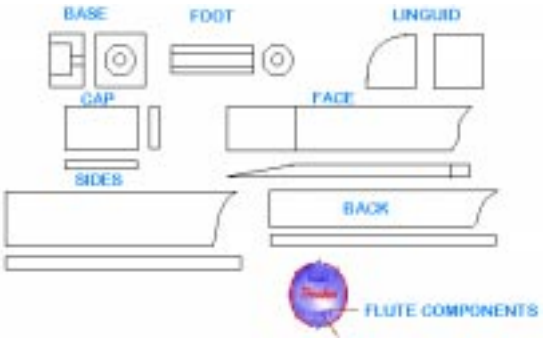
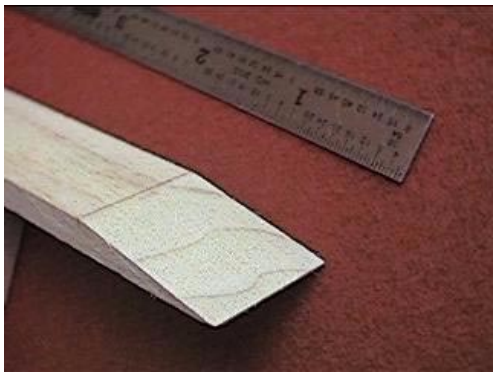
The “No Arithmetic Flute Pipe”

This article is published for my friends at The Mechanical Music Digest. These pipes are wonderful, easy to build flutes that are suitable for low wind instruments. They sound good and have a strong voice for their compact size. The can be made either open or stopped. The method of construction shown here is with common tools. The base is cut from ¾” poplar, precisely 1.000 inch square. The languid is the same size, only cut from oak or other very hard wood. The rest of the pipe is cut from ¼” poplar. The front and back are cut to 1.031 width and the sides are 1.500. The length for this pipe is 7.000 overall to allow trimming. As all of the arithmetic has been done for you, the cut sizes are critical. The sides of all pieces must also be square. Gaps or leaks are bad.

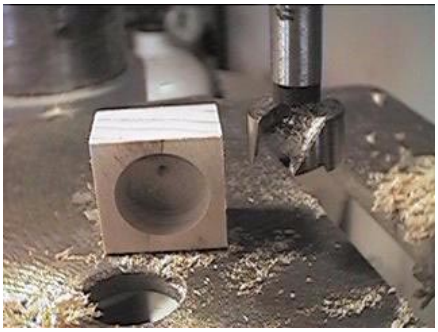


The first step is to cut all the pieces to length. They all need to be the same as the pipe is “self jigged”. Glue the back to one side using a true right angle support and clamps. The parts must be flush at the open end of the pipe. We have a lot of machined right angle jigs that are very useful for this purpose as well as a bunch of small bar clamps with soft faces.

Take the face and make a mark 2.000 from the end. Make another at 2.250 from the same end and a third at 3.625. Using a square, draw a line across the face at each mark. Draw an arrow on the piece just before the 2” mark. The little ¼” section is then cut out allowing material to finish the ends up to the line. The 2” piece becomes the cap and the other is the face. By aligning the arrow with what is now the throat, the grain in the face will be continuous. Not necessary, but nice looking! The ramp is then cut using a belt sander, file or any other means of going from ¼” thick to a knife edge over the 1.375 distance to the mark.



Once the front is shaped, it can them be glued to the side and back. The alignment is again at the open end of the pipe. Use enough clamps to get a good joint. The area around the ramp must seal so enough glue should be used to fill any gap. Extra glue running out needs to be removed. A bead of running glue will dramatically alter the performance of a pipe.



The base is then drilled using a Forstner bit. The ¾" bore is ½" deep. The through hole is then drilled 5/16 diameter. A Forstner bit provides a flat bottom bore to support the pipe foot later. The center of the block can be found by connecting the four corners and center punching the intersection of the lines because you *did* make it square and to size.

With the face in place, the languid can now be shaped. Using a ¼" spacer between the ramp and the languid, draw a line marking the angle of the ramp. There needs to be ¼" of material left flat to the ramp angle. The remainder can be a radius down to the base of the languid. As this pipe uses a flat cap, the gentile compression and direction of wind is set by the back of the languid.

The base and languid may now be glued into the pipe. The languid is positioned .250 from the edge of the ramp. The cap can be used as a gage. The base is flush to the bottom of the pipe. So far, all of the math and geometry for this pipe are in place. The squareness of the languid face to the pipe bore keeps unwanted harmonics and turbulence out of the pipe. The little ¼" flat on the languid and the 5/16" inlet on the base set the wind for the pipe.

Apply masking tape to cover ¼" on each side of the remaining side. Spray shellac to the remaining 1" strip. The rest of the assemble is also coated on the inside with shellac. As the front and back were cut a bit over 1.000, there is room to sand down to clean wood to insure a good joint. Carefully apply glue to the front, back, and languid then position the final side and clamp it. Clamps can be used to pull in the front and back if any bowing has occurred. Once the glue has dried, the exterior of the pipe may be sanded and the ends cut square. The inside of the cap should get a couple coats of clear polyurethane such as MinWax or Varethane to provide a smooth surface for wind control.

The cap can now be fitted. Carefully sand or file the sides until it will just press into the pipe. With a small gap above the languid, the pipe will sing at this time! To mount the cap, place a piece of brass shim or a feeler gage on the ramp and across the languid that is .014 inch thick. Locate the arrow end of the cap (remember that?) a distance of 1/32" (.031) back from the face of the languid. This will complete the designed in arithmetic! Clamp the face in place and drill 1/16" holes 1/8" in from each side of the pipe and ¼" from the face of the languid into the cap. Countersink the hole in each side of the pipe using a ¼" drill to just below the surface of the pipe side. Install a #2 x ¼ flat head wood screw in both sides. The final screw goes into the cap at the center of the pipe (3/4 from the side) and 3/8 from the bottom of the base. Drill and countersink the hole, but do not install the screw yet. The end of the cap will extend beyond the base so it should be cut flush to the rest of the pipe. The face can also be sanded to bring the cap flush to the rest of the pipe. Apply a finish coat to the pipe to seal and protect it. We use clear polyurethane. You can use any thing you desire. Two coats will protect the pipe from the elements and keep it in tune.

The next piece is the foot. We use ¾" hardwood dowel stock. The foot is drilled using a jig, halfway through with a 3/8" hole. It is then flipped over and the process is repeated to finish the foot. The length is determined by the layout of your organ. If you have a lathe, it is even easier except that wood tends to wander with the grain when drilling. Using a jig and drilling from each end will insure that the holes will align with mating chests. The foot may now be glued into the base. The jig can be used to keep the foot square to the base of the pipe. Once the foot is glued, the screw can be installed into the base of the cap.

The pipe we just made will sing at a B or slightly higher. It can now be tuned by sanding the open end of the pipe to bring it into tune. Once that is done, be sure to coat the end of the pipe to protect the wood and keep the tune. A pipe that is tuned and completely coated with a suitable covering will hold it's note regardless of humidity. The tuning will vary slightly due to atmospheric pressure but a pipe of this size will not vary enough to require tuning. Future tuning can be achieved by the use of a spoiler, slug or other means. We will cover these in a future article. This pipe will sing an octave lower plus probably one chromatic note if stopped. Stopping the pipe with your hand will reveal ANY leaks. There will be a nasty chiff and maybe a weak whistle on playing. A really wet coat of varnish or shellac, sloshed around the interior of the pipe may rescue it. Otherwise it becomes a lamp!

The math for this pipe is the result of 4 years of research. We have built three organs using this data. The pipes include tubas, tibia clausa, trumpet, string flute, open flutes, piccolo, clarinet, concert oboe, and our own bass flute. We feel that our pipe chording, voicing, and song faithfully reproduce the original pipes used in the classic band organs of the 1920's. The flutes described in this article will in fact sing anywhere from 2" to around 5". The fact is that they regulate their own wind due to the air channel designed into the pipe. They are set at 3" of wind internally. Over pressure will indeed cause ugly results. It just takes a LOT of over pressure to expose itself. The design of the pipe sets the wind. The .014 sheet of wind exposed to the edge of the ramp determines the song of this pipe. The laws of physics dictate how much air flow can occur through a given passage. A dramatic increase will increase the exciting frequency for the pipe. This will introduce harmonics that are not

desired. We supply up to 8" of wind to each chest in the organ. Thus far, the pipes regulate themselves enough to play correctly. A standard metal pipe toe can be installed to fine tune the wind if needed.

The throat size and the air gap under the cap can be opened up to let the pipe play at a greater wind. They will sing like a calliope pipe with a bit of voicing.

This pipe is currently used in our band organ with a stopper. These become a very compact Tibia Clausa. The range is from C2 down two octaves. Below that, the bore size is increased. The stopper consists of a close fitting block of poplar with a ¼" groove machined around it. The packing is felt, covered with thin pouch leather. Prior to assembly, it is well greased with Blistex lip balm! This provides a wonderful seal and will not deteriorate with time. The stopper is tapped in to go sharp and our mallet has a pin in the handle used to pull the stopper to flatten the pipe.

Quality control can not be overstated! Dedicated inspectors oversee all of our operations. Dolceanna and Clarabella have their noses in every aspect of our work! They report directly to Pooker, who spends a lot of time on the computer!