Chest of Drawers

This graceful piece is an education in cabinet design and joinery.

METRIC CONVERSIONS
1" = 25.4mm
1mm = 0.03937"

Foreword

In this article, I highlight the following furniture design and making elements:

- The design process, including a method for smoothly graduating drawer front height.
- Cutting lists, materials selection and conversion.
- Gluing the boards to make panels, and a method to attach the side panels to the legs to create a reveal.
- The jig used for shaping the leg.
- Finally, I round up the construction including a detailed drawer slide installation procedure.

The Design Process

I've been developing a range of furniture specifically for display in galleries and furniture shows, and this cabinet in American Cherry, Walnut, and Hard Maple is an example. Large pieces have their place in shows, but there are assembly, packing, set-up, and transportation considerations, and large items can dominate your space. Smaller furniture is easier to handle and arrange. Modestly sized pieces illustrate style and proficiency, are saleable, and can generate commissions. The leg style used was the design motif that inspired the piece, for this leg had already been used in tables and chairs, but this is my first use of it in a cabinet.

Designing for shows is both liberating and restricting; you can make anything you like, but will anyone else appreciate it? In this case, apart from the leg form, there were no design

limitations. It's often helpful to invent a realistic end use, perhaps a need of ones own to define the brief. This forces concentration on the job in hand and discourages flights of fancy which, if they occur, are filed in the 'for later' category. I didn't picture an end use here because the leg motif was so strong; I was designing for looks and would allow functionality to present itself.

General proportions were determined first, *i.e.*, the width arbitrarily set at 610 mm (24") with the depth of 472 mm (18-9/16") eventually set by the requirements of the proprietary drawer slides, and the height of 1100 mm (43-1/4") chosen as 'attractive.' The inside face of the legs were kept straight to reduce drawer, or door, fitting problems. Doors were rejected, because without hinge limiters, opened doors would hit the leg. Drawers and/or tambour or a flipper were possible choices and drawers were finally chosen because people always welcome extra drawer space.

With the broad parameters settled--a nest of drawers in a free standing cabinet--detailing was required. How many drawers, and how should they move? Hidden or exposed timber drawer dividers? Proprietary drawer slides? Planted or integral drawer fronts? Exposed dividers were ruled out to reduce the quantity of cluttered horizontal lines. Proprietary full extension drawer slides were chosen, selecting an Häfele Undermount type because they are quite inconspicuous and allow the drawer to fill most of the internal cabinet width. There are always arguments for and against proprietary slides, but I concluded they were a good choice here primarily because I wanted full drawer extension.

The next choice is how many drawers to incorporate, and eight drawers were chosen, with the top drawer front 80 mm tall so that its bottom edge coincided with the legs shoulder. The choice was made to graduate the height of the fronts incrementally, each front a consistent amount narrower than the one below it. Various ways exist to do this, but I used the following method:

1. Number of drawers = 8
2. Top drawer front height = 80 mm.
3. Every drawer front height must be > 80 mm, therefore calculate, 80mm X 8 = 640 mm.
4. To find the incremental height increase of each drawer front, subtract this 640 mm from the vertical height available, i.e., 890 mm. Therefore, 890 - 640 = 250 mm.
5. There are 28 equal increments [I] to divide into 250 mm (see table below.) Calculate, 250 mm / 28 = 8.928 mm. Each drawer front is approximately 9 mm taller than the one above, i.e., 80, 90, 98, etc.

Finding the no. of increments (I) in a stack of drawers
1st drawer = + 0 I
2nd drawer = + 1 I
3rd drawer = + 2 I
4th drawer = + 3 I

5th drawer = + 4 I
6th drawer = + 5 I
7th drawer = + 6 I
8th drawer = + 7 I
Total I (increments) = 28

8. For all practical purposes the figure used is 8 mm ± to ensure a gap between drawers, i.e., starting at the top, 82, 88.5, 96, 105 mm etc., and these figures reflect the practical realities of production.

If the incremental height increase had not suited, a drawer would have been removed or added, or the height of the top drawer front adjusted -- along with the leg shoulder -- and some recalculating done.

The drawer sides are joined to the drawer fronts with sliding dovetail housings, and they're hand dovetailed to the back. To provide a drawer stop a 12 mm reveal (rebate, US rabbet) at the joint of the leg to the carcase side panel is incorporated. Other details include curved elements to complement those in the outside face of the leg; for instance, the bottom 100 mm or so of the legs inner face is also curved, and the bottom edges of the lower front rail, and the bottom edge of the panel sides. The top has a shallow bevel worked on the underside to show a slim edge, the front edge is gently radiused.

Considering visible hardware requirements at the design stage is important; this prevents giving the impression that pulls are an afterthought. "Design from the handles back," to quote well-known designer Rupert Williamson. Early in the design process it was decided that proprietary pulls would be used, and a few possibilities selected. The choice was narrowed to one pattern, available in four colours, the final choice dependent upon the timber species used for the drawer fronts. They were selected to complement the curve above the high knee of the leg. Some flexibility at the design stage allows for small changes to be made in a pieces final appearance, the techniques used, and timber selection.

The original design called for the carcase sides and bottom to be made of cherry veneered plywood, the bottom of a piece of 18 mm ply. The sides were to use the same 18mm ply, but it would be glued to two pieces of 6 mm ply to make 30 mm thick. Solid lipping front and back would hide the plywood edges. When it came to material selection in the workshop, the plan changed. There was plenty of solid stock on hand, and only a 28 X 12 mm back strip is needed as seen in the suggested alternative plywood version sketched, and this strip is needed to form a channel for the back panel. Veneered board often doesn't polish up the same as solid timber without staining, and tinting of the polish, which is another reason for not using it in the cabinet I made. (Click here to view the typical plywood construction details.)

Cutting Lists:
Aids to efficient timber selection and processing.

The sample cutting list below is made on a word processing programme and saved on the computer's hard and Zip drives. It is simply a table formatted with columns and rows. If you highlight all the far left column from the row below the Ref. header (see table below), you can insert and format lettered bullets. A, B, C, etc., and the whole of this column will automatically fill in as you tab down. A whole page can be prepared with all the rest of the fields left blank and a few copies run off for workshop use, or the fields filled in for a job using the computer, and saved under a job name for future reference.

Ref.	Timber/ Material	Part	Quantity	L, mm	W, mm	T, mm	Found	2.S.S	4.S.S	Notes
A	Cherry	Leg	4	1080	70	70				Mark shape and joints from rod.
B	Cherry	Top	1	610	472	20				Make up from boards. Use biscuits.

The empty columns--Found, 2SS (2 sides square), 4SS (4 sides square)--are reminders used during material processing to keep track of the job. In large or complex jobs with many parts, the most used column is Found, where the located parts are marked off thus, ~~IIII~~, to show batches of 5 accounted for.

In specifying material dimensions for most furniture making projects, it's easy to calculate exactly what's needed for the main carcase elements, but drawer parts, for instance, can often only be reckoned approximately, and are therefore given generous notional sizes.

In using the cutting list, go through your timber and decide where to make cuts so as to get the best utilisation. Mark the parts as they are located with letters that correspond to the cutting list, and make a reciprocal note on the list. Regard as a minimum, the last 50 mm at both ends of a board as waste because the ends of boards tend to dry rapidly and are unlike the rest of the plank. Also because of the different drying pattern there is the possibility of hidden end shakes. Additionally, if there are readily visible shakes evident at the ends, allow at least another 50 mm as waste. Cut around any shakes in the middle of a boards length by 50 mm. Generally cut rough timber at least 100mm longer than the required finished length to allow for planer or thicknesser snipe, etc. Gang together short and/or narrow pieces into one and trim to size later, e.g., three pieces to finish at 300 mm long might come out of one piece about 1000mm long.

If the choice of timber species has been left flexible, make decisions now. Decide if some, or all the parts should come out of either quartersawn or plainsawn material, depending upon the design, and with quartersawn selected if stability is a concern. However,

a possible drawback of quartersawn timber is that the grain pattern is usually straight and plain which may not be suitable aesthetically. Quarter sawn oak is one notable exception where this cut reveals prized 'silver grain'. Like everything else in furniture making, timber selection is a compromise.

All the timber should be cut, surface planed and edged (US terminology is, jointed on the face and edge) and thicknessed as required. Parts not immediately needed to start construction, such as the drawer parts, leave long, wide, and a few mm thicker. Stack and sticker these parts in your office or house until needed. This gives the parts some time to acclimatise to typical interior conditions. (My workshop for instance, has no climate control.) Sometimes a good strategy is to cramp the pile or piles together if stability is a concern. This doesn't always work, but it often helps to maintain flatness.

Construction, Part I:
Building the Carcase

Typically, the order of work when making cabinets is to concentrate on making the basic carcase, then fit internal parts to suit. In a cabinet like this, this means the legs and sides, the cabinet bottom, the bottom front rail, and the three top rails. In addition, the top, of glued up planks, can also be made at the beginning.

A complication exists here in that the joinery of the legs to the other parts is undertaken whilst the leg blanks, rails and panels are still square. This makes the joinery work easier. Once joinery is completed, shaping is done. Planning jigs and rods to facilitate the shaping process is done at an early stage because joinery and shaping operations are interrelated. This should be borne in mind in reading the text.

The job of edge gluing boards for the two cabinet sides, the bottom and the top is done first. Leave the pieces that form these panels a bit thick, *e.g.*, the sides eventually finish at 30 mm thick, so leave them at 32 mm+. Prepare the edges by straightening them on the surface planer (US jointer) and hand planing, if required, with a No. 7 try plane. Biscuits or tongues might be used to help with alignment. Glue and cramp up. After the glue has gone off, plane one face flat on the surface planer (jointer,) and run the pieces through the thickness planer to size. If your machines are not wide enough to accommodate the wide pieces formed in one go, work in stages. Do the last join up carefully to keep misalignment to a minimum thereby reducing necessary handplaning. Lay the top and bottom to one side, stickered up in your office or house, like the drawer parts before, and work on joining the side panels to the legs.

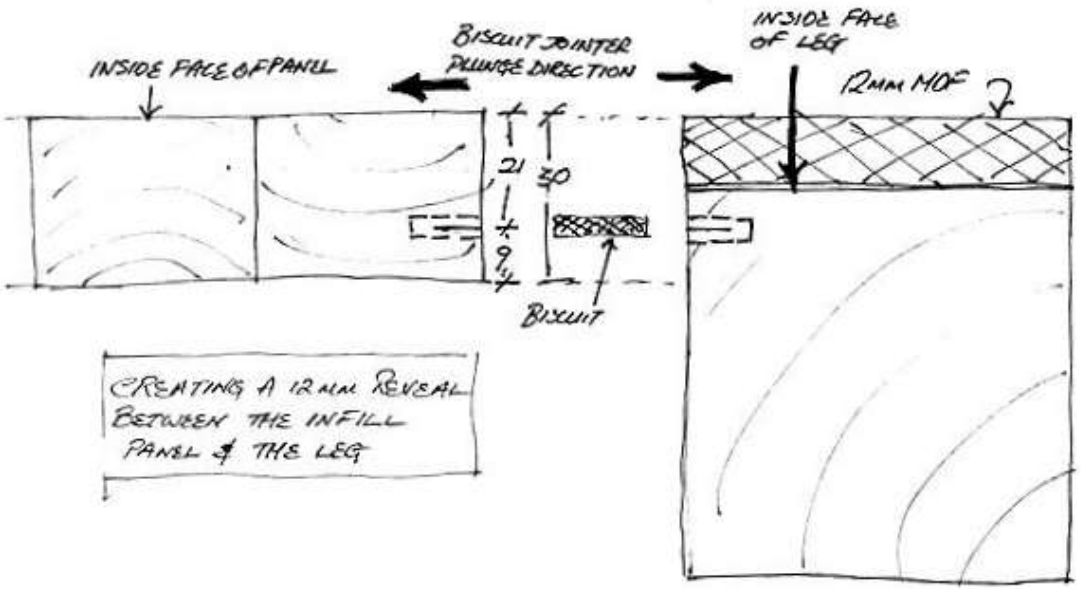
The legs of this piece were squared to 70 mm, and were cut exactly 100 mm overlength (i.e., 1180 mm) to fit a jig that is made and used later for shaping the curves. Allocate each leg to a specific corner and note their positions. Gang the legs together on the workbench, top and bottom ends aligned and the faces to be joined to the side panels facing up. Gently cramp them together. Square a line across 50 mm down from the top. Measure off the finished leg length, (1080 mm) and square this line across. This leaves 50 mm overlength at both ends. Mark the length of the panel (970 mm) down from the top line. Mark the position for (five) biscuits along the length for the panel to leg joint, and strike these positions across all the legs with a sharp pencil and a set square.

Use the marked legs to set out the requisite matching biscuits on the edges of the glued up panels. Cut and true up the long edges of the panels to the appropriate width (310 mm in this case) measure, mark, and square across the finished length (970 mm.) Offer up each edge of each panel in turn to its allocated leg, and transfer the marks for the biscuits from the legs to the inside faces of the panels. (Optional. Add one dowel per edge to eliminate slippage in the length during glue up but this is not really necessary.)

Where the panel and leg join, there is a 12 mm (1/2") step, rebate, (US rabbet) or reveal. To create a reveal without calculating and making adjustments to the biscuit jointer use the technique as sketched below. This uses the inside face of both the panel and the leg as the reference point for the fold down biscuit jointer fence. Set the jointer to cut 21 mm± down from the inside face of the panel, and cut the slots.

Then cut a piece of 12 mm MDF the same length and width as the leg. Attach the MDF with

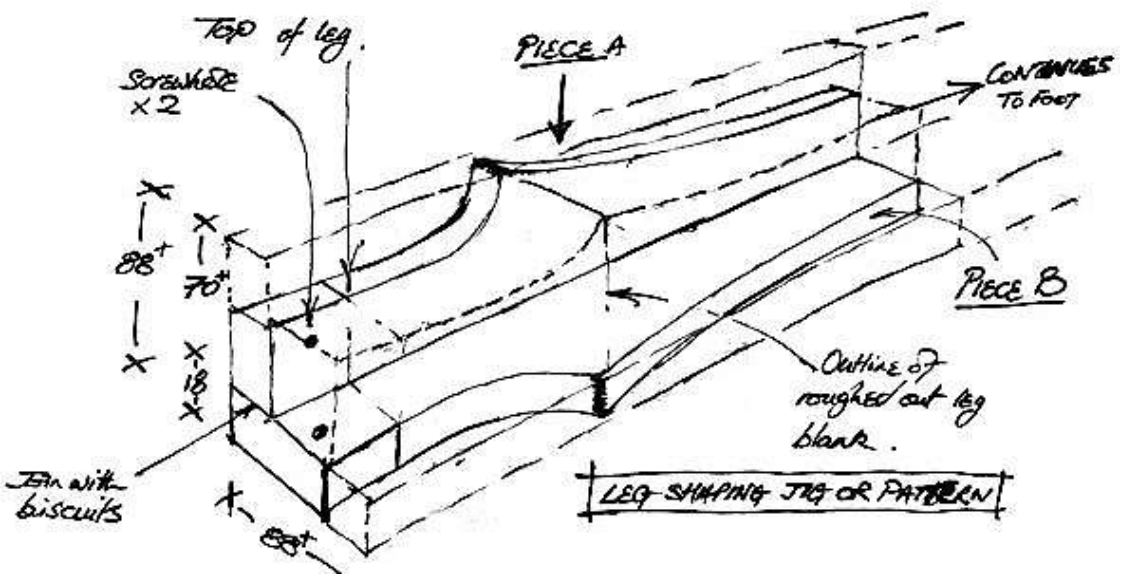
a long edge flush with the edge of the legs' face that is to be biscuited; cramps should be fine. Transfer the biscuit marks on the leg to the top face of the MDF. Without altering the setting of the biscuit jointer, cut the slots. The offset between the leg and the side will automatically be the thickness of the MDF. For different rebates (rabbets) or reveals, use a different thickness of MDF (or other board material.)



With this job done, the cabinet bottom can be trued up, cut to exact length, and dry biscuited to the inside faces of the side panels. In this cabinet there is a bottom front rail attached to the front edge of the cabinet bottom, and this may also be dry biscuited on, leaving this item 50- 60 mm overlength at either end.

Construction, Part II:
Jig Making, Shaping the Legs, More Joinery

Shaped legs like these can be formed by making an L-shaped cradle jig, as in the photo and sketch below. The squared leg blank is attached to the jig and shaped on the spindle moulder (US shaper) or router fitted with a pattern cutting bit.



To make a suitable jig, cut two pieces 18 mm ply or MDF to 1180 mm long, the same length as the leg, and 72 mm± wide (Piece A above) and the other 90 mm± wide (Piece B above) Dry biscuit the edge of Piece A to the face of Piece B. Mark a line along the inside of the corner on piece B. Plot the outside profile required on Piece A. (Ignore the inside curve at the bottom of the leg.) The profile can be plotted directly onto the MDF, or a full size paper template attached. Cut and smooth the curves.

Attach this shaped piece A to B as shown at right with countersunk (US flathead) screws. Cut close to the profile on A with a bandsaw and finish Piece B with a router and top mounted bearing pattern cutting bit. The tiny rebate on Piece A at the inside corner can be formed next, and provides a space for dust.

Glue and screw the jig together with the biscuits and countersunk screws. Ensure that the faces are perpendicular to one another. Trim the outside corner flush when dry.

Drill offset countersunk screw holes in each face of the jig into what will be the surplus at the top of the leg. Repeat at the bottom end. Place the inside corner of each leg in the jig and screw

them in. Trace round the jig to mark the leg.

Now that the exact profile of the leg is known, the bottom front rail that attaches to the cabinet bottom (dry biscuited four paragraphs previously) can be cut to length remembering that the distance between the shoulders is the length of the cabinet bottom, plus 24 mm, (*i.e.*, 12 mm MDF X 2 as used to cut the biscuit slots in the leg.)

Mark and cut mortises and tenons in the square leg blank. Set the back face of the rail flush with the back face of the leg, and the front face inset from the front of the leg. Leaving this job until now lets you make any minor adjustments to the rail thickness and to establish a safe mortice depth that doesn't penetrate through the outside face of the leg.

Bandsaw the waste from the legs. Cut one face, and re-attach the offcuts with masking tape. Cut the second face. Screw each leg back into the jig and use the spindle moulder, or a router and pattern cutting bit to follow the profile. Extra screws may be inserted to secure the leg in the jig, but screw only into the biscuited face; the holes will be hidden later. (These legs are from a different job, but the profile and procedure is the same.)

Complete the legs by cutting the short curved inside faces at the bottom; a small card template can be made to trace around, then bandsawn, and planed. Clean up all the machine marks and do any rounding over with hand tools in preparation for gluing the legs to the side panels.

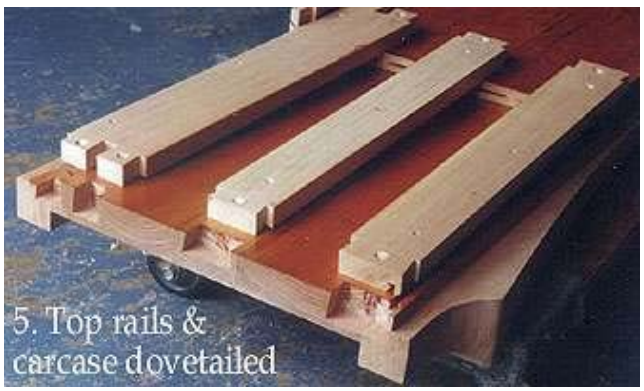
The chord of a circle can be marked at the bottom of the two side panels and the underside of the front rail. Cut and smooth these. A pattern of MDF for use with a router and pattern cutting bit speeds the job up. Glue the legs and panels together with biscuits, using a rig made of the curved leg offcuts for the sash cramps.

When the glue has cured cut the sides to length on a panel saw. Use the reveal at the leg to panel junction as the datum point for the saw fence, shimming, and packing as necessary to hold it flat and square.

Bevel the underside of the feet with a hand plane to strengthen short grain and reduce the chance of flaking off.

Construction, Part III:
Completing the Carcase

Provide channels to hold a back panel by machining a piece of timber to go into the reveal (rebate) at the junction between the side panel and the back leg. Cut it 28 mm X 12 mm+, and rout a groove in it for the panel. Glue this machined part in place with some pins driven through the channel- photo 4 earlier. Flush off level after gluing in place.


5. Top rails & carcase dovetailed

The three top rails that complete the main carcase should be cut to length and carcase dovetails marked and cut, not forgetting to run a groove for the back panel in the back rail. Bore the screwholes through the dovetails that will be required at glue up. Bore screwholes through the rails for holding down the top. A dry assembly of all the parts can be done at this stage, except that this is when the bottom rail is glued to the bottom shelf. Gluing at this point ensures that the rail overhangs the right amount at both ends.

Polyurethane glue is convenient because it has a long open time giving you chance to fiddle. Once the glue has set, dismantle the whole thing and clean up the internal parts, and apply polish after doing appropriate masking off.


6. Assembled carcase.

Cabinets of this pattern can be glued together in two stages. First glue in the bottom shelf using a couple of top rails to hold the sides apart. Check for square and winding, and then glue and screw the top rails in place one at a time. A helper or two is handy at this point. Prepare and fit a cabinet back; two pieces of 6 mm Cherry veneered MDF are glued together (a press is convenient) to make a panel 12 mm thick, then three edges are rebated. The panel slides in from the bottom and is locked in place with three screws through it into the cabinet bottom.

Construction, Part IV:
Drawer Work

The drawer material that was previously stored can be got out and worked. True up all the drawer fronts, and size them to width and thickness. For the Häfele slides used, the following are critical dimensions:

- –Each pair of drawer sides is 16 mm narrower than their matching front.
- –Every drawer side is 308 mm long, and this provides for an 8 mm sliding dovetail into the drawer front, and for through dovetails at the back,
- –A 6 mm+ wide X 5.5 mm deep groove is worked with the bottom edge of the groove 13 mm up from the sides bottom edge. This groove carries the drawer bottom of veneered 6 mm MDF.
- –Each drawer back is 39 mm narrower than its front.
- –The length of every back is 13 mm less than the internal cabinet width (i.e., in this case 422 mm long to go into a 435 mm space.)
- –All sides and backs are 12 mm thick.
- –This information is a guide, and you should recalculate according to your circumstances.

Once all the parts are dimensioned as above they can be used to position the drawers and slides inside the cabinet This can probably best be accomplished by making a rod or pattern of 12 mm MDF or Birch ply that conforms exactly to the interior side elevation of the cabinet side. Errors in layout are easily fixed with an eraser, and some re-measuring and drawing. If your cabinet is solid timber you should allow for expansion and contraction, and this is not provided for with this Häfele slide. Provide for it by joining two rear screwholes in the slide to form a slot. With sixteen to do as in this case, an engineering mill, if available, is convenient.

With the internal rod (pattern) cut, start by positioning and marking all the drawer fronts on the rod's long front edge, and work back into the cabinet marking out and drawing in the position of the drawer sides, and the position of the drawer bottom grooves worked in these sides. Then position the bottom drawer slide on the rod so that the top of the slide matches the position of the groove where the underside of the drawer bottom fits. The slide should be perpendicular to the rods' front edge, i.e. parallel with the bottom edge.

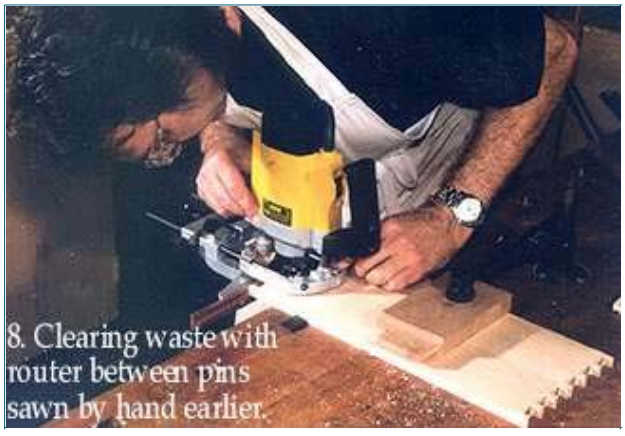
Mark the centre of the two screw holes, one front, one back. Use a marking gauge and scribe the inset distance of these screw holes from the rods long edges all along the length.

Next, work upwards, one drawer at a time and plot the position of every slide by marking the centre of the appropriate screwholes. Use a 2 mm or 2.5 mm twist, or brad point, bit and bore the marked screw centres. A drill press is handy, but it can be done freehand. Once all this plotting is complete, the rod is offered up to each cabinet side and the screwholes marked through.

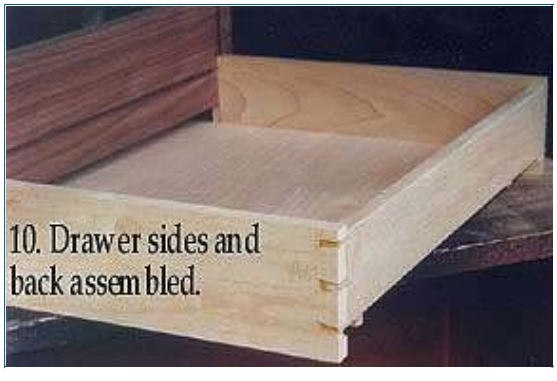
With this pattern of drawer, there is no slip. The weight of the drawer and its contents is carried by the bottom which sits on the Häfele slides, and by the channel worked in the drawer sides.

Drawer construction is fairly conventional, and stages are illustrated in photos 7-10 below. After the fronts are glued on the dovetail housing that runs out on the bottom edge of the drawer front can be plugged with a matched grained dovetail shaped piece of timber. Technically, this is unnecessary, but it's a neat touch. Flush off the top edges of the drawer box with a hand plane.

7. Routing drawer front sliding dovetail.

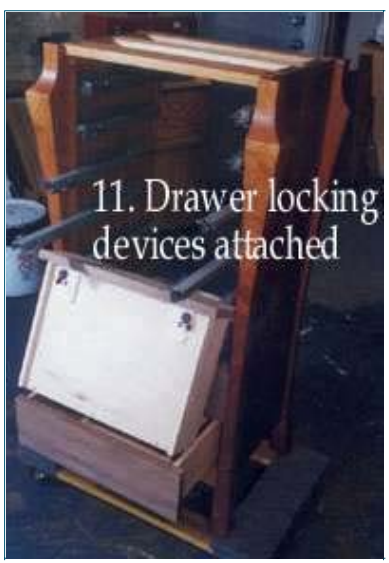

8. Clearing waste with router between pins sawn by hand earlier.

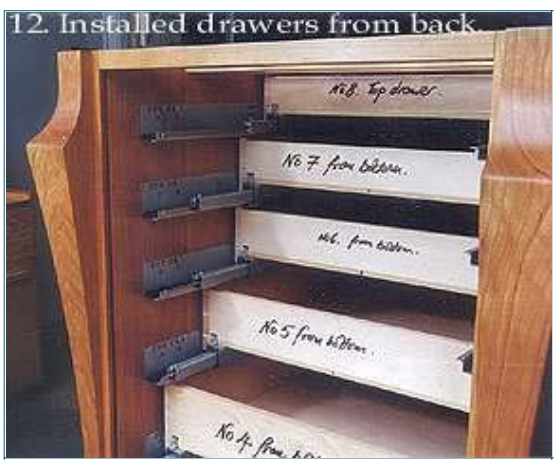

9. Completed drawer parts.


10. Drawer sides and back assembled.

Fit the drawer bottoms and insert three screws up through them into the underside of the back. The drawer back has a hole cut to capture the hook at the end of the slide. This can be drilled, but a plunge router, 3 mm bit and side fence can also be used. If using this latter method, shim out the drawer bottom with a piece of 18 mm MDF to create a flat reference surface for the router's side fence. Holes for the pulls can be centred and drilled with a shop made MDF boring jig that locates positively to the drawer fronts.

Final fitting of the drawers means boring the previously marked screw positions on the cabinet sides with pilot holes and fitting the slides. Then attach the slide locking devices to the underside of the drawer. (See photos 11 and 12 below.) They are attached to the back of the drawer front, 29 mm± away from the inner face of the drawer side. Cut a timber spacer this length, and attach a pair of the locking devices to a drawer with just one screw each. Test fit, and make an adjustment to the timber spacer if needed. Plug the original screw holes if the locking device position was found to be wrong first time, and rebore as required.





If the drawer racks a little at the back because it's a tad too wide to fit snugly over the slides, prepare timber shims about 50 mm long by 14 mm wide, and thicknessed to suit the gap. Rub joint them in place at the rear under the drawer bottom. Trim flush when dry. Attach all the locking devices, and number them to correspond with the drawer number. Install each drawer starting from the bottom. Use the locking devices to make small vertical and horizontal adjustments. Some drawers may need skimming with a hand plane here and there to space all the drawers evenly.

Finishing

Different people prefer different finishes, and a wide range of polishes would be suitable. I chose to polish with two types of finish:

- –Sprayed pre-catalysed lacquer on all the internal drawer parts and on the back panel.
- –The rest of the cabinet and drawer fronts were polished with a 'tung oil finish' that I further modified. Tung oil finish marked on the can indicates that pure tung oil has been cut with varnish, white spirit (US mineral spirit) dryers, and perhaps other components by the manufacturer.

Spraying was done after assembly of the drawers, with lacquer masking tape and newspaper shielding the edges and front faces of drawer fronts. The back panel was finished both sides with pre-catalysed lacquer also.

I modified the manufacturer's 'tung oil finish' by adding alkyd varnish and mineral spirits. The first coat of tung oil finish was applied as it came out of the can. The second coat was cut with about 15% alkyd varnish, and 15% mineral spirits Third, and subsequent coats were cut with about 30% of both mineral spirits and alkyd oil varnish. It's wiped on, and buffed off fairly quickly, concentrating on one manageable area at a time.

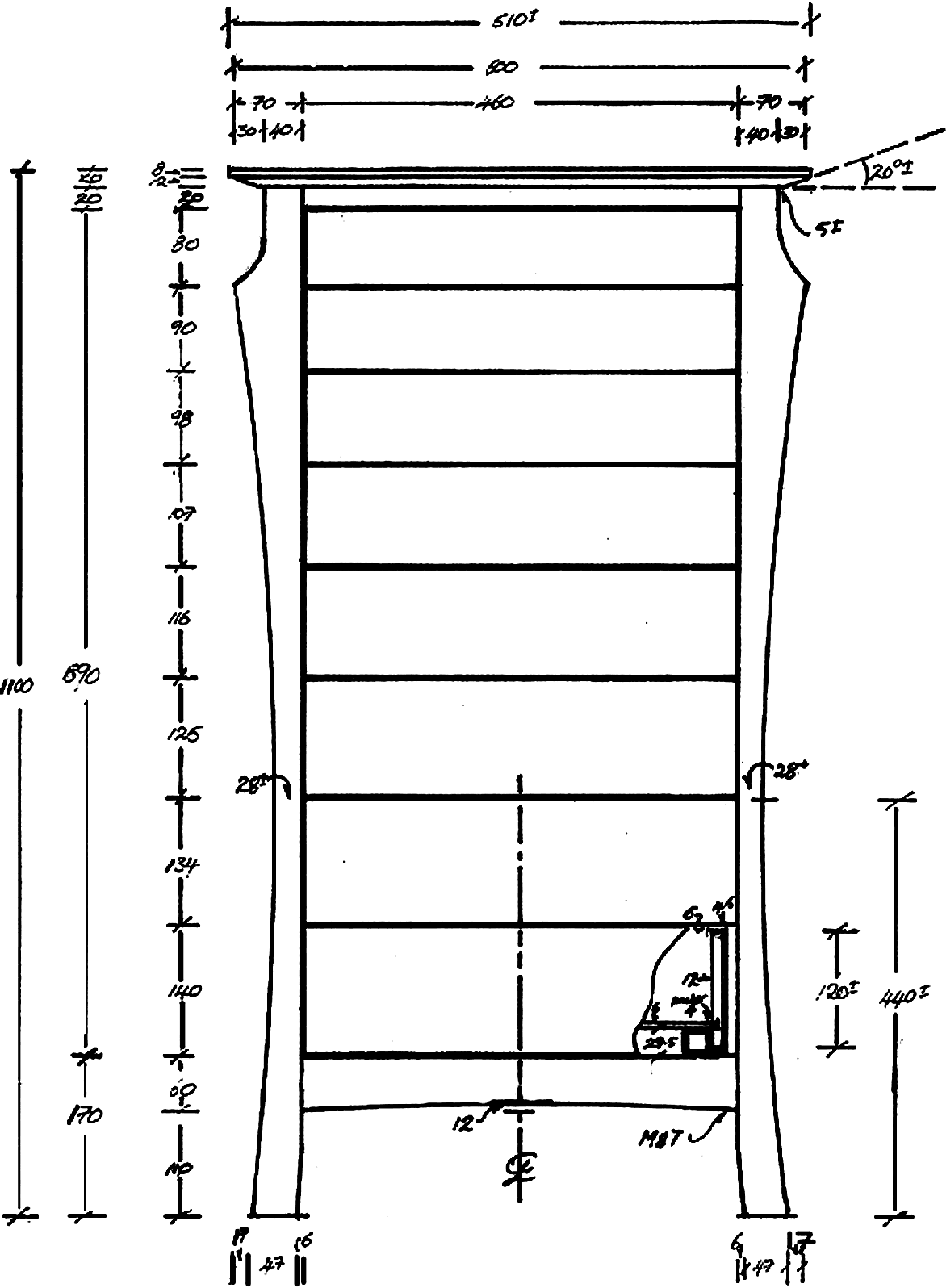
Preparing for, and polishing with this mix, was done both during and after assembly, as can be seen in several of the photographs. The drawer fronts, being walnut, had the grain filled prior to polishing. (See Photo 13.)

Note 1. The mixture I use works well in the hot humid climate I experience. Other workers, in cooler climates, prefer to use naphtha or turpentine in place of mineral spirits to allow for faster drying and other reasons.

Note 2. Pure oil finishes, such as linseed or tung oil, used on their own have a rancid, musty smell if used on internal parts that

have no air circulation, such as drawers. This is one reason why I will often finish all internal parts with, for example, pre-catalysed lacquer, and apply an oil finish only to the outside.

Finally, after the polishing, which entails breaking down the cabinet into its smallest constituents, it's re-assembled. The last job is to apply self stick felt bumper pads to the back side of the drawer front, one each end to soften the final closing action of the slides and prevent abrasion damage.



510±
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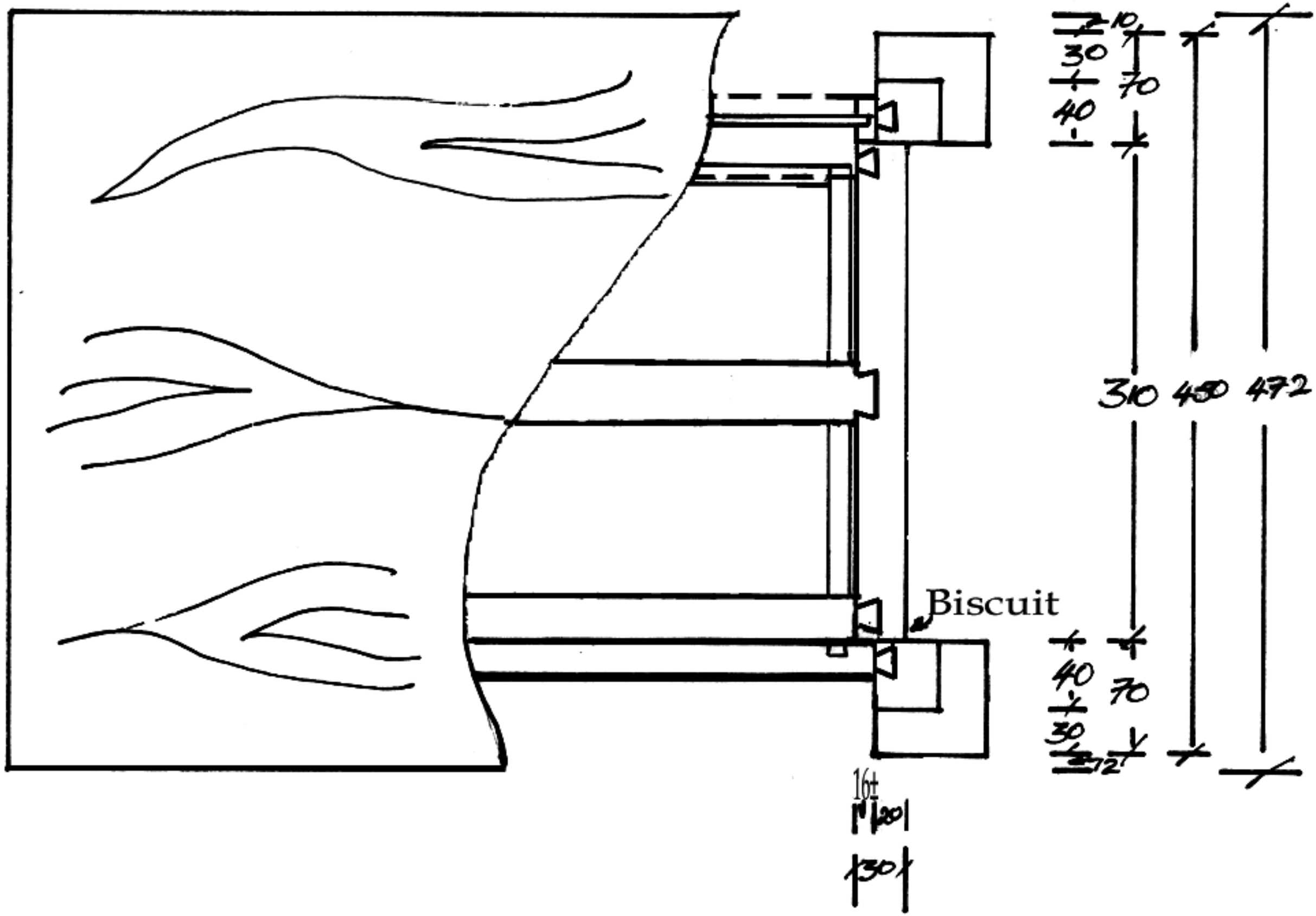
42
No. 8 screw
770
Biscuit
12
338


10±
30
+
40
-
70
310
450
472
Biscuit
40
+
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70
72
16±
120
130

Suggested layout if using plywood for carcase sides.