Build a MIDI Interface for the Raffin Crank Organ
(Part 1)

Mike Knudsen

I would like to describe how I built an interface into my Raffin 31-note organ that permits it to be played from a personal computer or MIDI sequencer as well as the original paper rolls. I still get to crank the wind and change stop registers. This article can be used as detailed instructions to build the interface for your own Raffin 31/84, or modified to fit your different model organ, or used as a bag of tricks to design a MIDI interface for almost any pneumatic instrument.

Why build this? A MIDI organ interface lets one:

· Audition and perfect your musical arrangement before committing to hours or dollars to punch a roll;

· Perform music outdoors just like the chip-operated organs, using a laptop PC or portable MIDI memory box and a battery;

· "Hand play" your organ for tuning and testing or just for fun -- play church hymns like "a real organ," using a small, portable, cheap electronic keyboard. Play along with a roll!

My interface hardware can be adapted to any instrument whose notes are triggered by opening a pneumatic tube to the atmosphere, whether vacuum or pressure. This includes all roll-operated organs that do not enclose the tracker bar in a pressurized box, player pianos, some organettes, and all keyless book organs.

My interfaced Raffin organ has been shown at the 2003 COAA rallies in Jamestown, NY and Franklin, PA. Note that my design does not read rolls and transfer them to MIDI. That is a bigger project, though others have done it.

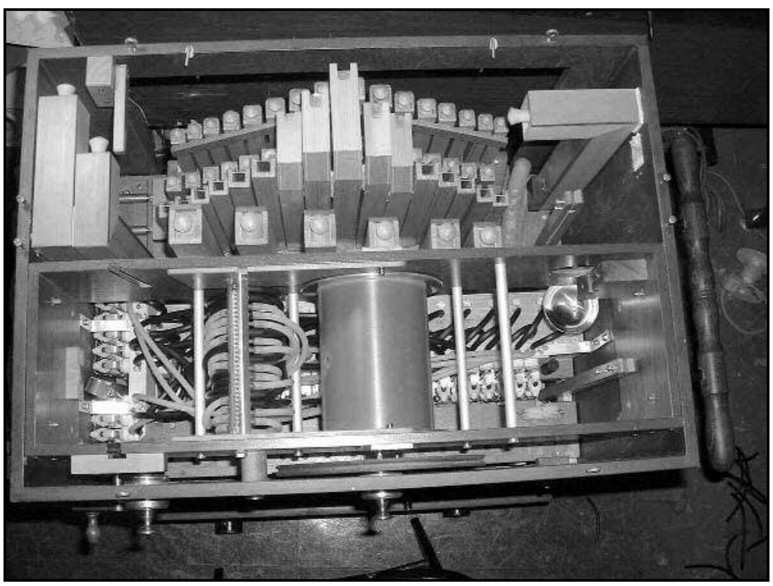

Figure 1. The MIDI interface tucked under the roll frame in a Raffin 31/84.

Design Goals

· The MIDI interface has to be built of readily available (by mail order) parts. Total cost is under US $300.

· The interface must be self-contained within the organ, as shown in **Figure 1**.

· The interface can be removed and the organ returned to original condition. The project must not disfigure the organ irreversibly. My design lifts in and out as one solid unit (**Figure 2**).

· The interface cannot interfere with the original roll playing operation, and can be quickly converted between MIDI and roll operation. In my system, you simply put a piece of tape over the tracker bar to use the MIDI, and remove it to play rolls. Or play along with the roll!

· No exotic skills or tools are required for construction. Electrical soldering and careful woodworking are needed, with a drill press, table saw, and electric hand drill. Borrow a friend's skills and tools if needed.

· The interface cannot block access to important adjustments for pipe tuning and the windchest's bleed screws, which will need careful tweaking for proper roll performance.

· The interface should not add too much weight to the organ. Mine came in at only five pounds.

How It Works

The original instrument has a piece of tubing for each note, running from that note's primary valve to its tracker bar hole. When the paper roll or book opens that hole to the free air, the vacuum or pressure in that tube is let out; a diaphragm or piston in the windchest senses the pressure change and operates a valve to blow that note's pipes.

My scheme interposes or "tees" an electromagnetic valve in each tube, between the organ's valve chest and the tracker bar. When the computer signals that valve via a MIDI command, it opens and breaks the pressure or vacuum in the tube the same as a roll hole passing over the tracker bar.

The brains of the interface is a small printed circuit board that receives the MIDI commands from the computer via a simple cable (**Figure 3**), and translates the commands into electrical drive currents to the individual note valves.

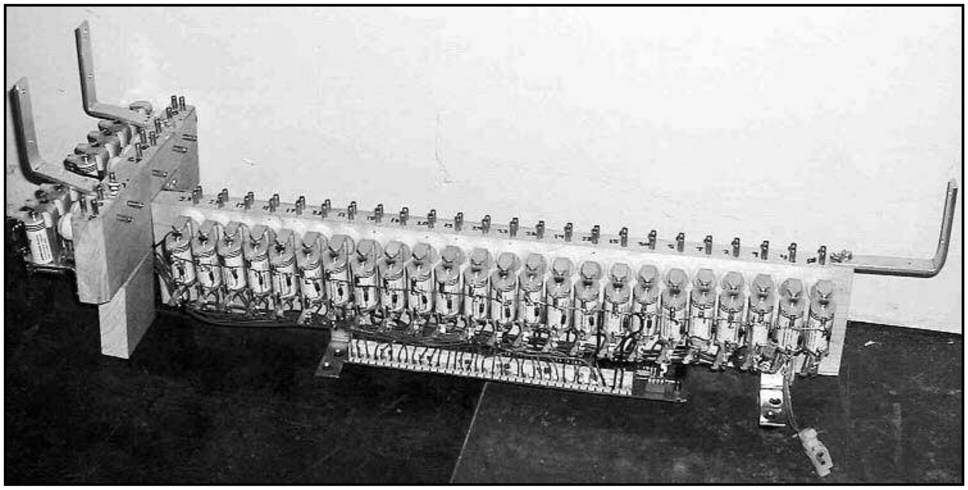

Figure 2. The entire interface unit, with brackets mounted and power plug exposed.

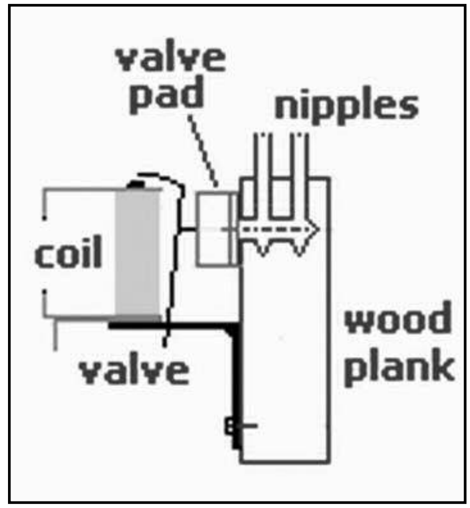

Figure 4. Diagram of a valve with "Tee" made from three drilled holes.

What You Need And Where To Get It

- · MIDI decoder circuit card from **jW Enterprises** (pronounced "jay-omega"), run by John Wale in the UK (http://www.j-omega.co.uk/)
- · Direct-electric valves—90 ohm coil, 5/8" (smallest size available), from **Peterson Electro-Musical Products** (http://www.petersonemp.com/)
- · Direct-electric valves also from **OSI (Organ Supply Industries)**, Erie, PA (http://www.organsupply.com/) tel. (814) 835-2244
- · 5/32" OD brass or copper tubing—local hardware or hobby shop.
- · Wire, cable, solder, connectors—local **Tandy Radio Shack** store
- · 3/4" by 4" hardwood plank, screws, brackets, etc.—local hardware and lumberyard.
- · Rubber tubing—**Player Piano Co. Inc**., Wichita, KS (316)-263-3241

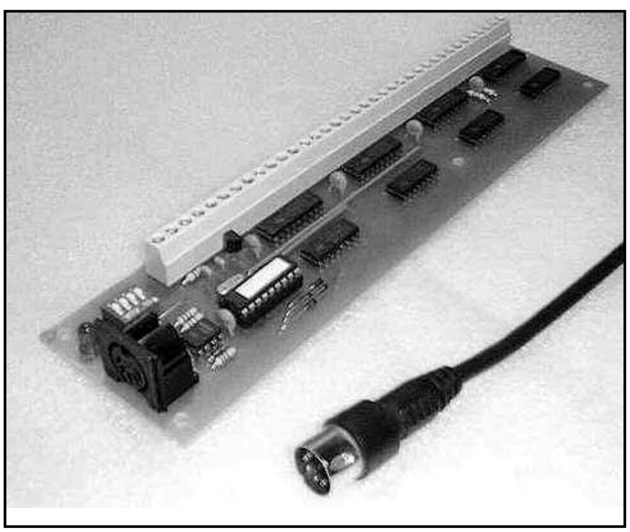

Figure 3. The jW MIDI Decoder Card and typical MIDI plug.

Alternative Supplies

MIDI decoder-driver boards are also made by **Hut Music and Electronics** (http://www.gemhut.com/hmeproducts.htm), but they are physically larger (harder to fit inside the organ) and have more outputs than you may need. Unlike the note-customized jW board, theirs is fully chromatic and may waste outputs on notes not built into your organ. For a large organ they may be ideal, but two or more jW boards can be cascaded to give more notes, and jW also sells a 64-note model.

A complete combination of MIDI decoder and valves is sold by **Spencer-Gerity** (http://www.spencerse-rolls.com/MidiValve.htm). Intended for use in reproducing pianos, it comes in compact modules of 16 notes each. While more expensive (about $700 for 32 notes), it will fit almost anywhere and requires far less work or thought to install.

Electromagnetic valves identical to Peterson's are also made by OSI as listed above, who are currently considering making smaller valves which would simplify my design to one long plank.

Ragtime Automated Music sells tiny individual electric valves that splice right into tracker bar tubing. While ideal, they are expensive ($15 each) and may fail from overheating on long sustained notes.

Design Considerations

I used the world's cheapest CAD (Computer-Aided Design) software—**Paint**, included free with all versions of Windows and Macs. Paint creates bitmap (. BMP) files, which any photo editor can convert to JPG or GIF, as for this article.

The Peterson electromagnetic valve is designed to mount on a flat wooden surface inside a pressurized wind chest and open a large enough hole to blow an organ pipe. To adapt them to my purposes, the valves are screwed to a hardwood plank just large enough to hold the valves, which has been drilled with small holes into which brass nipples are press-fitted to receive the rubber tubing of the organ's chest valves and tracker bar.

Teeing Off With Wood

Each mounted valve needs three "ports"—the valve's opening to air, one nipple for the windchest valve, and one for the tracker bar. To save the trouble and expense of trying to make or buy metal "Tee" fittings, I drill three holes per note in the plank to join as the tee, albeit more of a "U" shape (**Figures 4 & 5**).

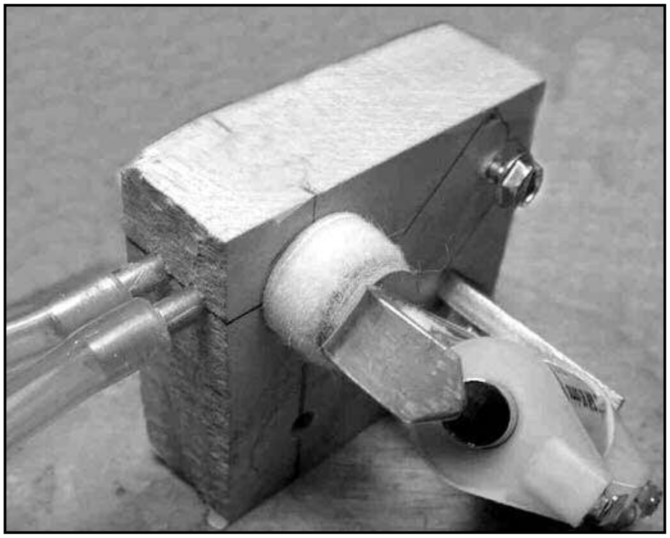

Figure 5. A prototype of "wooden Tee" connection to Peterson valve.

The 5/32" or 4mm OD nipples are compatible with the original Raffin tubing and nipples; measure yours if using a different organ.

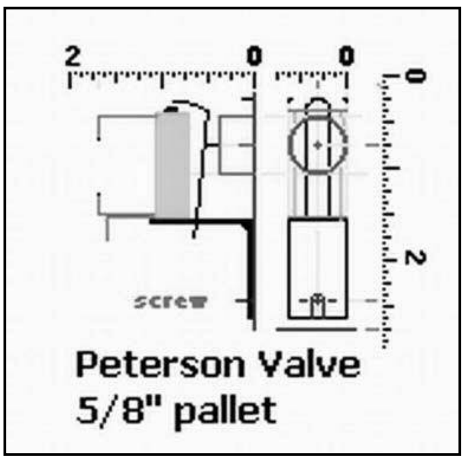

Figure 6. The schematic dimensions of the Peterson Valve.

It Fits Inside—Just Barely

The Peterson or OSI valve is much larger than I need, with a valve pad of 5/8" diameter, which is also the width of each valve unit. **Figure 6** shows exact dimensions. To allow clearance between valves, I enforced a spacing of 11/16". Since I need 32 valves (I included the "Director" note #0), the total length of the plank would be 22". Although the Raffin organ case is just over 22" wide inside, the tremolo bar and bellows crank connecting rod leave only about 19" of usable space. To make it fit, I split the system into two planks—a 24-valve plank across the organ's width, and a fore-and-aft short plank with eight valves (Figure 2). The two are joined into a large "T" by a bracket and screws (**Figure 7**).

Although millimeters are easier to work with, I use USA inches to match the valves, nipples, and wood.

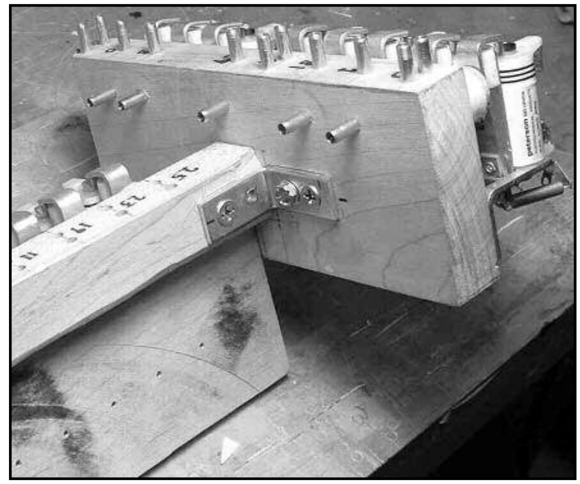

Figure 7. An angle bracket joins the two planks in a "T" formation.

The longer plank with its valves must fit between the Raffin windchest and the rear rank of piccolos, as shown in the blueprint (**Figure 8**), and its right end must dodge the bellows crank connecting rod. [NOTE: I will use "left" and "right" as viewed from behind the organ at the crank, not from the front.] The depth of the Peterson valves, even with the solder lugs bent over (see "Modifying Valves"), allows only 3/8" thickness of plank at the windchest. Since I require twice that, 3/4", the lower portion of the plank is routed out on a table saw and its upper portion, with the valve and nipple holes, extends over the rear of the windchest—but not quite enough to block access to the all-important bleed screws! **Figure 9** shows how the main plank fits over the Raffin's chest, plus the relative height of the short plank as viewed-end-on, not the way it really goes.

The jW MIDI decoder board fits between the chest and piccolos, but only after about 1/16" is removed from each long side with a belt or disc sander.

The shorter plank must just miss the left-most piccolo pipe and dodge the "tremolo bar" connected to the bellows top (**Figure 10**), which goes right where a valve should be. Careful measurements allowed me to avoid any nasty surprises when installing the finished unit in the organ.

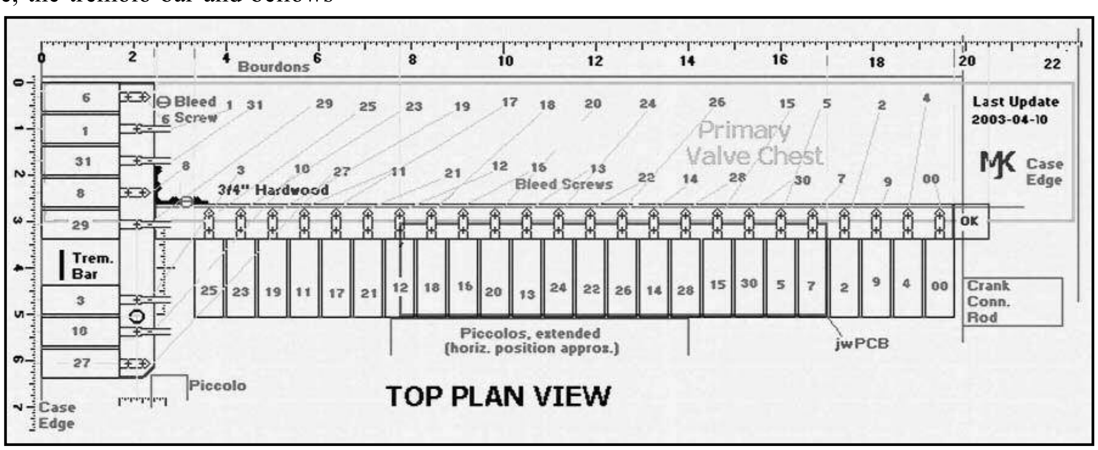

Figure 8. The blueprint of the Interface Unit, top view.

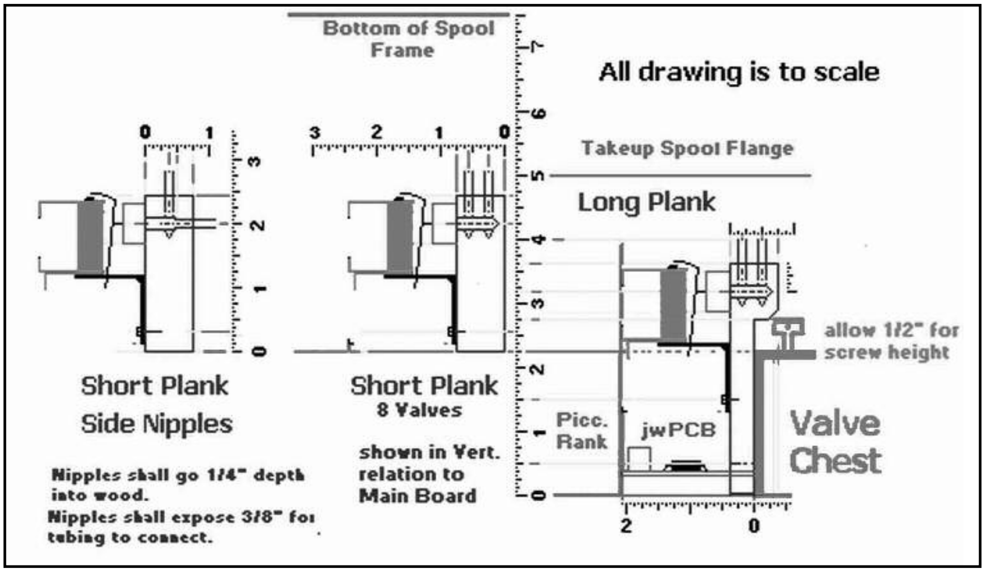

Figure 9. A blueprint of the plank's cross sections, nipple holes and vertical relations.

I followed certain rules in placing the 5/32" brass nipples in the planks:

· Each nipple has to penetrate 1/4" into the wood, to insure a firm grip so it won't pull out when I need to pull off its rubber tube.
· Each nipple has to leave 3/8" showing above the wood, for the tubing to get a firm grip on. This fixes the nipples' length at 5/8".
· There must be 3/16" of wood between a nipple's side and the plank's edge, so the wood won't split from the tight fit of the nipple.
· Each pair of nipples has to have 3/16" open space between their outer edges, so the two rubber tubes won't interfere with each other.
· Nipples should stop 1/16" short of the sides of a valve hole, to allow free air passage.

Adding these required clearances to the diameters of the two 5/32" nipples gives a total plank thickness of 3/4".

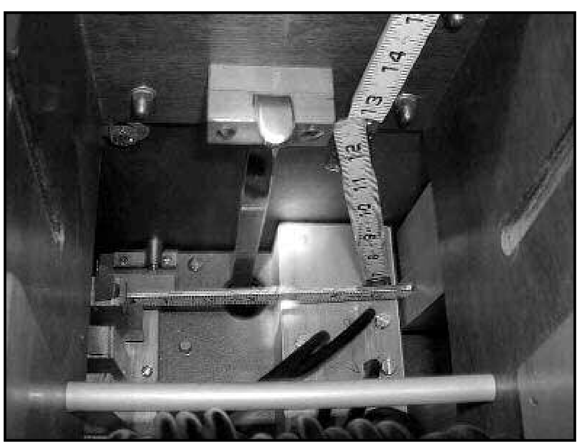

Figure 10. Taking measurements in the cramped confines of the Raffin 31/84 organ.

Making Nipples

Even if you buy ready-made 5/32" OD straight brass nipples, you may still have to cut them to 5/8" length and de-burr the cuts. I found it easier to buy one-foot lengths of copper or brass tubing and cut it into 5/8" pieces, using a drill press and fine-toothed model-builder's razor saw. The steps to making a nipple are:

· Mark
· Cut
· De-Burr
· Bevel
· Reverse, de-burr and bevel the other end

For each piece of 5/32" tubing, use an indelible felt-tip pen to mark off 5/8" steps along its length. Four pieces of 12" long tubing is more than enough.

To cut on the marks, you can't just hacksaw with the razor saw, which crushes the tubing out of shape and leaves burrs. Instead, use the drill press as a lathe. Insert the marked tubing piece into the drill chuck so that one nipple's worth is within the chuck, and the mark is just showing when the chuck jaws are tightened. The rest of the tube may go through the center hole in the drill press' worktable—this will keep it from flying away when cut (**Figure 11**).

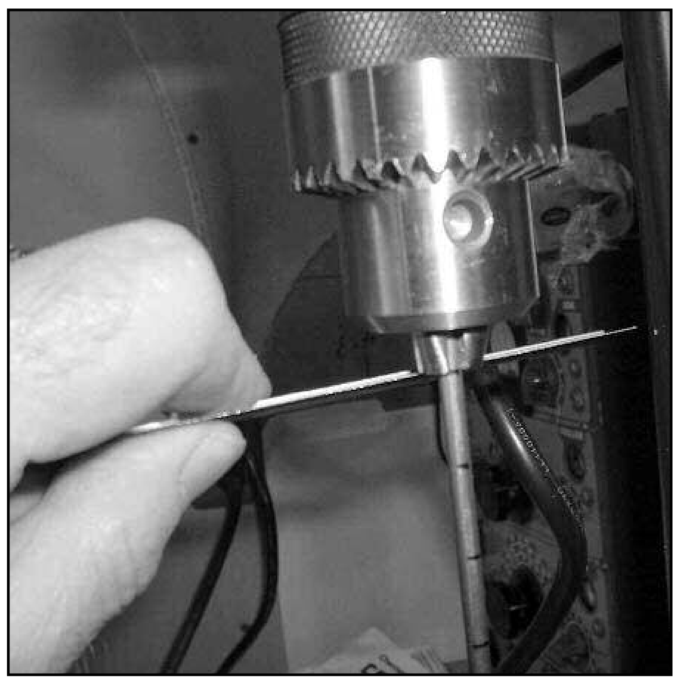

Figure 11. Cutting a nipple with the spinning drill, using measured marks on the stock.

Start the drill press and carefully hold the razor saw against the tubing right at the chuck jaws, on the mark. You may saw back and forth as the tubing rotates. Don't apply too much pressure.

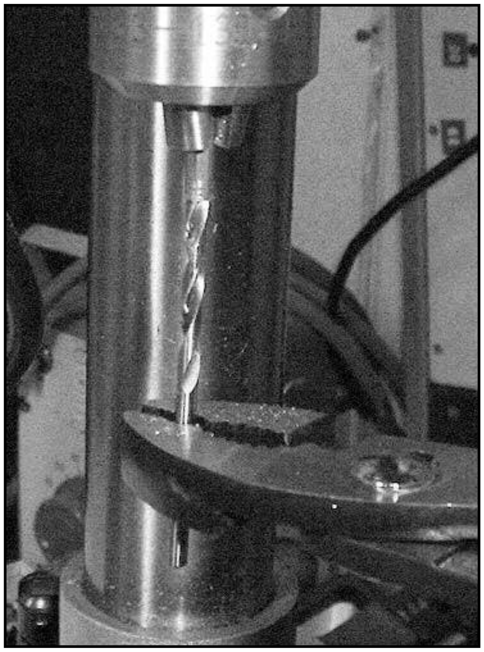

Figure 12. Deburring the interior of a nipple, using a 1/8 " drill.

After the free end of tubing breaks free, de-burr the inside of the nipple while it's still in the chuck and the drill is running. With a pair of pliers, hold a 1/8" drill bit and shove it up into the nipple to ream out inner burrs (**Figure 12**).

Stop the press, loosen the chuck and slip the nipple about halfway out, and re-tighten the chuck. Restart the drill and hold a fine flat file at about a 45 degree angle against the edge of the nipple, to de-burr the outside (**Figure 13**).

Stop the drill, remove the nipple, and re-chuck it the other way. Start the drill and repeat the outside deburring with the file. You should also repeat the inner deburring with the 1/8" drill bit held in pliers.

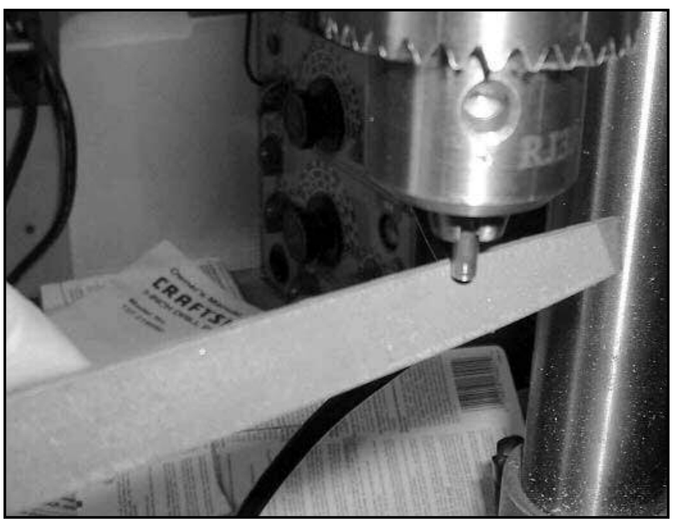

Figure 13. Deburring and beveling the outside edges of the nipple with a file, all the time with the drill spinning.

This sounds like a lot of work, but it goes swiftly and before long you'll have a jar full of 64 nipples, and hopefully all your fingers and thumbs (but not in the jar).

Modifying The Valves

As shipped by Peterson or OSI (**Figure 14**), the valves are not quite ready for our use. The valve pad travel is too long and should be shortened for faster operation. Also the solder lugs on the coil must be bent over to clear the piccolo pipes. **Figure 15** shows the modified valve ready for use.

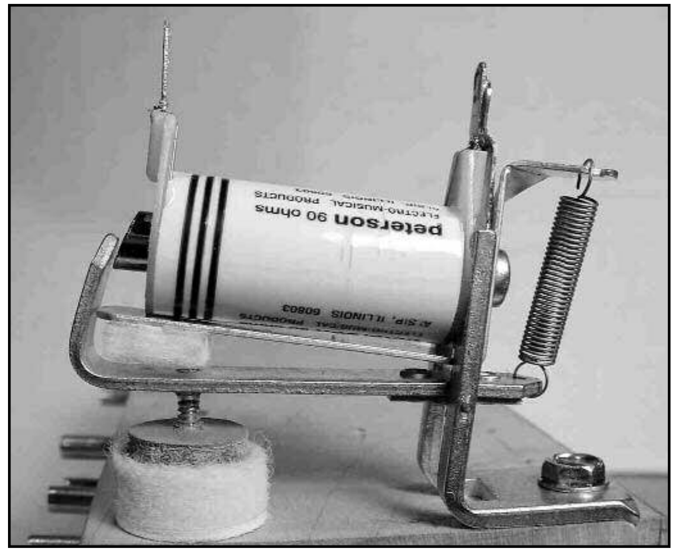

Figure 14. The Peterson valve as shipped—before modifications.

Prepare a small scrap piece of flat hardwood to which you can temporarily screw one valve at a time while working on it. Screw each valve firmly, its bracket "legs" digging into the wood, to simulate its mounting on the real plank later. In my photos I just screwed it to the workbench, an old door.

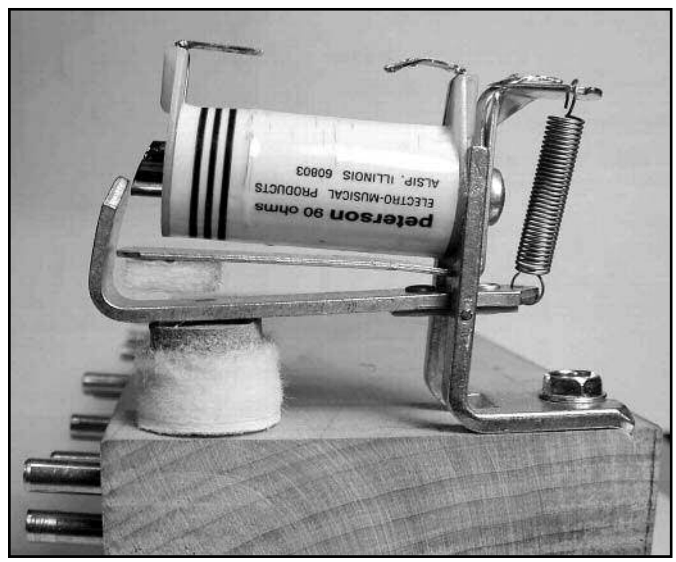

Figure 15. The Peterson valve after modifications.

Adjust the valve pad by rotating it, thus moving it up or down on the threaded bolt that connects it to the moving armature piece, being careful not to mar its leather face. You want the armature end to cover about 1/4 of the magnet's pole piece when at rest (Figure 15). Also, the travel will be longer than needed, so use needle-nose pliers to bend the thin metal strip that supports the felt block that limits the travel, so when operated the armature covers about 1/2 of the pole, and the valve pad clears the wood by at least 1/16" but less than 1/8" (2 mm is fine).

The upper solder lug (on the coil, at the end with the pole piece and valve pad) is bent over, using the flat side of pliers or a screwdriver blade, being careful not to break it. Bend it as

Figure 16. The start of spreading a Peterson valve lug with the soldering iron.

close as possible to its root. The other lug, at the mounting bracket end of the coil, must first be unsoldered from the dummy lug between it and the lug that carries the spring. Use a soldering iron and solder sucker or wick (**Figures 16, 17 & 18**). Solder sucking is usually needed to remove excess factory solder and free the lug (**Figure 19**). You'll need the soldering iron and skills anyway later to wire the interface. If a lug breaks off, reattach it with solder.

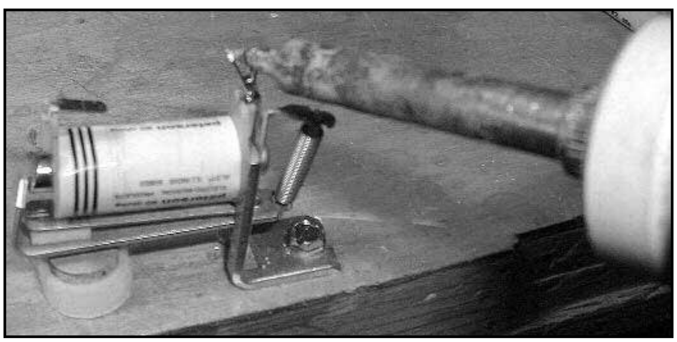

Figure 17. More spreading of the Peterson lug with the soldering iron.

If your organ (not a Raffin) uses more than 6" water gauge wind pressure, you may need to tighten the valve spring by bending up its little bracket lug. On a vacuum tracker bar system you may want to loosen the spring.

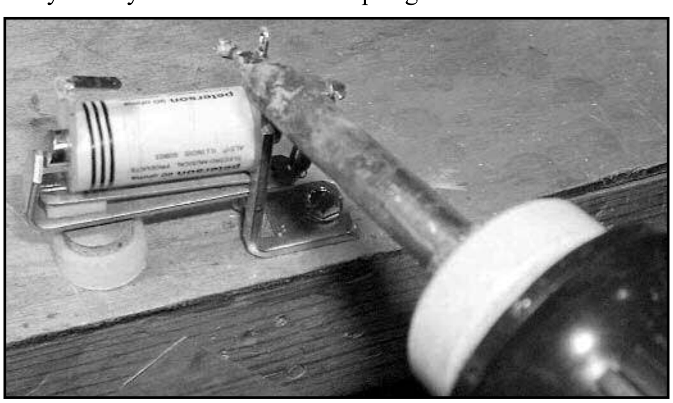

Figure 18. The finished Peterson lug now spread with the soldering iron.

Making The Planks

Fine-grained hardwood must be used, such as maple, though poplar may do. Both pieces should be 3/4" thick. Cut the short plank to 2-7/16" wide by 6-3/8" long, and the long one to 3-5/8" or 3-1/8" wide by 18" long. If you cut the long plank to the wider width, you won't need any leg brackets, but will have to cut out a large notch for the jW MIDI card to fit into. The narrower width allows you to file out just a small area to clear some MIDI card components, but you must add the brackets, as I did. The narrower plank is easier to route out on the table saw.

Figure 19. Solder-sucking a Peterson lug to separate it from the coil connection lug.

Be sure that both long edges of both planks are smooth and square to the wide faces, for accuracy in drilling later. Bevel one end of the short plank by about 1/4", using a plane or sander. Before any marking or cutting of wood, check against Figures 8 & 9—these blueprints are the reference for all dimensions.

Carefully use a steel rule and square to lay out four rows of holes on each plank—two rows along the top edge for the nipples, a row of valve pad holes on the wide face (these and the nipple holes will join to form the U-shaped "tee"), and the screw holes to mount the valves. All four holes for each valve line up the same distance from the plank's end, all centered on the valve.

Center the long plank's first valve (Note #25) 3/4" from the left edge (Figure 8 shows 7/8", but I would now use 3/4" to give more clearance at the right end for the connecting rod). The other 23 valves are spaced at 11/16" intervals. Don't measure 11/16" from each mark to the next—avoid cumulative errors and "do the math" to locate each valve absolutely, or hold the ruler steady and count off 11/16th marks for each one. Check against Figure 8.

The short plank's first valve (Note #6) valve is centered exactly 5/16" from the front end of the plank, and the next four valves are spaced at 11/16" intervals. Skip the Tremolo Bar and put the Note #3 valve at 4-11/16", spacing the final two valves at 11/16" intervals. Note the special nipple placement used for some notes (01, 31, 29, 03, and 10) of the short plank. You don't have to copy these, but I took the opportunity to eliminate U-turns in the air passages. I couldn't use this layout on the long plank, or the nipples would have blocked some of the bleed screws.

Use a spring-loaded center punch to pre-start the holes for accurate drilling (**Figure 20**).

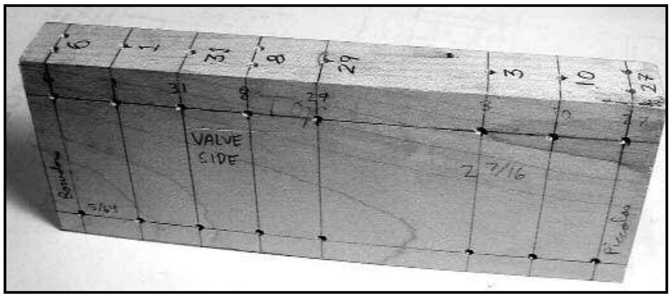

Figure 20. The short plank is scribed and center punched, ready to drill.


Figure 22. The routed-out back side of the main board.

When you've checked your hole placements a few times, it's drilling time. Accuracy and neatness are essential here! You are doing the same kind of woodworking as was used to build organ chests and player pianos, drilling holes that have to meet up with each other. Don't use a hand drill. If you don't own a drill press, now's the perfect excuse to buy a small one for under $99, or take your planks and a six-pack to a friend who has one.

For the nipple holes, use a #22 drill bit to get a snug fit on the 5/32" nipples. Don't try a 9/64" bit, which is too tight—buy the numbered #22 bit; you'll use it 64 times. But do test the bit on a piece of scrap from your plank wood, test-fitting your own nipples for a snug fit, just in case your nipple tubing stock was not exactly the same OD as mine. Drill the nipple holes "blind" to a depth of 3/8" to 1/2" measured to the full width of the drill bit (the tip will go deeper). For the short plank's oddball backside nipple holes, just drill clear through the plank with the #22 bit—later you'll drill out the pad side to a larger diameter. (You could use a 5/32" drill for a loose fit, and later seal each nipple with burnt shellac, but special care is needed not to insert any nipples too deep, blocking the valve-pad bore.)

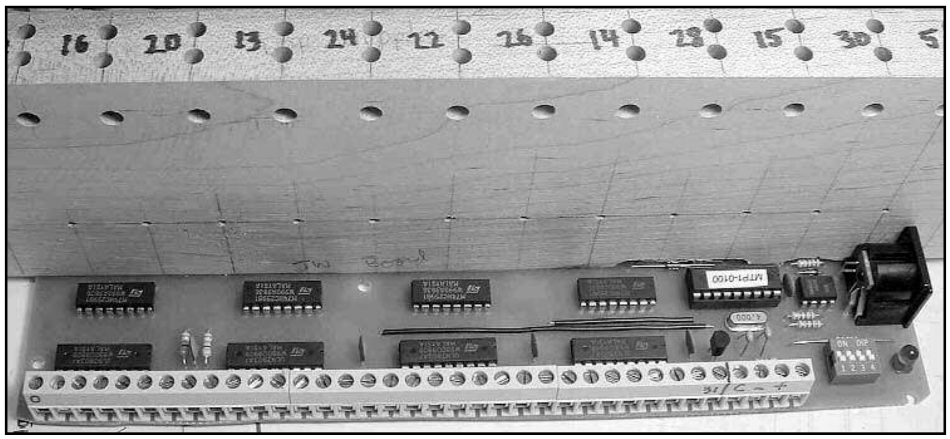

Figure 23. The jW board fitting onto its route-outs on the main board.

The valve pad holes may be 3/16" to 7/32". These are tricky since they must be drilled "blind" to a depth of exactly 9/16", enough to cover the second nipple bore without bursting through the back side of the plank. For the oddball side-nipple holes in the short plank drill only 1/2". A drill press has a limiting nut you adjust to set the hole depth. Set it carefully and test on a scrap piece.

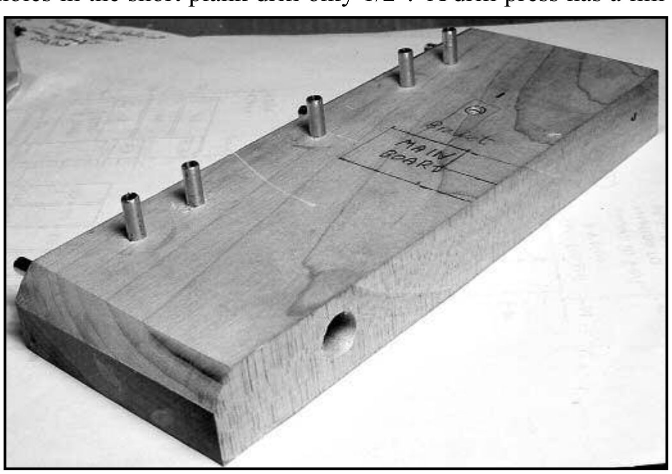

Figure 21. The side board showing the main board outline and foot joint dowel socket.

The valve screw holes may be 1/16" and at least as deep as the screws (3/8"), but may go clear through.

Somewhere near the rear end of the short plank, drill a hole in the bottom for a 3/8" wooden dowel that will serve as a back leg (**Figure 21**). The front bottom of the short plank will rest on the valve chest, and the dowel leg will keep the whole unit from tipping backwards while you work out the side mounting brackets later. In the photos, I have added a lower block of 3/4" wood, also drilled to receive the dowel as a joiner, but you can just make the dowel the exact right length. Put a sticky felt pad on its bottom.

Routing Out The Long Plank

After the long plank has been completely drilled (and optionally after inserting the nipples), the lower portion must be routed out to 3/8" thickness. I used a table saw, carefully adjusting the rip fence and saw blade height to get the required dimensions. Whatever width you cut your long plank, you must route to leave the upper 7/8" the full thickness. Hand planing or a Dremel tool are alternatives for the faint of heart, less likely to ruin your plank or fingers. **Figure 22** shows the result and the saw burn from forcing the work through the machine too fast, but no harm done. Bevel the new edge where it will overhang the bleed screws next to the routed area.

Route out a portion of the long plank's bottom to clear components on the MIDI card (**Figure 23**), using chisel, file, or Dremel tool. Or use plastic washers as spacers when screwing the board to the plank later.

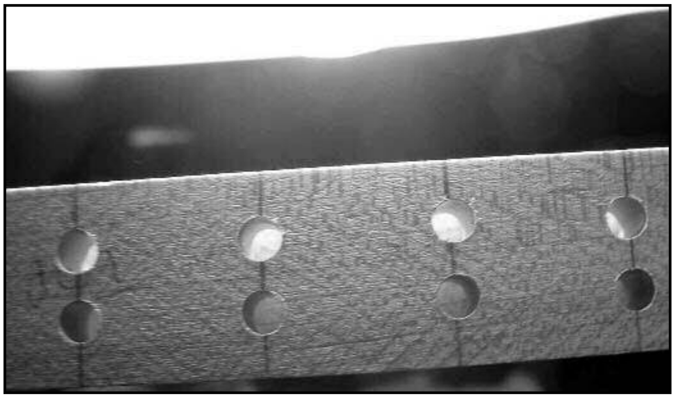

Figure 24. Checking holes for burrs and splinters to clean out.

Clearing The Air Holes

Before inserting any nipples, check to make sure that wooden splinters or burrs from the drillings will not interfere with free air passage through the holes. I blasted out every hole with compressed air, and held every hole of both planks up to a strong light to make sure (**Figure 24**).

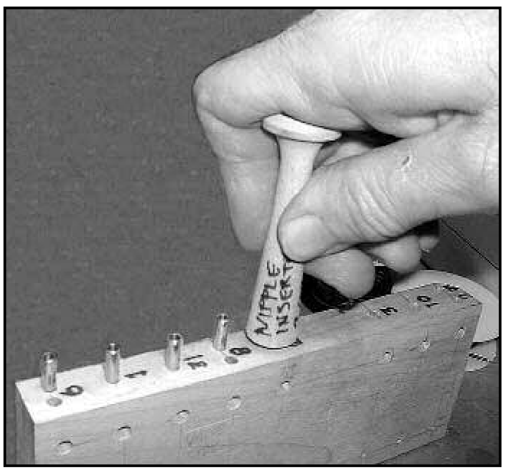

Figure 25. Inserting the brass nipples with the homemade tool.

Inserting Nipples

For ease in force fitting the nipples to the correct depth, I made a tool out of a wooden knob (**Figure 25**); drilled 5/32" to a depth of 5/8" which is the amount of nipple you want to project. But since the nipples will quickly cut into the tool's wood at the end of the hole, I drilled it 1/4" deep and shoved a 1/4" piece of scrap nipple tubing into the hole, to bear against the end of each nipple you insert. Also I sanded one side of the tool flat for placing nipples close to each other. It's easier to insert nipples into the long plank before it's routed out.

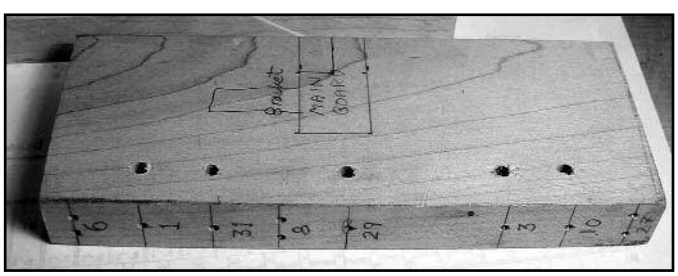

Figure 26. The side board showing the main board joint outline.

Joining The Planks

A simple metal angle bracket holds the planks in their T configuration. This avoids interfering with the valve on the short plank opposite the long plank's end. It's important to butt the long end into the right location on the short plank. **Figure 26** shows how this is carefully marked, and **Figure 27** the final result, so you can adapt to whatever bracket you can buy, but be warned that I miscalculated the height by about 1/4" so the photos are a little off—I later re-drilled the screw holes to fix this.

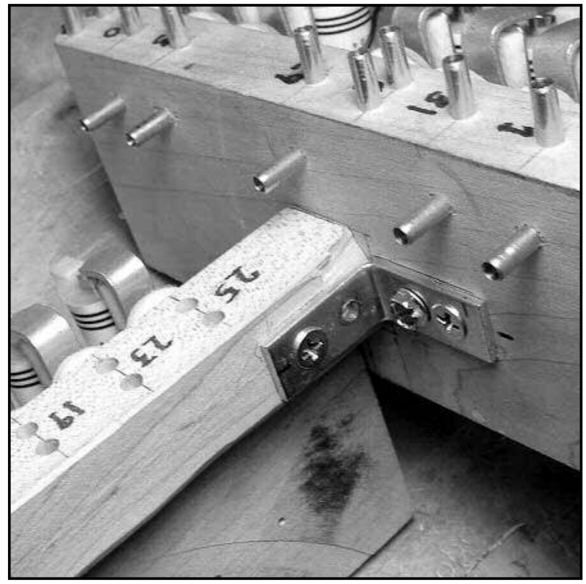

Figure 27. An angle bracket joins the planks in a "T" formation.

Once you have the joint firmly screwed together and checked out, unscrew the short plank and proceed to install the valves. Don't re-join the boards for keeps until testing the fit inside the organ, or wiring the individual note valves.

Mounting The Valves

It's best to use #6x3/8" hex-head sheet metal screws to hold the valves, since the head flange presses evenly on the valve bracket and the hex head lets you apply plenty of screwdriver (nutdriver) torque. Hold the valve with its pad exactly positioned over its hole while tightening the screw and forcing the

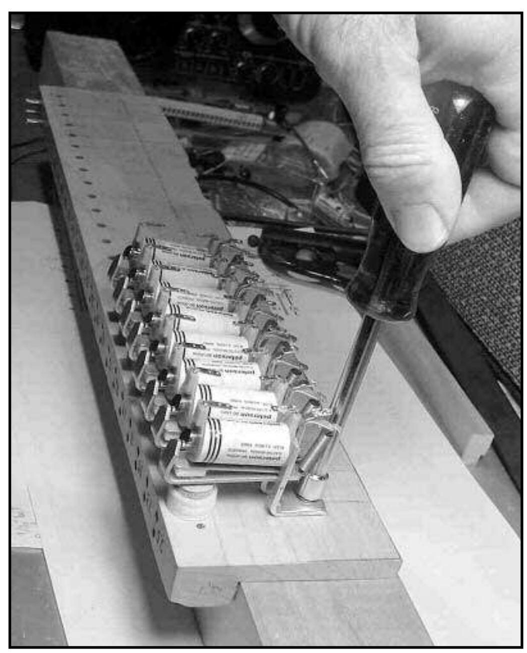

Figure 28. Details showing the use of a support plank while screwing on the valves.

"teeth" on the valve bracket to dig into the wood. Once those teeth have set, the valve cannot be repositioned, so get it right. Tighten firmly but be wary of stripping the wood threads—this is why I like hardwood.

Figure 29. A long plank foot bracket utilizing hand-drilled holes.

To avoid splitting the routed-out long plank with the nut-driver force, lay its routed-out potion over a piece of scrap wood as in **Figure 28**.

As each valve is installed, check its motion clearances as in "Modifying the Valves" above. It's really hard to adjust anything once there are valves on either side.

Labeling The Valves

The pipe layout of most organs gives an odd "firing order" of the windchest valves which does not simply count up in sequence from left to right. Figure 8 shows the Raffin 31er windchest valve note assignments, plus my assignment of electric valves on the planks to give the shortest total length of tubing for each note. Using Figure 8 as a guide, neatly mark the number of each valve on the top edge of the planks between each pair of nipples (for use in connecting tubing), and on the coil of each valve (for wiring), using a felt-tip indelible marker (it's easier to number the plank nipples before inserting the nipples).

If your organ's windchest is not already labeled, neatly pencil the note numbers by each windchest nipple as well, after removing the roll frame.

Leg Brackets

Unless you made it the full width (and cut out a section for the MIDI card), the long plank will rest on a pair of metal L-brackets. These are not screwed to the organ, but rest on felt pads stuck to the bracket bottoms. Horizontal placement is not critical, but it's vertical placement is, so the long plank will overhang the bleed screws at the proper height. I had to cut one leg short on each bracket and drill my own holes to get brackets large enough but able to fit under the valves (**Figure 29)**. Put a self-stick felt pad on the bottom of each bracket.

Ordering The Custom jW MIDI Board

An advantage of the jW MID decoder circuit boards is the ability of jW engineers to assign each of the 32 outputs to one note of your organ, not wasting any outputs on notes not in your organ's scale. When ordering your board, you must send jW a list of the 32 MIDI note values you want for each output (**Chart 1**). Middle C is MIDI note 60, and there are 12 chromatic notes per octave.

My list shown here gives the MIDI notes one octave lower than the Raffin 31er organ's actual pitches, by mistake, not design. You may add 12 to each value for concert pitch if you like, or add another offset to transpose to the key of C. Once your board has been made, the notes cannot be changed.

jW Electronics
MTP-1 MIDI to Parallel Converter Electronic Order Form
Quantity required of this configuration: 1

Output	**MIDI-Note**	**Pitch**	**Output**	**MIDI-Note**	**Pitch**
1	34	Bb (bass)	17	60	C
2	36	C	18	61	Db
3	39	Eb	19	62	D
4	41	F	20	63	Eb
5	44	Ab	21	64	E
6	46	Bb (accomp.)	22	65	F
7	48	C	23	66	F# Gb
8	49	Db	24	67	G
9	50	D	25	68	Ab
10	51	Eb	26	69	A
11	52	E	27	70	Bb
12	53	F	28	72	C
13	55	G	29	73	Db
14	56	Ab	30	74	D
15	57	A	31	75	Eb
16	58	Bb (melody)	32	31	(Low G, director)

Chart 1. Custom jW MIDI Board configuration.

Part II of ***Build a MIDI Interface for the Raffin Crank Organ*** may be found in Issue #19 (April, 2004) of the *Carousel Organ.*

Mike Knudsen is a retired telephone and computer engineer who now lives in Maine. He has collected mechanical music since 1970, plays trombone, and has composed several piano rags and marches.

Build a MIDI Interface for the Raffin Crank Organ
(Part 2)*

Mike Knudsen

Mounting And Wiring The MIDI Board

Before adding any wires, you may want to test-fit the interface into the organ (and make and fit the case brackets). Skip ahead if so.

The jW MIDI card is just a little too wide to fit between the Raffin windchest and the piccolos. Use a belt or disc sander, file, or Dremel tool to grind off about 1/16" from both long sides. Sand off the one side right up to the screw-down wire connectors and the other side as far as possible without breaking into the screw holes, which you'll need. It's good to have bench-tested the card first (apply DC power, see that red LED light up) before you trash the warranty this way.

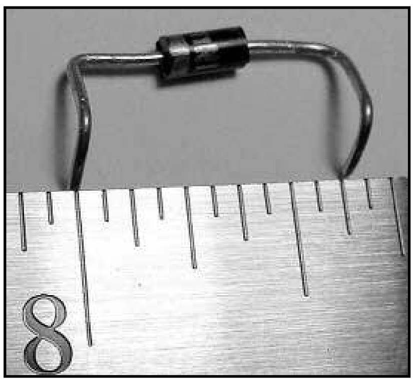

Figure 30. A diode with leads shaped and trimmed to length.

Depending on how you've routed out the bottom of the long plank, you may screw the MIDI board directly to the under side of the plank, or may need to use plastic washers as spacers. Tighten the screws firmly without cracking the board edge.

Before wiring the MIDI outputs to the valve coils, first install the protection diodes (Radio Shack package of 25 assorted, Catalog #276-1653) and the common power bus wire strap. Each coil must have a diode to absorb the kick-back voltage generated by its magnetic field when the note is turned off; otherwise the voltage spike would blow out the MIDI board's electronics. The jW Web site states that such diodes are built into the MIDI card, so you may choose to omit them, but I played it safe.

Figure 31. Diodes installed on the valve coils, with broken lug. Note the white polarity mark at the ends.

Figure 30 shows how to trim and bend a diode's stiff wire leads into shape before soldering it to its coil. Note the 5/8" distance between wire ends. Attach each diode to its coil by first inserting the wire ends through the holes in the coil lugs. Be absolutely certain to get each diode's white polarity marker as in **Figure 31** with the silver "cathode" marking toward the upper lug. Solder only the upper end of the diode near the valve pad; The other end by the bracket will be soldered later when it's wired to the MIDI card.

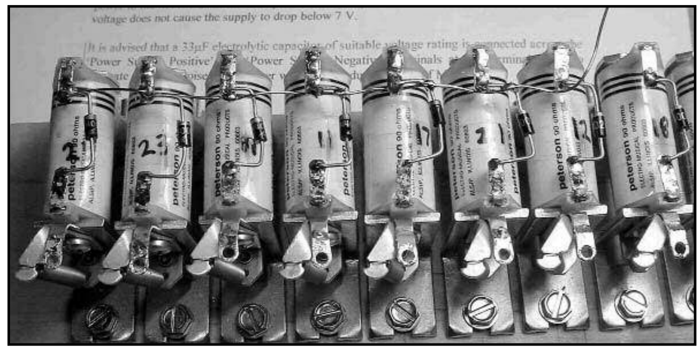

Figure 32. The wiring of the common positive return along coils.

After all diodes are soldered in, run a bare length of wire along the upper lugs of the coils (by the valve pads, already soldered) and solder it to each lug; no need to wrap it around the lugs, the solder will hold it in place (**Figure 32**). On the short plank, strap the coils separately on each side of the gap, then join them with an insulated wire pressed down against the board to clear the tremolo bar (**Figure 33**).

Figure 33. The wiring of the short plank, with screw eyelet guide and the wooden foot.

Now to wire the notes. John Wale insists on using screw-down connectors on his cards, although simple solder holes

* Part 1 appeared on pages 13 - 21 of issue #18 of the *Carousel Organ*.

would work better in this project. The screw connectors may cut and break off small wire, so use wire of at least 18 or 20 gauge (no higher numbers, which mean smaller wire), solid copper, not stranded.

Figure 34. Cable guide ring, pre-shaped from #18 gauge wire.

To help keep the 32 wires neatly bundled, I installed some screw-eye rings and also made some rings of wire and soldered them to the lugs on some of the valve coils (**Figures 34 & 35**). I numbered the notes 1-31, which matches the jW MIDI board's terminals numbered 1 to 32. The "Director" valve is #0 but wires to MIDI terminal 32.

To wire a note, unspool but don't cut a couple feet of wire and strip about 1/4" insulation from the end. Starting at the coil but not fastening the wire there yet, feed the wire through the eyelets and rings as appropriate, and down to the correct screw terminal on the MIDI board. Insert the stripped end as far as it will go and tighten the screw very firmly, sneaking the screwdriver past the valve bodies. Bend the wire straight up, against the upper edge of the connector block.

Figure 35. The cable guide ring installed, not yet trimmed.

Now work your fingers back along the wire towards its coil, bending and shaping the wire to conform to its mates. Bring it up to its coil's lower lug, shaping it neatly, and cut it about 1/4" past the lug. Strip the end and solder it. The finished job should look like **Figure 36**.

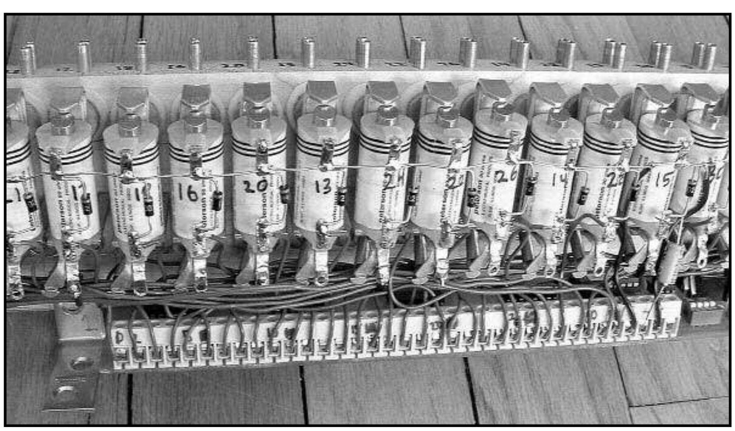

Figure 36. The MIDI card with finished wiring and temporary capacitor location.

Power Wiring

Next you must wire the MIDI card's power circuit. I use a "negative ground" electrical system, where all power and signal voltages are positive, and the negative side of the power supply is "ground" or zero volts reference. But note that the common power strap wire of the valves is positive—the valve coils "hang from the ceiling" electrically speaking and are actuated when the MIDI card completes the circuit to ground. Also note that Peterson intended their valves to have the common wire at the bracket end; I put it at the top end to avoid the individual wires going between the coils and possibly interfering with the valve movements.

The card takes power through the same style of screw connectors as used to drive the valves. I recommend loudspeaker "zip cord" for the power leads, with a quick-disconnect plug. Ordinary AC power zip cord is not marked for polarity (which wire is which). Speaker zip cord has one side marked with a silver stripe; use this for positive ("Hot") and the other for negative.

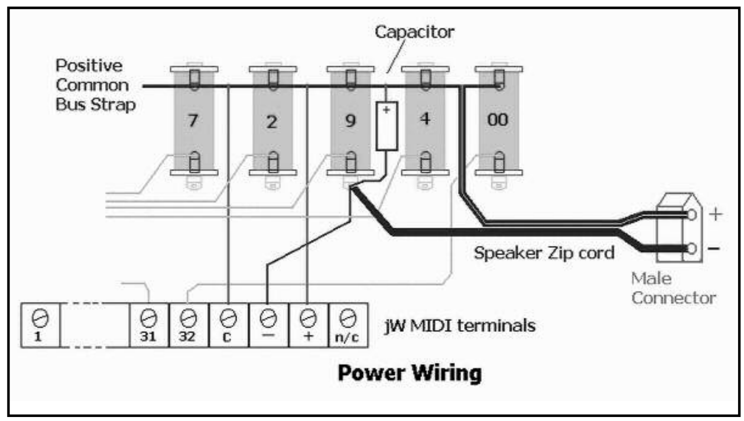

Figure 37. The power wiring at the unit.

This cord is stranded wire, which does not work well in the screw connectors. So I make a landing place where the zip wires can be soldered, using the frame lug of the third coil from the end. The negative (unmarked) zip conductor will be soldered to this lug (which was separated from the coil lug when the valve coils were modified), along with a short piece of the insulated 18-gauge wire and the negative lead of a 33 to 100uF, 25 WVDC electrolytic capacitor (Radio Shack), which is needed to stabilize the voltage. The other end of the wire is screwed into the MIDI cards "-" terminal. Follow **Figure 37**. Note the two short wires straight from the common positive bus strap to the MIDI card's "+" and "C" (Note Common) terminals. The "C" wire is vital if you've omitted the diodes.

The positive, marked Zip lead and the capacitor's positive lead are soldered to the common strap wire along the top of the coils. Be very careful to orient the capacitor the right way—again polarity matters! Only a few inches of zip cord are used here on the interface (**Figure 38**), but you will need about two feet more to wire the organ itself.

An alternate position for the capacitor is visible in Figure 36. The cap's negative lead screws directly into the MIDI card's "-" terminal, the positive lead to the strap as usual, and the two zip wires would be wrapped and soldered around the cap's two leads. I felt my capacitor's leads were too weak for this, so moved it to the coil lug.

Attach the male half of the 2-prong connector plug (Radio Shack part #274-222) to the short piece of zip cord soldered to the interface (the male half has the non-hollow pins). Solder the "hot" (Positive) stripe-marked zip lead to the connector pin at the sharp-pointed end of the connector body, and the unmarked zip lead to the other pin. Follow the directions on the back of the connector package.

Borrow a foot bracket screw to mount a nylon cable clamp (Radio Shack #64-3028A) to secure the zip lead, and screw in a small cup hook to guide the MIDI cable (Figure 38). Since the jW MIDI card already has a MIDI jack, no MIDI wiring is needed until you wire the organ case.

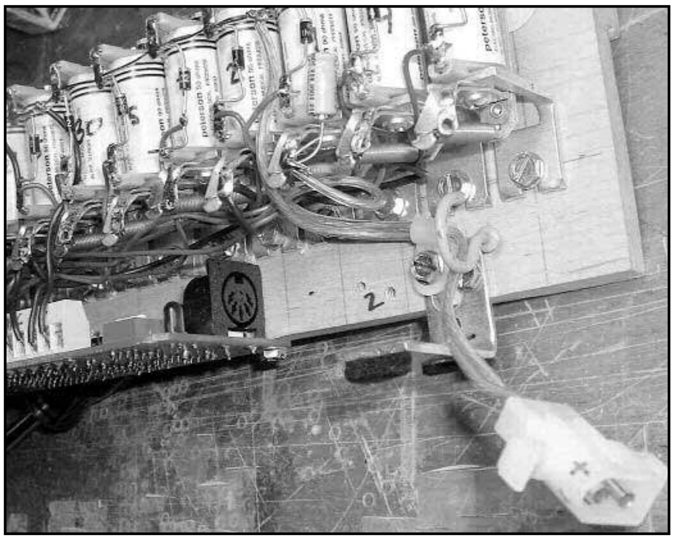

Figure 38. The unit power connector and MIDI hook as seen on the workbench.

Bench Testing

Now comes the scariest part before installing into the organ. You connect a DC power supply or battery of 12 to 18 volts to the unit, being terribly careful to get the positive/negative polarity right. Temporarily clip on to each side of the capacitor, or wire the female connector to your power source. Switch it on, and verify that the red LED (Light-Emitting Diode) indicator on the MIDI board lights up. No valves should operate.

I use a small Heathkit variable voltage supply; Radio Shack sells similar units, including adapters to run auto radios from wall socket power. Buy the smallest one available, as the organ uses less than 2 Amps. A 12-volt motorcycle or lawn tractor battery is good for outdoor use, or simply stack up at least 8 flashlight batteries. You want between 12 and 18 volts DC.

If the LED lights and nothing smokes, switch off and connect a MIDI cable between the board's connector and the MIDI OUT jack of an electronic keyboard. Set the DIP switches on the MID card to 0000, and set the keyboard to output keystrokes on MIDI Channel 1. Turn the power back on, turn on the keyboard, and run up and down the keys. You should see and hear valves operating. If not, check the MIDI channel settings at both ends; Channel 1 (all four switches on the jW card set Off) is usually the default for the keyboard.

Now carefully play and release the key for each note equipped on your organ. On the Raffin 31er, you begin with the Bb an octave below Middle C, then that C, Eb, F, and Ab to complete the bass notes. The accompaniment notes are Bb just below Middle C up through the A an octave higher, skipping B-natural and F#/Gb. Finally the melody runs 1-1/2 octaves from the Bb above Middle C up through Eb, skipping the B-naturals. Verify that each key operates the right valve, no more, no less. You'll repeat this test after organ installation, turning the crank and listening.

If the jW card's LED starts blinking, shut off power for a few seconds, check that your MIDI cable is snugly plugged in at both ends, and turn power back on.

Organ Installation

After passing bench tests, it's time to prepare the organ to receive the interface. In fact I recommend a trial insertion of the interface with the valves mounted and the two planks joined, before doing any wiring; this ensures everything fits, since it's much harder to correct parts placements after the wiring is in.

You must remove the spool frame (roll box) with its tracker bar and crankshaft. This is less daunting if done decently and in order:

· Remove the crank.
· Unscrew the 4 screws holding the lid and lift it off.
· Unscrew the 3 screws holding the outer brass crank flange and remove it.
· Use a 3.0 mm Allen wrench to loosen the setscrew holding the roll-drive pulley to the crankshaft. Slide the pulley out the back hole and off the shaft, letting the belt hang on the take-up spool's pulley.
· No need to remove the rewind parts, but do pull out its knob (as if to play), and the play knob too (as if to rewind).
· Remove all 32 note tubes from the tracker bar (but NOT the wind chest). Don't pull, but use a screwdriver blade to push each one off its nipple.
· Disconnect both bellows connecting rods from the crank shaft. For each, remove its outer screw and loosen the inner screw, then gently unsnap it from the crankshaft.
· Unscrew and remove the two wood blocks guiding the tremolo bar on the left side. Let the bar stand up by itself.
· This is tricky: Use a long Phillips screwdriver to remove three screws fastening the wooden strip supporting the accompaniment bourdon pipes, to the front face of the spool box. The center screw hides behind the tallest melody violin pipes, and requires a very short right-angled or ratchet-drive screwdriver.
· Remove the large screw on the rear of the case, in line with the tracker bar, taking care to catch the large wooden spacer inside.
· Undo the 8 bolts (4 per side) that hold the box to the organ case, being careful to catch the two washers under each pretty nut inside. Leave one bolt on each side until ready to lift out the box.
· Grasping firmly by the metal spacer bars where the roll pressure bar rests, push out the last two bolts and lift the box out. Tilt the front end up to sneak the crankshaft end out of the rear case hole.
· Set the box down carefully on one end.
· Go somewhere else and relax.

It's safest to remove the piccolos and their chest before trying to fit the interface, but you'll need to replace them to check the fit. Remove the back panel, remove the six screws holding down the piccolo chest, lift the unit up slightly to clear the register slide, shift it sideways as needed and pull it out the rear hatch. Try not to bump the tuning stoppers and shades, though you may need to re-tune this rank after the job is finished anyway. Leave the slide in place. Actually, the piccolos can be removed and replaced without removing the roll box!

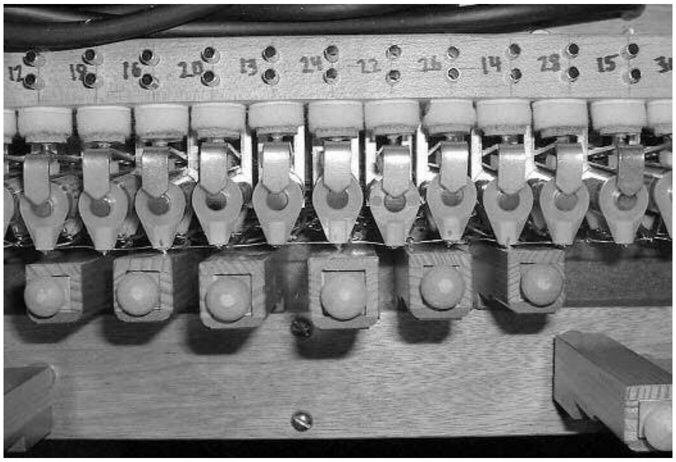

Figure 39. This is a tight fit against the rear piccolo rank!

Trial Fitting

Push the loose ends of tracker bar tubing out of the way and carefully lower the interface into position. Check the overlap of the long plank over the bleed screws on the windchest, and that the tremolo bar fits between the short plank's valves. Also the rear end of the short plank must clear the piccolos. With the short plank's valve lugs firmly up against the left side of the case, make sure the far end of the long plank clears the (now loose) bellows pump rod. All these checks should clear if you measured and cut correctly. Both foot brackets of the long plank and the extension wooden piece under the short plank should rest on the organ deck, and the front bottom of the short plank on the windchest.

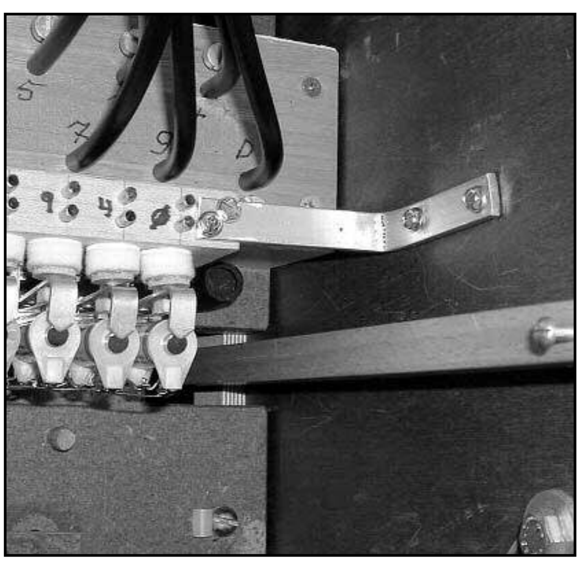

Figure 40. The long plank's hand-made bracket installed next to the connecting rod.

Replace the piccolos temporarily and check for clearance. Expect the coil lugs to scratch against the center pipes (**Figure 39**)—it is a tight fit! If this fails to clear, sand, grind, or plane down the long plank's face against the windchest as needed, watching out for the valve screws poking through.

Brackets

Once you're satisfied that the interface will seat properly and co-exist with the piccolos and machinery, make and fit the mounting brackets. Three brackets are used to hold the unit firmly in place. It may sit there on its feet, but it would shift and run afoul of the tremolo bar or bellows con rod, the moment you wheeled the organ around on its cart. So I screw the unit firmly to the organ case sides.

Rather than search for suitable brackets, it's easier to make your own out of 1/2" by 1/16" aluminum bar stock. Either way, you cannot locate the screw holes for these brackets, on the interface and on the organ case, without putting the interface exactly in its place in the organ.

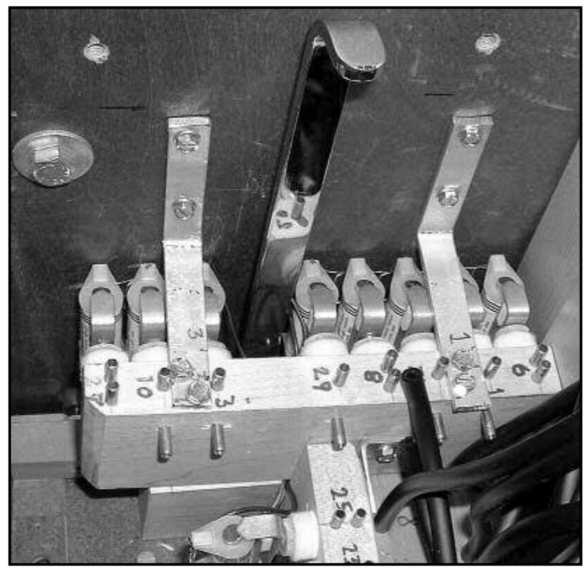

Figure 41. The short plank's hand-made brackets straddling the tremolo bar on the Raffin.

Two brackets hold the short plank on the left side, and one holds the end of the long plank, **Figures 40 & 41**. (I cut the long plank shorter than needed, leaving just enough wood to fasten the screws; your plank can be longer, and I've added the extra length in the text above.) Note how the short-plank brackets have scallops filed out to clear the nipples. Also these brackets are angled up slightly, to clear the valve armatures. With patience at your vise and hammer, you will arrive at the correct shapes. Note that the two short-plank brackets are labeled by the nipples they sit next two; since the brackets are hand-fitted, they will not be identical.

Once you have all brackets nicely screwed to the interface planks and pressing firm and straight against the organ case insides, and below where the roll box's bottom will be, drill screw holes into the organ case using the bracket holes (which you have drilled yourself in the bracket material) as a guide. Careful—don't let the drill break through the case's outside! And use the smallest drill bit that will ease the screw, maybe 1/16". Be sure you have screws that are not too long!

Screw the unit into the case, six screws total, verify everything fits right, then unscrew from the organ case and use the brackets as handles to lift the entire unit back out of the organ.

Organ Case Wiring

Two sets of wiring (DC power and MIDI) must pass from the interface down to the bottom of the organ, to emerge behind the bass pipes. There is room behind the windchest deck for the wires to be passed down, but a hole or pair of holes must be drilled in the lower deck that supports the bass pipes (this and the six small screw holes for the brackets are the only permanent "damage" to the organ). Luckily there is a deck space with no bass pipes right in the crank corner where I want the wires to go, and the bellows don't quite reach to this point either (please verify that your own bellows won't be in the path of a drill bit!).

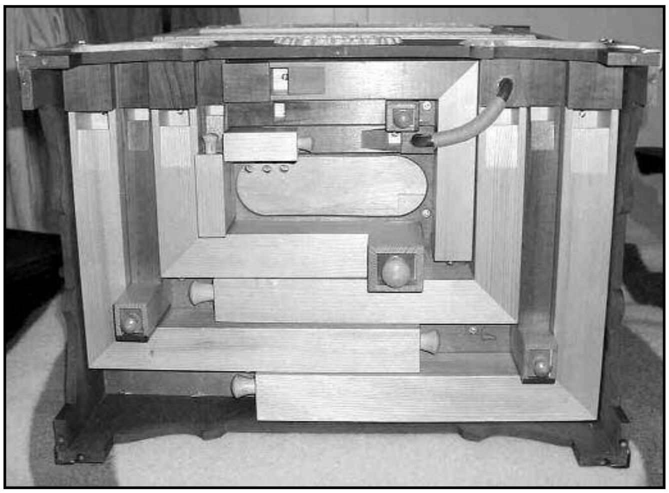

Figure 42. The bottom bass pipes, with the lower left corner wide open.

To access the lower deck, the organ must be "careened" off its cart onto a bed, couch, or other padded surface at about the level of the cart, and its bottom unscrewed. (This is an easy way to tune the bass pipes.) The lower left corner in **Figures 42 & 43** is clear of bass pipes, and there you will drill holes for the wires.

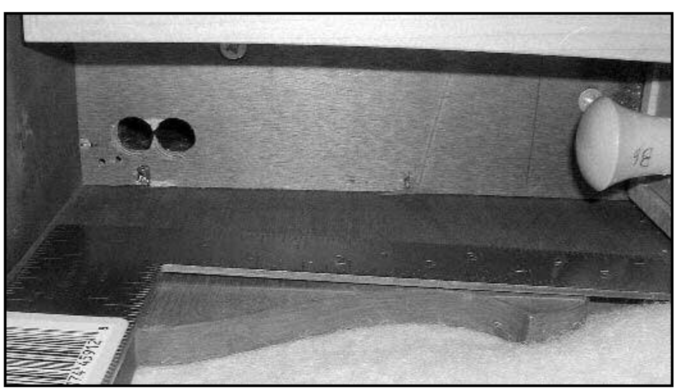

Figure 43. A close-up of the lower left corner of the bottom of the organ, showing the exact location of the drilled holes.

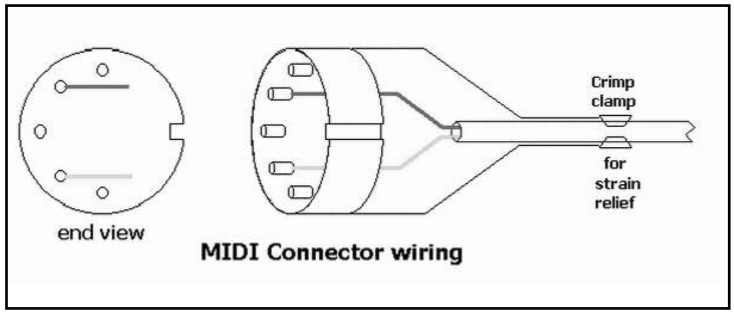

Figure 44. MIDI plug wiring uses just two of the five pins.

Threading the wires down through the organ is not a simple task, so to allow quick removal of the interface without undoing the wires; connectors are installed at the top end for quick disconnection. The MIDI board already has a standard MIDI jack, so the MIDI cable gets a MIDI plug (**Figure 44**). Use some more speaker zip cord for the power leads, and install the female mate of the connector you wired to the interface under "Power Wiring." Clamp the zip cord and nestle the MIDI cable into the cup hook as in **Figure 45**.

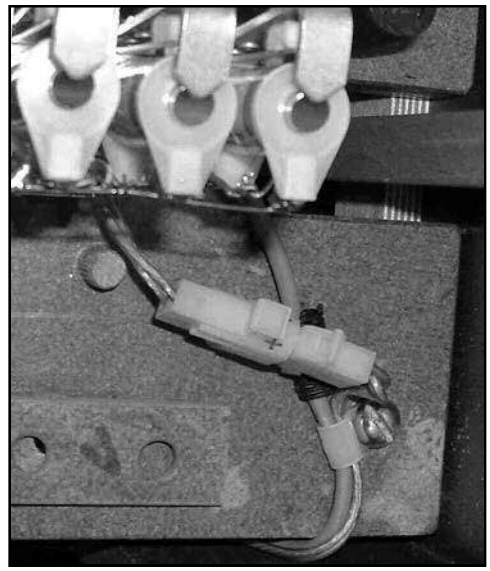

Figure 44. A top view (end) of the plugs and cables at the unit.

After both pairs of leads have been threaded through the new hole in the bottom, they each get another connector. **Figure 46** shows how the cables are just long enough to show their connectors under the organ, and stay out of the way. Your power supply and MIDI program source can have as long cables as needed.

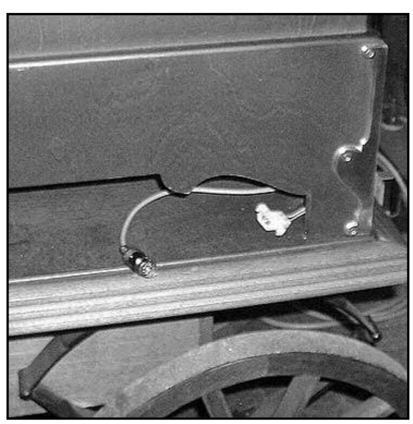

Figure 46. The MIDI and power plugs peeking out the rear corner of the bottom.

For strain relief, both leads have nylon cable clamps at their top and bottom ends. The upper clamp is held by an existing large windchest screw, while the bottom clamp requires another screw hole, out of sight. The clamps also keep taut and straight the cables within the organ, so they won't

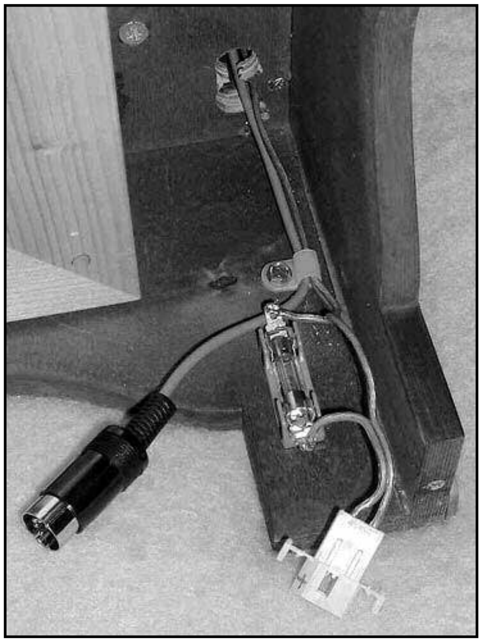

Figure 47. Holes drilled in the bottom of the organ for wiring.

rub against the pumping bellows. See **Figures 45 & 47**.

The case bottom needs one or two 1/2" holes drilled (**Figure 43**). The wires are stiff enough to poke through, working from the bottom or the top end, with patience. The connectors won't fit through the spaces and holes, so follow these steps: Cut a two-foot length of suitable MIDI cable (use shielded 2-conductor microphone cable from Radio Shack), and the same length of the speaker zip cord used for power. The microphone (MIDI) cable should have two stranded wires, usually one white and one striped red. Peel the woven metal shield back and don't connect it.

Solder a MIDI plug to the cable (Figure 43), and the male part of a second pair of Radio Shack power connectors as already used to the zip cord. Again, the striped side of the zip cord is positive.

Use a female inline MIDI plug if available, otherwise a male. Alternately, you can buy a ready-made MIDI cable and cut it off about 2' from one end, or a "5-pin DIN Audio Cable," Radio Shack #42-2151. Working from the top end, thread each cable between the rear of the windchest and the (removed) piccolo plastic panel, down past the bellows and through the hole you've drilled in the case bottom. Once both are safely through, install the upper clamp on the windchest screw to hold both cables near the MIDI board. Leave just enough slack to reach the board's MIDI socket and the mating (male) power connector you've wired to the MIDI board via the capacitor.

Now finish the bottom ends. Use a small screw to fasten the other clamp out of sight as shown in **Figure 48**. To protect against setting your organ on fire, install a fuse holder (Radio Shack #270-739) ahead of the lower strain relief clamp. I use a 2 Amp fuse, which should handle a 15-note chord. Cut just the Positive side of the power zip cord, peel the two ends back, strip the insulation and solder to the fuse holder. No fuse is needed in the MIDI line.

Cut each cable to about 6" free length. Solder the female half of a second power connector to the free end of the zip cord, again being very careful with polarity. Solder a MIDI plug to the MIDI cable, being careful to assign the two wires to the same pins (including polarity) as on the topside plug.

Note that if you reverse the DC power polarity somewhere along the line, you will burn out the jW MIDI card. Reversing the MIDI leads will cause no damage, but no notes will play until you correct it.

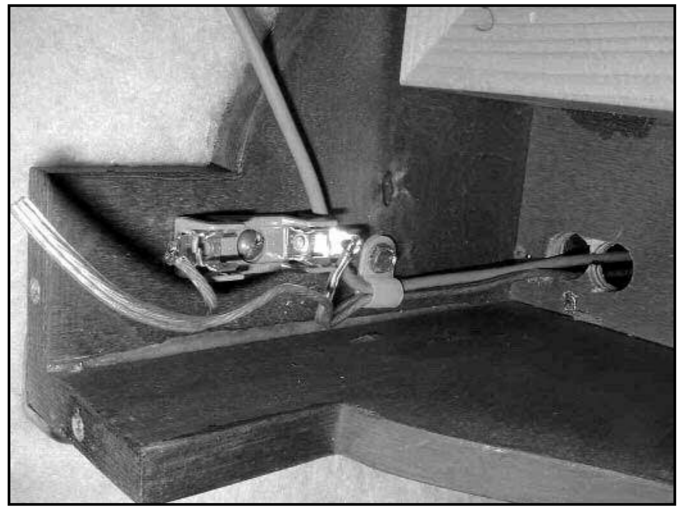

Figure 48. A closeup of the fuse clip and cables.

Final Assembly

Lower the interface unit back into the organ and screw the brackets to the case sides. Plug the MIDI connector into the board's socket, and plug the power connectors together. Loosen the clamp and adjust the two cables to get just the right amount of slack to reach the interface without getting out of line and into trouble. Tighten the clamp.

Repeat the Bench Test with power and a MIDI keyboard, observing that every note's valve operates. Now you can be pretty sure you won't need to remove the unit again.

Tubing

Now to hook up the note tubing. At this point you have the original tubes still connected to the windchest nipples. Since these are hard to remove from the windchest nipples, the best way to begin is by connecting these tubes to their interface valve nipples, cutting each tube as short as possible without forcing a bend in the rubber where it joins the nipple (**Figure 49**). Note that even the farthest interface valve can be reached by the original tubing, using the short plank's odd side nipples. Finish this phase before re-installing the roll frame.

Keep the cut-off remainders of tubing, since many can be re-used in going to the tracker bar, and are the best diameter of tubing for the job. About 10 notes can be finished with the scraps (**Figure 50**).

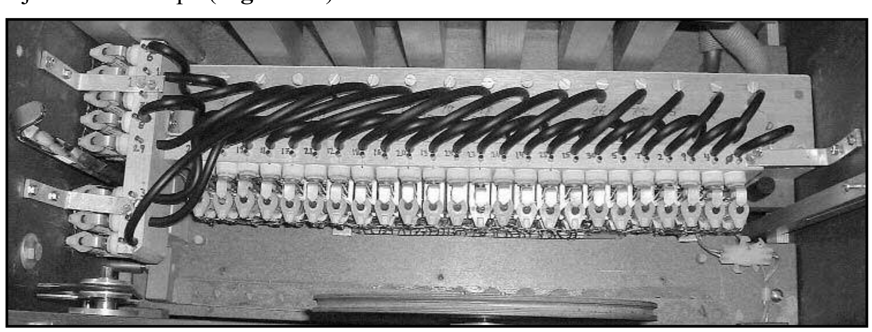

Figure 49. The interface in place with the original tubing coming from the valve chest.

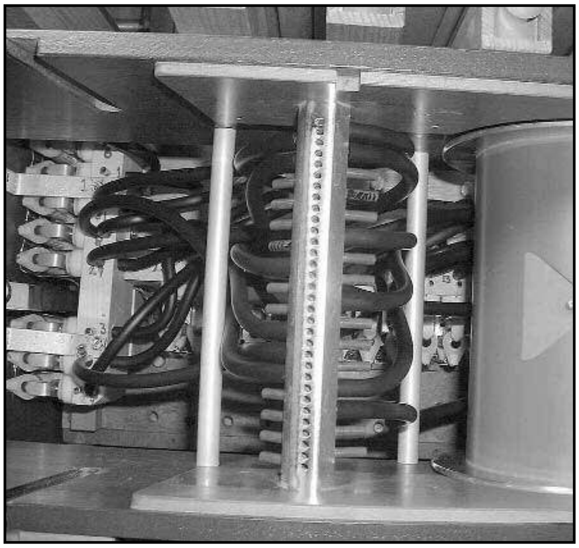

Figure 50. 12 notes of tracker bar re-tubed with scraps of original tubing.

After all windchest tubes have been re-routed to their interface nipples, re-install the roll box by reversing the order of the removal steps, but leave the piccolos out so you can reach in through the rear window.

Size Matters—Choose Tubing Carefully

For the rest of the tracker bar notes, it's very important to use the largest diameter of tubing that will fit snugly on my 5/32" interface nipples as well as the slightly smaller nipples of the Raffin tracker bar (about 4 mm). I've found that even slightly smaller tubing seriously impairs the attack of notes played from rolls. Ideally you want 9/64" ID (Inside Diameter) tubing, but when a supplier (like Player Piano Co.) lists "9/64" they mean tubing that fits snugly on a 9/64 nipple, which means 1/8" or even 7/64" ID. Even their 5/32" tubing, which is technically what I want by their standards, turned out to be narrower diameter than necessary for a tight fit. So speak clearly to your supplier that you want 9/64" ID tubing.

Also the OD (outside diameter) and wall thickness must not be excessive, or the tubes will not fit against their partners on the interface nipples or their neighbors on the tracker bar. Windshield-wiper tubing fails in this regard.

In some of my photos you will see translucent model airplane fuel tubing, but while easy to work with, it was too small and had to be replaced with player piano tubing that a friend had on hand. His was larger than what I bought new from Player Piano Co., which might have been adequate.

Routing Tubing To The Tracker Bar

When routing the new tubes, keep them as short as you can without crowding the underside of the take-up roll spool or forcing bends at the nipples. Keep all tubes below the metal spacer rods under each side of the tracker bar. I recommend working from the interface nipples back to the tracker bar. As your work progresses, you may find that you can route the latest tube shorter and neater by temporarily removing some other tube(s) already installed, finishing the new tube, then re-attaching the others. When finished, you may find that some tubes could be pulled shorter; feel free to push them off the tracker bar, cut out an inch or whatever of excess, and re-attach. Shorter is better!

Final Testing

With tracker tubing completed and the bellows rods re-connected, you can turn the crank and play the organ again. First play a roll and verify there are no ciphers, and that the correct notes play for each hole. If some notes are slow in speaking, tighten up their windchest bleed screws with a very long screwdriver.

To test the MIDI performance, put a strip of "library" transparent tape or masking tape over the tracker bar, connect the DC power supply and your MIDI keyboard (using a female-to-female MIDI coupler if needed), make sure at least one register stop is on, and play up the scale with one hand while cranking with the other. Since you already tested the interface after installation, before tubing the tracker bar, there should be no surprises.

If some notes play the wrong pipes, compare the errors when playing a roll against the errors when playing the MIDI keyboard, to find whether the rubber tubing is mis-routed between the MIDI interface and the windchest, or between the tracker bar and the interface, or both.

Playing MIDI Music

Of course you're itching to hear some real music via MIDI, using a PC or sequencer. Remember that the jW board can receive notes on only one channel (whatever you set on the DIP switches, preferably Channel 1), unequipped notes will not sound, and that if you copied my jW note numbers, the board wants its notes to be an octave lower than concert pitch. Don't include any percussion notes, as these will be bleats at the right times but random pitches.

Future Ideas

In retrospect, the wooden tee setup favors the MIDI valves for fastest attack and repetition of notes, but requires the roll-playing tracker bar signal to make a 180-degree U-turn inside the valve hole. I have found that under MIDI I can play fast triplets on the same note, which will not play from a roll. A proper metal Tee would serve the tracker bar better thanks to straight-through flow, and remove the unfair performance advantage of the MIDI valves. (However, I suspect that the MIDI valves will always play faster than a roll can, because they can open and close the hole faster than moving paper holes.)

I may rebuild the interface with proper tees. Doing so in the first place allows use of a thinner plank for only one nipple hole, but you must rotate the horizontal tee tops individually so they don't block access to the bleed screws.

Making the plank of plastic or aluminum would require less material around the nipples, making the plank still thinner. In fact, so would simply drilling the holes the full 5/32" for a loose fit of the nipples, and cementing the nipples in place with burnt shellac.

Mike Knudsen is a retired telephone and computer engineer who now lives in Maine. He has collected mechanical music since 1970, plays trombone, and has composed several piano rags and marches. His current project is doing many 31-note organ arrangements, including several holiday tunes.