PRECISION INSTRUMENT

Aaron Moore puts his skills on the line to build a class brass bound level

Owning a traditional brass bound level may not be the most important tool in your chest, but building one will expose you to some unique challenges not typically encountered in the woodshop. Afterall, how many woodworkers know they can hit a dimension within 0.005" (0.13 mm)? Don't feel too intimidated though, the project is relatively simple and the end product is stunning. So go find that precious piece of exotic wood you don't know what to do with and pull out your dial calipers -that's right, calipers- because it's time to have some fun… the nerdy woodworking kind of fun that is.

STARTING NOTES

Take note that this kit was designed using standard English dimensions. Correlating dimensions are listed in parenthesis for those of you employing the metric system. You may find it beneficial to make two level bodies at once; the first made from scrap wood that will be used for test cuts, the second will be used as the finished product. The wood should be dry and stable. Work the bodies to 1-1/4" x 2" x 8-7/8" (31.75 x 50.80 x 225.43 mm). Note that the level will be 9" long when the end caps are installed. Try to hit these dimensions within 0.005" (0.13 mm) with faces at perfect right angles. This may prove difficult for some, especially if you don't use hand planes, but it will pay off in the end. Just be patient and if you're struggling, it's better to be oversized and square rather than undersized and out of square.

A rift sawn blank will yield an even appearance on all four faces, but it's your call

THE TOP PLATE RECESS

With the blanks dimensioned, start by cutting the recess in the top face for the top cover plate. Cut 1/8" (3.18 mm) deep and 4" (101.60 mm) long, centered on the body. Most material can be cut with a stacked dado set or router table, any minor blow-out will be removed in the next step. Use the top cover plate itself to check the fit. It should drop in freely, not a press fit.

THE EDGE BANDING RABBETS

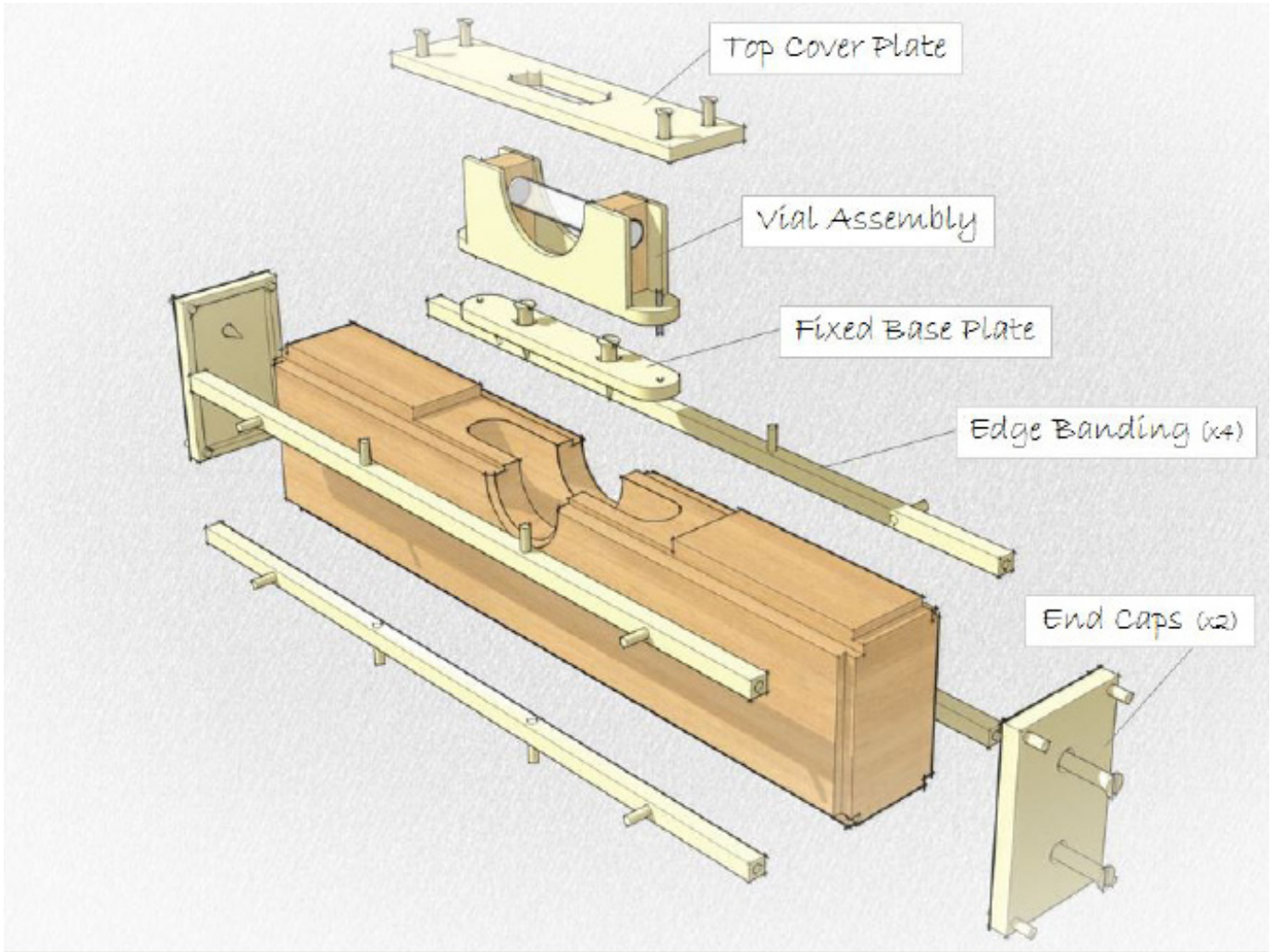
Cutting the rabbets is simple and can again be made with a stacked dado set on a table saw or using a router table. The cuts should be about 3/16" (4.76 mm) square, but adjust the cuts until the exposed top and bottom faces measure 7/8" (22.23 mm) wide and the exposed side faces measure 1-5/8" (41.28 mm). If your blank was oversized this will require rabbets that are slightly larger than 3/16" square, but that will be resolved in the final stages. What really counts here is getting the faces between the rabbets as close to 7/8" and 1-5/8" as possible.

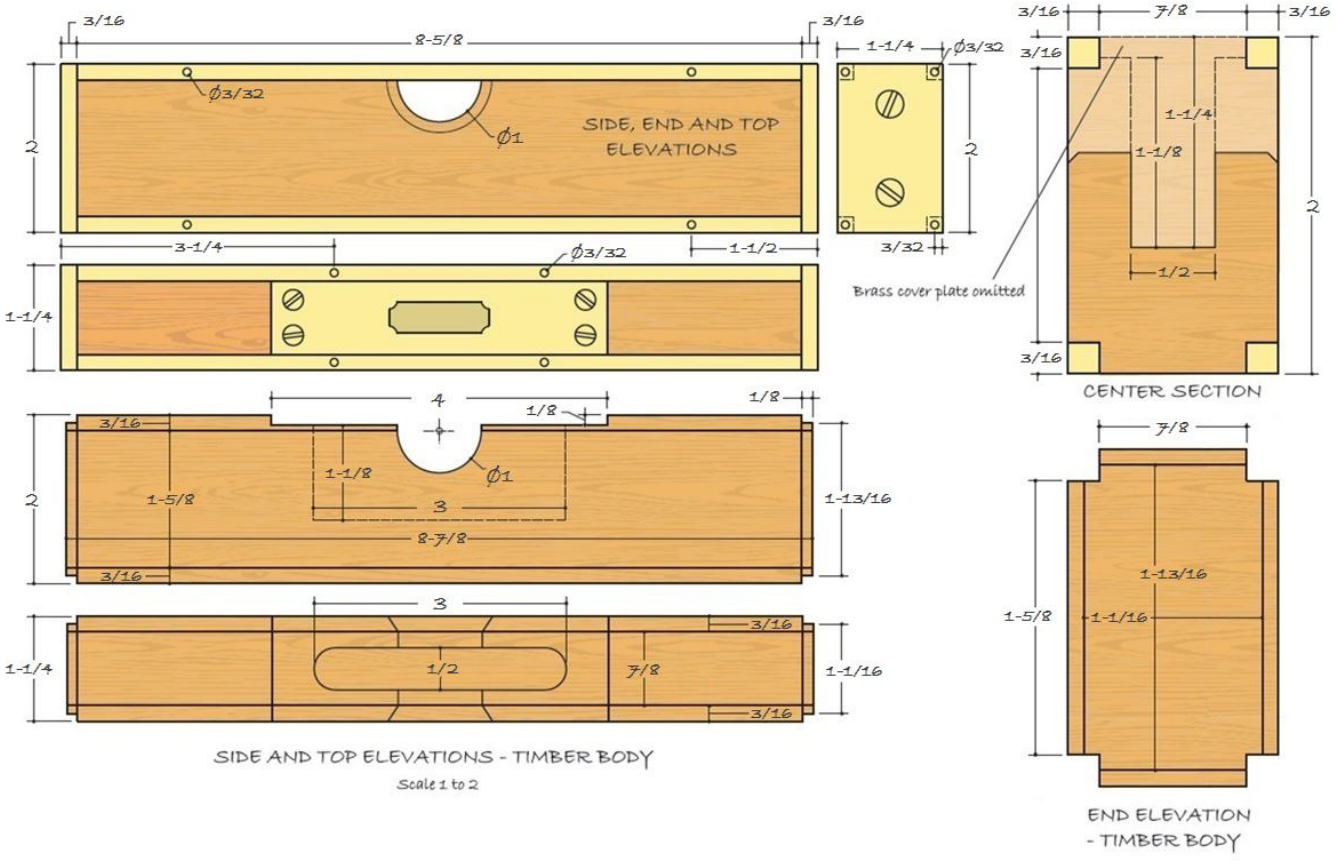
THE END CAP RABBETS

The rabbet that wraps around each end of the level allows the brass caps to firmly maintain their position laterally whereas the two screws simply prevent them from falling off. This is an important feature because the end caps also get pinned to the edge banding and if the caps shift over time (which can happen with a flat plate and screws) the edge banding will shift as well. Cut the rabbets 1/8" (3.18 mm) down the length of the body, leaving 8-5/8" (219.08 mm) of wood exposed on each face. Cut the depth of the rabbets such that the remaining end grain measures 1-1/16" (26.99 mm) wide by 1-13/16" (46.04 mm) tall. Check the fit with the end cap itself. You can use a chisel to pair away a little material as needed. It should slide on with hand pressure only (brass is soft, don't hit it with a hammer or rubber mallet to get it seated) and there should be a tight fit between the base of the cap and the rabbet's shoulder. If gaps exist then the rabbet was cut a bit long. This is easy to fix by trimming the protruding end grain, preferably with a shooting board to keep everything square.

Hog out the waste and chisel to your knife line

Hitting the final depth with a router plane


Top Cover Plate
Vial Assembly
Fixed Base Plate
Edge Banding (x4)
End Caps (x2)


SIDE, END AND TOP ELEVATIONS
Brass cover plate omitted
CENTER SECTION
SIDE AND TOP ELEVATIONS - TIMBER BODY
Scale 1 to 2
END ELEVATION - TIMBER BODY

A QUICK CHECK

Now is a good time to check the fit before moving on. Place the four edge banding strips in their rabbets and hold them in place with rubber bands or painter's tape. Insert the top plate and slide on the end caps. The outer faces will not be perfectly flush from the brass to the wood, but that's to be expected at this point. For now, inspect where the edge banding meets the end caps, where the top plate sits between the edge banding, and the shoulders of all the rabbets… any gaps that need correcting? When you're satisfied with the fit you may move on, otherwise take the time to fix it now. If you find the top plate can't fit between the edge banding there's an easy fix. Simply rub the edges against some sandpaper until it will just slide into place.

Testing the fit by placing the four edgebanding strips in their rabbets

THE VIAL MORTISE

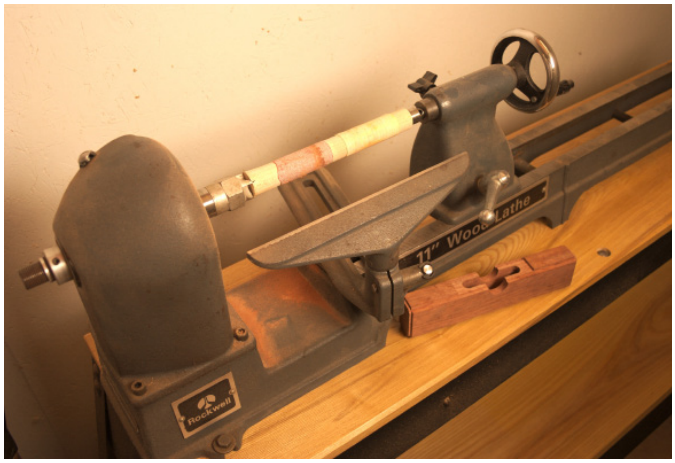
The mortise to house the adjustable vial pieces measures 3" (76.2 mm) long by 1/2" (12.7 mm) wide. It is centered on the body and has round ends rather than square which enables a 1/2" drill or router bit to be used. The mortise is 1-1/4" (31.75 mm) deep from the absolute top surface of the level or 1-1/8" (28.78 mm) deep from the base of the top plate recess you made prior.

The mortise to house the adjustable vial pieces measures 3" long by 1/2" wide

THE VIAL VIEWING WINDOW

Cutting a semi-circle through the body creates a window to the vial when viewed from the side. The window is a 1" (25.40 mm) diameter circle centered 3/16" (4.76 mm) below the absolute top surface. This can be drilled with a forstner bit, but a 1/2" thick piece of scrap wood should be placed in the vial mortise to prevent blow-out. The approach I prefer is to lay the circle out by hand using a circle template, rough out the shape with a fret or coping saw, and finally use a spindle sander to finish things off. A chamfer added around the edge of the semi-circle is a nice detail to add by hand using rasps and files.

Roughing out the window with a fretsaw



No spindle sander? A lathe can work too

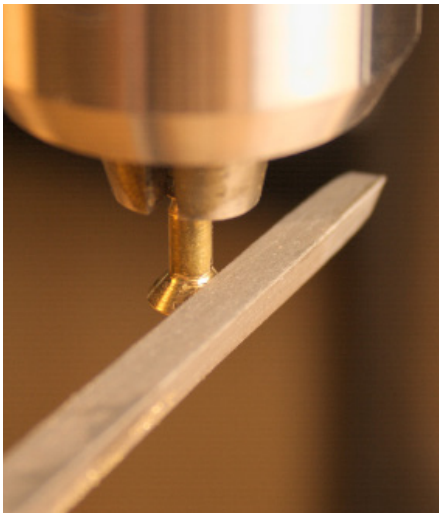
A simple chamfer adds a nice touch

DRILLING THE PILOT HOLES

Small brass screws are soft and can easily have their heads torn off. Before installing the screws, pre-drill some scrap wood of the same material you're using for your level and practice your technique. Install the provided steel screws first to tap the hole and add wax to both the steel and brass screws. When installing the brass screws there should be very little resistance until the screw head reaches the brass. It takes very little pressure to hold the plates in place, so gently drive the screw until you feel the screw engage the brass, then stop. You're done. Do not use a powered drill and again, practice this on scrap wood until you feel confident. You don't want to bury a broken screw in your level at this point. The kit includes additional brass screws should you destroy or lose some while practicing. Place the fixed base plate on the bottom of the mortise and mark the four hole locations. The two countersunk holes are used for mounting the plate, the outer holes simply provide clearance for the #2-56 machine screws that are used to adjust the vial. Drill these outer clearance holes with 1/8" (4 mm) bit to a depth of ~3/8" (10 mm). With the inner holes laid out and the outer holes drilled, place the top cover plate on the body and mark the four corner holes. These will receive #4 screws, as do the two inner holes on the fixed base plate. A 5/64" bit (2 mm) should work in most woods, but you may find a slightly different size is preferable depending on the density of the wood you're using. Test out different bit sizes on scrap wood until you're satisfied. The end caps are held in place with #8 screws. Lay out their locations and drill the holes with a 3/32" (2.5 mm) bit. If you want to clock your screws so the slots all align, install each screw noting how far off it is from vertical, then chuck it into a drill press and lightly file the underside of the head. After some trial and error this will go fairly quickly, but make sure you don't confuse which screw matches which hole once they have been adjusted.

Drilling the pilot holes

One skewed screw



Removing material from the underside of the screw head allows further rotation before it bottoms out on the end cap

The screw slots nicely lined up

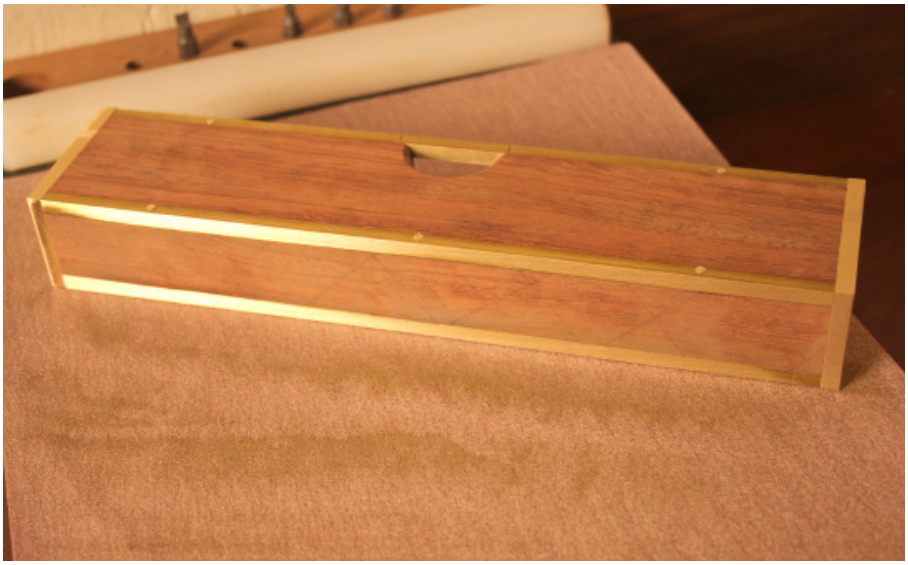
INSTALLING THE EDGE BANDING

The edge banding is held in place with a series of pins. Screw the end caps onto the body and place the edge banding into their rabbets. These can be held temporarily in place with a bit of packaging tape around the body. Once the banding is in place, drill 3/32" holes as shown in the dimensioned diagram. It must be a 3/32" twist bit or the pin will not fit properly. Center the hole on the banding and drill 7/16"-1/2" (11-12 mm) deep. Do not drill too deep or the pin will be buried instead of sitting slightly proud. Tap the pins home. Drill through the corners of the end caps as shown which should center the pin in the end of the edge banding. File the pin tops down until they are ~1/16" (1.5 mm) above the surface, then peen the ends. This basically involves light taps with a ball-peen hammer to deform and expand the end of the pin which in turn fills the hole and prevents the pin from backing out.

When drilling through the corners, make sure the bit will pass through the middle of the edge banding. Careless alignment can send the bit through the side of the edge banding and pull the bit sideways. Choking up on the bit will also help prevent walking or deflecting.

FINISH THE BODY

With the banding and end caps installed the outer faces can now be addressed. Note that brass contains lead. Gloves and a breathing mask should be worn during this process. Lap three faces flush with sandpaper on a lapping surface ignoring the top for now. Start around 80 grit to knock down the pins and get the brass even with the wood. Work up to 320-400 grit. Check to make sure the body is square as you work. If you have worked to close tolerances up to this point, lapping should be brief. For the top surface, if the Top Plate is below the wood surface simply lap until everything is flush. If the plate is above the wood slightly, install it upside-down and without screws. Lap this surface until it's basically flat, then flip the plate, install the screws and perform a final lapping. This will minimize the material removal from the top surface of the top plate which avoids wearing through the WMT stamp and screw heads. For the end caps, the screws should be slightly proud of the end cap surface. File these down and/or shoot the ends flush with a sandpaper shooting block. For a finish, oil works well as it will soak into the wood and won't build up over the brass, but it's your choice.



Begin lapping on 80-120 grit paper, stop around 320-400

Abrasive shooting block: a hunk of wood milled at right angles with sandpaper glued to the top portion. The bottom is left as bare wood and runs against the shooting board.

Lap the faces of the level flush using sandpaper laid on a flat surface

INSTALLING THE VIAL

The vial can be installed in its brass housing using Plaster of Paris, but a wooden infill looks much nicer. Do not use epoxy as this makes replacing the vial extremely difficult and can fog the glass. Work a strip of wood to just fit the opening of the vial mount. Do not make it an excessively tight press fit or the brass walls will deform. Make the strip about 1/4" (6 mm) thick and a few inches long. The vial will be captured in these strips, but the vial is curved slightly and non-circular in cross section. Drill two holes just smaller than the vial diameter, one at each end of the strip. Each hole will need to be opened up with a file to fit the vial. Cut the strip in two pieces, fit them over the ends of the vial, then lap the bottom and sides flat as a complete assembly. Install the vial and wood assembly into the brass housing. If it's a nice fit you can stop there or add a little glue to the wood to help it adhere to the brass.

Drill undersized holes, then open them up with a file to match the shape of the vial

When the infill strips fit over the vial, lightly sand the base and sides as an assembly to bring everything flush. If the fit is too tight in the brass housing, continue to gently sand the sides until the desired fit is achieved

Once installed, cut off the protruding wooden strips, then lap the top of the wooden infill flush with the brass

FINAL ASSEMBLY

The last step is to drop the vial assembly into the level body using the springs and machine screws. It helps to position the springs in the body first, aligning them over the holes with an awl or small piece of scrap wood, then lower the brass assembly with screws onto the springs and get the screws started. To adjust the vial, turn the screws until the vial is positioned vertically where you want it in relation to the viewing window, then adjust for tilt. To calibrate the level, you can check it against another level or with the 180° trick. This trick simply means you put your level on a surface, dial it in and rotate it 180°. If the vial reads the same, you're done. If the bubble moved from center to, let's say 1/16" (1.59 mm) to the right, adjust the vial again by splitting the difference, in this case 1/32" (0.79 mm) back towards center. Now rotate 180° again. If the bubble reading is repeatable (even if it's not on center) then it is adjusted correctly and your surface is simply not level. Once you find a level surface you should be able to place your level in any orientation and get the same level reading. Install the top plate with 4 screws (do not over tighten!) and your level is ready to go to work… or to show off to your friends.

QUESTIONS OR ISSUES?

Don't hesitate to contact us at aaron.moore@walkemooretools.com. We're happy to help and when you're done, send us photos of your completed level. We'd love to see what our customers come up with.

Install the fixed base plate...

Install the vial assembly...

Install the top plate