

HORNING IN ON THE HARMONIC SERIES

In this issue, the harmonic overtone series is further elucidated. While discussion of the series can be applied to almost any instrument, we will focus on the horns. It's a particularly interesting family of instruments because it exemplifies how the instrument improved as the makers grew in their understanding of the series.

Horns may be among the oldest families of musical instruments to survive into the present. The fact that we still call such an instrument a "horn" is a throwback to its origin when it was made from the horn of a young bull (see **Figure 1**). Modern horns are usually made from metal as evidenced by the "brass" section of the orchestra — but we still call them horns. It might

Harmonic	Freq.	Note	Relation to Fundamental Octave + Scale Degree	Horn/Brass Application
1	220	A3	Fundamental (Unison)	+Trumpet Blare - Heraldry
2	440	A4	Octave 1	-
3	660	E5	O1 + 5	-
4	880	A5	Octave 2	+Simple melodies like
5	1100	C6#	O2 + 3rd	- bugle calls (Taps, etc.)
6	1320	E6	O2 + 5 th	-
7	1540	G6#	O2 + 7b(-)	-
8	1760	A6	Octave 3	+Complex, scale-oriented melody
9	1980	B6	O3 + 2nd	- Clarino Register, Bach Horn
10	2200	C7#	O3 + 3 rd	-
11	2420	D7	O3 + 4th(+)	-
12	2640	E7	O3 + 5 th	-
13	2860	F7#	O3 + 6()	-
14	3080	G7	O3 + 7b	-
15	3300	G7#	O3 + 7(-)	-
16	3520	A8	Octave 4	+

Table 1. The harmonic overtone series & the evolution of the horn

interest the word buffs among you that we get the word "bugle" from the Latin "buculus," meaning "young bull," and the word "cornet," from the Latin "cornu," meaning "horn."

The most familiar horn is the trumpet with its three valves, but valves didn't actually arrive on the musical scene until the 19th century. Before valves, the musician had to coax out a melody using the harmonic overtones inherent in the instrument. The original horns were more like noisemakers than musical instruments and were used primarily for religious rites, coronations and military occasions. Jewish celebrations still use the shofar, a horn almost unchanged over time. Heraldry, as portrayed in the movies, used long horns draped with flags, banners or coats of arms to announce regal processions. The military, through many cultures and eras, has used the blare of the horn to communicate orders above the noise of battle. The bugle is still used today in this mode.

The original horns were one piece. They were played, like the modern instruments, by pursing the lips at the small opening; the moving air vibrated the lips and caused the horn to resonate at its fundamental frequency. To play any other note required a kind of controlled over-blowing to invoke the harmonic overtones above the fundamental. As we discussed last time (see Vol. 5, No 1, Page 4 in the Archives at www.folkworks.org) the overtone series leaves large gaps between notes until you get into the upper registers of the instrument (see **Table 1**). To reach the upper registers more easily, instrument makers began to make metal horns longer and longer to lower the fundamental frequency. Since such horns were used for "the hunt," the length of the horn soon became unmanageable. When it was realized that curving the body of the instrument did not change its acoustic properties these horns became circular, making them smaller. This also made it possible for the hunt master to free his hands by hanging the horn around his neck.

Over time more fine-tuning of the instruments occurred, modifying them in a variety of ways to allow the length of the tubing to be adjusted. These included adding a sliding portion to the tubing and having interchangeable crooks of different lengths. It was also found that placing the hand at various depths into the bell of the instrument (see **Figure 2**) gave the player better control over the pitch, a method that is still used by today's French-horn players.

It was not until the early 1600s in Nuremberg that enough improvements in the instrument were made to allow it to move well into the upper overtones.



Fig. 3 Bach Trumpet



Fig. 2 Hand In Bell



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Music began to be written for the upper register where the notes of the overtone series are closer together and the melodies more scale oriented. This was referred to as the "clarino" register and the "clarino" style flourished all through that century reaching its peak as the 1600s came to a close. A good example of this style can be heard in the Brandenburg Concertos where J.

S. Bach makes extensive use of the Baroque Horn, sometimes called the Bach Trumpet (see **Figure 3**). The instrument has a stunning effect as it pierces through, high above the orchestra's musical backdrop, creating a regal and pompous melodic statement. You may recognize the Brandenburg Concerto No. 2 since it was used as the opening theme for William F. Buckley's *Firing Line* program that ran from 1966-2000.

Today's horn player no longer needs to master the clarino register to play a scale-oriented melody. Modern-day trumpet valves allow the effective pipe length to be changed, thus altering the fundamental frequency of the instrument. Various combinations of the three valves produce different lengths in the resonating cavity. For the musician, it's like playing several horns of differing pitch combined into one instrument.

As noted in past articles, all musical instruments amplify sound by producing standing wave resonance, and standing waves can only propagate as multiples of the fundamental frequency. Those multiple frequencies are, in fact, the harmonic overtone series. The horn family, like all instruments, must follow the rules and as instrument makers gained a fuller understanding of the rules, they made better instruments. Similarly, as your understanding grows, you will make better music. So, blow your horn and, as usual, stay tuned.

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