Ξεναρμονία Ζ΄

# Xenharmonic Bulletin № 7

IVOR DARREG, composer and electronic music consultant
349½ W. California Av., Glendale, CA 91203 • [213] 243-3477

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## *Bulletin Policy*

*Beginning with the next issue, comments and Letters to the Editor will be published. Other outside contributions, such as articles, informative paragraphs, etc., cannot be handled at present, but this Bulletin's pages will be opened to such longer items in about a year from now.*

*Our emphasis is on practice, rather than theory, on doing rather than talking about, on what can be done right now rather than future generations, and on how vast the unexplored territory is for instrument-builders as well as composers.*

*We want to free your imagination; we do not like to see composers and designers of new instruments intimidated by non-composers who dredge up obsolete notions and discourage experiment.*
*In this issue, we show you many exciting possibilities, well within your means right now. Why wait any more?*

## FRETTING AND FRET-CHARTS

Even when one possesses sufficient motivation, talent, and opportunity, it still takes considerable patience and perseverance to become a piano or organ tuner.

As a result, tuners are now very scarce, and many inventions have been attempted to obviate the need for tuning-skills. So long as the piano was the principal instrument, this made experimentation with xenharmonics impracticable. All the more so, since tuners are taught only how to arrive at a workable approximation to 12-tone equal temperament, and the information necessary for constructing tuning-routines for other systems simply has not been available.

Now that the guitar is becoming the principal instrument, suddenly all is changed: the tuning of the Spanish guitar and other fretted instruments such as banjo, mandolin, electric bass, zither, ukulele, etc., is determined once and for all by the placement of the *frets* on the fingerboard.

The idea is easily extended to fretless instruments such as the (Hawaiian) steel guitar, by the simple expedient of placing a fret-chart beneath the strings. Such charts can be temporarily pasted to the fingerboards of violins, cellos, or of fretless guitars and basses.

Once a xenharmonically-fretted instrument, such as an electric guitar, is available, it can be used as a 'secondary standard' to tune other instruments, e.g. psalteries, keyboard instruments—electronic organs, harpsichords—or to learn to play in new systems on the violin, or to sing in those scales.

The problem thus reduces itself to what is now known as 'software'—having at hand the mathematical calculations showing where to place the frets. Re-fretting is nowhere near as difficult an operation as the killjoys, wet-blankets, and professional spoilsports try to make it seem!

In this issue, I am publishing some tables I have compiled for what seems to be the most popular guitar active string-length: 650 mm, which is close to 25-5/8 inches. Other tables will be compiled later on.

All measurements in these tables are given in millimeters. The U.S. Government recently opted for a metric conversion program, to take place over the next several years, so there is no point in giving inch equivalents in these tables, especially where the interest in non-twelve-tone tunings will take some time to develop. Accordingly, these tables have to reflect the state of affairs in 1980 or such a matter.

Those who adamantly refuse to convert should use an electronic mini-calculator to divide each entry by 25.4, the number of millimeters in one inch. Then, with the aid of a ruler from a large hardware firm or draftsmen's supply-house, frets can be set to the nearest hundredth of an inch.

The basis of calculation is this: The octave is to be divided into equal parts, so the applicable root of 2 is extracted and then this number is raised to as many powers as there are to be frets installed.

Since string-lengths are inversely proportional to frequencies (and hence to pitches), the reciprocals of all these numbers must then be calculated. This gives distances from bridge to fret. Since many bridges are movable or adjustable, the distance from the *nut*, or *zerothfret* on some instruments, is the one actually needed by the craftsman, so each string-length entry has to be subtracted from the total active string-length.

In actual practice on real instruments, the fret-positions must be slightly altered from the values given in the table, since pressing a string down behind a fret stretches it and therefore sharpens the pitch.

The amount of such compensation can be determined by taking measurements on orthodox 12-tone guitars, but be it noted that it is not necessary nor advisable to compensate *totally:* this can be done by an adjustable bridge. The first fret may need additional compensation, since it is going to be closer than standard to the nut when there are more than twelve tones to the octave.

Fret wire is shaped something like the top portion of a model-railroad rail, and comes in several sizes for mandolins, guitars, basses, etc. Special-width saws are required to cut the correct kerfs or grooves for a tight fit. The web of the fret-wire usually bears little barbs or projections so that gluing-in is seldom necessary.

Fortunately a number of do-it-yourself instrument-making and -repair books are coming on the market, in which the technical details are illustrated as well as explained.

There are some short-cut, rough-and-ready trick refretting conversions possible. One is to leave the 12-tone frets in, but intercalate new 24-tone or quartertone frets. Then by moving the bridge toward the nut till the former 11th (now 22nd) fret sounds the octave, you have a passable 22-tone instrument, even though there will be errors in the high register beyond the 26th fret or so.

Another one which works, however much it would make the mathematician or theorist shudder, is to remove every other fret from a 12-tone instrument, filling up the empty kerfs with suitably-stained wood-mender, and intercalate *two* frets to make an 18-tone instrument out of the 6-tone you have temporarily produced. Then move the bridge till the new 17th or new 19th fret sounds the octave.

Surely three systems for the price of one is a tempting bargain, and brings xenharmonics within the average person's means.

It should be mentioned that special instruments can be made with *movable* frets, which are tied on the neck or are made of wire and twisted to tighten or loosen them. The old viols, and some modern instruments of the East have such adjustable frets.

While the calculations for fretting an instrument to *just intonation* are much easier than those for tempered scales, peculiar problems make the practice unpopular. The comma (81:80) entails an inconveniently small fret-spacing. Introducing septimal intervals would aggravate this problem. With the ordinary Spanish-guitar tuning, the two E-strings will be out by a comma.

These objections, of course, do not apply to *fret-charts* for steel guitars, violin-family instruments, or monochords.

The application of tables such as these to the calculation of string-lengths for harps, dulcimers, psalteries, harpsichords, and the like requires some additional work: mainly, some of the lowering of pitch is obtained through the use of heavier strings as well as by increasing the length. Bass strings generally are much shorter than theory would suggest.

In his book *Genesis of a Music,* Harry Partch described and illustrated the fret-charting of instruments for just intonation: an extra-long-necked viola, the conventional cello, special guitars, etc. (Pp. 198 sqq. 2nd Edition) Please note his use of *colored* markers to clarify the complicated network of just intervals.

Acknowledgements are due Dr. John H. Chalmers, Jr., for his equal temperament tables, and Ervin M. Wilson for his tables and advice on the fretting of instruments.

In a later issue some of the relevant literature will be surveyed.

# FRETTING TABLES, 650 MILLIMETER ACTIVE STRING LENGTH



## 17-TONE SYSTEM

| Name F-strings | Fret No. | Distance From Nut | Distance from Bridge |
|---|---|---|---|
| e | 0 | 0.0 | 650.0 |
| f | 1 | 26.0 | 624.0 |
| gb | 2 | 50.9 | 599.1 |
| f# | 3 | 74.8 | 575.2 |
| g | 4 | 97.8 | 552.2 |
| ab | 5 | 119.9 | 530.1 |
| g# | 6 | 141.1 | 508.9 |
| a | 7 | 161.4 | 488.6 |
| bb | 8 | 180.9 | 469.1 |
| a# | 9 | 199.7 | 450.3 |
| b | 10 | 217.6 | 432.4 |
| c | 11 | 234.9 | 415.1 |
| db | 12 | 251.5 | 398.5 |
| c# | 13 | 267.4 | 382.6 |
| d | 14 | 282.7 | 367.3 |
| eb | 15 | 297.4 | 352.6 |
| d# | 16 | 311.5 | 338.5 |
| e | 17 | 325.0 | 325.0 |
| f | 18 | 338.0 | 312.0 |
| gb | 19 | 350.4 | 299.6 |
| f# | 20 | 362.4 | 287.6 |
| g | 21 | 373.9 | 276.1 |
| ab | 22 | 385.0 | 265.0 |
| g# | 23 | 395.5 | 254.5 |
| a | 24 | 405.7 | 244.3 |
| bb | 25 | 415.4 | 234.6 |
| a# | 26 | 424.8 | 225.2 |
| b | 27 | 433.8 | 216.2 |

## 19-TONE SYSTEM

| Name F-strings | Fret No. | Distance Nut | Distance Bridge |
|---|---|---|---|
| e | 0 | 0.0 | 650.0 |
| fb | 1 | 23.3 | 626.7 |
| f | 2 | 45.7 | 604.3 |
| f# | 3 | 67.4 | 582.6 |
| gb | 4 | 88.3 | 561.7 |
| g | 5 | 108.4 | 541.6 |
| g# | 6 | 127.8 | 522.2 |
| ab | 7 | 146.5 | 503.5 |
| a | 8 | 164.5 | 485.5 |
| a# | 9 | 181.9 | 468.1 |
| bb | 10 | 198.7 | 451.3 |
| b | 11 | 214.9 | 435.1 |
| cb | 12 | 230.4 | 419.6 |
| c | 13 | 245.5 | 404.5 |
| c# | 14 | 260.0 | 390.0 |
| db | 15 | 273.9 | 376.1 |
| d | 16 | 287.4 | 362.6 |
| d# | 17 | 300.4 | 349.6 |
| eb | 18 | 312.9 | 337.1 |
| e | 19 | 325.0 | 325.0 |
| fb | 20 | 336.6 | 313.4 |
| f | 21 | 347.9 | 302.1 |
| f# | 22 | 358.7 | 291.3 |
| gb | 23 | 369.1 | 280.9 |
| g | 24 | 379.2 | 270.8 |
| g# | 25 | 388.9 | 261.1 |
| ab | 26 | 398.2 | 251.8 |
| a | 27 | 407.3 | 242.7 |
| a# | 28 | 416.0 | 234.0 |
| bb | 29 | 424.3 | 225.7 |
| b | 30 | 432.4 | 217.6 |
| cb | 31 | 440.2 | 209.8 |
| c | 32 | 447.7 | 202.3 |
| c# | 33 | 455.0 | 195.0 |

## 22-TONE SYSTEM

| Name F-Strings | Fret No. | Distance Nut | Distance Bridge |
|---|---|---|---|
| e- | 0 | 0.0 | 650.0 |
| e | 1 | 20.2 | 629.8 |
| f | 2 | 39.7 | 610.3 |
| f#-- | 3 | 58.6 | 591.4 |
| f#- | 4 | 77.0 | 573.0 |
| g- | 5 | 94.7 | 555.3 |
| g | 6 | 112.0 | 538.0 |
| g#-- | 7 | 128.6 | 521.4 |
| ab+ | 8 | 144.8 | 505.2 |
| a- | 9 | 160.5 | 489.5 |
| a | 10 | 175.7 | 474.3 |
| bb | 11 | 190.4 | 459.6 |
| bb+ | 12 | 204.6 | 445.4 |
| b- | 13 | 218.4 | 431.6 |
| c- | 14 | 231.8 | 418.2 |
| c | 15 | 244.8 | 405.2 |
| c#-- | 16 | 257.4 | 392.6 |
| c#- | 17 | 269.5 | 380.5 |
| d- | 18 | 281.3 | 368.7 |
| d | 19 | 292.8 | 357.2 |
| d#-- | 20 | 303.9 | 346.1 |
| eb+ | 21 | 314.6 | 335.4 |
| e- | 22 | 325.0 | 325.0 |
| e | 23 | 335.1 | 314.9 |
| f | 24 | 344.8 | 305.2 |
| f#-- | 25 | 354.3 | 295.7 |
| f#- | 26 | 363.5 | 286.5 |
| g- | 27 | 372.3 | 277.7 |
| g | 28 | 381.0 | 269.0 |
| g#-- | 29 | 389.3 | 260.7 |
| g#- | 30 | 397.4 | 252.6 |
| a- | 31 | 405.2 | 244.8 |
| a | 32 | 412.8 | 237.2 |
| bb | 33 | 420.2 | 229.8 |
| bb+ | 34 | 427.3 | 222.7 |
| b- | 35 | 434.2 | 215.8 |

Second Sheet of 2 * FRETTING TABLES, 650 mm String-Length (active)

## 24-TONE (QUARTERTONE) SYSTEM

| Name on E Stg. | Fret No. | Distance from Nut | Distance from Bridge |
|---|---|---|---|
| e | 0 | 0.0 | 650.0 |
| e𝄲 f𝄳 | 1 | 18.5 | 631.5 |
| f | 2 | 36.5 | 613.5 |
| f𝄲 g𝄬 | 3 | 53.9 | 596.1 |
| f♯ g♭ | 4 | 70.9 | 579.1 |
| f♯♯ g𝄳 | 5 | 87.4 | 562.6 |
| g | 6 | 103.4 | 546.6 |
| g𝄲 a𝄬 | 7 | 119.0 | 531.0 |
| g♯ a♭ | 8 | 134.1 | 515.9 |
| g♯♯ a𝄳 | 9 | 148.8 | 501.2 |
| a | 10 | 163.0 | 487.0 |
| a𝄲 b𝄬 | 11 | 176.9 | 473.1 |
| a♯ b♭ | 12 | 190.4 | 459.6 |
| a♯♯ b𝄳 | 13 | 203.5 | 446.5 |
| b | 14 | 216.2 | 433.8 |
| b𝄲 c𝄳 | 15 | 228.6 | 421.4 |
| c | 16 | 240.5 | 409.5 |
| c𝄲 d𝄬 | 17 | 252.2 | 397.8 |
| c♯ d♭ | 18 | 263.5 | 386.5 |
| c♯♯ d𝄳 | 19 | 274.5 | 375.5 |
| d | 20 | 285.2 | 364.8 |
| d𝄲 e𝄬 | 21 | 295.6 | 354.4 |
| d♯ e♭ | 22 | 305.7 | 344.3 |
| d♯♯ e𝄳 | 23 | 315.5 | 334.5 |
| e | 24 | 325.0 | 325.0 |
| e𝄲 f𝄳 | 25 | 334.2 | 315.8 |
| f | 26 | 343.2 | 306.8 |
| f𝄲 g𝄬 | 27 | 351.9 | 298.1 |
| f♯ g♭ | 28 | 360.4 | 289.6 |
| f♯♯ g𝄳 | 29 | 368.7 | 281.3 |
| g | 30 | 376.7 | 273.3 |
| g𝄲 a𝄬 | 31 | 384.5 | 265.5 |
| g♯ a♭ | 32 | 392.0 | 258.0 |
| g♯♯ a𝄳 | 33 | 399.4 | 250.6 |
| a | 34 | 406.5 | 243.5 |
| a𝄲 b𝄬 | 35 | 413.4 | 236.6 |
| a♯ b♭ | 36 | 420.2 | 229.8 |
| a♯♯ b𝄳 | 37 | 426.7 | 223.3 |
| b | 38 | 433.1 | 216.9 |

## 31-TONE SYSTEM

| Name on E's | Fret No. | Distance from Nut | Distance from Bridge |
|---|---|---|---|
| e | 0 | 0.0 | 650.0 |
| f♭ | 1 | 14.4 | 635.6 |
| e♯ | 2 | 28.4 | 621.6 |
| f | 3 | 42.2 | 607.8 |
| g♭♭ | 4 | 55.6 | 594.4 |
| f♯ | 5 | 68.8 | 581.2 |
| g♭ | 6 | 81.6 | 568.4 |
| f𝄪 | 7 | 94.2 | 555.8 |
| g | 8 | 106.5 | 543.5 |
| a♭♭ | 9 | 118.5 | 531.5 |
| g♯ | 10 | 130.2 | 519.8 |
| a♭ | 11 | 141.7 | 508.3 |
| g𝄪 | 12 | 153.0 | 497.0 |
| a | 13 | 164.0 | 486.0 |
| b♭♭ | 14 | 174.7 | 475.3 |
| a♯ | 15 | 185.2 | 464.8 |
| b♭ | 16 | 195.5 | 454.5 |
| a𝄪 | 17 | 205.5 | 444.5 |
| b | 18 | 215.4 | 434.6 |
| c♭ | 19 | 225.0 | 425.0 |
| b♯ | 20 | 234.4 | 415.6 |
| c | 21 | 243.6 | 406.4 |
| d♭♭ | 22 | 252.6 | 397.4 |
| c♯ | 23 | 261.3 | 388.7 |
| d♭ | 24 | 269.9 | 380.1 |
| c𝄪 | 25 | 278.3 | 371.7 |
| d | 26 | 286.6 | 363.4 |
| e♭♭ | 27 | 294.6 | 355.4 |
| d♯ | 28 | 302.5 | 347.5 |
| e♭ | 29 | 310.1 | 339.9 |
| d𝄪 | 30 | 317.7 | 332.3 |
| e | 31 | 325.0 | 325.0 |
| f♭ | 32 | 332.2 | 317.8 |
| e♯ | 33 | 339.2 | 310.8 |
| f | 34 | 346.1 | 303.9 |
| g♭♭ | 35 | 352.8 | 297.2 |
| f♯ | 36 | 359.4 | 290.6 |
| g♭ | 37 | 365.8 | 284.2 |
| f𝄪 | 38 | 372.1 | 277.9 |
| g | 39 | 378.2 | 271.8 |

## 34-TONE SYSTEM

| Name E's | Fret No. | Distance from Nut | Distance from Bridge |
|---|---|---|---|
| e | 0 | 0.0 | 650.0 |
| f𝄳 | 1 | 13.1 | 636.9 |
| f | 2 | 26.0 | 624.0 |
| g♭𝄳 | 3 | 38.6 | 611.4 |
| g♭ | 4 | 50.9 | 599.1 |
| f♯𝄳 | 5 | 36.0 | 587.0 |
| f♯ | 6 | 74.8 | 575.2 |
| g𝄳 | 7 | 86.4 | 563.6 |
| g | 8 | 97.8 | 552.2 |
| a♭𝄳 | 9 | 109.0 | 541.0 |
| a♭ | 10 | 119.9 | 530.1 |
| g♯𝄳 | 11 | 130.6 | 519.4 |
| g♯ | 12 | 141.1 | 508.9 |
| a𝄳 | 13 | 151.3 | 498.7 |
| a | 14 | 161.4 | 488.6 |
| b♭𝄳 | 15 | 171.3 | 478.7 |
| b♭ | 16 | 180.9 | 469.1 |
| a♯𝄳 | 17 | 190.4 | 459.6 |
| a♯ | 18 | 199.7 | 450.3 |
| b𝄳 | 19 | 208.7 | 441.3 |
| b | 20 | 217.6 | 432.4 |
| c𝄳 | 21 | 226.4 | 423.6 |
| c | 22 | 234.9 | 415.1 |
| d♭𝄳 | 23 | 243.3 | 406.7 |
| d♭ | 24 | 251.5 | 398.5 |
| c♯𝄳 | 25 | 259.5 | 390.5 |
| c♯ | 26 | 267.4 | 382.6 |
| d𝄳 | 27 | 275.1 | 374.9 |
| d | 28 | 282.7 | 367.3 |
| e♭𝄳 | 29 | 290.1 | 359.9 |
| e♭ | 30 | 297.4 | 352.6 |
| d♯𝄳 | 31 | 304.5 | 345.5 |
| d♯ | 32 | 311.5 | 338.5 |
| e𝄳 | 33 | 318.3 | 331.7 |
| e | 34 | 325.0 | 325.0 |
| f𝄳 | 35 | 331.5 | 318.5 |
| f | 36 | 338.0 | 312.0 |
| g♭𝄳 | 37 | 344.3 | 305.7 |
| g♭ | 38 | 350.4 | 299.6 |
| f♯𝄳 | 39 | 356.5 | 293.5 |
| f♯ | 40 | 362.4 | 287.6 |
| g𝄳 | 41 | 368.2 | 281.8 |
| g | 42 | 373.9 | 276.1 |

While the fretting tables on the preceding pages have been given to a precision of 0.1mm (1/254 of an inch), one should not expect any such accuracy on a real fretted instrument! ½ mm would be doing pretty well, so no point trying for the unattainable ideal. Life is too short, and besides, there are so many sources of pitch-deviation on a guitar or the like that they will mask fretting errors.

Mainly, the extra decimal place permits one to carry out further calculations if that should be necessary: extending the frets a few notes further, converting to hundredths of an inch if you hate millimeters that much, extrapolating downward for a psaltery or harpsichord, etc.

If you do the work yourself, do not get too discouraged if you make a few mistakes at first. The most you can lose is a fingerboard. If you are timid, do fret-charts first.

If you have someone else do the work for you, precision is really going to *cost*, and wasted precision is worse than extravagant—it's a kind of financial crime. I want you to enjoy exploring several tuning-systems, and if you demand more accuracy than can be heard, just *one* non-twelvular guitar is going to be beyond your means.

In a later issue I will take up the question of how accurately the average commercial instrument is fretted, but my guess is that nobody is going to win any Precision Awards.

Actually, this doesn't matter too much. If fretted instruments were extremely precise, some people would consider them lifeless and boring. They might not be so popular as they now are. The widespread practice of tone-bending, and the expressive vibrato of many players, tend to support this notion.

We shouldn't take the same psychological attitude toward guitar-fretting that we might take toward organ-tuning or the manufacture of tuning-forks or electronic measuring devices.

Fretted instruments obviously have an upper limit—and this indeed is one reason for introducing the term *xenharmonic* rather than applying the word *microtonal* to such affairs as a 17-tone guitar. Since we already have synthesizers, electronic organs, and means of programming computers to perform minutiae beyond the ability of the ear to hear them, it is neither necessary nor advisable to force the fretted instruments beyond their proper territory.

For my sake, if not for yours, don't give our opponents legitimate cause for ridicule!

And please don't make the mistake I made about 12 years ago: I went immediately to the 31-tone guitar, with the result that I could not play it at an acceptably fast tempo—until, quite some time later, I developed my technique on 19- and 22-tone guitars. Then, and *only* then, could I play the 31-tone instrument fast enough to impress anyone with the very real merits of the 31-tone system, such as its serene mood.

It should now be obvious enough how to start in re-fretting or fretting a new fingerboard: Begin with either the 19- or 22-tone system, and the initial choice will be determined by how the *mood* of that system fits *your personality*. Some people are wildly enthusiastic about 19-tone at first hearing; others simply can't stand it, and may be lost to xenharmonics unless the other systems are demonstrated to them.

After you can play fluently on one or another of these guitars, go on to 31-tone, for you will almost certainly be captivated by its restful harmoniousness. Workshop-wise, you are going to be tempted by the ease of the quartertone (24) conversion job, which leaves *all* the 12-tone frets in place; but I beg you, put this one off till you have heard and played in the systems which free you from the over-symmetrical 12-tone squirrelcage.

Tables for such important systems as 36 (Hába's and Carrillo's sixth-tones) and 41, have not been given in this issue simply because 650-mm strings are too short for them—the frets would be too close together!

Indeed, one of the reasons I would rather you wait a while before doing 31-tone fretting, is that with longer strings for which I will give tables in later issues, you can take the frets up to higher notes, and the most-used frets will be better-spaced to accommodate your fingers.

Shorter-string-length tables will also be furnished for 19-tone mandolins, charts for steel guitars (usually 570mm) and tenor banjo if anybody still has one.

The usual E A D G B E tuning is satisfactory for 19-, 24-, and 31-tone guitars, but the 22- and 34-tone instruments have two possible tunings, depending on whether a harmonious major third is or is not more important to you than having the two E-strings "together".

The 17-tone guitar is better tuned in fourths throughout: E A D G C F, since the major third of that scale is a dissonance, and chords-in-fourths are quite good. When you are ready for systems like 13, 16, 18, or 23 you probably will want to invent your own fourthless tunings for them.

# THE HOBNAILED NEWEL POST

is the fourth in a series of new instruments of the steel-guitar type, designed and built by Ivor Darreg, to carry this idea as far as is feasible, and to fit the steel guitar for more serious and highly-structured types of music than has been its lot in the past.

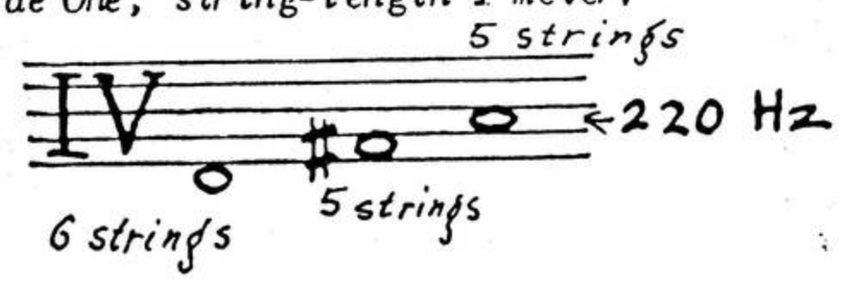
Details of the first three instruments were published in *Xenharmonic Bulletin No. 5*, q.v. To summarize: Two 4-sided maple beams, one with 41 strings and the other with 45, tuned to different just chords.

One very long two-sided instrument with 28 strings, 14 on each side, to bring this timbre and technique down to the contrabass register— this instrument has been named the *Kosmolyra* as suggested by Ervin Wilson.

All three of these instruments, as well as the Hobnailed Newel Post now to be described, have just been fitted with magnetic pickups for amplification, and have provision for other types of pickups to be attached.

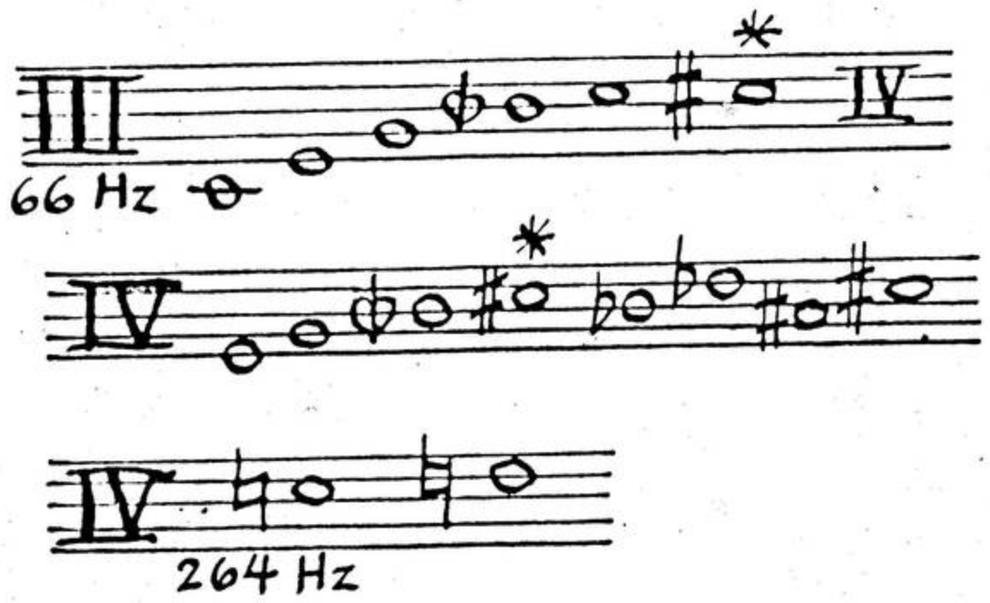
The Hobnailed Newel Post looks like just that, when stood erect on either of the squarish end-pieces. It has 64 strings, 16 on each of its 4 sides, and at present is tuned to the following chords in just intonation:

*Side One, string-length 1 meter:*




*(I have converted, for most of my future staff notation, to Augusto Novaro's clef-substitutes: IV is one octave lower than the treble clef, and III is two octaves lower, and so on.)*

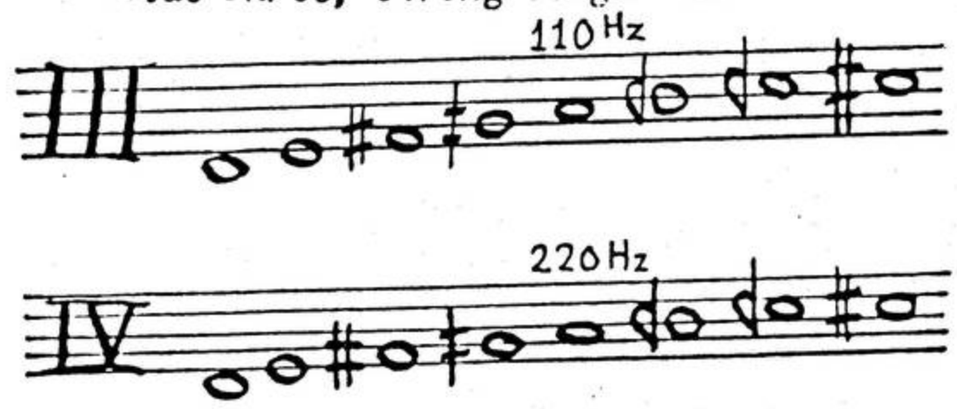
*Side Two, string-length 800 mm:*




The C-sharps with asterisks * bear the ratio 17:16 to their preceding C-naturals; the last C-sharp is part of a chain of minor thirds of ratios 5:6. (After Alexander Ellis.)

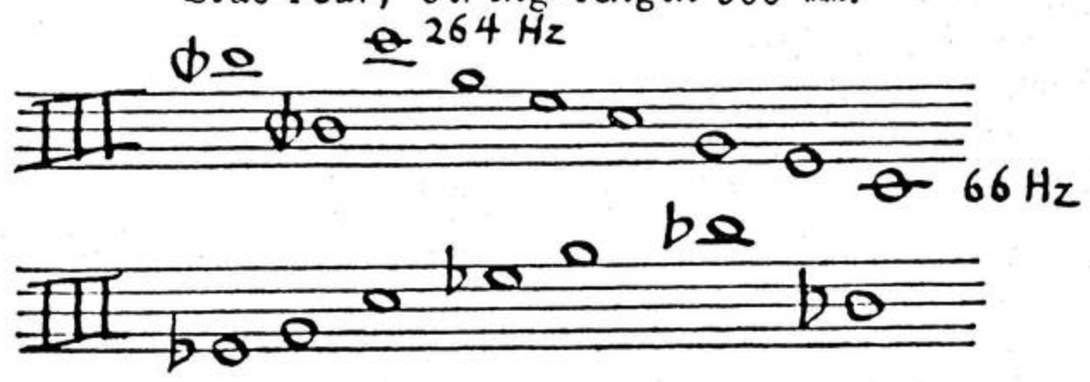
Of course one cannot expect such a complicated tuning of a stringed instrument to be highly accurate nor to stay in tune very long, but the shimmering effect of the different versions of the diminished seventh all sounding at once is really thrilling!

*Side Three, string-length 750 mm :*




That is to say, Side Three is tuned to 2 octaves of a harmonic series 8 through 15.

*Side Four, string-length 900 mm:*




The principle on this side is to have major and minor chords with the lowest note in the middle, and to put suitable sevenths for each, in octaves, at the sides so that they may be included or excluded at will, or used to play a melody in octaves. (7:4 & 9:5)

As with the other instruments, these chords or chosen portions of them may be played at any pitch whatever for 2½ octaves or more upward. On all four instruments, the harmonics can be elicited with telling effect, and the sympathetic vibrations of the strings on other sides of the instrument contribute to the total result.

The instrument may be laid on a table or the floor, or supported by a stand, and three of its four sides are accessible at any one time, simply giving it a quarter-turn to go to another side.

Dimensions of the Hobnailed Newel Post are: Redwood beam, 101 mm (nearly 4 in.) square cross-section; total height standing erect, 1315 mm (4 ft. 3¾ in); end-pieces, 270 x 305 mm (10¾ x 12 in.); but these end-pieces may be changed later.

Exact dimensions are not too important, anyhow; those of the 4 instruments in the group were dictated by materials on hand and suitable spacings and lengths of strings.

These instruments are not committed to just intonation nor to the tunings given above or in *Xenharmonic Bulletin No. 5;* they can be tuned to or play in any scale whatsoever, just as the violin family can.