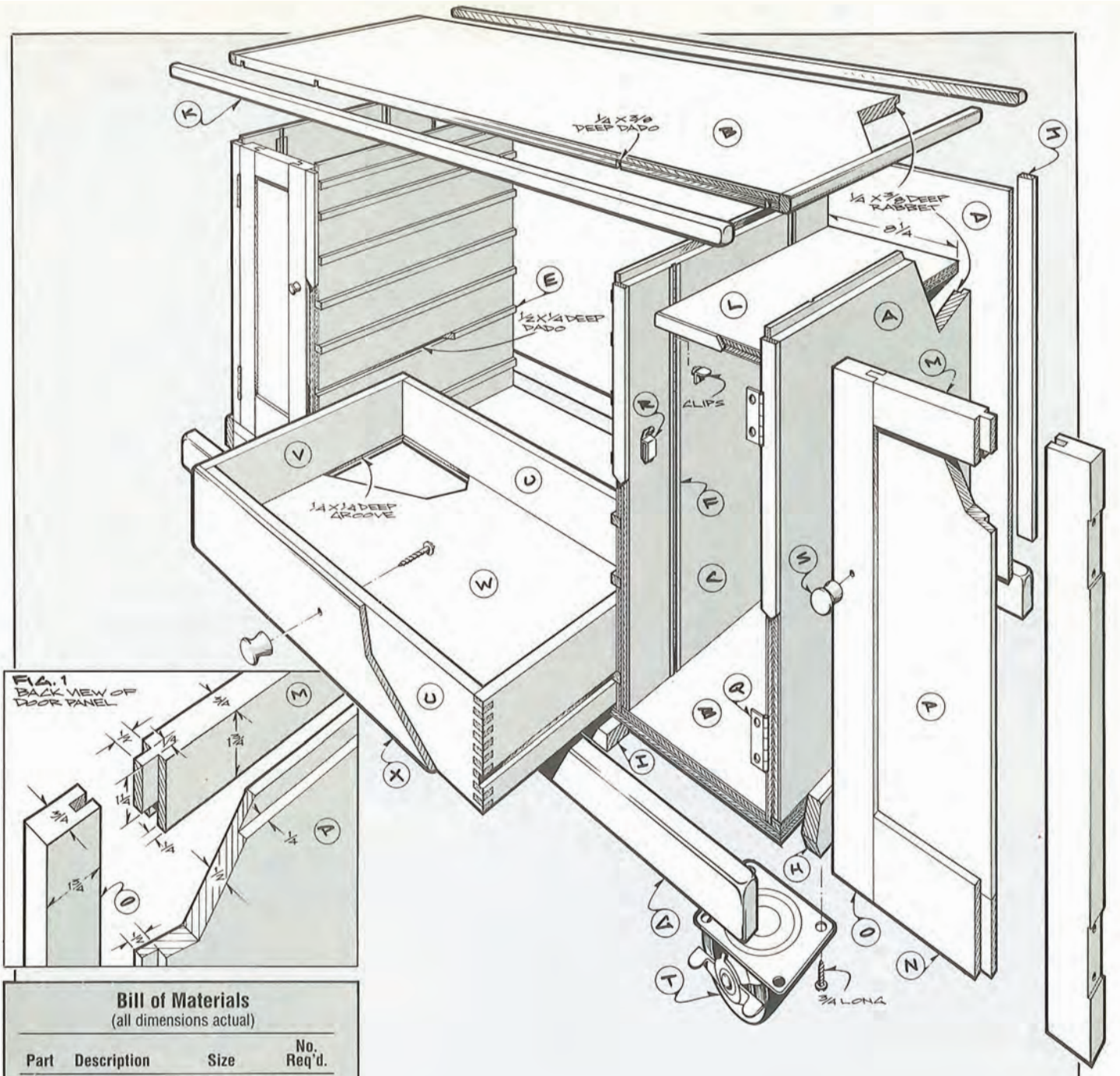


FIG. 1
BACK VIEW OF DOOR PANEL

Bill of Materials
(all dimensions actual)

Part	Description	Size	No. Req'd.
A	Side	3/4 x 17 x 21 3/4*	2
B	Top/Bottom	3/4 x 17 x 45	2
C	Divider	3/4 x 16 3/4 x 21 3/4*	2
D	Back	1/4 x 21 3/4 x 44 1/4	1
E	Drawer Runner	1/2 x 1/2 x 16 3/4	14
F	Shelf Support	21 long**	8
G	Base Front/Back	3/4 x 1 3/4 x 46 1/2	2
H	Base Side	3/4 x 1 3/4 x 17	2
I	Glueblock	3/4 x 1 3/4*	As Req'd
J	Edging	1/4 x 3/4	As Req'd
K	Top Edging	1/2 x 3/4	As Req'd
L	Shelf	3/4 x 8 1/4 x 15	As Req'd
M	Door Rail (Top)	3/4 x 1 3/4 x 6*	2
N	Door Rail (Bottom)	3/4 x 2 1/2 x 6*	2
O	Door Stile	3/4 x 1 3/4 x 21	4
P	Door Panel	1/2 x 5 7/8 x 17 5/8*	2
Q	Hinge	2 long x 1 1/2	4
R	Magnetic Catch	as shown	2
S	Knob	1 dia.	9
T	Caster	3 dia.	2 pair

Part	Description	No. Req'd Per Drawer	Top Drawers	Middle Drawers	Bottom Drawer
U	Front/Back	2	1/2 x 2 x 25	1/2 x 3 x 25	1/2 x 5 x 25
V	Side	2	1/2 x 2 x 16 3/4	1/2 x 3 x 16 3/4	1/2 x 5 x 16 3/4
W	Bottom	1	1/4 x 16 1/4 x 24 1/2	1/4 x 16 1/4 x 24 1/2	1/4 x 16 1/4 x 24 1/2
X	Face	1	1/4 x 2 x 25	1/4 x 3 x 25	1/4 x 5 x 25

* Dimensions include tongue or tenon.

(I), and the edging (J, K). Also cut as many shelves (L) as you need, and apply 1/4 in. thick edging to the front end only. Radius the top edging and the base as shown.

The doors are a simple stile and rail construction. As shown in Fig. 1, the 1/4 in. wide by 1/2 in. deep grooves in the stiles (O) capture the tongue on the panel (P) and also serve as the mortises for the tenons on the ends of the rails (M, N). The panel is sized a little under the actual groove-to-groove dimensions, and is allowed to float within the frame. The drawers are just finger-jointed boxes with an applied face (X). A 1/4 in. wide by 1/4 in. deep groove in the front and back (U) and sides (V) holds the plywood bottom (W). The 1/4 in. pin size of the finger joints enables you to use the same jig (Fig. 2) for all three drawer sizes; the deeper drawers just have more pins. The two top drawers have 8 pins, the four middle drawers have 12 pins, and the bottom drawer has 20 pins. The grooves in the drawer sides to fit the runners are cut after the boxes are assembled but before the faces are mounted.

Mounting the drawers and getting them to operate smoothly is probably the fussiest part of the chest assembly. Cut the 1/2 in. square drawer runners, test fit them in the carcase without glue, and try each drawer. Now is the time to make any adjustments. As dimensioned in the Bill of Materials, the drawers are butted tight top to bottom and on the sides, but in practice you must allow a little space between the drawers and at the sides. A sharp hand plane or a belt sander can be used to remove a little stock from the top and bottom edges and sides of each drawer. If you take about 1/32 in. from each edge and side, you'll have 1/16 in. clearance all around. This clearance is important since you don't want the drawers rubbing against each other or jamming against the dividers. Another way to get the needed clearance is to just size your stock dimensions a little under to start. Once you've got the drawers operating smoothly, glue the runners into the case. Mount the drawer faces last, after the drawers are fitted.

All that remains is to mount the hardware and apply a finish. The door hinges (Q), magnetic catches (R), and knobs (S) are all hardware store items. Note that if you mount the casters flush into the corners of the base, you'll need to chamfer the inside edges of the base front and back (Fig. 3) to provide the caster wheels with needed clearance. The finish is a coat of sanding sealer followed up with two coats of polyure-thane varnish and then paste wax.