Ξενάρμονία ιβ'

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NON-TWELVE-TONE GOES HOLLYWOOD

Since the 1920's, the Hollywood Bowl, a natural amphitheater nestled against the Hollywood Hills, has been world-famous for conventional orchestra concerts and performances by noted entertainers and groups. All down those years, it has not been thought of in connection with experimental music or unconventional instruments.

Until now! The new Hollywood Bowl Museum, in Spring 1992, opened an exhibit known as NEW SOUNDS IN NEW SHAPES, featuring eleven musical-instrument designers, and in the spirit of the late Harry Partch, whose Quadrangularis Reversum and Eucal Blossom dominate the exhibition by their sheer size and commanding aspect, break from the traditions of European 18th and 19th-century orchestral and keyboard instruments, and to all intents and purposes, form part of the Contemporary Sound-Sculpture Movement, which unites visual with auditory art.

Nor is this all: It so happens that practically every one of the instruments that crowd this gallery are outside the 12-tone equal-temperament system that has held ordinary music in bondage for more than two centuries.

Three instruments from Ivor Darreg's Megalyra Group, near the entrance to the gallery, all bear fret-lines for just intervals. A

(Continued on Page 14)

HIGHER-NUMBER SYSTEMS:

48 50 53

It is now time to consider a group of tuning-systems which reach a realistic stopping-place for any live performances in the said systems. With the 31, 34, and 36 systems discussed in a previous issue (No. 9), we already reached the practical limit for guitars or other fretted instruments, so far as performing at a fast enough tempo to keep listeners interested is concerned. Among theorists and writers on theory of tuning, there has been a shameful neglect of Listeners. It is almost as though mathematics was more important than any consideration for the limitations of human hearing and listening environments.

Under today's conditions, where any listeners for experimental music or something off the wornout Beaten Track is involved, it is high time we got more realistic. In 1992, you must have regard for the conditions under which the majority of your potential listeners are going to hear your compositions: from a copy-cassette over a cassette-player in their car under terribly high noise level, or at home with constant interruptions such as phone ringing or doorbells going off or something in the other room of the apartment happening that must be taken care of at once.

Oh sure: it's nice to think of a performance by somebody who had lots of time to practice, doing our thing at a college auditorium or some special concert location, but 99% of the time that is just not going to happen. If you demand such conditions you will NEVER get heard so long as you live. Please heed me! I am 75 years old and have composed for at least 61 of those years and I ought to know.

HIGHER-NUMBERED SYSTEMS
(continued from first page)

Hard enough to get performances in 19 or 22 tones per octave or just intonation carried out to 16 or more notes per octave.

But step up to the systems having 48, 50, or 53 tones per octave, and many of the persons you hoped might be your listeners, will beg off with excuses, such as thinking they might not have the ability to hear such tiny differences in pitch. Is that little shift there, for real, or did I just imagine it?

The systems 48, 50, and 53 have different kinds of errors. They appeal to quite different possible fields of application or users' interest. The motives for researching and calculating them are quite disparate: 48 can be considered a refinement or step beyond quarter-tones, something like our use of eighths and sixteenths of an inch; 50 is another member to add to the family of meantone tunings; 53 is a way of dealing with two kinds of tiny intervals called "commas" simultaneously by striking a happy medium between them and therefore the theorists have studied 53 as a usable imitation of just intonation.

The only reason for presenting them together in this issue is that we had to decide upon a logical place to end our series of discussions of microintervals. What is the largest number of tones-per-octave that a composer or arranger or harmony experimenter or performer can conveniently deal with under practical conditions?

Oh surely: we have discussed and will remark about finer subdivisions of the octave, but most of you want something you can use now, not having to wait forever. There has been too much hairsplitting speculation and too little hard-edged How To and almost no Help For Beginners. Most books that even mention non-12 rebuke and discourage and turn away any adventurous souls who are legitimately tired of the overdone clichés and wornout routines of twelve-tone harmony and the 12-tone atonal serialism. At last there are new ways to go that you can afford!

I have seen two 41-tone guitars and performing on them was definitely too slow and difficult. So by the time we reach 48 and above, special keyboards become about the only means for fast enough fluent enough live performance. Before I get any further into this, it is also necessary to remark that most advocates of higher-number systems will cheat: they will select a SUBSET of something like 53 or 60 or 65 or 72 (systems which have been discussed here and there in the literature).

With "friends" like that, who needs enemies? That is to say, overzealous advocates of new scales run a very real risk of handing the Opposition more than enough ammunition on a silver platter to give the Non-Twelve Cause a hopelessly bad name, and subjecting the rest of us in the field to withering scathing ridicule. After fifty-two years of tuning pianos and organs and harpsichords to ordinary 12-tone, and thus being able to examine and evaluate the actual tunings of 12 done by many other persons, the amount of deviation from standard 12-tone-equal is amazing. Guitar frets are not set to the proper places to get exact 12 either. Even when it is as accurate as one has a right to expect, strings are not perfect and guitarists don't tune that accurately.

Now with the arrival of advanced electronic keyboards, tuning to standard 12-equal is usually something embodied in a "chip" installed at the factory which does not exactly have an equal set of twelve pitch-classes per octave. Thus we face TEMPERED TEMPERAMENTS! There are quite a number of ways to get approximations to equal or unequal temperaments and to just intervals.

Using computers to produce music, directly or indirectly, also involves this sort of approximation of the standard as well as the new tunings. Many of these approximations are acceptable for 12 and up to say 31. But at this Stage of the Game that our Series on tunings has just reached, these inevitable approximations are going to matter. What is intended to be 53-tone equal temperament is going to get "disequalized" and it will no longer be possible for an experimenter to check the validity of a new instrument's or a computer's tuning to a higher-number system or to just intonation by listening for the correct amount of beating or the (just) absence of beats.

That is not the end of the story either: At thirty-one and beyond, the inevitable variations in recording and playback speeds will become noticeable.

Our potential audience for live events involving special instruments beyond 31 is very small, especially for those of us who do not live in major cultural centers.
Why doesn't any writer on contemporary composition ever say anything about the COST of transporting special instruments to and from a live venue? What am I supposed to wait for —40 years after my death? Be reasonable!
So nearly all of us are going to have to be heard through copies of recordings we make ourselves. We can dream about CD's and DAT and other things just around the corner, but most of those who entertain such dreams forget that a one-shot isn't going to give us enough publicity to matter: it takes dozens or better a hundred or more compositions and variations on them to get enough feedback from those in our networks and new acquaintances that we seek out. This is not a situation of the pop star or would-be star gambling on one professional recording until something is a hit bringing returns. This is a case of having to help set up special non-twelve communication channels, and thus avoiding the corrosive disappointment that will hit those who try to impose new efforts upon the mass market.

The cost per copy has to be brought down enough so that one does not have to get embarrassed by constantly appealing for funds.

Since most of us have to deal through affordable recordings, this abovementioned problem of wow and flutter, inevitable variations in recording and copying and playback speeds (i.e. the shortcomings of the listeners' playback equipment,no matter how good your own audio equipment system might be) sets a limit to how well you can get heard through scales having many notes per octave, or just arrays where the Absence Of Beats is Everything.

Those who wish to demonstrate temperaments like 77 or 99 or 118 or 171, will have to do it live in some kind of laboratory where there is special equipment and enough quiet to make it worth the trouble and anxiety and expense. Therefore and accordingly I choose to end this particular series of articles on tuning-systems with this 48-50-53 deal.

It just is too cruel to composers to give them too many false hopes. Too many Professional Mean Old Nasties out there to make us miserable and feel futile and sick inside.

That, indeed, was the motivational basis for our pamphlet WHERE DO I START? which hopes to end the average Newcomer's indecision about the first attempt to escape Twelve.

It sets out with a description of how to pick a lower-numbered system and get off the dime, so to speak.

All back issues of Xenharmonic Bulletin and a considerable list of other publications are still available! No out-of-print for us.

In the many years B.C. (before computers, and therefore before the many kinds of electronic keyboards and sequencers and automatic playing devices today), some newcomer might read Helmholtz/Ellis and see so much effort and time devoted to just intonation, and to the 53 system, that one would start dreaming of extremely cumbersome apparatus, which was all that was possible for escaping 12-equal 120 years ago.... the reader's initial enthusiasm would soon meet harsh invective and putdowns from all and sundry, and the Neophyte would end up bitter, cynical, and disillusioned, pounding out either pop clichés or the dead souvenirs of the dead composers of 19th-century Central Europe; or some University students would be dragged by their professors into the sterile closed-in world of twelve-tone Serialism.
More industrious initiates might actually start making inquiries around the USA for supplies and parts to build some kind of instrument as hinted at in "Sensations of Tone"'s Appendix by Ellis, and find every door slammed in their face, since most of the apparatus written about has been superseded 100 or 85 years ago or even the successor apparatus has in turn been superseded. Now with computer software, in many cases, the higher-number systems can be reduced to computer programming or even to some add-on special software item. No need to buy some big barn out on a farm somewhere anymore.

Some computers and some synthesizers are based on a system of some large number of small pitch-steps that may be enough to pick a 12--tone or even 24-tone subset from, but which give noticeably off-pitches when one tries to set up 41 or 53 or more with them.

Caveat Emptor, as usual.

Very well: getting down to the family of systems, equal temperaments having 48, 50, 53, notes per octave.

There are a few synthesizers capable of 48. Julián Carrillo of Mexico starting in 1895 conceived of splitting the "whole step" we all are familiar with, one-sixth of an octave, into various equal parts, such as third-tones, quartertones, fifth-tones, and all the way up to sixteenth-tones, or 96 per octave. Eventually Carrillo had a set of pianos for all his divisions of the whole-step made in Bavaria and they had regular keyboards, but the finer the subdivisions, the shorter the total compass became, so that the last two pianos played only one octave!

This system of Carrillo's unfortunately misses such fruitful divisions of the octave as 19, 31, 41, 43, 53, 65, 77, and 99, but we could say the same about other experimenters who also shared this notion that the 1/6-octave "whole tone" was sacrosanct and any division of the octave that did not have those sixths was suspect. Carrillo in certain articles kept mentioning the "Musician's Tone" and had no respect for the just major seconds of ratio 8:9 or 9:10. One article entitled LAS 53 COMILLAS DE HELMHOLTZ was especially polemic. So he wouldn't have cared for the 53-tone system or certain unequal systems near it. As proved by his having a 54-tone piano made!

Still we must be fair: he had a piano for 48 and did a little composing in 48, and that piano for 54 which he may have used, but all we hear of it is as part of a Tape Demo by Dolores Carrillo of which a copy was forwarded to me some years ago.

Earlier this century, Leopold Stokowski and some others introduced some of Carrillo's music to the public, and a few recordings were made.

Now that certain synthesizers we already mentioned can do 48, there has been some more experimenting.

Nikolai Kulbin way back when, in a paper called FREE MUSIC, proposed setting up musical glasses in eighth-tones, 48.
48 does not smooth out major thirds enough to claim improved harmony for it over 12 and 24. It belongs here only because several experimenters have tried it. Beyond the point where fretting it on a guitar would be worthwhile.

Joseph Yasser's book THEORY OF EVOLVING TONALITY took a different view of how to expand into new tuning-systems: he constructed a complicated argument alleging that music had tried a 5-tone equal temperament first, so that if we were to construct a Fibonacci Series beginning with 5 equally-spaced tones per octave (he doesn't say WHY 5 should be the first term, except that he does acknowledge the widespread use of something close to 5 equal in certain distant places, and he calls the 5-tone system the Sub-Infra-Diatonic scale and shows a notation of 2 principal and 3 auxiliary degrees, and then he says, continue as follows: 5+2=7; 7+5=12, our standard tuning; and now, he claims, the next evolutionary step is 12+7=19—i.e. twelve main white-key notes and seven chromatics or auxiliary notes (frankly, I use 19 a lot and it never sounds like that to me); 19+12=31; then 31+19=50; and 50+31=81 and so on but anything beyond 19 is for an extremely remote future. Ironically enough, the last several years' activity in 31 equals or surpasses that in 19. Why did Yasser ignore 22? He gives 24 or quartertones all the razzing and complaint he could muster about how dreadful it was to propose 12+12=24 rather than 12+7=19. He even went on for a space about *how* dreadful it would have been if the 7-tone musicians of yore had gone 7+7=14 instead of 7+5=12 to fit his series! He decried 14 so much that I made a set of metal bars and fretted a guitar to 14 and they work, on the principle that if Yasser could get so mad against it, 14 must have something in it! And it does.*
Be that as it may, the theorist and musician Tillman Schafer, who once lived here in San Diego, took up Yasser's theories and tried out 19 and did a little experimenting to find out how 31 and 50 might sound, and liked certain chords he was able to produce in 50-tone.
50 is a member of the Meantone Family, indeed it can be taken as a compromise between 19 and 31 with intermediate harmonic properties. One other property is that half of 50, =25, has a very rough fifth but a tolerable major third, so that to get an acceptable fifth one must double the number of tones to 50, and then there will be two circles of major thirds which never meet, but one circle of meantone-type fifths.

With today's electronic instruments, or certain of them, one can experiment with fifty without breaking the bank. Of course one's motive would be new harmonic properties and the 5- & 10-tone scales it contains for melodic experimentation, rather than Yasser's arithmetical arguments.

Now we get to 53, proposed some 300 years ago by the mathematician Nicolas Mercator. Can you imagine the computational labors of those days? what a chore it would be to extract the 53rd root of 2 and figure out its powers?

*see pages 19-20-21!

No wonder its perfect fifths remained unclaimed and unexploited for quite a while. The error of its fifth, a mere -0.068 of a cent or 1/17647 of an octave, nobody would ever hear, and its major third with an error of only 1.4 cents would bother only the nastiest of carping Nitpickers. In the 19th century, some keyboards were designed for it and instruments made by Bosanquet and by White in this country. 53-tone still remained an unrealizable Dream for most people until very recently, because of the difficulty of tuning it, and the further difficulty of devising acoustic instruments that would have agreeable tone-qualities while staying in tune to such exacting standards long enough to make the expense and trouble worthwhile. Sour grapes again! dozens of authors and experts have vented their spleens and become incredibly irascible and polemic about this system, and we can guarantee that few of them if any ever heard music performed in it. The Universal Musical Whipping-Boy, in fact. No remark was too cutting or nasty. Larry Hanson of the Los Angeles area pursued the documents and data about 53-tone and finally collected important papers and illustrations, then with the help of Ervin Wilson and others, got 53-tone-system aluminum-tube sets made.

I was over sixty before I could hear 53.

Today, of course, it can be produced by some synthesizers and computers, so will henceforth be more accessible. Don't worry too much about the difficulty of performing it on a necessarily complex keyboard: the Sequencer or automatic device for performing on electronic instruments will relieve us of the problem of playing-technique for such a complex system.

53 is so close to just intonation or untempered or pure tuning that arguing about it is a waste of time—this is why I went to such lengths above about the average listener's problems these days—everybody is so BUSY and lives amidst so much NOISE LEVEL and gets INTERRUPTED so often every day, that only a very favored few will have such perfect listening conditions as to make superfine distinctions of the kind that separate 53-tone temperament from real just intonation, and I cannot repeat too often that recording and record-copying methods are going to introduce inevitable deviations in pitch.

I am shocked at this paradox, that perfectionists spend so much time ensuring that the rest of us will not get any fun out of life, and that those who say they are seeking perfect smooth harmonies of Just Intonation are among the most angry and exasperating of mortals.

What we can do today with new tunings and the instruments to play and hear them is so much better than the restlessness and roughness of Ordinary Twelve, that they should enjoy making new systems available to others, rather than looking for opportunities to make experimenters dissatisfied with their current choices.

It's no longer necessary to make commitment to just one new scale and have to defend this against any and all other tunings because of the cost in both money and time that hitherto resulted from changing systems. Today, it can be a matter of a minute or less.

Going from one tuning-system to another can now be as simple as changing fonts on a computer printer. * * * For the listener, it is even easier: our cassettes such as TEEN TUNES play one system right after the other, such as 13 through 19 tones/octave, and the ALL SYSTEMS GO recording in collaboration with Brian McLaren offers twenty-two scales, with no waiting at all. Little chance for one's memory to fade.

Several generations of students and readers have been deeply intimidated by the diagrams of special keyboards in such books as Ellis's Appendix to "Sensations of Tone" and they have given up hope when they realized how hard it might be to learn a number of keyboards.

With today's facilities available in several forms, it is not necessary to wait for the ideal keyboard—right here in this studio some 47 different scales have been mapped onto and played with a conventional keyboard! That excuse or alibi for not even starting has gone by the board, pun intended.

Generalized keyboards have been constructed some time ago from available switches and colored plastic key-covers available on the market. The Motorola Scalatron used by George Secor is an example from the sixties. Ervin Wilson created a whole library of keyboard designs some years back. Currently, Bill Wesley is working out novel keyboard arrays.

Time now to present some of the rationale behind the 53-tone equal temperament and certain of its variants. During the past 100 to 130 years since Helmholtz and others published technical papers, there wouldn't have been much point teasing the general reader of musical matters with comment on Theory of Tuning with relation to just intonation and meantone and complex tuning-systems, but now in the Computer Age, the frustration and agony should be gone.

Let us then discuss two kinds of Commas. If one tunes perfect beat-less fifths one after the other, say in the series C G D A E B F# C# G# D# A# E# B#, i.e. twelve fifths upwards from the conventional starting-point of C, of course alternating the fifths with fourths to stay within the same octave, one will arrive theoretically at a B# which is 23½¢ sharper than that starting-point C. This interval is called the Pythagorean Comma and is the failure of a 12-tone equal-temperament to result from using 12 perfectly beatless just fifths.

To obtain the standard 12-tone temperament, one lops off some two cents (hundredths of a conventional semitone, 1200 ¢ to the octave) or slightly less than one six-hundredth of an octave from each fifth, whereupon the Circle of fifths will close.

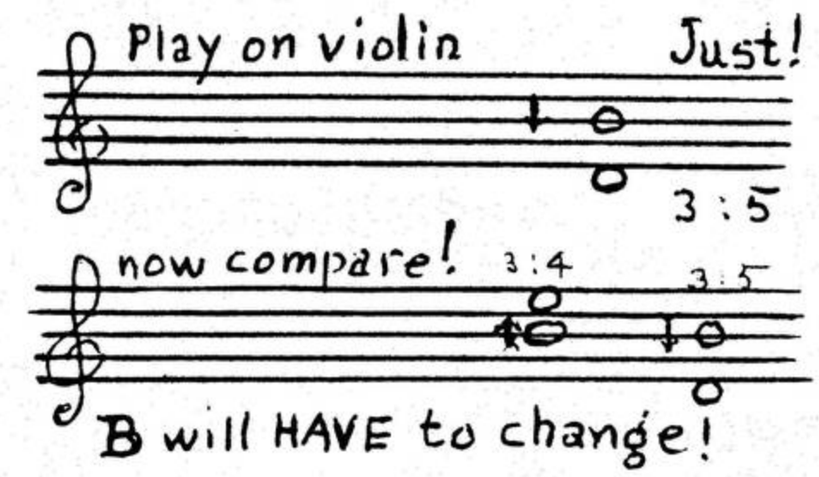
What piano and organ tuners actually do is of course not perfectly according to theory, but the average musician will never know, so there.

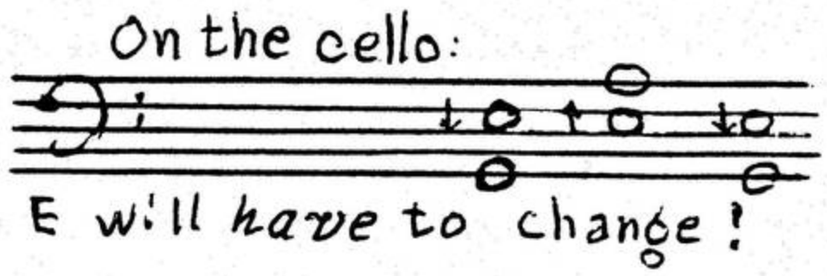
The other kind of comma is produced by tuning four fifths up: C G D A E, then taking a just major third, another kind of E, up from the same C. This comma is slightly smaller. It is known by various names such as Ptolemaic or Didymus or Syntonic, and now to make things more exasperating, the difference between the 21½¢ and 23½¢ commas was christened by Alexander John Ellis with the Greek name SKHISMA. That means "division" and there are kinds of experts out there who will fuss and grumble over this tiny interval and what it should be called. A skhisma is about 1/614 of an octave, audible only under aseptic laboratory conditions. OK, let's see if we can get rid of it and compromise the two kinds of commas. The 53-tone equal temperament does so! One fifty-third of an octave is 22.642 cents, a reasonable compromise comma. Hence the interest in 53-equal.

The smaller comma has the ratio 80:81 or 81/80 as Partch and his cronies write it. No matter, same ratio viewed from this or that angle. The Pythagorean comma that we discussed first has the ratio 524288:531441 or, again, as Partch would have written it, 531441/524288 same difference--who really cares?

The big figures because 12 successive fifths are involved; the other smaller comma involves fewer steps. There is a way, on a correctly-tuned violin, to experience this much more important Syntonic Comma: play D and B, using the middle strings; now play that B against the open E and note that that fourth will be badly out of tune. Or start the other way around, with a perfectly smooth fourth B E, and now sound the B with the open D string and note how rough and harsh the major sixth D B is. You will have to lower the B a trifle so small that you would have a hard time seeing the finger-movement, to get a smooth beatless just, major sixth. Since ordinary notation has no signs to put for notes a comma or more high or low, and there are no names for these different pitches, most writers on music ignore the Syntonic comma completely and hope it will go away. The Pythagorean Comma however, does have a conventional notation and naming-system, namely the difference between B# and C or G# and A-flat in Pythagorean tuning, which is the endless chain of absolutely perfect beat-less fifths (or fourths) which string players are taught to tune with, but which keyboard players are never told about.
Ellis in his famous Appendix to Helmholtz used that notation and naming for the Pythagorean larger comma and the subscript and superscript numerals for the Syntonic Comma.

But most theorists don't want to follow him; they'd rather keep quarrelling than ever settle anything.





Now getting down to reality and Brass Tacks, for any ordinary musical performance the Syntonic comma is a Nuisance. If you play in strict just intonation with perfect major thirds whose ratio is 4:5 and distinguish this from the sharp major third whose ratio is 64:81, you may find yourself one or two commas away from where you intended to be after some modulations. This might or might not matter depending on the music and the instruments involved. In the 53 temperament, this problem will exist, and in a number of other tunings that have some sort of a comma (e.g. 41 or 72). So, smooth and peaceful as 53 is, you may or may not want to compose and perform in it, and may or may not want to improve certain conventional existing music by doing it in 53.
The difficulty of performing with commas and remembering where to find them on a keyboard is easy enough to evade now: use a sequencer or other automatic playing system.

A comma off is clear enough to hear with sustained tones when the listener is in the same room, but when the 53-tone or just music goes through recording and copying and the listener's reproducing equipment, it will be partly or wholly concealed.
This is a severe test for a playing and playback system.

String quartets and choruses and a few other ensembles will find ways to blur the chords when a comma is going to cause trouble. Vibrato is an obvious way. Sometimes a small glide can be managed. Many common timbres contain enough noise to help blur the comma difficulty when this has to be done.
That is to say, use much the same kind of device that you would use to blur organ tones or disguise the beating of 12 or other equal temperament. Reverb. The Rock Groups' Fuzz.

Our set of systems, 48, 50, 53, with a nod to Carrillo's 54 mentioned above, will not be primarily melodic. The unit-interval will seldom be used in a melody, and two or three of the tiny units will be used instead. The bias is toward harmony. Dolores Carrillo's tape demonstrating pianos in successively smaller fractions of the whole-step, shows this clearly enough—the third-tone and quartertone pianos give out melodic steps distinctly, but by the seventh-tones (42) and eighth-tones, the ultrachromatic scale starts sounding like a CONTINUOUS glide—and when we get to 60 and 66 we might imagine an air-raid warning on Mars.

The piano hammer-blows are the only punctuation to encourage you at the end (90 & 96) to try to listen for successive steps. It's the modern Analog VS. Digital phenomenon in a new guise.

At the point we have been considering, 48, 50, 53, a one-unit movement of one note in a chord will still produce an audible harmonic effect. But the mood-difference that is so outstanding with 17, 18, 19, or 22, 23, 24, is very small. Good old Diminishing Returns. Ellis in his explanation of just intonation and 53's close imitation of it, proposed an alternative tuning-scheme: Suppose we insist on exact beatless fifths and major thirds, but cheated in just a few places in the Array of Fifths and Thirds (a portion of this theoretically infinite array is shown in Ellis's Duo-Denarium, which most people find so complicated that they ignore it.) Suppose that certain of the fifths shown in the Duodenarium chart were cheated-on just a little bit—2¢ or less than 1/600 of an octave taken off them as is done in tuning 12. It would only take a few such cheats to make everything come out even by the 53rd fifth and close a circle. There would still be commas, but most intervals would remain beatless and we would accomplish the same end as 53-equal does, but not have to temper every note.

Ellis's Unequally Just idea as he called it sounds like a nice neat way to Lose Your Temper, doesn't it? What might happen with many new synthesizers and computers and tone generator modules, however, might cloud the picture: they derive their pitches by computer-like manipulations, some by countdown, some by selection from a series of subharmonics, and inventors are still busy with many modes of Frequency Synthesizing, as this game is called.

The scheme which will be satisfactory for closely imitating 12 or even 22, might begin to show its seams and irregularities and deviations by the time one reaches 53.

In effect, this wipes out the difference between such things as strict-just, 53-equal, and Unequally Just just discussed.
You remember the fairy tale about the way they found out which little girl was the Real Princess and which one the impostress, by finding out which one could feel the pea stuck in between the eighth and the ninth mattress under each of them.

Something like that. Or precision hair-splitting of gnats' eyebrows.

...The ice-cream wagon just came down the street in front on its way to the grade school nearby, and the Doppler Effect of rising pitch with approaching and falling pitch with receding was more than a comma. So much for microtones.

This would be as good a place as any to tell about the third tape in the XENHARMONIC FRONTIER series, which presents new compositions in the scales 42 through 53. This cassette will continue to be available.

Before finishing this article, we had better mention the very thorny subject of microtonal notation which seems to be in a state of chaos these days. It's better not to get too involved with notation for new scales, now that we have so many new electronic resources for performing, using a sequencer, and recording immediately, and even editing what has been recorded—several varieties of computer software for that purpose already exist. It is so unrealistic to believe that anyone is going to learn new notations for scales like 48, 50, and 53, and play from any scores and parts that you might write. As recently as 1970, one would not have the equipment we have today, so people might still think in terms of getting an ensemble together, but frankly, who has the time today, to try reading a new notation in a scale like 48, 50, or 53?

Presumably, some will try a more or less conventional notation and expect the performer to know where to put the comma alterations in, or where to lower the minor sevenths to subminor sevenths, but even that is too much to expect when I haven't been able to get anything performed in a scale like 53 in my whole life.

For 48-tone, Julián Carrillo simply numbered all the tones from 0 through 47 and used those numbers to replace noteheads. He kept stems and beams and reduced the staff to one line, since now a staff-degree stood for a whole octave. Thus no accidentals like sharps or flats, and the numbers ran according to whatever multiple of six per octave, whatever fraction of the whole-step, he was dealing with at the time. I have never seen any notation for the 50 system, but why not use Carrillo's numbers? I understand that several notations for 53 have been invented; one deserves comment here, that was invented by Carrillo's Mexican contemporary, Augusto Novaro, who wrote his own book in Spanish, Sistema Natural de la Música. He devised a number of notations and keyboards, and for 53 his idea was: no sharps or flats. Take unmarked notes conventionally written as Pythagorean...to go one comma up, prefix a small figure 1 where a sharp or flat might go. For two commas up, a figure 2, and so on. A figure 4 or 5 would be one or another kind of sharp. To go down a comma, write a figure 1 with a closing parenthesis after it thus: 1) before the notehead where a flat might have gone. Two commas down, 2); so that a flat might be 3) or 4), for instance.

This idea appears to make sense. His examples of 53-tone notation in his book look neat and uncluttered.

8 commas make a small major second, corresponding to the just interval 9:10, while 9 commas make a large major second, corresponding to the just interval ratio 8:9.

After looking at some accidentals proposed by Easley Blackwood for scales 13 to 24, and the rival 31-tone notations in use, and several just notation accidental systems, I think Novaro almost wins. Hába didn't do bad for quartertones, but his twelfth-tone, (72) notation is quite hard to write and read.

Some people asked me if I would also discuss the 55-tone system along with 48, 50, and 53 in this issue. I decided not to, because on rechecking the data I have on that system, it doesn't seem to offer much promise and there are more harmonious systems that have fewer tones. No compositions in it so far as I know.

If somebody makes 55 work, it will be time enough then, after hearing it.
And how many of you are going to take up such temperaments as 44 49...56 57 . . . 110?

I don't think that's the sort of thing the majority of readers will want. For 300 years and more there has been all this theoretical writing with virtually no hope of hearing promising new scales and we have lots of lost time to make up for.

A rare book in the earlier 19th century by General Perronet Thompson telling of all his struggles in getting a pipe-organ with many tones per octave, of just intonation, getting it to stay in tune with temperature variations and other circumstances—it reads like a horror story and no wonder he was irascible. We ought to be exceedingly thankful that today's equipment has solved many of those problems, and there is no point in romanticizing about the Old Hard Way. Life is too short.

The peculiar 14-tone telephone-pushbutton scale is described on pp.23-24.

Elsewhere in this issue we will give comparisons of systems and various tables.

48-tone is on page 25; 50-tone is on page 26; 53-tone is on page 27.

Quest for Justice

The slide, steel, or Hawaiian guitar idea is now some 105 years old at last counting. For nearly all that time, steel guitars have been used for unsophisticated, simplified kinds of music. The standard tuning of a Hawaiian guitar had been an A-major chord on the usual six strings, so it could hardly appeal to the venturesome harmonic experimenters among us.

For a while around the 1940's, the instrument was almost eclipsed, and it could be seen in pawnshop windows when one walked down certain streets in any large city. As we moved into the sixties, there was somewhat of a revival of interest, with slide guitars coming out with 7 or 8 strings, then the so-called Country music took an interest in the Pedal Steel, with more strings and an apparatus to stretch or relax the strings for retuning to different chords. The mechanism underneath such an instrument reminded one of the gadgets on sewing-machines and the sprocket mechanisms on bicycles.

Naturally enough, pedal steels can be quite expensive, and require frequent attention. Was there any alternative?

Twenty years ago this set Ivor Darreg to thinking hard: for the slide-guitar principle had one capital merit: it almost compelled one to think about Just Intonation, the untempered, beatless scale which has been denied us for centuries due to the mechanical limitations of many musical instruments.

Fretting an ordinary guitar to a just or untempered scale runs into great practical difficulties, since the tiny comma interval appears; and when one attempts to modulate to other keys than the starting-point, either one must insert extra frets very close to the ordinary ones to take care of that tiny comma, about 1/56 octave, or very dissonant out-of-tune fourths and fifths will be heard, even within the ordinary major scale. Many of those enthusiastic at the beginning of a just-intonation venture, will suddenly grow cold and mighty disillusioned when they find this out.

Then they will tell everybody else how 'useless' just intonation is, and thus prevent other persons from progressing either!

One has to apologize to one's friends and colleagues, and many of the wouldbe exponents of Just Intonation adopt an air of Noble Religious Resignation as they pursue their Ideal and struggle against the limitations of an Imperfect Universe and the snide remarks of most everyone around them.

If you are new to the New Tunings you well may wonder why the people advocating un-tempered scales and special temperaments that afford better harmony than our familiar twelve, are so argumentative and critical—when one would quite logically think that those seeking the serene, unruffled, calm, beat-less, consonant, smooth harmoniousness of just or non-tempered tuning would themselves be calm, unruffled, serene, kind, and charitable to fellow musicians.

It is such a shock to find them otherwise. Few forms of polemic writing will be more savage and scornful, than the diatribes published against such advocates of just tuning as Alexander J. Ellis and Hermann Helmholtz in the last century, or the opponents of the late Harry Partch and his followers in this century.

Naturally, the victims of these attacks feel compelled to defend themselves, so the atmosphere of rancor and dissent grows.

Actual frets on a guitar limit the number of possible pitches, but the steel guitar has only painted LINES under the strings, and the board is no longer a fingerboard to which the strings are pressed behind the frets,

but merely indicaations of approximately where the steel slide ought to be moved to get this or that chord or single note at such-and-such a pitch. Any and all intermediate pitches Between The Lines will still be possible, or a wide vibrato, or a continuous glide.

Otherwise stated, the fretted guitar is DIGITAL while the steel guitar is ANALOG.

Whether this is officially published or not, the fret-lines on all slide guitars including Pedal Steels are calculated for the 12-tone equal temperament and supposedly the A-major or any other chord would be tuned in 12-tone-equal on these instruments. But: do so, and out of your amplifier will come a peculiar kind of distorted sound, caused by beats, and also by what the electronic engineer calls INTERMODULATION PRODUCTS—sidebands generated in most amplifiers and associated equipment when two tones are passed through a non-linear circuit element and react upon each other. In the case of the older Hawaiian guitar tuning, E A E A C♯ E, we have six, not just two, generating tones, and more intermodulation products than anybody wants to count.
"Modulation" to an engineer does NOT mean changing keys, but mutual interaction of two or more alternating currents to produce additional currents at other frequencies. The term for the corresponding phenomenon in the old acoustics books was "beat-tones" or "difference and summation tones"—now back in the Old Days when Ellis and Helmholtz did their Things, such additional pitches were faint and had to be listened for. Today, with nearly all music coming at us through loudspeakers and going through radios or recording media, these combinational tones become very loud and disturbing, making the contemporary sound environment radically different from anything in human history!

The piano evolved from Cristofori's day to the present in such a manner as to make its beats and difference--tones more bearable—piano tones always die away and thus the moment of sufficient intensity to hear a difference tone is a mere fraction of a second. But amplified and electronically-generated tones from today's instruments and recording media have difference-tones loud enough to curdle much of our music.

If the difference-tones are from just chords, they will be in tune with their generating tones; but if those tones are tempered, the difference-tones will be out of tune, and moreover they will not be members of either the tempered scale in question or of the just scale.

This is all subconscious, of course, since average listeners and even average musicians are not told about the the startling proliferation of difference tones. A public yearning for smoother, better harmony is still there, however unheeded and unawares.

This should also reveal to you why certain persons don't like electric guitars—these dissonant intemodulation products which nobody explains and which are produced in amplifiers and electronic apparatus.

On an acoustic guitar they will be very faint. However: the slide guitar cannot be quite as loud as a regular fretted guitar and it does not appear to sustain as long as an elecric steel guitar because its tones die down below the threshold of audibility more quickly, while the amplified tones are kept above that threshold much longer.

In today's noisy environment, that forces practically all slide-guitars to be electrically amplified.

In the minds of many musicians this gives rise to questions that never get answered, as set forth above.

Ivor Darreg has prepared a table of difference-tones which takes care of many just intervals and chords, and he has appended a table for certain chords in the 12-tone equal temperament showing the strange difference-tones that result, and how far they are from the 12-tone scale that generates them!

There are various realizations of just intonation: a restricted one that merely ensures smoothness of the major scale and perhaps the minor; another which uses intervals having the number seven in their ratios—in particular the harmonic or subminor seventh; then admitting the eleventh harmonic as Partch did; then still higher prime factors. Much argument among proponents as how many factors to admit to just intonation and build into instruments. Suffice it to say here that the Hobnailed Newel Post may have many possible tunings and that such tunings are entirely up to the user.

Information in acoustics and electronics books and university researches in psychoacoustics and much of the speculation in music theory in the far past, do not reach the average musician, let alone the average music listener.

The result of the difference-tones and the beats of tempered intervals heard on electric guitars is an instinctive desire to re-tune to get rid of them. This is automatically in the direction of just intonation.

But this will introduce discrepancies, since the frets or fret-lines are unjust—almost always the 12-tone equal temperament.

Mulling this over between 1972 and 1974, the concept emerged of EXPANDING THE SLIDE-GUITAR IDEA! And that, in several directions at once.

#1: Depth and Dignity: the instrument has been used for such trivia during the long time since its invention. Result: the Megalyra Contrabass of which there are now four, ranging in length from 1.8 meters (6 feet) to 2.5 meters (8 feet 2 inches).

Instead of one string to each pitch and forming a chord at such a low register of the bass or rather contrabass region, borrow ideas from pipe organs' pedals: have 12 to 16 strings, at different pitch-levels, to synthesize a compound tone as organs do. Usually this will be what organists call 16-foot, 8-foot, 5-1/3-foot, and 4-foot pitches, i.e. the first four harmonics of a 33 Hz Contra C, being the suboctave, the normal octave, the fifth above that, and the double-octave. A wide steel bar can be laid across all those strings and the compound effect, or just one string at a time, strummed on the instrument. Or one may take two wooden bars, one in each hand, and strike all strings and hold down, using the clavichord principle, which is less acoustically efficient, but pickups and ampification bring this up to an impressive loudness without any sliding.

A Megalyra Contrabass is strung on BOTH SIDES of the long board—that balances the tension, so the board does not warp.—Quite a number of would-be builders of similar instruments have found to their sorrow that a steel guitar made on a board that long will bend.

The other side of the Contrabass's board is strung with 12 to 15 strings, in groups of 4 or 5, for a chorus effect, and tuned to Contra C 33 Hz, Contra G 99 Hz, and Cello C 66 Hz, respectively, making it possible to play bass lines rapidly without having to move the slider too far between notes.

Double-bass players and some others might opt for a tuning in fourths such as B E A D or E A D G instead. This side will generally be used to supply a foundation to other instruments in an orchestra or ensemble.

#2: Smaller Instruments with Chords. The next idea was to have a few instruments of fairly normal guitar size

the name Cosmic Lyre was suggested for these by Ervin Wilson, well-known for his designs of instruments and evolving of tuning systems.

Going through a Greek Lexicon and some dictionaries, it was decided to give this name an international spelling as KOSMOLYRA. That works out in quite a number of languages. Then the big contrabasses could be called MEGALYRA (plural Megalyrai, or Megalyrae if you prefer Latin spelling to Greek) and then, obviously, all the instruments of this expanded steel-guitar sort can be referred to as the Megalyra Family or Group, and Megalyra, being so international, can be promoted as a trademark for them.

Three instruments of about average solidbody electric guitar size thus received the name Kosmolyrai and a Kosmolyra will have just chords on both, or even all four, of its sides with standard guitar strings, and common chords such as major, minor, seventh, ninth, added sixth, etc. will be tuned on them. Which chords is entirely up to the renter or user or purchaser. Most of the Kosmolyra instruments designed or built so far, have just chords on them. We'll get to the fret-line question in a moment.

#3: The Drones. Most of us are familiar with the music of India, and certain other cultures who use a drone bass of some kind. Then there is the famous Highland Bagpipe from Scotland, which has stubbornly refused to compromise with the piano's 12-tone equal temperament. Bagpipes are very loud and assertive, so you can't ignore a bagpipe with its non-twelve scale and its drones. The drones of India of course are very subdued in the background, but nearly always THERE.
So we rounded out the Megalyra Group with a smaller Drone which has the

Highland Bagpipe scale on it and duplicated for two octaves (so that the Practice Chanter pitch as well as the bagpipe pitch proper are there, this tuned on several unison strings), and then the Drone strings on the other side of its board.

Get a big rock-guitar amplifier and you can be just as loud as a bagpipe band, no fooling.

The other Drones are more oriented to the demure ideas of India—eight extremely thin strings in unison and four normal strings an octave lower, and on their other side a choice of several drone pitches, depending on what key you want the melody to be in at the time.

#4: The Hobnailed Newel Post. So called because of its shape. It has heavy endpieces on each end so it it looks like the newel post at the bottom or top of a stairway, when it is stood erect. It is strung on all sides of a 100-mm (about 4") square wooden beam. It can stand erect on either end, and it can be laid down anywhere on any of the four sides, according to which side or sides you wish to play on at the moment. 'Hobnailed' refers to the many tuning-pins at one end of a group of strings and the hitch-pins at the other end, on each side. The Hobnailed Newel Post can be made in two different models or designs for two different purposes:

One is an Arranger's or Composer's or Harmony Classroom model: Let's call it the Harmonic Laboratory Version. It will have up to 16 strings on each of the 4 sides—64 in all—which will nearly all be tuned to just intonation such as major, minor, neutral, harmonic series, inverted (submultiple) series, odd harmonics, chains of just intervals, major or minor ninths, high-order harmonics, whatever your pleasure or curiosity desires.
Another kind will be simplified with say 8 or 9 strings on a side, permitting wider spacing and ease in playing single notes, and this is for performers and simpler music and where ordinary steel guitars might be played.

The idea is to provide more strings in a smaller space, a more portable instrument despite the many strings; and have no need for any mechanism, because there will be no need to change tunings while playing, and thus no set-up and take-down problems as with the Pedal Steel.
Less space and expense as compared with that, or with the three- or four-neck steel guitars that have been tried.

Now we come to the COLOR CODING. The basic visual design of all fourteen Megalyra-Family instruments so far made has been one of Sound-Sculpture as well as Musical Instruments. Abstract design, totem-pole tradition, various art movements of this century, the mathematical basis of ratio and proportion, industrial and cultural uses of color.

This suggests applying color, putting it to work, giving it significance: in the present case, the Megalyra Instruments all bear at least two rows of lines on their boards. Instead of the conventional two octaves or so of black fret-lines all across the board, this conventional set of lines for the 12-tone equal temperament will only extend about one-third or two-fifths of the way across, and another set of colored fret-lines will extend one-third or two-fifths from the opposite side, with a small gap between the two rows of lines. This second colored group will generally be for 18 to 21 pitches of just intonation, and have black or white naturals, red sharps, and blue flats; the 12-tone row will be green lines unless the instrument itself is green, in which case it will have black lines.

Future Megalyrai that might have other tunings will of course have other colors.

At least two sets of fret-lines, because we do not want to repel and annoy newcomers to non-twelve by putting ONLY a new scale on these instruments--the user should be gently eased into just intonation or 19 per octave or some other non-twelve temperament, not FORCED to use the new lines before learning why they are there. The performer must be able to use existing knowledge, training, and practice to play familiar music from the beginning acquaintance with these instruments and moreover to use them in ordinary ensembles or orchestras or bands right away. Otherwise the instrument-maker will be wasting a lot of money and time populating attics and basements and trash-dumps with Orphans! It might be Noble to be a masochistic frustrated Inventor of instruments never seen or heard, but why this futile self-sacrifice? The extra scale or scales at no extra cost! These instruments could be duplicated in almost any normal cabinet shop or even home workshop with ORDINARY tools already there. Fourteen instruments already so made prove this beyond the shadow of a doubt. Others have copied them already, notably Buzz Kimball on the East Coast, and quite a number of persons have been able to play the instruments, so here is a way to just intonation and most of the new world of Xenharmonics that is easy enough.

NOTICE:

The design of the Megalyra Group of Instruments is not intended to be mass-produced in some impersonal huge factory, but rather is carefully fitted to the capabilities of custom-builders, who would make a few as and when ordered by musicians. Ivor Darreg has now passed seventy-five years of age and therefore must seek other persons in various parts of the country or abroad to take over the making of these instruments on a small scale.

The constraints of mass production would ruin the visual and audible design of Megalyra Family of Instruments to a point where it would be a tragedy and a travesty to let their names be on such denatured products.

INFORMATION on making instruments of the Megalyra family and similar affairs will often be available from Ivor Darreg and other sources. Fretting-tables for certain sizes are available on order, and in some cases referrals to other instrument experts can be made. Ivor Darreg has an array of informative leaflets on various phases of instrument-making.

Demonstration and lecture tapes are available, and several parties have videotaped and photographed these instruments.

NON-TWELVE-TONE GOES HOLLYWOOD

(continued from Page 1)

clavichord by Scott Hackleman has a special keyboard for the 19-tone scale. Ervin Wilson's Hebdomekontany has 70 pitches per octave and those are just, not conforming to the 12 pitch-classes of the piano keyboard.

This certainly is one of the first truly xenharmonic musical events of our time, and in addition to the visual exhibition of these instruments as colorful sculptural artifacts in that gallery, there have been concerts and also lectures including xenharmonic music.

For example, Jonathan Glasier, Bill Wesley, and Ivor Darreg performed there on 22 August 1992, and their instruments at the Museum were supplemented with Ivor Darreg's re-fretted guitars in 17, 19, 22, and 31-tone temperaments, and metallophones in 13- and 15-tone tunings, while just intonation was heard on the Hobnailed Newel Post and Megalyra Contrabass, and Jonathan Glasier improvised in several scales, and Bill Wesley used his Mbira instruments which have a Pythagorean array, and brought his new String Array with a unique arrangement of pitches.

So far this year, other musicians have performed at the Hollywood Bowl Museum on their instruments, again outside the 12-tone scale.

For a proper perspective on non--twelve-tone music, it is important to realize how long it has been neglected in practice, despite the centuries during which there have been so many writings on its mathematical theory.

This indeed is one reason why we selected a Greek-derived term, xenharmonics, and have used other Greek terms and lettering in this publication, to make the readers conscious of how long what we must call the Latent Period--over two thousand years!--between the ancient theorists and today's new possibility of realizing literally dozens of theoretical tuning-systems in sound and building them or programming them into instruments, has lasted.

One reviewer of the Museum exhibit, it is true, has pointed out that none of the newly-invented instruments in that show were electronic, but a number of them need amplification. What the reviewer did not realize was that the calculating of new scales as well as some of the work of designing such instruments either requires electronic calculators. or computers, or is greatly facilitated by using them.

The 17th-century physicist Huygens calculated the thirty-one-tone equal temperament and determined its close approximation to meantone tuning, but it had to wait till our day before it became convenient enough and affordable enough to start using it on practical instruments and Adriaan Fokker was able to initiate the 31-tone movement in the Netherlands which now has spread elsewhere. It still required the development of better electronic tuning-devices and synthesizers before it could be taken seriously enough and compositions in it could get heard by enough people.

Xenharmonic Bulletin No. 9 has further information on this subject.

Yes, it was possible "way back when" to calculate complicated scales and design instruments with pencil-and-paper, but the cost in TIME for the would-be instrument-maker was still prohibitive. Thus we must affirm that behind the acoustic instruments in the exhibit, stands a considerable amount of today's much more rapid mathematics.

I, for one, could never have produced twelve issues of XENHARMONIC BULLETIN, had it not been for other persons who employed modern means to calculate much of the information on which these issues have been based, so here is an excellent opportunity to thank them.

If you will, consider for a moment the enormous amount of other people's time that has been and will be saved by this "behind the scenes" calculating

and computing, making it possible instead of a sad futile resigned forlorn hope, for these designers to build their new instruments.

The Hollywood Bowl Museum is a joint project of the County of Los Angeles and the Los Angeles Philharmonic Association. Dr. Carol Merrill-Mirsky is the curator, and this exhibition has been scheduled to continue into 1993, possibly to Spring. Recently we were surprised to learn that attendance at this New Sounds in New Shapes exhibit had already reached the astounding figure of 23 060 persons by the end of August 1992! Surely that deserves an exclamation-point. This was way beyond anyone's expectations.

Jonathan Glasier, here at the San Diego end of Southern California, was instrumental in getting the late Harry Partch's two instruments out of storage at a local university and trucking them up to Hollywood over 130 miles north. Partch's instruments are difficult to handle, and we actually had to take the Eucal Blossom and Quadrangularis Reversum apart one morning on the grounds of San Diego State University, load them in a big van, and reassemble them in the Museum at the other end of the trip. Had Glasier not been quite familiar with Partch's work some time in the past, they might never have gotten back together right.

One of the fortunate effects of putting on the current exhibition is that it automatically expands the meaning of the term "Philharmonic" in a most desirable direction. Overcoming the narrow specialized meaning of that term in the Nineteenth Century as referring principally to symphony orchestras, for this exhibit "philharmonic" is returned to the expanded meaning of the original Greek, "lovers of music"; and this is a most fortunate emphasis on the INTERDISCIPLINARY attitude of the instrument-makers involved.

During the 19th century and most of the 20th, everything has been overspecialized and different kinds of artists have been kept apart from one another. In the Nineties, and we hope the 21st Century about to Dawn, NETWORKING is becoming a popular buzzword, and in order to have such an exhibit at all, today's communication facilities were essential!

Long-distance phone calls, letters, faxes, press releases, interviews, our near instant communications are largely responsible for the success of this event: remember that radically different kinds of people had to be kept continually apprised of one another's affairs to make this unique "first" work this well. Such co-ordination would have been unthinkable in the 19th century.

People from very distant countries have already been to the exhibit and it will be known about far and wide. We are giving it this much attention because, without deliberately intending to do so, it will cause an explosion of interest in xenharmonics, whether Partch's extended just intonation or the use of non-twelve-tone temperaments, or the constructing of of instruments which by their very nature and self-consistency, refuse to stay within the narrow constraints of the piano nor those of quantity mass production by impersonal soul-less factories with their rigid standards.

The Interdisciplinary nature of these instruments and of those who made them--present company included--is expressed in the way that they were designed according to visual as well as auditory principles from the very beginning of their planning. Certain more or less mathematical ideas of proportion while designing their visual aspects often react upon the acoustic considerations in the designs, such that one instinctively is driven away from the artificiality of the 12-tone-system instruments. Often as it did in Partch's and his followers' cases, this leads to some form of just intonation, but it need not.

As I have pointed out in other publications and lectures, there has been tremendous and radical progress in all

the visual arts, and it is high time music took this to heart and strove to catch up with them, instead of worshipping the instruments and spirit of Central Europe in the Nineteenth Century like a fanatical narrowminded religion. Today is a future way beond the dreams of the 1910 Futurists, and our music should reflect our future in which we live, move, and have our being, rather than the milieu of the 1830's or 1860's.

In the making of an instrument like those on show in Hollywood now, the builder must practice Interdiscipline within him/her/self. True, some members of the Sound Sculpture Movement merely add some kind of random sounds or Noise to their visual creations, but I have the feeling that everyone in this show acted more seriously than that, usually as musicians rather than just noisicians, and some kind of union of the auditory and visual aspects of their works resulted.

At this point I must sound a note of caution, as follows: Most readers of the XENHARMONIC BULLETINS will have read Harry Partch's book "Genesis of a Music" and inevitably may be thinking in terms of Partch's ideas, such as his building an orchestra for his own compositions, not for other composers of our time to use, but for his own personal music-system that he started from Scratch in opposition to the rigid formal 19th-century symphony orchestra and the 19th Century's Piano.

It well may be that when some people visit this Hollywood Bowl Museum exhibit and see two of Partch's creations dominating it by their sheer size and unique designs, they may leap to the notion that this current show is the Orchestra of the Future.

(There are Partch devotees who act like followers of some religion, and we must not take them so seriously.) Partch built an orchestra. But the ten other persons represented here are distinctly independent individuals, each going in different directions, and not submerging their personalities in some kind of Collective Uniform Structure!

What they do have in common is the creation of musical instruments that are also sculptures, rather than merely copying the instruments of bygone centuries and authoritarian rigidity of commercial musical-instrument manufacturers who are still trapped in the 1700's and 1800's somewhere.

Another thing most of the builders have in common is the Do-It-Yourself Movement of the last few years--taking instrument-making out of the soulless corporate empires who serve the conventional mass-market, and bringing instruments as well as music itself, BACK HOME to where they live, instead of expecting Industry and Corporate Decisions to do it all FOR them!

This is an extremely healthy phenomenon, and it expresses our American idea of Self-Reliance, and it is about time.

Furthermore it harks back to a period before the Industrial Revolution of the 1800's, when musical instruments were made in small shops or close to home, and music was made at home on such instruments, more than everyone being expected to travel to a big auditorium in some large city in order to hear performances. This new trend makes the instruments as well as the music played on them more personal after a couple of centuries of depersonalization and alienation that society has experienced. Furthermore, it ties in with some recent movements such as ecology and recycling--many materials suitable for making instruments are available in one's vicinity, discards from more pedestrian and mundane uses, or remnants from this or that project, that can now be saved from the dump or landfill or incinerator or other modern methods of destruction. (I published a leaflet on the Piano Reincarnation Project a while ago.)

While there are no electronic instruments in that Hollywood exhibition, please realize that the amount of surplus and discarded and recyclable electronic parts these days is amazingly large and varied, so there is ample scope for inventing new electronic musical instruments and accessories without having to depend exclusively on new manufactured equipment.

You should also remember that we now enjoy a number of ways of recording instruments and their music, which means that when you invent something or get an idea for an instrument or a new variation on an instrument-type, you DO NOT have to think in terms of Quantity Production for the Mass Market anymore! You do not have to kill off your new idea simply because no huge factory would consider making ten thousand of them. No, you make just one or two, and you probably can afford that; and then you and your friends can play these new instruments and record them and the recordings can be copied and sent far and wide, and you can get Feedback from other people out there and something new gets heard, instead of being stifled and suppressed and leaving you feeling sad and dejected.

Along with the Sound Sculptures in this exhibit is the new facility of video and the new possibility of copying videos of these new instruments, so that their forms and even colors can be experienced in many Elsewheres along with the new sounds. Indeed, it is quite probable that there would not have been enough co-operation and encouragement and energy available to have made this New Sounds In New Shapes event possible, were it not for video.

And what more appropriate place in the whole world to stage it, than Hollywood, which has been the capital of movies and talkies and then TV, growing up with the 20th Century's journey through Time.

The above facts mean that the Museum exhibit won't really be finished and over when it officially closes in 1993: there will be videos made, and people all over the planet will have the opportunity to see and hear it for quite some time to come. It will inspire sequels and similar events in other places--in fact there is talk and planning about this already.

Definitely an idea whose time has come, and in the right place to start it off.

We should point out that this is not just something to advance visual artists and instrument-builders: it also frees composers! When you do not have to put on the straitjacket of composing for the piano, or worse, on the piano exclusively, you are then free to explore non-twelve-tone, non-piano, tuning-systems and playing techniques, and now that you have recording means, you do not have to worry about notation for the new instruments you are creating and composing for. The new instrument, rather than the dim ghosts of the dead past, dictates how the instrument shall be played and what tuning-systems can be used, and what other instruments might go along with it.

Happiest note of all is that these eleven instrument-makers did not have to compete against each other. This is a pleasant movement together toward new horizons, not a competitive contest!

TAPE ARCHIVES

For some years now, Ivor Darreg has been recording most of his compositions on tape. It is unrealistic and impractical to expect other musicians to perform in a wide range of new scales and have to learn over a dozen new notations for such systems as 13, 14, 15, 22, 24, etc. and for just intonation. Enough other persons agree, so tapes have been exchanged back and forth till Ivor Darreg now has 414 cassettes and 250 reels besides the usual disk collection.

At that point now reached, and at advanced age, we have to think in terms of preserving this collection, so numerous copies have been made and sent out far and wide. Unless more people HEAR xenharmonic music, it does not really EXIST! For that matter, 60 years' worth of Darreg's and others' conventional compositions won't really exist either unless and until they are HEARD.

Archives must be established in different locations and must be kept ACCESSible to listeners, otherwise they are futile and stillborn.

1992 Performances

In Los Angeles (Eagle Rock) on 22 February 1992, Ivor Darreg gave a lecture/recital under the auspices of Art De Leon and Michael Stevens, who got a number of Darreg's instruments built for non-twelve-tone scales up there and back. Their plans came out perfectly, and the attentive audience made it a great success.

First event in Orange County: On 24 May 1992, Sabine Hahn and Edward Kneifel presented Ivor Darreg in a lecture/recital at San Juan Capistrano, where many of his special instruments were displayed and in addition, retrospective compositions and a demonstration of piano acoustics was given.

Prof. Ron Sherrod invited Ivor Darreg to a music class at Grossmont College east of San Diego on the 29th of July 1992 and the students' questions and comments were cogent and on the mark. This lecture/recital included refretted guitars in 17, 19, 31, 22, and some notations were explained.

Fourth event, already mentioned on Page 14, was held at the Hollywood Bowl Museum along with Jonathan Glasier and Bill Wesley. Duets were performed on 13-tone bars and 15-tone metal tubes built by Ivor Darreg. This lecture/recital on 22 August 1992 was part of a Saturday-afternoon series by exhibitors at the Museum.

The fifth event, which was on the 26th of December 1992, took place at the Better Worlde Galeria in the Mission Hills district of San Diego. The cello was featured at the beginning: the ancient Greek Enharmonic Genus was put through its paces, something which has been denied the ordinary musical world for over 2000 years. It provides a rationale for the use of quartertones, as well as suggesting other novel patterns available to us now that we have new instruments and new attitudes toward the materials of music. The Megalyra contrabass was given a chance under favorable circumstances. People were close enough to ask questions and find out about these modes of expression.

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Ervin Wilson

There were two of the Saturday afternoon programs at the Hollywood Bowl Museum where Ervin Wilson gave lecture/demonstrations. That on 8 August was called *Microtones and Polyhedrons*, at which he presented charts and models of tonal relations. On the 15th of August, he took part in a discussion called "Music in the Cracks" with some other microtonalists.

Ervin Wilson of Los Angeles, California has been active for the last thirty years and more, in promoting and using the various non-twelve-tone scales, including non-twelve-tone equal temperaments, and also various forms of extended just intonation which admit the prime factors 7, 11, 13, that lie beyond the usual 5-limit just systems.

In addition to drafting many charts and keyboard layouts for such scales, he has constructed a number of instruments and had metallophones made and more recently produced a series of multidimensional models which

project advanced tonal relations onto 3-D constructions.

His charts and tables have been of assistance to many persons in the xenharmonic movement.

New York

MICROTONALITY

Johnny Reinhard of New York City has produced a series of Microtonal Concerts for some years now, and a series for October into November 1992 was announced recently.

Most of the works performed are for conventional instruments.

A number of different tuning-systems have been used by the various performers, and interest in his concert series has steadily grown during the last decade. He has chosen the term 'American Festival of Microtonal Music' for these activities. Besides the series of concerts a very important set of publications under the title *PITCH* has appeared, including a Directory of Microtonalists, sets of fingering charts for producing microtones from wind instruments, lists of microtonal recordings on disc and tape, and a comprehensive bibliography of microtonality.

I'LL PLAY YOUR NUMBER

It is just about a century since the dial telephone was invented. Of course it took a little longer, say about the World War I period, for this to appear in the larger cities. Telephone operators would say "Number please" so that the customer would ask for a number, but when no person was there on the dial system to say anything, a substitute had to be found. That was the Dial Tone, a continuous humming or buzzing sound produced by a motor-generator or commutator/interrupter in the telephone exchange. Back in the 1920's, this sound was a rather rough E-flat in the third space of the Bass Staff. Later the pitch was lowered in many cities somewhere about B-semiflat below that original note. Today in this country, the dial tone is actually a dyad—a twin tone with A=440 or nearby as the upper hum, and the F at the bottom of the bass staff two octaves and a major third below that, the two tones arranged in such a way by the electronic apparatus that makes them, to roughen it up slightly. Why bother about all those details? Partly because we are looking at the beginnings of electrical and then electronic musical instruments! Necessity is the mother of Invention, or something like that.

Going back to our telephone operators, they used to say "The line is Busy"; but even before the abovementioned dial tone replaced "number please", the intermittent "Buzz Buzz Buzzity-buzz" of the Busy Signal became familiar back in the 1920's to even those persons who still had to deal with telephone operators. That busy sound was also located near E-flat in the middle of the bass staff, or it might have been slightly lower. (Page 23)

More recently it has been replaced by a new electronic sound composed of the B and D# approximately, third and fourth lines of the treble staff , with a more or less audible resultant tone in the bass, depending on where you live and your phone company.

This new busy-sound is thus a little more like present-day synthesizers.

We mustn't forget the Ringing Signal which started out in the old days as a kind of rattle, then was smoothed into a Whirr; and now with new electronic equipment, a certain amount of medium--pitch tone is added to the whirr.

Thus for some years these sounds have been in place. The dial still went clickety-click and sometimes this was loudly heard in the telephone receiver.

Later, the telephone engineers got busy with a new idea: The dial is mechanical. It's something like an egg-beater or the insides of an old alarm clock, or the ratchets on certain machinery. Necessarily, that made it somewhat slow. The equipment at the phone exchange that responded to the dialing was also slow, and if you tried to hurry the dial to make it return faster, you might get a lot of wrong numbers!

So they invented a whole new system of pushbuttons, and in the central exchange gradually started replacing the noisy electromechanical apparatus with new electronic equipment not too different from the insides of today's computers. You could almost say that today's telephone system is a giant computer.

Well, many of today's synthesizers and sequencers and samplers and portable keyboards are dedicated computers, or some kind of hybrid.

The Dial had ten digits on it: 1 through 9 and then 0 was really TEN clicks to express Zero, since Zero Clicks obviously would do Absolutely Nothing at the telephone exchange!

In certain countries or systems, one click means zero and two clicks mean 1.

The Pushbutton replacement for the dial actually has twelve digits, with symbols * and # added to the numbers proper. This allows for more functions in the future. Indeed, they are already beginning to use * and #.

Some companies have sixteen-button boards for more special signals. Now, instead of clicks, the pushbutton board is connected to an electronic circuit-board that generates two tones at a time: why not call them soprano and alto parts? Something like a synthetic flute and an imitation clarinet. Rather cheap and sleazy imitations, but remember, after all: this is a strictly Phoney Affair! See Page 23.

The new central office equipment can respond to these dyads of two tones at a time, soprano and alto, very fast. If you have a pushbutton phone, you already know you can get numbers on it much faster than the old dial system would let you use it.

Now we can come to the point. The clicks of older machinery done by the older dial system have just become a kind of musical effect produced by much the same method as those new portable electronic keyboards play tunes.

Could the electronic engineers and designers have picked out their favorite conventional musical scale and chosen this note or that to stand for such-and-such a numeral? You might have thought, for instance, that the 12-tone serialists' way of numbering pitch-classes so that 0 is C and 1 is C# and 2 is D and 3 is D# etc., might do? Why couldn't they have just taken a middle octave of twelve tones and gone C = 0, C# = 1, ... A = 9 and A# = * and B = # (the two new buttons they added)? No, that wouldn't quite have worked.

That's why we spent a little time up there about the dial tone and busy and ringing signals, and obviously the new number-sounds must not sound too much like them.

Another problem was that various common noises on the line and where the phone is must not trigger too many wrong numbers. So the designing of the set of number-tones was difficult. Much inventive skill had to be concentrated on avoiding false responses.

That is why all the foregoing begins to be relevant to Xenharmonics! They had to avoid the conventional musical scale of 12 tones/octave lest bits of conventional music heard by the telephone instrument accidentally "dial" too many numbers, and they had to avoid a lot of other pitches already standard in the phone system, lest other funny things happen at the other end of the wire. Single tones were not enough—thus a single tone will not cause or at least should not cause a wrong number. TWO tones would make things much more reliable.

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So, without any idea of what the musical consequences of their new system could be sometime, they accidentally invented a set of two-note chords in a strange, unheard-of scale, and thus produced some Xenharmonics. Ivor Darreg looked up the frequencies of the pushbutton system and consulted with John Chalmers and others, and between us we came up with approximations of these new standard phone pitches to musical tuning systems. A good fit is provided by a 14-tone equal temperament with a slightly stretched octave.

Very interesting, but again you may want to know, Why Bother?

---Because it is going to help us in the New Scale Music and Non-12-tone Movement, that's why! Do you realize that millions, yes, millions of ordinary people will be using pushbuttons to dial phone numbers for years to come, and without consciously knowing it, hear a slightly abnormal 14-tone scale that definitely is not the piano's 12? This will inevitably re-condition the Public Ear and thus make our xenharmonic music more acceptable and sooner accepted. All without arousing our enemies, so that when they find this out it will be very much too late to imprison us within 12 tones per octave anymore.

Quite a number of other new tone-signals and pitches have become familiar in recent years, so the above pushbutton system does not exist in a vacuum. Beepers, beep signals from answering machines, and the really strange sounds when fax and computer modems are overheard.

Broadcasting stations send out various new sounds that no previous generation of the public ever got to hear. We mention these because the above telephone sounds are included and get heard over radio stations along with the new special tones.

We ran into some more pertinent information just lately: before those tones for the modern pushbutton system were devised and put into use, there already was a system using two tones at a time to stand for phone numbers, but this earlier affair was not arranged to give dissonant intervals of what turns out to be the 14--tone equal temperament. This earlier affair was used mainly for certain long distance calls and other signals within a telephone exchange. It took its pairs of pitches from a Harmonic Series. That is to say, the frequencies happened to be odd harmonics of a bass note that we might call G-semisharp that we could put on the bottom line of the bass staff with ½ of a sharp before it. Very close to a quartertone above the G-string of the cello. Say 100 vibratiions per second.

Now that bass note was not used to indicate a number; we are just letting you know what would be the fundamental or Root of the Harmonic Series.

Like the late Harry Partch's scale, this was Extended Just Intonation. The harmonics used were: 7:9:11:13:15 :17. To express a number 0 through 9, PAIRS of tones were chosen, e.g. Harmonics 9 & 13 sounded together might stand for the digit 5.

Being harmonics, they were NOT tempered; they were just. Many music experts and musicians do not admit the 7th and higher harmonics to their harmonic system, but they do exist as components or partials of many well-respected qualities of musical tone, such as clarinet, oboe, violin, horn, etc. The idea of extended just intonation or harmonic series has been taken up by many contemporary experts on music, and forms a very important part of our field, Xenharmonics.

For the record, Partch used harmonics 7, 9, and 11; his only reason for not continuing with 13, 15, and 17 as above was simply the practical constraints of the instruments he built and the need to keep his system usable by the members of his ensemble.

It was many times more difficult to enter upon a progressive scheme like that when he was composing! Today with electronic equipment the only limit is the hearing ability of our ears.

We may surmise that the telephone engineers wanted to avoid obvious musical intervals and go for something which would not accidentally be sounded in ordinary telephone use.

The result of the 14 and just systems having been applied is that telephone practice turned out to be non-12--tone-tempered.

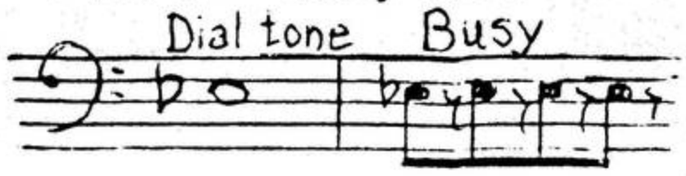
Let's refer back to the other article in this issue--Page 2, the last two paragraphs in the second column: The contemporary practice for generating tones in those portable keyboards is not to generate them directly as was done in earlier electronic organs; instead one uses a high-frequency master oscillator and a special counting chip which divides the ultrasonic frequency down to several wanted frequencies in the audible range. This means they are not strictly what abstract theory calls for, but will be within engineering tolerances. If you do some math on these tone-signals to try to compare them with old or new musical intervals, don't expect all the figures to come out perfectly even.

From now on, musicians and listeners will be more and more exposed to new scales, new tunes, new patterns, new themes, new effects that will be coming from outside music-proper!

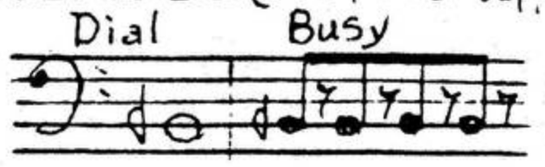
TELEPHONE TONES, PAST AND PRESENT

The following are approximate staff-notation representations of telephone sounds used on the Pacific Coast, and we cannot guarantee what might be heard in other parts of the country or from the smaller independent telephone companies. Pitches are shown as the nearest quartertone, and with some of them, small deviations from ordinary standard pitches are indicated by little arrows. ↑ ↓

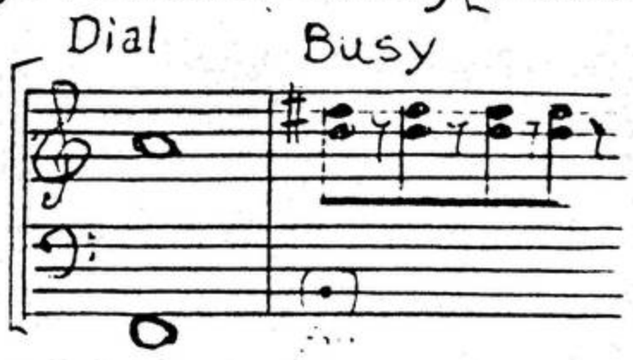
ca 1930 Reedy Timbre



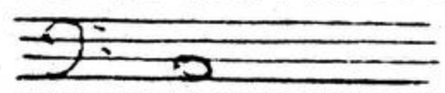
ca. 1950 (like power supply hum)



Present (1990's) [smoother]



1940 in Santa Monica CA.



1940's, not now heard

Non-existent prefix or non-working number:
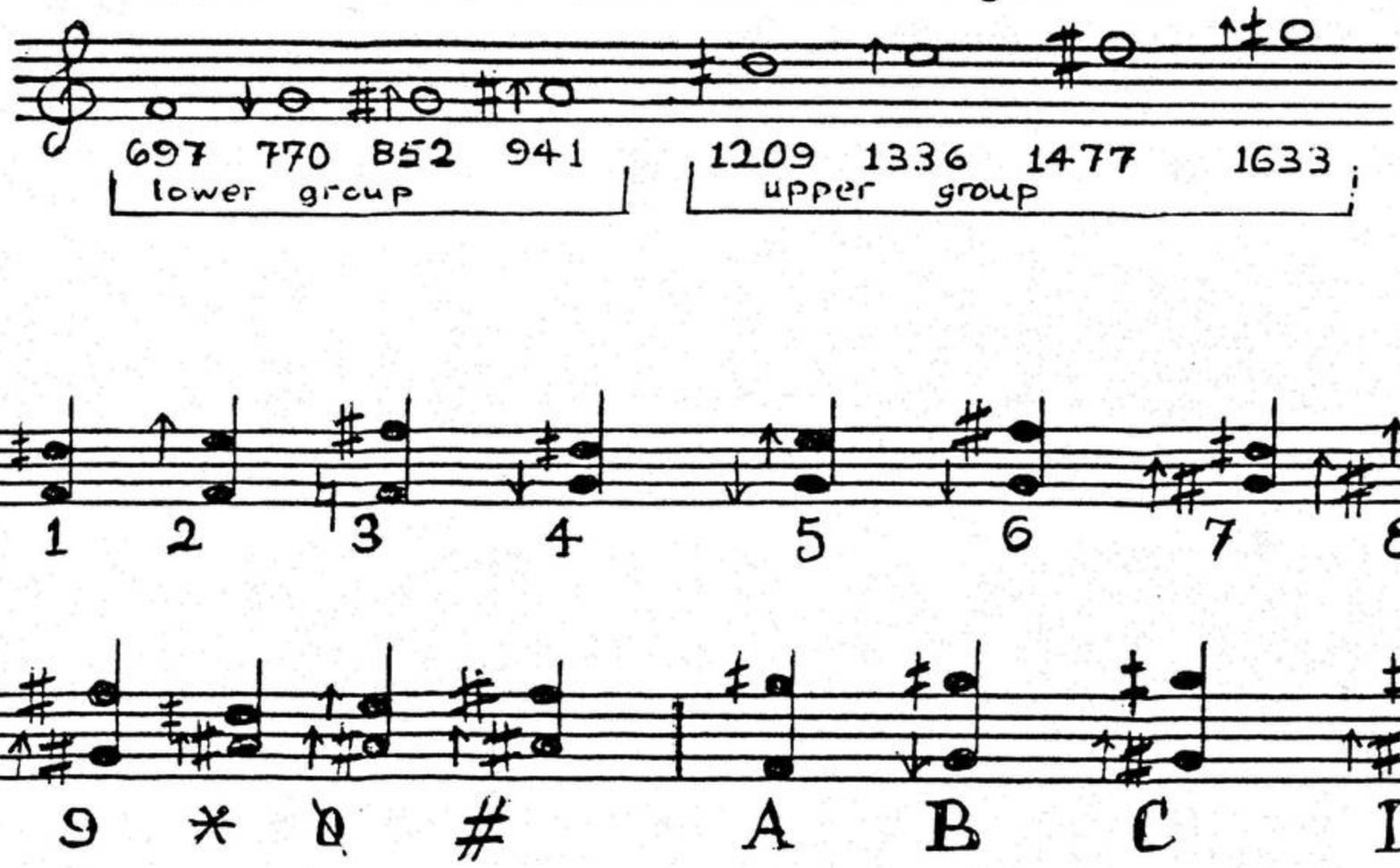
(At present, a recording asking one to hang up and dial again is often heard)



TONES USED FOR PUSHBUTTON DIALLING

*There are two groups of four pitches each, and one tone from the lower group is used with one tone from the higher group to stand for a number or the * or # symbol on the standard 12-button telephones. Four extra two-tone combinations have been assigned for special 16-button boards, and are called A B C D . These do not appear to coincide with the 'hex' base-sixteen numbering system used, e.g. for computers.*

All Notes below sound one Octave higher than written!



FORTY-EIGHT-TONE EQUAL TEMPERAMENT

No.	CENTS	TUNER	A = 220 Hz	A = 440 Hz
0	0	A exact	220.000	440.000
1	25	A + 25	223.200	446.400
2	50	A + 50	226.427	452.853
3	75	A# - 25	229.741	459.481
4	100	A# exact	233.082	472.944
5	125	A# + 25	236.472	472.944
6	150	A# + 50	239.912	479.823
7	175	B - 25	243.402	486.803
8	200	B exact	246.942	493.883
9	225	B + 25	250.534	501.067
10	250	B + 50	254.178	508.355
11	275	C - 25	257.870	515.740
12	300	C exact	261.626	523.251
13	325	C + 25	265.431	530.862
14	350	C + 50	269.292	538.584
15	375	C# - 25	273.209	546.417
16	400	C# exact	277.183	554.365
17	425	C# + 25	281.215	562.429
18	450	C# + 50	285.305	570.609
19	475	D - 25	289.455	578.909
20	500	D exact	293.694	587.330
21	525	D + 25	297.936	595.872
22	550	D + 50	302.265	604.540
23	575	D# - 25	306.667	613.333
24	600	D# exact	311.127	622.254
25	625	D# + 25	315.653	631.305
26	650	D# + 50	320.243	640.487
27	675	E - 25	324.902	649.804
28	700	E exact	329.628	659.255
29	725	E + 25	334.422	668.844
30	750	E + 50	339.287	678.573
31	775	F - 25	344.222	688.443
32	800	F exact	349.229	698.457
33	825	F + 25	354.308	708,616
34	850	F + 50	359.461	718.923
35	875	F# - 25	364.690	729.380
36	900	F# exact	369.995	739.989
37	925	F# + 25	375.376	750.752
38	950	F# + 50	380.836	761.672
39	975	G - 25	385.376	772.751
40	1000	G exact	391.995	783.991
41	1025	G + 25	397.697	795.394
42	1050	G + 50	403.482	806.964
43	1075	G# - 25	409.351	818.701
44	1100	G# exact	415.305	830.609
45	1125	G# + 25	421.345	842.691
46	1150	G# + 50	427.479	954.948
47	1175	A - 25	433.692	867.384
48=0	1200	A exact	440.000	880.000

The Mexican composer Julián Carrillo as early as 1895 had the idea of subdividing the conventional whole-step or whole-tone into smaller intervals, and later on produced compositions in the eighth-tone system (48 per octave) and also had a piano and other instruments made for this system. The pre-revolutionary Russian Nikolai Kulbin wrote an essay entitled FREE MUSIC in which he advocated the eighth-tone system. Certain electronic keyboards today can play in 48 per octave. 50 and 53 offer much better improvements of the Major Third than 48 does.

50-Tone Equal Temperament

No.	CENTS	TUNER	A = 220 Hz	A = 440 Hz
0	0	A exact	220.000	440.000
1	24	A + 24	223.071	446.142
2	48	A + 48	226.185	452.370
3	72	A# − 28	229.342	458.685
4	96	A# − 4	232.544	465.088
5	120	A# + 20	235.790	471.580
6	144	A# + 44	239.082	478.163
7	168	B − 32	242.419	484.838
8	192	B − 8	245.803	491.606
9	216	B + 16	249.235	498.469
10	240	B + 40	252.714	505.427
11	264	C − 36	256.242	512.483
12	286	C − 12	259.818	519.637
13	312	C + 12	263.445	526.891
14	336	C + 36	267.123	534.246
15	360	C# − 40	270.852	541.704
16	384	C# − 16	274.633	549.265
17	408	C# + 8	278.467	556.933
18	432	C# + 32	282.354	564.707
19	456	D − 44	286.295	572.590
20	480	D − 20	290.292	580.584
21	504	D + 4	294.344	588.688
22	528	D + 28	298.453	596.906
23	552	D# − 48	302.619	605.238
24	576	D# − 24	306.844	613.687
25	600	D# exact	311.127	622.254
26	624	D# + 24	315.470	630.940
27	648	D# + 48	319.874	639.748
28	672	E − 28	324.340	648.679
29	696	E − 4	328.867	657.734
30	720	E + 20	333.458	666.915
31	744	E + 44	338.113	676.225
32	768	F − 28	342.832	685.665
33	792	F − 8	347.618	695.236
34	816	F + 16	352.471	704.942
35	840	F + 40	357.391	714.782
36	864	F# − 36	362.568	724.760
37	888	F# − 12	367.439	734.877
38	912	F# + 12	372.568	745.136
39	936	F# + 36	377.769	755.538
40	960	G − 40	383.042	766.085
41	984	G − 16	388.389	776.779
42	1008	G + 8	393.811	787.622
43	1032	G + 32	399.309	798.617
44	1056	G# − 44	404.883	809.765
45	1080	G# − 20	410.535	821.069
46	1104	G# + 4	416.266	832.531
47	1128	G# + 28	422.076	844.152
48	1152	A − 48	427.968	855.936
49	1176	A − 24	433.942	867.885
0′	1200	A exact	440.000	880.000

The 50-tone equal temperament is a member of the Meantone Family, and stands between the 19- and 31-tone equal temperaments, or between 1/3-and 1/4-comma meantone. The theorist Joseph Yasser made up a series of equal temperaments as follows: 5 7 12 19 31 50 81 which he alleged would after centuries passed. evolve beyond the ordinary 12 in the above Fibonacci Series. T. Schafer once experimented with chords in 50-tone. but we do not know of special instruments built for all the pitches of 50.

53-Tone Equal Temperament

No.	CENTS	TUNER	A = 220 Hz	A = 440 Hz
0	0.0	A exact	220.000	440.000
1	22.642	A + 23	222.896	445.792
2	45.283	A + 45	225.831	451.661
3	67.925	A# - 32	228.803	457.606
4	90.566	A# - 9	231.815	463.630
5	113.208	A# + 13	234.867	469.734
6	135.849	A# + 36	237.959	475.917
7	158.491	B - 42	241.091	482.182
8	181.132	B - 19	244.265	488.530
9	203.774	B + 4	247.481	494.961
10	226.415	B + 26	250.739	501.478
11	249.057	B + 49	254.039	508.078
12	271.698	C - 28	257.384	514.767
13	294.340	C - 6	260.772	521.543
14	316.981	C + 17	264.205	528.409
15	339.623	C + 40	267.683	535.365
16	362.264	C# - 38	271.207	542.413
17	384.906	C# - 15	274.777	549.553
18	407.547	C# + 8	278.394	556.787
19	430.189	C# + 30	282.059	564.117
20	452.830	D - 47	285.772	571.543
21	475.472	D - 25	289.534	579.067
22	498.113	D - 2	293.345	586.690
23	520.755	D + 21	297.207	594.413
24	543.396	D + 43	301.119	602.238
25	566.038	D# - 34	305.083	610.166
26	588.679	D# - 11	309.099	618.198
27	611.321	D# + 11	313.168	626.336
28	633.962	D# + 34	317.291	634.582
29	656.604	E - 43	321.468	642.935
30	679.245	E - 21	325.700	651.399
31	701.887	E + 2	329.987	659.974
32	724.528	E + 25	334.331	668.662
33	747.170	E + 47	338.732	677.464
34	769.811	F - 30	343.192	686.383
35	792.453	F - 8	347.709	695.418
36	815.094	F + 15	352.287	704.573
37	837.736	F + 38	356.924	713.848
38	860.377	F# - 40	361.623	723.245
39	883.019	F# - 17	366.383	732.766
40	905.660	F# + 6	371.206	742.412
41	928.302	F# + 28	376.093	752.186
42	950.943	G - 49	381.044	762.087
43	973.585	G - 26	386.060	772.120
44	996.226	G - 4	391.142	782.284
45	1018.868	G + 19	396.291	792.582
46	1041.569	G + 41	401.508	803.016
47	1064.151	G# - 36	406.794	813.587
48	1086.792	G# - 13	412.149	824.297
49	1109.434	G# + 9	417.574	835.148
50	1132.075	G# + 32	423.071	846.142
51	1154.717	A - 45	428.641	857.281
52	1177.358	A - 23	434.283	868.566
0´	1200.000	A exact	440.000	880.000