New Types of Flute Embouchure Sections
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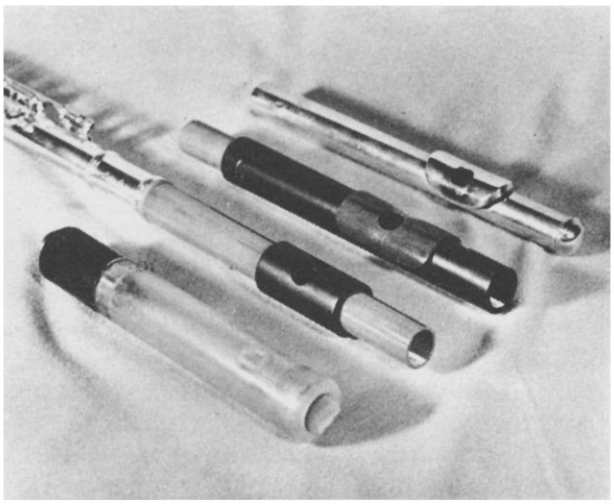
Reviewed work(s):
Source: *Early Music*, Vol. 1, No. 3 (Jul., 1973), pp. 152-153
Published by: Oxford University Press
Stable URL: http://www.jstor.org/stable/3126064
Accessed: 05/10/2012 12:04

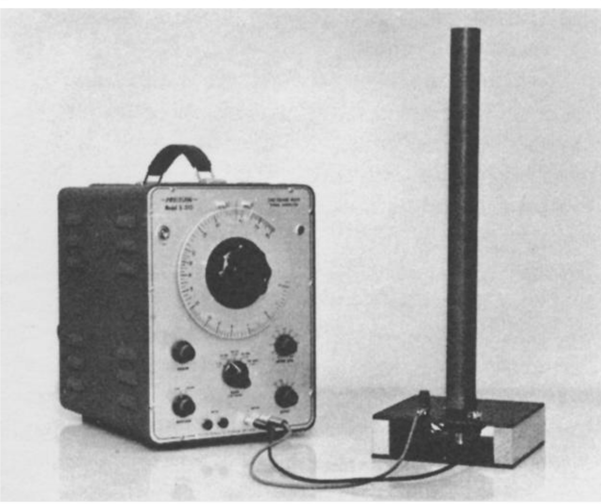
New types of flute embouchure sections

RAOUL J. FAJARDO

This article was felt to be of interest to readers of Early Music *as it puts forward general principles of flute tone production that have a bearing on the baroque as well as the Boehm flute.*

Various head joints *(see p. 153)*





Standard electronic signal generator activating a loud speaker box generating compression waves inside a pipe

The development of the new type of head joints, or embouchure sections, to be described here had its beginning in a musical soirée in the home of a friend of mine on the picturesque hills not far from Stanford University in California. Two friends and myself, each equipped with a wooden flute of the Boehm type, were playing a Vivaldi trio. Afterwards we began to compare flutes: a Ritterhausen made in Germany; a very old American Haynes wooden flute of magnificent tone; and a Lignatone Czechoslovakian flute of brilliant sonorities. The three flutes are made of granadilla wood, but they sounded distinctly different. We discovered that each had the same size of fittings, so that the heads could be interchanged. When I installed the head joint of the Haynes flute on my Lignatone instrument, it sounded like the Haynes flute. When I installed the Ritterhausen head joint on my flute, it now sounded like the Ritterhausen flute. This essentially scientific experiment had an obvious conclusion: the head joint is of primary importance in determining the tone quality of a flute.

That experience led me to more precise research during a sabbatical year at Fullerton State University in 1971. From phenolic plastic tubing, and using the proper taper, I constructed a head joint that would fit both a metal flute and a wooden flute. The sound of the metal and the wooden flute were distinctly different even to the uncultivated ear; but when equipped with the same plastic head joint the sound of both flutes appeared the same even to sensitive musicians. A frequency spectrum analysis of the sound by means of laboratory instrumentation substantiated the fact that if the body of the metal flute and that of the wooden flute have the same inside diameters (and the same length to diameter ratio) the sound difference would be mainly accounted for by the material and design of the head joint — and not by the material of the main body of the flute. It also became evident that the phase relationship of the harmonics of a given note (and not the amplitude alone) are affected by small variations in the bore and blow hole. Harmonic phase variations, unlike the classic opinions of Dr Hermann Helmholtz, have been found to produce detectable differences in the sensation of the tone quality of a sound, specially below one thousand cycles per second. This conclusion on the effect of phase of harmonics has been verified by different independent researches. One of them reported his findings in the November 1962 issue of *The Journal of the Acoustical Society of America.* In a harmonically simple sound, like that of the flute, phase differences in harmonic contents can contribute perceptible differences in the tone colour of the low and middle registers. Small variations in the dimensions of the head joint taper and of the blow hole shape, can effect phasing, and definitely affect the amplitude of the harmonics of each note; the material and wall thickness account for additional reinforcement or attenuation of the harmonics that make up the tone colour of a given note.

A full detailed account of the implications of the wave analysis and the various illuminating conclusions that can be derived from it would be out of place in the present brief article. The conclusions, however, were sufficiently significant and encouraging to lead me to experiment with the construction of flute head joints of different materials and design using, besides the scientific data, a certain element of intuition which is indispensable in the arts. I have built at least ten different head joints or embouchure sections. Three of my choicest ones are shown in the accompanying photograph (where the metal piece of the original flute is also shown for comparison).

One head joint, in the photograph, is made of translucent polymer glass ('potting compound'). Its inner taper and the dimensions of the embouchure hole depart slightly from those prescribed by Boehm. This head section gives the metal flute a greater dynamic range (in the lower octave) than that obtained with the metal section supplied by the manufacturer. The tone quality is also judged superior by every listener. I constructed the other two head sections shown in the photograph from linen phenolic material. They taper from a circular cross-section at the joint to an elliptical cross-section at the cork end. I claim this to be a new and entirely different design concept, which also permits a simple manufacturing technique for obtaining the desired taper from originally cylindrical tubes of any material.

The tone quality of the head section with the thicker wall (the black elliptic section) produces a sound resembling that of a baroque wooden flute, but having the more brilliant and powerful sound of the Boehm type of flute.

The elliptical head section of thinner wall is provided with a circular embouchure hole (blow hole) and produces a more brilliant sound of a distinctly non-metallic quality. It keeps a perfect intonation even with little attention to lip embouchure techniques.

The material and wall thickness of the head section, besides affecting the tone quality, have an important bearing on the volume or loudness of sound — based on the fact that they act as energy couplers or radiators between the compression waves inside the flute and the ambient air. Some light has been thrown on this subject by an instrument I designed and built for the Physics Department of Pasadena City College. With this instrument consisting of a standard electronic signal generator, which activates a loud speaker box, which in turn generates compression waves inside a pipe of any desired length and material, it is possible to compare the acoustic radiation properties of pipes of different materials and wall thickness. A photograph shows this simple instrument which also serves to demonstrate many principles of acoustic resonance and pipe behaviour in a more effective manner than the classical experiments with tuning forks and water-filled tubes familiar to students of physics.

This article outlines the Fajardo Elliptic Flute Embouchure which is the sole property of the author who has applied for copyright protection.