The *Serpent Website's* **"Patrick"**

Contrabass Squarpent

Disclaimer

Neither The Serpent Website or the author make any guarantees that the following instructions are free of errors, or that a resulting instrument ("Patrick" the Contra-Bass 'Squarpent', henceforth referred to in this document as CBS) will play at any anticipated level the builder might desire or expect. These instructions are intended to be used in conjunction with certain basic construction information as described in The Serpent Website's 'Squarpent' construction webpage and article, in order to duplicate the author's prototype. The resulting instrument is intended to be an educational device, and no promise is made regarding its suitability for performance situations.

The Serpent Website's 'Squarpent' construction webpage and 'Box-O-Cleide' construction article and associated photos should be used to better understand how the basic wooden pieces must be laid out, cut and trimmed for the 'rabbet' joints, as well as how to fabricate and use jigs that will be required to assemble the basic pieces into the square tube that is the basis of the CBS; however, this CBS article provides an overview of these steps.
Refer to *www.serpentwebsite.com*

the author playing the "Patrick" CBS prototype
- background: the 'Squarpent' and 'Box-O-Cleide'

Some photos in this article are from the original Squarpent construction article, so the alert reader may notice certain small discrepancies.

Description

The prototype of "Patrick", the CBS, is only the fifth contrabass serpent type instrument ever made. The original CBS was built in England in 1840, and came to be called "The Anaconda"; it now resides in the music museum at the University of Edinburgh, Scotland. Being made late in the serpent's heyday, it had extra holes and keys (more than the usual six). It never had any music written for it until 1956, when it was included in the score for Gordon Jacob's "Variations on 'Annie Laurie'" for contrabass instruments, played as part of Gerard Hoffnung's Music festival of that year. Since that time, the tune 'Annie Laurie' has become a traditional tune for all contrabass serpents.

The second example of a CBS was made in 1989, and was dubbed "The American Anaconda". It was made for use in the First International Serpent Festival, and being fabricated from plastic pipe, sheet metal and rubber bands, was dismantled soon afterwards. It had a round cross-section and square bends (pipe elbows).

The third CBS was made by Christopher Monk in 1990, for the 400th Anniversary of the Serpent Celebration in London. It had a different shape than the Anaconda, being an exact scale-up of a normal bass serpent, but had the same bore length and taper as the original, and also borrowed the locations and sizes for the six critical tone holes from that instrument. Being completed close to St. George's Day, it was named "George". A few years later, serpent maker Keith Rogers copied George, and this fourth CBS came to be called "George II".

In naming this fifth CBS, the first tradition of naming it after a big snake made no sense, as unlike the first two examples, it bears no resemblance to a serpent. Accordingly, the second tradition of naming the instrument after the nearest holiday was followed; St. Patrick's Day was less than a week away when the first tune was played. Also, as this instrument presented a considerable engineering challenge, it is apropos that

St. Patrick is also the patron saint of engineers. And, of course, there is always the saint's 'historic' (if contrary) association with serpents....

Materials

- (2x) 4' x 8' [122 x 244 cm] sheets of 0.2" [5 mm] plywood with two good/finished sides, preferably exterior grade, preferably hardwood type (Oak, Birch, etc.)
- scraps of 1/2" [1.27 cm] and 3/4" [1.9 cm] plywood, or other similar pieces of non-laminated wood
- scrap of 5/8" [1.6 cm] dia. (approx.) wooden dowel
- wood glue, exterior (water resistant) type, preferably gel formulation to resist running, e.g. Elmer's "Pro Bond Weather Resistant Wood Glue for Exterior Use"
- thin leather with at least one fairly smooth surface (felt cloth might also work as a substitute)
- 0.2" [5 mm] thick foam rubber (the prototype used foam weather stripping)
- 5 minute epoxy (2-part)
- rubber contact cement
- 5/32" [4 mm] dia. brass rod (for levers)
- small brass hinges & associated wood screws
- assorted small brass wood screws, for securing levers to keys, for anchoring rubber band springs, and for attaching rails, blocks, rests, feet, etc; to body of instrument
- felt pads, of the type intended for attaching to furniture legs to avoid damage to floors
- mouthpiece; most bass tuba types will work, preferably one for a BB-flat tuba or CC tuba
- rubber bands, (1/8" x 3" [0.3 cm x 7.5 cm] were used for the prototype)
- steel wire, approx. 1/16" [1.6 mm] dia; for rubber band extenders
- steel wire, approx 19 gauge [0.7 mm]
- polyurethane varnish
- white 'bathtub' caulk, or any rubbery low-adhesive caulk or similar

Tools

- hand drill, with assorted bits
- assorted hole saws (see dimension diagrams for sizes)
- wood saw; circular or table type preferable, 'saber' or 'jig' saws and handsaws will also work
- saw or drill-operated rotary cutter for cutting brass rod
- file or grinder for finishing and notching brass rod
- X-Acto knife or similar razor edge modeling or woodworking blade
- pencil with suitable lead for marking wood
- cotton swabs ("Q-Tips" or similar)
- small brushes for varnish and glue
- sand paper
- metal straight-edge to guide knife
- carpenter's 'square' or drafting triangle, to faciliate marking accurate 45 and 90 degree angles
- ruler or drafting scale
- tape measure
- wire cutters
- wide pliers (for twisting narrow wire tightly, and for making bends in thicker wire)
- heavy twine or nylon cord (clothes line, etc.), about 10' [305 cm] required
- bench mounted vise (optional; useful for bending brass rod)
- router with straight bit (optional; for making rabbet cuts - other methods and tools may be used to make these cuts, such as a circular or table saw)
- 'pipe' or 'rail' type clamps (optional)

Initial Cuts

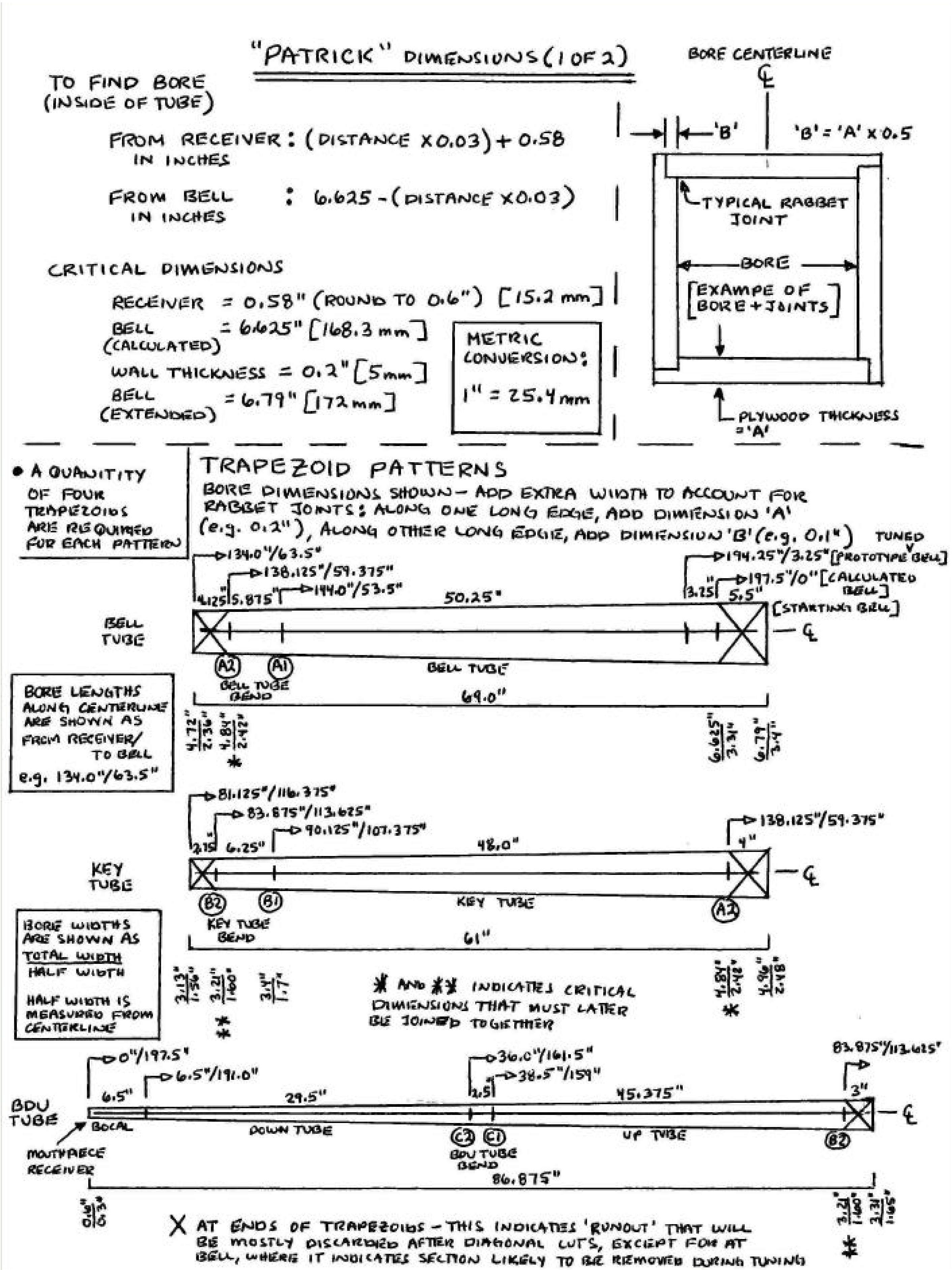
The bore of the CBS is made from three main sections, designed to be cut lengthwise from 8' [244 cm] long sheets of plywood; outside of North America, use whatever large sheets of plywood will fit pieces of the size shown on the Dimensions (1 of 2) drawing. The sections all have the same bore taper, with a width to length ration of 0.03. The sections are called "BDU Tube" (Bocal / Down-Tube / Up-Tube), "Key Tube" and "Bell Tube".

Each of the sections are made from four identical pieces of plywood, cut in tapered shapes called *trapezoids*. After cutting the the trapezoids from the plywood sheet, they need to be cut for making 'rabbet' type joints where they come together.

- Determine the actual thickness of the plywood; this will be dimension 'A'. Dimension 'B' will be half of 'A'.

- Decide which surface of the plywood has the better finish, and place it facing up on the floor. Mark lines on the top side of the plywood; there will be four lines per

12 trapezoids after cutting from plywood sheets



"PATRICK" DIMENSIONS (1 OF 2)
TO FIND BORE (INSIDE OF TUBE)
FROM RECEIVER: (DISTANCE X0.03) + 0.58 IN INCHES
FROM BELL : 6.625 - (DISTANCE X0.03) IN INCHES
CRITICAL DIMENSIONS
RECEIVER = 0.58" (ROUND TO 0.6") [15.2 mm]
BELL (CALCULATED) = 6.625" [168.3 mm]
WALL THICKNESS = 0.2" [5mm]
BELL (EXTENDED) = 6.79" [172 mm]
METRIC CONVERSION: 1" = 25.4 mm
BORE CENTERLINE
'B'
'B' = 'A' X 0.5
TYPICAL RABBET JOINT
BORE
[EXAMPE OF BORE + JOINTS]
PLYWOOD THICKNESS = 'A'
TRAPEZOID PATTERNS
BORE DIMENSIONS SHOWN - ADD EXTRA WIDTH TO ACCOUNT FOR RABBET JOINTS: ALONG ONE LONG EDGE, ADD DIMENSION 'A' (e.g. 0.2"), ALONG OTHER LONG EDGE, ADD DIMENSION 'B' (e.g. 0.1")
• A QUANITITY OF FOUR TRAPEZOIDS ARE REQUIRED FOR EACH PATTERN
134.0"/63.5"
138.125"/59.375"
144.0"/53.5"
4.125"
5.875"
50.25"
TUNED
194.25"/3.25" [PROTOTYPE BELL]
197.5"/0" [CALCULATED BELL]
3.25
5.5"
[STARTING BELL]
BELL TUBE
A2
A1
BELL TUBE BEND
BELL TUBE
69.0"
4.72"/2.36"
4.84"/2.42"
*
6.625"/3.31"
6.79"/3.4"
BORE LENGTHS ALONG CENTERLINE ARE SHOWN AS FROM RECEIVER/TO BELL e.g. 134.0"/63.5"
81.125"/116.375"
83.875"/113.625"
90.125"/107.375"
2.75"
6.25"
48.0"
138.125"/59.375"
4"
KEY TUBE
B2
B1
KEY TUBE BEND
KEY TUBE
A2
61"
BORE WIDTHS ARE SHOWN AS TOTAL WIDTH / HALF WIDTH
HALF WIDTH IS MEASURED FROM CENTERLINE
3.13"/1.56"
3.21"/1.60"
3.4"/1.7"
**
* AND ** INDICATES CRITICAL DIMENSIONS THAT MUST LATER BE JOINED TOGETHER
4.84"/2.42"
*
4.96"/2.48"
0"/197.5"
6.5"/191.0"
6.5"
29.5"
36.0"/161.5"
38.5"/159"
2.5
45.375"
83.875"/113.625"
3"
BDU TUBE
BOCAL
MOUTHPIECE RECEIVER
DOWN TUBE
C3
C1
BDU TUBE BEND
UP TUBE
B2
86.875"
0.6"/0.3"
3.21"/1.60"
3.31"/1.65"
**
X AT ENDS OF TRAPEZOIDS - THIS INDICATES 'RUNOUT' THAT WILL BE MOSTLY DISCARDED AFTER DIAGONAL CUTS, EXCEPT FOR AT BELL, WHERE IT INDICATES SECTION LIKELY TO BE REMOVED DURING TUNING

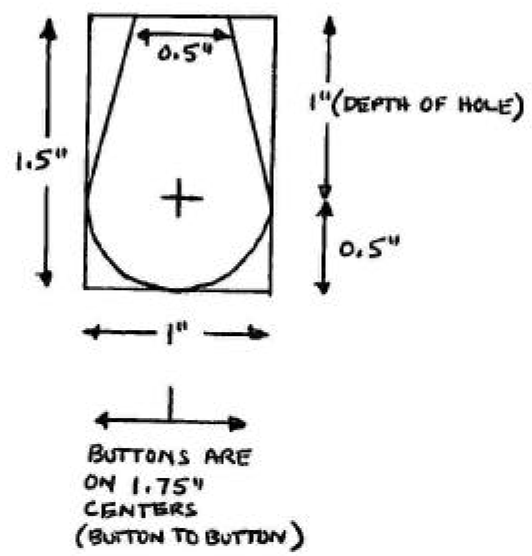
"PATRICK" DIMENSIONS (2 OF 2)

HOLE SIZES + LOCATIONS

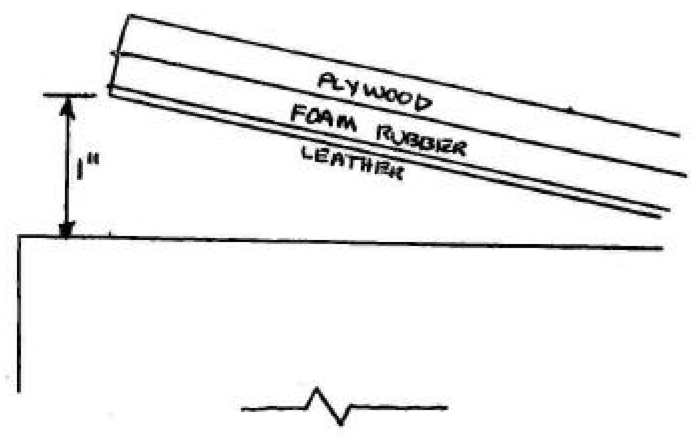
HOLE #	SIZE (DIAMETER)	LOCATION (MEASURED FROM RECEIVER TO HOLE CENTER)*	
1	1.75" (44 mm)	92.5" (235 cm)	UPPER HOLES [LEFT HAND]
2	1.375" (35 mm)	98.5" (250 cm)	UPPER HOLES [LEFT HAND]
3	1.375"	104.25" (264.8 cm)	UPPER HOLES [LEFT HAND]
4	1.375"	122" (310 cm)	LOWER HOLES [RIGHT HAND]
5	1.75"	127.5" (323.8 cm)	LOWER HOLES [RIGHT HAND]
6	1.75"	134.5" (341.6 cm)	LOWER HOLES [RIGHT HAND]

* MUST BE MEASURED ALONG CENTERLINE OF BORE

BUTTON SHAPE (TO SCALE)

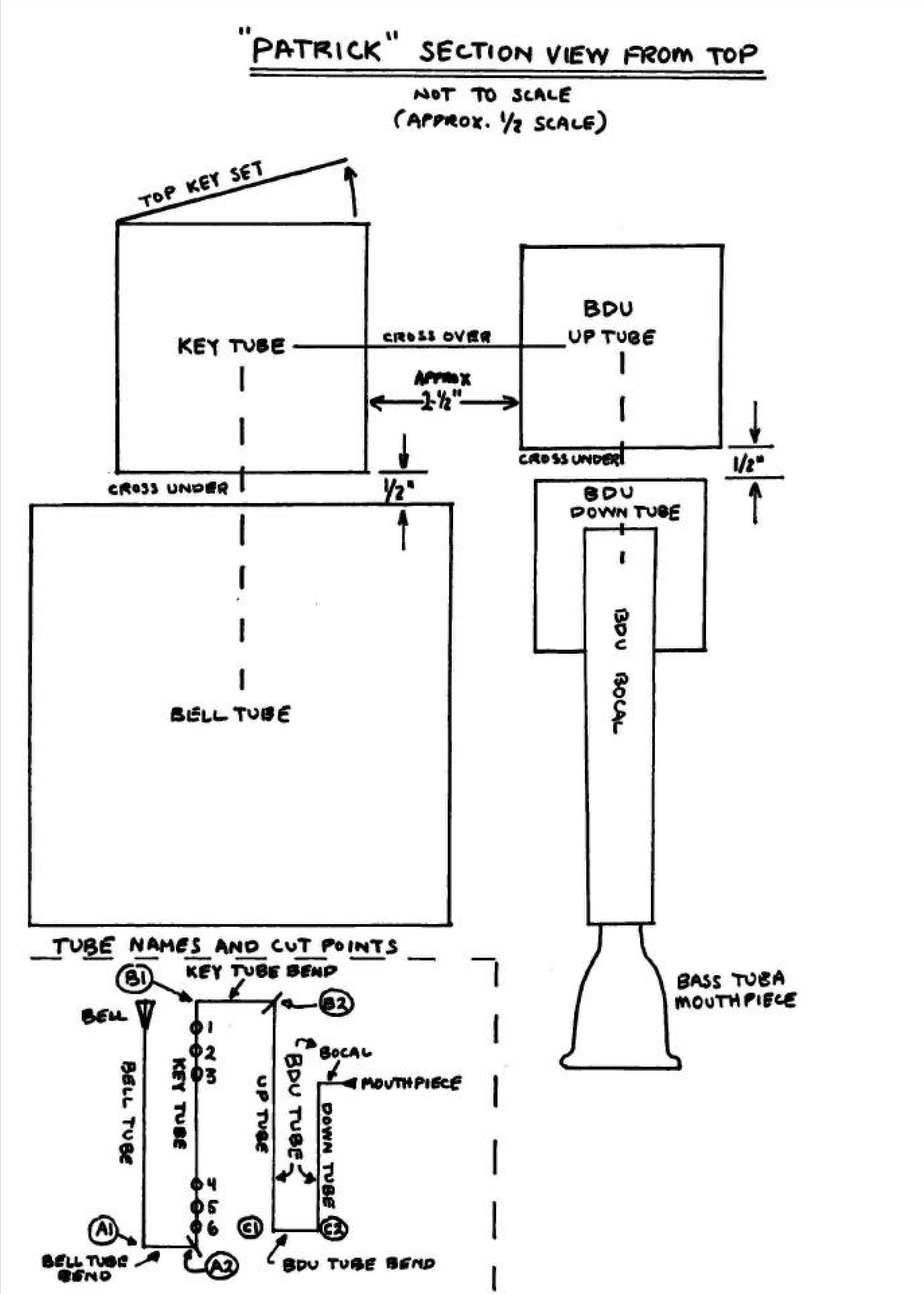


KEY OPENING (NOT TO SCALE)



each of the three sections, and their lengths will be the dimensions shown on the Dimensions (1 of 2) drawing. For example, the lines for the BDU Tube sections will be 86.875” [220.7 cm] long. These lines will be the *centerlines* of the bore, and will be used for several critical measurements and cuts during construction. Make sure that the lines are far enough apart to allow for the tapering width of the sections. Make sure that the centerlines are accurate, straight and clearly visible.

- At one end of the lines, make small marks to either side of the centerline, e.g. 0.3” [0.76 cm] for the small end of the BDU Tube section. At the other end of the lines, make similar marks to either side of the centerline, e.g. 1.65” [4.2 cm] for the same section. Cut a strip about 3” [or about 4 cm] wide from the long side of one of the plywood sheets (opposite the side that the sections are being laid out on); the factory-cut edge of this strip will be used as a straight edge for marking the trapezoids (a carpenter’s long straight edge may also be used if available). Using the straight edge, draw lines between the ends of the small marks, to define the trapezoid shapes for all four sides of all three sections. These marks define the edges of the inside of the bore.


"PATRICK" SECTION VIEW FROM TOP
NOT TO SCALE
(APPROX. 1/2 SCALE)
TOP KEY SET
KEY TUBE
CROSS OVER
BDU
UP TUBE
APPROX
2-1/2"
CROSS UNDER
1/2"
CROSS UNDER
1/2"
BDU
DOWN TUBE
BDU BOCAL
BELL TUBE
BASS TUBA
MOUTHPIECE
TUBE NAMES AND CUT POINTS
B1
KEY TUBE BEND
B2
BELL
1
2
3
BOCAL
MOUTHPIECE
BELL TUBE
KEY TUBE
UP TUBE
BDU TUBE
DOWN TUBE
4
5
6
A1
C1
C2
BELL TUBE BEND
A2
BDU TUBE BEND

- To define the actual cut lines for the trapezoids, draw additional lines parallel to the first lines. On one side of each trapezoid, draw the new line a distance ‘A’ outside the bore line (remember dimension ‘A’ from above?); this will be for the rabbet cut. On the other side of the trapezoid, draw the new line a distance ‘B’ outside the bore line; this will demark the ‘no varnish’ zone that will be glued into the adjacent trapezoid’s rabbet cut. Refer to the Dimensions (1 of 2) drawing to see how rabbet joints and cuts work out.

- Cut the 12 trapezoids from the plywood sheets, being careful to make the cuts clean and accurate. Do not allow the saw to wander; the cuts must be straight (very small deviations can be compensated for during gluing).

12 trapezoids after varnishing

- Varnish the unmarked (poorer finish) side of the trapezoids. For the first 12” [30 cm] (approx.) at the small end of the BDU Tube section’s trapezoids, use two coats of varnish. Be careful to avoid varnishing the ‘no varnish’ zones; you will be varnishing the unmarked side, so the work does not need to be precise....it is better to get some varnish in the ‘no varnish’ zone than to leave other parts of the wood unprotected.

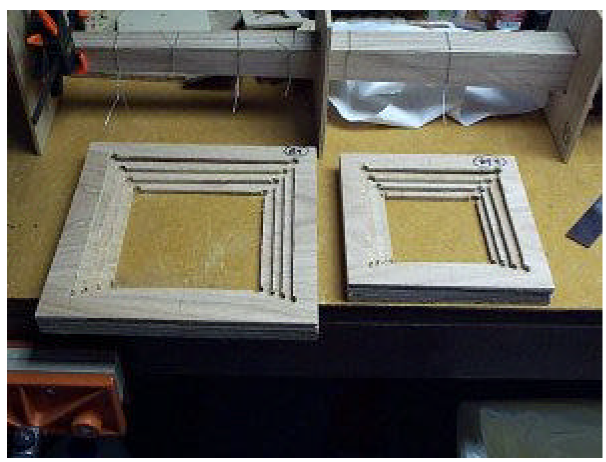
example of rabbet cut (actually a bit too deep)

- Cut the rabbets along the ‘A’ edge of the trapezoids, making sure to cut on the varnished side of the wood. The cuts will be dimension ‘A’ wide and dimension ‘B’ deep. A router works best for this process, but successive adjacent shallow cuts with a table or circular saw also work well, and other methods (including razor knife cuts) may also be used.

Jigs

The four trapezoids making up each section will be glued together into ‘boxes’, or tubes with a square cross-section. The rabbet joints will help by keeping the edges locked together, and will help keep the glue in place for the best quality joint. However, it will still be difficult to align the eight edges of the four trapezoids in each section before the glue runs or begins to set. Making a set of jigs is the solution to this problem.

- From the remaining plywood, cut eight squares, each 5” x 5” [12.7 cm x 12.7 cm]. These will be for the outer jigs of the BDU Tube section. Mark a square, centered on each wooden piece, with progressively larger sizes (*see photos*). The marked squares should be sized so that the jigs will fit at even increments along the trapezoids, but with the smallest and largest sized to fit slightly inside the overall length (i.e. not right at the ends). Drill a 3/8” [1 cm] dia. hole at each each corner of the marked squares; this will help prevent excess glue at the rabbet joints from touching the jigs. Saw between the holes, being careful to cut straight along the marked lines.



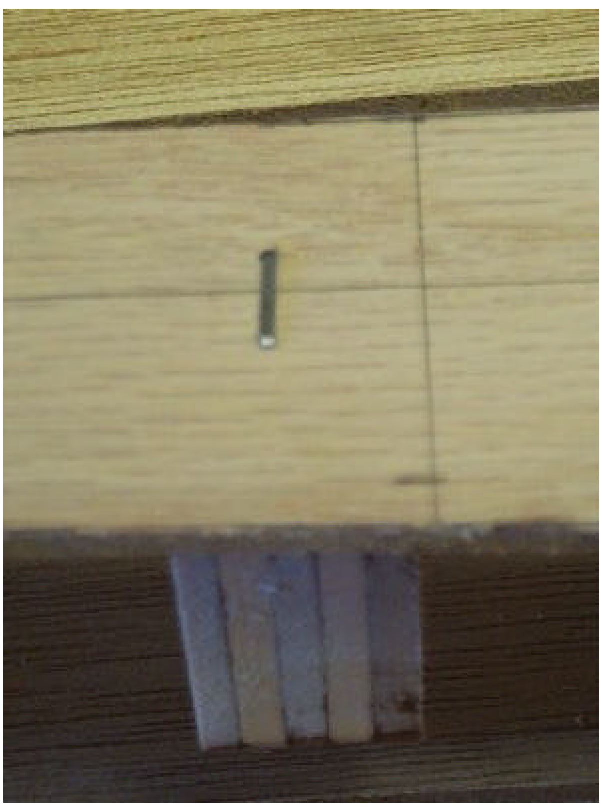
stacked outer jigs for the Key and Bell Tube sections, and outer jigs for BDU Tube section in place on the tube

- In the same manner, make four or five jigs for each of the larger sections, Key Tube and Bell Tube; the overall sizes of the squares will need to be increased for these.

- For the BDU Tube section, make a set of four inner jigs. Build them up from several glued thicknesses of plywood, or use 1/2” or 3/4” plywood scrap if available.

inner jigs in place on trapezoid, with cord

The jigs will be cut to squares sized to fit inside the bore at equal lengths along the section, keeping the ones at the ends slightly inside, as opposed to right at the ends. Round off the corners of the jigs, to prevent glue from the rabbet joints from touching them. Drill a hole



inner jig stapled to trapezoid

in the center of each inner jig, and pass a length of cord through all of the jigs for a section (the length of cord may be reused for the other sections). Make a knot in the cord at each jig, on the side of the jig that faces the smaller end of the trapezoids. Keep a small loop, secured with a slip knot, in the cord between each jig.

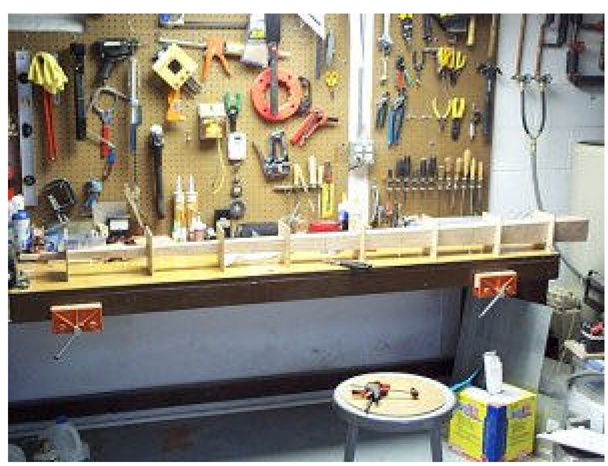
- Test fit the BDU Tube trapezoids, and carefully place this section’s inner jigs between then so that they touch. The idea is to position the jigs so that they will support the trapezoids during gluing, yet not get in the way of the pieces fitting together completely at the rabbet joints. Use a staple or two small nails for each inner jig, to temporarily secure them to one of the four trapezoids. Note: an inner jig is not needed for the small end of the BDU Tube section; cut a short length of 5/8’ [1.6 cm] dia. dowel and use it at this location as an inner jig. Jigs for Key and Bell Tubes will be similar.

Sections

Follow this procedure for each of the three sections.

- Lay all four trapezoids down parallel to each other. Lay a bead of wood glue in the rabbet cuts of each trapezoid. With one trapezoid as the base (this will be the one with the inner jigs stapled to it), position two more trapezoids on edge along the sides of the first one, so that their ‘no varnish’ edges engage the rabbet cut edges. Make sure that the ends of all three trapezoids are aligned. Fit the fourth trapezoid on top of the first three, and check alignment again. Slide the outer jigs over this assembly, sliding them towards the larger end of the tube until they fit snugly.

- After another check of alignment, make sure that the rabbet joints are properly engaged over the length of the tube assembly. Cut short pieces of steel wire and wrap them around the tube between the outer jigs. Use the pliers to twist the wire so that it tightens and pulls the trapezoids firmly together. Readjust the outer jigs for optimum tight fit. Excess glue should now be visible,



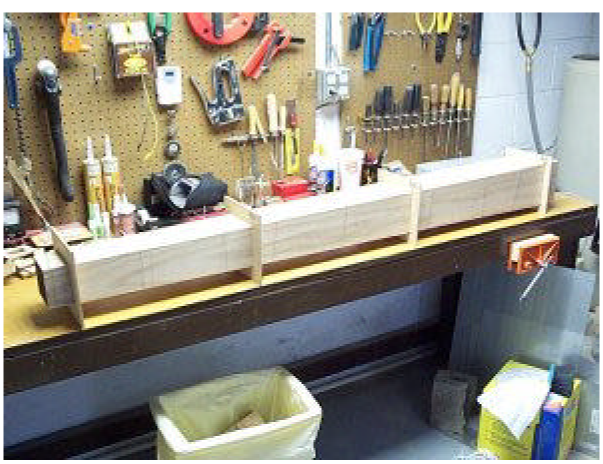
BDU Tube section glued with outer jigs visible having been squeezed from the rabbet joints, and it should be wiped off. In the case of the BDU Tube, temporarily remove the dowel rod from the small end, wipe off any glue, and replace it in the tube; make sure that the four sides are tight against the dowel at their very end.

- Set the assembly aside until the glue has dried completely (overnight). Note: the assembly, supported by the outer jigs, must rest on a flat surface in order to guarantee that the tube will not have any twist or irregularity to it's shape once dried.

- Cut the steel wire from the tubes. In the case of the BDU Tube, remove the dowel. Remove the outer jigs; this might require light tapping with a mallet or screwdriver handle. Remove the stapes that secured the inner jigs, and pull on the cord from the large end of the tube to remove the jigs. Rub wood glue into the staple holes and allow to dry. Lightly sand the outer surfaces of the tube to remove excess glue, and sand the edges to slightly round the corners. Make sure that the bore centerlines have not been erased by sanding; touch them up with a pencil if necessary.

- Repeat the above process for the other two sections.

BDU Tube section with jigs removed



Key Tube section glued with outer jigs visible

Bell Tube section glued with outer jigs visible

all three sections with outer jigs removed

Shaping

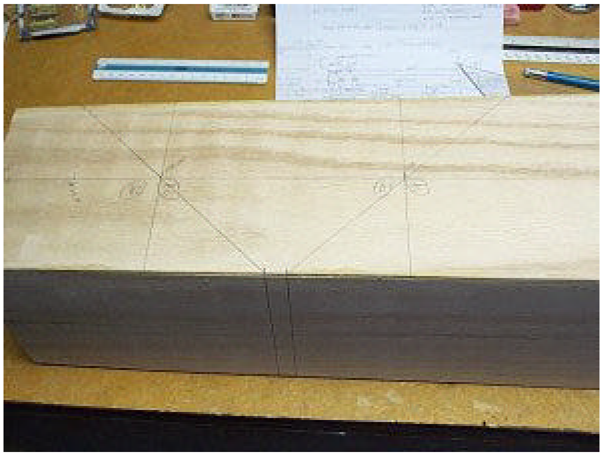
With all three sections formed, the sections will be cut and their pieces rearranged to create the final shape of the CBS.

- Refer to the Dimensions (1 of 2) drawing and the separate Tube Names and Cut Points diagram on the Section View From Top drawing. Study these diagrams to understand how the tube sections will be cut:

- For the BDU Tube section, the tube will be cut in four places (Bocal cut, C2, C1 and B2), with a short piece (the *runout*) on the large side of the B2 cut being discarded.

- For the Key Tube section, the tube will be cut in three places (B2, B1 and A2), with one short piece (the *runout*) on either end being discarded.

- For the Bell Tube section, the tube will be cut in two places (A2 and A1), with a short piece (the *runout*) on the small side of the A2 cut being discarded. Later, during tuning, some of the large end of this section will also be cut and discarded.



Bell Tube cut marks A2 and A1 (L - R)

- With the exception of the Bell Tube section, one of the cuts on each section will be on a different 'plane' than the other cuts. Study the photos, and note how, for example, cut A2 on the Key Tube section will be on a plane 90 degrees rotated from the plane of the cuts B1 and B2. This provides the change in angle that allows the instrument to fold back on itself and take up less space.

Once the cuts and their angles are understood and visualized, proceed with marking and making the cuts.

- Make pencils marks on the centerlines of each section at the 'cut' (also called 'bend') points. For example, on the BDU Tube section, measure from the small end and make a mark at the 6.5" [16.5 cm] point along the

Bell Tube cut A2 (upside down)

Key Tube cut marks B1 and B2 (L - R)

centerline. The Trapezoid Patterns diagram on the Dimensions (1 of 2) drawing shows the cut / bend points with a pair of dimensions for each; measured from the receiver and from the 'calculated bell' point. It will be best to always mark the cut / bends points based on the first (from the receiver) dimension, for consistency.

- Mark the cut lines on each section, being careful to use a square aligned to the marked centerline of the bore; do not align the square to the edge of the tube! Cut lines will all be 45 degrees relative to the centerline, and will intersect the centerline at the measured marks. The cut marks will all be made on only one side of each tube section, and this side will be the top side during cutting. Note that due to the different 'planes' of cut on the BDU and Key Tubes, the tubes sections must be rotated 90 degrees for the one cut that is on a different plane; it will have a different 'top' side than the other cuts.

Key Tube with it's bend

- On each adjacent side of the tube to the angled cut marks, extend the cut lines, this time at 90 degrees to the centerlines. The three lines at each location will help in keeping the saw straight during cuts.

- use a hand saw or mitre saw (but not in the mitre box) to make the cuts. Start the cuts along the top (angled) cut line, then continue down through the tube, using the other two lines as a guide. Once the tube is cut through, lightly sand all cuts to remove burrs.

typical gluing of tube bend

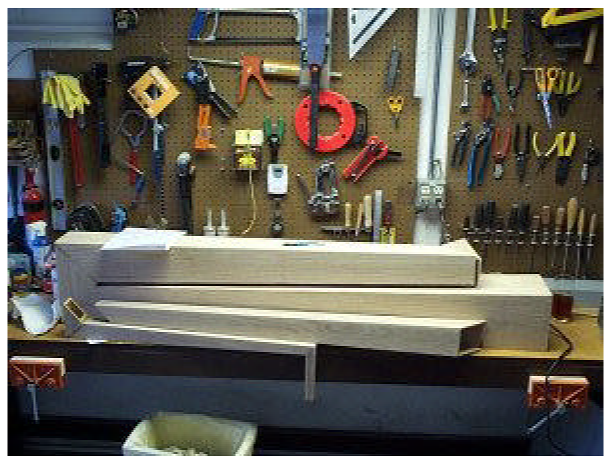
- Refer to the photos and reassemble each section with the cut pieces rotated to make the 90 degree bends. Test fit first, and sand the cuts as required to adjust for a tight joint with all pieces in alignment along the centerlines. The Bell and Key Tube sections will each have a short section rotated and glued at 90 degrees. The BDU Tube section will be rotated back on itself twice to for the up and down tube sub-sections, and the bocal sub-section will also be rotated to form another 90 degree angle; glue a small wedge of wood at this corner for reinforcement.

typical 1/2" spacers

- Assemble the three reshaped sections into the final CBS shape. Cut and fit pieces of thicker wood between the parallel tube sections as spacers and for reinforcement. These pieces may be made from 1/2" or 3/4" plywood (or other wood) scraps, or may be built up by glue laminating layers of the thin plywood; refer to the photos. Note that the spacing between the Bell Tube and Key Tube should be 1/2" [1.3 cm], and the same spacing will be used between the up and down tube sub-sections of the BDU Tube section. A 2.5" [6.3 cm] spacing applies between the Key Tube and BDU Up Tube. Carefully cut and fit the wooden spacers to maintain these distances. Use wood glue for the spacers.

- Do not glue the final bend joint between the BDU Tube assembly and the combined Key & Bell Tube assembly at this time; first make the mouthpiece receiver.

Bell Tube with it's bend and Key Tube



Bell & Key Tubes, with BDU Tube subsections in foreground

BDU Tube's Bocal subsection with wooden wedge

reshaped BDU Tube assembly ready for mating to reshaped Key / Bell Tube assembly

Receiver

The *receiver* is the small end of the tube where an airtight fitting is made with the shank of the mouthpiece. Follow this procedure to form the receiver on the end of the BDU Tube section's Bocal subsection.

- If not already done, remove the 5/8" [1.5 cm] dia. wooden dowel piece from the end of the bocal, where the bore is 0.6" [1.5 cm] wide.

- Mix sawdust (preferably fine dust from routing the rabbet cuts) with epoxy to make a thick wood-filled paste; the mixture should be about half sawdust.

Bocal and receiver dowel with 1" mark

- Mark a piece of 5/8" [1.5 cm] dia. wooden dowel at a point 1' [2.5 cm] from one end; there should be at least another 0.5" or so dowel on the other side of the mark. Use a small screwdriver or similar tool to pack epoxy mixture into the inside corners of the bocal to a point 1" inside the tube. Coat the marked 1" part of the dowel with more epoxy mixture.

dowel epoxy-ed into Bocal's receiver

- Slowly work the epoxy coated part of the dowel into the end of the bocal tube, using a twisting motion and also continuously packing more epoxy into the areas between the dowel and the inside corners of the tube. When 1" of dowel has been inserted into the bocal, pack the entire end area with the remaining epoxy, and also work epoxy into any gaps on the outside of the bocal for the first inch or so.

receiver with excess dowel cut off

- After the epoxy has cured, cut off the extra dowel, taking about 1/16' [1.6 mm] of the tube with it. This will leave a clean cut surface. Drill a small hole in the center of the remaining piece of dowel inside the bocal, then drill again with a progressively larger series of drills until the entire dowel has been drilled out. Note that if the large hole is drilled in one pass, the hole may be out-of-round; drilling in steps will help the hole stay round (if a wood boring bit is used instead of a twist drill, it will make a cleaner hole and should be done in one pass). Also note that this recommended hole size is based on a typical contrabass tuba mouthpiece shank diameter. If in doubt, measure your mouthpiece shank at a point 1" from the small end, and drill the receiver hole to this size.

forming the caulk receiver fitting

- Wrap the first 1" of the mouthpiece shank with a layer of plastic wrap or wax paper; make the wrap tight. Liberally coat the paper with caulk, and place a bead of caulk around the edge of the receiver hole. Press the mouthpiece into the receiver, without twisting, until it stops. Allow the caulk to set, then twist it out of the receiver. Remove the wrap from the mouthpiece, and use a razor knife to trim the excess caulk from the end of the receiver.

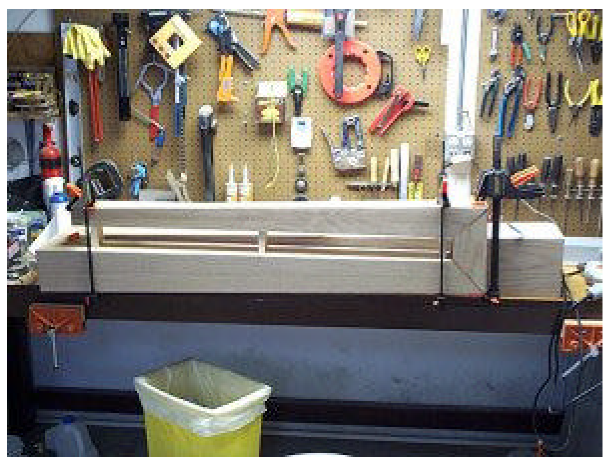
- The mouthpiece should now fit easily into the receiver with an airtight fit.

Final Section Assembly

- With the receiver fitting completed, fit the assembled BDU Tube section to the rest of the instrument. Use larger spacing blocks to maintain the 2.5" [6.3 cm approx.] distance between the BDU and Key Tube assemblies. It will be necessary to use some sort of clamps to secure the assembly while the glue sets.

large spacers between BDU and Key Tube sections

- Once the glue at the last bend has dried, apply a liberal amount of glue to all bend joints to guarantee that there are no weak and/or leaky spots.

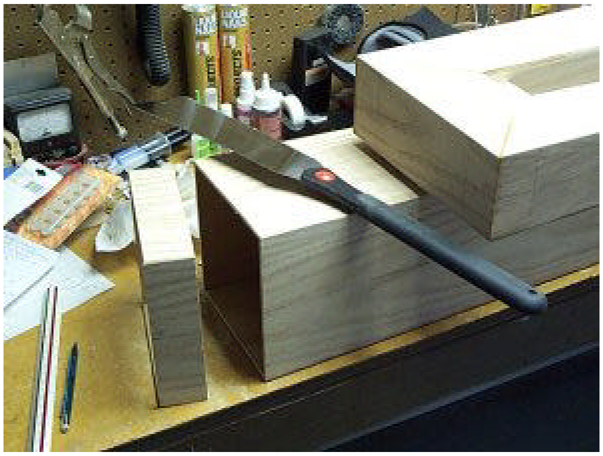


clamps holding assembly together for final glue joint

Tuning

The CBS is tuned once by adjusting its overall length as required to produce a pitch 'C' two octaves below middle C. The design of the CBS allows for some variety of pitch standards, but the prototype was tuned to the A = 440Hz standard. Historical pitch standards were somewhat 'flatter' than modern pitch, so the extra length of the Bell Tube section can be trimmed as required, as long as the desired pitch standard is not TOO flat.

- Place the mouthpiece into the receiver. Make sure to use the same mouthpiece that will be eventually stay with the instrument. Hold the CBS between the seated player’s calves, and play some ‘bugle calls’ (such as Taps) to verify that the instrument so far still has acoustic integrity (i.e. no leaks or major buzzes, etc.) Remember that this is a true contrabass instrument; if you test it on pitches that are too high, it will not work properly. If the horn sounds easily and clearly, proceed with tuning.

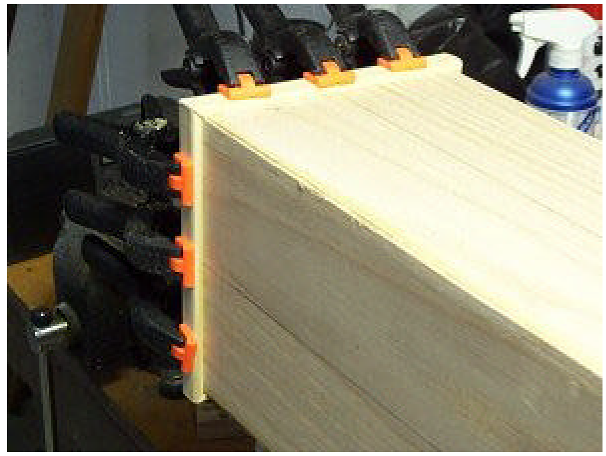


trimming the bell during tuning

electronic tuner with instrument in tuning configuration

Bell Wreath

Because the plywood is rather thin compared to the width of the bore at the bell end, the wood may warp or buzz. It can be stabilized by adding a bell *wreath* made from a narrow strip of wood (plywood or wooden molding / moulding). Cut these pieces to length and carefully glue to the outside edge of the bell, just below the edge (i.e. there should be perhaps 1/16” of bell exposed beyond the wreath). Once the wreath glue has dried, trim the excess wood that extends beyond the wreath; this may be done by sawing, filing or sanding, and will not affect tuning. Use epoxy to fill any gaps at the corners of the wreath. When all glue has dried, liberally soak the edge of the plywood at the bell with varnish to seal the fibers.

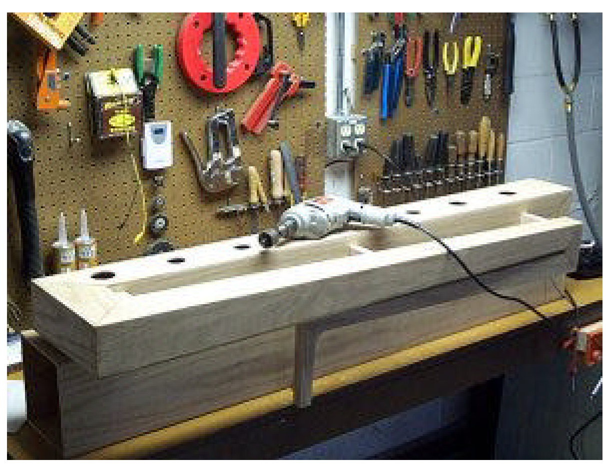


clamps holding bell wreath in place during gluing

Cutting Holes

The CBS has six tone holes, spaced in two groups of three and all located on the Key Tube section. This pattern is typical of traditional serpents in general, and is consistent with all previous contrabass serpents, although the original had additional holes to improve the worst notes. The holes are best cut with a hole saw, although any narrow blade single ended saw can also be used if the holes are marked with circles drawn on the tube.

- Use a tape measure, and starting from the *side* of the receiver, measure along the centerline until the first (bocal) bend is reached. Note the exact tape measure position where the centerline meets the bend joint. Reposition the tape measure to measure along centerline on the side of the BDU Tube’s Down Tube subsection, starting with the previously noted tape measure position aligned with centerline and bend joint. In other words, do not gain or lose any measured distance when going around the bend. Continue measuring this way, along the centerline and around



a drill operated hole saw and six completed holes bends, until the bend ‘B2’ is reached. Hold the tape in position and note where the centerline along the adjacent side of the ‘key tube bend’ would be if it extended to where the tape measure is being held; note the measurement at this point.

- Move the tape measure around to the adjacent side (i.e. to the front of the CBS), realign the noted tape measure position with the point where the two centerlines meet at the ‘B2’ joint, and continue measuring along the key tube bend, around bend ‘B1’,

left side of CBS after varnishing

right side of CBS after varnishing

rear side of CBS after varnishing

front side of CBS after hole cutting and varnishing and down the front side centerline of the Key Tube section. Once again, the idea is to measure the centerline of the bore, regardless of which way the tube bends or which side you are measuring on. Make six marks along the centerline at the points where the tape measure indicates the hole locations listed in the Dimensions (2 of 2) drawing. The first hole should be close to the nearest bend ‘B1’, and the sixth hole should be close to the next bend ‘A2’. Looking at the front of the Key Tube section, the two groups of three marks should appear pretty much centered lengthwise on the tube, with a long space between the two groups.

- Two sizes of hole will be cut at these locations. Make careful note of which hole location gets which size hole, based on the Dimensions (2 of 2) drawing. Drill a small pilot hole at each hole location, making sure to drill where the measured marks intersect the centerline on the front side of the tube.

testing player / instrument fit after varnishing

- Cut the holes, being very careful to go slowly and gently, in order to avoid suddenly breaking through to the inside of the tube and damaging the wood fibers on the inside of the tube near the holes.

- After all six holes have been cut, thoroughly sand the edges of the holes, paying extra attention to de-burring the inside edges. Use a pencil or drafting eraser to remove all centerline, and other, pencil marks that remain on the CBS. Lightly sand the entire outside surface of the instrument, then use a brush or vacuum cleaner to remove all sawdust from the inside and outside of the instrument. Coat the entire CBS with polyurethane varnish, lightly sand after drying, and apply another thin coat of varnish. When the second coat is dry, use a very fine sandpaper to smooth the areas around the holes (about 2” [5 cm] on all sides of the holes).

Key Pads

The six tone holes on the CBS are too large to be covered by the player’s fingers, so they need keys. The keys are made from pieces of 0.2” [5 mm] plywood, scrap from the sheets used to make the instrument’s tube sections. The keys need pads to form the actual airtight seal with the holes. The pads are comprised of a simple piece of leather or felt, with an intermediate layer, or substrate, of foam rubber between it and the plywood. In order to fit and seal correctly, the foam should be about the same thickness as the plywood, and the pad material should be slightly thicker than the material of the hinge itself; since the foam and pad will be thicker than this optimal amount, a hinge rail system allows the hinges to be mounted as required to compensate for pad thickness.

The prototype used leather obtained at a craft shop; the leather had one side a bit smoother than the other, so the rough side was oriented towards the foam. A piece of thin felt cloth will probably work as well as leather. Obtaining foam rubber in a thickness close to 0.2” [5 mm] can be difficult, so the prototype used foam rubber weather stripping. Some possible alternates to foam rubber are the resilient foam sold by hobby shops for use as rail bed for small gauges of model railroads, or even several thicknesses of felt.

On the prototype, the weather stripping had adhesive on both sides, but this adhesive would not adhere to the leather, possibly due to a chemical reaction between the adhesive and the leather treatment. Rubber contact cement was used with good results in this instance.

plywood keys test fit for upper hole group; they are still too wide

- Cut six rectangles from the remaining plywood sheet(s). The ones for the top three holes (holes 1 - 3) should be about 4” [10.1 cm] wide, and those for the bottom three holes (holes 4 - 6) should be about 4.5” [11.5 cm] wide. The center key for each group (holes 2 and 5) should be about 3.5” [8.8 cm] tall. There should be a separation of about 0.5” [1.3 cm] between each center key and the edges of the adjacent keys. The outer two keys of each group will be much taller than the center ones, and should extend past their respective holes by the same amount that the keys for the center holes extend past the edges of their holes. Accordingly, each key will have a unique set of dimensions. Note that the keys will be wide enough to extend all the way to the edge of the tube along one side, in order to reach the hinge rails that will be mounted later.

keys with foam attached and ready for leather

- Attach the foam rubber to the poorer side of the plywood keys, using the weather stripping’s own adhesive, or rubber contact cement. Note that, for the outer two keys of each group, it is not necessary to have the foam and pad as tall as the key (study the photos); this is because these four keys are tall only to get closer to the center keys to simplify the lever mechanism that will be added later. Also, the foam should not cover the part of the key where the hinges will be attached (see photo on next page). Next, attach the pad material, leather or felt, to the foam. If using self-adhesive weather stripping, press the pad material firmly against that adhesive surface and try to peel it off. If it sticks firmly, leave it as is, otherwise remove the pad material

keys with leather glued to foam

and then reattach it using rubber contact cement. Use a razor knife to trim all excess foam and pad material around the edges of the keys.

keys with foam and leather trimmed

keys with bumpers & pads trimmed short of hinges

- Apply a coat of varnish to the keys' exposed plywood surfaces and edges, being careful to avoid getting varnish on the foam or pad material.

- Attach felt bumpers to the areas of the outer four keys, to better support the key when pressed against the instrument during playing. The bumpers should be slightly shorter than the combined thickness of the foam and pad material.

- Mark the keys with their respective hole numbers; this can be done on any surface that will not be visible once the keys are mounted.

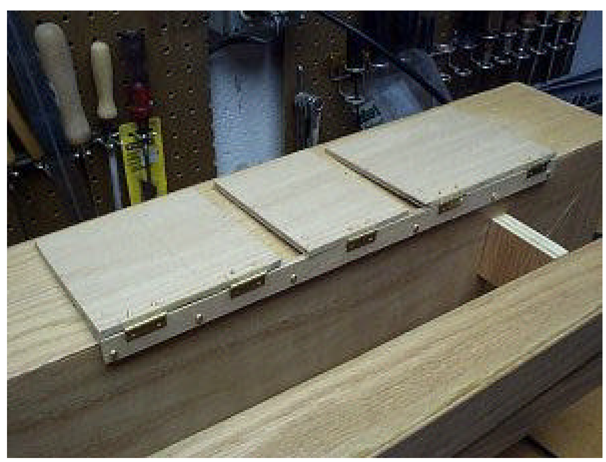
- Cut the hinge rails from scrap 0.2' [5 mm] plywood. The rails should be about 1" [2.5 cm] wide and as long

hinge rail mounted for upper hole group

as the outer ends of the outer keys of each group. Mount the the rails to the sides of the Key Tube section, adjacent to the two groups of holes, using wood screws. The rails should extend about 0.2" [5 mm] past the edge of the tube (see the Upper and Lower Hole Levers drawings). Note that the rail for the top group gets mounted to one side of the tube, while the rail for the lower group gets mounted to the other side (see photos and drawings).

keys mounted to hinge rail for upper hole group

- Mount the hinges to the inner surfaces of the keys (see drawings and photos), and file or grind the excess length that might pass through the plywood to the front side of the keys. Depending on available hinges, the keys might require either one or two hinges each, in order to be stable and prevent wobbling. However, make sure that the type of hinges, and their mounting, does not prevent free bending of the hinges.



keys mounted to hinge rail for lower hole group

- Position the keys along side their hinge rails, and make sure that they are correctly aligned with their holes. Holding each key & pad assembly firmly against the hole side of the Key Tube section (but not so firmly that the foam is compressed), mark the hinge rails where the hinge mounting holes should be located. Drill tiny pilot holes at these locations, the mount the key hinges to the rails, thereby attaching the keys to the instrument. It is OK if this set of hinge mounting screws extend through the rail; do not grind or file these off. Check to make sure that all keys pivot easily and smoothly on their hinges, and that the pad material fits flat and evenly all around the tine holes when the keys are in the closed positions. If any problems are apparent, readjust the hinges where they mount to the rails.

all six keys mounted; note how each group is mounted on the opposite side of the Key Tube

testing key pad seals, with keys taped closed

Levers

Each key is operated by a lever in a double-articulated system where pressing a button with a finger closes the associated key. The levers can be made in many different ways, but the CBS prototype used brass rod with a diameter of 5/32” [4 mm]. This size rod can be bent fairly easily using pliers and a vise, or even two pliers, and yet is thick enough for small wood screws to pass through holes drilled in it, and is stiff enough to resist unwanted bending during use. Steel wire might also be used, but would probably be less attractive.

1” wood block holds keys open for fitting levers

The following procedure describes the basic method of making the lever system for one of the six keys, specifically the center key of the top group (hole #2). The same method can then be used, with minor modifications, for the other five holes.

- Refer to the Upper Hole Levers drawing. This was drawn to scale and might be used as a template as long as it is printed to full scale. If the printer produces a copy where the marked 1” and 2 cm scale reference marks are inaccurate, use a photocopier to enlarge or reduce the drawings as required.

- Use a scrap of wood cut to 1” wide, and place it under the top group of keys along their unhinged ends. This block will hold all three keys open, with their pads 1” from the Key Tube surface (see photo).

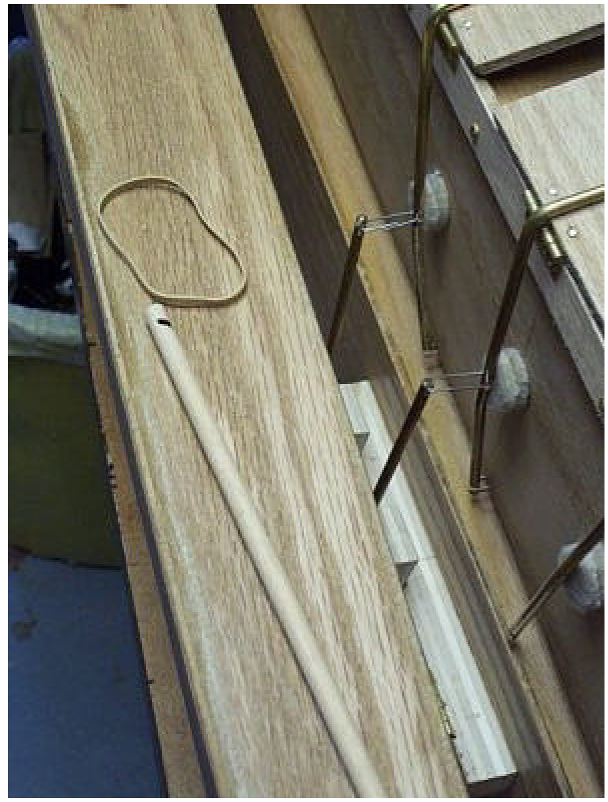
- Mark the center of the key with a line perpendicular to the bore centerline, and extend the line around to the adjacent side of the tube and past the hinge rail. Where this extended line crossed the bore centerline on the tube’s side, attach one or two felt pads to make a bumper about 0.375” [1 cm] thick (see drawing and photos). Bend a piece of brass rod as shown on the drawing, so that it lays flat on the top of the key and curves around the side of the tube, contacting the top of the felt bumper. Bend the rod again at the bumper, so that it comes close to the side of the tube at the rod's farthest point. Drill a small hole through the rod where it comes over the bumper (sized just large enough to pass steel wire or a small paper clip). File a notch in the end of the rod to anchor a rubber band spring. Double check the fit and bends.

first half of lever pair, with felt bumper and rubber band spring

- File two shallow flat spots on the rod where it lies on the top of the key. Drill holes at these two locations, using a drill bit just the size of the small screws that will secure the rod to the key (the prototype CBS used extra screws that came with the hinges).

- Carefully place the rod on the key and recheck the alignment. Drill two tiny pilot holes through the centers of the rod's holes and into the keys. Secure the rod to the key with two screws. If the rod is now misaligned, remove the screws temporarily and tweak the rod's shape before reattaching it. NOTE: The rod will be quite strong after being bent, but will quickly fatigue if a bend is flexed backwards; try to avoid over-bending the rod, so that bending backwards is unnecessary.

- Cut a hinge block about 7" [17.8 cm] long, but made from 3/4" [1.9 cm] thick plywood (or similar wood), cut to the same width to form a square cross section. Mount this hinge block to the edge of the Bell Tube as shown in the drawing. Align the block to the centerline, not to the edge of the tube. Note that the photos show beveled



spring tool with rubber band

cutouts in the hinge blocks; these were made on the prototype to facilitate a hinge arrangement that turned out to be unnecessary.

- Cut a 1" [2.5 cm] square piece of thin plywood to make a hinge tab. The tab is required so that it will not be necessary to solder or weld the second lever rod to the hinge; using the hinge tab allows screws to be used for the attachment. Mount the hinge tab to the hinge block, using a hinge fastening technique identical to that used for the key hinges.

- Bend the secondary lever's rod as shown in the drawing, and mount it to the hinge tab in the same manner that the previous rod was attached to the key's

rubber band spring passes between Key and Bell Tubes and anchors at far side of Bell Tube

thick wire spring extenders with felt vibration damper

surface. Before mounting this rod, drill a small hole in the end to accept the steel wire or paper clip.

- Bend a short piece of steel wire so that it has a 7/8" (0.875") [2.22 cm] section with 90 degree bends at either end (see drawing and photos). Insert the bent sections through the holes in the two rods, and fold the wire over to keep it from falling out of the holes. The key should now move open and closed as the button end of the other rod is moved.

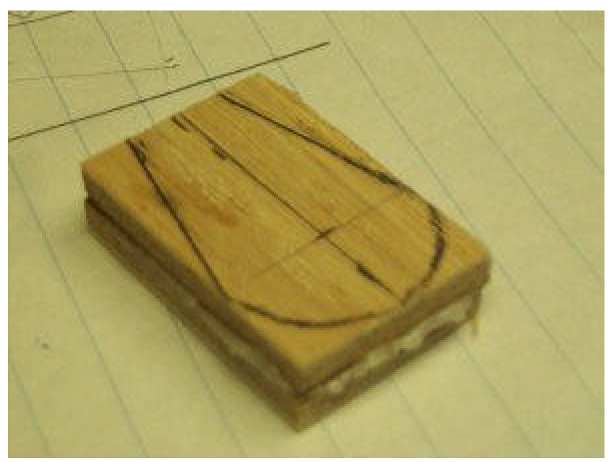
hinge block (beveled cuts are not required)

hinge tab (thin version for upper key group)

- Place a small screw into the Bell Tube on the opposite side of the Key Tube, and in line with the levers. Fashion a spring tool from a piece of stiff wire or thin dowel rod with a hook or notch at the end. Use the tool to fish a rubber band from the screw to the lever's notch. This rubber band spring will hold the key in the open position. If the spring tension is too great, use a longer rubber band or else fashion a spring extender from thicker steel wire; the extender has a loop at one end for the screw, and a hook at the other end for the rubber band spring. Since the extender will buzz against the Bell Tube, isolate it with a felt vibration damper (see photo).

hinge tab (thin version) with second part of lever pair attached

- Refer to the photos of the lever mechanism in its open and closed state, and verify that yours works in a similar manner. Operation should be smooth and quiet, with an approximate button motion of 5/8" (0.625") [1.6 cm] moving the key through its entire range of motion from 1" open to fully closed.



button laminated and marked for cutting

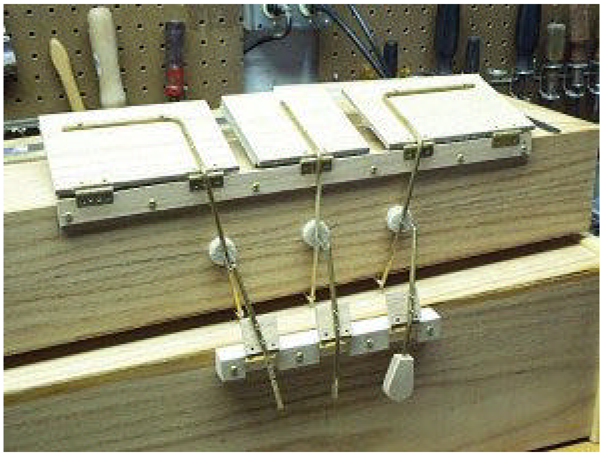
- Glue two pieces of the thin plywood together to make a block 1" x 1.5" [2.5 cm x 3.8 cm]. Mark the button shape on the block and saw and sand to this shape. Drill a 5/32" dia. [4 mm] hole 1" deep in the block, and use epoxy to glue the button onto the end of the lever. Varnish the button.

hinge tab with lever and button ready for mounting

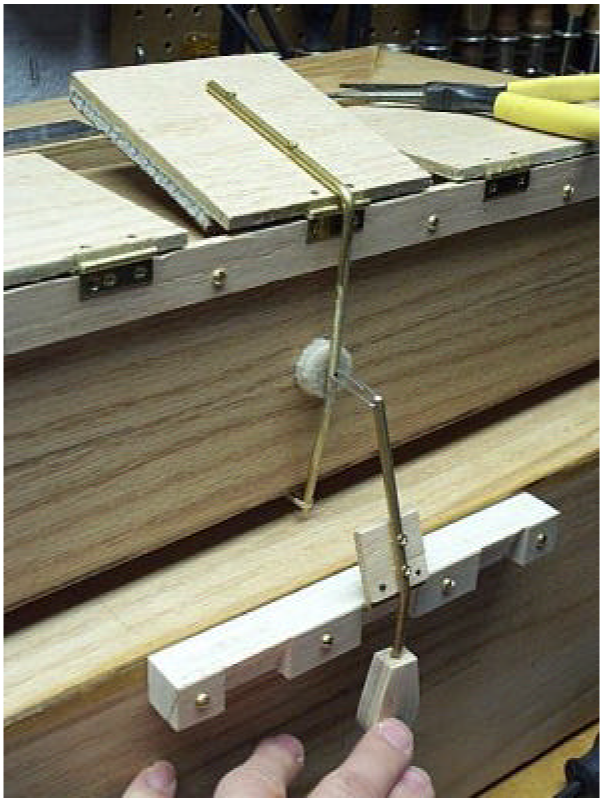
This completes fabrication of the first lever system. Use the experience gained with this pair of levers to fabricate the other five pairs, using the drawings and photos as a guide. Observe the following critical points:

- The two keys on either side of the center key of each group will have levers that angle together, in order to fit the reach of the player's fingers. The levers for these keys should pass directly over one of the key hinges, then bend and extend over most of the key's length. This will stabilize the key, prevent warping, and will also distribute the lever action evenly to where is actually needed over the hole.

- For the three holes of the lower group, the button half of each lever pair will be bent differently from those of the upper group; refer to the drawing and photos. Also, the hinge tabs for this group's levers should be from thicker wood, perhaps 3/4" [1.9 cm] thick. This improves the geometry of the lever, allowing it to pivot



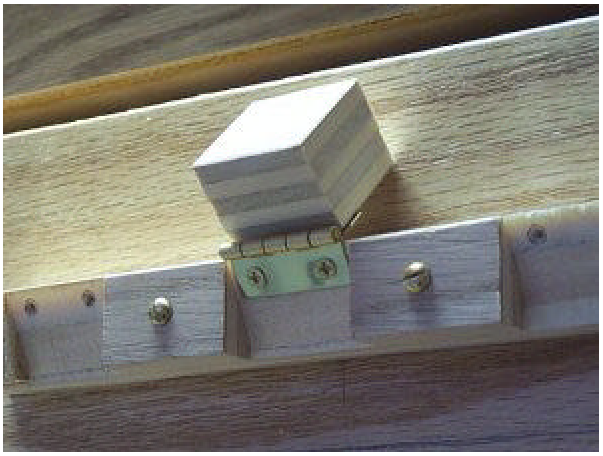
all three lever pairs for upper hole group



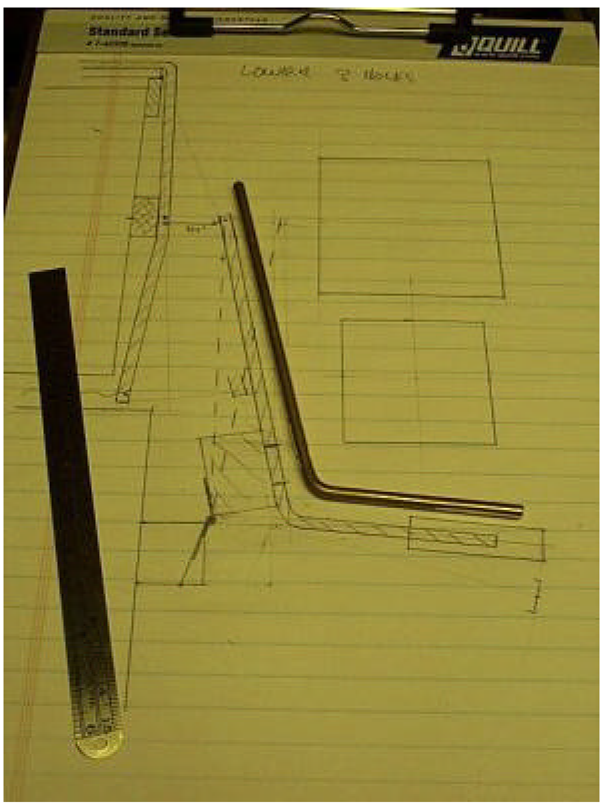
first key lever completed; the left photo shows the key open and the right shows it closed
- the button lever is shown flipped upside down from the final design's orientation

optimally while keeping the rod bends simple. For this group, the wire linkage will be slightly shorter than the linkages for the upper group.

The CBS will be playable once all six keys have working levers.



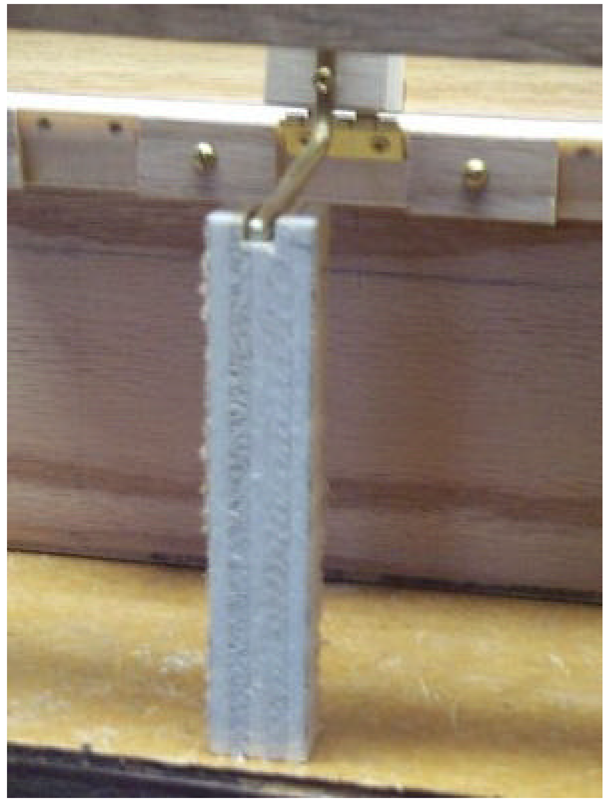
hinge tab (thick version) mounted on hinge block for lower key group



bending lever rod according to full scale template

Attachments

To facilitate holding and playing the CBS, a few additional attachments are required. There are many different ways to design these, and most are not critical. The following text and photos illustrate how the attachments were done on the prototype.



jig for holding button levers in correct position while mounting and adjusting wire linkage

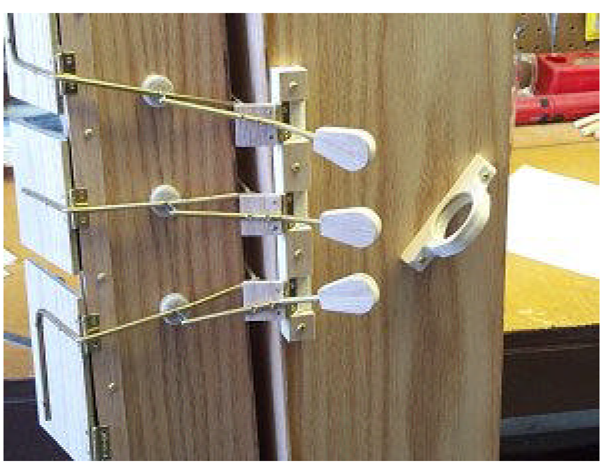
levers and linkages for lower hole group

Both of the player's thumbs need to have their own thumb hooks. The hooks serve to assist the player in holding the instrument steady, as well as to anchor the hands so that they can more effectively operate the buttons on the levers. The exact size, position and orientation of the thumb hooks is up to the individual player, and so will be unique for each instrument.

right hand thumb hook assembly

On the CBS prototype, the right hand thumb hook was made from three pieces of 1/2” [1.3 cm] plywood, arranged in an arch in front of the buttons of the lower key group. This arrangement allowed easy access to the key mechanism for making adjustments, yet also provided a strong anchor for the thumb, which fit through a hole cut in the middle piece of wood.

For the left hand thumb hook, a small piece of 1/2” plywood was cut to shape and screwed to the side of the Bell Tube. The instrument was first held in a comfortable position, with the left hand’s fingers on the



left hand thumb hook assembly

peg parts

buttons and the thumb in the hook. The hook was moved around by the thumb until a comfortable position was found, then the hook’s location was marked for later mounting by screws.

In order to play the CBS, it must be held some distance above the floor, depending on the height of the player’s mouth when seated. The instrument was held between the player’s legs, with the mouthpiece on the lips. The legs then adjusted the instrument’s height until the mouthpiece was at its optimum position relative to the lips. The distance between the bottom of the instrument and the floor was measured, and a peg was made to hold it at this height. The peg was made from a piece of wooden dowel, rounded at one end and sized to fit into a PVC pipe fixture. The fixture was the kind intended

peg parts after gluing fittings to wooden parts to adapt plain pipe to a threaded fitting, and the end of the dowel was epoxy-ed into the fitting. Next, a mating fitting with the opposite threads, was cut in two pieces, leaving only the threaded part. This piece was epoxy-ed into a hole drilled in a piece of 3/4” [1.9 cm] plywood. This block of wood was mated to another piece of wood, this time wider but thinner, and the assembly was screwed to the bottom of the CBS. The peg can be attached or removed from the instrument by twisting it in or out of the fixed fitting.

peg anchor screwed to bottom end of CBS

To allow the CBS to balance on this end, with the peg removed, wooden feet were added, complete with felt pads. This did not turn out well, as the instrument’s balance made it unstable while resting on these feet. Accordingly, an attachment was added to the opposite

stabilizer rail on bell end of CBS

feet with felt pads, on bottom end of CBS

end of the instrument, allowing it to balance upside down. The CBS will almost balance while resting on the bell, but needs a little help to prevent tipping towards the Key Tube bend. A tapered stabilizing rail was screwed to this bend, sized to provide a flat surface on the same plane as the bell rim.

Completed

The CBS is now complete. Attach the peg, insert the mouthpiece, and play! The instrument is pitched very low, so don’t be confused about which octave to play in. Since the fingerings are different for each octave, you must be in the correct octave for them to work. Note that, because of the low pitch range, the sheet music (including the example tune included with this article) is arranged one octave higher than the actual sound produced. This allows normal serpent music to be played.

The CBS uses vast amounts of air, so it will be difficult to play more than fairly short notes and musical passages for every breath. The lower the note played, the more air it takes, and the lowest few pitches are very hungry for air.

To transport the CBS, fashion two “U” shaped jigs from thick foam rubber, with the inside of the “U” having square corners, sized to fit the width of the tube(s) at ether end of the horn. With these jigs in place, the CBS will be held up off the surface, without the keys or levers touching anything.

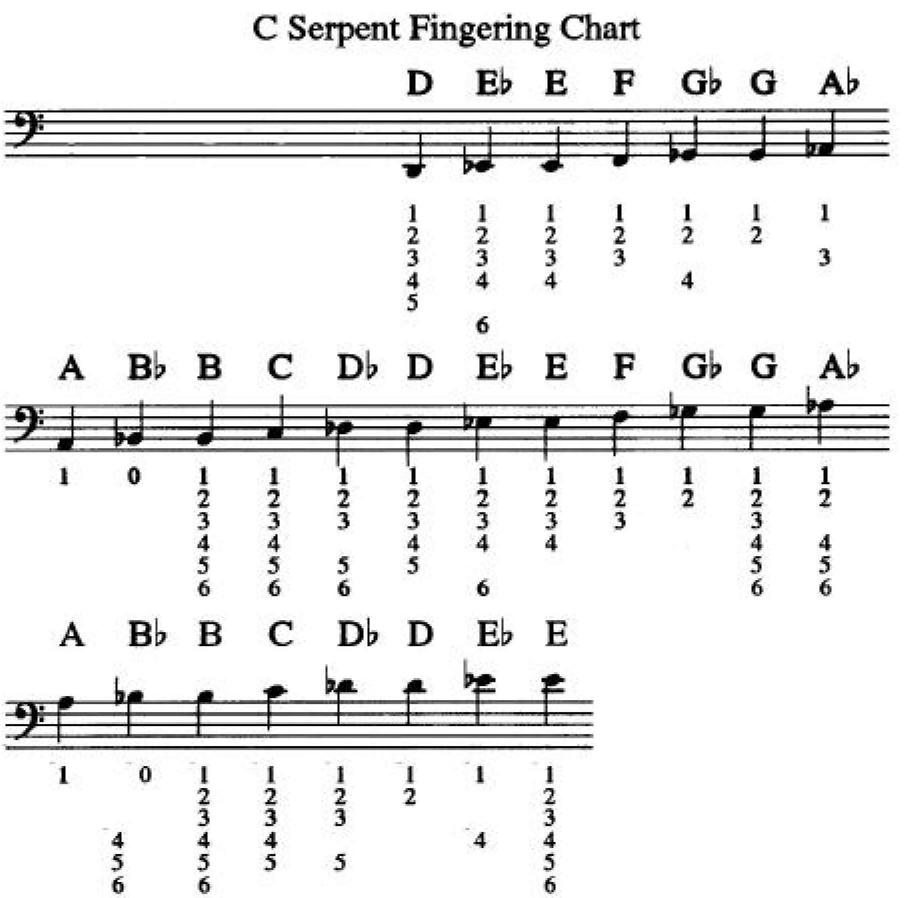
rear (player side) view of completed CBS

front view of completed CBS

right side view of completed CBS

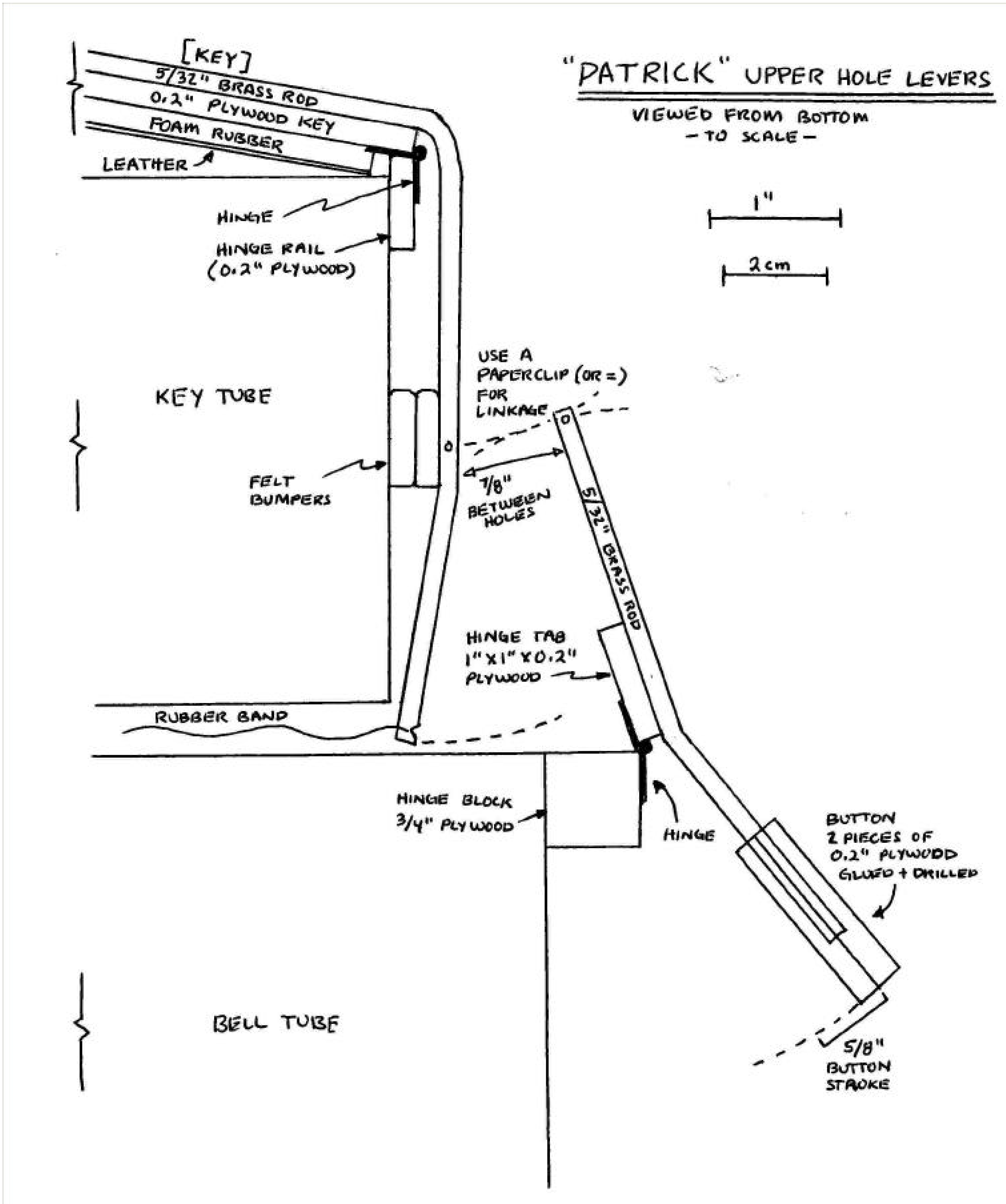
left side view of completed CBS

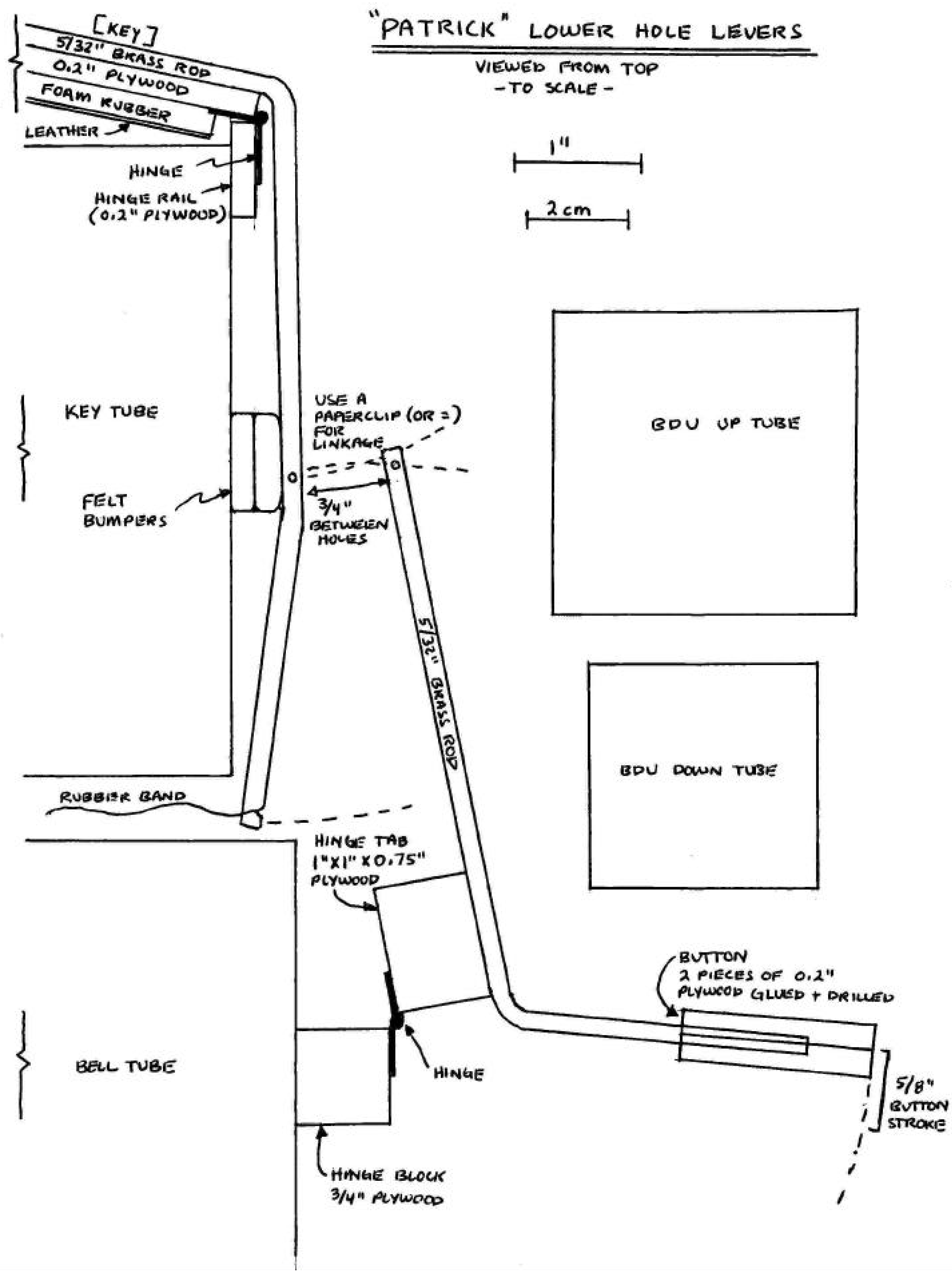
CBS hole numbers (for fingering chart)



CBS fingerings; actual pitches will be one octave lower than shown

ANNIE LAURIE
FOR CONTRABASS
SERPENT


"PATRICK" UPPER HOLE LEVERS
VIEWED FROM BOTTOM
- TO SCALE -
1"
2 cm
[KEY]
5/32" BRASS ROD
0.2" PLYWOOD KEY
FOAM RUBBER
LEATHER
HINGE
HINGE RAIL
(0.2" PLYWOOD)
KEY TUBE
FELT BUMPERS
USE A PAPERCLIP (OR =) FOR LINKAGE
7/8" BETWEEN HOLES
5/32" BRASS ROD
HINGE TAB
1" X 1" X 0.2" PLYWOOD
RUBBER BAND
HINGE BLOCK
3/4" PLYWOOD
HINGE
BUTTON
2 PIECES OF 0.2" PLYWOOD GLUED + DRILLED
5/8" BUTTON STROKE
BELL TUBE


"PATRICK" LOWER HOLE LEVERS
VIEWED FROM TOP
-TO SCALE-
1"
2 cm
[KEY]
5/32" BRASS ROD
0.2" PLYWOOD
FOAM RUBBER
LEATHER
HINGE
HINGE RAIL (0.2" PLYWOOD)
KEY TUBE
FELT BUMPERS
USE A PAPERCLIP (OR =) FOR LINKAGE
3/4" BETWEEN HOLES
BDU UP TUBE
5/32" BRASS ROD
BDU DOWN TUBE
RUBBER BAND
HINGE TAB 1"X1" X 0.75" PLYWOOD
BUTTON 2 PIECES OF 0.2" PLYWOOD GLUED + DRILLED
HINGE
5/8" BUTTON STROKE
BELL TUBE
HINGE BLOCK 3/4" PLYWOOD