The Partch Hoax Doctrines

What's in a *new* name? when the source from which it flows is old.

by Cris Forster

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www.chrysalis-foundation.org

A print publication recently released inaccurate and misleading descriptions of my work as a builder of unique acoustic musical instruments. The writers of this dictionary do not lack historical and factual information about these instruments. At the website, www.chrysalis-foundation.org, launched in 2002, and in my book, *Musical Mathematics: On the Art and Science of Acoustic Instruments*, published by Chronicle Books in 2010, I have described the musical origins, overall construction, and special features of all my instruments. An obvious reason why my efforts have had no effect on these writers is that they have not read my texts, and therefore have opinions on subjects they know nothing about. Another and more insidious reason is economics. Large and small print and online publications tend to promote products that are most convenient for them to produce. To minimize costs and maximize gains — either in the form of monetary profits or political power and prestige — they not only analyze and respond to popular opinion, but have a vested interest in shaping it as well. Since predilections, favoritisms, and intentional omissions are never openly acknowledged, agenda-driven writers, editors, and publishers always portray themselves as gallant visionaries, or as magnanimous providers of "educational" resources for future generations.

Over the past 40 years, I have spared no expenditures of time and energy in building, tuning, composing for, and writing about unique acoustic musical instruments. Also, as curator of the Harry Partch Foundation (1976–1980), I restored and tuned virtually all the instruments. Therefore, I am also qualified to speak about the origins, construction, and tunings of the instruments built by Harry Partch (1901–1974). With these skills and experiences, I will try to be objective, accurate, and truthful in my objections to the half-truths of this publication.

Before I begin, I would like to address a severe limitation that surrounds me on all sides. When someone ignores facts or suppresses evidence, I cannot prove that the perpetrators of such omissions seek to denigrate the truth by promulgating half-truths. All students of philosophy know that you can't prove a negative. You can't prove that something does *not* exist. Therefore, since I cannot prove a negative, I also cannot presume to know what exists in another human being's soul.

I begin with *The Grove Dictionary of Musical Instruments*, the first edition (*Grove1*) published by Macmillan Publishers Limited in 1984, edited by Stanley Sadie, and the second edition (*Grove2*) published by Oxford University Press in 2014, edited by Laurence Libin. *Grove2* appeared 30 years after *Grove1* but used almost the exact same text to misrepresent my work. And again, despite my website and book, *Grove2* perpetrated a largely incorrect description of my first concert-size instrument, Chrysalis I.

In his Preface, Laurence Libin draws attention to several distinctions between *Grove1* and *Grove2*. In the following statement, he singles out discussions on tunings as a unique contribution:

"On the other hand, playing techniques (e.g. bowing, tonguing, fingering), pitch, and tuning, are given due attention as they are crucial to understanding how instruments work and sound."

Similarly, he touts a greater inclusion of instrument makers by acknowledging their contribution to the development of music in this century:

"This edition pays substantially greater attention to electronic and experimental instruments and to instrument design and manufacture, and discusses more persons—acousticians, collectors, curators, dealers, as well as makers—whose work has shaped our understanding of instruments and thus of music in the 21st century."

In Volume 3, p. 462, under the heading "Microtonal instruments," and the subheading

"§4: After 1930. *(i) Harry Partch and the California group.*"

one finds the following text, again almost identical to the description in *Grove1*.

"Cris Forster made several instruments in 56-note just tuning: two of them, the Harmonic/Melodic Canon and Diamond Marimba, were inspired by Partch; a third, Chrysalis, consists of a disc mounted vertically on a stand with 82 strings on each face, which radiate out from an off-center circular bridge."

In 1982, *Grove1* wrote to me to obtain a photograph of Chrysalis I, demonstrating that they know how to contact people when they want something. In contrast, *Grove2* never informed me about their impending publication. Had they contacted me for any reason, I would have explained to them why the last two quotations include *six* misrepresentations of my work. So now, under the worst possible conditions for me personally, I will set the record straight.

[1] — There is no such thing as a "California group." Yes, I have lived and worked in California since 1961. If Grove wants to make up a group based on some arbitrary geographical location and then cast me into that fictitious group without acknowledging my activities over the past 30 years, the least they could do is find a more appropriate category than so-called "microtonal instruments." The adjective 'microtonal' can apply to any and all scale and tuning theories known to man. 'Micro' is a relative term, as is 'macro', and therefore has no mathematical meaning. Experiencing new tunings is the principal reason why I build musical instruments. Scales and tunings cannot be intelligently discussed without numbers. So, without mathematics there will never be advancements on the subject of tuning, no matter how noble the aspirations to evoke change. Finally, just because a fiddle maker may have lived next door to Stradivarius does not justify throwing him into some non-existent "Cremona group."

[2] — The statement about having "made several instruments" gives the false impression that my life's work consists of only three instruments. Here is a list of all my instruments to date. [**1**] Little Canon (1975). [**2**] Chrysalis I (1975–1976, restored 2015). [**3**] Harmonic/Melodic Canon (1976, rebuilt 1981, final version 1987). [**4**] Diamond Marimba I, with pernambuco bars, after a design by Max F. Meyer, (1978, rebuilt 2019). [**5**] New Boo I, with tubes made from phenolic, (1979). The Harry Partch Foundation specified this resin-impregnated linen material and commissioned the instrument as a replacement for Boo I, which had disintegrated and become unplayable.

[**6**] Glassdance (1982–1983, modified with many new mechanical and electrical components: 2018, 2024). [**7**] Bass Marimba (1983, 1985–1986). [**8**] Bass Canon (1989). [**9**] Diamond Marimba II, with Honduras rosewood bars, (1989). [**10**] Just Keys, a restrung, retuned, and rebuilt console piano, (1990). [**11**] Simple Flutes, based on the equations in *Musical Mathematics*, Chapter 8, (1995). [**12**] Chrysalis II (2013–2015). After years of arduous work, including numerous critical improvements and refinements, all the instruments exemplify my most complete and diligent efforts.

[3] — I have *never* defined or tuned a 56-tone scale! With the exception of my Diamond Marimbas, I base the tunings of my instruments on my voice. As a composer, I categorically reject the formulation, presentation, and documentation of theoretical scales as a means to establish legitimacy in the tenuous worlds of "microtonality" and "just intonation." As a student of art, I have always understood the frequency ratios by which acoustic instruments are tuned in the context of paint on a painter's palette. None of the artists important to me ever predetermined a painting based on a set of colors they would use or not use. I know of no color theorists among the painters I admire. As a composer, scale theory, or what ratios to tune and not tune over the span of an entire instrument, is the most intimate of all subjects, and as such, is my personal choice. As for the human voice, it is *not* a musical instrument. Musical instruments can only sound like musical instruments. And yes, the human voice can be trained to sound like a musical instrument. However, at its core essence the intonational inflections and expressions of the human voice are unfathomable and for this reason alone, the human voice has never been and will never be a musical instrument.

[4] — The innovations in design and construction of my Harmonic/Melodic Canon and Bass Canon enable these two instruments to function as true canons; in other words, the ratios these instruments produce (up to a carefully described limit) are absolutely predictable, and therefore have nothing to do with the instruments Partch called "canons." The veracity of modern science depends on two unshakable principles: predictability and repeatability. The ancient Greeks understood these principles perfectly, hence the word 'canon'. From *Musical Mathematics*, p. 65:

"In Greek, the word *kanōn* means (1) a straight rule or rod, as in measuring instrument, and (2) a general rule or principle, as in code of law."

When one divides a string into a given length by means of a movable bridge, one portion of length to the left of the bridge produces a predictable frequency, and the second portion of length to the right of the bridge also produces a predictable frequency. (See *Musical Mathematics*, Equation 3.34, and Figures 3.15 and 3.20.) In other words, on a canon with movable bridges, all string divisions produce frequency ratios that are predictable and repeatable. In all my studies, I know of no other musical instrument named after a mathematical principle.

I have correctly called the canon a musical instrument. But a true canon as described above has never existed as a *performance instrument*, at least not until my design and construction solved the following problem: To function as a mathematically accurate instrument, a movable bridge that divides any given string into two predictable ratio lengths must not be too high, or must not deflect the string too much from its equilibrium position. From *Musical Mathematics*, p. 792:

> The canon as described in the works of Ptolemy (see Section 10.19) and Al-Jurjānī (see Section 11.52) represents the mathematical embodiment of tuning theory. Although this instrument has a noteworthy history, it did not develop into a precise musical instrument because of a persistent

> mechanical problem: rattling bridges! When one places a triangular-shaped bridge under a string, and then plucks the string, the applied force causes the bridge to rattle against the soundboard. To avoid this difficulty, it is possible to make a long bridge, so when one plucks a given string the other strings hold the bridge in place. Even so, after much playing such a bridge begins to creep due to the vibratory motion of the strings. To prevent the bridge from moving, it becomes necessary to increase the downbearing force (or downward force) that the strings exert on the bridge. An increase in the height of the bridge increases the strings' deflection, which in turn increases this vertical force. However, because the downbearing force effectively increases the tension of the strings, all the stopped strings sound sharp.
>
> To qualify as a precision instrument, a canon must satisfy two mathematical requirements. For example, if a canon bridge stops the right side of a string at length ratio ⅔, then the right section *must* sound a "fifth" above the open string, or frequency ratio $^3/_2$. Also, since this bridge stops the left side of the string at complementary length ratio ⅓, the left section *must* sound an "octave and a fifth" above the open string, or frequency ratio $^3/_1$. (See Sections 3.11 and 3.13.) Now, suppose that a canon bridge is too high, so that the "fifth" on the right side sounds 30.0 ¢ sharp, and the "octave and a fifth" on the left side sounds 50.0 ¢ sharp. Under such circumstances, we would be correct to call this instrument a kind of zither (see Section 11.3), but incorrect to call it a canon.

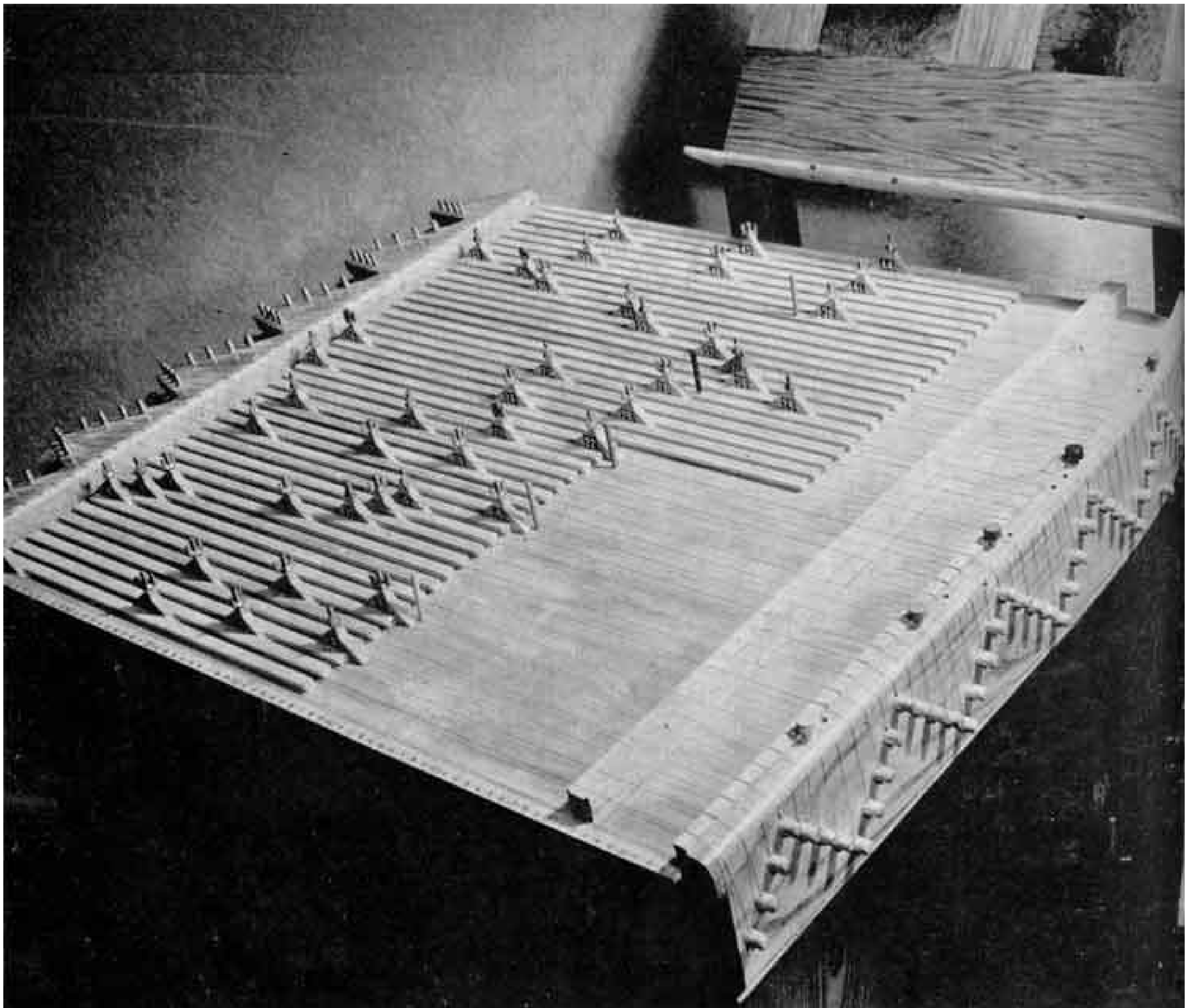
As a young instrument builder, Partch understood these problems all too well, and formally addressed these difficulties in the first edition of *Genesis of a Music* (*Genesis1*), published by the University of Wisconsin Press in 1949. On p. 5, please find (1) a scanned photo from *Genesis1*, opposite p. 205, that shows Partch's first Harmonic Canon (1945), and (2) a scanned line drawing of the bridge design for this instrument, p. 99.

Partch attempted to solve the problem of rattling and creeping bridges by gluing wood laths, or a system of rails, directly to the soundboard. The line drawing shows a notch in the lower right hand corner of the bridge that ran the length of the bridge and acted as a secondary restraint to stabilize or hold the bridge against the rails. Also, both the photo and drawing show a machine screw and wing nut assembly used to lock the string to the bridge, thereby eliminating the downbearing force needed to secure the string in a notch at the top of the bridge. For many reasons, all these design features were doomed to failure.

Finally, notice a ruler along the front edge of the soundboard, which proves Partch knew that all canons require accurately measured string lengths for the construction of length ratios.

Rulers do not appear on any of the five so-called "canons" built by Partch after *Genesis1*. And they are also not included on copies of "canons" built by Partch disciples and aficionados. Why? Because on all these instruments, a ruler serves no musical-mathematical function.

In the second edition of *Genesis of a Music* (*Genesis2*), published by Da Capo Press in 1974, pp. 235–242, Partch describes the "reconception" and "reconstruction" of this instrument but offers no mathematical or musical reasons why he gave up on the task of building soundboards and bridges that produce accurately tuned canon strings. On p. 98, Partch acknowledges that on his canon, "…a high bridge increases both the tension and length of the string. I have experimented with



FACE OF THE HARMONIC CANON

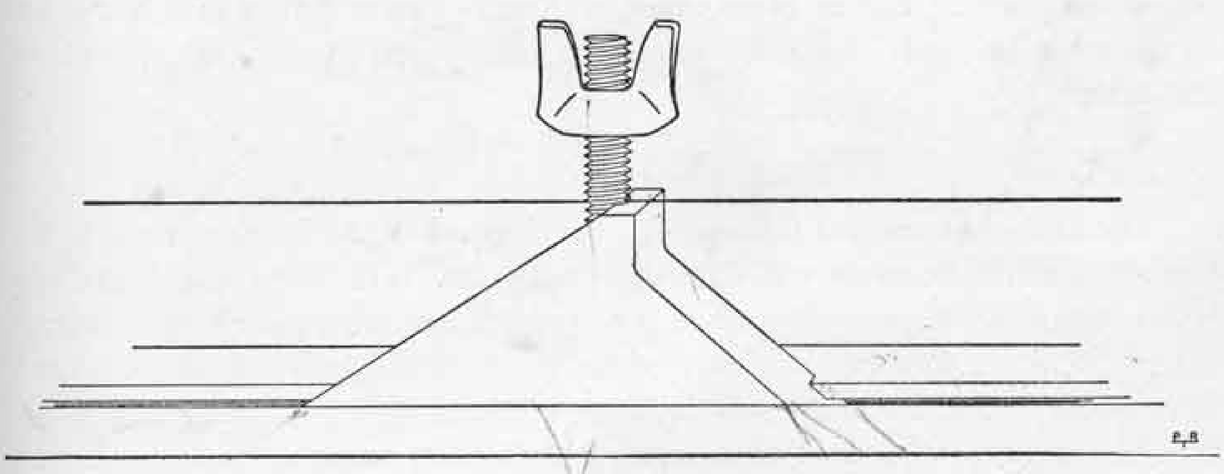


Diagram 4.—A Bridge on the Harmonic Canon

bridges just high enough to give a good tone, using guitar first strings, and the results varied greatly from theory.” And on p. 99, he concludes, “But it must be kept in mind that results on a harmonic canon are almost always approximations.”

Compared to theory, what exact approximations did Partch’s canon produce? No one knows. Subtle differences stand in stark contrast to glaring departures; the former conditions would warrant calling such an instrument a canon; the latter conditions would not. Contrary to Partch’s experiments, canons have been used by mathematicians and musicians for thousands of years because these instruments produce accurate results. By not disclosing the magnitude of his tuning discrepancies, Partch evaded the possibility that his particular stringed instruments with movable bridges may not deserve to be called canons. So, on the basis of exclusively negative test results, Partch simply dismissed the mathematical principles of tuning canon strings, which in turn enabled him to rationalize his incompetence as a builder of such instruments.

Partch Hoax Doctrine #1.

In *Genesis2*, on the lower half of p. 245, Partch gives a tuning chart for Harmonic Canon II (or for *Pollux* as described on the top of p. 246) that demonstrates why I call this instrument PHD #1. For String #1, he states that the portion on the right side of the bridge sounds the “octave,” ratio $^{2}/_{1}$. On a canon, therefore, the portion on the left side of the bridge must sound the same “octave,” ratio $^{2}/_{1}$. Instead, he states that the left side sounds a “sharp major seventh,” ratio $^{40}/_{21}$. Continuing, for String #2, the right side sounds the “small minor third,” or the “septimal minor third,” ratio $^{7}/_{6}$. According to the mathematical laws of canon strings, the portion on the left side must sound a “flat minor seventh,” or simply the seventh harmonic, ratio $^{7}/_{1}$. Instead, Partch states that the left side sounds a “flat fifth,” ratio $^{40}/_{27}$ (one “octave” higher). In all, his table contains 24 spurious left/right frequency ratio combinations. As explained above in *Musical Mathematics*, p. 792, the first and simplest reason for these arbitrary ratios is that Partch had no choice but to increase the downbearing force of the strings by making extremely high bridges. Such bridges produce large string deflections that cause the strings to press the bridges against the soundboard with considerable downward force.

However, an equally important but less obvious second reason is that Partch never acknowledged tension as a critical *constant* for tuning open canon strings to a fundamental frequency. Instead, while moving his *high* bridges back and forth, he simultaneously turned the knobs of his tuners until the string sections on the left and right sides of the bridges produced the frequencies he wanted to hear. With this method, I wonder how many strings Partch broke before he chanced upon his final arbitrary string tensions and equally arbitrary bridge locations.

Fact: Throughout *Genesis1* and *Genesis2*, Partch never discussed — and gave no information about — measured string tensions and measured bridge locations.

Any data on these two properties of Partch’s strings would have immediately revealed that his instrument is *not* a canon. Contrary to the above-mentioned description, it is physically *impossible* for a bridged canon string to produce ratio $^{2}/_{1}$ on one side and ratio $^{40}/_{21}$ on the other side unless someone turns the tuner to some arbitrary tension and moves the high bridge to some arbitrary location.

Finally, under these three non-mathematical conditions: (1) unmeasured string tensions, (2) extremely high bridges, and (3) unmeasured bridge locations, the strings of this instrument do not sound the *just ratios* listed on p. 245; at best, they only produce frequencies that approximate the rational ratios of just intonation. For all these reasons, Partch's "canons" are in fact zithers, which means that the above-mentioned instrument should be renamed "Harmonic Zither II." Since this will never happen, Partch's damage to the word 'canon' is irreversible and therefore permanent.

Let us now reexamine the text on pp. 98–99 of *Genesis2*. Observe that with respect to tuning, Partch mischaracterized the canon as an inaccurate instrument. This contrived assessment allowed him to justify the mathematical inaccuracies of his own instruments and tunings. However, if, according to Partch, canons do not produce accurate tunings, then why did he repeatedly refer to his zithers as canons?

In *Genesis2*, Partch included descriptions of five pseudo-canons. The Greek word *kanōn* and its definition as a measuring instrument and code of law is at least 3000 years old. By not adhering to these two time-honored definitions, and by refusing to explain his non-mathematical interpretation of the word 'canon', he appropriated for himself the historic legacy and prestige of this instrument. In doing so, he has played all his uninformed and unsuspecting readers for fools. Because Partch failed to develop soundboards and bridges that facilitate accurately tuned canon strings, his zithers are not governed by the scientific principles of predictability and repeatability, and therefore have absolutely nothing to do with the design and construction of my canon soundboards, bridges, and tunings. Stated differently, a person cannot be inspired by something that does not exist.

The webpages

https://chrysalis-foundation.org/instruments-and-music/harmonic-melodic-canon

https://chrysalis-foundation.org/instruments-and-music/bass-canon

https://chrysalis-foundation.org/musical-mathematics-pages/forster-canon

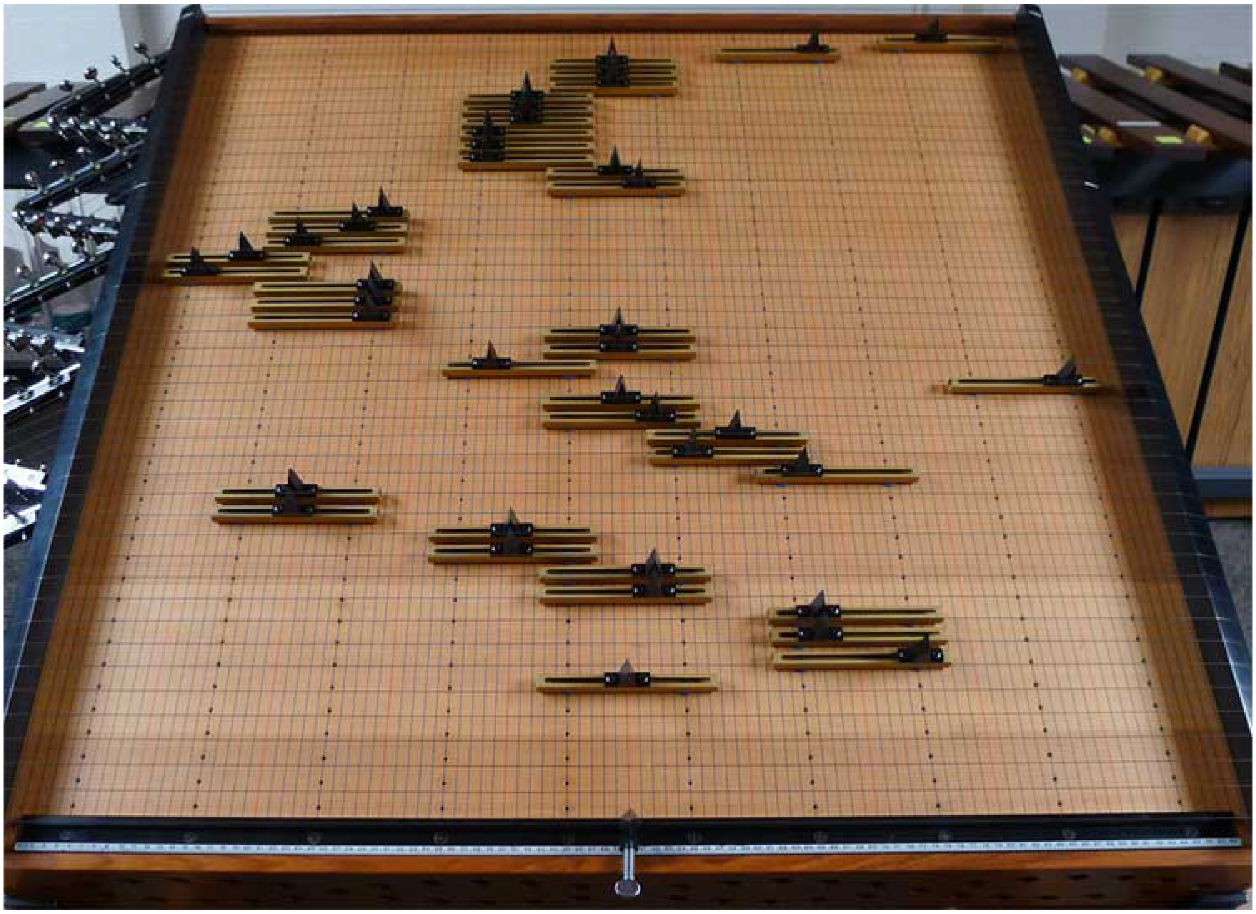
accessible to all since 2002, describe how I managed to solve the problem of rattling and creeping bridges, which in turn enables me to fulfill the requirement of tuning to length ratios. On p. 8, please find a photo of the Harmonic/Melodic Canon soundboard, which is essentially the same as the Bass Canon soundboard, and a detailed line drawing of the bridge design for both instruments. (See *Musical Mathematics*, Section 12.3, and Figure 12.3.)

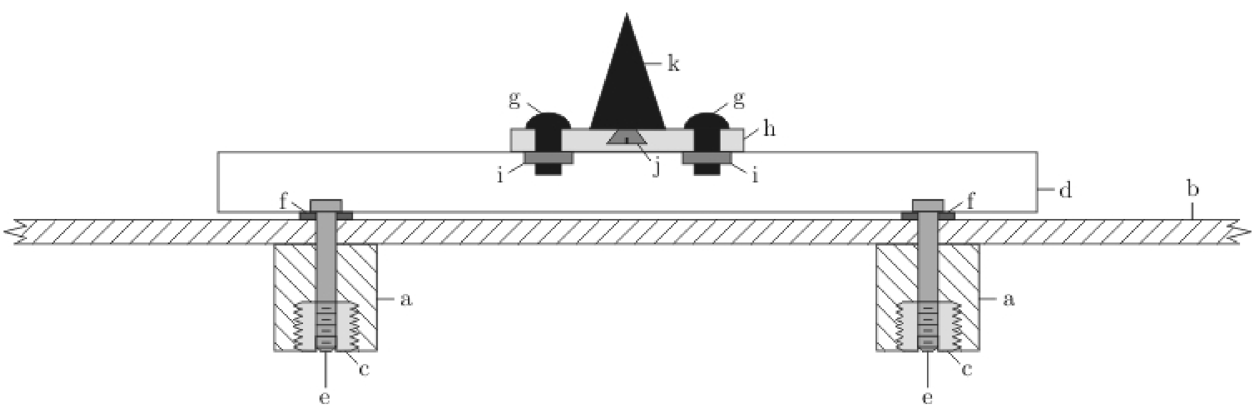
In the history of music, these are the first canons that satisfy two musical conditions. Both canons have independently movable bridges that produce mathematically predictable length ratios; and both canons function as fully resonant performance instruments.

Furthermore,

https://chrysalis-foundation.org/musical-mathematics-pages/al-jurjani-canon

gives a canon building and tuning description by Al-Jurjānī (d. 1413) that is complete, and therefore true. Based on his knowledge of Euclid (fl. *c.* 300 B.C.) and Claudius Ptolemy (*c.* A.D. 100 – *c.* 165), Al-Jurjānī's text specifies the three mathematical principles of accurately tuned canon strings:





(1) "Tension the strings equally so that they all produce identical notes."

(2) "The top of the bridges must be slightly higher than the semi-cylindrical [rod]."

(3) "Then determine on the strings the points that correspond to each of the divisions on the ruler. Move the bridges to place them in line with each of these points, so as to make each of the strings produce one of the notes of the desired system."

If anyone inspired me to resolutely pursue how canons should be built to "…test the rules of music," it was Al-Jurjānī!

Finally, in *Grove1*, Volume 2, p. 128, and in *Grove2*, Volume 2, p. 547, under the heading "Harmonic Canon," we find two slightly different versions of the opening sentence. *Grove2* states:

"Name given by Harry Partch to the members of a group of his instruments that are ultimately derived from the Middle Eastern *qānūn*."

(1) To my knowledge, the word *qānūn* appears nowhere in *Genesis1* and *Genesis2*. (2) The word *canon* is the Latin transliteration of the Greek word *kanōn*. So, when we say the Latin word *canon*, we are speaking Greek. Likewise, the word *qānūn* is the Arabic transliteration of the Greek word *kanōn*. So, when we say the Arabic word *qānūn*, we are also speaking Greek.

To counteract this kind of etymological and organological nonsense found not only in *Grove1* and *Grove2* but in countless other texts as well, I give the following complete description in *Musical Mathematics*, p. 628.

"Here the Arabicized word *qānūn* does not refer to the modern zither, built in the form of a trapezoid and equipped with strings of different lengths, but rather to the ancient Greek *kanōn*, described at length in Ptolemy's *Harmonics*."

<u>Summary.</u>

A zither has no neck, and its strings are stretched between two opposite ends of the body, which may or may not function as a resonator. Therefore, all canons are classified as zithers. However, by definition, a canon must be built and tuned according to four mathematical requirements. All *open* or unbridged strings must be identical, or have the same length, tension, linear density, and fundamental frequency. If such an instrument does not satisfy these conditions, it may be called a zither, but it is not a canon. Why? Because on a stringed instrument without these four constants, the concept of what constitutes a length ratio — namely, a comparison of two measured string lengths — does not and cannot exist. Based on these facts, we conclude that a canon consists of nothing more than a set of *identical* monochords. However, in this context, the Chinese *ch'in* is a remarkable exception. Although the *ch'in* is a zither, it functions exclusively on the basis of length ratios because musicians play its strings as a set of *non-identical* monochords. This design requires only one critical constant: all the strings of the *ch'in* must have identical lengths. Similarly, this is how lutes or instruments with necks, which include sitars, violins, guitars, etc., are built and played: non-identical monochords with identical lengths are stopped by the fingers according to the principle of length ratios. So, musicians always play the "octave" at the half-way point of the strings, length ratio $^2/_1$, the "fifth" at two-thirds of the strings, length ratio $^3/_2$, etc.

Imagine you have a canon where all the strings are identical and 1000.0 millimeters long. The first string is open, and the second string has a *low* bridge that is only slightly higher than the open string. While playing both strings, slide the bridge back and forth until you hear an unfamiliar interval. This raises the question, "What is the mathematical and musical identity of this interval?" Suppose the longer section on the right side of the bridge is 525.0 mm long. Ratio $^{1000.0\text{ mm}}/_{525.0\text{ mm}}$ reduces to length ratio $^{40}/_{21}$ [1115.5 ¢], which means that the right section sounds a "sharp major seventh." Also, since the shorter section on the left side of the bridge is 475.0 mm long, ratio

$1000.0\text{ mm}/475.0\text{ mm}$ reduces to length ratio $40/19$. Because this ratio is larger than an "octave," it is difficult to comprehend. The solution: lower it by an "octave" so that its quotient is greater than 1, but less than 2. If the numerator is even, divide by 2; otherwise, if the numerator is odd, multiply the denominator by 2. Length ratio $20/19$ [88.8 ¢] now identifies the left section, which sounds a "flat semitone" (one "octave" higher). For ratio $40/21$, a length of 525.0 mm clearly indicates that the bridge is located near the center of the string. Finally, to determine the frequency of this section, multiply the fundamental frequency of the open string by 1.90476, the decimal ratio of $40/21$.

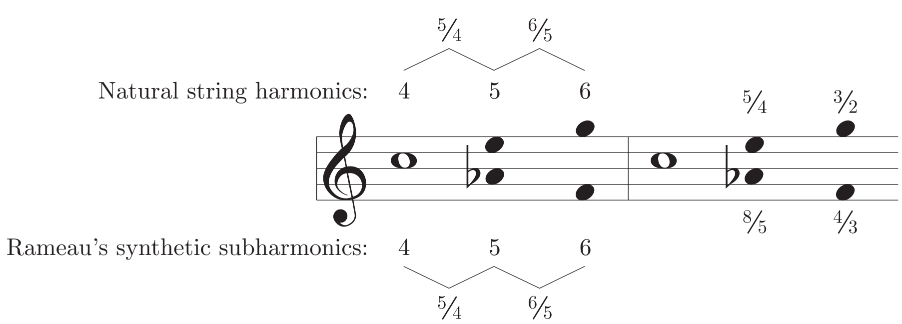
Consider now a photo of the previously mentioned *Pollux* instrument on p. 243 of *Genesis2;* it's the one on the right side of the image. Note that the bridge for ratio $40/21$ is *not* located near the center of String 1. Consequently, on this bogus "canon," the string sections on the left and right sides of the bridge do not represent length ratios. In fact, all the left/right ratio pairs in Partch's table have absolutely nothing to do with length ratios. Instead, they are all *frequency ratios*, like those found on nearly all zithers, built with or without bridges. After turning the knobs of his tuners to some arbitrary tensions, and after moving his high bridges to some arbitrary locations, Partch was unable to analyze the ratio pairs by simply measuring string lengths and constructing length ratios. To identify complicated frequency ratios, he had to play some other instrument on which these ratios already existed (Chromelodeon) or could be realized as length ratios (Adapted Viola).

Finally, if String 1 of *Pollux* was on a canon that had *identical* strings and *low* bridges, then the location of the bridge in the photo indicates that the left string section would sound an interval in the vicinity of a just "fifth," length ratio $3/2$ (or $2/3$), and the right string section, an "octave and a fifth," length ratio $3/1$ (or $1/3$). (See *Musical Mathematics*, Section 10.53.)

Although the ancient Greeks and Arabs had no knowledge of frequency ratios, they were nevertheless able to accurately determine the mathematical and musical identities of intervals on their canons and lutes, respectively, through the construction of length ratios.

[5] — In *Musical Mathematics*, Chapter 10, I devoted Sections 10.59–10.64 exclusively to four treatises written by Jean-Philippe Rameau (1683–1764). From *Musical Mathematics*, pp. 445–446:

"In the *Génération harmonique*, Rameau attempted to present *ut* (or C) as the dual-generator of an ascending major harmony, and of a descending minor harmony. If we simplify 'octave' equivalents in Figures 10.55 and 10.56, the illustration below shows C_5 as the generator of the ascending major triad C_5–E_5–G_5, and of the descending minor triad C_5–$A\flat_4$–F_4:

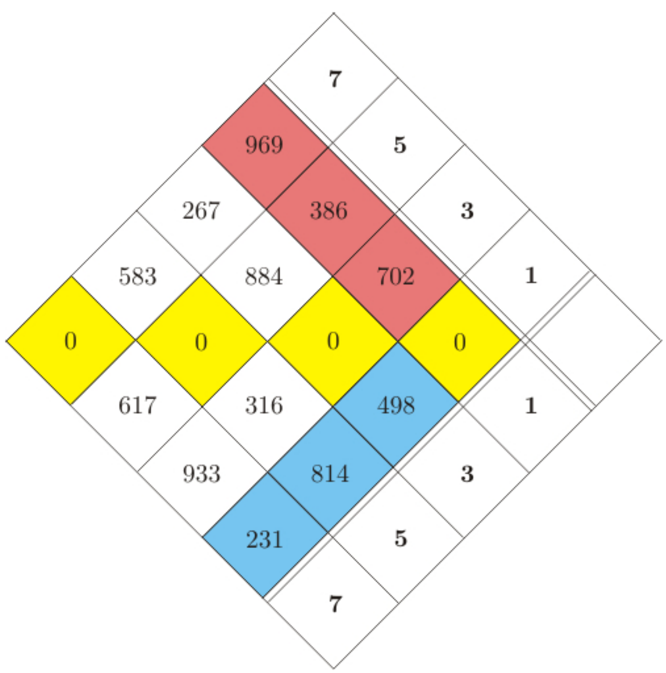


Rameau found the idea of an acoustic dual-generator that produces the major tonality and minor tonality in opposite directions immensely appealing." (Expanded figure for the 2nd edition of *Musical Mathematics.*)

Max F. Meyer (1873–1967), German-born American psychologist, studied Rameau's treatises in great detail. Because Meyer's contribution is central to this discussion, here is a brief summary of his life. Under the mentorship of renowned physicist Max Planck (1858–1947), and distinguished acoustician Carl Stumpf (1848–1936), Meyer received his Ph.D. from the University of Berlin in 1896 at the age of twenty-three. With the approval of Planck and Stumpf, Meyer's dissertation, *Über Kombinationstöne und einige hierzu in Beziehung stehende akustische Erscheinungen*, which describes a mathematically based theory of hearing, was published in the same year. In 1900, Meyer founded the Psychology Department at the University of Missouri, and held the position as Professor of Experimental Psychology until 1929.

Max F. Meyer

On p. 22 of Meyer's book, *The Musician's Arithmetic*, published by the Oliver Ditson Company in 1929, we find the following figure:



I color-coded 10 tiles in this graphic. For a detailed analysis of Meyer's tonality diamond, please visit

https://chrysalis-foundation.org/musical-mathematics-pages/meyer-diamond

The numbers in the figure represent cent values. Notice the four zeros in the middle row of this diamond-shaped tuning lattice. I call this the *neutral axis* because it consists of four tones with identical frequencies. In other words, because the tonality diamond contains four crisscrossed diagonals, the neutral axis includes four unisons. If it had five, six, or seven diagonals, a consistent mathematical expansion of this design would require five, six, or seven unisons, respectively. Meyer's unisons represent a two-dimensional interpretation of Rameau's dual-generator. As shown in the musical illustration on p. 10, Rameau's high-C dual-generator has the same musical-mathematical function as the rightmost zero in Meyer's tonality diamond. In an upward direction and in scale order, this zero generates a major tonality: C-0 ¢, E-386 ¢, G-702 ¢, B♭-969 ¢. *And by inverting this sequence of intervals*, in a downward direction and in scale order, the same zero generates a minor tonality: C-0 ¢, A♭-814 ¢, F-498 ¢, D-231 ¢.

Regarding the ascending sequence, the first three cent values represent frequency ratios C-$^1\!/_1$, E-$^5\!/_4$, G-$^3\!/_2$. Rameau demonstrated that the 4th, 5th, and 6th harmonics of the harmonic series of vibrating strings generate the major tonality, expressed as ratios 4:5:6. And regarding the descending sequence, the first three cent values represent frequency ratios C-$^1\!/_1$, A♭-$^8\!/_5$, F-$^4\!/_3$, which is an intervalic inversion of the first sequence. Rameau realized that an inversion of the intervals of the major tonality produces the minor tonality. However, because he was unable to demonstrate that such a sequence occurs as a natural phenomenon of vibrating strings, he eventually conceded that the minor tonality only exists as a manmade or synthetic construct. Approximately one hundred years *after* Rameau, music theorists began referring to the inversion of harmonics as 'subharmonics', to the inversion of so-called overtones as 'undertones', and to the inversion of the harmonic series as a 'subharmonic series'.

If transformed into a musical instrument, Meyer's design would require four identical frequency-producing sources. For example, on a piano, it would require four keys and four sets of strings all tuned to the same frequency; on a marimba, it would require four bars and four resonators all tuned to the same frequency; etc.

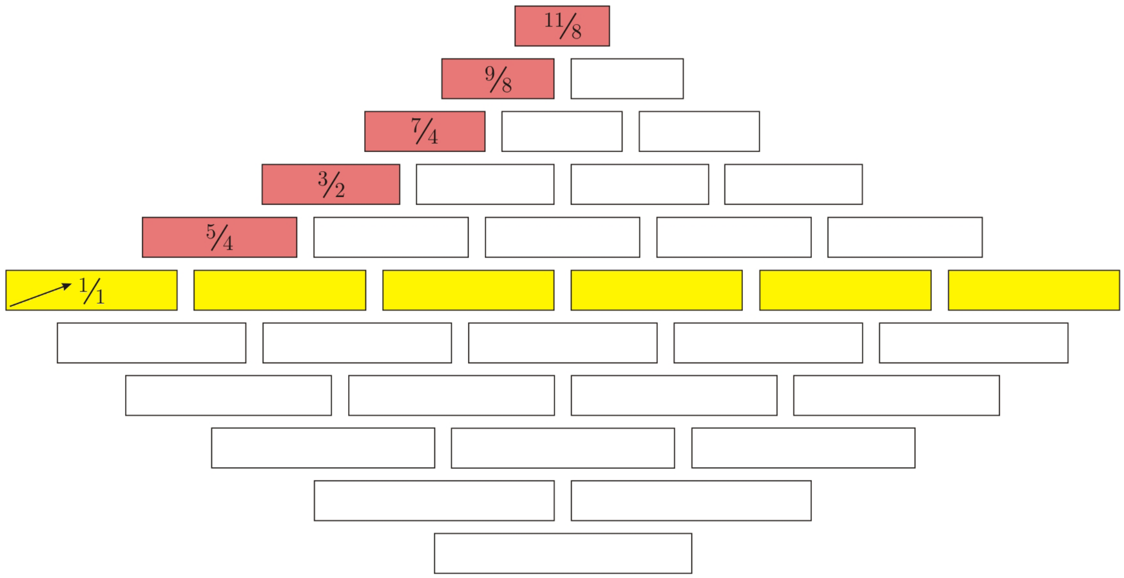
Human beings began making musical instruments approximately 40,000–60,000 years ago. In all my studies, I have never encountered an acoustic musical instrument with separate, multiple, and identical frequency-producing sources; all drone instruments excluded.

I categorically reject the speculation that after tens of thousands of years, two contemporaries — one a mature scientist with a stellar university education, the other ten or so years out of high school — independently discovered a two-dimensional tuning lattice with an axis of multiple unisons running through its center. Why? Because nothing in the arts and sciences gets easier in time. As the difficulty of discovery increases, the probability of codiscovery decreases. Whenever codiscoveries are highly questionable, proponents always sing the old song that "anything is possible," but this argument renders them less intelligent than they are or would like to be.

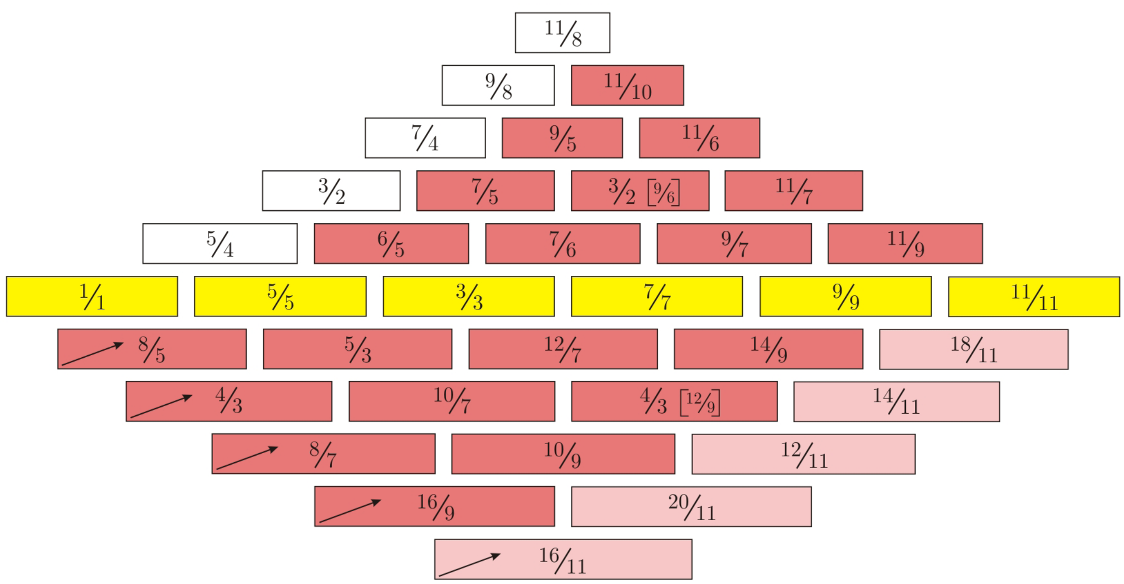
<u>Partch Hoax Doctrine #2.</u>

Ironically, Partch was the first to reject the possibility of codiscovery. If, on the basis of his claim, Partch had recognized Meyer as a codiscoverer, he could have eliminated the specter of plagiarism.

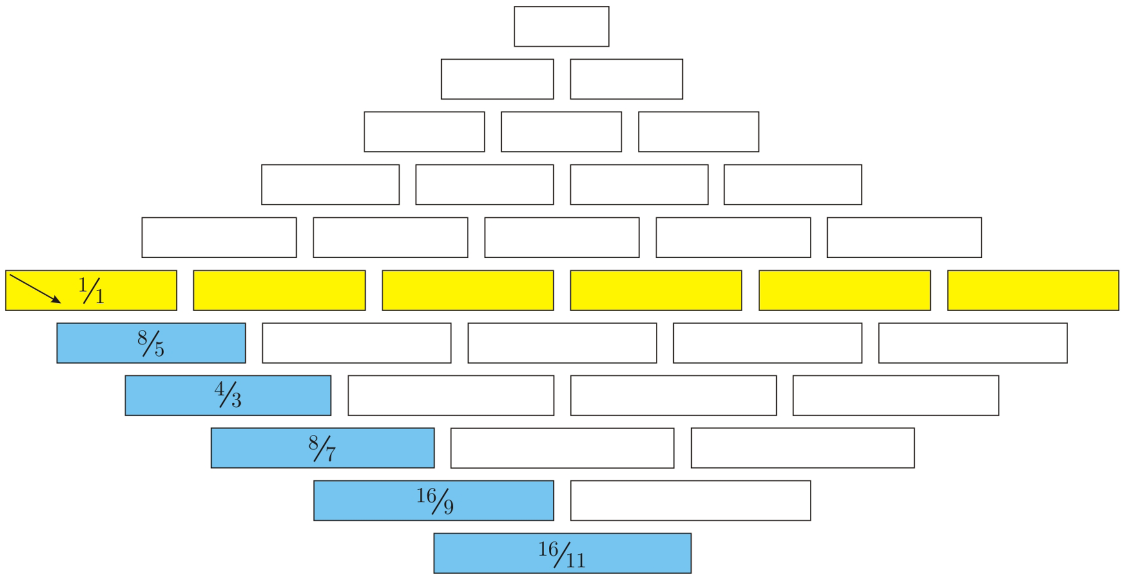
Ascending from Meyer's Neutral Axis



Ascending through Meyer's Neutral Axis
Ascending to Meyer's Neutral Axis

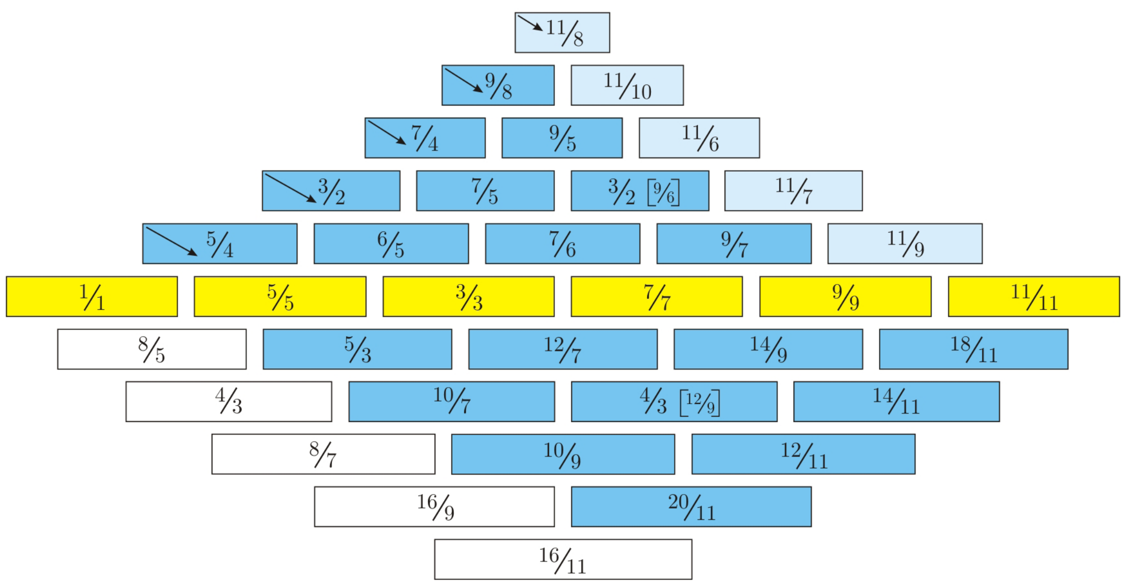


Descending from Meyer's Neutral Axis



Descending through Meyer's Neutral Axis

Descending to Meyer's Neutral Axis



However, this would have required him (1) to acknowledge Meyer's design and (2) to describe how he conceived of his own design. *Remarkably, both editions of Genesis do not discuss the genesis of the tonality diamond.* Although he often referred to Meyer's book in *Genesis1* and *Genesis2*, Partch never admitted knowledge of Meyer's diagram. He simply pretended that it did not exist. Consequently, Partch spent his entire adult life acting as though he was the only discoverer of the tonality diamond. Because Partch did not explain the origins of his design, I call his Diamond Marimba PHD #2. For a detailed analysis of Partch's plagiarism of Meyer's diagram, please visit

https://chrysalis-foundation.org/musical-mathematics-pages/partch-diamond

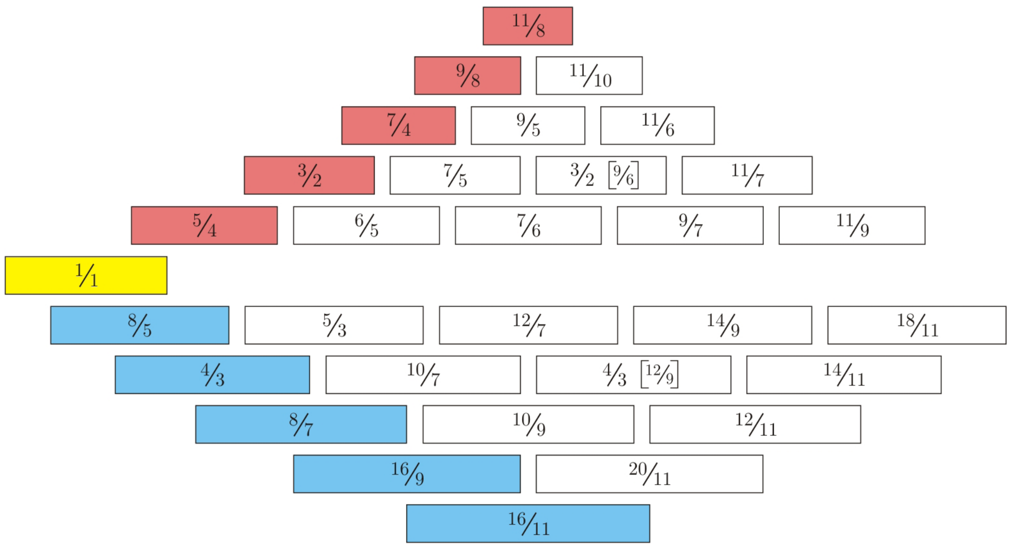
Some have tried to exonerate Partch of the charge of plagiarism by claiming that he got the idea for the tonality diamond from Augusto Novaro and Henry Cowell. However, these non-scholarly arguers — eristics — of codiscovery have provided zero evidence that the *original texts* of these two theorists ever even remotely suggested (1) a two-dimensional tuning system based on the harmonic and subharmonic series that requires (2) multiple unisons.

Furthermore, as if to denigrate Meyer's idea, on the cover of *Xenharmonikôn 3*, Spring 1975, Erv Wilson (1928–2016) published a stellated interpretation of the 11-Limit Tonality Diamond in which he eliminated the neutral axis presumably because it constitutes a mathematical redundancy. Unfortunately, in the context of understanding the development of a musically inspired design, belaboring the obvious with non-musical reductionism contributes nothing but a disservice to the discussion. Wilson gutted the neutral axis to illustrate Meyer's non-linear two-dimensional lattice as a purely mathematical construct. Although the mapping of Meyer's *lattice ratios* over a stellated surface gives the appearance of a two-dimensional design, Wilson's graphic represents nothing more than a linear one-dimensional set of symmetrically paired *scale ratios* arranged in various geometric patterns. The reason for this anachronistic distortion of Meyer's original design is the position of the first unison, ratio 1/1. Wilson placed it at the center of his diagram, which means he depicted it as the generator of all the other ratios. This, of course, is nonsense because we cannot consistently interpret the other unisons — 3/3, 5/5, 7/7, etc. — as generators. On the contrary. Every unison ratio and every non-unison ratio occupies a unique location and, thereby, serves two uniquely different musical functions in Meyer's two-dimensional diamond. Finally, it is impossible to systematically calculate all the ratios of Wilson's graphic without ascending and descending in diagonal directions (1) from the neutral axis, (2) through the neutral axis, and (3) to the neutral axis. So, without Meyer's neutral axis, Wilson's one-dimensional diamond does not exist.

Fact: Wilson's diagram — entitled *Hexadic Diamond on a Centered-Pentagon Crystallograph* — first appeared as a gift he gave to Partch in 1969, or two years *after* Meyer's death in 1967.

This raises the inevitable question, "What exactly did Wilson give to Partch?" In my opinion, Wilson devised his diagram as a distraction from Partch's plagiarism. Wilson's figure, which conveys no musical meaning, suggests that anyone with *only* a knowledge of ratios and the inversion of ratios could have produced Meyer's diamond. Proponents of what I call the *Musically Absurd 1/1-Generated Diamond* never acknowledge (1) the natural harmonic series and (2) the synthetic subharmonic series as two basic requirements for the construction of all tonality diamonds. These writers maintain that modern discoveries in the physics of vibrating strings and the musical implications of these discoveries are irrelevant to a strictly numeric interpretation of this structure. With Partch in the lead, they advocate the ludicrous possibility that the ancient Greeks, with their knowledge of ratios, could have conceived of this design. From *Musical Mathematics*, p. 453:

The Musically Absurd 1/1-Generated Diamond



Based on a diagram by
Erv Wilson
1969

"However, it is important to point out that for Partch, '. . . neither overtones [harmonics] nor undertones [subharmonics] are predicated as determinants of Monophony's tonalities; these are implicit in small-number ratios.' (*Genesis2*, p. 75. Text in brackets mine.) In other words, Partch maintained that his musical thinking is not indebted to modern discoveries in acoustics. He thereby renounces all ties to the recent past and claims that his musical theories are solely based on the ancient Greek method of dividing canon strings."

In support of Partch's plagiarism, Wilson's gift demonstrated to Partch how his set of 30 non-unison ratios could be rearranged as a *geometrically subdivided numeric diamond* that bears no resemblance in either form or function to Meyer's *acoustically expanded sonic diamond*. Also, since Partch had no choice but to reject harmonics and subharmonics — or the two basic organizational principles of Meyer's creation — Wilson intentionally avoided arranging these ratios in sequences that would have acknowledged the presence of the harmonic and subharmonic series.

Unfortunately for Partch, Rameau was a famous composer, and unfortunately for Wilson, Meyer was a practicing musician, and for these two reasons, Meyer's diagram will always represent a stunning synthesis of the major and minor tonalities of Western music. When Wilson stripped the neutral axis out of Meyer's diamond he destroyed the two-dimensional integration of these two tonalities; the result: a *Musically Absurd 1/1-Generated Diamond* that only a cynic would build.

From *Musical Mathematics*, pp. 452–453:

"In both editions of *Genesis*, Partch included four illustrations based on Meyer's tonality diamond: a 5-limit Incipient Tonality Diamond, an 11-limit Expanded Tonality Diamond, an 11-limit Block Plan of the Diamond Marimba, and The Tonality Diamond on a 13-Limit."

In the first two and the last illustrations, Partch rotated Meyer's tonality diamond 90 degrees so that the neutral axis now runs through the center of the diamond in a vertical direction. These drawings exhibit all the hallmarks of reinvention. Partch rotated Meyer's diamond to give the appearance of something new.

However, in the third illustration — the 11-limit Block Plan of the Diamond Marimba — he could no longer escape the gravity — the truth — of Meyer's neutral axis as it runs in a horizontal direction through the center of the diamond. On an actual three-dimensional musical instrument, Partch had no choice but to copy Meyer's original design. Why? Because while performing on this instrument he wanted to experience the major tonalities by playing the bars of his so-called *Otonalities* in an ascending diagonal direction *Over* (or above) the neutral axis; and the minor tonalities by playing the bars of his so-called *Utonalities* in a descending diagonal direction *Under* (or below) the neutral axis. (Note the directions of the arrows in the figure on p. 13.) This is exactly how Rameau intended his dual-generator to work, and so Meyer placed the neutral axis in the *only* possible location where it could function in this manner. This chronology of documented facts establishes beyond a reasonable doubt that Rameau's and Meyer's observations, imaginations, ideas, and designs constitute the *genesis* of the horizontal neutral axis at the center of the tonality diamond. In short, Partch contributed nothing to the musical mathematics of these two predecessor theorists.

At the self-proclaimed "encyclopedia" webpage

https://en.wikipedia.org/wiki/Tonality_diamond

Wikipedia states the following half-truth:

> "Although originally invented by Max Friedrich Meyer, the tonality diamond is now most associated with Harry Partch."

And at

https://en.wikipedia.org/wiki/Harry_Partch

Meyer's name does not exist; it is ignored to death. Similarly, the article on Harry Partch in *Grove2* makes no mention of Max F. Meyer's contribution.

Fact: Due to six crisscrossed diagonals, the 11-Limit Tonality Diamond generates by default 29 tones of Partch's 43-tone scale.

Therefore, I also credit Meyer for providing Partch with a two-dimensional tuning lattice to musically realize and mathematically identify two-thirds of the tones of his scale.

At

https://en.wikipedia.org/wiki/Max_Friedrich_Meyer

Wikipedia comes full circle:

> "Meyer invented the tonality diamond, popularized by the theories of composer Harry Partch."

Again, Wikipedia demonstrates its addiction to half-truths. Obviously, Partch could have given Meyer credit for his invaluable contribution and simultaneously popularized it in the two editions of his book and in his music. *These two possibilities are not mutually exclusive.* In *Musical Mathematics*, I describe two more incidents of plagiarism: Plato's plagiarism of Philolaus, and Zarlino's plagiarism of Stifel. All three cases have a common theme. Plato, Zarlino, and Partch were neither scientists nor mathematicians. Scientists and mathematicians formulate ideas, theories, and structures that philosophers and musicians cannot even begin to imagine; *vice versa*. Albert Einstein was a great physicist; consequently, he was an amateur musician.

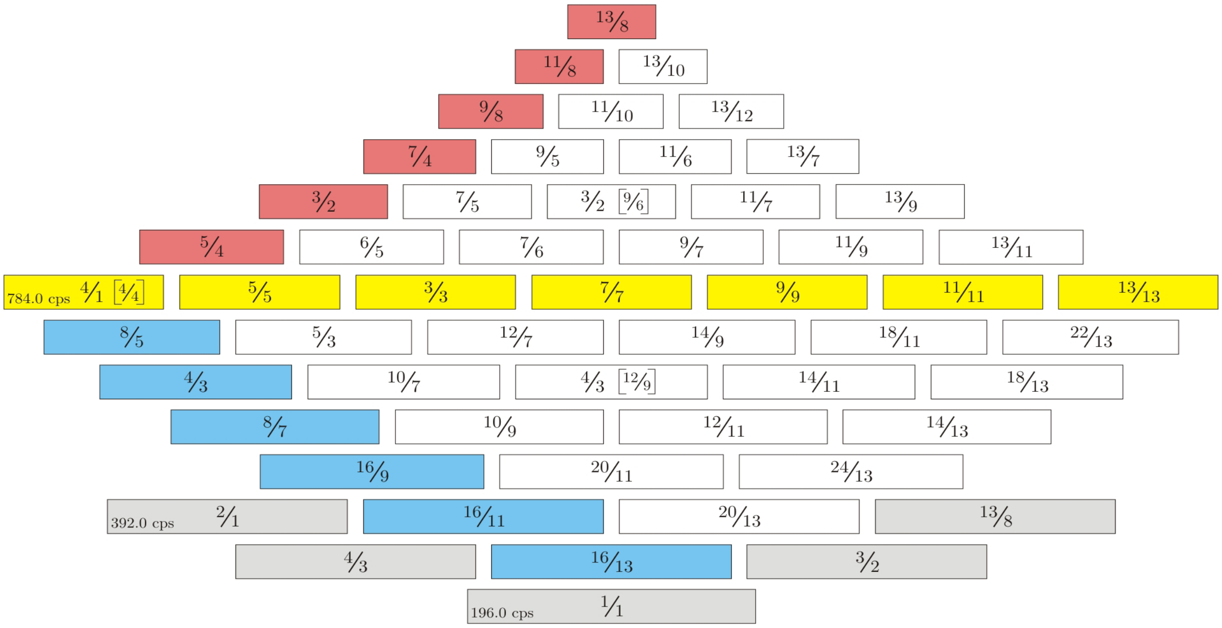
It is impossible to express the whole truth without great cost and inconvenience. Conversely, a half-truth is always profitable and easy because it requires no attention, no thoughtfulness, and ultimately, no deliberation from uninformed and unsuspecting readers. Consequently, the incisiveness of a half-truth makes any attempt at rectification extremely difficult, if not impossible. Wikipedia and Grove are partners in perpetrating the misconception that the "…tonality diamond is now most associated with Harry Partch." The most egregious expression in this statement is the word "now." It suggests that due to the inexorable passage of time, all sins of omission simply fade away, and therefore we can "now" — through the processes of attrition, suppression, and denial — bestow legitimacy on Partch's theft.

To further expose the inanity of the latter quotation, consider the following absurd analogy: 'Although originally invented by Albert Einstein, the equation $E = mc^2$ is now most associated with Robert Oppenheimer.' Why? The equally absurd response: 'Because Oppenheimer was the director of the Manhattan Project that actually built the first nuclear weapon.'

Some have tried to defend Partch's appropriation by claiming that he "borrowed" the tonality diamond from Meyer. If you take something that belongs to another person and (1) you don't ask for the owner's permission, and/or (2) you don't acknowledge the owner's existence, that's not borrowing. That's called stealing. Furthermore, under certain circumstances, it is not possible to "borrow" another person's property. For example, it would have been impossible for Oppenheimer to "borrow" Einstein's energy equation because in the 1940's everyone in the world knew that it belonged to Einstein. So, if Partch had attempted to "borrow" Hermann Helmholtz's resonator equation (see *Musical Mathematics*, Section 7.13), all hell would have broken loose. To some, Partch got away with "borrowing" the tonality diamond because in the 1940's, Meyer was not a well-known music theorist. I say, all the more reason to give credit where credit is due because — as Walt Whitman reminds us — greatness does not belong exclusively to the famous. Look around. It seldom does.

In 2003, I received an email from Max F. Meyer's grandson in which he thanked me for my efforts to restore his grandfather's legacy and reputation. At that time, Wikipedia had no webpage on the life and achievements of Max F. Meyer. All the perpetrators of half-truths have one thing in common: they are oblivious to the presence of real people and real families who remain forever traumatized by the theft of their intellectual property.

In building his 11-limit Diamond Marimba, Partch was inspired by Meyer's *Arithmetic* (1929) but refused to give him credit in *Genesis1* (1949) and, 25 years later, in *Genesis2* (1974). In building my 13-limit Diamond Marimbas plus five extra bars, I give Meyer unconditional credit for his creation. In *Genesis1* and *Genesis2*, Partch does not credit a single *contemporary* scientist, mathematician, or music theorist for having inspired his life as a builder of musical instruments. The Wikipedia and *Grove2* hero-worship articles follow suit. How? Publications such as these refuse to reproduce Meyer's original diamond-shaped lattice as it appears on p. 22 of his book.



Lattice by
Cris Forster

Based on a diagram by
Max F. Meyer
1929

Diamond Marimba I — Pernambuco — Built 1978. Rebuilt 2019.

Diamond Marimba II — Honduras rosewood — Built 1989. Modified 2008, 2010.

With the exception of *Musical Mathematics* and www.chrysalis-foundation.org, Meyer's diamond appears nowhere in print or on the internet. No wonder, because the systematic eradication of Meyer's name first began in the unpublished papers, newsletters, books, and journals of "important" contemporary theorists, professors, aficionados, and microtonalists who produced their American wunderkind texts and graphics in the years 1960–2000.

All these intentional omissions — designed to exclude Meyer from the history of just intonation — are too obvious to warrant further comment.

However, the stonewalling of Meyer's lattice has also caused a deafening silence over independently verifiable dates of discovery as witnessed by (1) publishers, (2) notaries public, (3) postmasters (who routinely apply dated stamps across taped seams of registered mail envelopes and packages), (4) copyright specialists at the Library of Congress, etc., *before* 1929.

Fact: With Partch, we get none of the above.

Fact: With Meyer, the provenance of his book is irrefutable because it was published by the Oliver Ditson Company in 1929.

Finally, as curator of the Harry Partch Foundation, I repaired and tuned virtually all the instruments. While I learned a lot, I gave as much as I got. Regarding my efforts to save and restore Partch's instruments, and all my other contributions to the Harry Partch Foundation, not a single half-truth or whole-truth exists anywhere.

In 1978, I built the first Diamond Marimba with pernambuco bars; in 2019, I rebuilt it with the original bars and now call it Diamond Marimba I. In 1989, I built Diamond Marimba II with Honduras rosewood bars. For information on these two instruments, please visit

https://chrysalis-foundation.org/instruments-and-music/diamond-marimba-i

https://chrysalis-foundation.org/instruments-and-music/diamond-marimba-ii

https://chrysalis-foundation.org/musical-mathematics-pages/forster-diamond

Shortly after completing the first Diamond Marimba, I was perplexed by an unexpected acoustic phenomenon. Although I had tuned the fundamental mode of vibration of the seven bars of the neutral axis to the exact same frequency, G_5 at 784.0 cps, none of the bars' fundamental frequencies sounded the same. Deeply worried, I sat by the instrument for days trying to determine the cause. Unless a musical instrument requires the inclusion of multiple unisons, this phenomenon is *terra incognita* to all builders. As if struck by lightning, the answer suddenly came to me: the higher modes of vibration of the bars — similar to yet distinctly different from the harmonics of vibrating strings — were influencing my aural perception of the fundamental frequencies of the bars. From *Musical Mathematics*, pp. 163–164:

"In the G_1–A_3 frequency range, F_2 and F_3 of bars fall well within the span of human hearing. More important, these two modes greatly influence our pitch perception of the fundamental frequency. For example, if we tune F_2 to a 'double-octave' plus 25 ¢ above a tuned F_1, then the fundamental will have a tendency to sound sharp even if it is exactly in tune. In this context, the subject of pitch perception should not be confused with the subject of timbre. The former is about tuning, and the latter, about tone color or quality of sound."

Here, F_2 refers to the first mode of vibration above the fundamental mode of vibration F_1, and F_3, to the second mode above F_1. In *Musical Mathematics*, Chapter 6, I explain in full detail how I managed to solve this problem by methodically removing material from a standard single-arch design, which enables me to simultaneously tune *two modes of vibration in a treble bar;* and by creating a unique triple-arch design, which enables me to simultaneously tune *three modes of vibration in a bass bar*. On the Bass Marimba, I tuned the lowest bar to G_1, G_3, and G_4. And as shown in the graphic below, on Diamond Marimba II, I tuned the lowest bar to G_3, G_5, and G_6.

So, from an intonational perspective, and with regard to numerous original structural components, my 13-Limit Diamond Marimbas are fundamentally different from Partch's 11-Limit Diamond

Marimba. In *Genesis2*, p. 272, Partch gives the following academic, or musically meaningless description of this critically important experience:

"However, for many years, I had heard about or read about one strong inharmonic overtone created by this type of vibrating body. After building the Diamond Marimba, Bass Marimba, and Marimba Eroica, I still could not say that I had ever heard this overtone. Finally with the Quadrangularis, I do hear it, in the alto flanks… Theory finally becomes fact."

On the contrary, I maintain that within the span of human hearing, the acute perception of an acoustic phenomenon suggests the presence of an underlying theory.

At the webpage

https://chrysalis-foundation.org/creative-aspects/instrument-design-features

I describe two more encounters with unexpected acoustic phenomena. Whenever confronted by the unknown, I always respond to what my ears are telling me. Only through highly developed aural perception is painstaking progress possible.

[6] — The webpages

https://chrysalis-foundation.org/instruments-and-music/chrysalis-i

https://chrysalis-foundation.org/instruments-and-music/chrysalis-ii

https://chrysalis-foundation.org/building-new-chrysalis-ii

and *Musical Mathematics*, Chapter 12, give general and detailed descriptions of the basic components and construction of Chrysalis I and Chrysalis II. Over the past 60,000 years, I know of no acoustic musical instrument built with two soundboards. Meyer's tonality diamond with its intrinsic neutral axis is a distinctive creation, and Chrysalis I and Chrysalis II built with two soundboards each are equally unique.

Furthermore, the central volume of air between the inner surfaces of the two facing soundboards constitutes a critical factor in sound production. This volume of air functions like a cylindrical resonator that is *closed at the two ends and open around the circumference*, to my knowledge not previously described in any text. Together with the two soundboards, two circular aluminum bridges, and 82 strings per soundboard, this resonator contributes significantly not only to the amplitude, but also to the timbre — the audible harmonic spectrum — of the instrument.