Building the John Smith Organ

Paul Senger

Why I Built An Organ

When I participated in the MBSI National Capital Chapter's annual C&O Canal Organ Grind and music box demonstration every year, I got to hear and crank the monkey organs. This was a lot fun, I loved the music and I had a great time. I thought it would be neat to have my own organ.

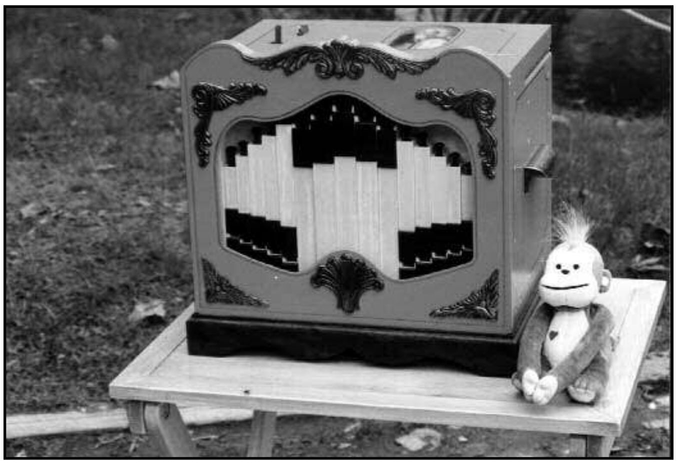


Figure 1. The Basic 20-Note John Smith organ—completed and ready to play at a rally.

Then I heard about the John Smith organ. I did some research but was still not to sure I was ready to build my own organ or how good it may sound compared to the professionally built organs. Finally after attending about four of the annual organ grinds I decided it was time to order the plans.

Ordering

Burl Updyke had a John Smith Organ at the MBSI Convention in Baltimore in the summer of 2001. I was really impressed with the sound and how impressive it looked. I showed Burl a sample flute pipe I had built using Bob Stanoszek's Wurlitzer 105 Band Organ Plans to see if he thought my skills were up to building the John Smith. He thought my pipe looked great and said I should be able to build the John Smith organ. That got me going again.

I contacted John Smith by e-mail and he recommended that I reorder from his new agent, Roll Cutter. His original agent had quit suddenly.

Roll Cutter now sells plans for John Smith organs and parts for the organs including leather, tubing, tracker bars, crankshafts, springs, and turned wheels. The are three organs: the Basic 20-Note, the 20-Note Senior with built-in rewind, an automated conductor and improved layout, and the 26-Note which has valves, 69 pipes and a Glockenspiel. I built the Basic 20-Note organ (**Figure 1**).

The Plans

The plans are drawn in multiple styles from ruler and circle template to free hand. In many cases the sheets have mixed metric and english measurements. In some cases the thickness of materials and dimensions were left to the builder. If you are used to Norm's "Measured Drawings" or wood working magazines this is sort of shock. I met John Smith a year or so after I finished my organ and he said he gets some complaints about the plans. He had a friend help him draw up the plans and it was a lot of work to just get them that far. If you think about the complexity of an organ and how to get your design on paper to make it simple enough for someone to build it's not an easy task. This is a low quantity production item and it would have cost a lot of time to get the plans in a more formal level. After trying to draw up parts of the plan on a CAD (computer aided design) program, I sympathize with the problem. As John told me, "if you have some mechanical building skills and work your way through the steps, you will get an organ."

Read the plans carefully. There are important little hints all through the plans. I recommend going through the plans and annotating key points. For example, I didn't know what kind of glue to use to attach the window in the pressure box. I used clear silicon seal. My window came loose about 8 months later. I then reread the plans and found that John had said to use contact cement. I did an experiment with the two glues and found that the contact cement was twice as strong as the silicon seal. In the process of doing the article and reading the instructions for the umpteenth time I am still finding additional details I missed.

The plans came with a video tape which is very helpful. I got a lot of use out of the video for assembly details and sizes of material. In the video you see John with scalpel, rubber bands, ball point pen, and glue making pipes at the dining table. John intended for the organ to be simple and inexpensive to build so it could be built by an amateur. John says you should be able to build one for about 75£ which is about $150. The organs have been built by school children and people have built them in six weeks time, so they can be built without becoming a major project. John's clever design greatly simplifies the complexity of the organ by eliminating the valves, and has a pipe design that is easy to build. The video is a compilation from three earlier organs being built so there are some slight differences from the final plans.

I copied the paper plans so I would have a copy to mark up with builder annotations without ruining the originals. The tape would not pause clearly on my VCR, but I copied it to a new tape on my VCR and then it would pause with a clear picture.

John also wrote a Guide to Improvements which can be obtained free from Roll Cutter. It helps to troubleshoot organs that aren't performing well. See the link to Mel Wright's page below and go to the Articles page for lots of helpful information. John also gets queries from builders which he answers.

Key Assemblies

Pipes

The pipes use a simple design that avoids some complex tapered channel cuts required on the mouth of many flute pipe designs. Cereal box cardboard is used to provide a simple way to get the windway spacing (**Figure 2**).

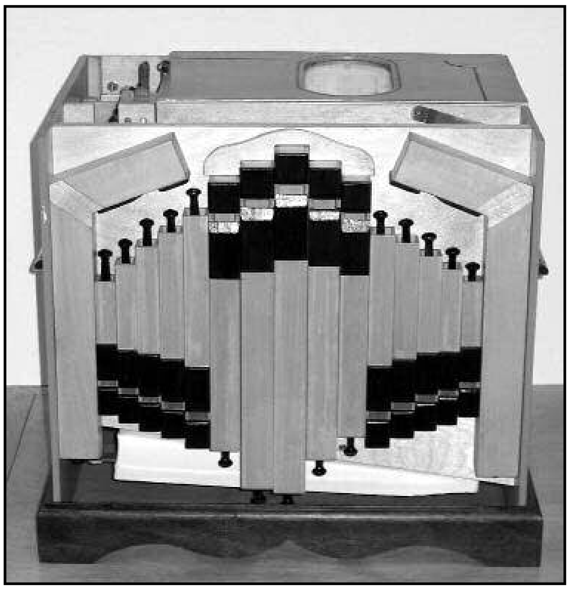


Figure 2. The John Smith organ displaying its pipes. This photo shows the organ without the case—the plans left the case design to the builder.

The plans provide two methods of sizing pipes. One is a scale chart which has slope lines which provide the width and depth of the pipes and horizontal marks for each note that give the pipe length. The other is a table of values in millimeters. I built a spread sheet to compare the two methods. There were some differences in the results, but I ultimately used the values from the scale chart. I used the spread sheet to calculate and list the key pipe part dimensions and checked the combined pipe width which is critical to fitting within the case. The plans and other articles recommend adding 5 to 10 percent to the length of pipes just to give some extra length. I used ten percent. I also added an extra inch to the largest three pipes to allow for mitering. Only one pipe seemed a little short (Number 2 - C pipe), but I still had enough length to tune it.

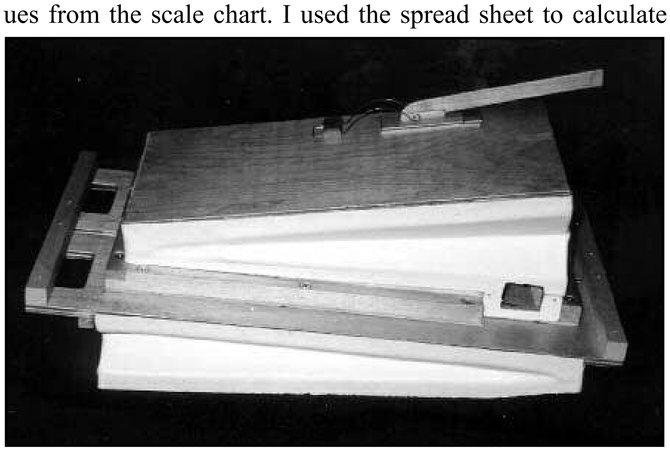


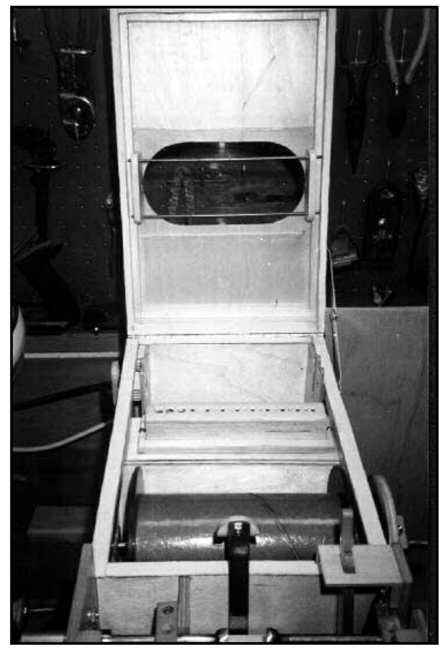
Figure 3. The reservoir and bellows unit.

Bellows and Reservoir

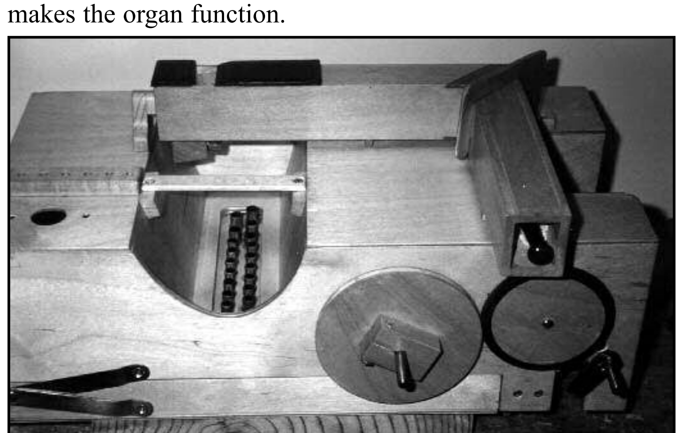
The organ uses double bellows and a single reservoir that sits on top of the bellows (**Figure 3**). The bellows and reservoir are similar in function to those in large organs and band organs. The reservoir has a relief valve and a heavy spring to maintain the pressure.

Pressure Box

The pressure box is the heart of organ and becomes the mechanical backbone of the rest of the organ (**Figure 4 & Figure 5**). It is the most complicated assembly since it holds the roll transfer mechanism, the tracker bar, supports the crank shaft, and multiple wheels and shafts to transfer movement from the crank shaft to the take up spool. There is also a lever mechanism to disengage the take up spool for rewinding, paper loading, and static testing with the test roll. It has the largest number of unique parts. In spite of the complexity, you build it one part at a time and you get this amazing mechanism that makes the organ function.



Figures 4 (above) and 5 (below). Above is the finished pressure box; a C pipe lays on bottom (below).



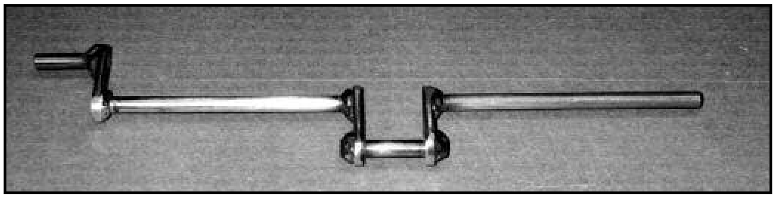


Figure 6. Simplicity is noted in the design of the crankshaft.

Crankshaft

The crankshaft is supported by hardwood bearing in the pressure box (**Figure 6**). It is simple in design and construction, made of ¼" steel rod and flat steel stock readily available at the home improvement store and welded together. There is a crank with a handle on the end and a metal bearing on the case to provide good wear.

Case

The case design is left mainly to the builder. The plans provide the design necessary to build a working organ but not the full enclosure (Figure 2). The main components to the case are the two side panels that hold the pressure box, the pipe board and the base. The design of back, front and remainder of the top is left to the builder. There are lots of examples on Mel Wright's web site to give you ideas. The front is where the builder can put his or her personal touch on the decorations and character of the organ. The finished organs come in all styles with all kinds of personal touches.

I built my case so the top, front panel, and back panel would readily come off so I could show people the inner workings of the organ.

Tracker Bar Assembly

The organ uses a simplified design that eliminates building valves. The paper roll and the tracker form the valves (**Figure 7**). The original design used 4 mm holes except for the last three bass notes where 6 mm holes were used to get enough air to the pipes. The holes in the music roll were also cut to the larger width. The bass holes were also spaced further apart. The paper roll is the same as 31-note Raffin roll but with this unique spacing and hole sizes. The supply tubes are also bigger for the five larger pipes. John later discovered that the size of the holes in the roll for the bass pipes could be reduced to 4 mm by lengthening the holes in the tracker. That is the current design. This information is in the later part of the plans and is referenced from the tracker bar assembly page. The design also provides additional shaping of the tracker bar to minimize the distance in which the air has to flow though the holes. The tracker sits on top of a small box with partitions that channel the air to the metal tubes in the base which connect to the tubing to the pipes. In keeping with using readily available materials the plan recommends using a school ruler for the tracker bar, and cardboard for the sides and dividers. It took some skill to lay out the dividers and holes in the base to get everything to line up. I actually did a number of trial layouts on a computer CAD program to maximize success.

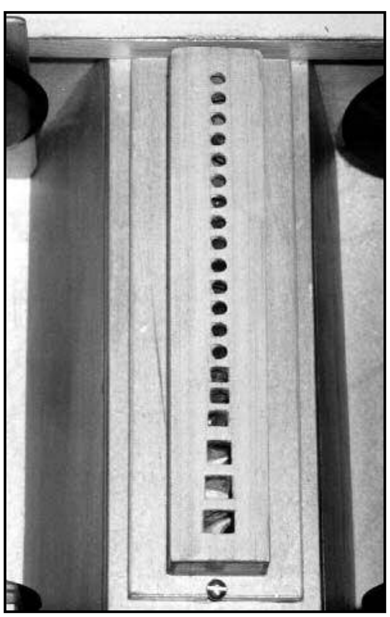


Figure 7. The newly-made tracker bar.

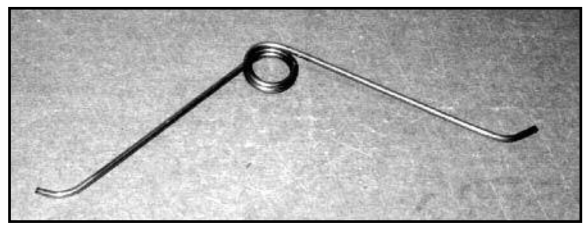


Figure 8. The reservoir spring that maintains pressure in the organ while playing.

Miscellaneous Parts

There are miscellaneous parts tying the major assemblies together. There is the tubing tying the tracker bar to each of the individual pipes and the air supply tube with a connector at each end that goes between the reservoir and the pressure box. There is also the reservoir spring that fits between the pressure box and reservoir to maintain pressure in the organ (**Figure 8**).

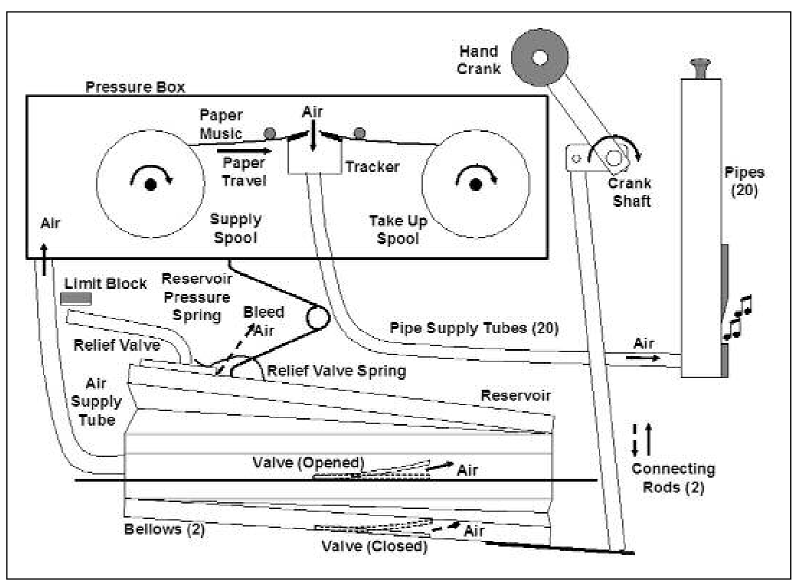


Figure 9. A schematic of the working John Smith Basic 20-Note organ.

Concept of Operation

Figure 9 shows a schematic of the organ. The process starts when the hand crank is turned. The hand crank turns the crankshaft which moves the two connecting rods up and down in opposite directions to raise and lower the bellows. This provides for a continuous supply of air with one bellow feeding air into the reservoir and the other taking in a new supply of air. The flow is controlled by the flapper valves between the bellows and outside air and the reservoir and the bellows. Figure 9 shows the bellow on the upstroke with the reservoir valve open letting air into the reservoir and the bellow valve closed holding the air in the bellow. On the down stroke the value positions are opposite, holding the air in the reservoir and letting new air into the bellow. There is a heavy spring that holds the top of the reservoir down to maintain the pressure in the reservoir. There is a relief valve and a limit block that will tip the relief valve and let air out of the reservoir if the pressure gets too high. This combination helps to maintain a relatively constant pressure. If you look inside of a band organ you will see a similar setup only on a much larger scale.

The air supply then goes into the pressure box which has a sealed lid and houses the tracker bar. There are drive wheels between the crank shaft and the music take up spool. As the crank shaft is turned the music roll moves over the tracker bar. When a hole in the paper lines up with the hole in the tracker bar, the air in the pressure box goes through the hole and through the tubing connected to one pipe and the note plays. After the hole passes the hole in the tracker bar is sealed again and the sound stops. There are 20 holes and individual chambers in the tracker bar which feed the 20 pipes via individual pipe supply tubes.

Time Table

The next MBSI Grind was planned for late May of 2002 so after Christmas I started studying the plans and video in earnest. I had seen builders on the internet that had put their organ together in six weeks so I figured I still had time to make the May Grind. I did a lot of research on Ed Gaida's and Mel Wright's web sites, I looked for wood and leather suppliers, and started figuring out how much material I needed. By the end of February I decided I better get going so I started ordering materials (**Figure 10**).

Figure 10. Material ordered for construction of the John Smith organ.

Finally in mid March I started building the pipes. It took about five weeks to get the basic pipes built. At that point I temporarily put the covers and stopper on one pipe and blew into the air inlet. It played and made a very nice sound. I knew I was headed in the right direction. I had the remainder of the pipe parts built by May, but the final assembly was left until I mounted the pipes and tuned the organ.

By the end of April building an organ in six weeks was looking ambitious and I decided I better get going on the rest of the organ. I started building the tracker bar. I knew that this needed to be built accurately since it had to match the paper music and was one key to the organ working. It took a number of tries to get the holes drilled accurately but I was happy with the final results (**Figure 11**).

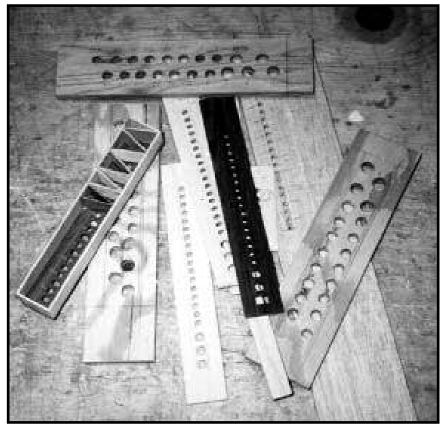


Figure 11. Multiple tracker bar attempts!

By the time the May Grind came along I didn't have an organ but had some pipes and a tracker bar to show to the park visitors. I vowed to have an organ the following year.

I started building the bellows and reservoir in mid-May and had them done by the end of July. A lot of time was spent trying to figure out what kind of stiffeners to use on the bellows. The plans said to use a good quality card the same thickness as a cereal box cardboard but stiffer. I finally used the pressed board that they make Accopress binders out of. Once this was figured out (which cards to use) the leather work went pretty smoothly except for a missed cut. I didn't want to throw that nice piece of leather away so it was patched with fish glue and it has held every since. I did some pressure testing with a manometer (design included in plans) and was amazed how much pressure it would generate. The organ works at a pressure of five inches of water.

Mid-June I started building the pressure box which took till the middle of September to finish, along with building other smaller pieces including the crankshaft. It was relatively simple and I took it to a local blacksmith to weld.

The last half of September I started in earnest to get the pipes mounted. The pipe board was built with the first seventeen pipes mounted on it. That included mitering two pipes.

By the middle of October I started building the case and mounting the major assemblies. In a few weeks the pressure box and bellows were mounted, the connecting rods installed and the bellows working with the crankshaft.

November saw the final assembly and tuning of the pipes which only took a few days. The rest of the month was spent mounting the pipe board, building a rewind mechanism, and connecting the major pieces of the organ with tubing. By the end of the month the organ could play minus two bass pipes which hadn't been mounted yet.

December was spent applying polyurethane to various parts, fine tuning the pipes and mitering the two bass pipes to fit inside the cabinet.

The first week of January I was able to mount the two bass pipes and finish the basic machine. At this point the case was basically two sides and a partial back and top formed by the pressure box. Now came some of the creative work. I spent three weeks building the rest of the case including the back, front, and top. A lot of time was spent looking at other John Smith organs on the internet. For the base and front I came up with some curved patterns for the wood.

By the first week of February all the wood working was done including removing some interference between parts. I spent a lot of time picking a color. I was trying to match the antique red color of Bill Schaffer's Raffin organ. Unfortunately, the picture I used was taken in bright sun light so it looked a shade brighter than it really was. So my organ came out a little rosier than I had planned. The end of February the decoration and reassembly were completed. I re-tuned the organ and declared victory, after almost a year of building plus additional planning before that.

Improvements

Elbows

The design of the organ has holes drilled in the pipes and the air tubing friction fitted in the holes. This seemed like a fragile arrangement. I thought it would be sturdier to have the tubing on brass nipples. Ed Gaidia used this approach on his organ with elbows with brass tubes (**Figure 12**). I adopted that design. The elbows were built in sets—drilled sets of intersecting holes in a length of ¾" maple. The hole for the brass nipple was drilled at 15 degrees to provide some clearance between the tube and the pipes. I drilled all the holes with adequate spacing for each elbow plus the width of the table saw blade. When the holes were all drilled I the cut the wood into individual blocks. This beat trying to hold and drill each individual elbow. The brass tubing was then epoxied into the holes. The last five elbows were slightly wider to accommodate the larger tubing on those pipes.

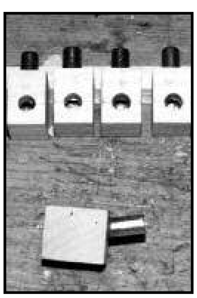


Figure 12. Elbows with brass tubes for tubing each pipe.

Pipe Mounting

The plans show that the smallest 10 pipes are mounted with small wood screws. There were also 1/8" plywood plates on the back of the pipes to provide more material to screw into and to hold the air tubing. I felt like using the small screws would not be very strong, and I would have to be careful in assembly not to pierce the pipe wall. This would also not allow for many removals and reassembly of the pipes. Instead I used small T-nuts to mount the pipes (**Figure 13**, middle, right). They mate with 6-32 machine screws which gave good strength and unlimited chances for removal and reassembly. I drilled a slight depression on the inside surface of the backing plates with a forstner bit to accommodate the T-nuts and then glued the fixing plates on the back of the pipes. The solution has worked well. I have seen similar schemes where other builders have used small hex head bolts attached to the back of the pipe.

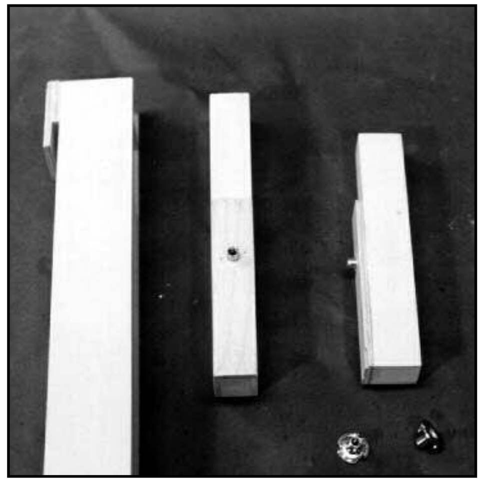


Figure 13. Pipe mounting examples.

The next five pipes in the middle of the pipe board hang upside down with wood hooks and a hold down bracket, and stay very sturdy (**Figure 13**, left).

The plans were unclear on how to mount the two largest accompaniment pipes on the front panel. Similar techniques were used as was done with the smallest pipes, but the smaller pipes are held away from the pipe board by the thickness of the backing plates. For better support I cut holes in the mounting board to accept the backing plates and then I screwed cross pieces over the T-nut to overlap the pipe board. This kept the pipes against the pipe board (**Figure 14**).

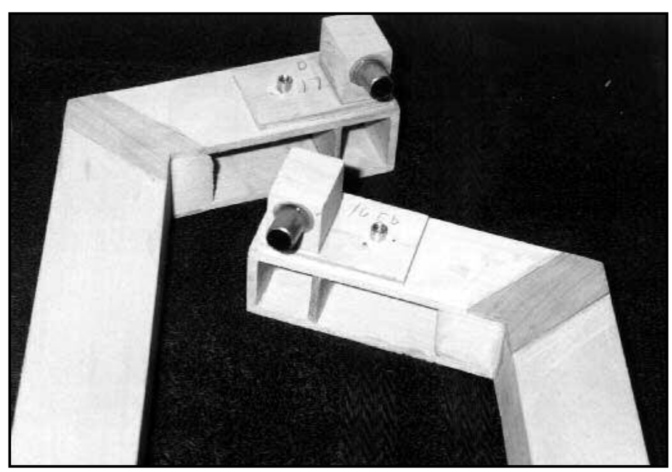


Figure 14. Technique of mounting the two largest accompaniment pipes on the front panel of the organ.

Friction Wheel

On the crankshaft is a friction wheel that drives an idler wheel that drives the take up spool. The position of the friction wheel on the crankshaft means that a solid wheel can not be put onto the crankshaft. The plans recommend that the wheel be made by wrapping a strip of cardboard around the crank shaft until the desired diameter is achieved. It seemed like it would be difficult to get a nice round wheel and there would be a bump at the point where the winding stopped.

Instead a dowel was used that was slightly larger in diameter than the design size, mounted it with a bolt in the center on a drill press and used sandpaper and a file to reduce the diameter to the desired size. I then used a forstner bit to drill a slight depression in the wheel to fit around the weld on the crank shaft. Then I took a chisel and split the wheel in half and then glued it back together around the crankshaft (**Figure 15**). After the glue dried I epoxied the wheel into place on the crankshaft around the weld. This worked really well and provided a nice round wheel.

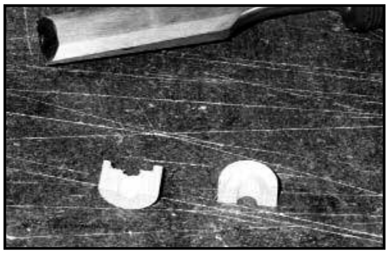


Figure 15. The fraction wheel in process of assembly.

The design uses sandpaper glued on the friction wheel to drive the take up spool. I used an abrasive from a belt sander since it is cloth and more flexible. When applying the abrasive I used a 45 degree joint instead of a butt joint and slid the ends sideways to make a nice tight joint.

Spool Holder

I found that the plastic rims on the Raffin spools are not perfectly flat—they would drag on the spool holder even though they have a small plastic ridge molded on end to prevent this. To fix this a thin wood disk was cut with a wheel cutter on the drill press. I then glued it on the spool holder and cut the notch where the spool drops into the holder (**Figure 16**). Adjusting the spacers on the holder to maintain paper alignment eliminated the dragging problem.

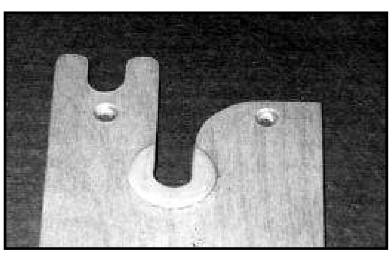


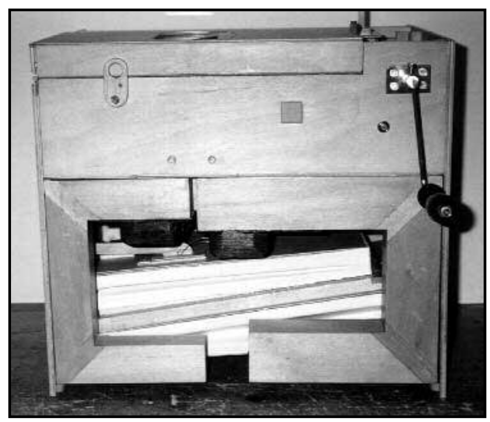
Figure 16. Spool holder design.

Problem Areas

Bass Pipe Interference

A common problem seen with some organs was fitting the two bass pipes in the organ case. The design is to have each of the pipes mitered into a U shape and fitted into the case with the bases touching and stoppers pointed at each other. The problem was when you get the pipes long enough to tune to the proper tone the stoppers would touch. A third miter would then have to be put into one pipe so the pipe would be in a modified "P" with the stopper at a 45 degree angle to the other stopper.

Figure 17 (above) and 18 (below). Bass pipes fit in the case with the "ears" added to the pipes.



In the plans and the video John recommended putting card "ears" on the bass pipes by the mouth to lower the pitch without making the pipes longer and also reduce the effect of the back cover. I experimented with ears and found they lower the pitch by about a half a note. Using the ears I have was able to cut a significant reserve off the length of the pipes and easily fit them in the case without the extra miter (**Figures 17 & 18**). I tell everybody I talk to that the "ears" are a key part of the organ.

Dimension Errors

Some earlier builders had experienced some problem with some measurements in the plan being inaccurate. Doing some calculations and using cardboard prototypes in those areas, everything looked like it was correct so I just went along building and hoping everything would work. An e-mail or call to John or to other builders would have cleared up the problem but at the time I was new to the hobby and didn't know how helpful everybody in the hobby was. I went on building for about nine months with the fear that I would have to put an ugly patch in the organ or have to go to extraordinary measures to get the bass pipes in the box.

When I built the case I added a couple inches to each dimension of the end panels to allow some room to install the bass pipes. The final dimension for the case depth ended up only a little deeper than John's to allow room for the pipe elbows and a little taller to leave a little more room for the connecting rod travel. The case width was the same as the plans since it was dictated by the pressure box and pipe board sizes. When I got everything fitted I ran the whole organ through the table saw and ripped off the extra material on the sides, after coverings up the mouth of the pipes with masking tape to keep them clean.

Bass Pipe Mounting

The inlets to the two bass pipes are right below the tracker assembly in the pressure box. Builders have had difficulty connecting the final two pipes. Ed Gaida has a picture of this problem on his on his web site. Ed put in an intermediate wooden block that went to the tracker bar and then used brass nipples on the bass pipes with a friction fit into the wooden block. This problem also slowed me down. I used a similar approach to Ed's. I built a small "windchest" (**Figure 19**) with a removable top and a divider in the center and brass tubes out of the bottom to go to the tracker assembly and holes in the top to fit brass nipples from the two bass pipes.

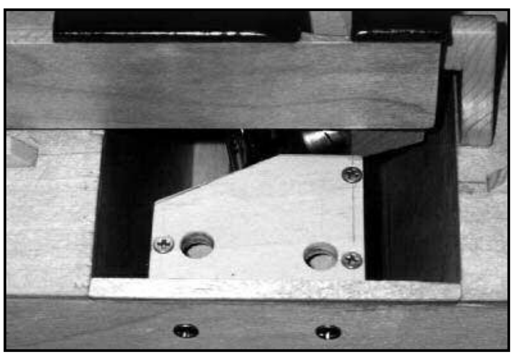


Figure 19. Windchest detail.

To install it I put pieces of clear plastic tubing on the wind chest cut to the proper length. Then I put dowels down the center to keep them from bending. I heated then up with a hair dryer to make them soft and pushed the wind box and tubing down on the tracker bar tubes while they were soft, then installed the top on the wind chest.

I epoxied brass tubes to the bass pipes to go into the holes in the wind chest, making the holes on the wind chest a snug fit. I also put some leather washers on the tubes to provide a better seal. The tubes in the bass pipes must be glued in exactly perpendicular or you will end up drilling the holes in the wind chest at a compound angle to get it to fit. I know this from experience.

Connecting Rod - Idler Wheel Axle Interference

The organ has a simple drive mechanism which has a friction wheel on the crankshaft, a drive wheel on the take up spool and a movable idler wheel in between. The idler wheel is on the end of an axle that runs the width of the pressure box that is loosely attached with screws through the pressure box and a small piece of leather on the inside to allow it to pivot. The idler wheel is held against the other two wheels with a spring and has a lever to push it down when you want to disengage the drive for rewind. When the organ was assembled the center connecting rod hit the idler wheel axle. I had put a "U" in the axle so the two would miss (**Figure 20**).

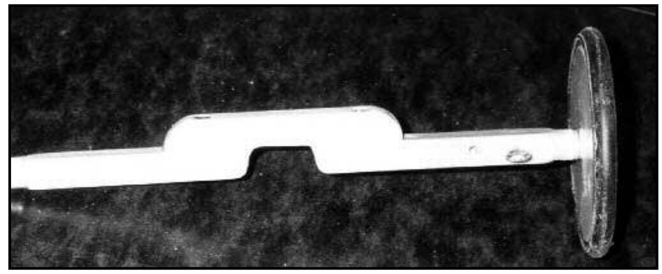


Figure 20. A "U" placed in the idler wheel axle to prevent contact with the center connecting rod.

Looking at John's video recently, there is very little clearance in this area even on the original organ. I also noticed that my connecting rod was bigger than John's at the crankshaft end. The connecting rod needs to taper down quickly after the crank shaft hole leaving more for the axle.

Crank Handle

The plan recommends using 3/16" rod as the crank handle (**Figure 21**). After a lot of use I find my crank arm bent in towards the case. This is easy to bend back out but not a desirable situation. The crank arm needs to be a little thicker and or use flat brass stock. Other than that it is a sturdy machine.

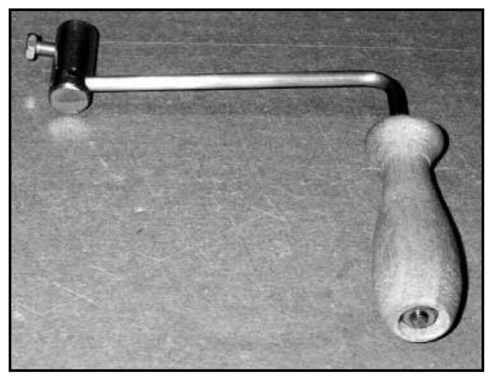


Figure 21. The organ's crank handle.

Roll Hang-ups

When I first played the organ every so often it would get stuck on a note then move on. I kept looking at the drive mechanism and couldn't see anything wrong. Finally I looked at the belt around the idler wheel and noticed the word *Hoover* in small raised letters along the length of the belt. I took a small file and removed the letters and never had the trouble again. The letters were pushing the idler wheel belt away from spool drive wheel causing the skip.

Pipe Cut Up

The plans say to cut the base of the pipe and languid (shelf to form the wind way) from the front strip on the pipe and this would leave a suitable aperture on the front of the pipe. This worked well for the smaller pipes, but for the larger pipes the

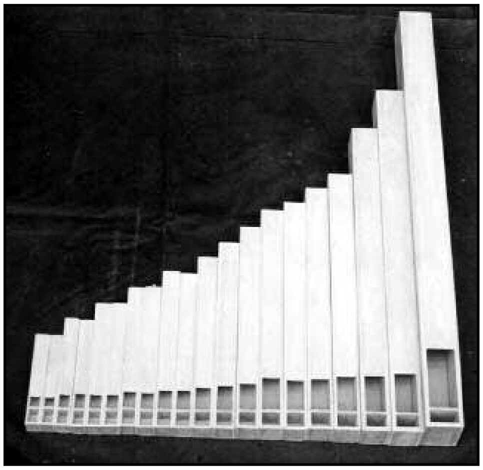


Figure 22. Pipe cut up details.

opening was too large which required using quite long front covers (**Figure 22**). This also presented a problem for the some of the mitered pipes with the miter close to the cut up opening (**Figure 14**). For the larger pipes this cut up could probably be smaller.

Part II of
"**Building The John Smith Organ"**
(including sections on "Building Techniques," "Tools," "Materials," and "Results")
will appear in the next issue (#25) of the
Carousel Organ.

Links

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8). For small power tools Micro Mark (I have no experience with this site) at www.micromark.com.

Paul Senger is a systems engineer from Maryland and has built a John Smith organ. He has been interested in band organs since childhood and has collected mechanical musical instruments since 2000. He is also interested in crank organs and nickelodeons.

COAA Rally
St. Joseph, Michigan — August 26 to 28, 2005

Be sure to hold the last weekend in August open for the rally in St. Joseph, MI. This should be a really exciting time for all. The larger organs will be placed in a park on a bluff overlooking the convergence of the St. Joseph River and Lake Michigan. The smaller organs will be placed around this popular town and accented by the 53 replica Carousel Horses scattered throughout in support of the Silver Beach Carousel Association, which hopes to place a carousel by next year. Carousel organs, Carousel horses, wonderful views and a great city. What could be better?

How about a Friday party in a converted factory that has been converted into a theater and is so unique that it has been featured on HGTV's Building Character program? What is so good about that, you may ask: how about a theater pipe organ--how about three of them? There is a Wurlitzer three-manual console that will be restored, a four-manual Grand Barton that may be playing 30 ranks at the time of the party (depending on if I can get it done by then) or at least a three-manual Grand Barton playing 14 ranks. Tours of the organ will be available. This will be a lot of fun.

How could this be better? How about Saturdays' dinner in another park, this time along the St. Joseph River in a relaxing setting. Watch a baseball game, walk along the river or just relax in this serene setting. That and good food and friends.

The city has really gone out to support this rally. The Bayonet Inn has given us VERY good rates for lodging and many of the local businesses have given us discounts on their food or products. Look for the coupons in your packet upon check-in. Also be sure to take the free horse drawn wagon ride around town and consider a ride on the trolley of the local area also. If you want to venture out, there are many antique shops in the area and this is considered the center of Michigan's wine country. Contact the visitor's center about winery tours locally at one of our award winning wineries. This will be all about fun. Both, for us, and for all the people coming to attend the rally.

Hope to see you here.

Jim & Donna Partrick, Hosts

Building the John Smith Organ
Part II

Paul Senger

Building Techniques

Wheel Cutting

I had to cut a number of round wheels for the take-up spool and the drive mechanism. I used a band saw with a technique I've seen on television and woodworking magazines. A short piece of dowel or metal rod is put in a hole drilled in a thin piece of wood attached to the band saw table and aligned with the band saw blade. It is clamped at a distance from the blade, equal to the radius of the wheel. A square blank is cut to the width of the wheel and a hole drilled in the center. The blank is then put on the dowel and rotated on the shaft to cut the wheel. I then put a bolt in the center and put the wheel in the drill press smoothing the edge with sandpaper.

Wheel Notching

Some of the wheels required notches to accept rubber belts. To cut the notches I put a bolt through the center of the wheel and placed it in the drill press. I clamped a small round file between two pieces of hardboard spaced the same distance as the thickness of the wheel. With the drill press spinning I was able to file the notch in the wheel with the hardboard guides keeping the file centered.

Spring Winding

Winding the reservoir spring was a fun project. It is made of music wire. One characteristic of music wire is when you wrap it on a form it will spring back a little towards its original shape so you have to bend it past where you want it to end up or use a form smaller than the desired size. I made a trial run with coat hanger wire which is about the same diameter as the music wire, then I wound the real spring.

I used the winder on Mel Wright's web site design by Charles Darley. It uses a ½" center post with a forming handle. It has a bolt with a hole in it to hold the wire in place while forming it. This is very important. This must be kept snug or the wire will be pulled into the forming tool as you rotate the former, and the spring will come out longer than you intended. Charles made his tool out of steel. I used ¾" plywood for base but by the time I was done I had severely bent the forming post over, pulling the bolt of the forming post into the wood. Making it of some scrap metal is much better.

Crank Shaft Jig

I built a jig to hold the pieces of the crank shaft in place for the welder (**Figure 23**). I used a table which cuts an 1/8" kerf to cut slots for the flat iron pieces on the crank arm in a piece of pine. I nailed some blocks of wood perpendicular to the slots to keep the shaft aligned. One mistake I made, was to have both crank arms gong the same direction instead of opposite directions. Luckily this was caught before I took it to the welder. The welder was pleased with the jig and probably glad he didn't have to align all the pieces himself. On final assembly a slight tap with the hammer was given on one end to make it run smooth and true between the bearings and the brass plate on the side of the case.

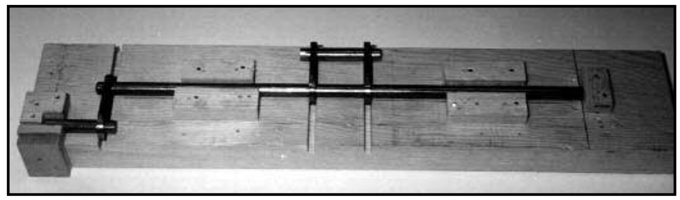

Figure 23. Crank shaft jig.

Tracker Spacing

Drilling the holes in the tracker bar with accurate spacing was critical. The plans recommend marking the holes on the top of the bar with a steel rule then drilling them. Using an awl to carefully mark the holes and a brad point drill bit, the spacing was still uneven. I devised a technique to make the holes very accurate. I taped a steel rule to the fence on my drill press, put a pencil line reference mark on the tracker bar, and slid the bar to line up with the correct measurement on the ruler. I built a spread sheet which gave the cumulative measurements for each hole which made it easy to line up on the ruler (**Figure 24**). I drilled a hole with a brad point drill bit to get a starter hole to prevent wander and then came back and repeated the process with the correct size bit to get holes to the final size. This gave me accuracy close to less than a pencil line's width. It is important to back up the bar with a piece of scrap wood for each hole to prevent breakout. I first tried walnut for a nice contrast of woods but found it splintered easily and cause breakouts between the closely spaced holes (using maple worked well for this).

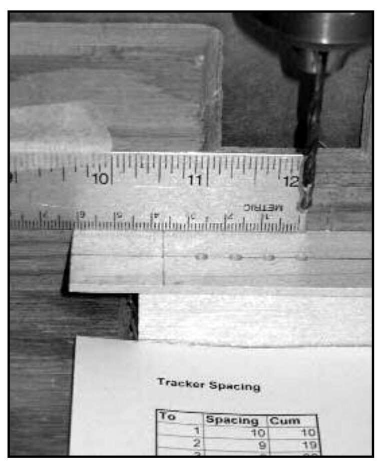

Figure 24. Accurately drilling tracker bar holes.

Allen Wrench for Spool.

The Raffin spool has a hexagonal hole on the end for the rewind. This fits a 5 mm hexagonal Allen wrench perfectly. I cut a short length off with a hacksaw to epoxy in the rewind handle but it is hard steel. I understand it is better to grind notches in it with a grinding wheel, break it off, and then grind it smooth.

Test Roll

The first roll you will need for your organ is the test roll for tuning the organ and at least one tune roll so you can enjoy the fruits of your labor. The plan says the test roll is included but I never found one. Music for the organ is available from Mel Wright as paper masters you use to punch your own rolls and Ed Gaida who sells the punched rolls and provides a quality product and prompt service. I buy my music from Ed.

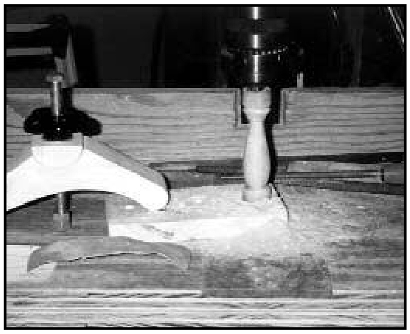

Figure 25. Shaping of the handle. The pivot on the table holds it stable.

Crank Handle

For the crank handle I traced the winding handle off of a Regina disk music box and used it as a guide for my handle. I set up the drill press as a vertical lathe to cut the crank handle and used various files to shape the handle (**Figure 25**).

Final Pipe Assembly

The pipes are initially built with the hardwood front covers attached temporarily with rubber bands to allow for final sizing, mounting and finishing. You first need to sand the pipes so the combined width fits the pipe board. Lay out and attach the pipes to the pipe board before the final assembly and tuning. Next, remove the pipes from the pipe board and tune them individually.

To voice the pipes, I connected the reservoir outlet to a simple wood manifold I built with an outlet to a manometer to monitor air pressure and an outlet to the pipe I was tuning. That way I was tuning the pipes using the organ air supply and able to monitor the pressure (**Figure 26**). I used the *TUNE!IT* computer program along with a small microphone to tune the organ.

Figure 26. Using a manometer to monitor air pressure in the pipe.

I initially put the covers on with rubber bands close to their final location and used the *TUNE!IT* program to adjust stopper to the correct position. That way I would be adjusting the covers with pipe speaking as close a possible to the final frequency of the pipe.

When you are ready to tune the pipes the first thing is to glue on the cardboard wind way spacer and the lower front cover. Bob Stanoszek's book on the Wurlitzer Band Organ shows that the cover is 1/64" over the block on the melody flute pipes. Using this as a guide, I tried to glue the covers on just even with the top of or slightly above the languid. Gluing them below would increase the wind way due to the rounding of the front of the languid. I built a little jig in the shape of a "T" so I could mark the position of the languid on the front of the pipe. Then putting the leg of the T against the languid with the cap of the T resting on the pipe edge, I drew a line that showed where the top of the languid was. I then placed the lower cover, just up to the line or partially covering it.

Once the lower cover was on I attached the top cover with a rubber band and slid it up and down for the best sound. When hearing the best tone I marked it with a fine pencil and then glued the covers on. You may want to do the first few one at time until you feel comfortable with the process. If you start with the cover wide open you will get a thin sound. As you slide the cover down the sound will improve to a nice tone. As you continue it will start breaking up, get real airy, and high pitched. Then you can slide the cover back to the spot where it gives the best sound. You can do this a couple of times and put a mark for each try. You will find the marks will be pretty close together. The top cover gets glued on at the mark. After tuning, I cut the pipes so they all had the same amount of the stopper pulls showing. I used a cardboard template for this.

Case Decoration

I had thought about decorating my organ with the painted designs like I had seen on the Raffin organs. I started looking for stencils or decals I could use. I didn't find any that were suitable. I didn't know anyone that painted and I knew that it would add months to the build if I tried it myself. I was inspired by Burl Updyke's organ. He used a simple painted case with applied wood carvings. I decided to go with that approach along with some gold accent stripes. The wood carvings are readily available at the home improvement store and wood working catalogs.

Having seen a striping tool in catalogs that has a bottle and rollers of various widths to roll on the strip, I went to the local crafts store but could not find one. I did find a metallic gold marker that I could use. I had learned in drafting class in high school from using India ink that I could not just run the marker against a ruler without having the paint flow underneath the ruler by capillary action. To do the job I built a tool (**Figure 27**) out of scrap wood to hold the marker in a vertical position. It had an adjustable "L" shaped rod that rode against the edge of the case to give nice lines parallel to

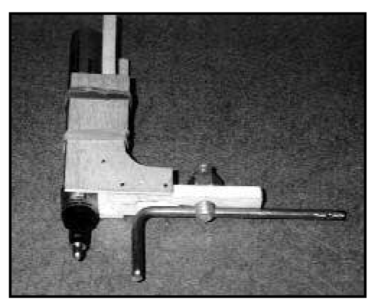

Figure 27. The home-made striping tool.

the edge of what ever I was decorating. It even worked on curved openings. I used masking tape at the end of the line to make sure I got a clean stop. I drew radii by placing the L rod in a hole in a strip of wood. To stripe around the pressure box window which was already installed I removed the L rod and install a thin strip of plywood as a guide to paint the stripe.

Tools

My 10 inch table saw was the most used tool on the project. There were thousands of cuts starting with ripping the wood for the pipes. It gave cleaner cuts than my band saw. Many times small pieces were gingerly pushed through the saw and sometimes fell between the blade and the table or thrown back at me with a chunk missing. I considered getting a mini table saw but never got one. If I were to every build another organ I would think seriously about one. Craig Landrum discusses his experience with his microLux saw from Micro Mark on Mel Wright's web page.

Another tool I used a lot was my drill press. There are a lot of holes to be drilled. I also used the drill press for smoothing wheels after I cut them out and as a vertical lathe to shape the crank handle. I used my forstner bits a lot to give clean holes and also brad point wood bits.

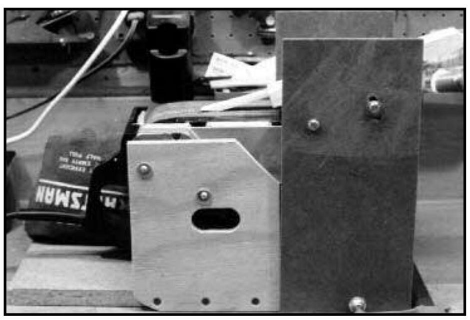

Figure 28. A jig built, using a belt sander and an adjustable guide, to taper pipe covers and pipe fronts.

The pipe fronts and pipe covers needed to be tapered (forty tapers). To do this, I built a jig to mount my belt sander up side down and built an adjustable guide to hold the wood and set the proper angle (**Figure 28**).

The band saw was used mainly for cutting wheels and curved pieces such as connecting rods and the cabinet base. I had trouble making long straight cuts on the band saw. If I had to cut a large hole in plywood I would usually drill out the corners and center with the forstner bit and then cleaned it up carefully with a file.

You can never have too many clamps. I used a lot of clamps in gluing the pipes and bellows pieces. I also made a jig for gluing the pipes. I set up two boards at a right angle to allow me to have support to keep the pipes square and used pairs of wood shims to quickly hold the different size pipes against the jig. Even with all the effort I still had some pipes that weren't perfectly square (**Figure 29**).

I used a CAD program to lay out cuts for the major parts to figure out how much wood I needed. That was about 160 pieces. It was also a time saver for laying out the partitions and air tube holes for the tracker. I laid out full size patterns for cutting the leather for the bellows and reservoirs which I printed accurately on laser printer in sections and taped together. I also made a dimensioned drawing of the crank shaft for the welder.

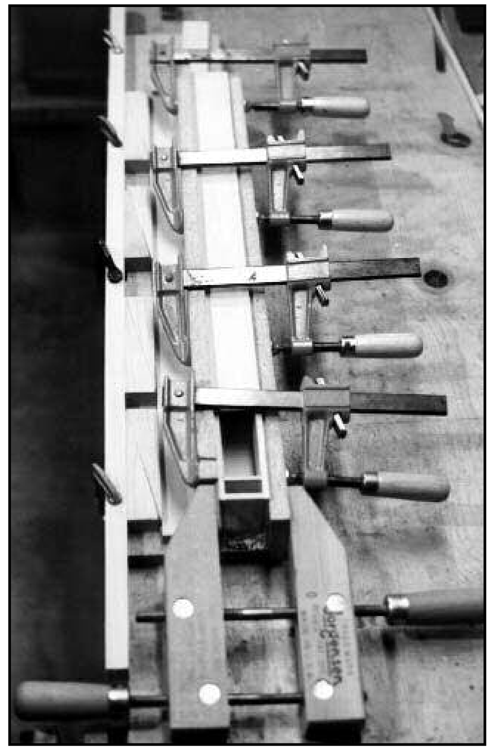

Figure 29. A jig made to hold the clamps squarely against a glued pipe.

When designing the case I used the CAD program and Power Point to design various facades for the front trying out different colors and shapes. I did a lot of trial and error for the grill holes on the back of the organ and the decoration on the base. Ultimately the best tools for developing the curves on the front were my old French curves from drafting class. I also used a thin strip of wood under tension to draw some spline curves on the base.

Microsoft EXCEL was used for a photographic log, to keep a parts list, track costs, keep a work log and calculate the sizes of all the pipe pieces.

I used the TUNE!IT program by Detlef Volkmer from Australia on my computer to tune the pipes. It displays the frequency, the note, the number of cents from the desired tone and a spectral display of the sound. It can be set for various temperaments.

Results

It was a long project but I learned a lot of new skills including working with leather, organ building and tuning, metal working, and spring making. I'm now having a lot of fun playing the organ for people.

The hardest part of building the organ was to know what materials and dimensions were critical. Sometimes I made it harder than it had to be by rethinking the design. A lot of time was a spent sitting in front of the computer or a sheet of paper planning a part of the design when going to the workshop and building a few prototypes would have been easier and more fun.

Parts Count

I kept track of the parts in the organ. There were 901 of which nearly a quarter were fasteners. Some of the parts count was driven by my design changes but I estimate that there are still nearly 800 parts in John's basic design including about 300 parts in the pipes alone and 200 in the pressure box not including the tracker assembly and crank shaft.

Cost

I purchased $588 in materials. When I thought I was going to build the organ in 6 weeks I ordered a lot of extra wood. Taking away the extra material, in whole pieces I didn't use, I still spent $439 on materials. Some of the difference from John's target cost can be attributed to leather versus cloth covering on the bellows, use of Baltic birch plywood throughout, use of basswood versus balsa wood for the pipes, walnut versus pine for the base, costs for the top, front, and back panels, elbows on the pipes, and finishing materials.

Rallies

I took my organ to nine rallies or demonstration in the first two years I had it (**Figure 30**), plus I showed it to friends and neighbors. I had lots of good comments on it from visitors to the rallies and from experts I respect within the mechanical music field. Adults, and kids a like, love to crank it. Older people love the music and the sound because it reminds them of earlier days.


Figure 30. The author with his completed John Smith Organ.

Meeting John Smith

In 2003 my company sent me to England on a trip so I took some extra time to look up John Smith (**Figure 31**). I met John and his wife Julia. They took me to the St. Albans Organ Museum. John also took me to see some organs in the area where he lives. I had a change to discuss organ building with John and see some of his other organs.

Figure 31. John Smith and the author (on a visit to England).

Materials

John Smith wanted the organ to be build with readily available materials. Some of the unusual materials he used include: bamboo skewers for pipe stopper handles; weather stripping for pipe stoppers and gaskets; a school ruler for the tracker bar; a vacuum cleaner belt for idler wheel tire; an English penny for the crankshaft bearing on the case; rain water downspout for the take up spool; a large binder clip for the reservoir spring, wire coat hanger for the lid paper tensioner; flexible electrical conduit for the air supply hose, and blackout cloth for the bellows and reservoir covering.

Leather

I purchased my leather from Columbia Organ Leathers. I used the Columbia Pneumatic Leather (CPL) Gusset Leather—Medium for the bellows. This is what Burl Updyke and Jim Meyer used. I wanted to get a skin big enough so I could make the longest pieces without a splice. I receive a piece that was almost seven square feet. It was actually big enough for two organs. For the stoppers I used CPL Split Leather. I also used it for gaskets between the bellows and reservoir and as the seal in the pressure box lid. I have had no problem with leaks. For the flapper valves in the bellows and reservoir I used the Columbia Goat Leather (CGL) Valve—Heavy. It is buffed on both sides and has provided a good seal. You don't need much but the skins are relatively large, so you are paying a lot for what you need. I also used their Fish Glue for attaching all leather to the wood.

Wood

John Smith used balsa wood for his pipes. That makes the organ lighter and easier to cut with a hobby knife. Other builders used basswood so I choose that. That meant using a table saw to build all the pipe pieces. The original plans used balsa for the languid in the pipes then adding a small strip of hardwood to gave a durable material to be shaped to form the wind way. I also used solid maple to form the languid. I also used maple for the crank shaft bearing, connecting rods, tracker bar, drive wheels and anyplace else I wanted wood that would wear and be strong. I used walnut for the pipe covers, pipe ears, and the organ base. I used Baltic birch plywood for the case, pressure box, bellows, reservoir, back plates on the pipes, and tracker assembly base. I used pine mainly for battens.

I bought my basswood from National Balsa. It was available in the thicknesses that were recommended in the plan. It was very stable wood. The relative thin sheets stayed flat even a year after I got them. I had initially bought some basswood from a local wood supplier who had to cut it to thickness from a larger block. It cupped soon after I had it. Itasca Wood Products was recommended by another builder. They had good prices but not the 3/32" thickness wood used in the smaller pipes and I don't own a thickness planner. Balsa and basswood are available at hobby and craft stores but the prices are steep.

As part of writing this article I built a balsa pipe just to see how it worked. It sounded good. I found that getting nice square cuts on balsa wood with a hobby knife was difficult.

Metal

I used the K&S Engineering Metal Center at the hobby story for the brass tubing, flat brass, and music wire. Craig Landrum found On Line Metals is a good site for the brass in small quantities.

Tubing

I used plastic tubing from the home improvement store to connect the pipes. I know that drives all the purists "nuts." I looked into getting some neoprene tubing but it was not available locally. Since I thought I was on a short build schedule I went with the quickest option. For the main connector pipe I wanted to get the flexible tubing I had seen in Raffin organs which looks like it is a fiber material. I couldn't find that. I ended up getting some clear plastic tubing with spring metal support which was very flexible. I took advantage of the internal spring by drilling the mounting holes from two sides leaving a small lip so the spring would literally screw in for support. I sealed it with silicon sealant (**Figure 32**).

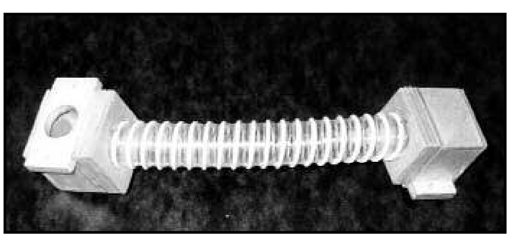

Figure 32. Spiral tubing for the wind supply with a connector on each side.

Other materials I used were; mailing tube to make the take up spool; tempered hardboard for the take up spool ends; brass tube for the pipe and tracker air tubes to connect to the plastic tubing; Lexan for the pressure box window; music wire in various sizes for the reservoir and the relief valve springs; a faucet washer for the idle wheel axle mount; Shaker pegs for the pipe stopper handles, 31-note Raffin spools for the supply spools; and rubber weather strip to seal the supply tube connectors.

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