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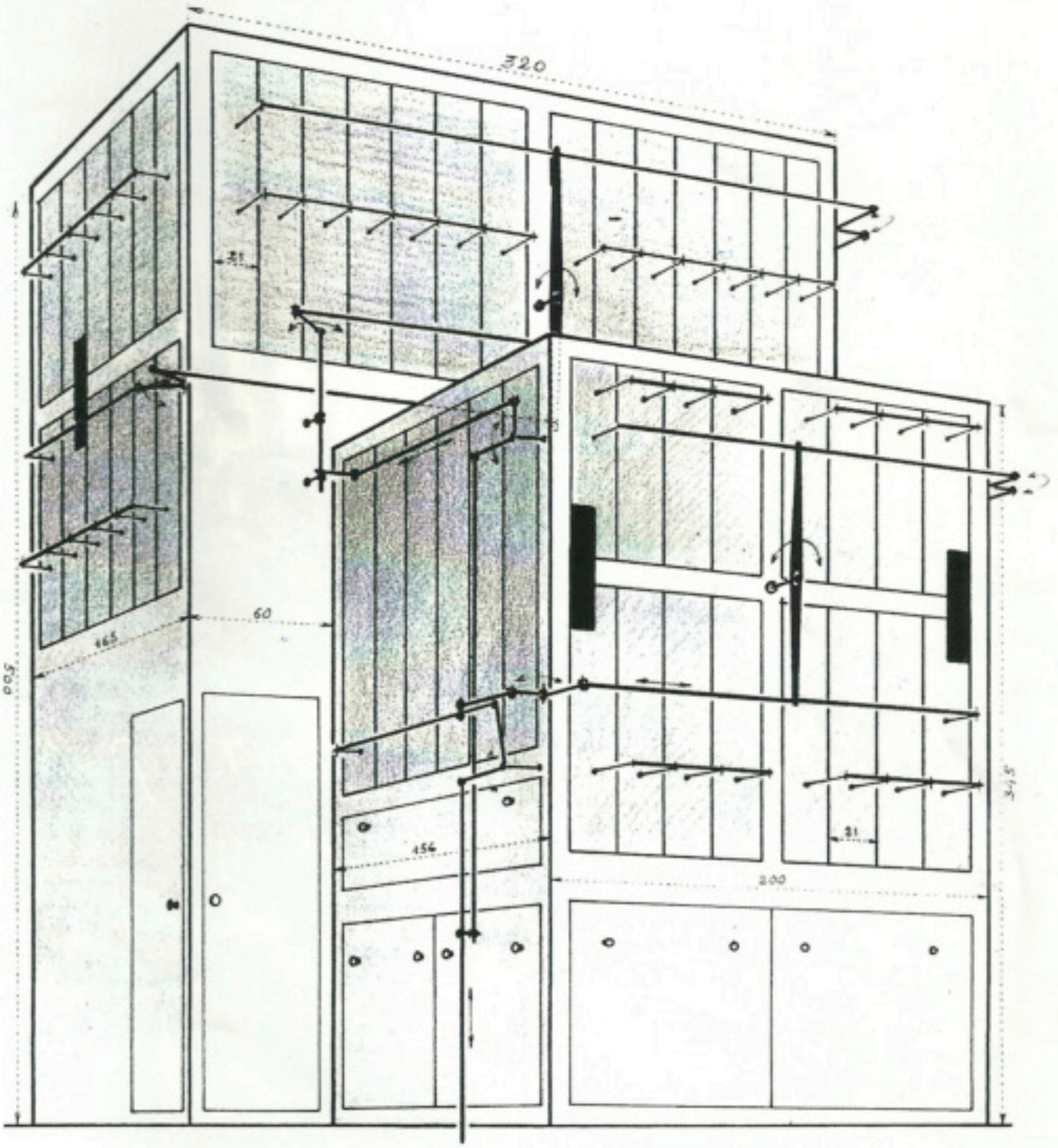

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Swell Box Design and Construction

PART ONE: A STUDY OF PRINCIPLES

by James Tickel

1. EVOLUTION OF THE SWELL BOX

To discuss the technical details of what makes an effective Swell division, it is pertinent to explore, at least briefly, the evolution of the Swell and what it does for the instrument as a whole.

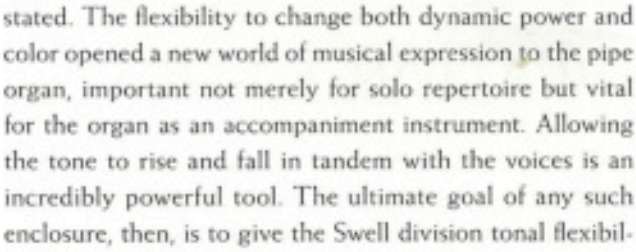
Perhaps the first seed of what would evolve into the modern Swell is described in Thomas Mace's *Musick's Monument* (1676) regarding a division of his own chamber organ. Mace describes a "Table Organ," whose top is comprised of eight desks that can be lowered or raised. Fully lowered, the desks fit tightly together, quieting the division to a whisper; entirely open, the desks allowed the tone to speak freely and strongly. One could also open a partial number of desks to moderate the volume.

Further adaptation of this idea wasn't made practical until 1712, by the Abraham Jordans, father and son, in their organ for Saint Magnus Church, London, England. That instrument contained an enclosed division whose sliding shutter was operated by a foot-lever. The "nag's head swell," as it was termed, was a crude adaptation mechanically. The resistance on the foot-lever made opening the shutter difficult to regulate, and it could descend with audible noise.

The nag's head design was superseded by the "Venetian swell," introduced by Samuel Green and borrowing a similar invention for the harpsichord developed in 1769 by Burkat Shudi (an English harpsichord maker of Swiss roots). The Green-Shudi concept resembles modern swell boxes, with rotating shutters similar to Venetian blinds.

What musical goal were these builders striving for? The answer lies in the very purpose of any Swell division: dynamic expression. The resulting effects cannot be understated. The flexibility to change both dynamic power and color opened a new world of musical expression to the pipe organ, important not merely for solo repertoire but vital for the organ as an accompaniment instrument. Allowing the tone to rise and fall in tandem with the voices is an incredibly powerful tool. The ultimate goal of any such enclosure, then, is to give the Swell division tonal flexibility and the power for musical expression.

What characteristics make one box more effective than another? Each aspect of a good swell box is equally



Ernest Skinner's "whiffletree" swell engine concept, in which sixteen pneumatics move a common trace incrementally (from Skinner's The Composition of the Organ*)* important to the end result: construction, orientation, shutters and seal, how the chests and pipes are placed within the enclosure.

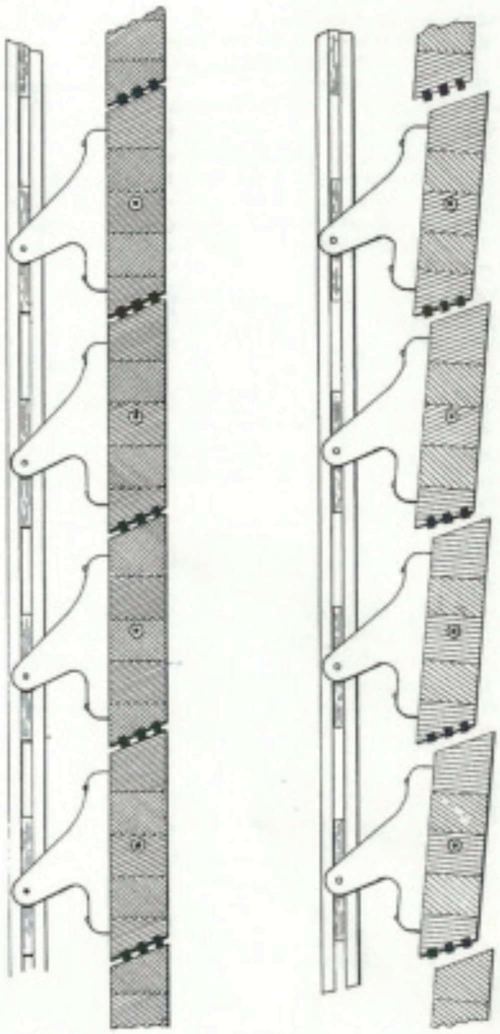
2. SHUTTERS: SOME CONSIDERATIONS

A key factor to consider first is the shutters themselves. The best shutters, when fully open, allow an enclosed division to mimic the effect of unenclosed pipes. It follows that the larger the surface area of the shutters relative to box size, the greater the effect of unhindered tone with the shutters fully open. While it is common for builders to install shutters on the enclosure's front face, shutters may also be placed on the sides or even the top of a box. (Prewar Casavants are known for this, see next page.) In certain instances where swell boxes have both side- and front-facing shutters, the ability to dis-engage one set can further extend the flexibility available to the organist. Perhaps you have encountered organs with a "Transept Shutters" control, which performs this function.

The next job of a good set of swell shutters is to produce an even crescendo and diminuendo. Their orientation is something of debate. It is more common, and arguably more practical, for shutters to operate vertically. This arrangement offers mechanical advantages, since with horizontal shutters gravity plays a role, and without careful regulation the shutters can be noisy. Also, vertical shutters can have a directional effect on the tone, which is either helpful or detrimental, depending on the situation. Horizontal shutters tend to distribute reflected sound more evenly left and right, giving more sonic breadth. Shutter orientation thus depends on the individual instrument and the location of the box within the instrument; the builder must weigh the attributes of either design and choose accordingly.

The next step in achieving the best dynamic range is to consider a proper seal between the shutters when closed. Perhaps it is worth noting that it is not necessary to mute the division to complete silence; the division needs to still be audible with the shutters fully closed. Rather, the target dynamic for closed shutters should be similar to that of an orchestra playing pianissimo—very soft, yet still audible and producing a full tone.

Leaving the shutter edges square to achieve a proper sound-dampening seal would entail placing the shutters so close together as to invite trouble. Any increase in humidity would prevent the shutters from closing, while any decrease would leave gaps between the shutters, destroying the seal and letting tone through. In light of this, builders have employed several designs, the general practice being to bevel the shutter edges or to cut overlapping rabbeted edges on corresponding edges of shutter pairs. This

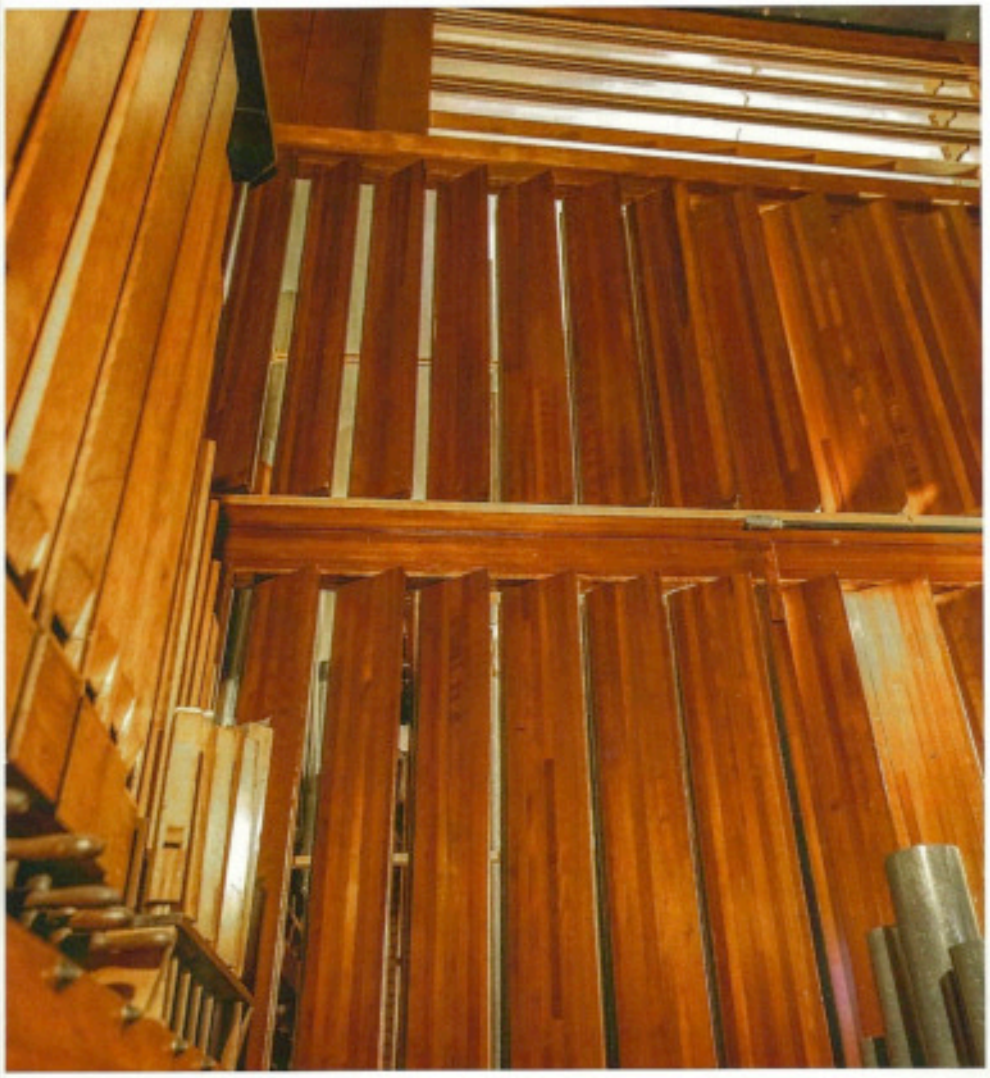


Typical swell shutter construction, showing butcher-blocked panels, beveled edges, and felt for seal and cushion against slamming noise (also from Skinner's The Composition of the Organ*)*

allows the shutters to seal without concern for expansion and contraction due to changes in humidity. Some sort of sealing material—most commonly felt but sometimes foam or types of rubber—is generally placed on the bevel, so that as the shutter edges make contact, a tight seal is produced, again without fear of humidity-related issues or undue noise upon closing.

3. MOVING THE SHUTTERS

It is ideal for the operation of the shutters to be essentially unnoticeable: smooth and even in operation, quick and responsive, and as quiet as mechanically possible. Creating a smooth crescendo is more complicated than it seems at the surface. For the dynamic change to sound smooth, the shutters must affect the sound exiting the box in the same way that our ears perceive the change in sound. In most



Inside the Woolsey Hall organ at Yale University: the 1915 Swell by Steere with vertical shutters, with added horizontal shutters by Skinner in 1928 to eliminate a tone pocket

PHOTO Zachary Ventrella

aspects of sound, our ears perceive sound in logarithmic scaling. In other words, when the dynamic volume is soft, only a small opening is necessary to create a perceived change in volume. However, as more sound emits from the box, the greater the increase in shutter opening needed to sustain the rate of volume growth. When regulating shutter movement, then, it is imperative to pay careful attention to this detail.

Historically, builders have operated the shutters all together as one group. Connections were almost invariably direct mechanical. The traditional ganged system uses what is called a "trace" to connect all the shutters together, linked either by direct mechanical connection to a foot pedal, or by an intervening electro-pneumatic or electric motor. Generally speaking, the motor will have discrete stages, sixteen being a common number. The goal of adjustment is to achieve what is described above: spreading the span of volume across the travel of the shoe, placing the various stages appropriately to produce that result.

Beginning in the 20th century, however, certain builders began to operate shutters individually, to increase speed and the possibility for sharp accent. Kimball, Wurlitzer, Wicks, and Möller, were among those who employed this kind of shutter control. The goal of individual shutter control was largely speed. In the ganged system, one motor, however powerful, had to overcome the combined mass of a potentially large shutter front. In the individual system, one pneumatic has only its assigned shutter to move. Thus, speed is the advantage of this style; noise and a smooth crescendo, however, are potential downsides. In order to minimize the effect of one shutter opening full bore, and thus letting out too much sound with the first opening, shutters in this system were often made in different sizes, so the builder has the flexibility to have a shutter of smaller width open a small distance. Then as the swell shoe travels farther, the other shutters of larger width open wider, thus creating an even and natural crescendo.

While this design offers a large amount of flexibility, the design utilized by Austin and Skinner boasts efficiency in operation. There is no clear superior design. Here is another decision the builder must make based on parameters and priorities.

Swell motors of the early and mid-20th century were large and electro-pneumatic. Indeed, the types of pneumatic, hydraulic and electric motors used in swell shutter operation could be its own lengthy article. In recent years, the development of the electric servo-motor, by Peterson, Heuss, Laukhuff and others, has not only reduced the space such equipment requires, but also increased flexibility in control.

4. ENCLOSURE CONSTRUCTION

Shutter and wall thickness both play critical roles in the effectiveness of any swell box, both at forte and at pianissimo. Mass in construction not only dampens the sound with the shutters closed, but reflects it out—bass and treble—with the shutters open. When dealing with solid wood construction, we have found there to be little increase in sound dampening properties beyond 2" in thickness. Some builders construct the walls in a sandwich form, trapping a layer of sound-dampening material, such as sawdust, between two thinner panels of wood. (Many post-war Aeolian-Skinner swell boxes were constructed in this manner.) While this is most likely inefficient for solid wood construction, this can be effective in a situation where a different material is used for the wall paneling, such as Masonite, a reflective surface with low frequency absorption properties. This allows the division to speak well when open, while the layer of sawdust appropriately dampens the division when closed.

This discussion of box construction presumes there a dedicated box is being considered. In many cases, an instrument is built into existing chambers, some part of which may provide one or more walls for the swell enclosure. Those walls demand the same consideration as any wall being built new. If it is insubstantial, it is unlikely to provide the reflective or dampening qualities you seek.

Understanding the chamber wall construction, then, is an essential part of your research before construction. Lining the chamber walls with dense, sound-reflecting materials, such as well-varnished hardwood, will help. This is also the time to consider whether the chamber, particularly if any wall is an outside one, requires insulation, which can be factored into the design of the wall modifications.

5. PLACEMENT OF THE BOX AND PIPES WITHIN IT

Placement of pipes within the box is just as important as how the box is built. A common practice is to locate bass pipes against the enclosure walls; we find many early– and mid–20th-century organs designed in this manner. But sometimes, lining the walls with pipes inhibits the reflection of sound, since the wall surfaces are now made complex with pipes. The trade-off here is that bass pipes, particularly those of large scale or louder tone, are usually happier on an offset chest rather than crowded onto the main chest, particularly those of "A" formation. Thus, in your design, it's important to consider any trade-off in the placement of those basses.

The placement and orientation of the swell opening is another vital factor. Sometimes a swell will not speak directly to the intended listener, and thus the sound coming from the chamber must reflect first within the chamber. This can reduce the strength of tone, sometimes dramatically. In instances where the chamber opening is perpendicular to the listening hall, vertical shutters that open to face the audience will direct more of the sound towards the hall. This is not a complete solution, but rather a compromise.

NEXT INSTALLMENT
BUILDING THE SWELL BOX

AUTHORS

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NATALIE LEEK also contributed to this piece. Originally from Mumbai, India, she moved to the United States in 1991, where she earned a graduate degree in Business Management from Case Western Reserve University. Meeting James Leek at a swing dance event, she caught the organbuilding bug; his passion soon became hers, and they married in 2002. Until 2008, she was Senior Assistant Director of Admissions at Oberlin College of Arts and Sciences, but did part-time work at the Leek shop, where she now works full time.