Traditional Band Organ Pipe Construction (Part I)

David F. Wasson

Over the past several years at band organ rallies, I have noticed the appearance of many new home built organs. I am delighted to see so many new organs. The cost of a purchasing a new or restored organ has perhaps caused this to happen. Organs are expensive, but not because of the materials used, but mostly due to the time involved in construction.

What is also fascinating to see at the rallies, is the many methods people have devised of constructing organ pipes, including some commercial builders. Traditional construction methods and materials require not much more time than the non-traditional.

I am in the process of replacing the accompaniment foundation flutes in my organ, this has given me the perfect opportunity to describe, step by step, the construction process.

First, I will describe and label the different parts of a typical stoppered flute pipe. The drawing in **Figure 1** gives an isometric view of the pipe to be described. This drawing is from the late Ken Smith, the numbers are reference to a list of dimensions. I will use some of these numbers to help locate and identify the pipe parts.

The sides, front and back, numbered "2" and "5" in Figure 1, are made usually made from a soft wood, such as poplar, pine, or as labeled in this case, spruce. Softwood is chosen for these parts because it is less likely to warp than a hardwood. Since the majority of the machining processes are on these large pieces, it is also easier on tools. The front, back, and sides are glued to a piece in the bottom of the pipe called the block. As the block is hidden in the bottom of the pipe, it is drawn separately toward the bottom of Figure 1. The block has a hole in the bottom of it to accept the toe. The toe is also drawn separately at the bottom of the drawing. **Figure 2** is a cross section through the bottom of the pipe, the inside of the block can be seen clearly. The piece that attaches to the front of the block, is the cap. This part is numbered "10" in figure 2. In the Figure 1, it is labeled with it's note name, "A#." The toe, which fits in the hole in the bottom of the block, is strictly a lathe job. This is the piece that connects the pipe to the organ. The toe is tapered, three degrees on a side. The socket that the toe fits into should also be tapered exactly the same for a good fit. This allows the pipe to be attached to the organ with nothing but a friction fit into the toe board. With a properly sized and constructed toe, pipes of up to 24 inches in length can be fit to an organ with no other external bracing. The block, cap, and toe are made of a hardwood such as maple or beech. The block has a small slot formed between it and the cap. This gap, or slot, is called the windway, it is numbered "9" in Figure 2. The windway forms a windsheet as the wind travels from the organ, through the toe, through the block, through the windway, and then strikes the upper lip. The upper lip is the top of the "window" of the front of the pipe, just above the windway. The distance from the windway to the upper lip is called the cut-up. The cut-up is labeled "7", in Figure 1. The cut-up is a very specific proportion based on the width of the pipe. In this case, the cut-up is two thirds the width. The upper lip is narrow in thickness compared to the thickness of the front of the pipe. The upper lip is formed by the front chamfer. The front chamfer is labeled "8", in Figure 1.

With most of the parts identified and labeled, I will proceed to construction (the fun part!). The first parts to make are the blocks. In this case, I am making twelve pipes, one octave. In addition to the block, I make one

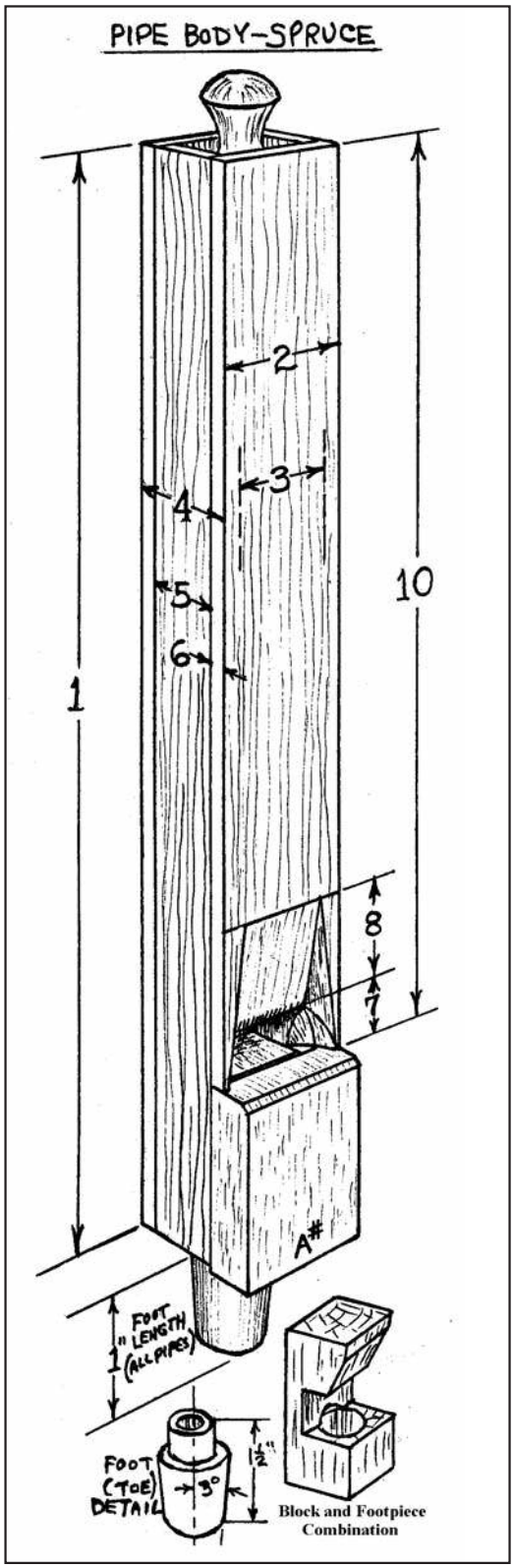


Figure 1. Typical stoppered flute pipe. Drawing used with permission from the Ken Smith Archives.

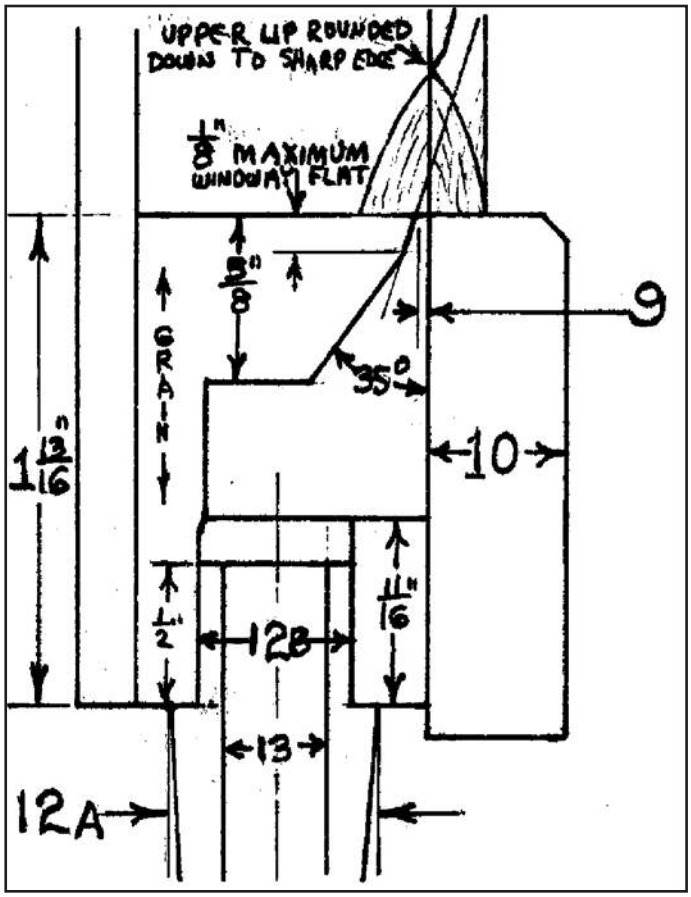


Figure 2. Cross section through bottom of pipe. Drawing used with permission from the Ken Smith archives.

more piece, the same dimension as the block, for assistance in gluing. So, I need a piece of lumber that will be large enough in dimension to make the block for the largest pipe, and long enough to make twelve blocks plus the gluing spacer. These blocks are 1-13/16" long, plus 1/2" for the spacer. My saw blade is 1/8" thick, so I must allow two saw cuts per pipe block and spacer, or 1/4". Adding this all up, I need 2-9/16" of material per pipe. To be safe, I'll allow 2-5/8" per pipe. Twelve times 2-5/8" equals 31-1/2". So the length of the material must be at least 32 inches, a few inches longer will be even better so the last piece will not be so short to work with. **Figure 3** shows an end view of the three pieces of wood that will be glued up to form the lumber for the blocks. The thin piece of the three is beech. It will be the front face of the block that forms one side of the windway. This way both sides of the windway are formed from hard wood. The block will also be more dimensionally stable if it is not constructed of one solid piece of beech. The other two pieces of wood that form the block lumber are poplar.

Figure 3. Three pieces of lumber are used to create the pipe blocks. The thin piece is a hardwood facing.

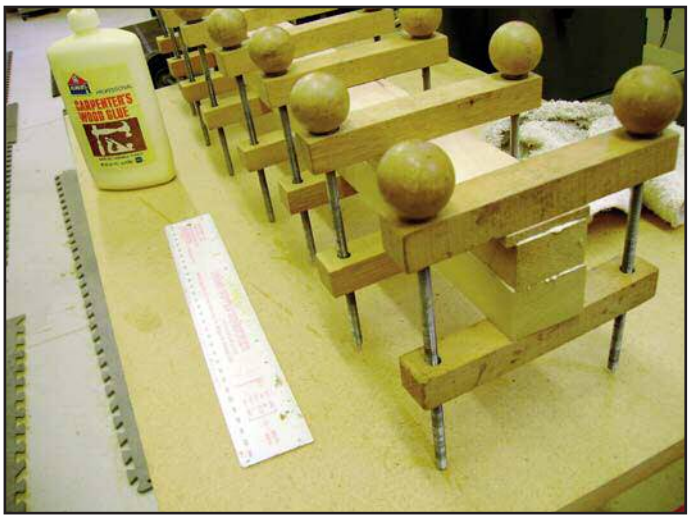


Figure 4. Pipe block lumber being glued up.

Figure 4 shows the three pieces of wood glued up and clamped together to form the block lumber. The challenge in gluing things, is to make sure that nothing slides as the clamps are tightened. As a result, I have come up with some clamps specifically for gluing and clamping small organ pipes, **Figure 5**.

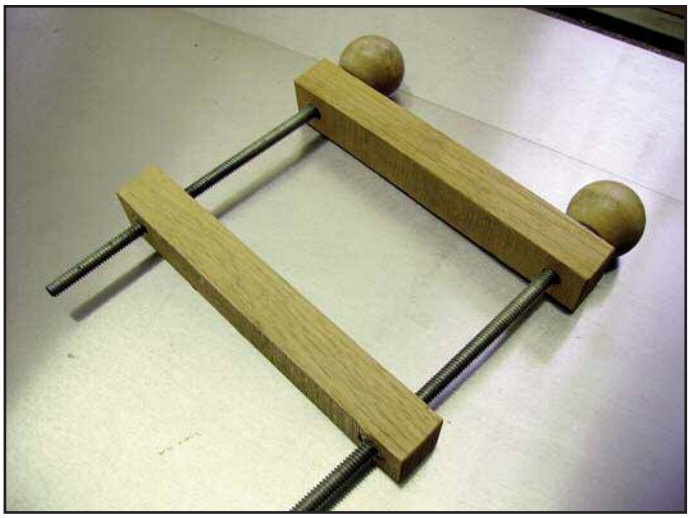


Figure 5. Homemade clamp for gluing up organ pipes.

The clamp is constructed of hard wood, these are made from oak. The bars are 3/4" by 1" by 6" long. I have several larger ones for clamping up large pipes. The six inch clamps will accommodate most small pipes in band organs. The thread-

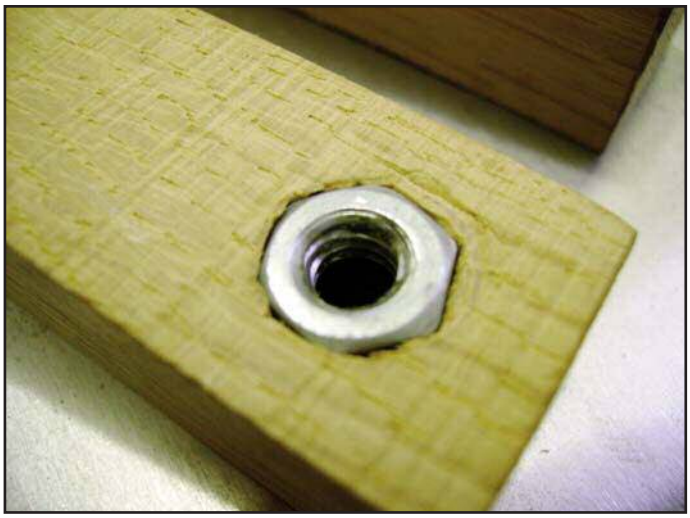


Figure 6. Detail of clamp arm.

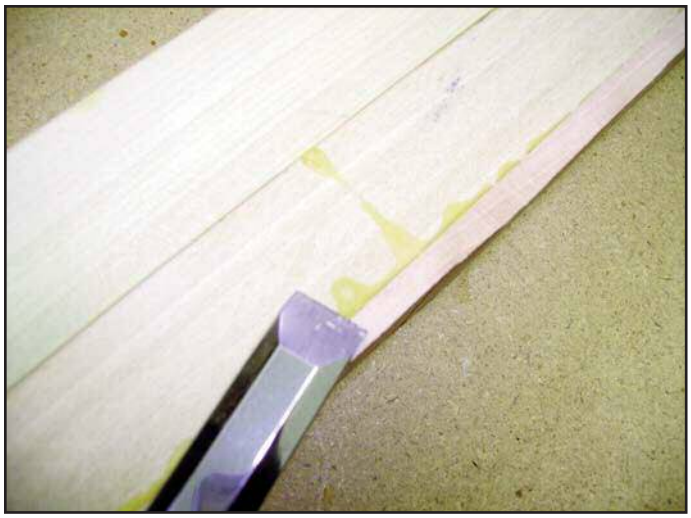


Figure 8. Remove excess glue with a chisel.

ed rods are 1/4-20 rod about seven inches long. A wooden drawer knob makes a good handle, and a washer between the knob and the bar helps reduce friction. The bar near the knobs has holes drilled in it to clear the threaded rod. The bar farthest from the knob has a 1/4-20 nut pressed into a 7/16 hole, the thickness of the nut, **Figure 6**. Beyond the nut is of course a clearance hole for the threaded knob. All of the clamp parts can be seen in **Figure 7**. Parts can still slide while gluing them up, but these clamps minimize the problem.

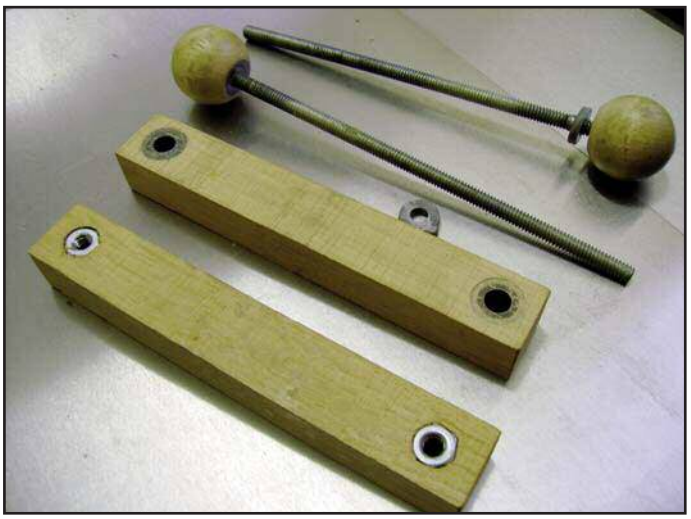


Figure 7. Pieces for organ pipe clamp.

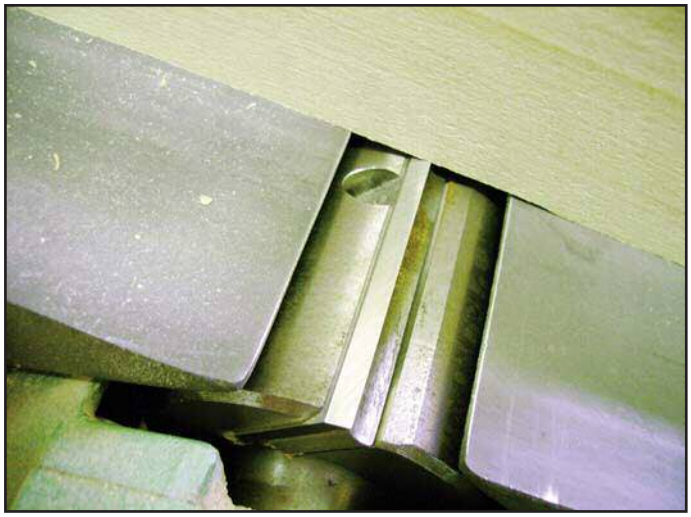


Figure 9. Establish reference side of block lumber by running across a jointer.

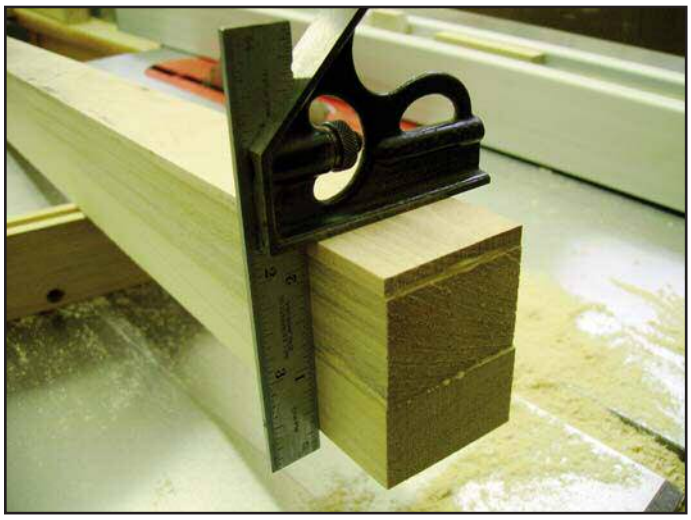


Figure 10. Reference side must be square with adjacent side.

After the glue for the block lumber is dry, remove excess glue squeeze out with a chisel, **Figure 8**. The process is to now square up two sides of the lumber. The front, with the beech face, should be a fairly good flat side from which to start. With the beech against the fence of a jointer, machine one side of the lumber until it is flat and square with the side faced with the beech, **Figures 9 & 10**. With two sides flat and square, the other sides can be cut parallel and square also. This can be done on a table saw, **Figure 11**. This is best done with a carbide blade. The blade I use for these processes is pictured in **Figure 12**. In addition to the blade I use a special washer to help damp vibrations

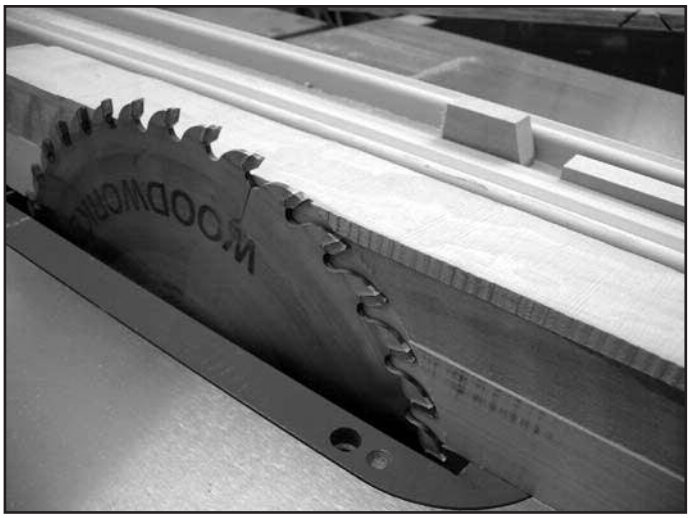


Figure 11. Bringing block lumber to width.

Figure 12. A good table saw blade will allow the saw to be used as a jointer and a planer.

in the blade, it too is in Figure 12. The lumber is now brought to width and depth of the largest pipe, **Figures 13 & 14**. The depth dimension is left just a little oversize, as it is brought to size later on, **Figure 15**.

Figure 13. Block lumber is brought to oversize depth.

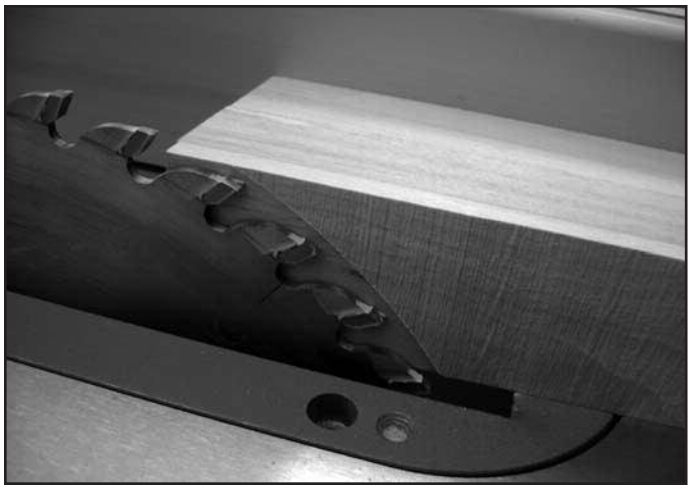


Figure 14. A minimum cut is made on hardwood face to assure flatness.

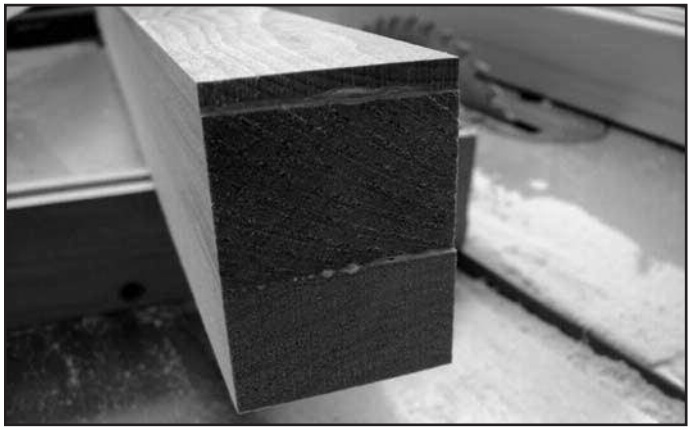


Figure 15. Block and space lumber ready to be cut into sections.

The lumber for the block is now ready to be cut into the sections that will be the blocks and the spacers. Just before cutting the pieces for the blocks, draw a line or two on the front face for reference, in this case two lines are drawn on the side faced with beech, **Figure 16**. Square one end of the lumber,

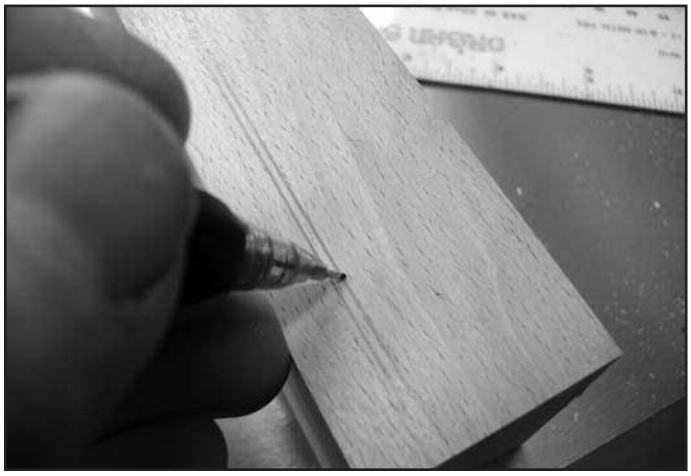


Figure 16. Reference lines are drawn on one side of block lumber.

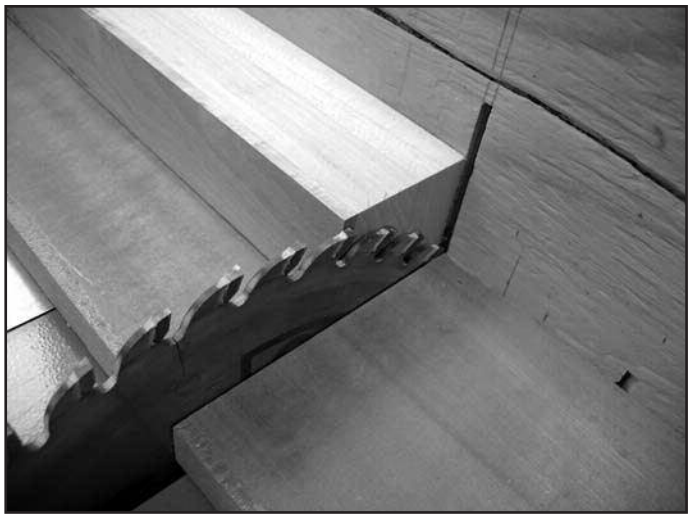
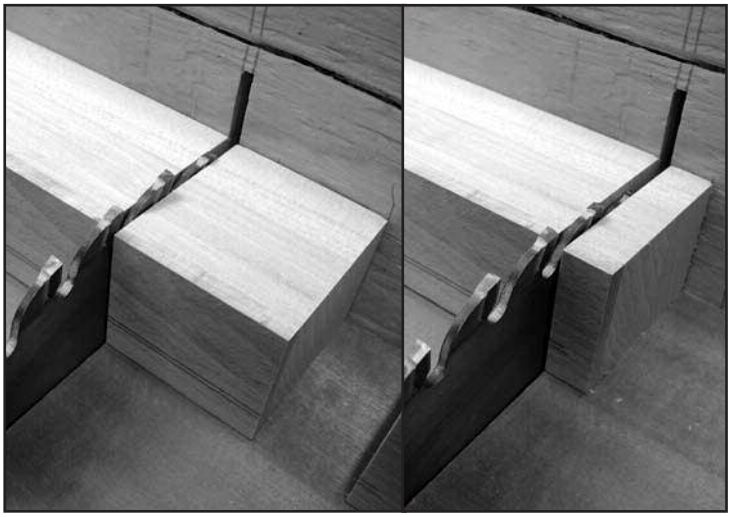


Figure 17. Trim and square up one end of the block lumber.

Figure 17. Cut a piece from the lumber 1-13/16" long, this will be the block for the largest pipe, **Figure 18**. Cut from the same end of the lumber a piece 1/2" long, this will be the spacer for gluing, **Figure 19**.



Figures 18 & 19. Cut one block and one spacer for each pipe.

Figure 20.Trim the lumber to width for the next smaller pipe.

Figure 21.Spacer and block for each pipe.

Now the lumber will be cut a little narrower, to be the width of the next smaller pipe, **Figure 20**. As each block and spacer is cut from the lumber, write the note name on the front of each piece, **Figure 21**. The reference lines should all be on the same face. When all 24 pieces are cut, you will have a graduated set of blocks and spacers as in **Figure 22**. As these blocks and spacers are cut, it is not necessary to keep cutting the lumber in the depth dimension, as this dimension is finished later on.

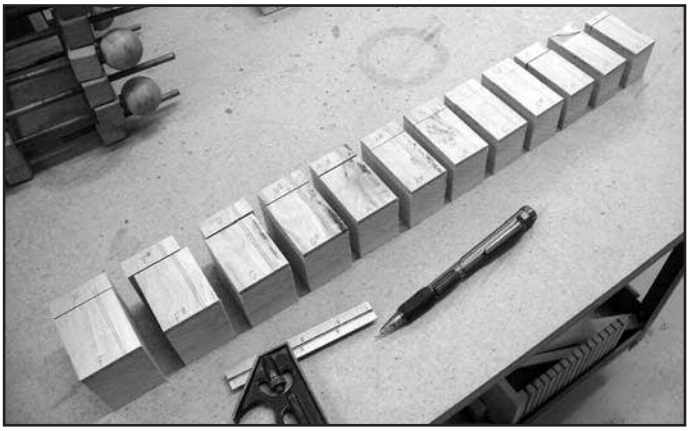


Figure 22. Complete set of twelve blocks and spacers.

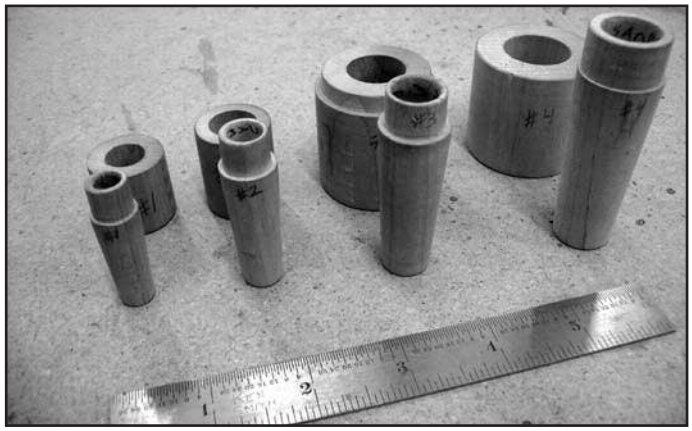
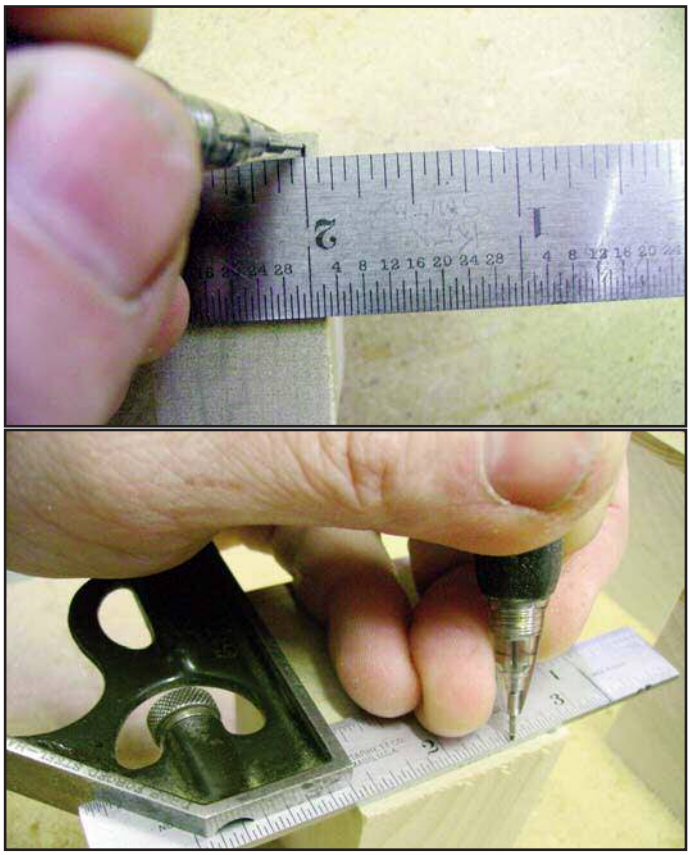


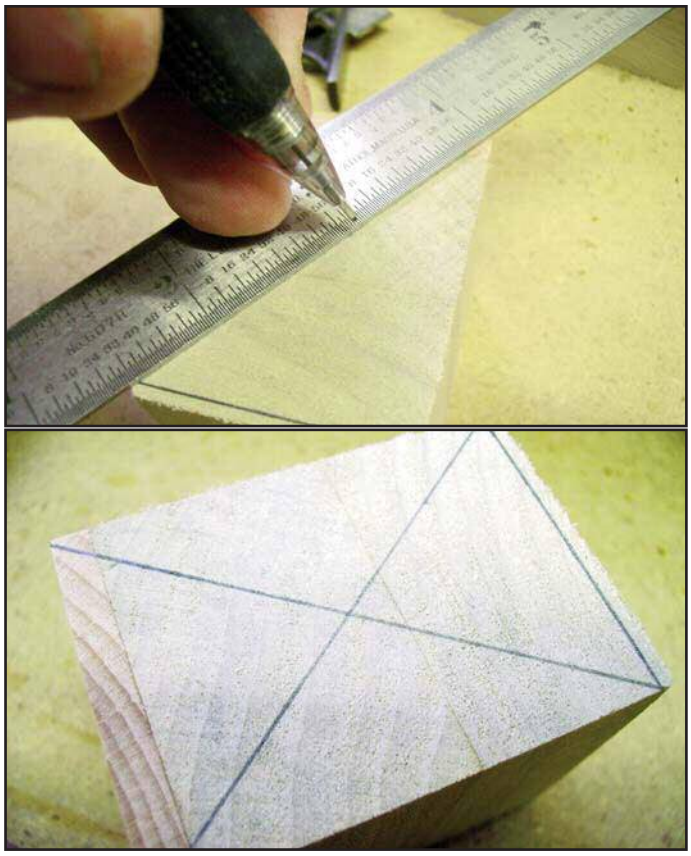
Figure 23. Four standard toe sizes.

Figure 24. Tapered reamers for maching toe holes.

The blocks can now have the toe hole bored in the bottom. It is possible to bore the holes after the pipes are assembled, but it is much easier to do it before. I have four standard size toes that I use, **Figure 23**. The toes are pictured with a tapered socket behind each. The socket is used for machining the tenon on the toe. For machining the board that the toes go into, I have a set of two tapered reamers that can accommodate all four toe sizes, **Figure 24**. These reamers are home made, and since they are for only reaming wood, they are machined from carbon steel, and not hardened.



Figures 25 & 26. Mark the bottom of each pipe with a line showing finished depth of pipe.



Figures 27 & 28. Cross the corners on each block to indicate toe hole positions.

The finished dimension is marked on the bottom of each block, **Figures 25 & 26**. After the finished depth is marked, a line is drawn across the corners to indicate the finished center of each block, **Figures 27 & 28**. **Figure 29** shows all centers marked, the front face with beech is also visible. **Figures 30** through **34** show the finished depth line being extended around to the side of the block, this will assist in cutting out the center of the block later on. This also helps to determine with the first block, how deep to bore the toe hole. The idea is to bore the hole deep enough so it penetrates into the cut out area in the center of the block, about halfway, **Figures 35 & 36**. Figure 36 shows several of the blocks with the toe hole bored.

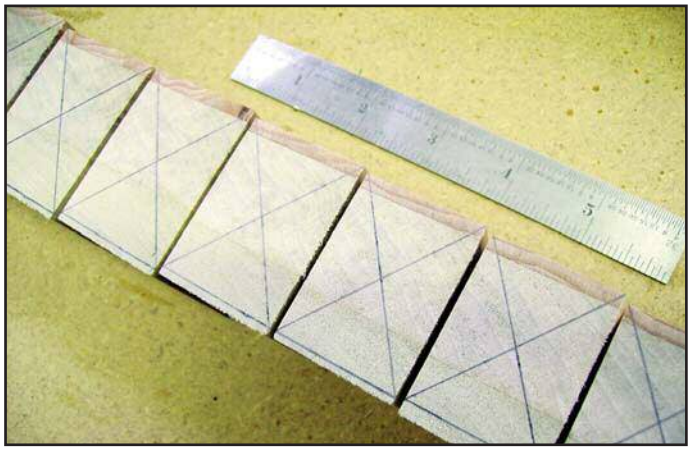
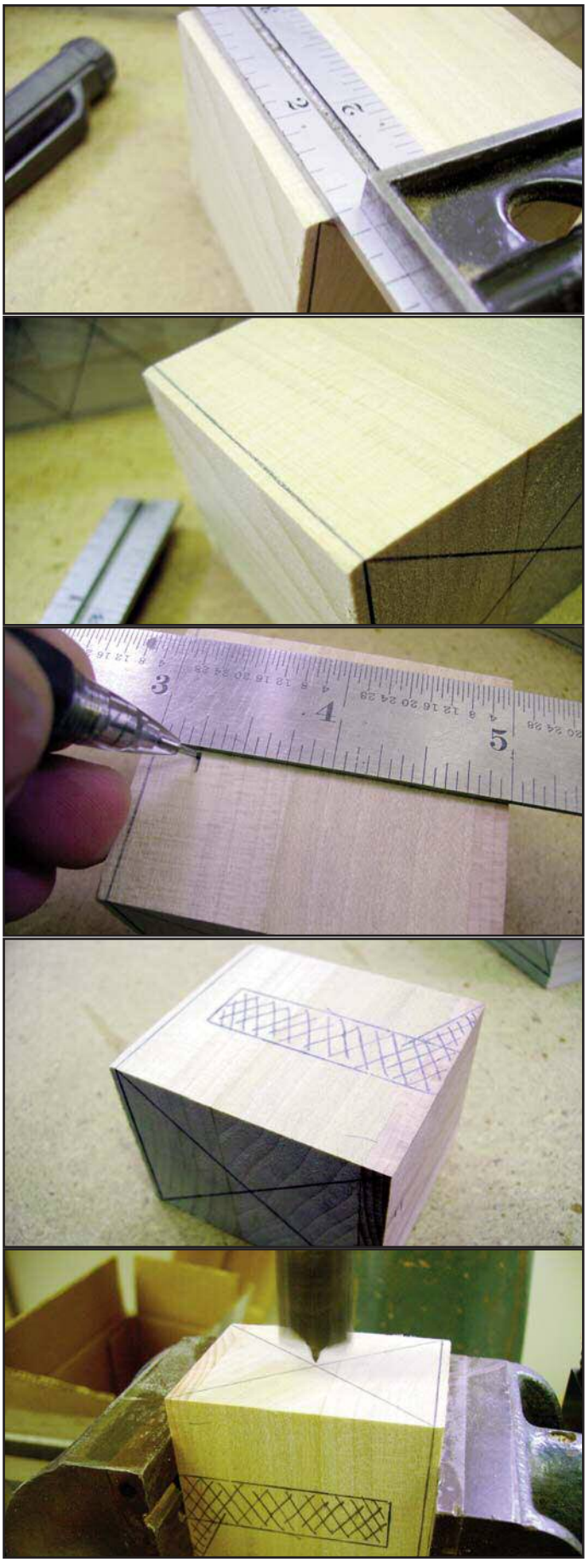
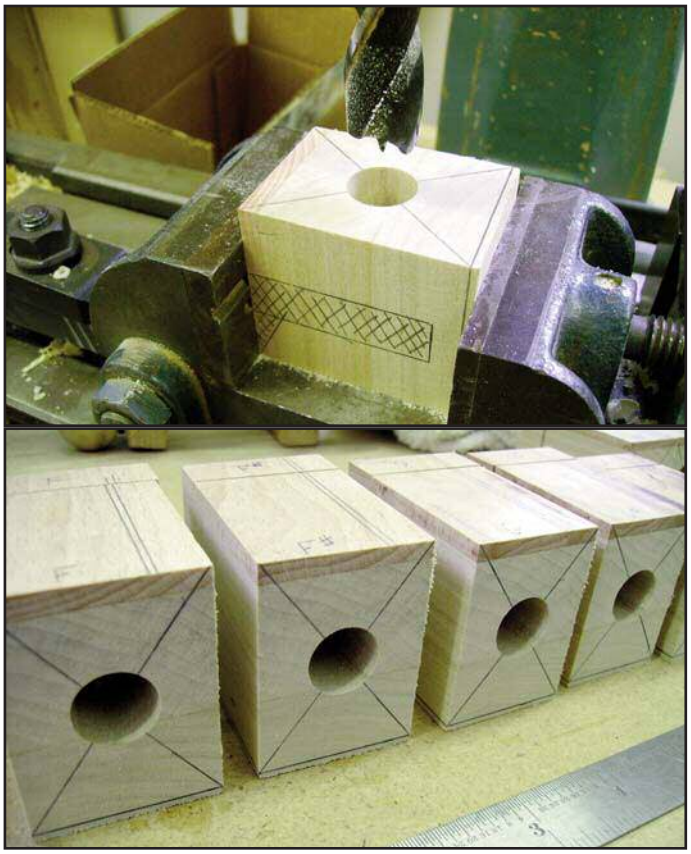


Figure 29. All blocks marked with the toe hole centers.



Figures 30 to 34 (left five photos). Finished depth line is extended to the side of the block. The inside cut-away part of the block can now be layed out and indicated.



Figures 35 & 36. Toe holes are drilled.

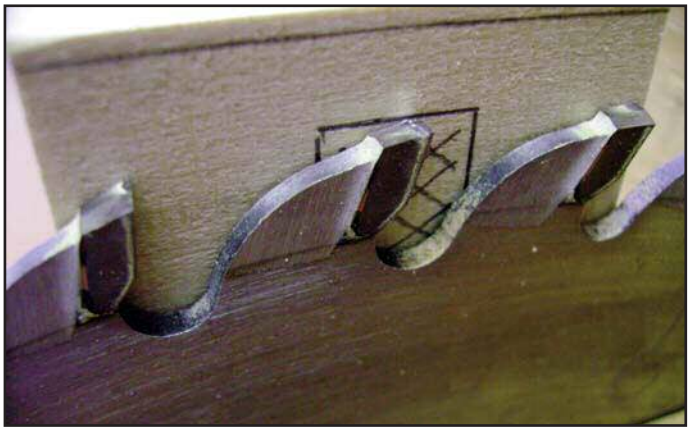


Figure 37. Saw blade height is set to remove cut-away part of block.

The center of the block is ready to be cut away. Using the marks previously made, raise the blade just high enough to touch the bottom of the cut away section, **Figure 37**. For cutting small pieces on the table saw, I use a sliding sled that runs in the miter gauge slot. For cutting each side of the cut away part on

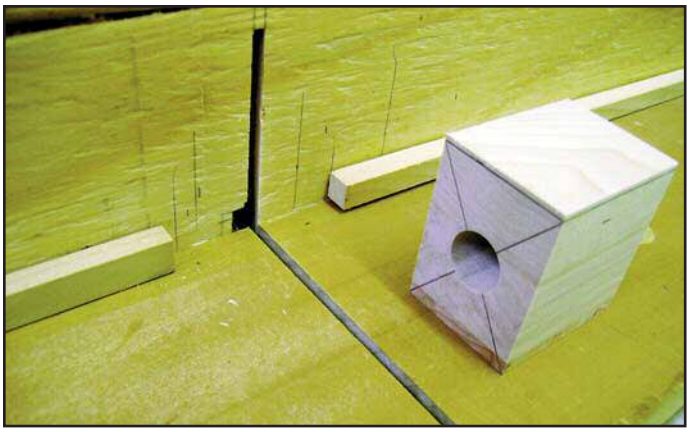
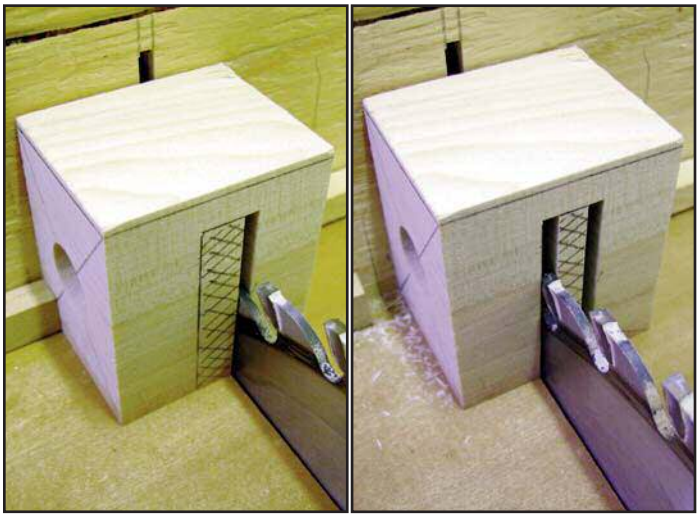


Figure 38. Left and right stops are set on sliding sled.

the block, I clamp a stop on the sliding sled, **Figure 38**. One side is cut in the block, **Figure 39**, then the other **Figure 40**. **Figure 41** shows a close up of the two slots, or sides cut on the table saw. The angle is now cut, **Figure 42**. I am using just half of the table on the sliding sled for this cut. Make sure you have space for the cut piece to get out, **Figure 43**. **Figure 44** shows the angle on the inside of the block cut, make sure you leave a small flat between the angle and the top of the block, about 1/8" wide. The windway is cut later on.



Figures 39 & 40. First and second cuts are made on block.

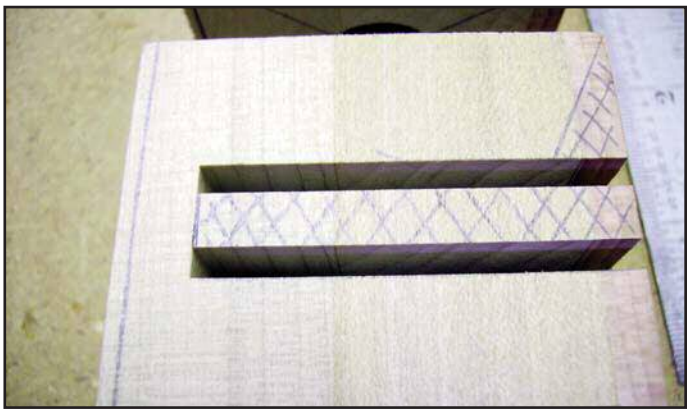


Figure 41. Top and bottom cuts completed on cut-away area.

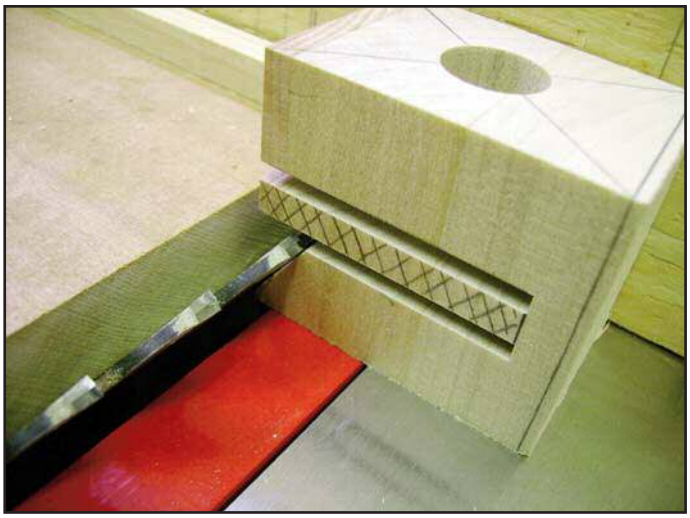


Figure 42. Angle for windway is cut.

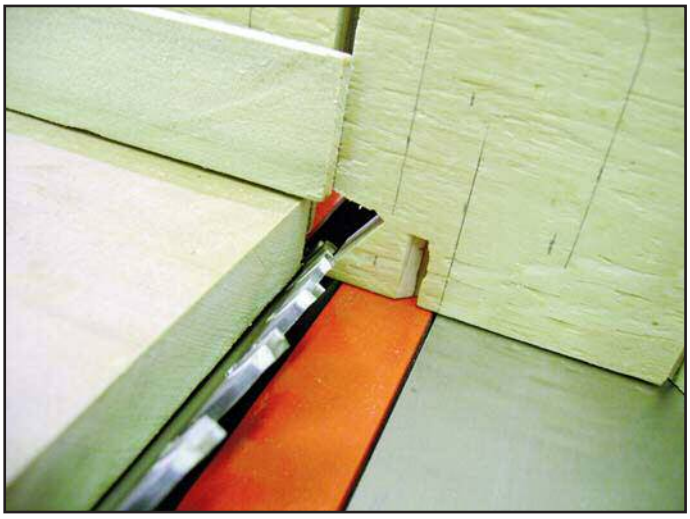


Figure 43. Be sure there is room for the cut piece to eject.

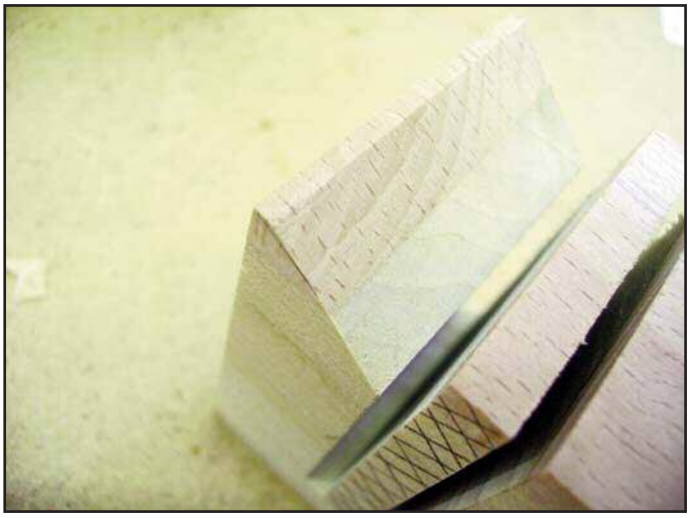
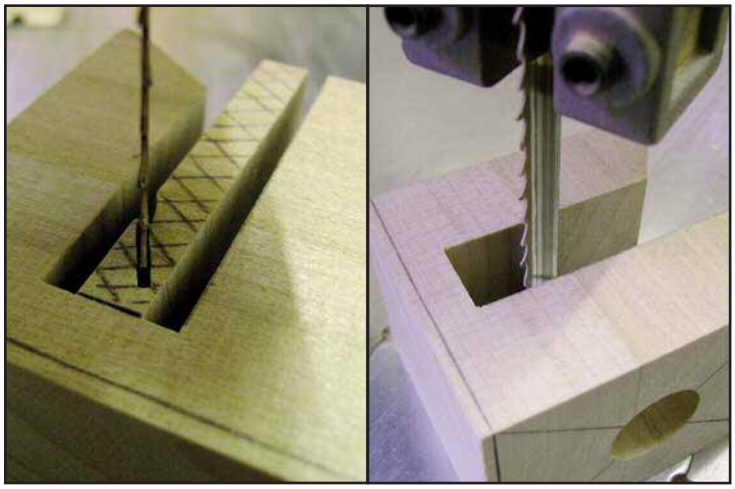


Figure 44. Completed angle cut on block.

Figure 45. Table saw work completed on all blocks.

Figure 45 shows several block with their angles cut, next to each block is the gluing spacer. Now the center section can be completely cut away using a band saw, **Figures 46 & 47.** Hopefully the toe hole was bored deep enough that it connects to the inside of the block, but not so deep that it has left a mark on the top of the inside. The blocks with the center section complete is shown in **Figure 48**.



Figures 46 & 47. Remainder of cut-away is removed with a band saw.

Figure 48. All cut-away areas removed from blocks.

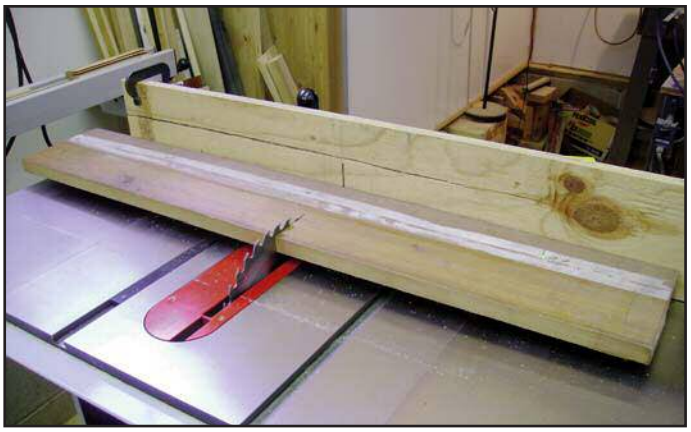


Figure 49. Preparing lumber for pipe sides.

The lumber for the sides must now be prepared. As indicated earlier, poplar, pine or spruce is fine for pipe sides. I am using poplar from old discarded organ pipes. A few large organ pipes can be a source of wood for many band organ pipes. These pipes were already cut apart, so I start by cutting sections to length. I start with the length of the largest pipe, **Figure 49**. I leave the length a little long to accommodate the gluing spacer, it is later cut away when the pipe is cut to proper length.

Figure 50. Side lumber grouped in pairs. Each piece will be resawn to create two sides.

This lumber is about 7/8" thick. The finished thickness of each side is 5/16". Each piece can be ripped to make two pieces, **Figure 50**. The unwanted wood is cut away from this old pipe

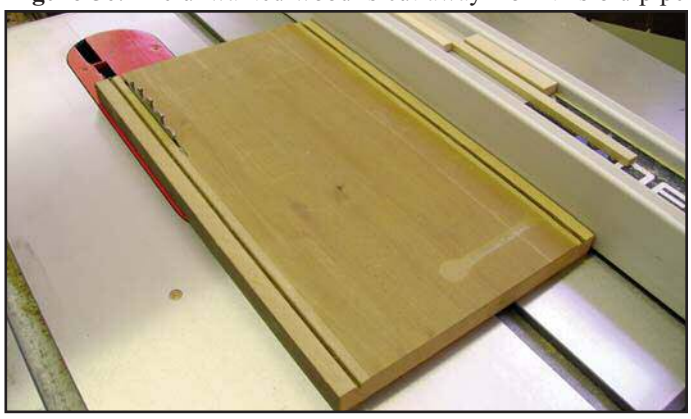


Figure 51. Lumber used is from old recycled organ pipe wood. Unwanted sections are cut away.

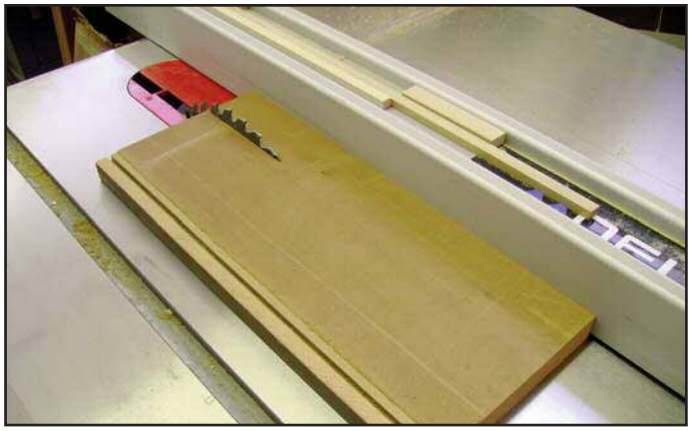


Figure 52. Lumber is sawn to width for each pipe front and side.

lumber, **Figure 51**. The width of each pipe plus the wall thickness is taken into consideration when rough sawing the pipe sides, **Figure 52**. Leave the pipe sides at least 1/16" oversize in width. The rough sawn pieces are shown in **Figures 53 & 54**.

Figures 53 & 54. Note names are written on the end of each piece. All lumber is now rough cut.

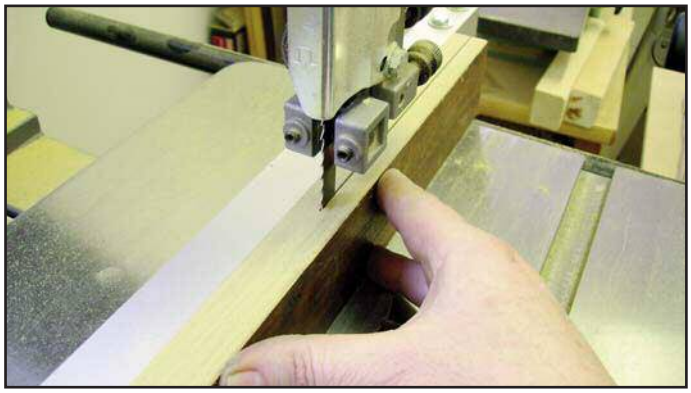


Figure 55. Each piece is resawn to create two pieces.

Figure 56. All side lumber is now resawn with four pieces for each pipe.

The note names are written on the end of each board. Each board is then ripped in half on the band saw, **Figure 55**. The new stack of lumber is shown in **Figure 56**. The band sawn side of each pipe side is run across the jointer until it cleans up 100 per cent. This will become the "good" face of each board, **Figure 57**. The large block on top of the board is a "pusher stick," keeping hands and fingers well away from the jointer blades.

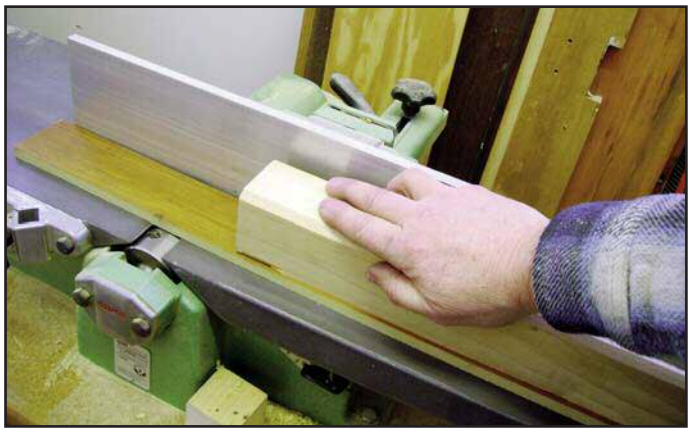


Figure 57. Inside face is machined flat on a joiner.

Figure 58. Other side is brought to finished thickness on a planer.

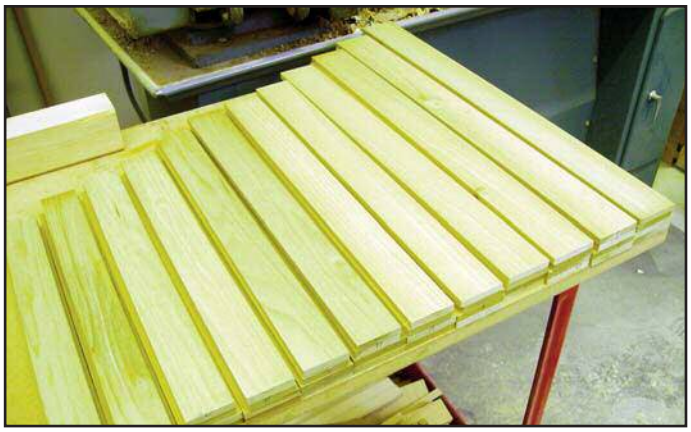
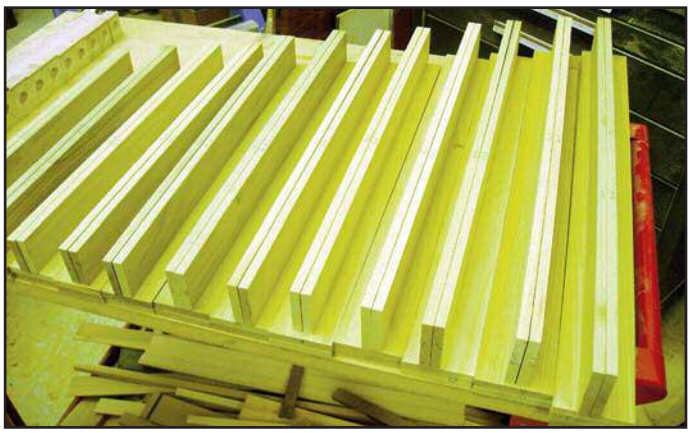


Figure 59. Front and back of each side piece is finished.

After each board has one side finished, the other side can be brought to finished thickness dimension of 5/16", **Figure 58**. The finished stack of side lumber is shown in **Figure 59**. The two pieces that are to be used for the sides get glued to the block and spacer first. One edge of each side piece should be run across the jointer, **Figure 60**. This jointed edge will become the front edge of each side piece. **Figure 61** shows the side pieces with their edges jointed and placed on edge for reference.

Figure 60 (above). One edge of each side piece is jointed.

Figure 61 (below). The jointed edge is labled. This edge will face toward the front of the pipe.



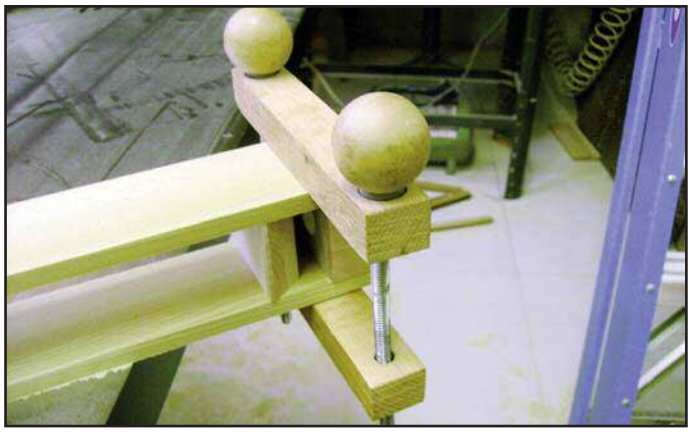


Figure 62. Side pieces are glued to the block.

Before glue is applied to the block and spacer to attach them to the sides, they are temporarily clamped together, **Figure 62**, so the spacer can be pinned to help prevent movement during gluing. The front edge of the sides, and the front side of the block must all be glued so these surfaces are flush with other. I pin the spacer with a piece from a round tooth pick. The block can be drilled with a portable electric drill for the toothpick section, **Figure 63**. In this case, the piece I cut from the toothpick to use is about 5/8" long, the hole drilled into the pipe sides and spacer is about 3/4" deep. Trim the sharp end off the toothpick so just a small portion of the taper is left, about 1/8". Then cut the piece off 5/8." Rolling a single edge razor blade is an easy way to cut toothpicks. Wooden shoe pegs were often used for this very same thing, and can often be seen on old organ pipes. If the section where the peg was driven, is cut away, these pins or pegs are never seen. After one pin is fit, turn the pipe over and fit the other, **Figure 64 & 65**.

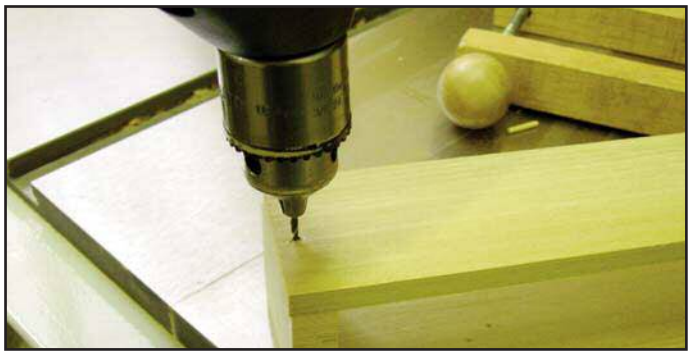
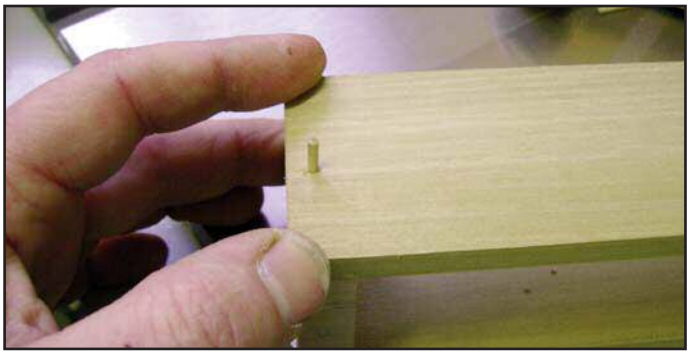


Figure 63 (above). Hole for the pin is drilled through side and into spacer.

Figure 64 (below). Side is pinned to spacer to reduce movement during glue-up.



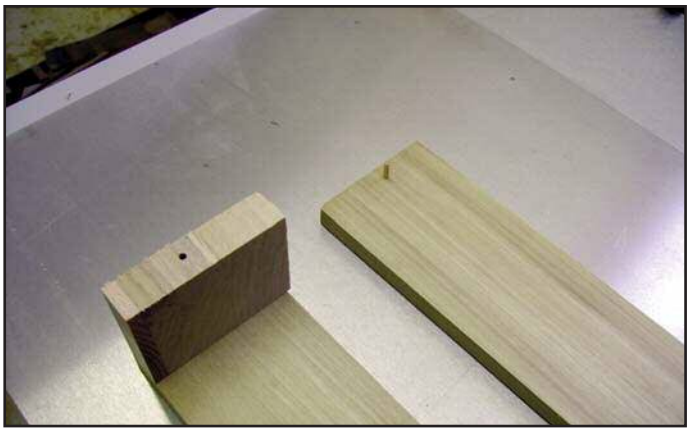


Figure 65. Pin is driven through side.

Now the sides are ready to be glued to the block and spacer, **Figure 66**. Before applying glue, make sure your clamps are set to the approximate opening, to avoid fussing with adjusting the clamps after the glue is out. Apply glue to one side of the block and spacer, **Figure 67 & 68**. Put a pin in the side and place the pin and side onto the block and spacer. Flip the pipe over and glue and pin the other side. Since the sides are not pinned to the block, make sure the sides are flush with the front side of the block before clamping, **Figure 69**. Now apply the clamps, not too hard or they can easily dent the wood. Make the clamps just tight enough that you can see glue squeeze out a bit, **Figure 70**.

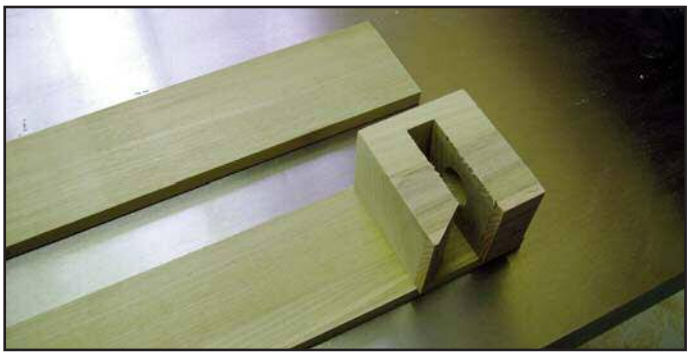
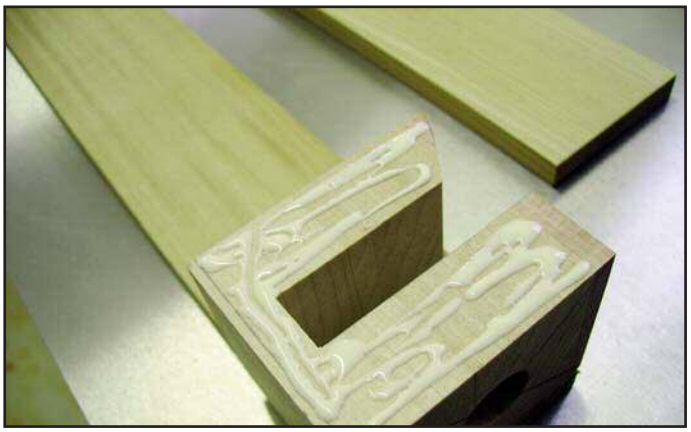


Figure 66 (above). Block is ready for glue.

Figure 67 (below). Block with glue applied.



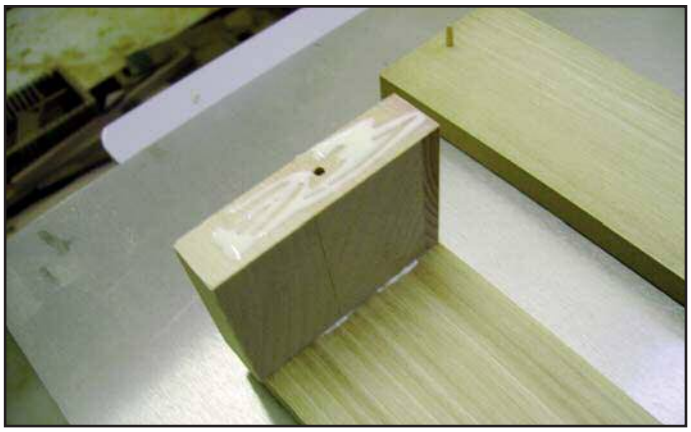
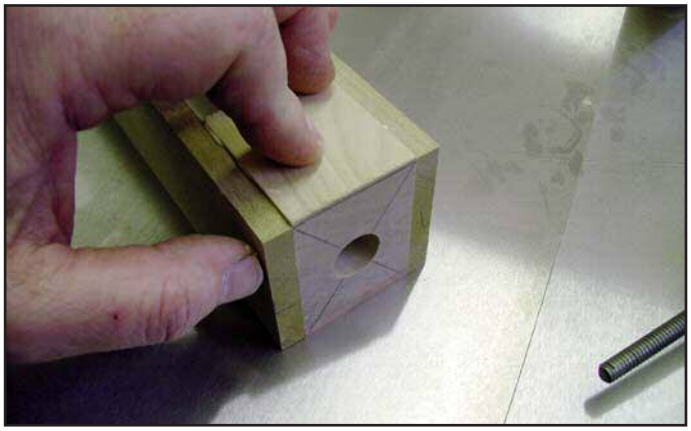


Figure 68 (above). Spacer with glue applied.

Figure 69 (below). Side is brought to spacer and block.



The sides, front and back are made usually made from a soft wood, such as poplar, pine, or as labeled in this case, spruce. Softwood is chosen for these parts because it is less likely to warp than a hardwood.

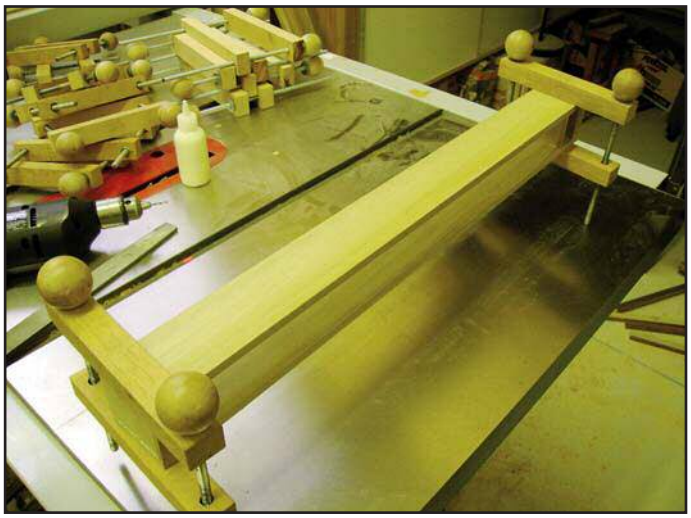


Figure 70. Both ends are clamped.

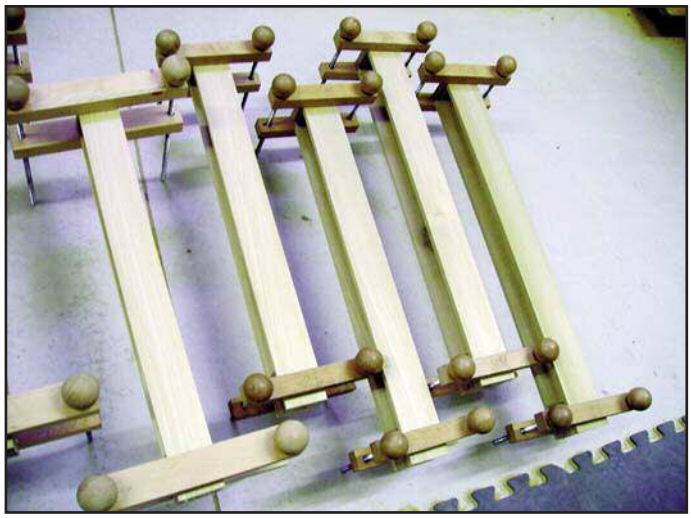


Figure 71. Several pipes with sides clamped to spacers and blocks.

Figure 72. All sides glued up.

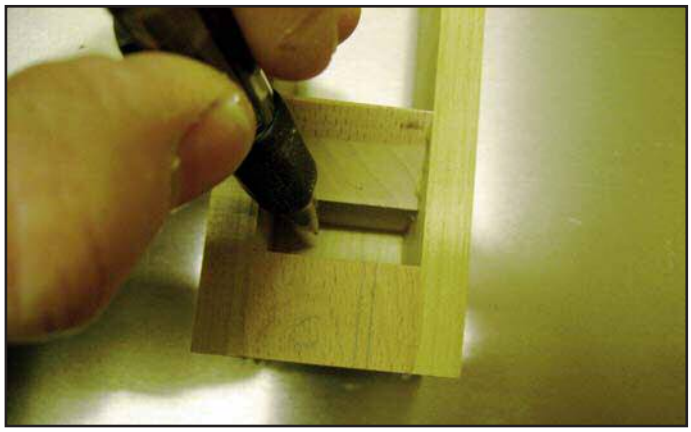


Figure 73. Note name is written on inside of block.

Figure 71 shows several pipes in the clamps. **Figure 72** shows all of the pipes out of the clamps with their sides attached to the block and spacer. **Figure 73** shows re-establishment of the note name at the inside back of each block.

The pipe sides, block, and spacer are now machined to finished depth. The front of the pipe is the reference side, remove any glue squeeze out from this surface with a chisel, **Figure 74**.

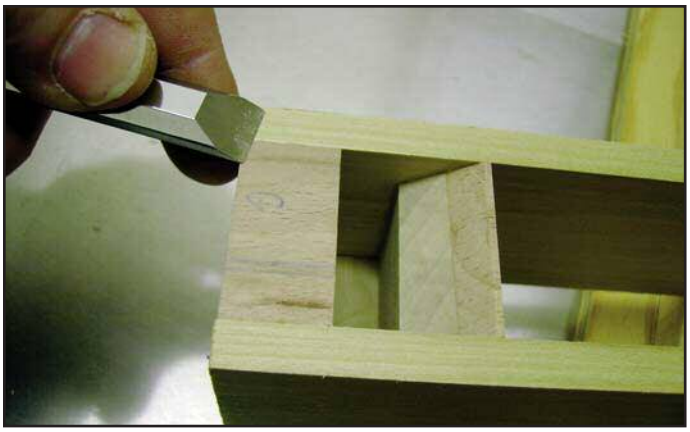
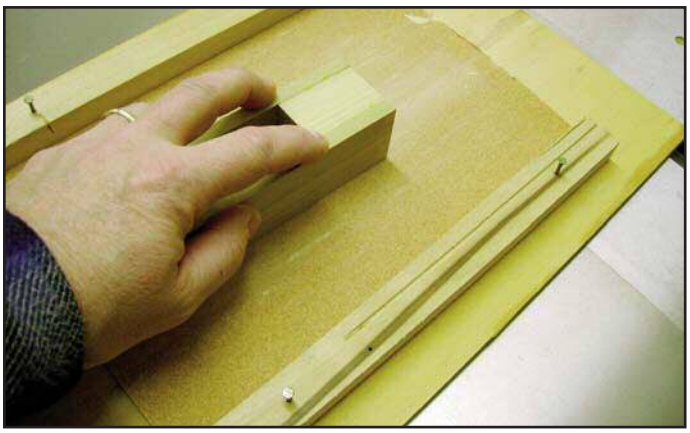


Figure 74 (above). Chisel is used to remove any excess glue.

Figure 75 (below). Front of pipe is rubbed on sandpaper to assure flatness.



Rub the front across a piece of sand paper just to make sure it is really flat, **Figure 75**. Using the fence of the table saw to set the distance, finish the depth dimension of the pipe, put the front side against the fence as this is a finished side, **Figure 76**.

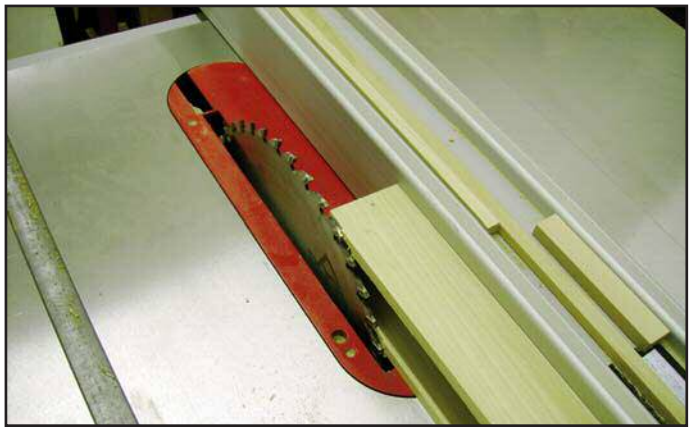


Figure 76. Back side of pipe is finished to depth dimension.

After all of the pipes are finished to the depth dimension, the back can be glued to the side and block assembly, **Figures 77 & 78**. A clamp every 3 to 4 inches is all that is needed. I use the front piece positioned on the front of the pipe, but with no glue, for a spacer between the clamps and front edge of the

sides. I have enough clamps to do only about two pipes at a time. I let the glue dry for one hour, and then cycle them to the next two pipes.

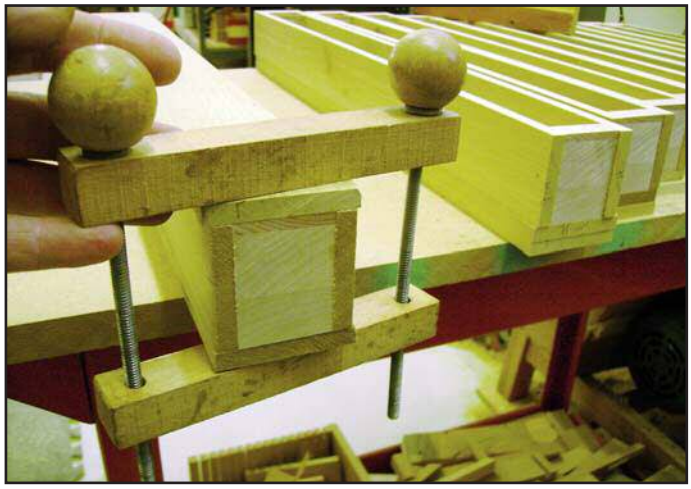
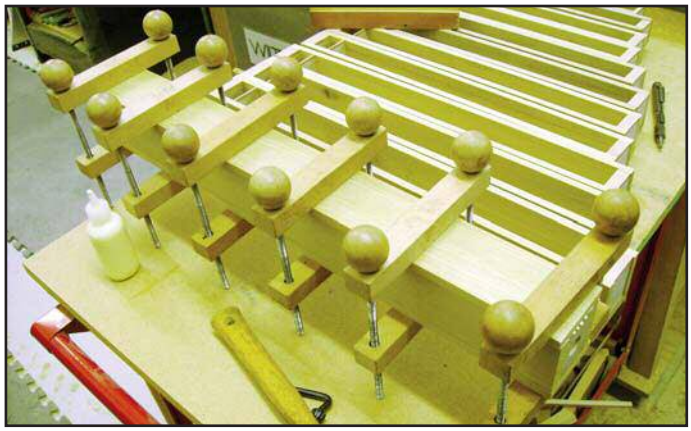


Figure 77 (above). Back is glued to sides.

Figure 78 (below). Several clamps are used to glue the back to sides.



While the pipes are drying, I start preparing the pipe fronts on the pipes that are not in the clamps. I determine which end of the front piece I would like to have toward the cap with the cut in, as the other end will be cut away. Square up the end, **Figure 79**. The front of the pipe will be scribed with the position of the top of the chamfer, and the sides of the cut up. The

Figure 79. One end of front side is squared up on the table saw.

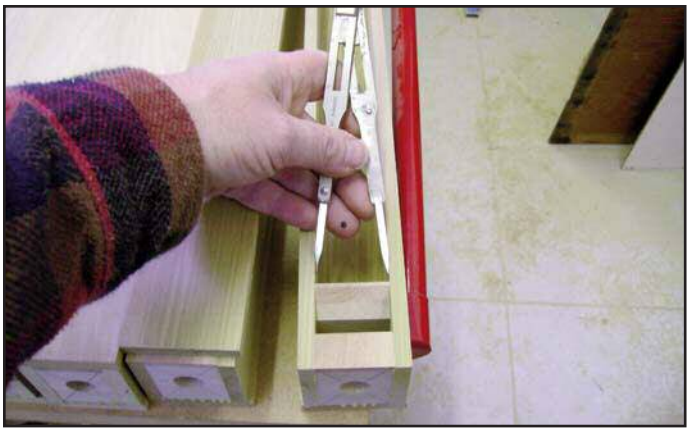


Figure 80. Proportional dividers are used to calculate cut-up on the front piece.

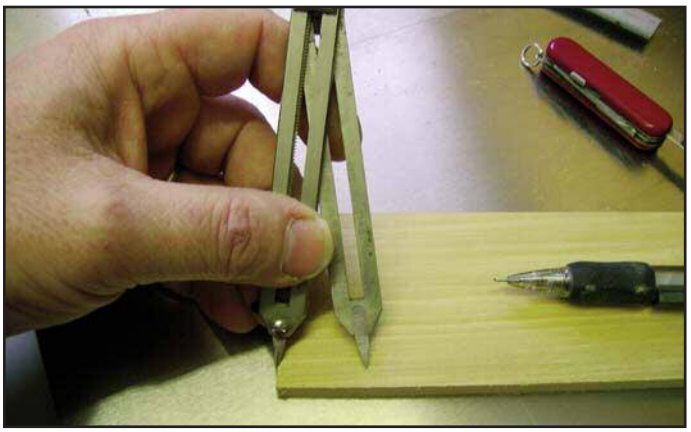


Figure 81. Cut-up is marked. It is two thirds of the width.

Figure 82. The top of the cut-up is marked on the inside of the front.

inside will be scribed with the position of the cut up. For these pipes, the cut up is two thirds the width, a set of proportional dividers can be used to set this distance. With the dividers set at two thirds, place the long legs just inside the width of the pipe, **Figure 80**. Now with the short legs of the dividers, mark the position of the cut up on the inside of the front piece, **Figure 81**. Scribe the cut up with a knife, make it about 1/32" to 1/16" deep

Figure 82. Draw the knife multiple times until you are to depth, do not attempt to make this cut in one pass. Also, do not let the scribe go out all the way to the edge of the front, or it will make a cut that will be visible after the front is glued on.

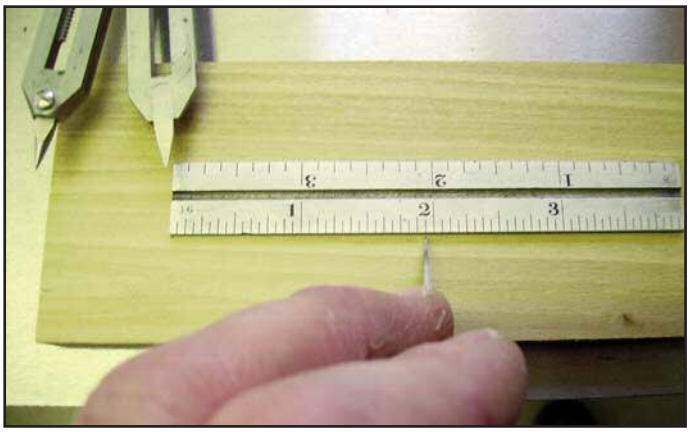


Figure 83. The top of the chamfer is marked on the outside of the front.

Turn the pipe front over so the front is on top. Mark again where the cut-up will be, **Figure 83**. Then measure where the top of the front chamfer will be. Scribe all the way across the pipe front where the top of the chamfer will be. This mark needs to only be about 1/64" deep, **Figure 84**. Bring the pipe front to the block and side assembly. Mark on the bottom edge of the pipe front the inside dimension of the pipe with a marking knife, **Figures 85 & 86**.

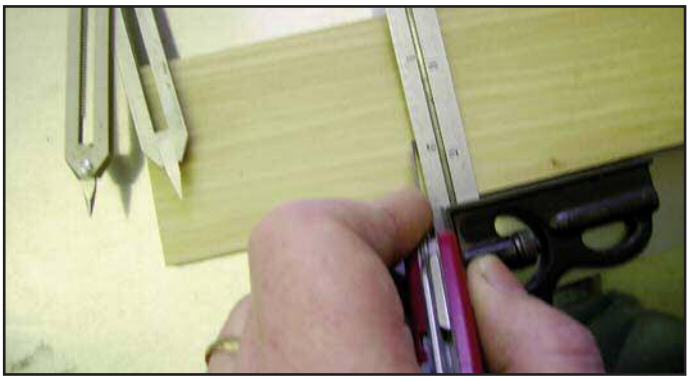
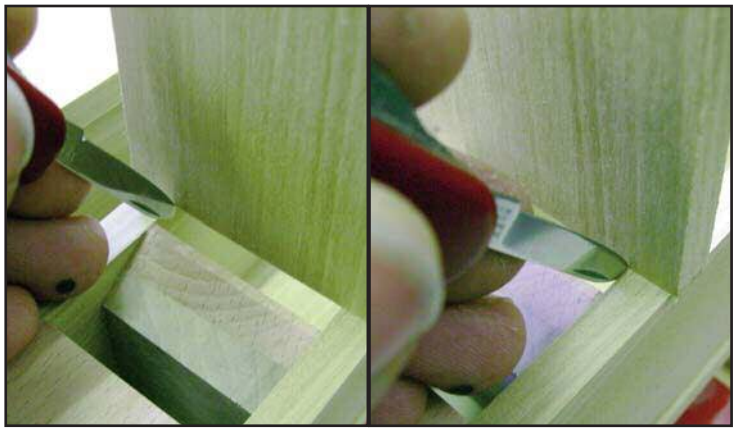
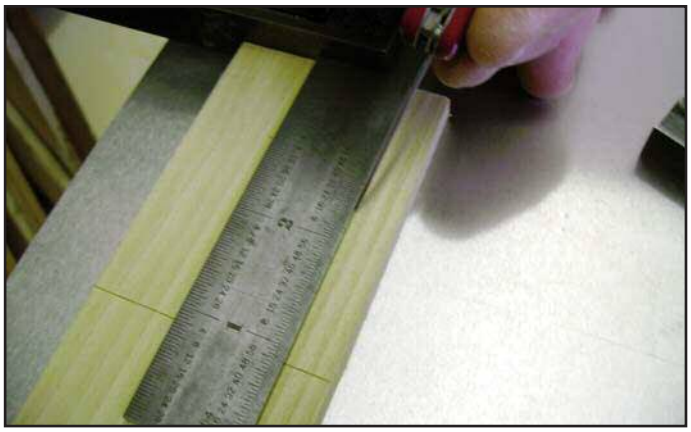


Figure 84 (above). The chamfer top mark is extended all the way across.

Figures 85 & 86 (below). The inside width of the pipe is transferred to the front piece.





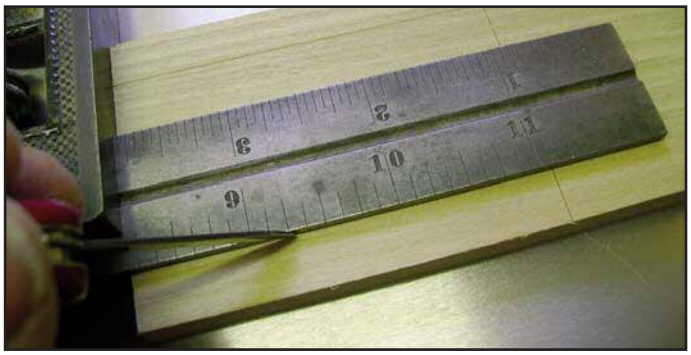


Figure 87 (above, top). Chamfer width marks are extended to meet the chamfer top mark.
Figure 88 (above). All lines marked must be parallel and square.

Transfer these marks from the bottom edge of the front to the chamfer top with a knife, **Figures 87 & 88**. These marks are made with a knife to establish a place where the wood will more easily be chiseled away without splintering. The marked pipe front is now ready to have it's chamfer cut, **Figures 89**. I have also machined pipe chamfers with a milling machine and end mill, but cutting them by hand gives you more control, and is much more satisfying.

Figure 89. Completed marking of chamfer and sides.

Figure 90 shows the beginning of cutting the upper chamfer. A 3/8" of 1/2" chisel works just fine. If you use a chisel too wide, you will not be able to push it through the wood. The chisel should be sharp enough to push it by hand, you should

Figure 90 (above). Waste material of chamfer is removed with a chisel.

Figure 91 (below). Corners of chamfer more easily kept square with a corner chisel.

not have to ever strike the chisel with a mallet. **Figure 91** shows a handy chisel for keeping the corners square as the chamfer progresses. Stay 1/16" away from the sides of the chamfer as you start. As the chamfer get deeper and closer to being finished, let the sides get closer to the scribe mark, **Figures 92 to 94**.

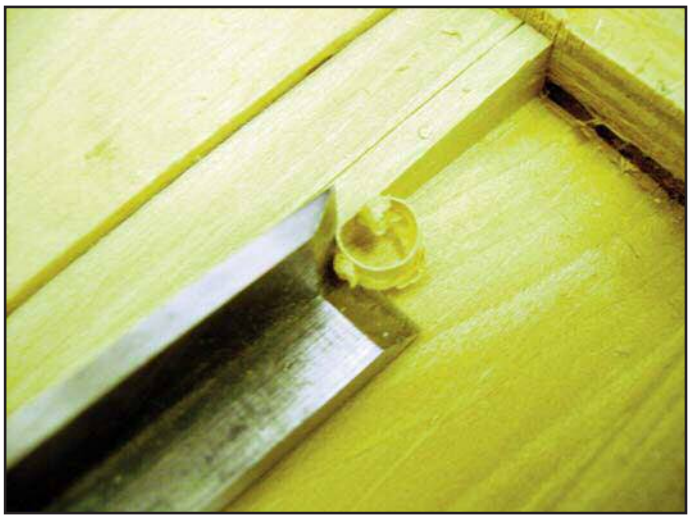


Figure 92. Corner chisel in use.

Figure 93 (above). Chamfer is slowly brought to width and depth.

Figure 94 (below). Stay about one sixteenth of an inch away from the side mark until the chamfer is nearly finished.

Figure 95. As the chamfer approaches the finished depth, it will meet with the backside.

The top of the cut-up, scribed from the back side, will eventually meet the chamfer. It should break away, leaving a nice straight edge, **Figures 95 & 96**. Attempt to keep the chamfer straight and flat. You can check your progress by placing the

Figure 96. The chamfer will meet the cut-up mark on the backside, leaving a nice square window on the front of the pipe.

chisel shank on edge, **Figure 97**. The chamfer can be finished with a file. The file will also tend to show high spots, which can be re-addressed with the chisel, **Figure 98**.

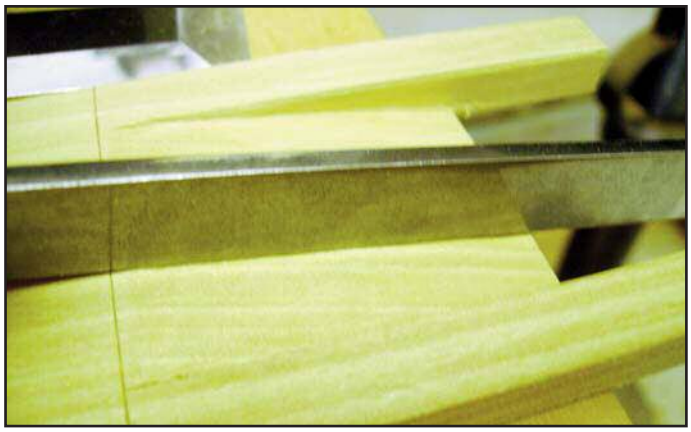


Figure 97. Chamfer is checked for flatness using the side of the chisel.

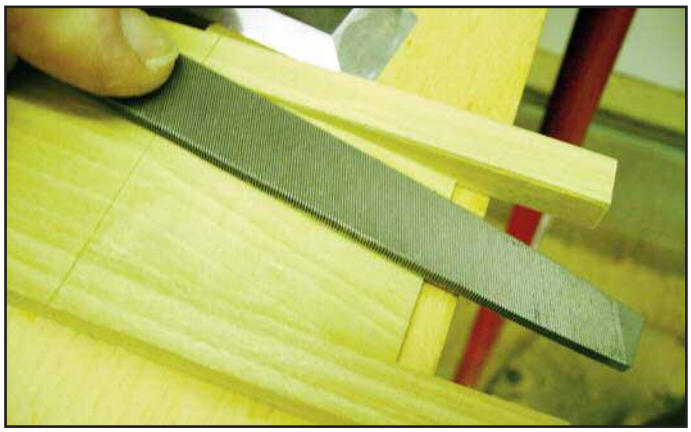


Figure 98. A file is used to smooth and flatten the chamfer.

Do not use sand paper on the chamfer during the forming process, this will take the edge off your chisels as the abrasive becomes embedded in the wood. **Figure 99** shows the inside of the front. Visible is the cut-up scribe, and the nearly finished upper lip. **Figure 100** shows the front finished, but the upper lip left with about a 1/32" flat. It will be finished later.

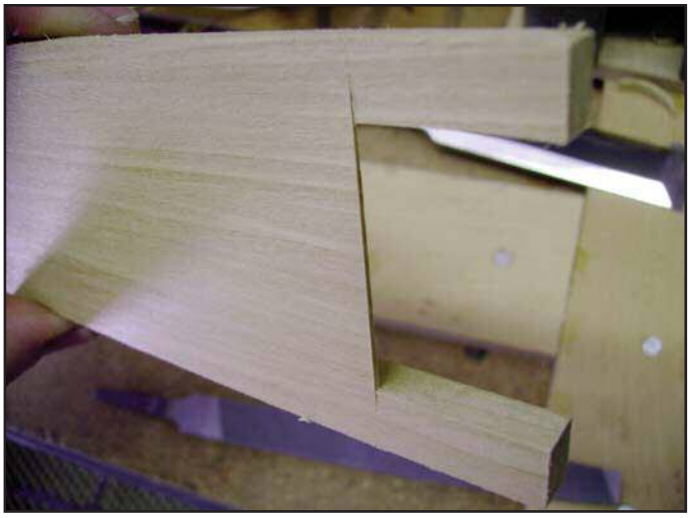


Figure 99. Inside of front, showing cut-up scribe mark.

Do not use sand paper on the chamfer during the forming process, this will take the edge off your chisels as the abrasive becomes embedded in the wood.

Figure 100. Nearly finished chamfer and cut-up on pipe front.

Part II to be continued
in issue #36.

David Wasson has been building and experimenting with pneumatic devices for automatic musical instruments for over thirty years. Much of his inspiration for band organ construction has come from fellow organ builders, especially the late Ken Smith of Ohio.

Traditional Band Organ Pipe Construction (Part II)

David Wasson

Part one of this article, almost finished up the front side of the pipes. There are a few things left to do before the front is glued to the side and back assembly. **Figure 1** shows the pipe fronts with the upper lip nearly completed, but not yet glued. The small flat left on the upper lip, should have a slight radius on the outside edge to meet the inside. The inside edged should have no burrs. This should all be done gently with a flat file.

Figure 1. Nearly finished pipe fronts lying on pipe bodies.

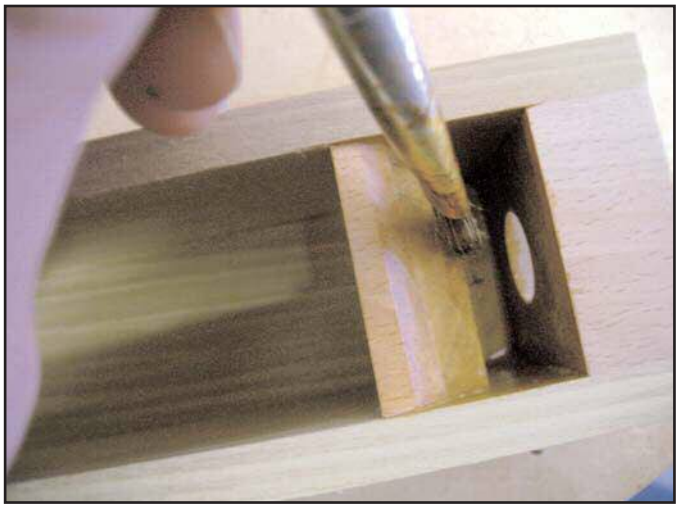


Figure 2. Shellac applied to block inside.

I like organ pipes to be shellacked and finished inside and out. In order to shellac the inside of the pipes, the back and side assembly can be shellackedbefore the front is glued to the sides. I also shellac the inside of the block as shown in **figure 2**. To shellac the inside of the front, I mark on the inside where it will be glued to the sides as shown in **figures 3 and 4**. Once the inside of the fronts are marked, it is just a matter of painting the shellac down the center of each pipe front as shown in **figure 5**.

One other thing I usually do before the front is glued is cut the windway. The windway is the small slot formed by the cap and the block. I have cut windways both with a milling machine, and by hand using a file. It is actually easier, and just as accurate, if cut by hand with a flat file. I have seen home built pipes that have their windways created by the gap formed by a piece of cardboard. While this does work, it creates a windway with flat sides. Windways are

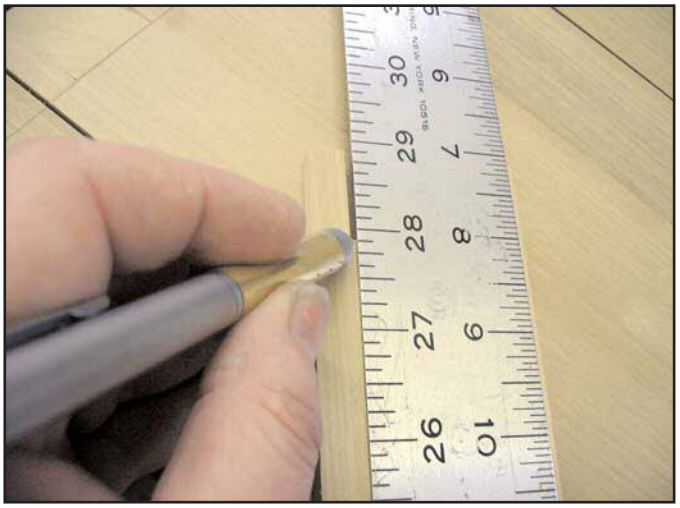


Figure 3. Laying out lines inside pipe fronts for shellac.

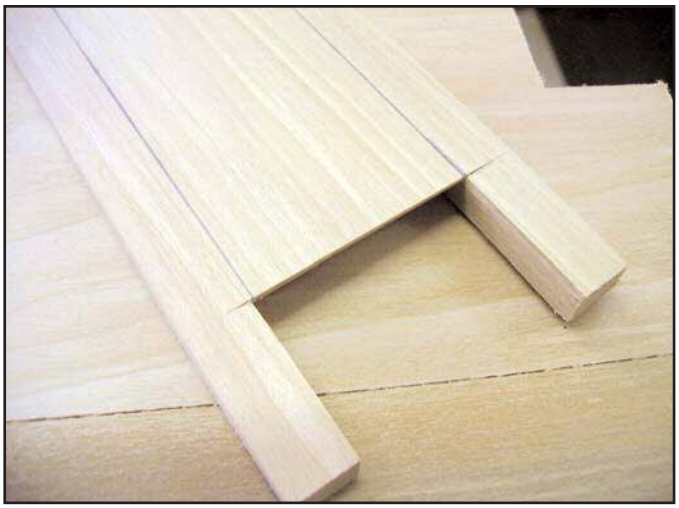


Figure 4. Completed shellac guide lines inside pipe front.

typically tapered from the point where the wind escapes. As wind flow is laminar, a flat windway does not allow for a full flow of air. It may be possible to compensate for this by making the windway deeper than necessary by using an extra thick piece of cardboard, but this type of windway may cause the pipe to sound breathy, or windy.

Figure 5. Shellac applied inside pipe front.

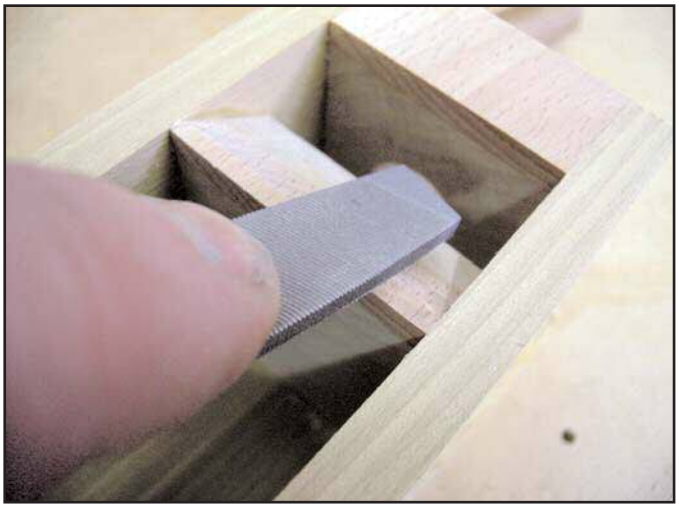


Figure 6. Creating windway with a flat file.

Figure 6 shows the windway being cut, or opened using a flat file. **Figure 7 and 8** show the windway before and after it has started to open. The width of the windway, in this instance, is the distance between the block and the pipe front. I use a straight edge across the pipe front to show this. In **figure 8** you can see the gap, or slot that is the windway. Windways are usually very specific widths. This is usually measured in thousandths of an inch. Over an entire rank, or set of pipes, the windway will vary in depth. Smaller pipes usually have small windway depths, and large pipes have proportionally larger windways. Since this set of twelve accompaniment pipes is so few in number, all of the windways will be set at .040".

Figure 7 (above) & (below). Windway, before and after.

Figure 9 shows a .040" gauge laid into the windway with a straight edge across the gauge. As the windway is cut to depth, I use the gauge frequently to check the progress. This work is not difficult, and is actually easier than it might seem.

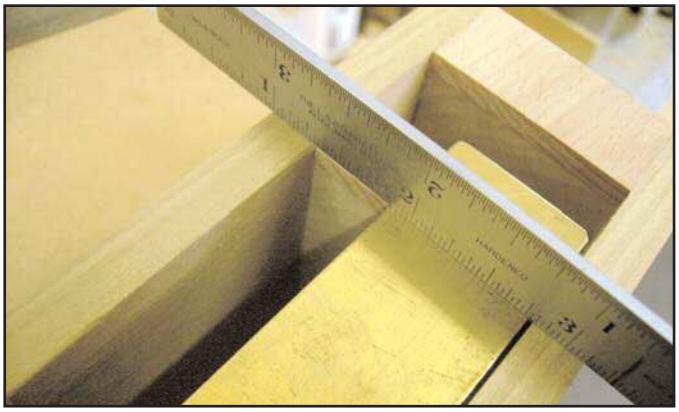


Figure 9. Gauge for checking windway depth.

Figure 10. Pipe front insides all shellacked.

Figure 10 shows the entire pipe fronts shellacked. **Figure 11** shows all of the side and back assemblies with the windways cut into the blocks. With these things finished, the fronts are ready to be glued to the sides.

Figure 11. Pipe back and sides all shellacked inside.

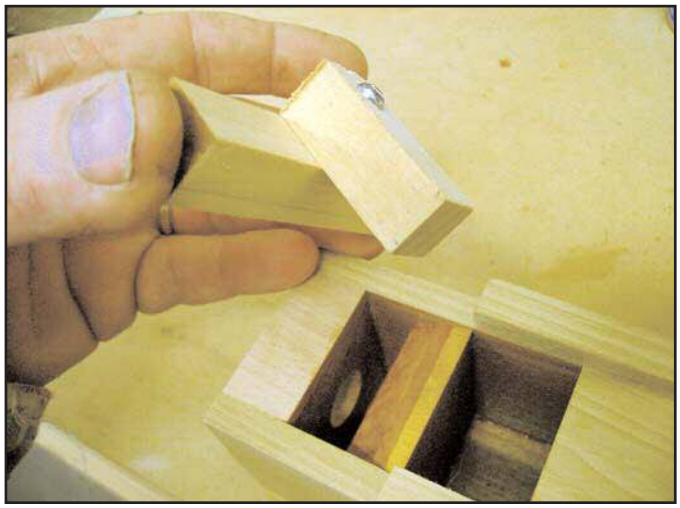


Figure 12. Jig to assist in placing pipe front.

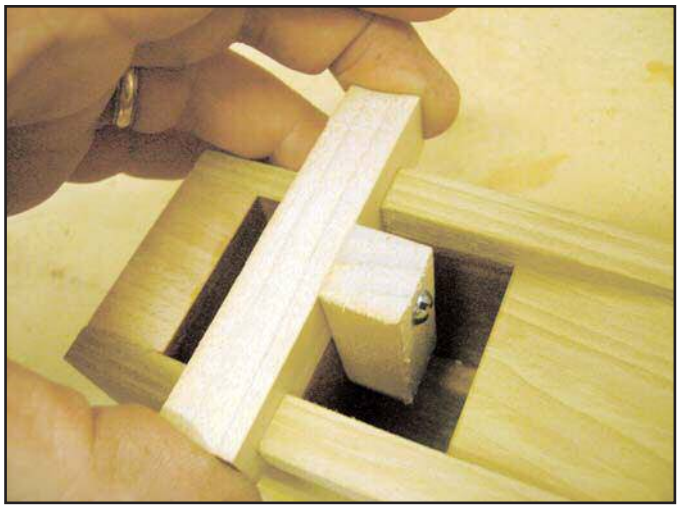
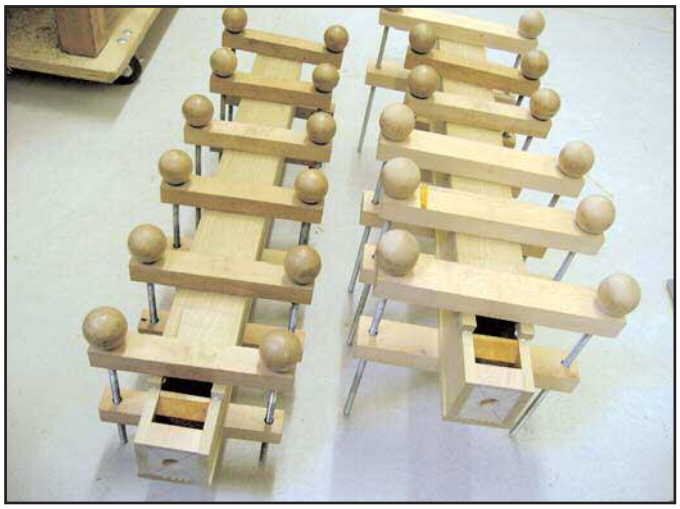


Figure 13. Jig and pipe front in place.

The front must be glued with the bottom of the front exactly even with the block. **Figure 12** shows a little jig I used to align the front with the top of the block. **Figure 13** shows the jig in place. As the sides were pinned to the spacer, the front is pinned as well, for alignment during the gluing process. **Figure 14** shows the front being drilled for the pin. The drilled hole goes into the front and into the spacer. **Figure 15** shows two pipes in the clamps with the front glued on.

Figure 14 (above). Drilling for pipe front pin.

Figure 15 (below). Two pipes with fronts glued and clamped.



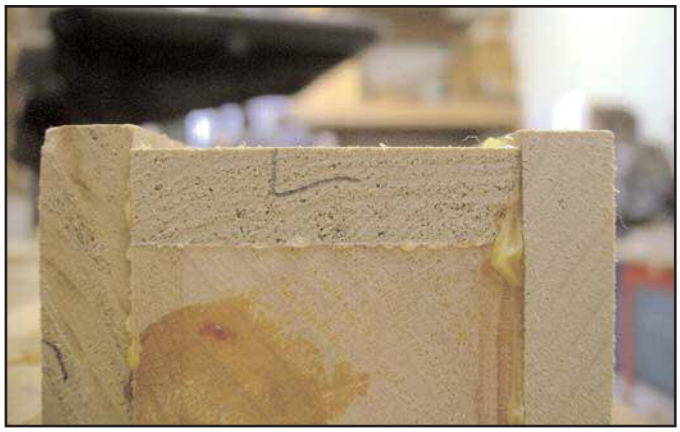


Figure 16. Pipe fronts and backs need to be trimmed even with the sides.

Now the sides of the pipe need to be trimmed to meet the sides. As can be seen in **Figure 16**, the front and back are slightly wider than the sides. I do the rough trimming with a hand plane as shown in **Figure 17**. The finish trimming of the front and back can be done on a jointer or an edge sander.

Figure 17. Rough trimming the front and back.

With the front and back to size, it is now possible to mark and scribe the splaying of the sides of the pipe front. The splaying for these pipes is laid out 1/16" from the outside bottom edge of the front of the pipe, as shown in **Figure 18**. The scribe

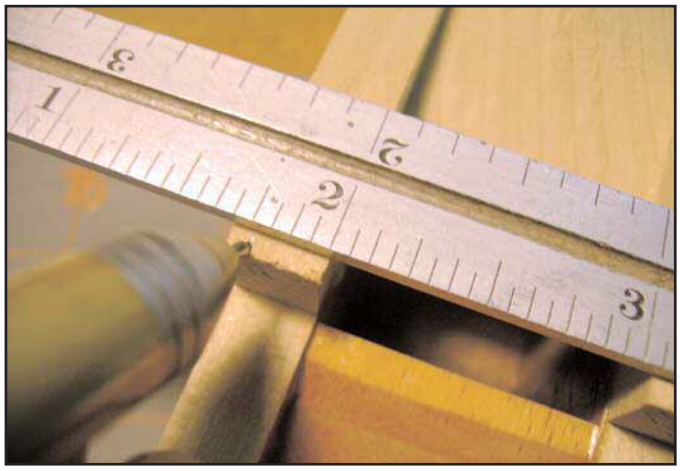


Figure 18. Marking for pipe front splay.

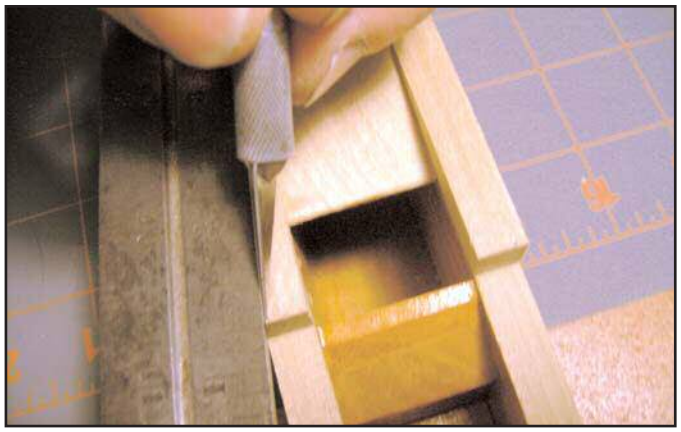
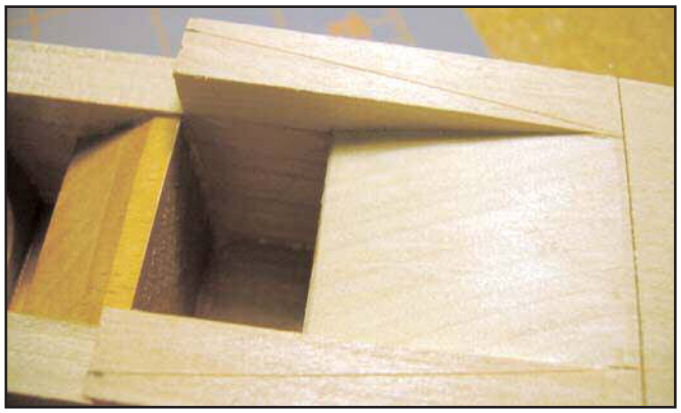


Figure 19 (above) & 20 (below). Scribing for splay.



mark for the splay continues up the side of the pipe at an angle, to intersect with the place where the champher meets the pipe front. This is shown in **Figures 19 & 20**. With the splay marked, it is opened up with a flat chisel shown in **Figures 21 & 22**. The splay is shown finished in **Figures 23 & 24**.

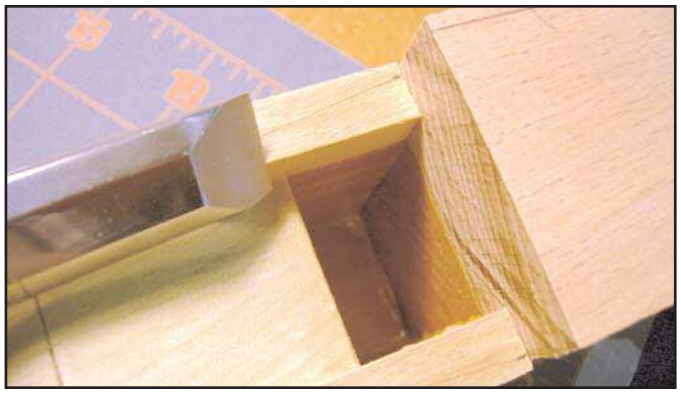
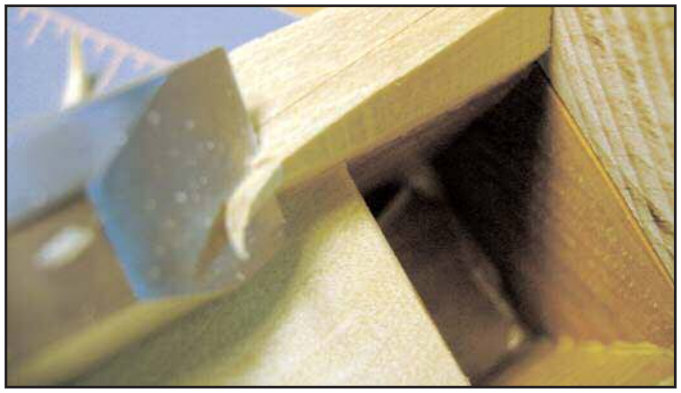


Figure 21 (above) & 22 (below). Flat chisel used to create front splay.



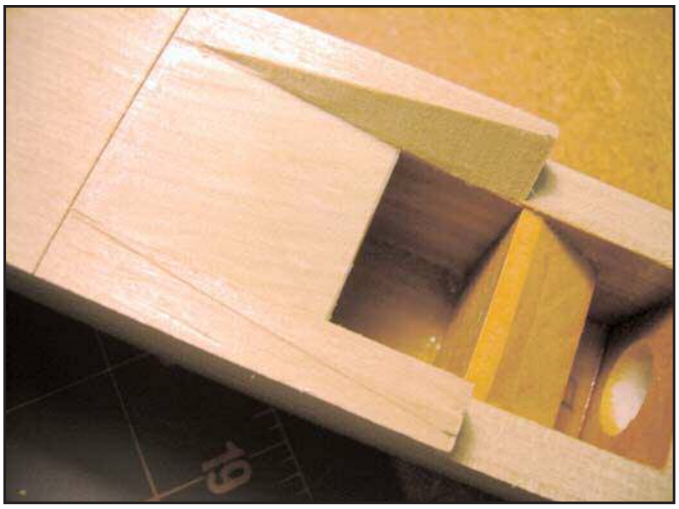
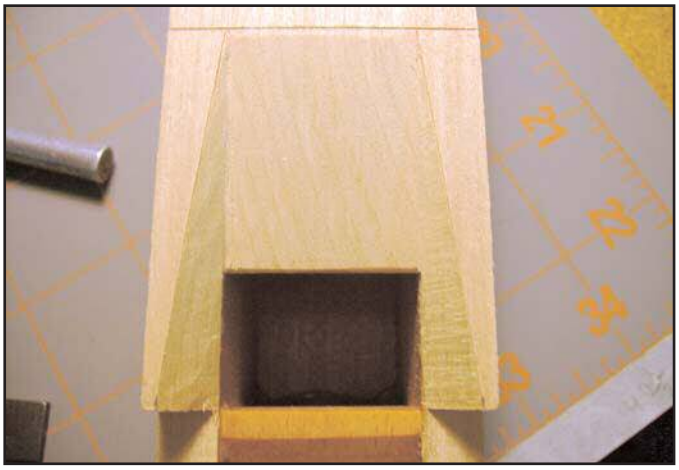


Figure 23 (above). One side with completed splay.

Figure 24 (below). Both sides completed.



With the splay finished, it is now time to remove material at the left and right side of the windway. This removal of material allows for less noise of the wind rubbing against the side of the pipe, and allows for a little more volume of sound from the pipe. This technique is often seen in European organs. The side material can be removed with a very sharp knife as shown in **Figure 25**. The finished result is shown in **Figure 26**, several pipes are shown **Figure 27.**.

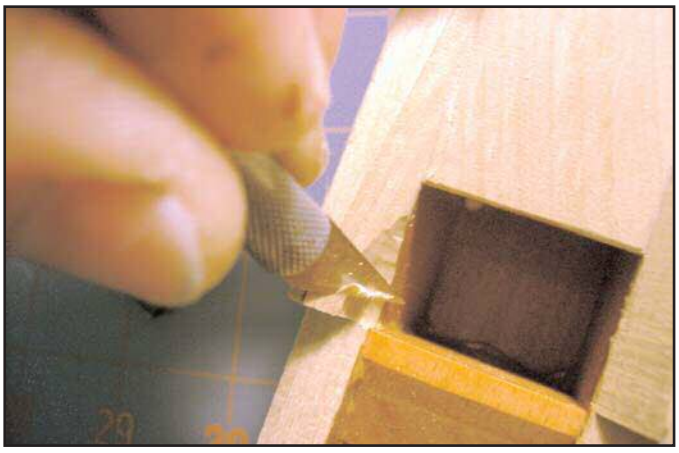


Figure 25. Removal of material around windway.

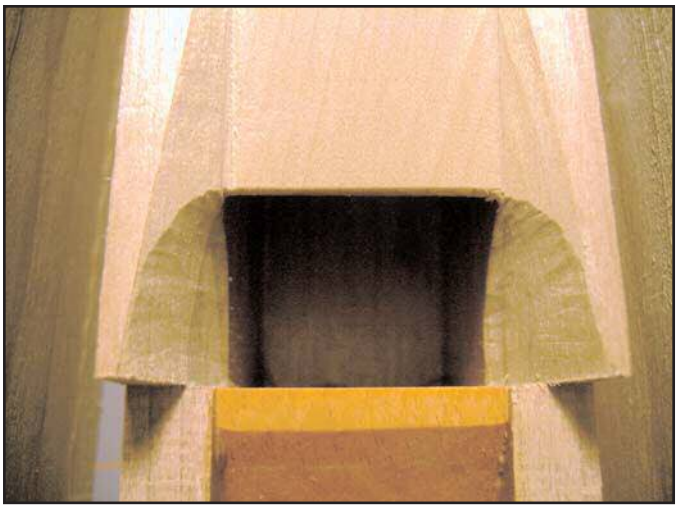
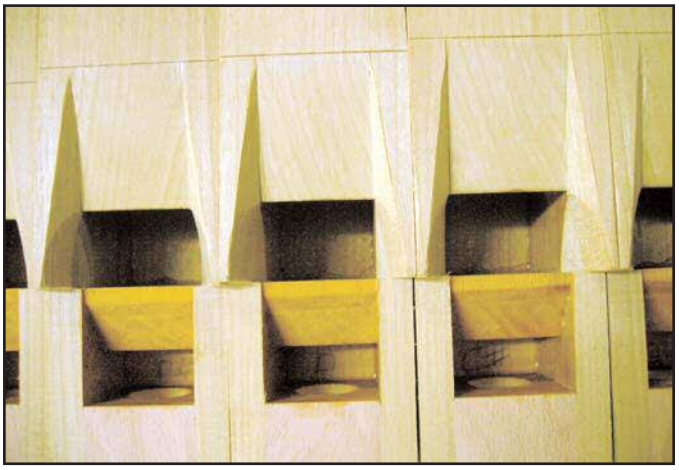


Figure 26 (above). Finished pipe mouth area.

Figure 27 (below). Several finished pipe fronts.



The cap can now be fabricated. To properly fit the cap to the block, remove any glue that may have squeezed out from the front as shown in **Figure 28**. Prepare cap material of proper thickness, and cut pieces of correct length and over size width as shown in **Figure 29**. Use the pipe body for a gauge to determine correct width of pipe cap plus about 1/16", this is

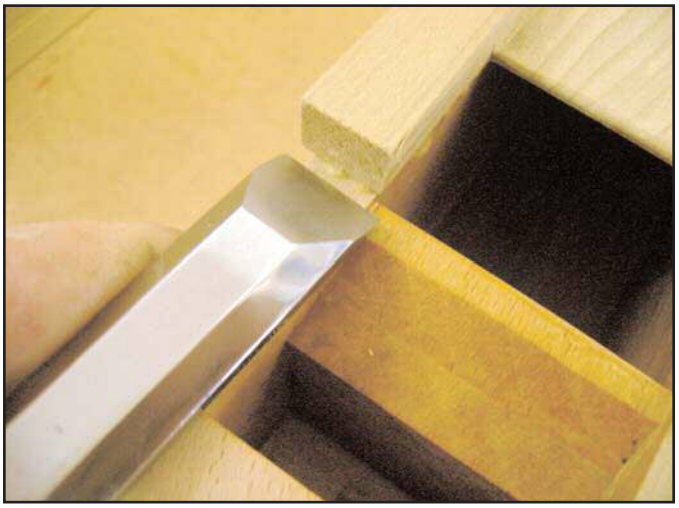


Figure 28. Removal of glue squeeze-out from pipe front.

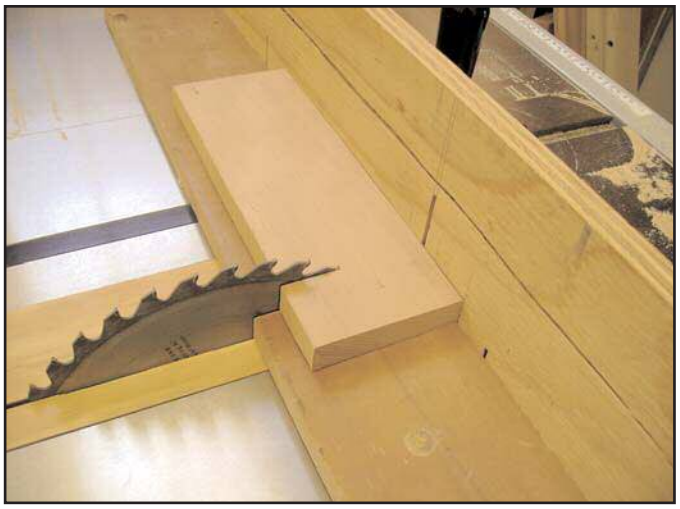


Figure 29. Preparing pipe caps.

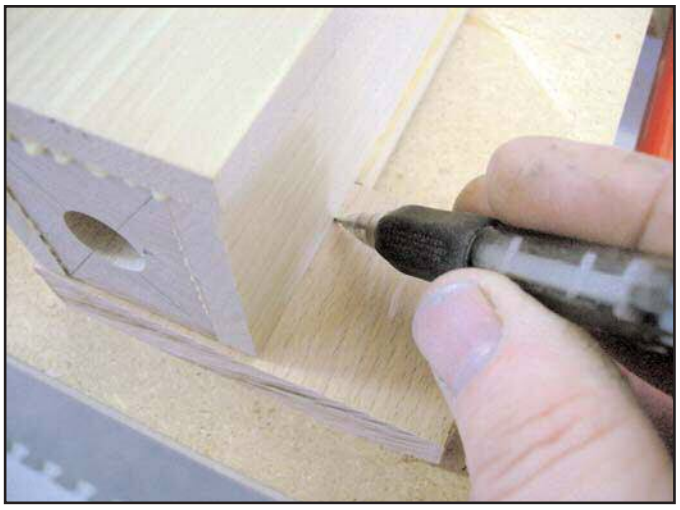


Figure 30. Marking pipe cap material for width.

shown in **Figure 30**. After the over size width caps are made, the inside surface can be labeled with the pipe note name, and then finished with shellac. **Figure 31** shows the inside surface of the caps. The area where the pipe side was removed should

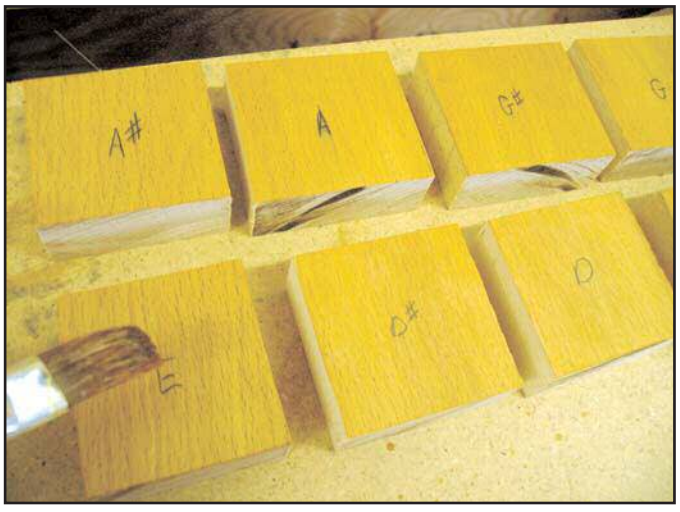


Figure 31. Inside of pipe caps with note names and shellac.

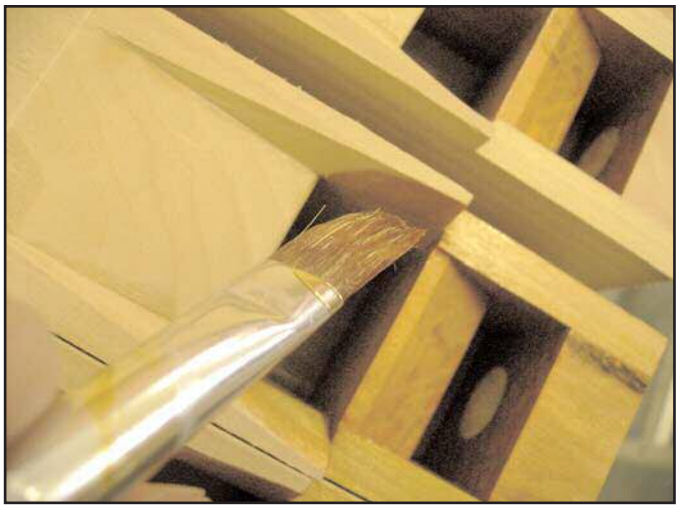


Figure 32. Shellacking area around windway.

be shellacked now. This is shown in **Figure 32**. The outside of the caps can now have the beveled edge cut, and the front and top side shellacked. The front edge of the sides, and front of the block should be shellacked where the cap will be glued. Traditionally, pipe caps are glued on with hot glue. If the windway in a pipe ever needs to be adjusted, this is very difficult to do with a hot glue bond. Of course the cap can be screwed to the pipe, but this is usually never done on small pipes. With this in mind, I glue the caps to the block and pipe with PVC-E glue. The glue is plenty strong to hold a pipe cap on, yet is weak enough to make removal of the cap very easy should adjustment of the windway be necessary. If both the inside of the cap and the front of the block and pipe are shellacked, there should be no worry about the PVC-E glue penetrating raw wood. It does not take much glue to bond the cap to the pipe; the bead of glue is shown in **Figure 33**. The cap can be help in place with masking tape until the glue is set as shown in **Figure 34**. After the glue is set, the cap can be sanded to meet the sides of the pipe. The bottom of the pipe can now be sanded to bring the cap, sides, and block to the same exact length. This is shown on **Figures 35 & 36**.

Figure 33. Gluing for pipe cap.

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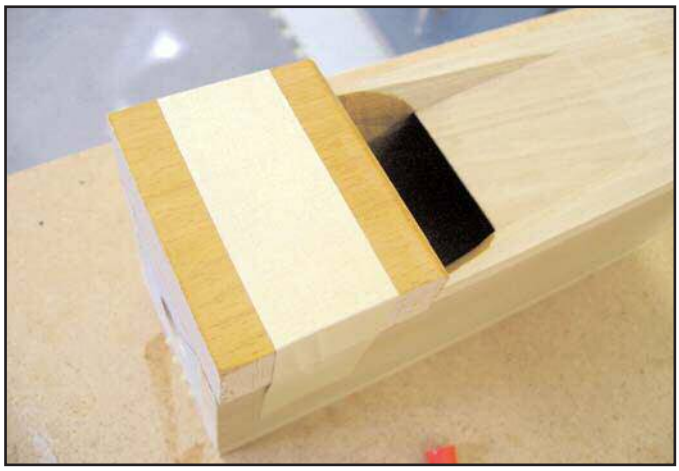


Figure 34. Clamp for pipe cap while glue sets.

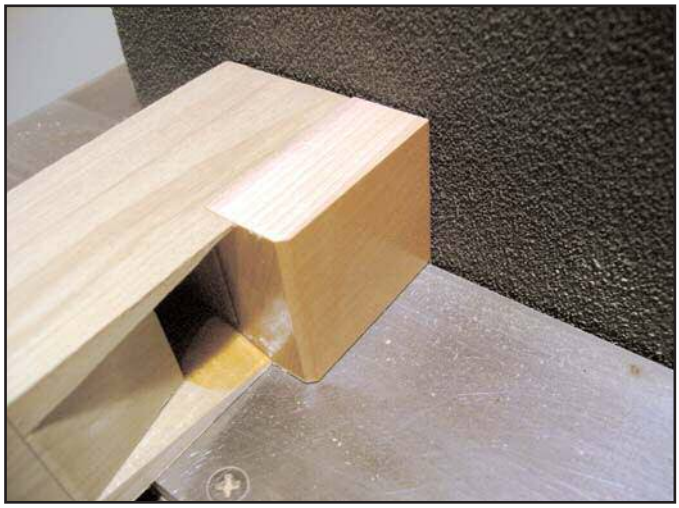


Figure 35. Squaring up pipe bottom.

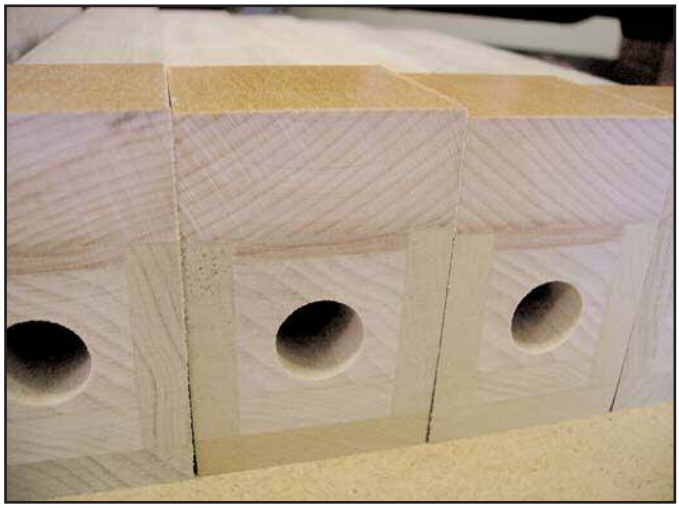


Figure 36 Finished pipe bottoms..

The toes can now be made. I make pipe toes slightly longer than traditional toes. This allows for a more secure pipe. Allowance must be made for this extra length by a thicker toe board. I make pipe toes on a metal lathe. The taper of the toe is exactly three degrees on a side. This makes for a secure fit into the toe board, and allows for easy removal of the pipe. The top slide, or compound of the lathe is set to three degrees, **Figure 37**.

Figure 37. Compound slide of lathe is set to three degrees.

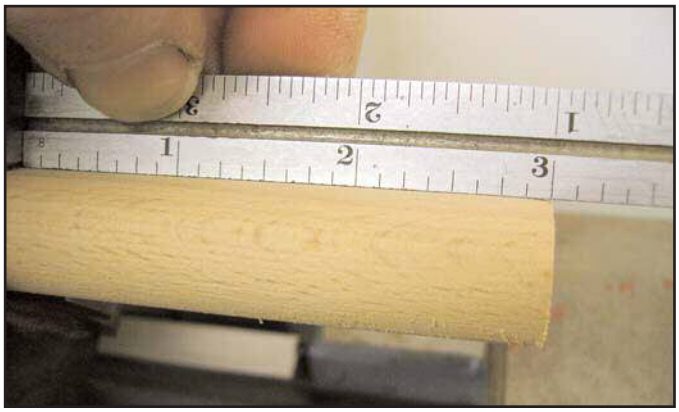


Figure 38. Stock is measured from lathe chuck front.

The material the toes are made from, is chucked so that each time a toe is made, it protrudes from the lathe chuck exactly the same amount, **Figure 38**. This allows the saddle of the lathe to be locked in position, and all part will be made the same with a minimum of effort. The hole in the toe is bored first, **Figure 39**.

Figure 39. Toe hole is drilled.

Figure 40. Taper of toe is machined.

The taper is cut next, **Figure 40**. In order for the taper of each toe to be the same, I use a gauge with the same taper as the toe, **Figures 41 & 42**.

Figures 41 (above) & 42 (below). Gauge for checking taper of toe.

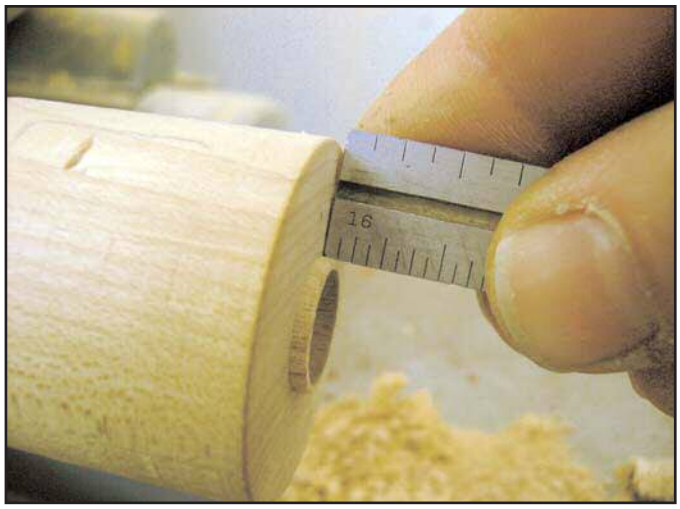
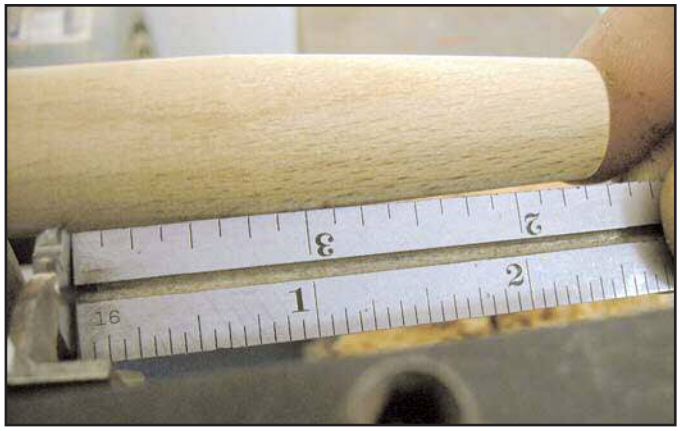


Figure 43. Proper fit of gauge.

The taper is complete when the toe protrudes from the gauge 1/16", **Figure 43**. When the correct size is reached, I zero the cross feed hand wheel, **Figure 44**, and make all the toes to this dimension.

Figures 44. Hand wheel is zeroed so all toes are machined the same.



Figures 45. Parting tool is set at the correct distance from the toe end.

With the taper finished, I mark on the toe the finished length, **Figure 45**. The piece is parted from the stock, **Figure 46**. **Figure 47** shows the nearly finished toes with my sample toe in the front.

Figure 46. Toe is parted from stock.

Figure 47. Tapers on all toes are completed. Sample toe is in front.

Now the shoulder on each toe can be machined. When all of the pipes are planted in the toe board, the bottom of each pipe should be exactly the same distance from the toe board. One way to do this, is to mark on each toe exactly where the shoulder should be on the finished toe. I mark each toe on the inside with its note name, and place each toe into the final position in the toe board, **Figure 48**. In this case, I want all of the pipes to be 1/4" above the toe board. Using a 1/4" gauge, each toe is marked appropriately, **Figure 49**.

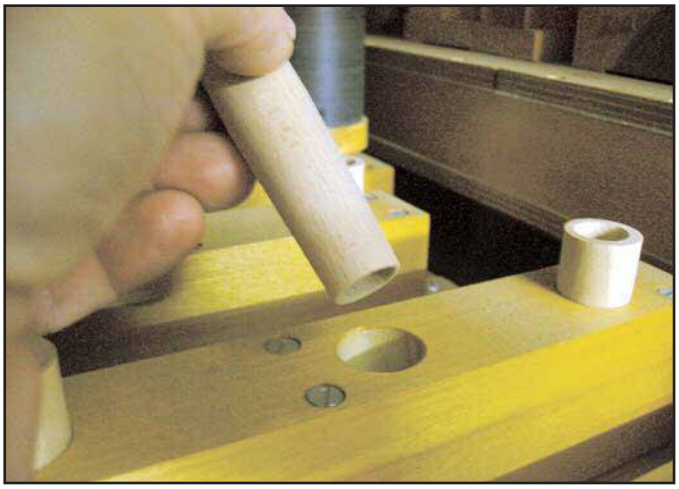


Figure 48. Toes are placed into toe board.

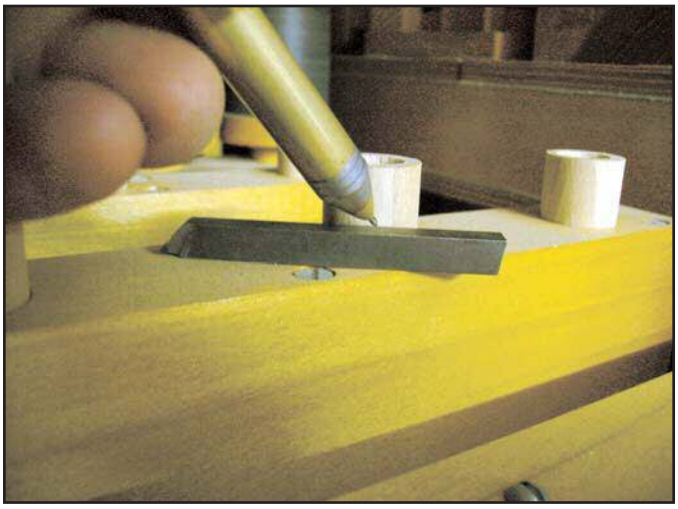


Figure 49. Shoulder is marked on each toe.

The toes are returned to the lathe to have the shoulder machined. Using the taper gauge as a chuck, the shoulder is machined on each toe, up to the previously made mark, **Figures 50 & 51**.

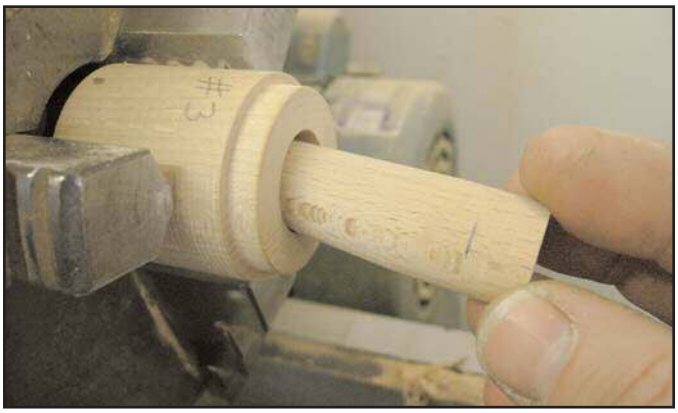
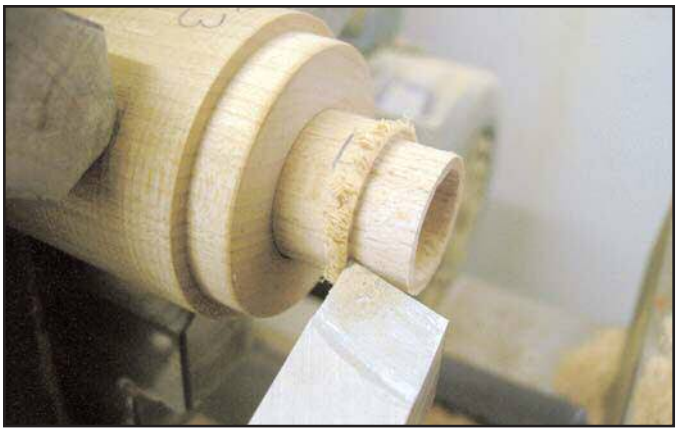


Figure 50 (above). Each toe is returned to the lathe.

Figure 51 (below). Shoulder is machined.



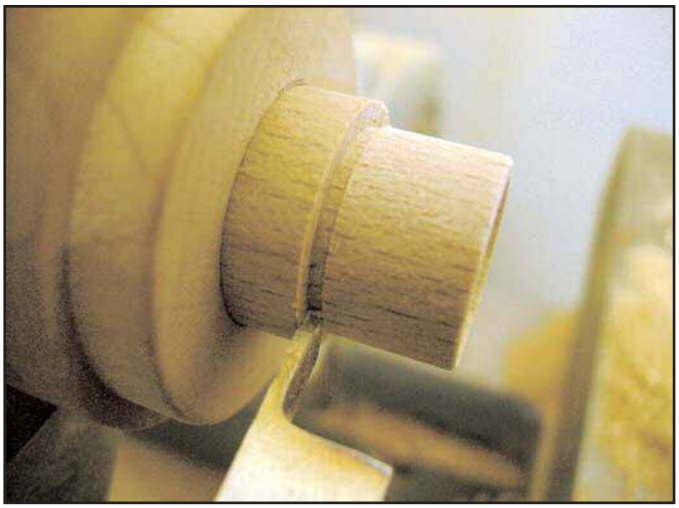


Figure 52. Relief is cut at shoulder bottom.

At the end of each shoulder, I make a small relief to ensure the toe can be driven completely home into the bottom of the pipe, **Figure 52**. **Figure 53** shows the shoulders finished on all of the toes. The toes should be a good tight fit into the bottom of the pipe, but not so tight that all of the glue is wiped out as the toe is fitted, **Figure 54**.

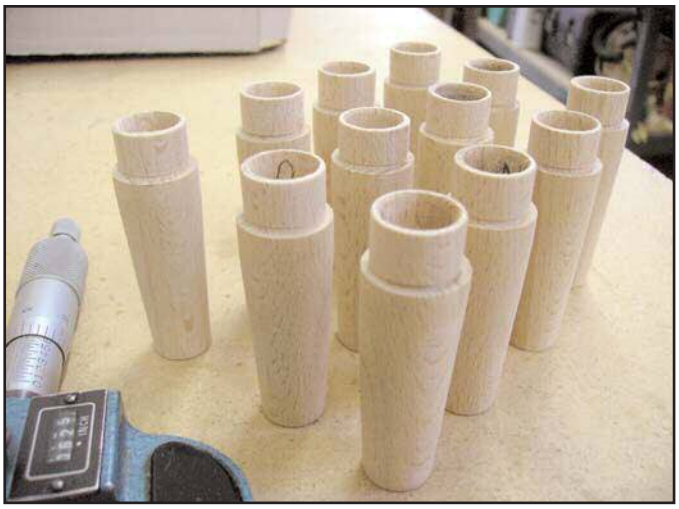
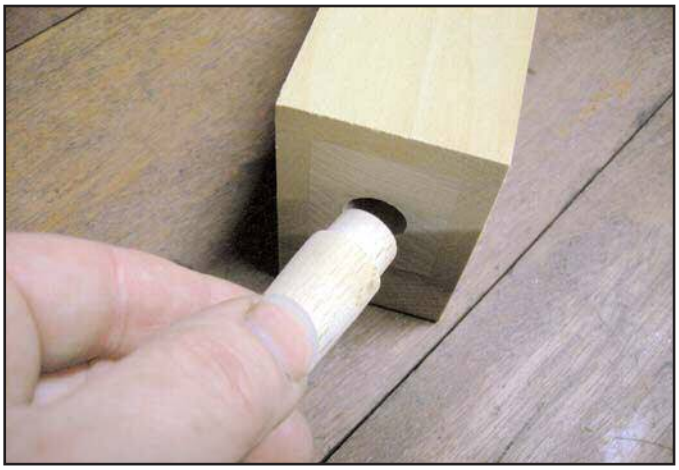


Figure 53 (above). All toes are finished.

Figure 54 (below). Toes are glued into pipe.



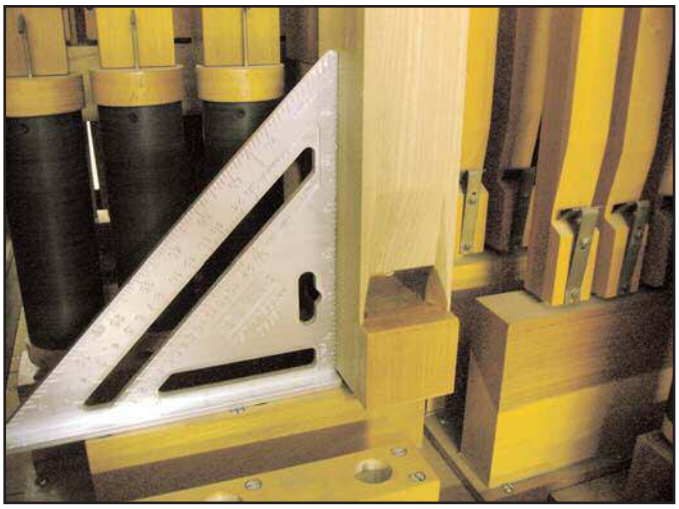


Figure 55 (above). Pipe body is checked for squareness with toe board and chest top.

Figure 56 (below). All pipe bottoms should form a straight line.

As each toe is glued in to the bottom of the pipe, place each pipe into its position, and make sure it is square with the toe board and chest top, **Figure 55**. **Figure 56** shows six of the twelve pipes in position. The bottoms of all the pipes are 1/4" above the toe board.

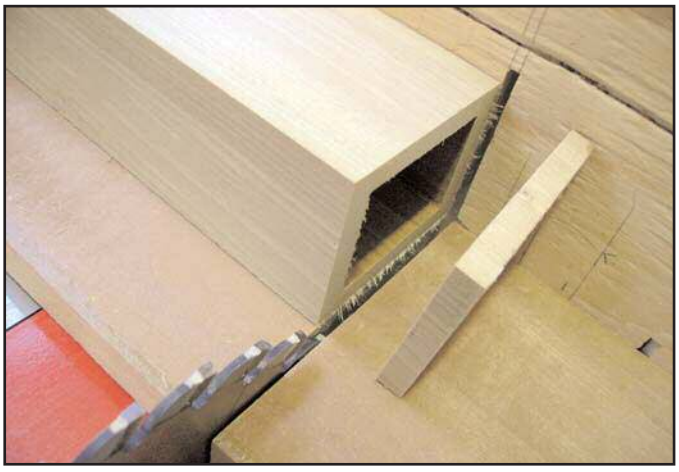


Figure 57. Pipe spacer is cut off.

The last part to fabricate is the stopper. Good fitting stoppers are not difficult to make. I once saw an organ that had stoppers fabricated from two pieces of thin wood connected in the center with a machine screw. When the machine screw was tightened, a piece of modeling clay between the two thin pieces of wood squeezed out towards the pipe sides to make a seal. This would work in the short run, but with the same amount of effort, a wood and leather stopper can be made that will last for the long run.

First the pipe must be trimmed so that the spacer is cut away, **Figure 57**. Now you can gauge the width and depth of the stopper. For stopper material, I use bass plywood, in this case about one inch thick. Baltic birch plywood would work for this as well. Plywood is used because it is dimensionally stable, and will resist the possibility of breaking when the handle is wedged in position. If Baltic birch is used, several pieces will have to be glued to make a thick enough stopper. A thin stopper may tend to tip during tuning manipulation and not seal well.

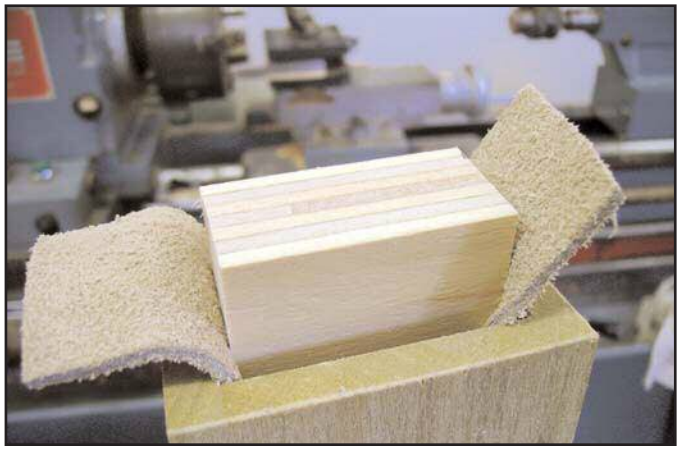


Figure 58. Test fitting stopper with leather strip.

Figure 58 shows the stopper material being test fitted to the pipe. Strips of stopper leather can be placed across the end of the pipe, and the stopper tested for fit. Only one direction at a time is tested for fit. With the stopper material on edge, test the fit for width, and then depth, Figure 58. Once you are satisfied with the fit, the center is marked for the stopper handle, **Figure 59**.

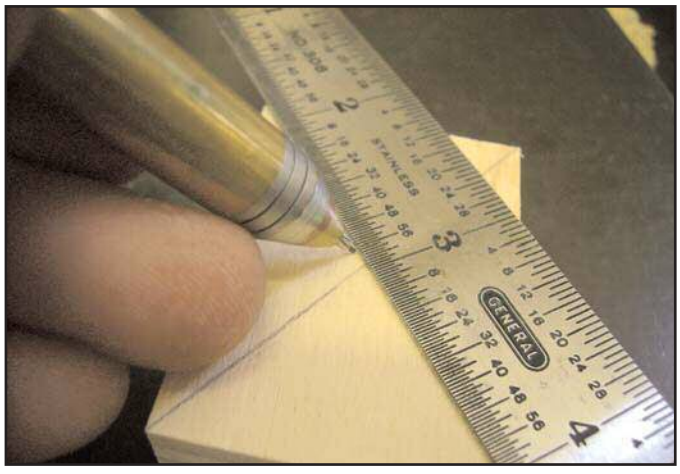
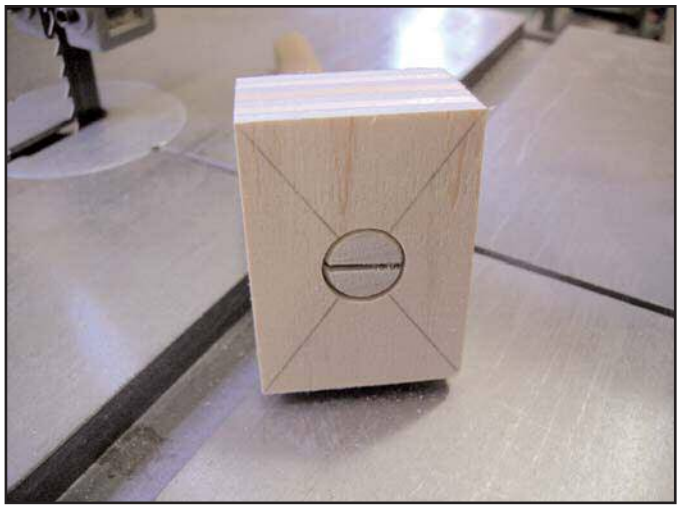


Figure 59. Marking center of stopper.

Figure 60 (above). Handle is split for wedge.

Figure 61 (below). Handle is driven into stopper.



For these pipes, 1/2" dowel is secure enough for a handle. The dowel is split, **Figure 60**, and placed into the through hole in the stopper, **Figure 61**.

Figure 62. Handle wedge is created.

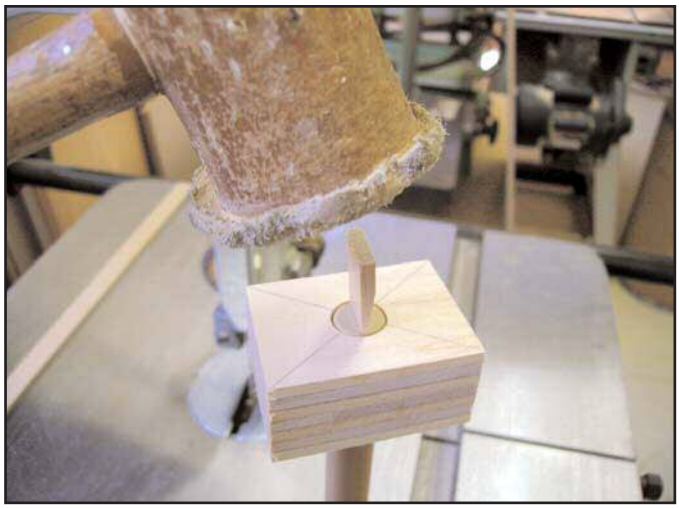
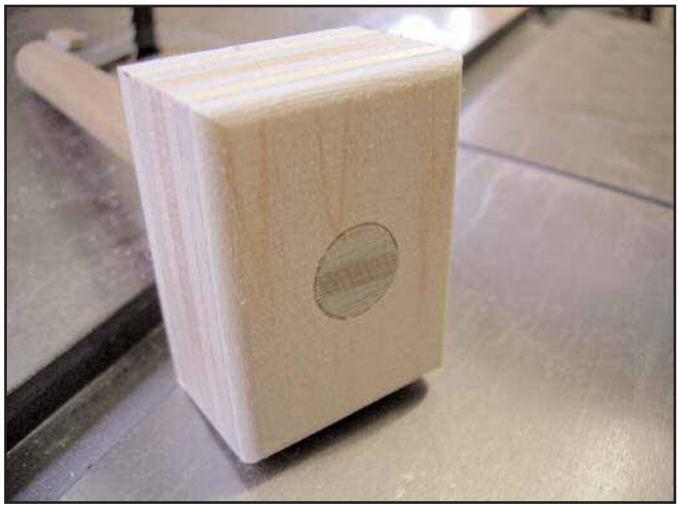


Figure 63 (above). Wedge is driven into stopper handle.

Figure 64 (below). Bottom corners of stopper are radiused.



A hardwood wedge is fabricated on a disk sander, **Figure 62**. The wedge is cut from the stock and driven into the stopper, **Figure 63**. This joint can be glued, but is not necessary with a tight fit. The stopper has a radius on the bottom corners, and the wedge is sanded flat, **Figure 64**.

Figure 65. Leather for pipe stopper.

The stopper is ready to be leathered. Large stoppers can have a strip glued to the bottom of the stopper wide enough so that the leather extends up the side of the stopper. For small stoppers such as these, a piece of leather is fabricated that attaches to the bottom, and extends up the sides. Create a rectangle of appropriate size such that the leather can extend up the side of the stopper and beyond about 1/8", **Figure 65**.

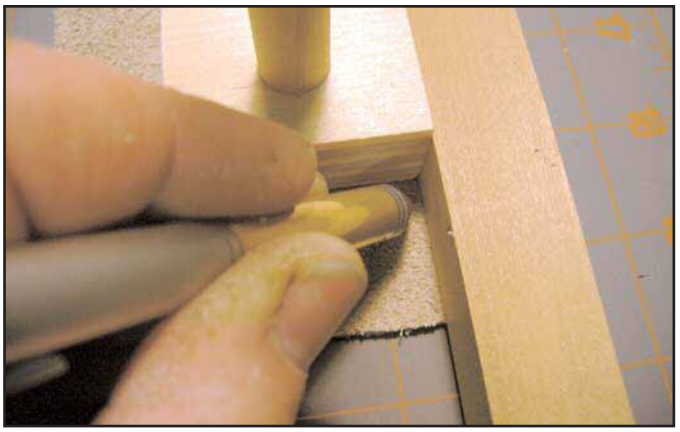
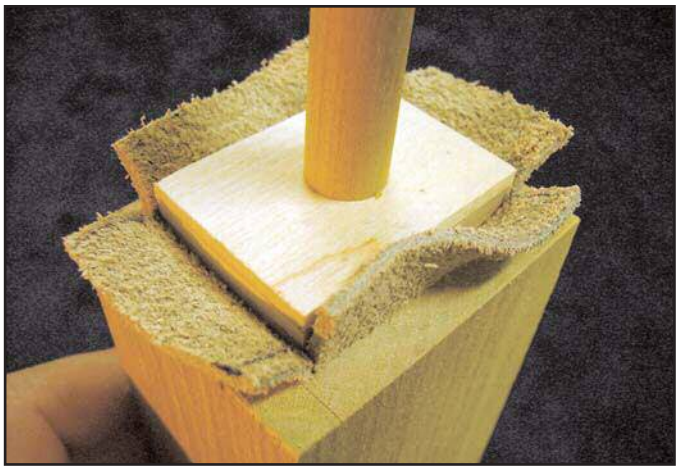
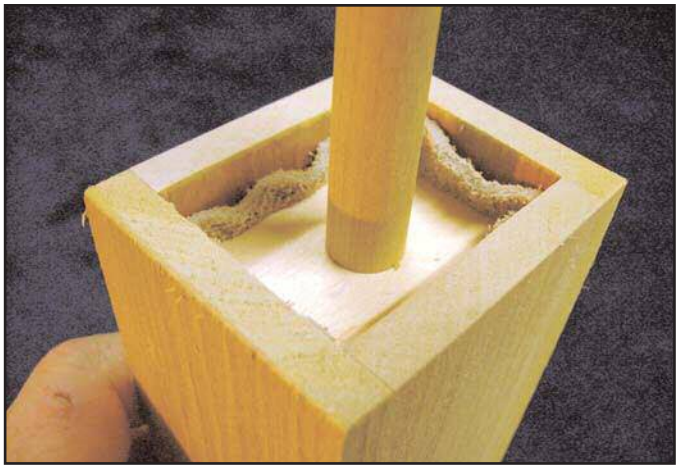


Figure 66 (above) and 67 (below). Lines are created from stopper sides.

Draw a line extending from each side of the stopper to the edge of the leather, **Figures 66 & 67**. Cut the corners of the leather such that there is extra material in each corner about the thickness of the leather, **Figure 68**. The stopper can now be fitted to the pipe.

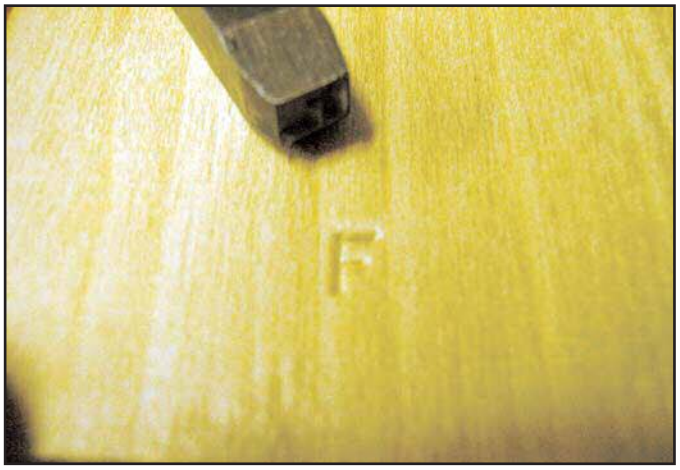
Figure 68. Leather is cut slightly larger than where lines are located.





Figures 69 (above) & 70 (below). Stopper is fit to pipe.

You should end up with a little extra leather in the corners of the stopper to ensure a good seal, **Figures 69 & 70**. The leather on the side of the stopper is left unglued. Sometimes stoppers loosen over time; thin pieces of leather can be placed between the stopper leather and the stopper in this unglued area.



Figures Figure 71. Note name is stamped on pipe back.

Figures 72. Pipes in place.

The note name can now be stamped or written on the back side of each pipe, **Figure 71**. Note names on pipes should be discreet so as not to detract from the pipe appearance. The pipes can be now tuned, and the pipe lengths and stopper handles trimmed to appropriate lengths. The last thing to do is to finish the outside of the pipes. I have used orange shellac for this. To finish the top of the stopper and the handle, it must be removed. The center of **Figure 72** shows six of the twelve accompaniments in place. **Figure 73** shows a side view of the same pipes, but with the other accompaniment pipes in position as well.

Figure 73. New pipes in place amongst the other accompaniment pipes.

David Wasson has been building and experimenting with pneumatic devices for automatic musical instruments for over thirty years. Much of his inspiration for band organ construction has come from fellow organ builders, especially Ken Smith of Ohio.