Directional Characteristics of Pipes

(The reason for the inimitable character of pipe-produced sound)

by R. J. Weisenberger

Other than the sheer range of dynamics and tonal colors, what other factors contribute to the unique, inimitable character of pipe produced sound? The answer to this question does not lie with any building or voicing technique. Builders and voicers have control of only tonal quality and power, but to a very great degree.

As I have said in my previous articles, the scales of the pipes themselves largely determines their tonal quality, while the cut ups of their mouths determine their power. Both of these factors are related to the operating pressure by the dimensions of the flue. (The mathematical formulas for correlating these factors, and graphs of actual test results are available on request).

But, getting back to the original question, the answer lies in the pipes themselves. Pipe produced sound represents a sound made up of multiple sources, each with their own polar (directional) characteristics.

Let's look at the polar characteristics of several types of pipes in general:

1.) Closed pipes:

Closed pipes radiate all of their energy from their mouth. Since the mouth area is insignificantly small as compared to the wavelength, the sound is dispersed equally in all directions, creating a spherical field of sound around the pipe. A closed pipe can be considered as a point source radiator.

2.) Open pipes:

Open pipes radiate equally well from the top of the pipe as well as the mouth. An open pipe can be considered as two point sources vibrating in phase. At fundamental frequency these sources will be separated by almost ½ λ (½ wavelength) for small scale pipes with high mouth cut ups, such as flutes. For large scale pipes with low mouth cut ups, such as the 2' extension of a tibia, the source separation will be somewhat less than ½ λ. Such is also the case of mitered pipes. (See note)

Two equal small sources, separated by ½ λ will produce a toroidal (roughly donut shaped) field of sound around the pipe, with the greatest output perpendicular to the axis of the pipe.

3.) Harmonic pipes:

Harmonic pipes are open pipes which are overblown to sound their octave, rather than their fundamental. Besides having a tonal structure unlike normally blown pipes, these pipes also disperse sound differently. A harmonic pipe can be considered as two point sources, vibrating in phase, separated by roughly 1 λ (1 wavelength).

Two equal small sources separated by 1 λ will produce a lobed field of sound around the pipe, with the greatest output on axis with the pipe (above and below it). Smaller, secondary lobes will also be formed perpendicular to the axis.

4.) Reed pipes:

In reed pipes there are three factors which control sound dispersion.

A.) The mouth diameter (bell of horn.

B.) The rate of flare (rate at which diameter increases along length of horn)

C.) The type of flare (conical, exponential, etc.)

The (bell) mouth diameter has an effect primarily on the dispersion of the fundamental frequency and lower order harmonics. A resonator with a small mouth is less directional than one with a larger mouth at the fundamental frequency of the reed.

The rate of flare has an effect on the dispersion of the higher order harmonics. A resonator with a high rate of flare is less directional than one with a lower rate of flare at the higher order harmonics of the reed.

The type of flare also has an effect on the dispersion of the higher order harmonics. An exponential flare, such as that of a brass trumpet, projects a gradually narrowing beam at the higher order harmonics, while, the conical flare of a kinura produces a sound beam which becomes progressively broader at the highest order harmonics of the reed.

My next article will look at the fundamental properties of reeds.

FOR FURTHER READING:

Acoustical Engineering by Harry F. Olson, Ph. D; Copyright 1957, D. Van Nostrand; Chapter II - Section 2.4 and 2.19 (point sources and horn sources)

Considerations for Organ Chamber Design in Homes by Lance Johnson; THEATRE ORGAN, January 1977

NOTE: Mitering OPEN flue pipes (such as strings) will alter their tonal quality. This is because the even harmonics are radiated 180 degrees out of phase from the mouth to the top of the pipe.

In extreme cases, where the top of the pipe would be next to the mouth, the even harmonics will cancel each other out, resulting in a tonal quality similar to a stopped pipe.

Straight pipes always give superior results. If limited space dictates that any pipes must be mitered, remember to keep the tops of these pipes as far as possible from their mouths.

The use of electronic tuning and voicing aids, rather than the ear, cannot make a pipe organ sound like an electronic as commonly supposed. It is the *manner* in which the sounds are produced, not the degree of precision which gives the pipe organ its unique sound.

It is difficult to build an electronic organ to sound anything like a pipe organ. It is impossible to build a pipe organ to sound like an electronic.

All organ pipes ever built operate by the same basic scientific laws, whether or not their builders were ever aware of these basics.

A contemporary awareness of these laws, guided by the products of modern technology as tools for further research, will give new life to a fading art which was thought by many to have already exhausted its possibilities.

CORRECTIONS TO PREVIOUS ARTICLES IN THIS SERIES

In the December/January issue I found two ambiguous statements caused by a change in the printed format from my original illustrations.

The note at the bottom of Figure 2 (page 26) was intended for pipe 'c' only, and should read: "If extended to 16', pipe 'c' will appear the same."

The note at the bottom of Figures

5 and 6 (page 27) was meant only for Figure 6 and should read: "Pipe ratios are drawn to scale; actual length will be greater for the pipe in Figure 6 for a given note."

In my original copy these notes were written next to the sketch of the pipes involved, and in print were moved to the bottom of the drawings, resulting in a loss of their original meaning or significance.

I will try to improve the clarity of all future illustrations submitted so that any alteration in format will not result in a change of context.

There is also a printing error in the October/November issue concerning my boat whistle project on page 16.

In Figure 2 the dimensions given for the back view should be 2.25", 2.25", and 2.5" instead of 2.5", 2.25", and 2.25". All pipes except the C pipe share a common wall, and it is this pipe which will require the added width of the extra wall as viewed from the back. Figure 4 should show three separate pipe fronts as can be clearly seen from Figure 3.

R. J. Weisenberger □

the letters to the editors

Letters to the Editor concerning all aspects of the theatre organ hobby are encouraged. Send them to the editor concerned. Unless it's stated clearly on the letter "not for publication," the editors feel free to reproduce it, in whole or part.

Address:

George Thompson
Editor
P.O. Box 1314
Salinas, Calif. 93902

Dear George Thompson:

I would like to clarify a misinterpretation of an article that appeared in a recent issue of New York Magazine, and was reprinted in part in the THEATRE ORGAN, October-November edition.

When I compared the wonderful organ in Radio City Music Hall to the organs of Leipzig and Canterbury cathedrals, what I was explaining to my writer was that these instruments all share the same type of experience from the standpoint of the organist seated at the console. Each one provides an enormous amount of power and the vast number of pipes and the experience to play these instruments is wondrous.

While I realize that anyone knowledgeable on the subject of organs would have recognized that there had been a misinterpretation of my intent, I nevertheless wish to clarify that particular point, and to hastily explain that it is very often difficult to have writers who are not knowledgeable on the subject of organs understand the meaning of all the intricacies of the organ world.

The organ at Radio City Music Hall is a great instrument, but as we all know, was designed for the playing of ballads and that it does superbly, whereas the other instruments in Leipzig and Canterbury of which I spoke, are classical organs designed for playing repertoire of the organ classic masters and the only thing they have in common is the fact that they are wind instruments and use pipes, and are played from keyboards. Beyond that, the purpose of their voicing and their intent is quite different.

Nevertheless, they are all exceptional instruments and in the case of the Radio City Music Hall organ it remains an important part of the history of Radio City Music Hall and the major reason many people would attend performances there in the first place, and it certainly deserves the best of treatment.

I would like to offer my congratulations to the American Theatre Organ Society who have traditionally for the last several years taken it upon themselves at great expense, often from their own pockets, and great amounts of time to rebuild in a most admirable fashion, many of these fine theatre organs that have been forgotten for years and because of the devotion of these members these organs now remain for posterity.

I would like to make comment also in closing to the man whose picture the October-November edition bore on the cover, specifically Mr. Richard Simonton. He was a wonderful friend, personally speaking, and truly a great friend of the organ world and his quiet benefactions were behind the scenes in many positive steps forward that were taken by the entire industry with regards to saving, restoring theatre organs. I personally shall miss, as shall the industry, the smiling face and the ready enthusiasm of Richard Simonton.

Sincerely,
Virgil Fox
Palm Beach, Fla.

Dear Sir:

I am renewing my subscription to your magazine. To me it is one of the most exciting ones I have ever read. I always look forward to it. I am also very happy that Radio City Music Hall was saved and now it is back giving people good music. I have my organ records from the Hall; Dick Liebert and several more — all beautiful to hear. A friend of mine here, who is a theatre organist, told me he had heard about a young organist at the Hall. I believe his name is Lance — but I forgot his last name. *[Ed. Note: The name is Lance Luce.]* All the critics are giving him good write-ups. I hope he will make some records. The young people are doing a good job of playing the theatre organ and I am proud of them — for one who heard his first movie organ over forty years ago and I'll always be an organ nut.

I remain yours truly,
Gordon MacDonald
Vancouver, B.C.

P.S. As I got the fight started to save our Orpheum Theatre (with organ) I hope you get the Chicago Theatre. I see George Wright is helping. Good for him.

Dear Vi Thompson,

Just a big THANK YOU VI . . . for all you have done in the past fifteen years as Circulation Manager for ATOS. The hours you have spent over the files checking new memberships, changes of addresses and even correcting some mistakes that a