

## Questions & Answers

**Editor's Note:** With this issue we inaugurate a new column in the Historical Instrument Section. Throughout the years we have received a variety of questions pertaining to historical low brass instruments. We sensed an annual "questions and answers" column would be of great interest. To launch this issue, I posed one of the most commonly asked questions: Why do the serpent and contrabassoon double orchestral parts when, in fact, they play in different octaves? For the answer I turned to the renowned acoustician and serpentist Murray Campbell from the University of Edinburgh. We greatly appreciate Professor Campbell's thorough and speedy response.

For future issues of this "Question and Answers" section, please send your questions to Craig Kridel. His contact information can be found on page 2 of any issue of the ITEA Journal.

### Serpent and Contrabassoon Acoustics

by D. M. Campbell

Why does the serpent's sound often seem to be an octave lower than its actual playing pitch? As a scientist who spends much of his time probing the arcane mysteries of brass instrument performance I am used to fielding bizarre questions from fellow musicians, but this one, posed by *Historical Instrument Section* editor Craig Kridel, made me stop and think. The question relates, of course, to the bass register of the serpent, which in pre-tuba days was called on to reinforce the bottom end of the orchestra by composers from Händel to Wagner. I have had the privilege of taking part in a number of orchestral performances on the serpent, and the question recalled one particular piece of music: the Overture *A Calm Sea and a Prosperous Voyage* by Mendelssohn. Playing the serpent part in this, I was struck by the fact that Mendelssohn used

the instrument as the bass of the woodwind section rather than the brass. My feeling of being an honorary bassoon was strengthened by the realisation that the contrabassoon was doubling the part throughout. Since the contra plays an octave lower than written pitch, the effect should have been of octave doubling; but my memory is rather that the two instruments blended together to give a

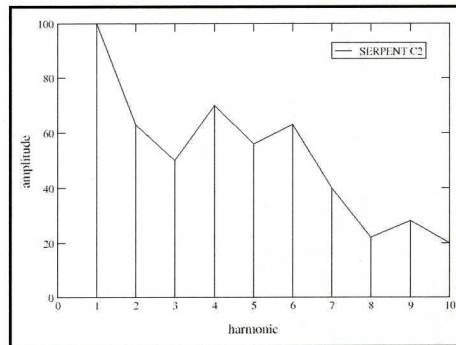


Fig. 1: Spectrum of the C2 on a serpent.

surprisingly unified sound.

The bottom note of the serpent is a wonderfully rich and fruity sound, but on a C instrument its pitch is C<sup>2</sup>, corresponding to a frequency of 65.4 hertz. The contrabassoon is undoubtedly an octave lower—its bottom C is C<sup>1</sup>, the lowest C on a piano keyboard, with a frequency of 32.7 hertz. Why then does the serpent seem to be "as low" as the contrabassoon? The answer lies in the difference in timbre between the two instruments. This difference in timbre is dramatically illustrated by examining the frequency content of each of the sounds.

Any musical note with a clearly defined pitch is actually made up of a whole series of different tones sounding simultaneously. This set of tones is known as the "frequency spectrum" of the sound, and each tone is a "frequency component." For a pitched sound the frequency components are members of a harmonic series: this means that the frequencies of the components are whole-number

multiples of the lowest one. The note C<sup>2</sup> on the serpent, for example, has a lowest component (or "fundamental") with a frequency of 65.4 hertz, and a series of higher components with frequencies 2, 3, 4, 5 ... times 65.4 hertz.

The timbre of a sound is largely determined by the relative strengths of the different frequency components. A spectrum analyser displays the frequency spectrum as a set of vertical lines, each one representing one of the components; the height of each line is proportional to the relative amplitude of that component in the overall sound. I measured the spectrum of a mezzoforte C<sup>2</sup> on a serpent and obtained the result shown in Figure 1. The line joining the tops of the vertical lines shows the overall trend of the harmonics: in this case strongest for the fundamental, dropping in amplitude for the second and third, rising again at the fourth and then falling strongly around the eighth harmonic. This is the spectrum of a full and mellow sound.

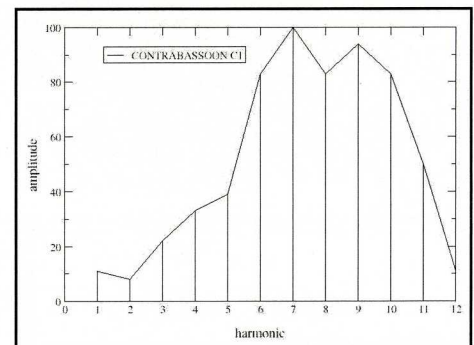


Fig. 2: Spectrum of the C1 on the contrabassoon

A very different story is revealed by the spectrum of the C<sup>1</sup> on the contrabassoon, shown in Figure 2. The fundamental is very weak, and the second harmonic even weaker; the amplitude then grows steadily, reaching its maximum at the seventh harmonic before falling away again. This spectrum is characteristic of a very buzzy timbre, lacking fullness but rich in high frequencies. It should be

