

53 notes per octave are needed if all of the G#'s, for example, are to be in tune as the root, major & minor third and fifth in all chords of every key, and the 30-page pamphlet included elaborate charts showing where to place the 12 frets/octave needed for the most common keys. But what if the music modulates to another key? No problem! the proud purchaser of the Enharmonic Guitar received 150 blue frets for simple keys, 20 white metal frets for 'mutations', and 20 brass frets for special dissonances! The author does warn that, "... (the frets) should not be so loose as to fall out. It is necessary, however to keep the instrument at all times in a position which shall not risk losing the frets". Also included were musical examples by William Byrd, Verini and an excerpt from Paisello's famed chestnut 'Nel Cor Piu non mi sento'. Thompson's Enharmonic Guitar could be purchased from the famed London luthier Louis Panormo from his shop on the High Street in Bloomsbury. Luckily, one copy of the instrument still exists in the Instrument Museum of Karl Marx University in Leipzig. A less radical but no less ingenious solution to the "untuneableness of the common guitar" was invented by the renowned 19th century French luthier Renee Lacote. Seeking to remedy the inherent mistuning of the standard scale caused by string falsity & increasing string

"I purchased my original guitar in 1934 and spent several years (1934-1942) in the effort to evolve effective frets in Just Intonation. The usual low, wire-type frets were not very satisfactory, and I eventually fitted high, stainless-steel frets into slots in a brass plate, which was then screwed onto the neck. Both Barstow (1941) and U.S. Highball (1943) were originally written for this guitar, and I played it in performing these pieces for some two years."

Harry Partch

depression up the neck, Lacote also decided to make each note individually tuneable. But rather than use discrete steps that were determined by predrilled holes, he shrewdly provided *sliding* frets, each mounted on a block of ebony which could be infinitesimally adjusted to produce the required pitch. Of course he only provided 12 notes per octave, rather than Thompson's 53, since he was only interested in aligning his instrument with the piano scale of the day. Even though the minor deviations from the intended equal scale were small, his sole surviving 1852 instrument (Cité de la Musique, Paris) set the precedent for a far more versatile system created over a century later that could accommodate dozens of notes per octave when necessary. The first half of the 20th century witnessed several musical retappings of the guitar, predominately for quarter-tone music by the Mexican composer Julian Carrillo, and the Czech Alois Hába. But in 1900, an American inventor named Erickson took out a patent for a straight-fretted fingerboard tuned in Just Intonation in the key of A, though it is doubtful that the idea ever made it past the patent office or out of the inventor's workshop. By midcentury, four different just intonation guitars had been created to compose, perform and record over an hour's worth of amazingly original music: the instruments and music were by American composer Harry Partch (1901-1974). Though he trained as a concert pianist, Partch's first 'microtonal' instrument was a viola that was customized in 1929; fitted with a cello neck & fingerboard and restringing an octave below the violin, the Adapted Viola was played between the knees like a viola da gamba. The guitar was the second instrument that he adapted to his newly devised 'Monophonic Scale' of just intonation. While the fingerboard of the Adapted Viola was peppered with brads to mark 29 of the dozens of intervals/octave used for his groundbreaking song cycle *17 Lyrics by Li Po* (1930/33), his Martin parlor guitar posed other challenges:

The Enharmonic Guitar (1829)
fretted in Just Intonation in the key
of A & Enharmonic Fingerboard

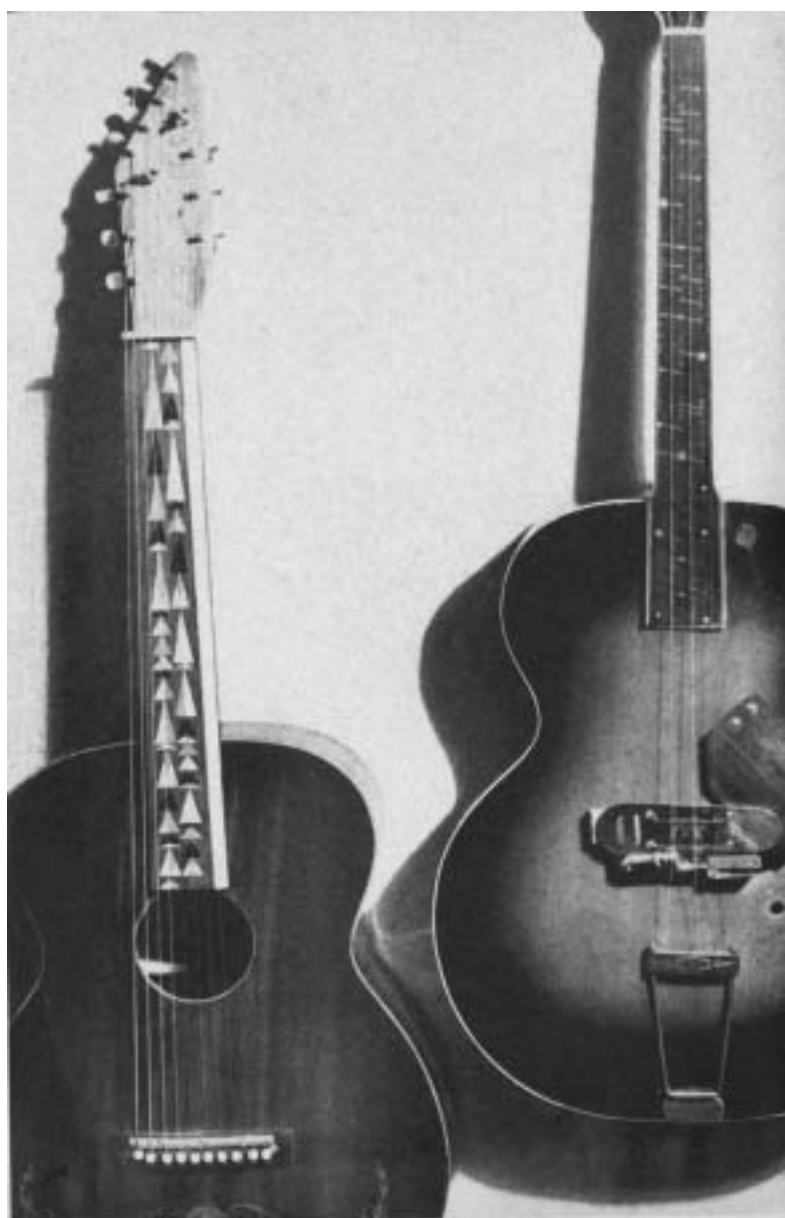


This was the guitar that Partch used for his famed 1944 Carnegie Hall concert which included the trio versions of *Barstow & Highball* (guitar, chromelodeon & kithara), though he had also written a short song cycle *December 1942* and *Letter from Hobo Pablo* (1943) in the years preceding. Though the body was original, Partch completely reconceived the instrument's stringing, tuning and fretting. There were still six strings, but they grouped in three pairs of octaves, and tuned in pure thirds to Eb-G-B (low to high), while there were wide gaps between the fretted notes, which were tuned to scale of just intonation in the key of G. When I recreated the instrument in 1990 with luthier Greg Brandt, we used regular frets for ease of playing:

Partch was dissatisfied enough with the limitation of what must have been very uncomfortable replaceable frets, that in 1945 he created a fretless amplified version of *Adapted Guitar I* (now lost), and a Hawaiian-type slide guitar with ten strings called *Adapted Guitar II*:

The tuning of *Adapted Guitar II*'s open strings was mutable, alternating between a just dominant seventh chord ("Otonality" in Partch parlance) and its minor equivalent ("Utonality"). The color-coded triangles on the fingerboard indicates where to stop the slide to produce Partch's infamous 43-tones/octave. The gliding tones of *Guitar II* were not new to Partch's musical language: his earlier *Kithara* had two sets of hexads (six stringed open chords tuned to the 1-3-5-7-9-11th harmonics) that were slid with pyrex rods held in place by the strings. *Three Intrusions* (1949) were the first of many compositions to use the *Adapted Guitar II* (as well as the newly invented *Diamond Marimba*), and the first of several subsequent groups to use the whimsical title "Intrusion" which eventually numbered eleven:

Harry Partch & *Adapted Guitar I*
 JS & *New Adapted Guitar I*
 with standard fretwire
 Adapted Guitars I & II





Just Strings with copies of the Guitar II, Diamond Marimba & the original Kithara (1938)
 John Schneider with *Serenade* (1978) fretting (MicroFest 2001)
 Mode for *Serenade* (1978)
 Novatone's Guitar with Interchangeable Fingerboards



By 1950, Partch had covered the brass plate of the original Guitar I and used it as a slide guitar with six equidistant unison strings, using both guitars in most of his larger stage works along with the ensemble of two dozen exquisitely unique instruments that he had either adapted or invented over the decades. Partch also scrupulously documented his musical evolution in the landmark publication *Genesis of a Music* (1949) which soon after inspired the first composer to apply Just Intonation to the Classical Guitar.

Lou Harrison (1917-2003) was working as a reviewer for the New York Herald Tribune when his boss, American composer Virgil Thompson handed him a new book by Harry Partch, and said, "Here Lou, see what you can make of this..." A seed planted in fertile ground! Harrison had spent much of the 1940s rethinking the basic tenets of music, and was already extremely interested in tuning systems from other cultures - he immediately bought a tuning hammer and 'never looked back'.

Some of Harrison's first efforts in retuning the received Western scale of Equal Temperament were piano studies using the "Pythagorean" tuning of pure fifths which he called *Pastorales* (1949/51), and a few years later the *Incidental Music for Corneille's 'Cinna'* (1956) for a single strung tack-piano returned to include not only pure fifths, but pure major thirds & minor sevenths as well. In the interim, a letter Harrison wrote to composer Frank Wigglesworth who was learning guitar in Rome contained Harrison's first solo guitar piece:

"How wonderful that you are playing piano and guitar!!...I'm cocoo for it! A friend of mine, a painter. ...was over during [the] Xmas holidays & played for me...what a pleasure! Those dulcet tones ringing through the house. Oh, I'm delighted you've taken it up!! I'll write some pieces for it soon & send [them] to you...Soon? Why not now? Here goes!..."

What followed was a delightful binary serenade which the composer titled in Esperanto. In the eventual performance notes for *Serenado por Gitaro* (1952), Harrison included these hopeful directions:

Anyone who just might own a guitar with moveable frets should arrange these to play the "Intense Diatonic" (Syntonon

those who wish to go further & retune,
 the following is a just intonation of the
 8-tone mode in which the Serenade is
 composed:



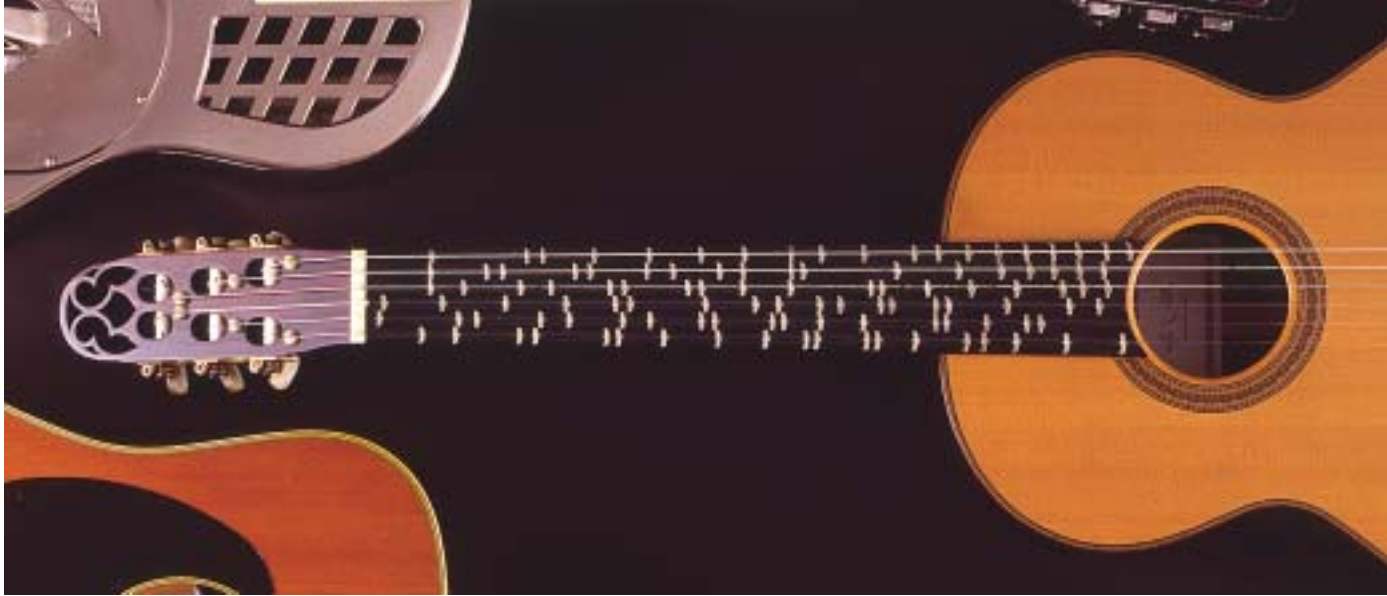
Diatonic), which is the "vocal" major scale. The piece will sound lovely in that tuning."

Years later, I asked him how in the world he considered such a thing, to which he replied, "...the frets of lutes & gambas have movable frets, so why not guitars!" This, I might add, in an era preceding the Early Music revolution when such instruments were virtually invisible except to the most ardent researcher. He also admitted that the seed may have been planted by the strange guitars that he had seen in Partch's *Genesis*, though he had also reviewed Partch's famous Carnegie Hall concert in 1944 while on the beat for the *Tribune*, and had seen him perform the entire cycle of *The Wayward* on the original Adapted Guitar I with its visually arresting replaceable frets.

The fretting for *Serenado* (1952) was not fully realized for another two decades, when San Francisco guitarist Tom Stone invented the Guitar with Interchangeable Fingerboards, inspiring Harrison to begin five Suites, each in a different tuning. The first became the *Serenade* for guitar & percussion (1978), composed in an fascinating octatonic mode of alternating half & whole steps, tuned so that the fifths and major thirds are acoustically pure:

not be limited to the standard twelve notes per octave. If a player needs both a G# and a Ab to be acoustically in tune, why not have two frets? Inspired by this capability, the esteemed American composer Ben Johnston (1926), whose ten just intonation string quartets and work with both John Cage & Harry Partch are legendary, has written me a delightful song cycle called *The Tavern* (1999) on a text by Jalal ad-Din ar-Rumi that uses 15 notes per octave:

The score tells this story: "While Mother played an afternoon of Mah Jong with friends, we children listened to records or radio. We heard a lot of Hawaiian music - and the sliding & waving tones of their guitars - I remember over a gap of almost 80 years. The wonderful sculpture & architecture of Nek Chand, near Chandigarh (Northern India) set me to composing three small pieces in admiration." [Created from the detritus of an urban renewal project, folk artist Nek Chand's extraordinary five acre *Rock Garden* is populated



The scordatura tunes the open strings to harmonic series of the A-string: E-A-C#-G-B-D¹¹ (G = 'G'-31c, D¹¹ = 'D'+51c) and is fretted to also include notes based on the thirteenth harmonic (C#-40c & F#+41). Since Vogt's death in 1990, the patent for "THE WORLDS ONLY FINE-TUNABLE GUITAR" has passed into the hands of the esteemed luthier Hervé Chouard who creates superb "Fret Mobile" instruments with either nylon or steel strings.

with hundreds of fantastic sculptures & structures that have has enchanted millions of visitors since its opening in 1976.] Though the piece was premiered by David Tannenbaum on an equal tempered instrument, the composer's assistant Bill Slye & I worked with the National Reso-phonic Guitar company here in California to refret an instrument in the intended tuning, and the just *Scenes* were premiered at MicroFest 2002, and recorded a few months later.

Into the 21st Century!

This new century has already witnessed several new works & new instruments conceived in just intonation. Responding to a commission by San Francisco's Other Minds Festival, Lou Harrison's composed what was to be his final composition, a guitar piece written for a National Steel guitar, custom fretted in Just Intonation. The *Scenes from Nek Chand* (2002) uses a six-note mode based on the 6th through 12th harmonics generated by the note G, including the pungent 11th, which is almost an exact quartertone:

The composer was so delighted with the instrument that he planned more works for it, but sadly, it was not to be. In our last meeting, a few months before his death, we not only reconstructed the second Suite for Tuned Guitars, with the result that the *Ditone Set* for guitar & percussion (1978/2003) was premiered at MicroFest 2003 in Los Angeles ("Renaissance echoes & Middle East sonorities somehow blended beautifully..." *LA Times*), as well as the chamber version *Quartet Set*, but also created a *Suite for National Steel Guitar*.

While Lou Harrison & Ben Johnston were inspired by instruments, music and theories of Harry Partch, Terry Riley's profound interest in just intonation began with his colleague

Tuning for Nek Chand (score)

Tuning: 1) the instrument 2) the Mode

6 7 8 9 10 11
(OVERTONES)

LaMonte Young and the vocal ragas of India. LaMonte Young's first minimalist works from the 1950s [*String Trio & for Brass*] used extremely long, sustained tones which highlighted mistunings between equal tempered intervals. Subsequent investigations led the radical young composer to tune to just intonation, also inventing the *Well-Tuned Piano*, an instrument and composition that has been ongoing since the early 1960s. Meanwhile, both he and Terry Riley became disciples of the Indian singing master Pandit Pran Nath, a relationship which deeply effected both men's music. After



decades of legendary compositions & improvisations on just intonation electronic organs [*Persian Surgery Dervishes*, *Rainbow in Curved Air*, etc], Terry Riley retuned the piano for his two-hour *Harp of New Albion* (1984), using a scale of pure 3/2 fifths and 5/4 thirds. This tuning is called 5-limit just

C#	D	D#	E	E#	F#	G	G#	A	A#	B	B#	C#
1	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{6}{5}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{64}{45}$	$\frac{3}{2}$	$\frac{8}{5}$	$\frac{5}{3}$	$\frac{16}{9}$	$\frac{15}{8}$	$\frac{2}{1}$

intonation because the fifth harmonic is the highest prime, and still produces an amazing 35 distinct ratios from 12 notes of the octave.

Enthralled by this amazing music, I had a special fingerboard constructed to play this tuning, and have recorded two movements from this modern masterwork, the *Chorale* and *Cadence of the Wind* on classical guitar (*Just Guitars*). Terry Riley has certainly been no stranger to the guitar: since his son Gyan began learning the instrument, the father has produced a prodigious amount of music under the title *Book of the Abbeyuzzud* (1993), but always for equal tempered classical guitar - until now.

Ever since the composer and I began discussing *New Albion*, I had been after him to include just instruments in the Abbeyuzzud cycle, but it was the creation of the just intonation National Steel guitar that finally did the trick. In 2003, Riley composed *Encrucijado*, a three movement suite

with two slow movements and a rousing *National Broadstreet March* - all of which will be premiered in the Spring of 2004. There is also a concerto for National Steel and gamelan being completed by Lou Harrison's colleague Bill Alves, and new works by Dartmouth's Larry Polansky, opera & glass harmonica (see Sony release *Cristal*) composer Garry Eister & Just Intonation Network's David Doty in the works...but the best news of all is that the National Reso-phonic Guitar company is now producing these wonderful instruments on request, or the instrument can be rented for concert performances. Now this wonderful new instrument and its rapidly expanding repertoire by Lou Harrison, Terry Riley, Dusan Bogdanovic and others is available to all players. The inevitable question arises, does one *have* to refret to play in just intonation? The short answer is "No", depending on how many notes are needed. Playing *any* non-octave harmonics automatically produces tonal microtones, though the choices and timbres are quite limiting. Several composers have sidestepped that restraint by using multiple micro-tuned instruments and combining their output to produce more abundant scales. In his *Harmonium #2* (1977) for two electric guitars, James Tenney tuned the instruments approximately 1/3-semitone apart (tuning the open D-string of one to the 7th harmonic of the low E-string of the other), with later works exploring smaller mistunings for other intervals, though more guitars are needed to perform them. His *Septet* (1981, rev.2000) uses six electric guitars, bass guitar, though the longer multimovement '*Water on the Mountain...Fire in Heaven*' (1985) uses only the sextet of guitars. Of course the master of multiple electric guitars is Glenn Branca, whose *Symphonies* for orchestras of retuned microtonal instruments are legendary for their spectral diversity as much as their ear-splitting volume. [Speaking of electric guitars, they have also been refretted to just intonation, most famously by Jon

Catler whose designs are commercially available from Leo Fender's *G&L Guitars*. Catler's music along with his guitar work with LaMonte Young is groundbreaking and worth seeking out.] Retuning standard fretted classical guitars to just intonation is still relatively uncharted area, with Jeffrey Holmes *Five Micro-Tonal Studies* (2002) for two guitars being an excellent example, which coincidentally uses the same tuning as Tenney's earlier *Harmonium*.

how does this music actually *sound*? The harmonies and melodies created by Just Intonation are refreshingly new, yet somehow quite familiar. The superb clarity that common chords gain through accurate tuning makes their consonances all the more vivid, like seeing colors more deeply saturated, or a picture more sharply in focus. And the dissonances also benefit: they are far more pungent and emotionally charged, enhancing both the tensions and resolutions of standard harmonic relations, and creating entirely new ones.

Remembering that since composers in this marvelously flexible musical language choose which intervals are tuned pure, **there is no single just intonation**, meaning that each custom scale can be



Scale & Switchboard for *Harp of New Albion*

