Building a Wurlitzer 105 Band Organ

Howard Wyman

Why did I build a band organ? Well, the simple answer would be that I had a desire to own one and buying one can be an expensive proposition. But more important for me was the idea of creating a band organ from basic materials and the sense of accomplishment that would bring. I had restored a number of player pianos and a player reed organ but this project would be different in that I would be starting from "scratch". Actually I had something smaller in mind. For several years I had considered building a street organ or monkey organ but could not find suitable plans. Then about three years ago I learned that plans were available for a replica of a Wurlitzer 105 band organ. I obtained a set of the plans and after studying them for a few days I said, "I can do that." There were a couple of items such as the crankshaft and roll frame that were probably beyond my metalworking abilities but it was my understanding that there were some individuals out there that could provide those items!

Starting the project it seemed to me that the most critical items would be the pipes. It would be extremely frustrating to build the case, bellows, etc. first and then find out that one could not build a pipe that worked. So based on that I decided to build a few smaller pipes just to see if I could. I started with one of the smaller stopped flutes from the melody section. In **Figure 1** these would be the small pipes at the right. The large pipe to the left is approximately four feet long, which will give you some idea of the size of the other pipes. After assembling the pipe I tested it by blowing with my mouth, not really the way to test pipes but I will have more to say about that later. To my amazement it actually made a sound, and a pleasant sound at that. This was encouraging. I put together five more pipes in that section. I was able to tune them to the proper pitch using an electronic guitar tuner as a guide. However, the only source of wind I had was my own breath and that is not a controllable or constant pressure. Organ pipes are voiced and tuned to operate at a specific air pressure. If the pressure is increased the pitch will also rise. If the pressure is decreased the pitch of the note will drop. If I were to continue it would be necessary to have some sort of test box to provide a constant source of air pressure and a valve for turning it on and off. I should mention at this point that after successfully constructing a few small pipes I decided to try something larger and ended up building the largest pipe in the organ, the four foot bass G pipe at the left in the picture below.

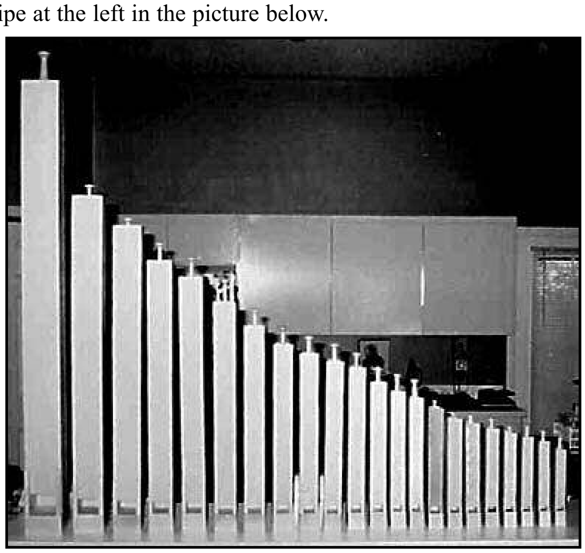


Figure 1. The 22 flue pipes which will later be installed beneath the floor of the organ.

Windchest

I considered building a test box for voicing and tuning each pipe as I constructed them, but opted instead to go ahead with the wind chest. The pipe feet sit in the wind chest and inside the chest there is a valve for each note, therefore it could be used for testing without having to build a separate test fixture. For an air supply I purchased a blower box from the Player Piano Company in Wichita, Kansas. The blower box has a motor speed control so that it can be adjusted to provide the correct amount of pressure, in this case 8 inches of water. In pounds per square inch this would be less than one psi. An organ does not require a very high pressure but does need a fair volume of air.

Figure 2. The windchest before adding risers for the pipes.

Parts of the organ that need to be airtight, such as the wind chest, are usually made of a dense, low porosity wood. Maple is an excellent choice for this application. In addition it is a strong wood not prone to splitting. **Figure 2** shows the beginnings of the chest. If you look closely you can see holes drilled in the top of the chest for the various pipes. In reality the pipe feet do not fit directly into these holes. In **Figure 3** one can see that the tapered pipe feet actually fit into tapered holes in a board which sits above the openings in the chest. Sandwiched in

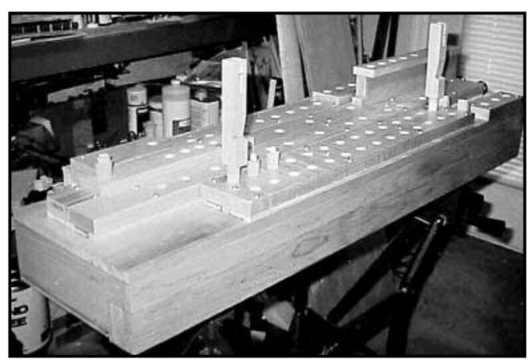


Figure 3. The windchest now with risers in place for the pipes.

between is a slider with matching holes. This slider can be moved lengthwise so the holes do not line up and thus cut off the air to that set of pipes. **Figure 4** shows the underside of the wind chest at this point in its construction. It is divided into channels, one for each of the 41 notes.

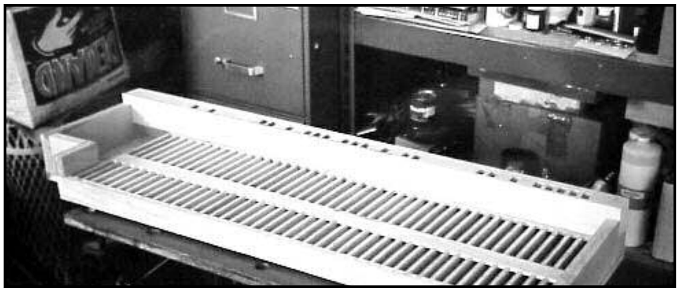


Figure 4. The windchest as seen from the bottom (before the pallet valves are installed).

These channels line up with the openings for the pipes in the top of the chest. At the far side can be seen openings through which air flows from a channel, through a connecting duct down to one of the pipes which are mounted in the lower part of the organ. The wooden strip across the channels provides a place to attach the hinges of the pallet valves, one for each channel. **Figure 5** shows the pallet valves with their leather hinges glued into place. The remaining open area of the channels is covered with an airtight cloth normally used to cover small bellows. This can be seen as the red area behind the pallet valves. In the next section I will go into a little more detail about the pallet valves.

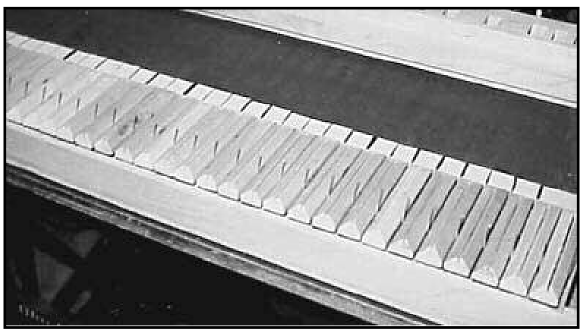


Figure 5. The pallet valves installed in the wind chest.

The pallet valves are the valves which open to allow the air to flow to a certain pipe or pipes. The lower part of the windchest receives the pressurized air from the bellows. The upper part of the windchest is divided into 41 channels, one for each note. In between there is a pallet valve for each channel. When a valve is opened by the player mechanism it allows the air from the lower part of the chest to flow into that particular channel and to the pipe or pipes that are connected to that channel. Each pallet valve must make an airtight seal when it is closed and that is accomplished by facing each valve with a suede-surfaced leather backed with felt. The most efficient way of doing this is to cut a strip of felt whose width is equal to the length of the wooden pallet valve and whose length is slightly greater than the sum of the widths of all of the valves. Then cut a piece of leather the same length but about 3/4-inch wider. Glue the two together with one of the long edges aligned. Then, with the felt side up, glue the wooden valves side by side onto the felt. After the glue has set, you can run a single edge razor blade between the valves and cut them apart. The extra leather tail at the end of each valve serves as the hinge. **Figure 6** shows the leather hinges glued in place. In this photograph you can also see the springs that hold the valves in the closed position as well as the guide pins which keep the valves from moving sideways. The springs are made of piano wire.

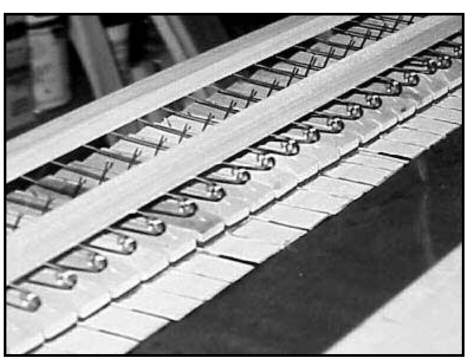


Figure 6. Pallet valves with return springs installed.

The Wurlitzer 105 Band Organ plays the Wurlitzer Style 125 roll which will play 41 notes plus snare drum and bass drum. The 41 notes include 14 melody, 13 counter melody, 9 accompaniment, and 5 bass. One note may sound several pipes and so the organ has 97 pipes. For example, in the melody section there are four ranks of pipes, melody flutes, violins, piccolos, and flageolets. To illustrate, let us say we open the valve for the melody note of C. Four pipes will sound simultaneously, all tuned to C but each with a different timbre or sound quality. In the accompaniment section each note will play two pipes, a flute pipe and a cello pipe. In the bass each note plays two pipes, a bourdon and a cello pipe. The counter melody has only one pipe per note, a trumpet pipe.

Figure 3 shows the windchest in the upright position. In this photograph one can see the openings for the pipe feet. Also it may be seen that some of the pipes fit on risers above the chest. Each pipe foot is tapered and fits into a tapered hole. This provides an airtight fit. I used a small lathe to make the tapered feet, but I was not certain how to go about making the tapered holes. Here is the solution I finally came up with. On the lathe I turned a tapered piece similar to a pipe foot but with a sort of shaft at the large end which I could lock into the chuck on the drill press. I then cut a piece of sandpaper which I glued around the taper. The most difficult part was figuring out the curved shape which would wrap around the taper. Then I drilled each of the holes for a pipe foot with a straight drill but made it slightly undersized. Then I used the taper with the sandpaper to shape it to the correct size. I am certain others can think of a better method, but it worked for me.

Flageolet Pipes

At the beginning of this project I built a few flute pipes primarily to see if I had the ability to build a pipe that would make a proper sound. My reasoning was that if I couldn't build a decent sounding pipe then there was no point in proceeding with the rest of the project. After building about five stopped flutes, I went on to the construction of the wind chest as I have described earlier. With that done, it was time to return to the making of pipes.

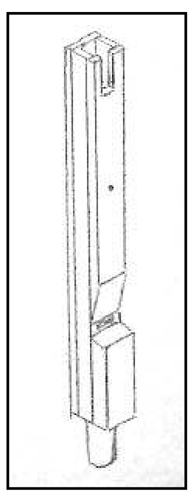
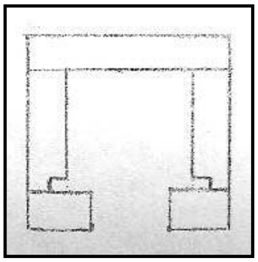


Figure 7. A drawing of a flageolet pipe.

I decided to build the set of 14 melody flageolets next. As it turns out this may not have been the wisest choice since I had more problems with this set of pipes that I did with any of the others. **Figure 7** is a sketch of a typical flageolet. It is of similar construction to an open flute with the addition of a nodal hole at about the midpoint of its length. The frequency at which a pipe sounds is determined by its length. The effect of the nodal hole is to cause the pipe to sound an octave higher than it would for that length but without the hole. The slot at the top of the pipe is for tuning. A brass plate in this slot is moved up or down to tune the pipe to the desired frequency by effectively changing the apparent length of the pipe. At first I was uncertain how this plate should be configured so that it could be adjusted. The method I finally used was to employ a small router to cut a rabbet in the front edge of the pipe sides before gluing on the front. The depth of this



rabbet should be the same as the thickness of the brass plate. **Figure 8** is a drawing looking down at the top of the pipe. It can be seen that after the front of the pipe is attached a groove is formed on each side of the pipe for the brass plate to slide into.

Figure 8. A drawing of the top of the pipe showing the groove for the tuning slide.

The first step in building a pipe of this type is to cut a piece of maple with the dimensions of the inside width and depth of the pipe. This will be used for the block. It should be long enough to make the block plus one or two pieces to be used as spacers when gluing the pipe together. The spacers will insure that the inside dimensions are consistent throughout the length of the pipe. After the glue sets they will be removed. Next the sides of the pipe are glued to the block. I made the sidepieces a little bit wide and when I glued them on I made certain they were flush with the front edge of the block. After the glue set I planed the excess from the rear edge of each side until it was also flush with the block. Next the back was glued on. I also made this piece slightly wide and after the glue was set it was planed until it formed a smooth joint with the sides. Before attaching the front of the pipe it is necessary to cut the chamfer which will be just above the mouth of the assembled pipe. I experimented with several methods of doing this and the method I had the most success with is as follows. Using a pencil, I marked the top and bottom of the chamfer. Turn the board over and mark the bottom of the chamfer on that side also, then using a sharp knife cut across the board on this line. This will give a clean edge to the bottom of the chamfer as the material is cut away (there is a very good description of the construction of wood pipes in "The Art of Organ Building" by George Ashdown Audsley, Chapter 34—Iwould recommend reading it before beginning construction of any wooden pipes). Next, on the edge of the front board of the pipe I drew a line from the upper edge of the chamfer at the front of the board to the lower edge of the chamfer on the rear of the board. This showed the angle of the chamfer. I then clamped the board face-up into a drill press vise. I aligned the marks on the edge of the board with the top edge of the jaws of the vise. I then put a 1/4-inch router bit in the chuck of the drill press and adjusted the speed to the highest setting. I could then remove material by sliding the vise across the drill press table. Since the speed of the drill press, even at its highest setting, was still much less than the speed of a typical router I could only make shallow cuts, therefore it was necessary to make a series of shallow cuts in order to remove enough material. When I got close to the desired result, I finished shaping the chamfer by hand. I made some home made files by cutting strips of wood and gluing various grades of sandpaper onto them. These are handy not only for the final shaping of the chamfer, but also the filing of the windway in the block.

After the chamfer is shaped the front can be glued on the pipe. Next the windway is formed by filing the front of the block at approximately the same angle as the chamfer. While filing, periodically lay the cap on the front and measure the windway slot with a feeler gauge. Before gluing on the cap, I would place the pipe on the windchest, adjust the wind pressure to the proper setting, and while the pipe was sounding I would move the cap up and down a small amount until I got the desired tone. I would then mark that position so the cap could be glued on accurately.

I mentioned earlier that this set of pipes gave me more problems that any of the others. The main problem was "overblowing" in that the pipe was not stable at its fundamental frequency but would break into a tone an octave higher. I finally solved this problem by making the wind hole in the foot of the pipe slightly smaller than called for in the plans. The completed set of flageolet pipes is shown mounted on the wind chest in **Figure 9**.

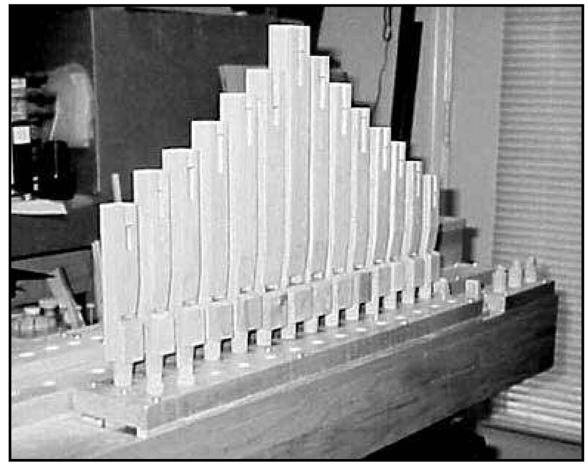


Figure 9. The flageolet rank installed on the windchest.

Piccolo Pipes

After completing the flageolet rank, I decided to tackle the piccolos. In the Wurlitzer 104/105 plans that I am using the specifications are shown for brass piccolo pipes. A little research revealed that the early models of this organ had brass piccolos but the later models had wooden piccolos. In the early model which had a cabinet made of varnished oak the front was open and the piccolos could be seen, however in the late model which had a painted cabinet with more ornamentation the pipes were hidden behind a screen with a landscape painted on it. This cleared up a question for me. Thinking that both models used the brass piccolos, I could not understand how the screen could be put in front of the pipes. The bases of the brass piccolos project forward slightly past the front of the cabinet and would interfere with the painted screen. However, by using wooden piccolos the flatter fronts of the pipes would allow room for the screen. I learned about this while trying to decide which style of cabinet I wanted to use, oak or painted. One thing that I was sure of, I wanted the front to have an opening through which some of the pipes could be seen and the brass piccolos would look very good in that location.

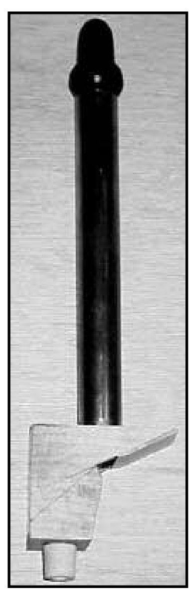


Figure 10. A side view of the piccolo pipe.

A side view of one of the piccolo pipes is shown in **Figure 10**. It is transversely blown in a manner similar to an orchestral flute or piccolo. The air enters the opening in the foot and flows through a slit which directs it across the open bottom of the brass tube, much like when one blows across the top of a bottle. An exploded view is shown in **Figure 11**.

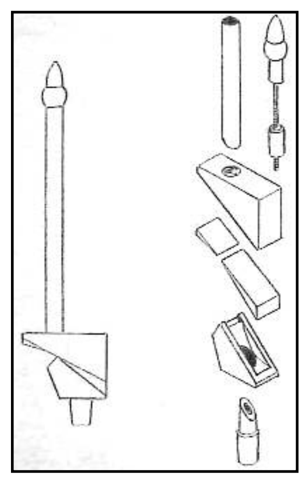


Figure 11. An exploded view of the piccolo pipe.

Several diameters of tubing are required, the largest diameter being used for the pipe with the lowest pitch. I tried to find the tubing locally, but the only supplier I found only sold ten-foot lengths. Finally, I found a couple of catalog firms which would sell the tubing in 12 inch and 36 inch lengths (if anyone would like the names of these suppliers send me an e-mail and I will reply with the information). In at least one case, the diameter specified in the plans was not available, but a size very close to it was. I figured that the slight difference would not be a problem.

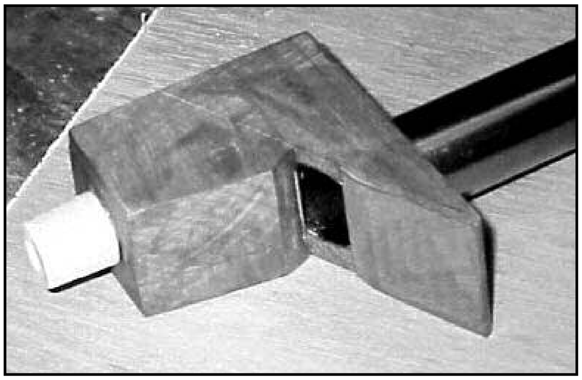


Figure 12. The base of the piccolo pipe showing the windway.

For the wooden base, I used maple. A view of the base can be seen in **Figure 12**. There are some interesting angles involved and I first envisioned cutting long strips with the proper angles and then sawing them to width. This would work since all of the bases have the same dimensions other than the width as viewed from the front of the organ. However, the method that ultimately worked the best for me was to cut a block of wood of the proper width for a particular pipe and large enough for all the pieces of the base. I then laid out the dimensions on the side of the block allowing space for the saw blade cut between the pieces of the base. The band saw I used only makes about a 1/32 inch cut. After cutting the pieces apart on the band saw only a light sanding was required to make the pieces fit together snugly. The next step was to drill the hole in the bottom for the pipe foot and then drill the hole in the top piece for the brass tube. I then placed the tube through the hole and carefully sawed it off even with the bottom of the hole so that the angle of the bottom of the tube matched that of the wooden piece. Using a small drill, I drilled a hole through the longer side of the tube into the wood and then drove in a small brass nail to hold the tube in place.

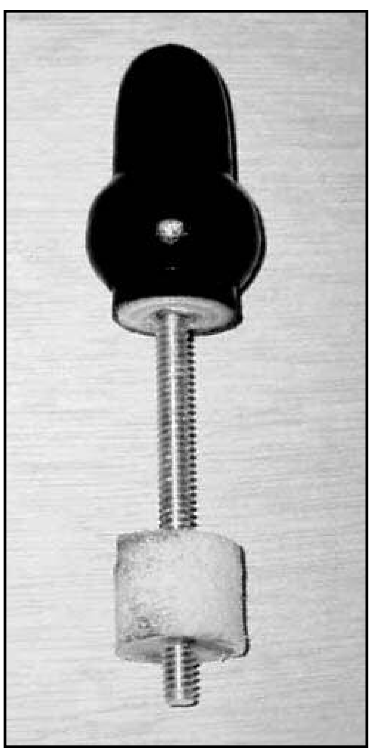


Figure 13. A detailed photo of the tuning plug for the piccolo pipe.

The next step was to file the slit or windway into the upper edge of the bottom piece. For this task I made up several narrow strips of wood with various grades of sandpaper glued on. It is necessary to file a while, then place the wedge which fits on the top of this piece in place and while holding them together use a feeler gauge to measure the depth of the slit. This procedure is repeated until the correct depth is reached.

The piccolo is a stopped pipe. The stopper is a wooden cylinder covered with soft leather which is sized to fit snugly into the brass tube, **Figure 13**. The pipe is tuned to proper pitch by sliding this plug up or down inside the tube. An ornamental wooden piece, frequently called an acorn, fits into the top of the tube. A shoulder on the acorn sits on the upper edge of the tube. Fixed into this acorn is a threaded rod which extends down into the tube. The leather-covered plug has a threaded hole through its center, which screws onto this threaded rod. By rotating the acorn one way or the other, the plug is moved up or down in the tube causing the pitch to drop or rise. I used a small lathe to turn the acorns, making all of the dimensions smaller as the diameter of the various pipes decreased.

After assembling all of these parts, the final step is to attach the thin piece of wood which fits up under the front of the top piece, the rear edge of which partially covers the opening in the bottom of the tube. I placed the pipe in the windchest and with the pressure adjusted to the correct reading I slid this thin piece slightly forward and back until I obtained a good solid clear tone from the pipe. I marked this location and then glued the piece on. Then I tested the pipe again to make sure I had it in the right place.

Figure 14 shows the piccolos in place on the windchest with the flageolets directly behind them.

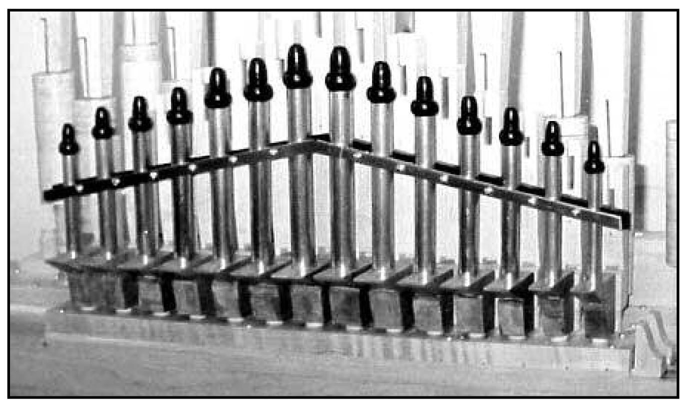


Figure 14. The complete rank of piccolos installed on the windchest.

Trumpet Pipes

The Wurlitzer 105 band organ has a rank of 13 trumpet pipes. Some of the other styles of Wurlitzer band organs used brass trumpets but in the case of the style 105 the trumpets are made of wood. **Figure 15** shows a completed trumpet. At times the trumpets play the melody along with the other melody pipes and at other times the trumpets play a counter-melody. They can also at times carry the melody. A brass reed assembly produces the sound. This consists of a brass tube or shallot, which is closed at one end and an opening, is cut in the side. A thin strip of brass, or tongue, covers the opening in the shallot. This assembly is housed in a larger wooden cylinder known as the boot. Air from the wind chest enters the boot at the lower end through a foot which fits into a hole in the wind chest. A stopper, known as a block, fits tightly into the upper end. In some cases this block was made of lead, but in my case I used wood. Two holes are drilled through the block. The open end of the brass shallot fits into the underside of the larger of the two holes.

Figure 15. The wooden trumpet pipe.

The shallot and tongue are held in the block by means of a small wooden wedge, but the lower end of the tongue is free to vibrate. In **Figure 16** the brass shallot can be seen at the lower center. The tongue is to the right of the shallot and the wooden wedge can be seen between the tongue and shallot. At the left is the boot with pipe foot and in the upper right is the block. Additional blocks can be seen at the top of the photograph. A tuning wire passes through the smaller hole in the block. The lower end of the tuning wire is bent up at an acute angle so that presses on the tongue. Raising and lowering the wire changes the length of the tongue, which is free to vibrate permitting tuning to the desired pitch. A resonator fits tightly into the upper end of the larger hole in the block above the shallot. In **Figure 15** the resonator is the tapered portion at the top. And, in Figure 16, one can also see the cylindrical boot and at the bottom the foot which fits into the wind chest. The tuning wire can be seen protruding from the top of the boot in front of the resonator. **Figure 17** shows the shallot and tongue installed in the block and held in place by the wooden wedge. In this photograph one can visualize how the length of the free portion of the tongue is adjusted by sliding the tuning wire up or down.

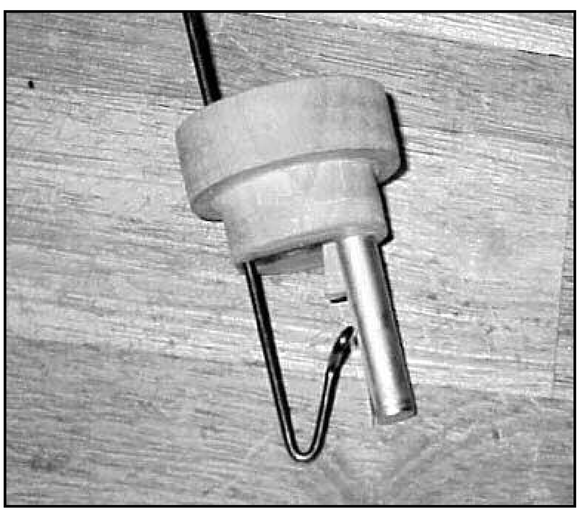


Figure 17. Tongue, shallot, and tuning wire installed in the block of the trumpet pipe.

The tongue is curved slightly away from the opening in the shallot. When air enters the boot the flow of air causes the tongue to vibrate against the shallot and sets the column of air in the resonator into sympathetic vibration. The resonator amplifies certain parts of the sound and helps to make the note more audible and give it its characteristic timbre.

If the builder is a fairly skilled metal worker he could make his own shallots and tongues. The dimensions originally used by Wurlitzer are given in the plans. However, since I consider myself more of a wood worker than metal worker I opted to purchase them from a company which supplies materials and parts for the organ industry. They also furnished the tuning wires. These have the hook formed at the end, which fits against the tongue, and are straight at the other end. After the wire is inserted up through the hole in the block a 90-degree bend is put into the upper end to give the person tuning the pipe something to grip. The shallots should be polished before installing. This was done by placing a sheet of very fine sandpaper on a smooth surface such as a drill press table and rubbing the flat area on the side of the shallot with the opening until it is smooth and shiny. The tongues as furnished by the supplier are perfectly flat and so must be given a slight curve. One end of the tongue is clamped onto a smooth flat surface and using a round metal bar about 1/2-inch in diameter, the bar is rolled from near the clamped end toward the free end. This is repeated until the end of the tongue is raised 1/32 to 1/16 inch above the surface. If the gap at the end of the tongue when installed is too small the trumpet will be too quiet. If the gap is too large the pipe will never speak.

Figure 16. Components of the trumpet pipe.

I used a small woodturning lathe to turn the boots, blocks, and pipe feet. A forstner drill bit was used to hollow out the boot. Another small foot was made which is fitted to the bottom of the resonator and which fits into the hole in the block above the reed assembly.

In addition to tuning the reed with the tuning wire, the resonator must be cut to the proper length. All the resonators should initially be made an inch or so longer than the specified length. The wind pressure is adjusted to the specified value and then the tuning wire is adjusted until the pipe sounds the correct pitch. However, if the resonator is too far from being the correct resonant length, the pipe may not speak at all, or may fly off to some other pitch before the reed reaches the correct pitch. In this case, a little is trimmed from the large end of the resonator. All of the resonators have basically the same angle of taper, so a jig should be made to hold the resonator while it is being run through the saw. The resonator is trimmed in small increments and tested again after each cut. In the plans it is recommended that the resonator be shortened until laying two fingers over the open end no longer causes the tone to fly off, or change pitch. I tried another method, which I believe is a reliable indicator of resonance. Based on my training in electronics and years of being a ham radio operator it seemed to me that the resonator could be tuned in the same way that a dipole antenna is tuned to resonance. If one considers the reed assembly to be the transmitter and the resonator to be akin to an antenna, then with the resonator in place once would tune the reed to the pitch that gave the fullest, strongest tone. That would be the pitch at which the resonator is resonant. The pitch is then determined and it will likely be lower than the desired pitch due to the resonator still being too long. The resonator would be trimmed by a small amount and the procedure repeated. This time the pitch should have moved closer to the desired pitch. This would be repeated until a good strong tone is achieved at the desired pitch. I believe that this method gives one a better idea of how close he is getting to the resonant length.

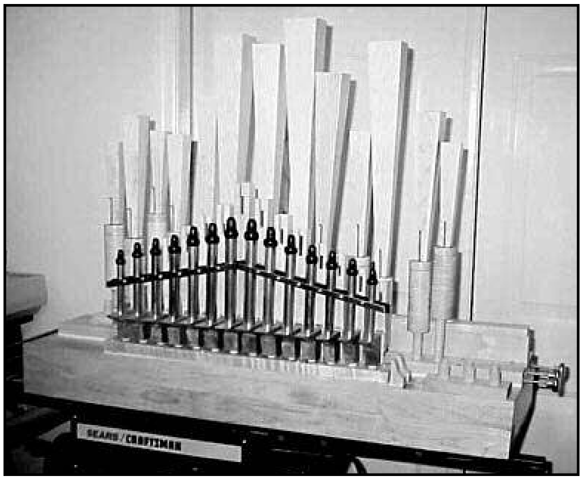


Figure 18. Trumpets installed on the wind chest behind the piccolos and flageolets.

Tuning the trumpets takes a little more time than the other pipes in the organ. One other caution: you might be tempted to try a trumpet pipe by blowing into the foot—this is not recommended. The high moisture content of your breath is not beneficial to the metal parts. Finally, a view of the trumpet pipes installed in the wind chest can be seen in **Figure 18**. In this photograph the piccolos are in the front row, the flageolets in the second, and the trumpets behind that.

Flute Pipes

At the outset of this project I constructed a few flute pipes and when I gained some confidence in my ability to build pipes I moved on to the flageolets, piccolos, and trumpets. Now I decided it was time to finish up the remaining flutes. A large number of the 97 pipes in the organ are stopped flutes, 28 to be exact. In large pipe organs such as church and theater organs there is usually a stop called the diapason. This is a rank of pipes, which encompasses the full range of the organ. In the Wurlitzer 105 the stopped flutes could almost be called the diapason since they range from the lowest note in the bass to the highest note in the melody. All 28 stopped flutes are shown in **Figure 19**. At the left is the bass G pipe followed by the other four bass pipes. The next nine pipes are the accompaniment flutes and to the right of that are the 14 melody flutes. One can see in the picture that the six pipes on the far right have feet for insertion into the top of the windchest. The other 22 pipes are mounted underneath the floor of the organ and so the openings for the air to enter are at the bottom rear of the pipes. I should also point out that some of these pipes are too long to fit inside the case as they are shown. The five bass pipes and the longest accompaniment pipe will have to be mitered to fit into the organ. According to organ builders with more experience than me, closed pipes such as these can have a 90-degree miter without affecting the tone. However an open pipe should be mitered with two 45-degree bends.

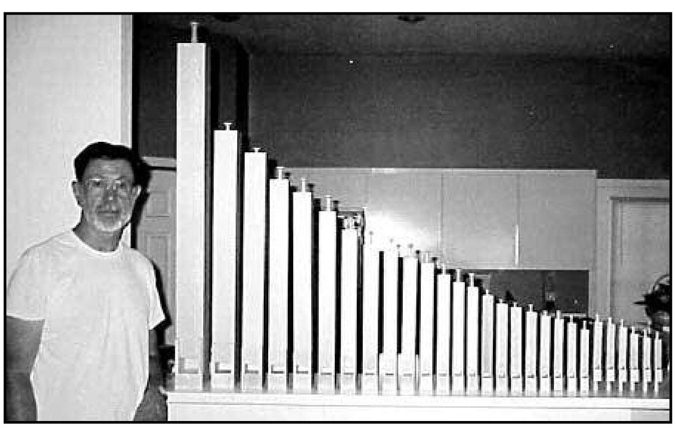


Figure 19. The author with the complete set of 28 flute pipes.

Mitering Open and Closed Pipes — an Explanation

The sound is produced by the vibration, or oscillation, of the column of air inside the pipe. In an open pipe the mode of vibration is such that there is a node, or point at which the column is not vibrating, at the mid-point of the length of the pipe. When the end of the pipe is closed the node is at the closed end. According to Audsley in his book, "The Art of Organ-Building", mitering a pipe at a point near the nodal point will have an adverse effect on the performance. Since the closed pipe has its node at the end the position of the miter is not critical. An open pipe should not be mitered near its mid-point since that is the location of the node. Audsley states that mitering should be avoided if at all possible, but if it is necessary then the curve should be gradual. He goes on to say that one should never use a 90-degree miter, however Wurlitzer used it in the original and so I followed their example.

In order to miter a pipe with a 90-degree bend one cuts the pipe through at a 45-degree angle then by rotating the upper section of the pipe 180 degrees, it should fit together with the upper part at a 90 degree angle to the lower part. The length of the pipe at the longitudinal centerline is still the same so if the pipe was tuned to the proper pitch before mitering it should still be very close to the correct pitch. In order to make the miter joint stronger I cut slots in the edges of the front and back boards where they were to be glued together and glued thin splines into these slots.

The actual construction of the flutes is similar to the method I described above for the flageolets. The differences are that the flageolets are open pipes with a tuning slide whereas the flutes are closed pipes and are tuned by a move able plug at the end of the pipe. Also, the chamfer on the flageolets extends completely across the face whereas the chamfer on the flutes is only as wide as the inside width of the pipe. When making the maple piece from which the block will be cut it should be long enough for the block plus a tuning stopper. Also allow enough to make a couple of spacers to hold the proper dimensions as the pipe is being glued together. Assembling the pipe walls to the block is performed in the same manner as described for the flageolets. Before the front is glued on, the chamfer and cup up for the mouth should be formed. The method for forming the chamfer was described earlier in the section on building the flageolets. As I mentioned earlier, the chamfer on the flageolets extends across the full width of the face of the pipe. However, the chamfer on the flutes is only as wide as the inside width of the pipe. In order to do this, I made up a wooden jig for the drill press table which has a fixed fence on one side and an adjustable fence on the other. The jig is fastened down to the table so that the stationary fence limits the sideways travel of the vise to determine where one side of the chamfer will be and then the adjustable fence is set to the point which will determine the other side of the chamfer.

After the chamfer and cup up for the mouth are formed the front can be glued onto the pipe. Next the windway is formed by filing the front of the block at approximately the same angle as the chamfer. Periodically lay the cap on the front and measure the windway with a feeler gauge.

The next step was to make the tuning plug. The plug is covered on the bottom and sides with a suede type of leather in order to make an airtight seal. The wooden piece for the block must be trimmed so that after the leather is glued on it fits snugly into the pipe. However, it must not be so tight that it cannot be moved up and down to tune the pipe to the correct pitch. For the handles for the tuning plugs I used the ready made pieces called shaker pegs, which are available at most craft stores. I was able to find these in three sizes and in the photograph you can see the largest protruding from the top of the large bass G on the left and the smallest on the melody flutes at the far right.

Finally, the caps are glued onto the face of the blocks. Before actually gluing the cap on, set the air pressure to the correct level and move the cap up and down slightly to find the best tone. Mark that spot and glue or screw the cap in place.

Next I will discuss the construction of the violin and cello pipes and that will complete the pipe work.

Violin-cello Pipes

So far we have built flute pipes, piccolos, flageolets and trumpet pipes. The remaining pipes in the organ, although in different ranks, are all of the type that make a "string" sound. That is, they are known as either violin or cello pipes and are made to be somewhat imitative of those orchestral instruments. This is achieved in a couple of ways. If you were to look at the cross section of a flute pipe it would be nearly square. The width across the face of the pipe would be about the same as the depth from front to back. However, in the violin and cello pipes the scale is small in comparison to the flute pipes. That is to say, the width is somewhat narrow when compared to the depth for a flute pipe of similar pitch. In addition, a device known as a harmonic brake is added at the mouth of the pipe. The characteristic tone of an instrument is determined by the number of harmonics and their relative strength. The tone of the orchestral violin consists of the fundamental plus a generous supply of harmonics both odd and even and in order to make an organ pipe with a violin-like tone, it is necessary to create these harmonics. The narrow cross-section encourages the formation of harmonics but also makes the pipe unstable, causing it to overblow. That is where the harmonic bridge comes into play. The most common type used in band organs is known as a "frein harmonique", a device patented by Gavioli in 1876. It consists of an adjustable metal plate the lower end of which is screwed to the cap of the pipe below the mouth. The plate is curved so that the edge of the other end lies close to the mouth of the pipe. This prevents overblowing by controlling the wind current at the mouth of the pipe. The frein harmonique can be seen in **Figure 20 and 21**. The larger, lower pitched pipes have a slightly different harmonic brake, which is made of wood that is attached across the mouth of the pipe. **Figure 22** shows the wooden harmonic brakes on the bass cello pipes for pitches C, E, and F. The photograph is a little misleading because all three pipes are butted up against each other and it looks as though the brake is one long piece. However, there is a separate brake for each of the pipes.

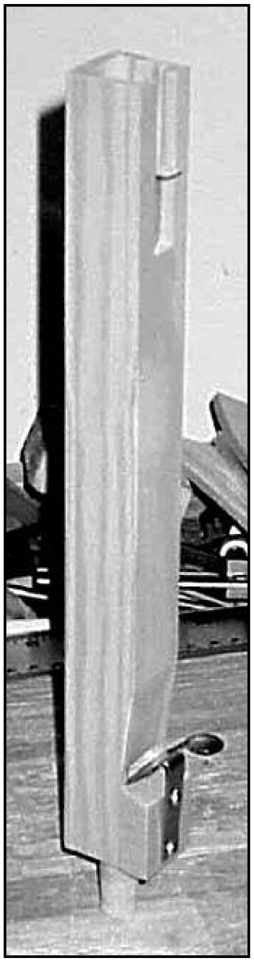


Figure 20. The violin pipe.

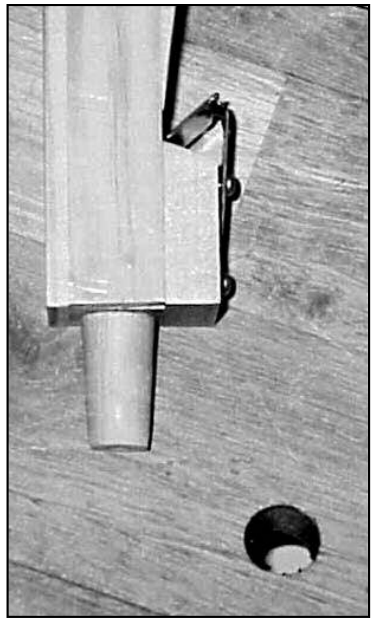


Figure 21. A view of the *frein harmonique.*

In the Wurlitzer 105 there are 28 pipes of this type, 14 melody violins, 9 cello accompaniment, and 5 bass cellos. It might be appropriate to mention at this time that the melody violins and accompaniment cellos are mounted in the organ with their mouths facing the rear of the organ. In the case of the accompaniment pipes this probably serves the purpose of keeping the volume level below that of the melody. In addition, for both ranks it makes the pipes somewhat easier to tune by reaching in from the rear of the organ to adjust the tuning slide. Construction is basically the same as that for the flageolets however there is no nodal hole in the violins and cellos. The tuning slide is fitted into slots in the same way as in the flageolets. Here is the procedure I used for voicing the violins. After the windway has been filed to the correct gap I fitted the pipe without the frein into an opening in the windchest and adjusted the pressure to the correct level. While sounding the pipe I adjusted the cap up and down slightly to achieve a good solid tone. At this point the pipe will most likely have a pitch an octave above the desired pitch. I then glued the cap in this position and then attached the frein to the cap and while the pipe was sounding the position of the frein was adjusted by sliding it up and down in its slotted screw holes and also in and out by turning the upper screw clockwise or counter-clockwise. A position should be found which causes the frequency or pitch of the pipe to drop back down to the proper note and also produce a violin-like tone. The bass cellos are voiced similarly except that the wooden harmonic brakes of course can only be moved up or down and not in or out. The bass cellos serve to augment the bass bourdons. The bourdons are closed flute pipes, and as such have only the fundamental and odd numbered harmonics. The bass cellos are basically the same length but are open pipes and so create a fundamental one octave higher than the bourdon plus many odd and even harmonics. The combination of the two played together has a much richer quality than the bourdon alone.

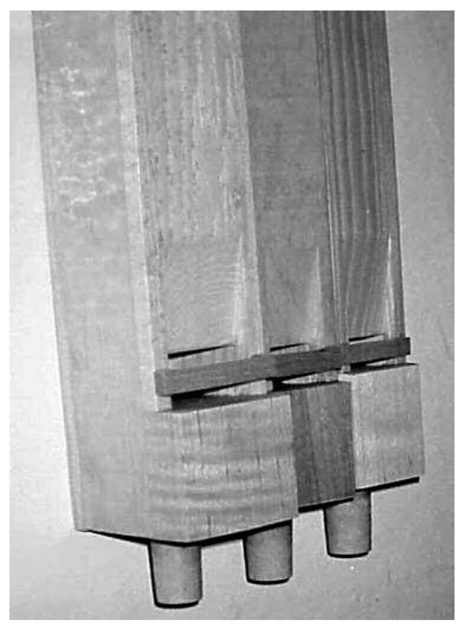


Figure 22. A set of three cello pipes — note the wooden harmonic brakes.

In the plans I used, the drawings, which indicate the mitering of the bass cello pipes, were somewhat confusing. I hope that the photographs I am showing here will help to clear up some of that confusion. In **Figure 23** the pipe on the left is the C bass cello, the one in the center is the E bass cello, and the one on the right is the F bass cello. When mounted in the organ the mouths of these pipes face the rear of the organ. This is further illustrated in **Figure 24**. This photograph also shows the melody violins on the right with their mouths facing the rear of the windchest and just to the left of that the accompaniment cellos can be seen. Also note the positions of the tuning slides. For the E pipe in the center the tuning slot will need to be in the backside of the pipe before mitering in order for it to end up in the position shown. For the C pipe, the tuning slot will need to be in the right side of the pipe before mitering. I also found that the dimensions given for the spacing between holes for the pipe feet for these three pipes put the holes too close together to be able to fit the pipes in without interference between them and I had to remake the riser that these pipes fit into.

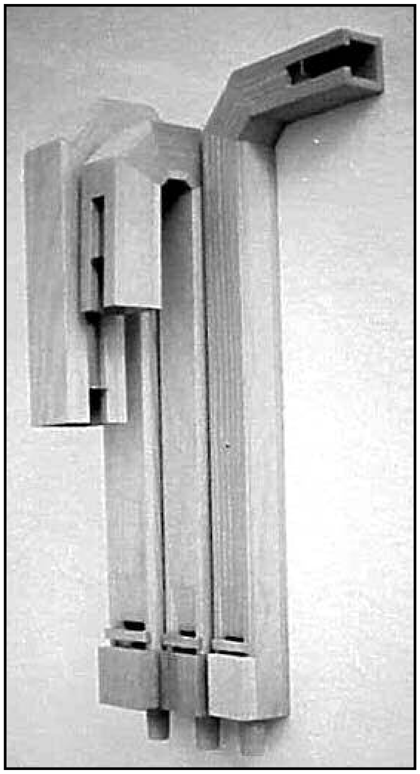


Figure 23. The C, E and F bass cellos.

Figure 25 shows the G bass cello with its mouth pointed toward the left side of the organ. One can see in this picture that as the pipe rises from the windchest it is mitered toward the front of the organ and then in **Figure 26** one can see how it is then mitered so that it extends across the top front of the organ. The D bass cello can be seen next to the G bass cello with its mitered top. The G bass cello will not fit into the case if the dimensions given in the plan are used. Fortunately I realized this before I mitered the pipe and was able to calculate the dimensions that would work. And finally, the windchest with its pipes in place is shown in **Figure 27**.

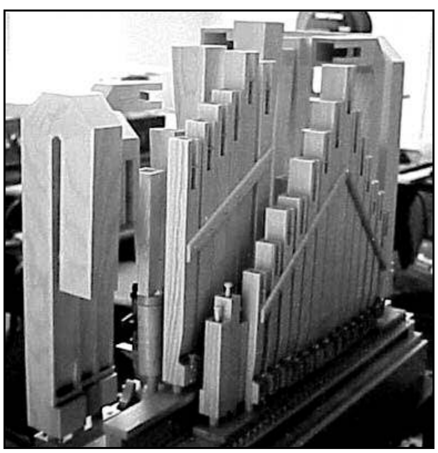


Figure 24. The rear view of the windchest showing the melody violins at the right.

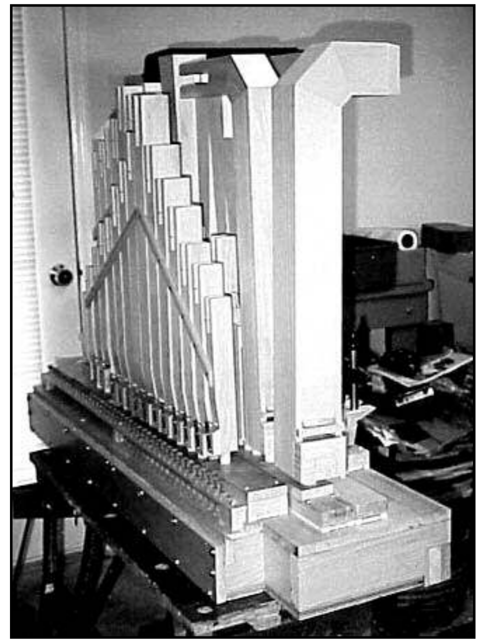


Figure 25. The left end of the windchest.

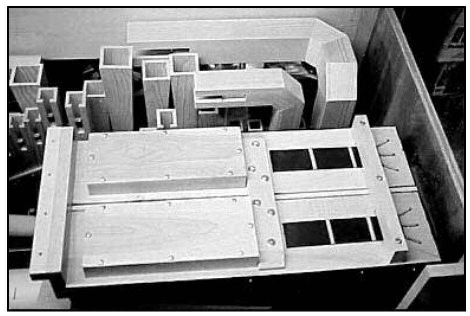


Figure 26. The bass cello pipes G and D as seen from above.

Figure 27. The completed windchest with all of the pipes installed.

Thanks to Bruce Zubee, Bill Black and Howard Wyman who have been running this article as a multi-part installment on the Carousels.com website (http://www.carousels.com/index.html). Part II will be published in the next issue of the *Carousel Organ.*

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Building a Wurlitzer 105 Band Organ — Part II —

Howard Wyman

The first installment of *Building a Wurlitzer 105 Band Organ* included information on construction of a windchest as well as making the flageolet, piccolo, trumpet, flute, and violin-cello pipes. Now we will progress into completing the case and constructing the vacuum and pressure pumps.

Building the Cabinet

Now that the windchest and pipes for the band organ had been completed this seemed to be a good time to start building the cabinet in order to be able to install not only the windchest but the remaining components as they are built. I had decided earlier in the project to paint the cabinet in a manner similar to the later model 105's. That allowed me to use 3/4-inch birch plywood for most of the cabinet. If the builder chooses to have a finished oak cabinet like the early models he could use oak-veneered plywood. For the front of the cabinet I used 3/4-inch clear pine boards doweled and glued together. I started by attaching the front to the sides using dowels and glue. This was then attached to the floor of the cabinet using screws. Before installing the floor I laid out the positions of the pipes that would be installed beneath the floor and cut the holes for the passage of air to the pipes. It was necessary to calculate the distance from the holes to the front of the cabinet so that they would line up with the row of holes in the bottom front of the windchest. **Figure 28** shows the bottom of the floor and the positions of the holes. One can also see the suede leather strips on which the pipes will be glued. I should also mention that I added about three inches to the height of the sides and front. In adding up the various dimensions it appeared that there was not enough height to accommodate the tallest trumpet pipe. As you can see in the photographs this probably would have been the case.

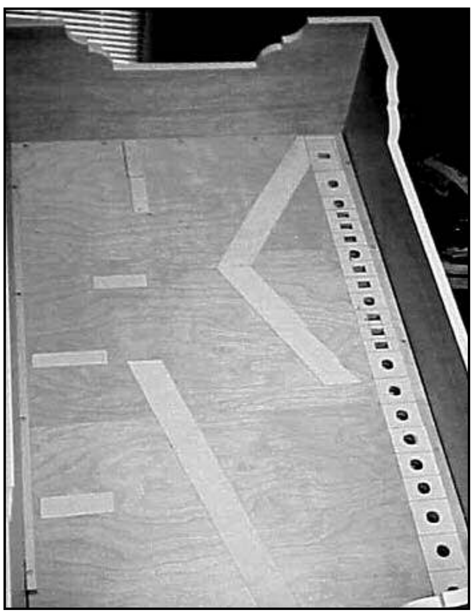

Figure 28. The underside of the organ case reveals future pipe positions.

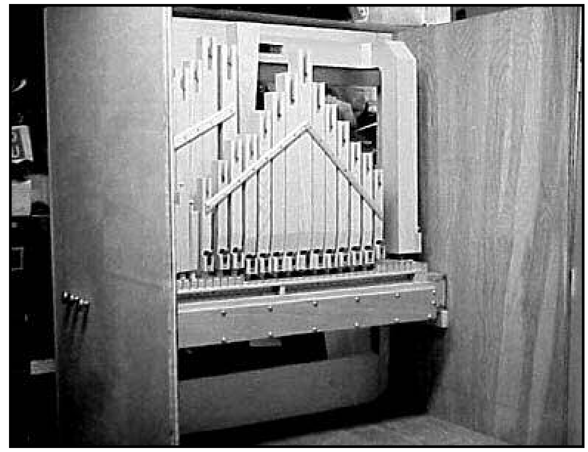

Figure 29. The windchest is now installed in the organ cabinet.

The windchest was then installed in the cabinet. I attached wooden strips to the inside of the cabinet sides and the windchest rests on these strips. In the plans it indicates that the chest is held down by long screws which go through the chest and into the wooden strips. However screws long enough to do that were impossible to find. Instead I screwed brackets above the chest to hold it down. **Figure 29** shows the windchest installed in the cabinet. With the wind chest in place it was now possible to determine the position of the air passages in the riser block. This is the block that contains the passageways from the wind chest to the pipes beneath the floor. To make a pattern I cut a thick piece of cardboard of the proper length and with a height which fit exactly between the front of the windchest and the floor. After putting it in position I marked the locations of the openings in the bottom of the windchest and also the openings in the floor. I then removed it from the organ and drew in the locations of the passages to connect the upper holes to the corresponding lower holes. This pattern was then used to make the riser block.

If the builder chooses to have a finished oak cabinet like the early models he could use oak-veneered plywood.

I made the riser block by forming a sandwich of 1/4-inch plywood on each side of 3/4-inch wood. The 3/4-inch wood is cut to form the passageways and glued onto one of the pieces of plywood. The other piece of plywood is then glued onto the remaining side. There should be no leakage from one passageway to the next. After the riser is glued together the passageways should be sealed with shellac or some other sealer. I used a product called Phenoseal, which I obtained from The Player Piano Co. Next, the riser was attached to the floor with the air passages lined up with the holes in the floor. The plan is rather sketchy as to how the riser is attached. I used screws up through the floor and into the bottom of the riser. To prevent air leakage I glued a leather gasket to both the bottom and top of the riser before installing it. The windchest was then secured to the top of the riser block. As I stated earlier, I was not able to obtain screws long enough to do this. Instead I used 1/4-inch lag screws. A countersink has to be drilled in the top of the chest so that the top of the head of the lag screw is flush with the top of the windchest. A couple of the screws are located underneath the strip, which holds the piccolos and flageolets so the heads have to be countersunk. This also means that the strip has to be removed while the windchest is being anchored down. **Figure 30** shows the cabinet with the riser block in place. The box sitting in the bottom of the cabinet is the blower box which I used to test individual pipes. Finally, in **Figure 31** one can see the front of the untrimmed cabinet with the wind chest and riser block installed. Gradually it is beginning to look like a band organ.

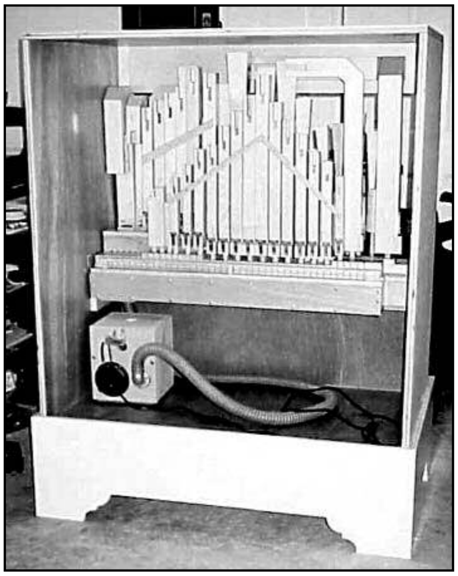

Figure 30. The organ cabinet with the riser block in place.

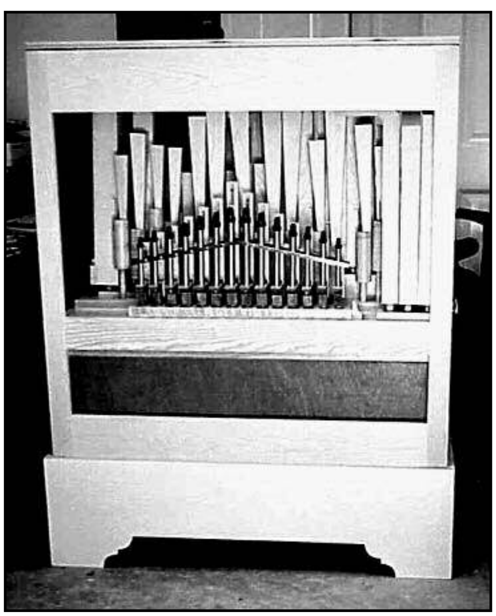

Figure 31. The front of the organ case with the wind chest and riser block installed.

Installing the Floor pipes

Of the 97 pipes in the Style 105 Wurlitzer Band Organ, 22 of them are mounted under the floor of the organ. All 22 are stopped flue-type pipes and they include the five bass bourdons, nine accompaniment flutes, and the eight largest melody flutes. The remaining six melody flutes are mounted on top of the windchest. In order to fit into the space beneath the floor some of the pipes must be mitered. All five bass pipes require mitering as well as one of the accompaniment flutes. Previously I mentioned that I had arranged the pipes in the positions in which they would be mounted in order to determine where to locate the holes for passage of air through the floor to the pipes. At that time I had not yet mitered the pipes. That was a good time to also check to see if the dimensions for the mitered sections as given in the plan would fit into the space. The pipes will be glued onto leather strips, which can be seen in Figure 28. The leather strip around the air passages serves as a gasket to prevent leaks. By gluing the pipes to the leather they can also be removed later in case they become damaged and need to be replaced or rebuilt. I used hot hide glue to attach the pipes to the leather because it forms a tight bond, yet can be broken apart later with a minimum of damage. As I was building the pipes I had applied a polyurethane finish to protect the pipes. Hot hide glue really needs to be applied to bare wood to hold properly so when I determined the areas on the backs of the pipes that would be glued to the leather I sanded the finish off in that area.

. . . a stopped pipe can be mitered with 90 degree angles without affecting the tone, whereas an open pipe should have two 45 degree angles to give a less abrupt change in direction

Next came the mitering of the pipes. I had been told by a couple of people who are experienced in pipe construction that a stopped pipe can be mitered with 90 degree angles without affecting the tone, whereas an open pipe should have two 45 degree angles to give a less abrupt change in direction. This has to do with the location of the nodes in the air column inside the pipe and I will not go into that subject here. In order to put a 90-degree bend in a pipe it is only necessary to cut through it at a 45-degree angle and then rotate one section 180 degrees. This was not a problem except in the case of the largest pipe, the G bass bourdon. Even when raised as far as it would go the blade in my table

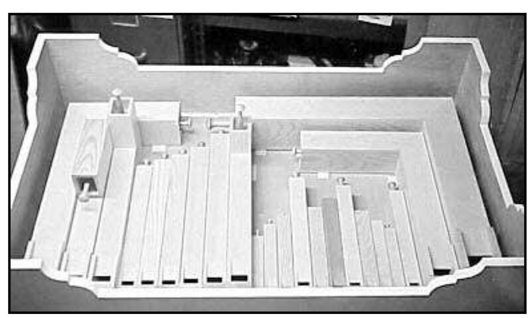

Figure 32. Floor pipes placed into position.

saw would not cut the full thickness of the pipe. The band saw would not open wide enough for the pipe to pass through either. I finally ran it through the table saw and then flipped it over, reset my guide and ran it through again. Of course it didn't quite match up but using a wide belt sander I was able to dress the cut ends so that they fit together fairly well. To strengthen the joint between the pipe sections I cut a groove into the edges of the angled sides and inserted a spline into the matching grooves when I glued them together.

It was now time to glue the pipes into place. Earlier, in the process of constructing the riser block which contains the air passages from the wind chest to the pipes beneath the floor, the wind chest had been installed. I removed the wind chest so that I could, with assistance, turn the cabinet upside down. **Figure 32** shows the pipes after they were glued in place. The large bass G can be seen on the right, with the bass D next to it. On the far left is the bass C, next to it the bass E, and to the right of that the bass F. Earlier I had been concerned that the handle on the stopper in the bass F pipe might not have enough clearance when the organ was turned upright and I had increased the height of the skirt by 3/4 inch over what the plan calls for. As it turned out there probably would have been sufficient clearance. Now with the floor pipes in place I could set the organ upright again and proceed with the bellows and pneumatic chest.

Some builders have opted to use a blower to provide the wind supply for the pipes but I preferred to use the traditional method.

Pressure Bellows

Now that the pipes and windchest have been installed in the case, this seemed to be a good time to build the pressure bellows. Some builders have opted to use a blower to provide the wind supply for the pipes but I preferred to use the traditional method. It would definitely be easier to use a blower but in any case, a reservoir is needed whatever wind supply is used. The reservoir with its spill valve provides a constant pressure, which is required for the pipes.

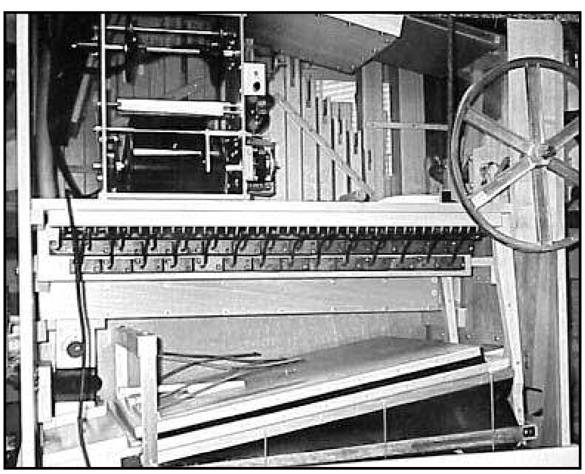

Figure 33. The newly installed pressure bellows sit at the bottom right of the organ case.

There are two nearly identical bellows sections which sit next to each other-the reservoir mounted on top. Each of the sections has a stationary top board and bottom board and a moveable centerboard. The centerboard is moved up and down by means of a wooden rod connected to one of the lobes on the crankshaft. As the board moves it causes air to be drawn into one of the bellows chambers while at the same time air is being pushed out of the chamber on the other side of the centerboard. This air is pushed into the reservoir. Leather check valves keep the air from going back into the bellows when the centerboard starts moving in the other direction. As I said earlier, there is another almost identical unit sitting next to this one and its centerboard is connected to another lobe on the crankshaft which is 90 degrees rotated from the first one. This means that as the crankshaft rotates there is an almost constant air flow going into the reservoir. I say “almost constant” because there are still fluctuations in the flow. It is the job of the reservoir to even out these fluctuations and also set the pressure at the desired level. In **Figure 33** one can see the pressure bellows at the bottom of the picture. The bottom board cannot be seen because it is below the white board, which is part of the back of the cabinet. The moveable centerboard is just above this white board and one can see the slot in the edge of it that is the air intake port. The flexible leather sides of the bellows are black cowhide. In this picture the crankshaft is not turning and so the reservoir is closed. The top of the reservoir is being held down by three large leaf springs.

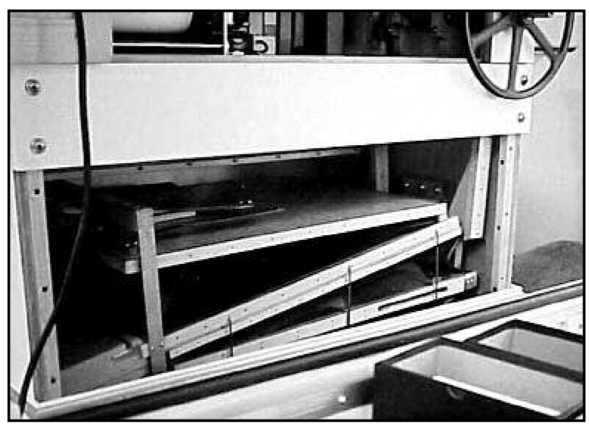

Figure 34. The open pressure reservoir sitting above the bellows unit.

In **Figure 34** one can see the reservoir in the full open position because the crankshaft is turning and air is being pumped into the reservoir. The top of the reservoir pushes against the three springs and the level of pressure is set by adjusting the amount of tension in the springs. In **Figure 35** the spill valve can be seen sitting between the springs. When the top board of the reservoir reaches its maximum height the arm of the spill valve strikes the wooden bar causing the valve to uncover a hole in the top board and exhaust the excess air. The crankshaft is supported by the two large wooden bearings, which can be seen in this picture. The rear of the cabinet itself serves as the third bearing for the crankshaft.

Most of my experience with player pianos, etc. has been with vacuum bellows. Since those bellows are operating as a suction device the flexible covering just naturally is pulled inward as the bellows operate. However, in the case of pressure bellows such as the ones we are building here, as the bellows closes it causes the leather to be blown outward. Because of this it is necessary to glue stiffeners to the inside of the leather covering. These can be thin wood or stiff cardboard. I have been told that Formica works quite well for this purpose also.

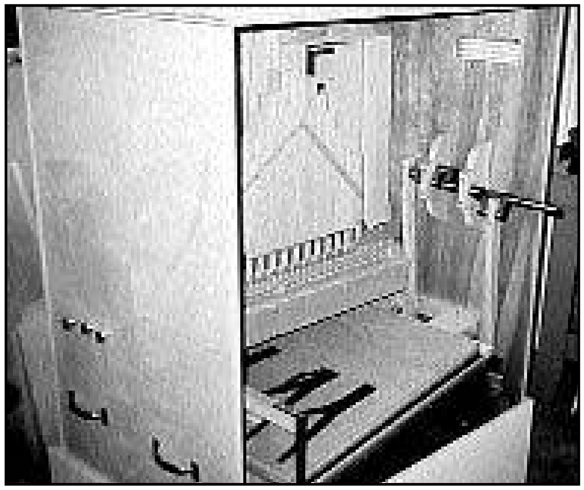

Figure 35. Another view of the pressure bellows and reservoir detailing the springs and spill valve assembly.

Vacuum Bellows

Previously we discussed the pressure bellows which furnish the air for the organ pipes that give the Wurlitzer Style 105 band organ its voice. Wurlitzer band organs also have a vacuum bellows. The "player" mechanism is operated by this vacuum. The music for the organ is contained on paper rolls similar to player piano rolls, however each roll has about ten different tunes. Vacuum is used to read the holes in the paper roll and through a system of valves and pneumatics open the corresponding pallet valves in the windchest to send the pressurized air to the pipes. We will go into more detail on this subject later. The basic configuration of the vacuum bellows is similar to the pressure bellows but somewhat smaller. The difference is mainly in the configuration of the valves. Whereas the pressure bellows draw in air from the atmosphere and pressurize it, the vacuum bellows draw air from the player mechanism and exhaust it into the atmosphere.

Vacuum is used to read the holes in the paper roll and . . . open the corresponding pallet valves in the windchest.

In retrospect it probably would have been smarter to build the vacuum bellows before the pressure bellows since they are smaller and not as cumbersome, but then we all have 20/20 hindsight. The bellows can be seen in **Figure 36** in the top right area of the case. The dark triangular area is the pumping part of the bellows. It appears dark in the photograph because of the black leather covering. The box-like assembly attached to the bottom and to which the hose is attached is the cover for some of the valves which prevent reverse air flow. As in the pressure bellows, there are two almost identical units side by side and each unit has a stationary top board and bottom board with a moveable center board forming two air chambers. The center board is moved up and down by a wooden rod connected to the crankshaft. As the center board moves it draws air into the chamber on one side through the common intake port. At the same time it is forcing the air out of the other chamber into the atmosphere. Check valves prevent the air from flowing the wrong direction. You may recall that the pressure for the pipes was regulated to a constant pressure by a reservoir which sat directly on top of the pressure bellows assembly. The vacuum system also uses a reservoir to maintain a constant "negative pressure," however the vacuum reservoir is separate from the bellows. They are connected through a one inch inside diameter hose. This hose can be seen in the above photograph. The pressure reservoir was held in a closed position by external springs, however the vacuum reservoir is held OPEN by internal springs. When the organ is operating the reservoir is drawn shut against the tension of the springs. The amount of tension determines the level of suction that is maintained, which in this case is 20 inches water. A level lower than this is insufficient to operate the mechanism but then a level greater than 20 can also cause problems. I inadvertently had set the suction level to almost 30 inches and in playing a roll noticed that toward the end of the roll the tempo was slowing down. After I readjusted the level I didn't have that problem so I came to the conclusion that the extra suction on the paper roll as it passed over the tracker bar holes was causing drag on the roll.

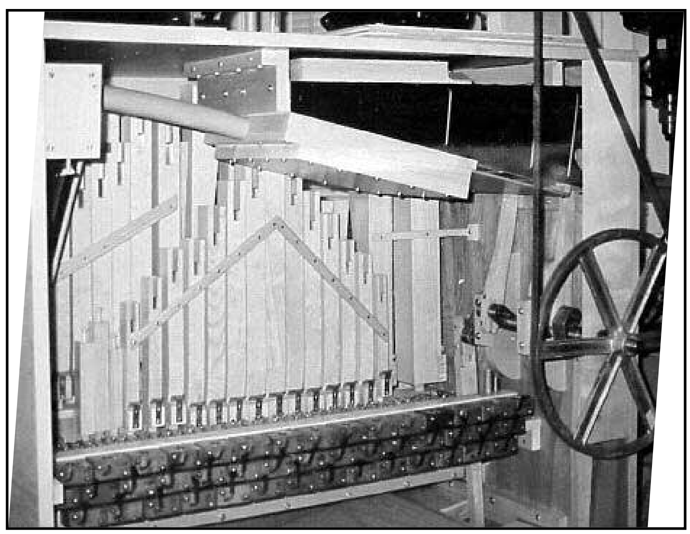

Figure 36. The back of the nearly-completed organ showing the vacuum bellows at the top right of the case.

The tension is set by bending the leaf springs inside the reservoir. For that purpose, the top board of the reservoir has a wooden plate which covers a large opening in the board. This plate is attached with screws and a leather gasket to make it airtight. The springs can be accessed by removing this plate. It usually takes a few tries before the correct level is obtained. The springs exert quite a bit of force and the only thing holding against this force is the leather covering of the reservoir. All of the time that the organ is sitting idle the force of the springs is keeping tension on the leather. In order to keep some of this pressure off the leather I put a reinforcing strap on the open end of the reservoir before gluing on the leather. This strap is a piece of cotton belting about an inch wide, tacked and glued at each end. **Figure 37** is a view looking down at the top of the organ with the top removed. At the right one can see the suction bellows. The two box like structures are airtight covers for the valves which only allow air to flow into the bellows. An internal passage from these two covers goes to the valve cover on the bottom of the bellows which we pointed out in the previous photograph and to which the hose from the reservoir is attached. To the right of these covers there is a maple support bracket which holds the bellows assembly together and to the right of that the two dark strips are the leather flap valves which allow air to be exhausted to the atmosphere during operation. In Figure 37 one can also see the hose going from the bellows to a T-connector. One leg of the T goes to the reservoir which is attached to the side of the case. The other leg of the T goes to a cut-out seen in the lower left. This cut-out shuts off the vacuum to the player mechanism during rewinding of the roll, otherwise the organ would make some strange sounding music while rewinding.

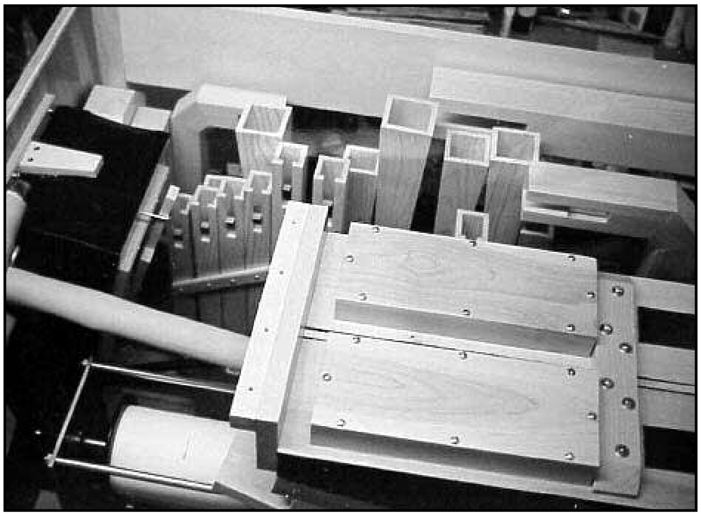

Figure 37. A view of the vacuum bellows from above (with the top of the organ case removed).

In the third installment of this article we will see how this vacuum we have created is used to read the holes in the music roll and operate the valves and pneumatics to actually play the music. We will also cover the percussion and end with the finishing touches.

Thanks to Bruce Zubee, Bill Black and Howard Wyman who have been running this article as a multi-part installment on the Carousels.com website (http://www.carousels.com/index.html). Part III will be published in the next issue of the *Carousel Organ.*

Howard Wyman is an electrical engineer retired from the Army Night Vision and Electro-Optics Laboratory at Ft. Belvior, Virginia, and now living near Tampa, Florida. He has had a long time interest in mechanical music but became really involved with the acquisition of a non-working player in 1989. He is also a ham radio operator with call sign, W9BVD.

Luigi's "Rescued"

Hal O'Roarke

Like many small organ enthusiasts I'm always on the lookout for old postcards, magazines, knickknacks, etc, depicting organ grinders. Recently, while pursuing one of my other interests in life, buying and restoring pinball machines, I attended an auction where people in the amusement business dump their old and excess coin operated equipment. To my surprise among all the other treasures (read junk) there stood two aging "redemption" games named *Luigi's Corner* containing animated organ grinder and monkey figures. I should explain that "redemption" games come in a wide variety of types and are used in arcades to entice players to demonstrate some skill in order to win tickets later to be redeemed for mostly worthless prizes. *Luigi's Corner* required the player to insert a quarter (or token) in a shooter device and try to make it land in Luigi's hat, his monkey's cup, or other winning locations. To make the game more difficult Luigi is cranking the organ, raising and lowering his hat (the big jackpot award) and the entire organ and figure is moving from side to side. The monkey is also moving side to side to make his cup more difficult to hit.

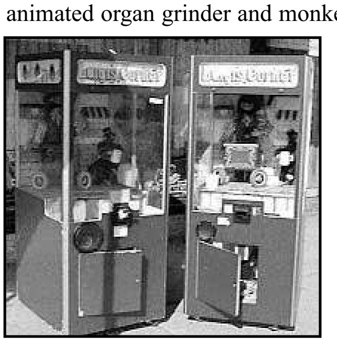

Figure 1. Two *Luigi's Corner* coin-operated games.

Figure 2. Luigi and his monkey removed from the case.

Even though I had no idea what I was going to do with them there was no way could let them pass unless the price went to the ridiculous. It didn't, so I was high bidder and prevailed on a friend to haul them back for me. This is the type of equipment those in the business call "whales" and I could not even fit one in my pick-up.

The games had been pretty well cannibalized for generic parts and their life as commercial equipment was in the past. The figures are essentially complete and mostly work, but require someone to love them and spend some time on restoration. They were rather easily extracted as a unit from the cabinets (which are now in the dump) and await their fate in my garage along with all the other "future" projects. Hopefully someday you will see Luigi reincarnated in a rally, museum, or collection near you.

Hal O'Roarke not only collects coin-operated equipment but is also an organ grinder who supplies many collectors with 20-note rolls.

Building a Wurlitzer 105 Band Organ
— Part III —

Howard Wyman

[*Howard Wyman has presented a step-by-step approach to the building of one of Wurlitzer's most common band organs, the Style 105. The first two chapters of this fascinating story may be found in issues No. 5 & 6. This current article represents the final installment — Ed.*]

The Pneumatic Chest

Let us take a look at the process by which a hole in the paper roll causes a pipe to play. A simplified diagram, **Figure 38**, is used to demonstrate. The vacuum that is generated by the bellows described in the previous section is applied to the pneumatic chest. On this chest is mounted a valve block for each note in the organ scale. A small amount of vacuum is passed through a tube from each valve block to the corresponding hole in the tracker bar. As the roll passes from the top spool down over the tracker bar to the bottom spool a hole in the paper roll crossing over one of the holes in the tracker bar will allow air at atmospheric pressure to pass through the tube to the corresponding valve. This causes the valve to operate and allow vacuum to go to the small pneumatic bellows mounted on the deck of the pneumatic chest. When the pneumatic is sucked shut it depresses a rod on the windchest causing the pallet valve to open and send wind through the channel for that note and to any pipe or pipes mounted on that channel.

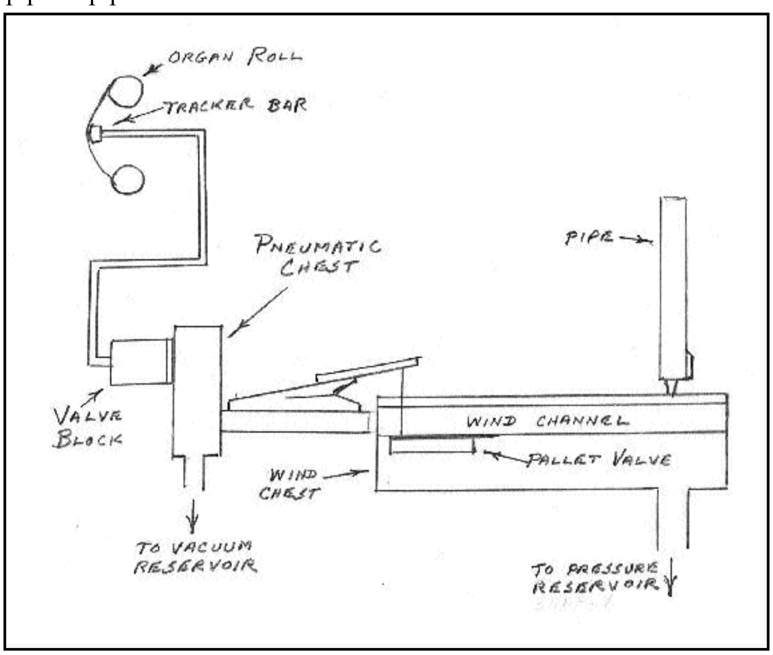

Figure 38. A diagram revealing the necessary components by which a hole in the paper roll causes a pipe to play.

Before beginning construction of the pneumatic chest it is necessary to determine what valve blocks will be used. The dimensions in the Stanoszek plans are for Wurlitzer unit valve blocks just like the ones originally used by the Wurlitzer Company in the original band organs. If one is going to use another type of valve block it will be necessary to adjust the dimensions for that particular type. New Wurlitzer type valves are available from a couple of sources. Another type of valve that several builders have used is a valve block made from plastic commonly called the "Doyle Lane" valve. I believe that these valves are available from Doyle Lane or from the Player Piano Co. The height of these valves is greater than the Wurlitzer valves and so the vertical dimensions of the mounting surface on the pneumatic chest must be increased to make room for them. The horizontal dimensions stay the same.

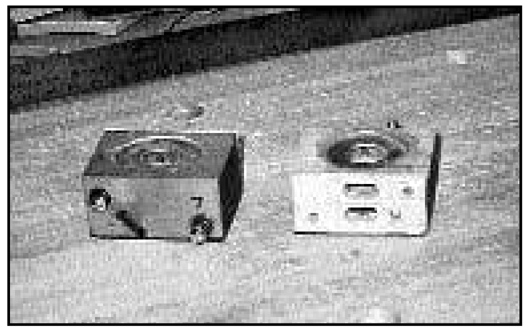

Figure 39. A front and back view of two restored Wurlitzer valve blocks

I toyed with the idea of making my own valve blocks. A set of drawings for the Wurlitzer style valve is sold by Player Piano Co. I built a couple for practice and was successful although it looked like a job that would take some time. Of course most of the work on the organ had been time consuming so this would not necessarily be any different. Fortunately I was talking to a friend who does a lot of restoration and construction of mechanical musical instruments and he asked, "How many valves do you need?" He gave me a box full of old Wurlitzer valves. The only catch was that they all needed to be rebuilt, but then that would be easier than building them from scratch. I had rebuilt quite a few valves in the past while restoring several player pianos so I was pretty much familiar with the process. **Figure 39** shows a front and back view of two restored valve blocks. In the view on the left one can see the brass nipple sticking out at an angle that the tube from the tracker bar attaches to. You can also see the two mounting screws which are used to attach the valve block to the chest. There is a small coil spring under the head of each screw. This serves to hold the block firmly airtight against the chest when the wood swells or shrinks in changing humidity. In the right hand view the lower oval shaped opening is the pathway for the constant vacuum from the pneumatic chest to the valve. The upper opening goes to a passageway in the chest which goes to the small pneumatic bellows which operates the pallet valve in the wind chest. A leather gasket is placed between the valve block and the pneumatic chest in order to make an airtight seal.

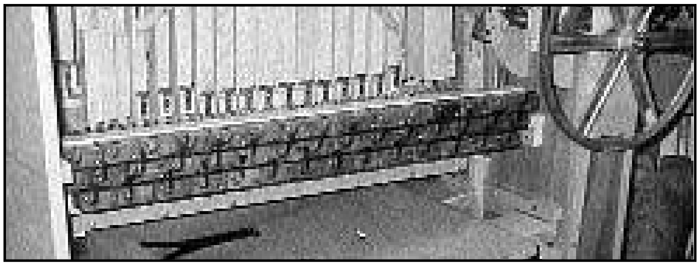

Figure 40. A view of the three rows of valves mounted on the pneumatic chest.

The vertical board to which the valves are mounted is made up of two or three layers. The method I used was to start with a board for the side that faces the front of the organ. I then glued wood strips to that to form the channels for the vacuum which goes to the bottom openings of all the valves. The third layer was then glued on top of that forming the back surface of the chest. After all of the holes have been drilled for the air passages to the valve blocks and also to the deck board with the pneumatics, all of these internal passages should be sealed to make them airtight. I covered all of the openings on the front and back of the chest with masking tape, then with the chest upside down I poured shellac into the drill holes in the bottom of the chest. After making sure that the sealant has run all through the chest the shellac is poured out, the masking tape is removed, and the chest is allowed to dry. The same should be done to the passages in the deck board. The deck is attached to the chest with long screws through the chest and into the deck. Care should be taken to drill the screw holes in between the channels in the chest. Flat head screws should be used because some of them will be partially under a valve.

In **Figure 40** one can see the three rows of valves mounted on the pneumatic chest and the chest mounted in the organ. The tips of the fingers on the small pneumatic bellows are just barely visible beyond the top edge of the chest. **Figure 41** was taken after the shelf for the spool frame was mounted in the cabinet. The organ is now ready for a final tuning and then to play a roll, without drums and cymbal of course. A few minor adjustments had to be made, but it would be hard to describe the exhilaration I felt when the strains of *The Blue Danube* echoed through the workshop. Now to add the percussion.

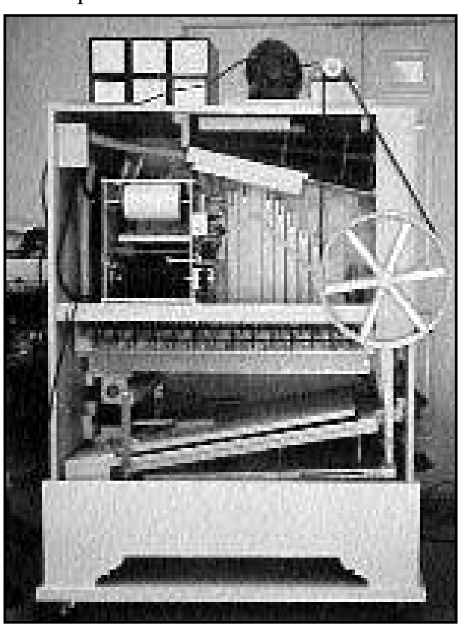

Figure 41. The completed organ (sans percussion) ready for play.

Percussion:

As I mentioned early in this article, the only difference in the Wurlitzer Style 104 and Style 105 is the percussion. At this point our organ is configured like a Style 104 and as such sounds just fine. However, the pneumatic mechanisms that are used to strike the drums are intriguing enough that I felt compelled to build them. Also, I have noticed that when I demonstrate the organ most people seem to enjoy watching the drum beaters in operation.

. . . it would be hard to describe the exhilaration I felt when the strains of "The Blue Danube" echoed through the workshop!

The snare drum and cymbal were fairly easy to obtain. However, the bass drum was a problem. Most present day bass drums are much deeper. I finally found an old bass drum that was close to the right size that a local music store owner had in the back room. According to Bill Black the original bass drums were about 20 inches in diameter and 10 inches deep. The only drum that I could find that was even close to those dimensions was 22 inches in diameter and 8 inches deep. Not only that, it looked like a real basket case. After I restored it about the only original part left was the drum shell. I installed new hardware, new rings and new heads. As for the shell, I obtained some thin maple veneer which I glued around the shell. After it was stained and varnished and all the new hardware added it looked pretty good.

The snare drum beater works on vacuum. It can be seen in **Figure 42**. There are two beaters which are attached to pneumatic bellows and in between the pneumatics one can see two unit valve blocks just like the ones used on the pneumatic chest

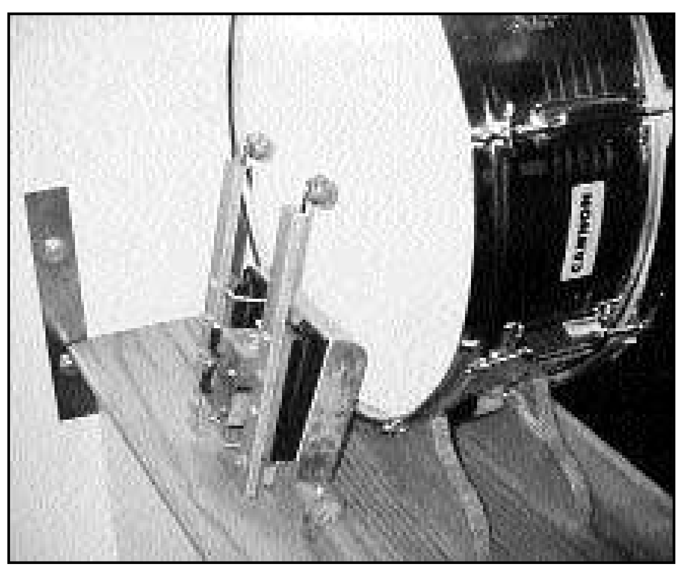

Figure 42. The snare beater mechanism.

inside the organ. When vacuum is applied it passes through one of the valves and causes the pneumatic closest to the organ to start collapsing which moves the attached beater toward the drum. As this is occurring the lower end of the beater lifts a pallet valve which causes the first valve to shut off and the other one to turn on which in turn cuts off the vacuum to the first pneumatic and causes it to go to the pneumatic farthest from the organ. This causes the beater attached to that pneumatic to move toward the drum and in the meantime the original beater is moving back away from the drum. Also, when the second valve turns on it sends a vacuum signal through a channel in the mechanism to the first valve which causes that valve to turn on and the second valve to cut off. Then the whole process begins all over again. All of this occurs quite rapidly and when vacuum is applied to the mechanism continuously it sounds like a drum "roll." A very short hole in the music roll on the other hand will cause just one tap on the drum because the vacuum is cut off before the second beater has time to hit the drum.

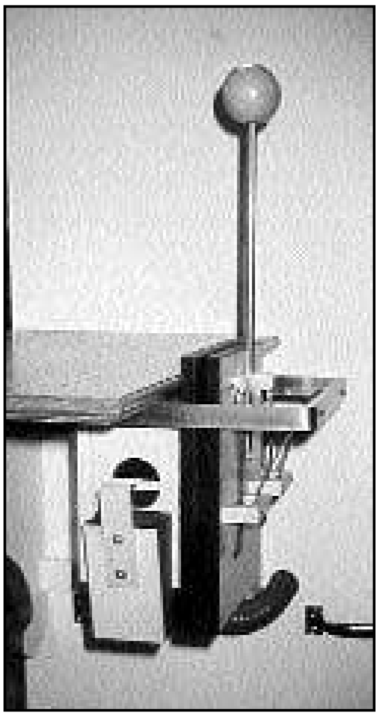

Figure 43. The bass drum beater mechanism.

The bass drum beater works quite differently. The bass drum beating mechanism is shown in **Figure 43**. When the organ is turned on, pressure from the pressure reservoir is sent through the large hose seen just to the left of the handle. This hose is attached to the box mounted beneath the drum shelf. The round opening seen in the side of the box is closed at this point by a leather covered valve seat on the inside. The pressure passes through an opening in the back of the box into the bellows to which the beater is attached causing the bellows to inflate against the two springs shown and moving the beater back away from the drum. It stays like this until a short hole in the music roll operates a unit valve inside the organ which sends a vacuum "trigger" signal through a smaller hose to the pneumatic on the side of the mechanism. When this pneumatic collapses, its arm pushes on a shaft which moves the valve seat away from the round opening in the side. At the other end of this shaft is a valve which closes off the pressure supply to the box at the same time, and so the pressure in the beater pneumatic escapes through the hole allowing the pneumatic to be forced shut by the springs. The force of the springs causes the beater to strike the drum with a fair amount of force.

There is no hole in the music roll dedicated to the cymbal. . . it is triggered by the perforation for the bass drum.

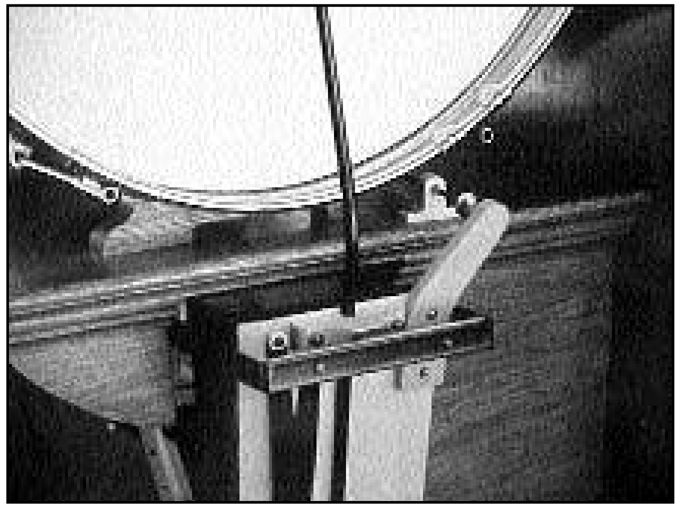

Figure 44. A mechanism for striking the cymbal—note the wooden "ear" on the right of the pneumatic posed ready to strike a brass rod.

And finally, we come to the cymbal. Apparently some of the Style 105 organs had the cymbal mounted at the center of the top and it had its own beater mechanism. Others had the cymbal mounted in front of the bass drum and the beater was tied in with the bass drum beater. There is no hole in the music roll dedicated to the cymbal and so in either case it is triggered by the perforation for the bass drum and strikes simultaneously with the bass drum.

Figures 44 & 45 were taken of another organ at a band organ rally in Indiana and were the pictures that I used as a model when making my own cymbal beater. Later I got a chance to get a close look at an original Wurlitzer band organ and was pleased to see that the cymbal mechanism looked very much like the one in these pictures. In **Figure 44** one can see a wooden arm attached to the upper corner of the beater pneumatic. When the pneumatic collapses this arm strikes the end of a brass rod which passes through to the front of the drum shelf.

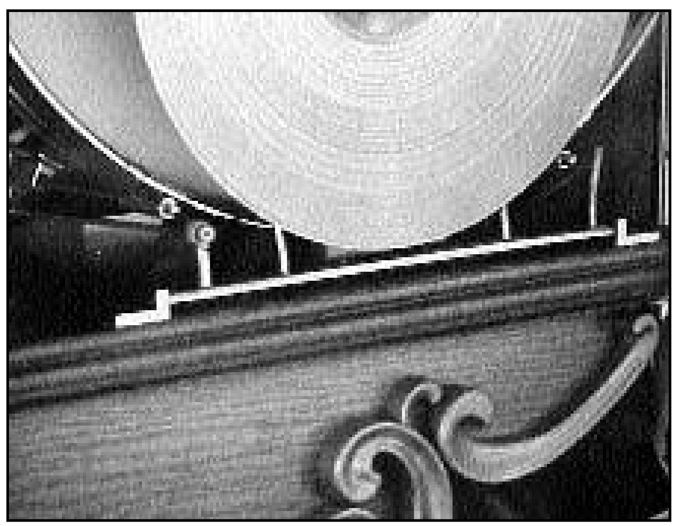

Figure 45. A front view of the cymbal mechanism seen in Figure 44. The brass rod pushes the beater forward to strike the cymbal from behind.

In **Figure 45** it can be seen that the other end of this rod is attached to an arm near the left end of the larger brass rod running across the front of the shelf. Near the right end of this rod is another arm with a spring attached. Not seen in the photograph is a brass rod bent into a circular shape just slightly smaller in diameter than the cymbal and resting behind the cymbal. The spring at the right end causes this circular rod to be held back away from the cymbal. When the bass drum beater pneumatic collapses and the beater strikes the drum, at the same time the wooden arm strikes the rod and pushes it forward rotating the rod to which the circular rod behind the cymbal is attached. This causes the circular rod to strike the cymbal. The forward end of the push rod is threaded where it passes through the hole in the arm. A hard leather nut is screwed onto the rod behind the arm and another in front of the arm. This provides an adjustment for the striker mechanism.

Having reached this point in the construction I have to admit that I spent more time listening to the organ than working on it. But, there was still work to be done.

The Finishing Touches

The decorating of the organ case is determined by the builder's taste. At the band organ rallies that I have had the pleasure to attend, I have seen several home-built Style 105s and each one is different. The basic shape is similar but the ornamentation varies. However, I know of at least one organ being built in which the case will be more like the early Style 125 organ. The top half is open at the front and halfway back on the sides with a column at each front corner supporting the top.

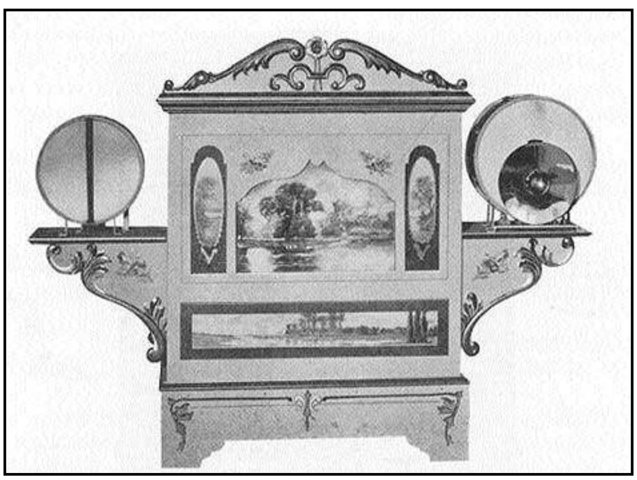

Figure 46. A 1920s catalog illustration of Wurlitzer Style 105 Military Band Organ.

For my organ I kept pretty close to the design shown in an illustration that Wurlitzer used in their catalogs. An example is shown in **Figure 46**. Fortunately I had purchased the carved trim for the drum wings at the mart at a band organ rally, however I wasn't certain what I would do about the carving on the top of the front. Finally, using some carving tools and a rotary tool I did the carving myself. It looks OK if you don't look too closely. I carved these pieces out of oak. The crown molding around the top of the case, the tops of the drum wings, and the molding around the top of the base are also oak. All of these parts were stained golden oak. Before attaching these pieces I painted the large areas of the case an ivory color. I wanted a fairly smooth finish like one would obtain by spray painting, but not only did I not own the equipment for spray painting I also did not have a very large space in which to work. At the home improvement store I found a small foam roller that is normally used for trim work and this is what I used to apply the paint. It worked quite well.

Having reached this point in the construction I have to admit that I spent more time listening to the organ than working on it.

The "finished" organ is shown in **Figure 47.** I have put the word finished in quotation marks because I consider the organ still a work in progress. I plan to use imitation gold leaf to add some pin striping to the base and around the openings in the front. Also some painted flowers would probably look nice in certain areas but I really haven't decided what I want yet. In the meantime I am quite happy to just sit back and listen to the music. I spent many hours building this organ but I can truly say that it was a "labor of love."

Figure 47. The "finished" Wurlitzer Style 105 organ.

Thanks to Bruce Zubee, Bill Black and Howard Wyman who have been running this article as a multi-part installment on the Carousels.com website (http://www.carousels.com/index.html). Flue Pipe Acoustics

After wrapping up this project Howard felt that he would like to work on something smaller. He has now begun construction of a 36-key crank organ using plans he obtained from Huismuziek in The Netherlands. Howard also reports that he has become somewhat proficient in reading Dutch.