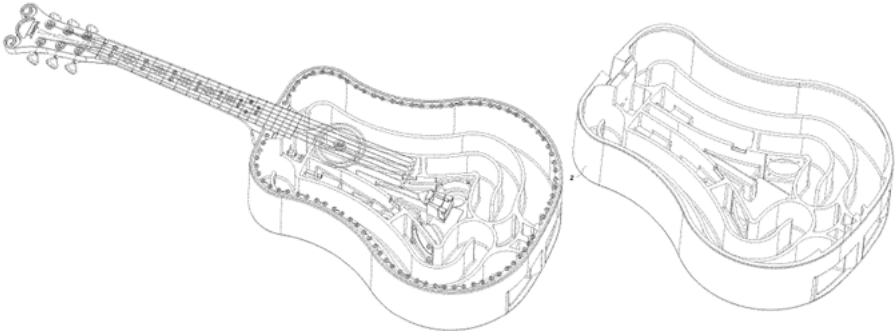




Captures $\frac{1}{4}$ wavelength of approx. 80 Hz. Also waveguides are not so big that high frequency waves do not bounce around so much, and cancel each other. Plus back of speaker sound goes outside and also into upper chamber. Need to test results, still building!

Folded Horn Acoustic Guitar Patent # 10,177,172 7-16-22 Updates

(12)	United States Patent		(10)	Patent No.: US 10,777,172 B1	
	Katzenberger		(45)	Date of Patent: Sep. 15, 2020	
(54)	FOLDED HORN ACOUSTIC GUITAR		4,987,815 A	1/1991	Shockley
			5,208,410 A	5/1993	Foley
(71)	Applicant: Joseph J. Katzenberger, Crawfordsville, IN (US)		5,333,527 A	8/1994	Janes
			5,461,958 A	1/1995	Dresdner
			5,442,986 A	8/1995	Cota
			5,549,027 A	8/1996	Steinberger
(72)	Inventor: Joseph J. Katzenberger, Crawfordsville, IN (US)		5,567,896 A	10/1996	Gottschall
			5,661,252 A	8/1997	Krawczak
			5,682,003 A	10/1997	Jarowsky
(73)	Assignee: Joseph J. Katzenberger, Crawfordsville, IN (US)		4,995,293 A	11/1999	Anderson
			6,040,510 A	3/2000	Yuan
			6,124,536 A	9/2000	Hoshino
			6,646,191 B1	11/2003	Martin
(*)	Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.		6,664,452 B1	12/2003	Teel
			6,800,797 B2	10/2004	Steiger
			6,833,501 B2	12/2004	Jagmin
			(Continued)		
(21)	Appl. No.: 16/431,553		OTHER PUBLICATIONS		
(22)	Filed: Jun. 4, 2019		U.S. Appl. No. 10/686,839, filed Oct. 14, 2003, Henry Langeman.		
			U.S. Appl. No. 11/142,487, filed Jun. 1, 2005, Kenneth Preece.		
			U.S. 11/810,948, filed Sep. 7, 2007, Jan Anders Linden.		
(51)	Int. Cl. G10D 13/02 (2020.01) G10D 3/02 (2006.01) G10D 1/08 (2006.01)		<i>Primary Examiner</i> — Kimberly R Lockett		
(52)	U.S. Cl. CPC G10D 3/02 (2013.01); G10D 1/08 (2013.01)		(57) ABSTRACT		
(58)	Field of Classification Search CPC G10D 3/02; G10D 1/08 See application file for complete search history.		This invention is an acoustic guitar with two internal folded horns built into the guitar body. Each left and right horn is five feet long. The natural acoustic sound inside the guitar is captured by a microphone (not a pickup under the strings), inside the guitar's upper chamber. It is then sent to an internal preamp, which sends the signal to left and right speakers, which are mounted to the compression chamber at the start of each folded horn. It then travels through the throat of each folded horn, which increases exponentially until it reaches the end of the horn. The sound waves are concentrated throughout this shape (does not lose sound energy), and are also directed to left and right exits out the end of the instrument. The material for the body is Rock Maple, and the other materials are Sitka Spruce, Rosewood and Mahogany.		
(56)	References Cited U.S. PATENT DOCUMENTS 2,001,723 A 5/1935 Hammond, Jr. 2,228,463 A 6/1942 Kislingbury 3,194,870 A 7/1965 Tondreau et al. 3,549,775 A 12/1970 Kaminsky 3,612,741 A 10/1971 Marshall 3,656,395 A 4/1972 Kaman 3,892,159 A 7/1975 Houstma 4,464,967 A 8/1984 Trimborn 4,748,886 A 6/1988 De Byl		6 Claims, 5 Drawing Sheets		



Folded Horn Acoustic Guitar Patent # 10,177,172 7-16-22 Updates



Body wood is 100% Hard Maple, same as a violin.



CNC machine start.



CNC machine about halfway through. I can cut the entire body and horns in about two full days, runs at night.

Folded Horn Acoustic Guitar Patent # 10,177,172 7-16-22 Updates



Solid stock on the CNC machine.

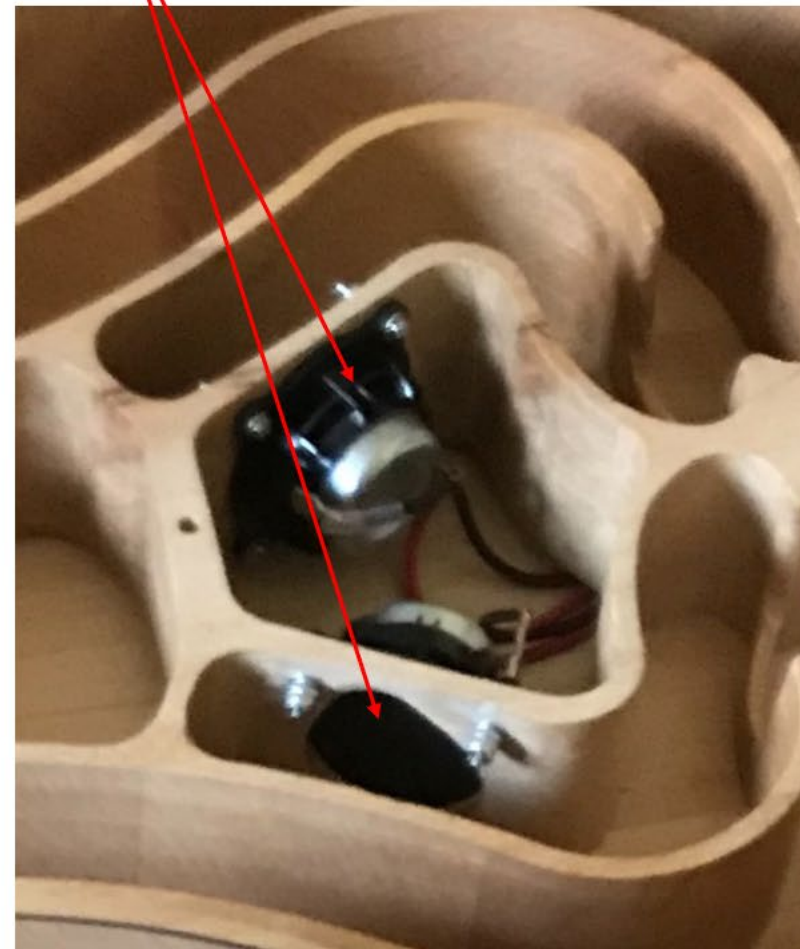


Not final shape, but close!

This speaker
not being
used.



Same speaker



Speaker in cabinet, 117 dB max, bass
is OK, but obviously missing a woofer.

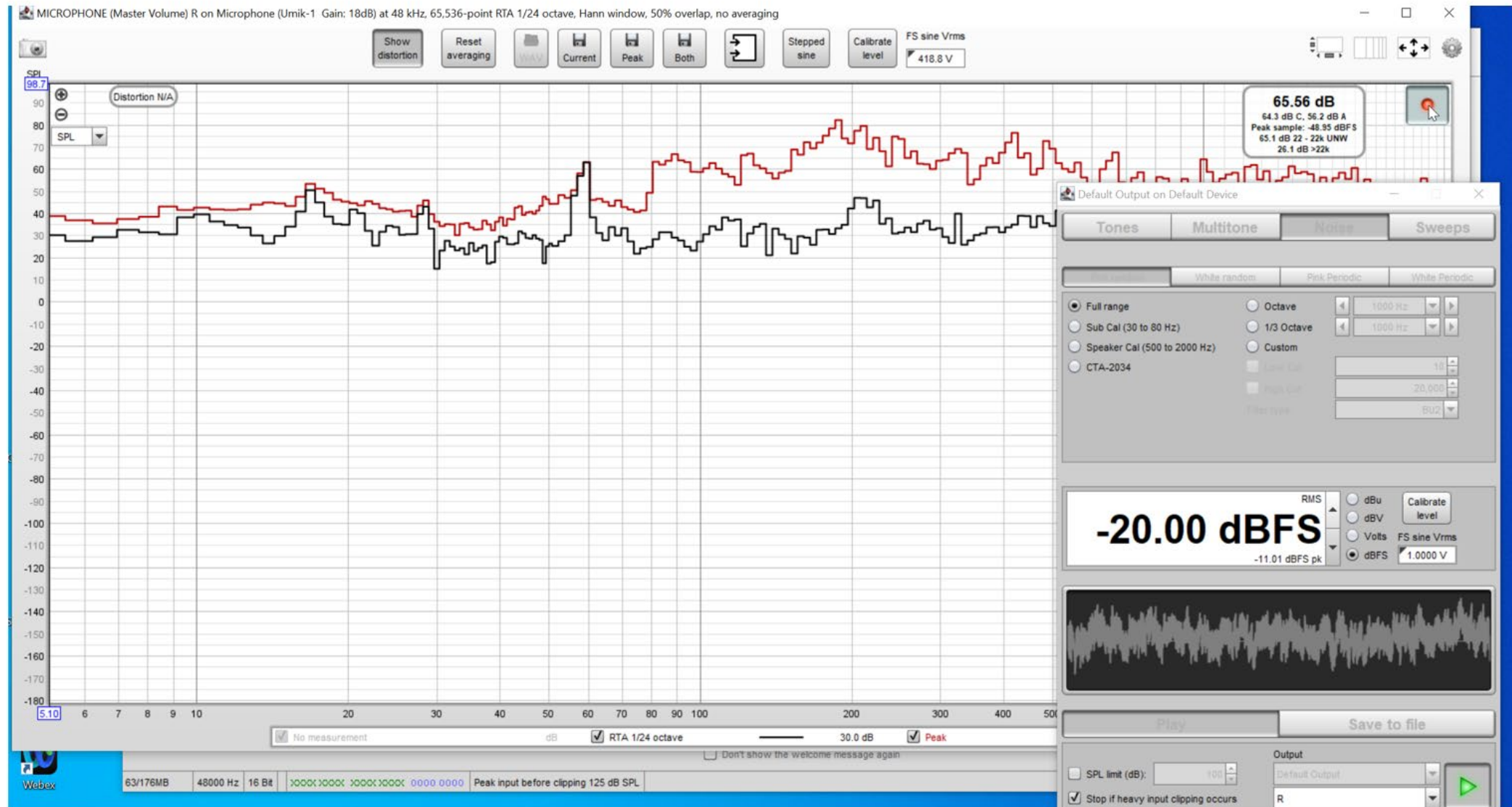
Speaker in guitar 125 dB max, very strong bass.



I was pleasantly surprised by this Bose Waveguide CD player. It is only 14" across, and does indeed fill a 15' x 15' room with sound, bass was pretty good. Speakers are almost exactly the same physical size as mine, and dB was also similar, encouraging.

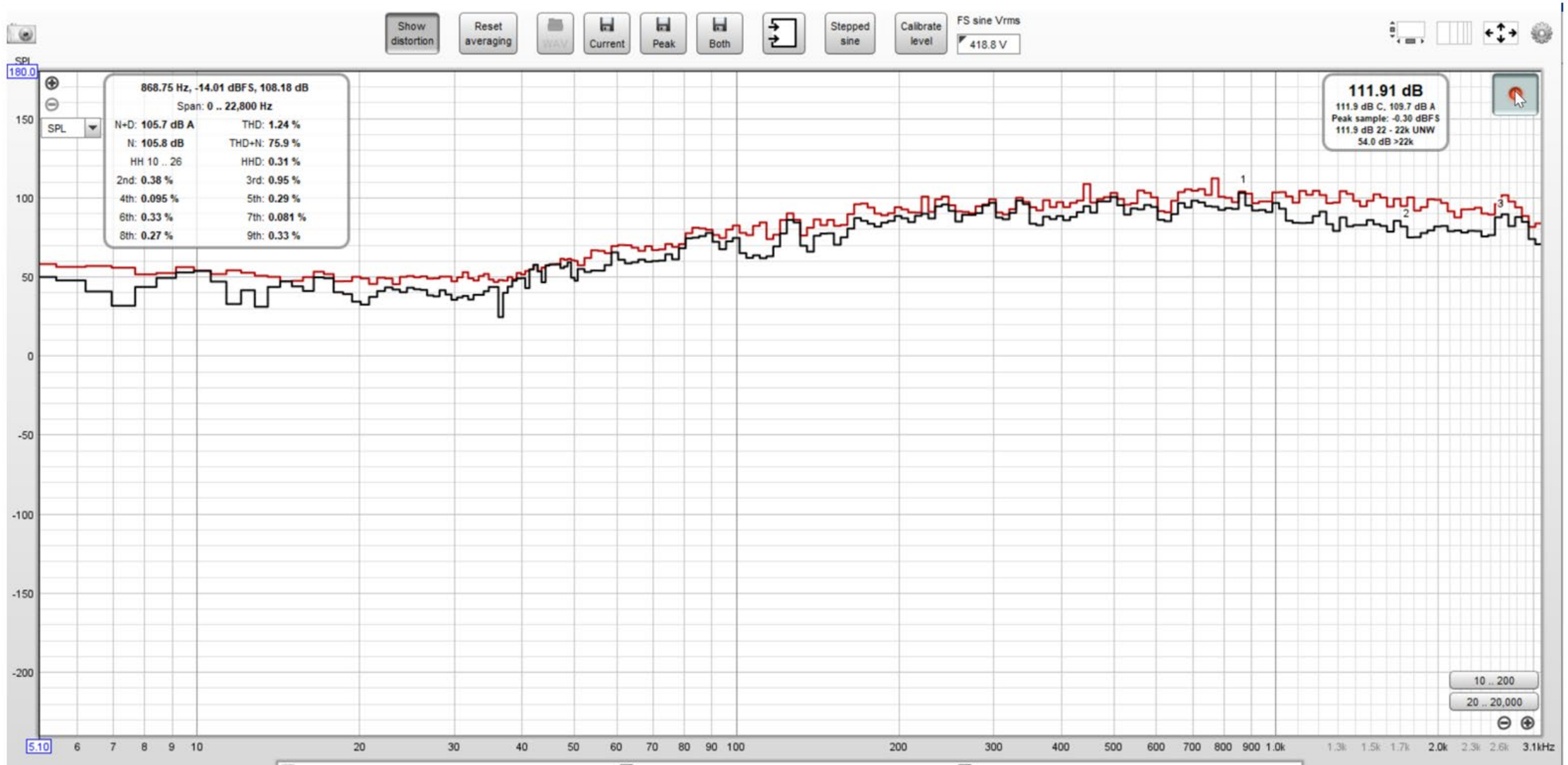
My waveguides are much longer. The Bose waveguide is 27" long, one only. I have two five foot long waveguides, and you can hear the richer bass in mine, capturing $\frac{1}{4}$ wavelength of about 80 Hz.

Folded Horn Acoustic Guitar Patent # 10,177,172 7-16-22 Updates



Measurement Mic – acoustic guitar only – no folded horns, amp or speaker.

Folded Horn Acoustic Guitar Patent # 10,177,172 7-16-22 Updates



Measurement Mic – actual Folded Horn Acoustic Guitar – 112 dB max, not even rocking hard.

NOTE! Since my guitar is not finished yet, I play another guitar through it for now. Guild, Taylor, low end Martin.

Folded Horn Acoustic Guitar Patent # 10,777,172 Highlights January 2022

(12) **United States Patent**
Katzenberger

(10) **Patent No.:** **US 10,777,172 B1**
(45) **Date of Patent:** **Sep. 15, 2020**

- 1) The guitar body and soundboard on this guitar are three inches longer, so the soundboard is louder. The soundboard is made from light yet strong material (Baltic Birch Laminate), so it moves more, which also makes it louder. The natural sound of the acoustic guitar provides much of the great tone of this guitar, in addition to speakers and folded horns.
- 2) Two folded horns are built into the guitar body for true stereo sound ----- update this.
- 3) Each folded horn is five feet long, which captures the $1/4$ wavelength of the lowest guitar frequency (approx 80 Hz). This captures the low frequency range of the guitar. This can not be done with small speakers only, that need to fit inside guitar, without these horns.
- 4) A 90 Hz wavelength is actually (12) feet long. $1/4$ of this wavelength is (3) feet. Horns that are (5) feet long easily capture this wavelength, with room for side ports, and still will not break this critical $1/4$ wavelength rule. This is a truth in physics and acoustic engineering.

Folded Horn Acoustic Guitar Patent # 10,777,172 Highlights January 2022

5) The folded horns (also known as wave guides, if not tapered) provide sound directivity, and does not lose sound energy. It is not possible to amplify a sound wave once it is in air, but it is possible to prevent sound loss, by directing sound to a desired source.

6) Battery powered. Can use standard batteries or Lithium Ion batteries, similar to what Tesla and all other Electric Vehicles use.

7) The guitar body is cut from a 6" thick maple block, and the walls are 1/4" thick, which resonates more like a piano than a standard acoustic guitar that has very thin walls (needed for traditional bending of the sides).

8) The vibrations are so powerful, you can feel them in your body as you play, similar to a violinist that can feel the vibration of the instrument through their neck.

9) A piano is powerful due to a large soundboard, thick wood and substantial size. This guitar has a larger soundboard, thicker wood, and a more substantial size than a standard dreadnought guitar.

Folded Horn Acoustic Guitar Patent # 10,777,172 Highlights January 2022

10) A violin, which is approx. $1/3$ the size of a guitar, produces greater volume because it is bowed, not plucked or strummed like a guitar. Also the soundboard has only one brace and a bass bar, which allows it to vibrate more.

11) Soundboard and chamber divider are made of Baltic Birch. This $1/4$ " thick wood is laminated with (5) pieces of Birch, each one having the grain 90 degrees from piece below it, for exceptional strength. This is NOT plywood, it is solid Birch on every laminate. The soundboard is machined down to a much thinner size, while leaving braces in solid. This requires only two CNC machining processes (top and back sides). This provides great soundboard movement, which increases natural acoustic volume, before the sound is captured and fed into the folded horns. Many harps have Baltic Birch sound boards due to strength required on such a large soundboard, with tremendous amounts of string pressure.

12) The nut is pocketed and floats for ease of removal. The saddle and nut can be easily removed, and both replaced with different heights of nut and saddle. This allows action adjustment at the nut, and also the saddle/bridge. Action height combinations are available in many combinations not seen previously with standard acoustic guitars.

Folded Horn Acoustic Guitar Patent # 10,177,172 7-16-22 Updates



Body and horns - really more like a waveguide with horns on the end. Speakers shown, amp and battery pack go here (charge at night like your iPhone).



Making two guitars to start.



Chamber divider

Front of
soundboard

Back of
soundboard
CNC machined
from one
piece of Baltic
Birch (except
bridge support
is glued).
Moves like a
speaker, light
but very
strong. I can
move this
thing $\frac{1}{4}$ " with
my hand.



Dovetail neck fit is great! CNC machining is accurate to $\frac{1}{5}$ the thickness of a human hair (.001"). Straight as an arrow.