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NEW MOODS

>>> The time has come for me to share an important discovery with other composers, and some of you who are interested in performing or adapting existing music to new tuning-systems might like to join in.

Recent items in Dr. John Chalmers' new journal "Xenharmonikôn", into which my Xenharmonic Bulletins are bound, do not treat this subject of system-moods for reasons which will become quite understandable and perfectly excusable as my article proceeds.

The musical-theory literature does not go into the subject of moods either, for the very same reasons.

>>> In my opinion, the striking and characteristic moods of many tuning-systems will become the most powerful and compelling reason for exploring beyond 12-tone equal temperament.

It is necessary to have more than one non-twelve-tone system before these moods can be heard and their significance appreciated! I urge all of you not to become "stuck" in any one non-12 tuning-system no matter how excellent it is. To fence yourself in, to stop so soon, is just as bad as to remain obstinately wedded to 12-tone equal.

These moods were a complete surprise to me--almost a shock. Subtle differences one might expect--but these are astounding differences.

The available literature dealing with non-twelve-tone scales is heavily theoretical. Under such circumstances, it is not too surprising that certain aesthetic and emotional aspects of music have been overlooked or deëmphasized. In consequence, many persons who should be participating in the xenharmonic movement have been "turned off".

We shouldn't allow this situation to get any worse. During the last eleven years or so, that is, since I started composing and performing in such scales as 17-, 19-, 22-, and 31-tone, I have become more and more aware of the characteristic *moods* of those systems, and later on, of the characteristic *mood* of the ordinary 12-tone system as well.

That is to say, you only become aware of your environment after leaving it and then returning to it—or to use McLuhan's *bon mot*, 'the fish is not aware of the water'.

You will notice that I did not include the quartertone or 24-tone system up there. I left it out intentionally on purpose: 24 is twice twelve, and the quartertone mood, while it does exist and is a most useful mood to have, is both underpinned and held back by the twelve-tone mood, so that no matter how many quartertone intervals you use in your compositions, you have not *escaped* the 12-tone mood and are still its helpless slave. The quarter- and sixth-tone works of Hába, Carrillo, et al. are evidence enough of what I am talking about here.

Since one cannot anticipate the emotional and aesthetic effects of a system before building or modifying instruments to play in it, and since there is nothing in the mathematical theory of tuning to suggest or hint at or indicate that

MOODS, continued

certain temperaments will have novel general effects, I find myself in the uncomfortable position of having a monopoly that I want to get rid of!

Some of the promoters of the 31-tone system point to the major third, which is so much better than that of the 19-tone system that they cannot understand why anyone would want to use 19 at all if they could afford 31. And as for 17-tone, well, that 'major third' is so terribly sharp as to be ridiculous! So again, why do I still compose in 17 when I can use 31? All the mathematical arguments seem to go against me. All the charts and diagrams, *including my own*, would be enough to dissuade many people from experimenting with 'less harmonious' or 'further from just' systems. On paper, the arguments for 17 and certain other systems are long since crushingly lost.

My only effective counter to this is to *perform* in the 17-tone system and *show* that it can get emotional effects that 31 does not have. This could not be predicted. The mood of 17 is a hard, steely, sparkling brilliance. Once I write down that sentence, the behaviorists and cold, *soi-disant* 'objective' theorists will accuse me of 19th-century fuzzy Romantic metaphor and effete subjectivism.

While much of my discussion here is concerned with 'tonal' music in some kind of key-system, I am sure that some xenharmonic systems will be found with just the right moods for some kinds of atonal or serial music—these mood-differences are not the same as *mode*-differences or the all-edged 'characters of keys' so dear to some Romantics.

Such systems as 10-, 11-, 16-, and 23-tone are not likely to have much key-feeling about them. However, 'dollars to doughnuts' they are going to have decided *moods* in which some serial and atonal music is going to be more exciting than any 12-tone serialism!

I could explain here that the seventeen-tone system turns certain common rules of harmony upside-down: major thirds are dissonances which resolve *into* fourths instead of the other way round; certain other intervals resolve *into* major seconds; the pentatonic scale takes on a very exciting mood when mapped onto the 17 equally-spaced tones**** and so on; but I can't expect you to believe me until you hear all this yourself. If you try to play these pieces in another system, it just doesn't work; they lose their punch; the magic is all gone.

Quite as much, if not more so, when certain pieces composed in and for 19 are tried in 31. They go flabby, no punch. On the other hand, certain pieces composed in 31, when tried in 19, become too crude or coarse-textured. They lose their finesse, their subtlety, and the restful calm of 31 is replaced by the aggressiveness of 19.

I had better not go on with these comparisons because this Bulletin has no record with it and I have not sufficiently delved into the systems such as 13, 14, 41, and so on which promise to have special moods of their own.

I will hazard a guess that beyond the trio of systems 41, 43, and 46, the 'diminishing returns' principle sets in: mood-differences will be very slight. At the other end of the scale-scale, the mood-gap between 17 and 18, 18 and 19, is tremendous. Debussy's 6, or wholetone scale, contained in 18, is an important factor here; its soft, ambiguous mood carries through to 18 because there are no fifths or fourths such as the 12 system has to dilute its effect. In 17, the wholetone scale overshoots the octave, while the wholetone scale in 19 falls decidedly short. This and the asymmetrical augmented fourths and diminished fifths of 17 and 19 undoubtedly have something to do with their mood-differences.

Before going on any further, I should mention an *Encyclopaedia of the Violin* published about fifty years ago which had a brief article on the quartertone system and was mildly unfavorable in attitude—but let me say, very fair about it for that period. The encyclopaedist complained that quartertones were suitable only for the weird emotions.

It's so many years since I read the article that I can't quote it verbatim, but I will try to look up the author's name etc. in time for my next *Bulletin*.

Partch alludes in his book to the perennial restlessness of the twelve-tone scale, so he must have been aware of the 12-tone mood as compared with his own system.

The average listener's experience may include a small amount of just intonation, so the contrast between the mood of 12-tone equal temperament and just intonation has never been *completely* absent; but it has been almost so.

MOODS, continued

This contrast, furthermore, had been badly muddied up by the intermediate state of string ensembles and the hopelessly irregular intonation of orchestras.

This subconscious appreciation of mood--differences may help explain the current vogue of ethnomusicology and the fad for some of the music from India, Japan, and more exotic places.

Some of the exoticity of these alien forms of music has to do with their tuning-systems, not the different cultures.

Unfortunately, some of these exotic varieties of music are being, or alas! have been already, diluted or subverted by the importation of the 12-tone equal temperament or the actual imposition of it by Government or other authorities.

Few of the experimenters in non-12 instruments have had the money, time, or patience to build or have built instruments in *more than one non-12 system.* Only very recently has it become practical to compare say, 17 with 19, or 22 with 31, on a fair and realistic basis. It has always been 12-tone compared with something else—some *one* thing else.

The motivations have been to secure smoother conventional chords, hence just intonation or that close imitation, 53-tone; or to get restful major thirds, hence meantone or 31-tone or one of the numerous 'unequal' or incomplete systems. The motivations for quartertone and some other systems have been to enlarge the vocabulary without having to scrap 12-tone, and similar obvious reasons.

When I started out as a teen-ager, I learned to play the cello so that I could find the quartertones and hear them, and later, sound just major thirds and sixths—all of which annoyed my cello teacher no end! I knew nothing then about 19--tone and its mood, and since you can only play two sustained tones at a time on a bowed instrument, I did not hear sustained just triads or tetrads for quite some years to come. I did persuade someone to let me tune their piano to a just scale, but that was not a necessary or sufficient test—the very factors which make the piano tolerable in the 12-tone temperament conceal the possibilities of just intonation.

Anyone who has invested money, time, and effort in one non-twelvular instrument is not likely to have enough left over to go on and compare a 19-tone organ with a 22--tone one or anything of that sort, so these mood-differences as between 17 and 19 or 19 and 22, or the nature of the ambivalent relation between 19 and 31, have not been explored. Instead, the comparisons have been in silent numbers on paper.

Furthermore, the difference in mood between 12 and some of these others such as 19 or 31 is so profound and striking that I can't blame anyone for feeling that they need not explore further once they have a good instrument in such system. One who is stuck with a heavy investment also and quite naturally will feel that he has to defend his agonizing choice. Again naturally, this will determine and influence their line of argument. They will choose this point and ignore that one, to make a good case for 22 against 19, or for 19 against 22, or whatever. When so much has been invested, one can no longer be objective!

I've got good news for them: you no longer have to give up hope of having 19 in order to have 22 or 31 or both. With synthesizers or the new Motorola Scalatron, or by using fret-charts laid under the strings of a Hawaiian steel guitar, a wide variety of systems may be tried and compared. For that matter, the cost of having regular Spanish guitars re-fretted and having more than one for more than one xenharmonic scale is not so great as to prevent this becoming more popular.

No doubt more easily-convertible, retunable instruments will appear: much as this Varityper or its successful rival, the IBM Selectric, can be switched in a jiffy from one language to another or one size or style of type to another, new instruments will be made which can retune instantly with a simple adjustment.

Watch the new developments in computer miniaturization: some of these micro-assemblies will be applied to portable electronic music devices, ultimately leading to automatic tuning. My own electronic organ unit built some 12 years ago already has a kind of automatic tuning—but that is a story for another article.

The subject of *deviations* from the 12-tone temperament was covered in the last *Bulletin,* so we might tie things together here by alleging that these deviations often are a subconscious search for *moods* that the twelve-tone temperament does not afford.

MOODS, continued

The 'flatting' of the characteristic notes in singing the 'blues' will be familiar to most of you, and this does succeed in changing the mood in the sense I am using the term here. More recently, 'bending the tones' is resorted to, for similar reasons.

Even when the ideal of twelve-tone tuning was being proclaimed with fiercest loyalty, say 60 years ago, player-pianos, circus orchestrions, and some other instruments were deliberately allowed to get out of tune and to remain so—perhaps they were *put* out of tune or intentionally tuned carelessly—anyhow this quite noticeable form of deviation is associated in the popular mind with the heyday of the player-piano, which, as you know, lasted into the 1920's and was killed off by the joint impact of radio broadcasting, talking motion pictures, and the Great Depression.

Sometimes the term 'honky-tonk piano' refers to just this mood created by out-of-tuneness; sometimes it means the 'tinny' tone-quality of worn, hardened piano-hammers; sometimes it means *both*.

The current nostalgia craze and some revival of player-pianos helped out by the public fascination with and dread of IBM punch-cards and automation, has brought back this out-of-tuneness for authentic coloring and that Good Old Days Mood.

Gliding, sliding, scooping, and wavering pitches constitute another attempt to enlarge the mood-vocabulary—a straining at the leash as it were. I will be charitable and not detail the deviations of cellists, singers, and other concert soloists, but they may be taken as another kind of attempt to get more moods.

The fact remains, established to my satisfaction, that the 17-tone system offers a harsh brilliant cleanness that 12-tone cannot match; that there is a driving aggressiveness to many pieces performed in 19-tone, that 22-tone can be more subtle and restful in character; that 31-tone can be harmonious and serene; and that no one of these systems can do everything nor be universally appropriate—we need them all!

To repeat myself some more, what I called *tempered temperaments* in an earlier bulletin may be viewed as an attempt to have one's cake and eat it too. To maintain lip-service loyalty to twelve-tone equal and yet create subtle shadings.

Augusto Novaro, in his very scarce book on tuning-systems, describes *afinaciones* or varieties of tuning, and helpfully he lists the emotional and mood aspects of these subtle tempered temperaments.

I had better warn experimenters that such subtle and refined retemperings as these would have their full value and effect only on a *freshly*-tuned piano; a few weeks later the average piano would go out enough to make it ordinary and commonplace.

Also please remember that if you use a *piano* to try out just intonation, quartertones, or the 17- or 19-tone system, it will try to go back to the tuning it had before, and in a matter of weeks *must* be re-tuned or the comparison will not be fair!

If the two pianos required for 17, 19, 22, or 24 tones per octave are of different makes or types or ages, this problem can really ruin things. Moreover, it's not necessary! We can now leave the piano back in the past, and go ahead with electronics.

I am quite sure that this perverse trait of pianos, having to do with the tons of stress stored in the frame, strings, and elsewhere, is responsible for many neophytes getting turned off or disappointed with new tunings and so they meekly abandon the quest.

Unfortunately for an explanatory article such as this, one cannot consider *mood* in isolation, because in the real world of real musical instruments too many other important factors are always present: timbre, noise-in-the-tones, lack of precision, aging and drifting out of tune, and above all, the near-certainty that you have heard so much in 12-tone temperament and so few actual performances of compositions in 17 or 19 —— or 22 or 31—I mention these here because of their pronounced individual moods—that nearly all I have written thus far has been empty words to you.

Maybe there is some better term than *mood;* your suggestions are invited as soon as you have heard the effect of the different tunings.

I have further confirmed the reality of these moods by hundreds of trials with many different kinds of people—while most of them just listened, quite a number played my xenharmonic instruments and had, *right at first hearing,* individual preferences for this or that system and dislike for others—the personality preferences for 22 or for 19 are especially strong—I am sure some psychologists will make this 22-vs.-19 thing into a standard test some day!

I can't quote percentages yet, but my estimate is that 19 and 22 are running neck-and-neck with about an equal number of persons favoring each. In the 22-vs.-24 comparison, the margin is definitely in favor of 22, but those who prefer 24

MOODS, continued

are quite emphatic about it.

One way in which I have tried to effect a fair comparison has been to compose pieces for guitar in one system and then try playing them on a guitar re-fretted to another system to see what happens. Besides that, I have tried these pieces on an unfretted instrument such as the cello or a new unfretted banjo-like instrument. I have tuned my specially-designed electronic organ to just, 12-tone, 17-, 19-, 22-, and 24-tone to get comparisons on the very same instrument. Admittedly, this is not absolute impartiality; but it gets very close. The computer-music people can take the next step. But *someone* has to start *now*, so I did.

Hitherto, comparisons of systems have been made on a basis of *How closely does this system come to just intonation? How many tones does it need? How strange or awkward a keyboard does it require? Does it require special notation-signs, and if so, how many? Is it compatible with existing printed music? Can it be tuned with the standard organ or piano-tuning routine?*, and on and on the critics go with their endless restrictions and demands—

—what I have quoted above is already too much, since no system comes near to meeting all of them.

When I read the usual arguments in this vein, I cannot help thinking of Voltaire's famous passage about the dazzlingly brilliant but icy-cold light of Reason. The critics' allegations seem quite sensible, on paper. They smugly bask in one another's moral support. A mere composer, without whom there would have been no music in the first place, is told to 'Get Lost!'—none of his fool business.

Two arguments from J.M.Barbour's oft-cited book, *Tuning and Temperament*, will give you an inkling of what I mean: In one place he claims that the flat major thirds of the 19-tone temperament (7 cents flat) coupled with the equally-flat fifths, will make the system sound terribly insipid. Actually, the opposite is the case! Far from being insipid, lackadaisical, or 'blah', the mood of the nineteen-tone system is forceful, dynamic, even aggressive. I didn't know that either until I heard the tape of 19-tone preludes by Joel Mandelbaum. Thus I will contend that judging 'sound unheard' is even worse than the proverbial 'sight unseen'.

Once I had actually *heard* this 19-tone mood, I tuned my organ to 19-tone and was able to compose as I never composed before, with this same mood and with an intensity I never dreamt was within me. Since I can't put this impressive mood onto a chart, I can't diagram it as I can the Web of Fifths and Thirds or as the crystal-lattice of Adriaan Fokker, and I can't set this mood down in algebraic symbols nor can I include it in my 19-tone guitar-fretting tables, I suppose few of you will believe me.

If you try to perform my 19-tone scores in another system: just, 18-tone, quartertone, 22, or 31 for instance, I *positively guarantee* you will be let down, annoyed, and disappointed—

these are all good and useful systems, but

THEY JUST *DON'T HAVE THAT 19 MOOD!*

Conversely, the serenity of one of my 22--tone preludes is lost and caricatured by attempting to play it in 19-tone.

The second Barbour allegation concerned the 22-tone system: the good major third, 4½ cents flat instead of the 12-tone major third's 14 cents of sharpness, is obtained by going up to D-sharp; i.e., the 22-tone fifths are so sharp that 9 of them make a good E for the C-major scale, whereas the Pythagorean D-sharp, made out of 9 just fifths up, is a dandy *minor* third or E-flat for the C-*minor* scale, only 2 cents sharp from just.

Since nobody in their right mind would dream of writing the C-major chord as C, D-sharp, G, Barbour forbids me and all other composers to explore the 22-tone system: never mind how good it *sounds;* it violates the customary musical notation, and therefore let it be anathema!

As will be evident to those who read or play from my scores that happen to be in the 22-tone system, I rely on other people's common sense, and don't write D-sharp, but E, when I mean the major third of C. The whole affair is a pseudoproblem, a 'straw man', constructed by a group of spoilsports and killjoys out of pure meanness.

Perhaps we will be able to explain these new moods 'after the fact'—once having heard their effects and the new unprecedented contrasts they make possible, some systematic thinking may be attempted. But I deplore and resent these attempts to condemn that which has never been tried or heard!

Another such tempest in a teapot concerns the objections to the flatness of leading-tones in meantone and the 31 system. The cure is very simple: When the melody-line sounds better, play the next higher tone. Never mind the purists' dismay! Especially in ornaments, C–C-flat–C is going to sound more brilliant in the 31-tone system than C–B–C.

MOODS, continued

For example, the famous subject of the Fugue in C Minor, Bach's first book, W.T.K.:



can be played in 31-tone thus :



I'm going to get really heretical here and suggest that written B can stay that way when the harmony keeps it 'down', but be replaced by C-flat in primarily-melodic situations, as above.

Before dashing off angry letters to me, let me call your attention to the late Dr. Fokker's notation, which would put B-semisharp as a raised leading-tone—it means the same as C-flat in the 31-tone system, and was doubtless invented to placate visually-biassed musicians so that the septimal version of the dominant 7th chord wouldn't have to be written C•E•G•A-sharp.

Actually, playing the Bach C-minor fugue, first book *W.T.K.*, in the thirty-one-tone or meantone temperament is not my cup of tea at all: its mood would suit the *thirty-four*-tone system much better; and because of its rapid tempo, it might be tolerable in seventeen. However, it has been and will be played in meantone and 31, so I make suggestions as to how this might best be negotiated.

The meantone mood is similar or let's go whole-hog and say it's nearly identical with that of 31-tone—any difference is due to the unhappy tradition of using only *twelve* notes of meantone on conventional keyboards and thus sounding the famous 'wolves'.

This means that some of Bach's Preludes and Fugues are going to fit the calm, restful mood of 31 and of Meantone-Without-Wolves admirably well, whereas others of a more forceful mood are going to disappoint you when tried in those systems. This makes the numerous arguments over What Temperament Did Johann Sebastian *Really* Use? kind of fishy.

Now we can choose from a tremendously large array of systems and even change systems during a performance, so those interested in older or not-so-new music can experiment and find the right mood for everything.

> I have proposed the term *transfer* for a change of systems during a performance. *Modulation* will not do, obviously.

Sometimes this right mood will just happen to be that of the ordinary 12-tone temperament; and furthermore more people will become aware of the 12-tone mood when there is something else or rather there are several things else to contrast it with.

It should be noted that the use of only *part* of a system, such as only 12 notes of either 31 or meantone, may create a different mood than the complete or more-fully-carried-out system would have. This may be brought home to you by considering only 6 of the ordinary 12 tones, i.e., the mood of the whole-tone scale. Or if one restricts oneself to the 5 tones of the piano's black keys, that's another mood.

In the case of just intonation, it makes a great difference in the mood if one does or does not use the intervals based on 7. It makes some difference whether commas are allowed to be heard or are carefully avoided; it also makes a difference whether such intervals as the diesis 125:128 (a pile of three major thirds) is or is not used. Partch's just system does not carry the major thirds that far, but it uses some intervals based on eleven, so we have two mood-affecting factors.

Certain *instruments* have moods such that these will aid or cancel out the moods of certain tuning-systems. It will soon become evident what some of the good and bad system-instrument combinations are Certain combinations are not going to be worth having, in much the same way that one does not try to play *Flight of the Bumblebee* on a set of tubular chimes, nor to render the Chopin nocturnes on a quartet of banjos.

I think the common-sense thing to do is for somebody to run through a large number of system-and-timbre combinations with a bank of computer-controlled synthesizers to make a reference tape.

To get personal for a moment: It took me much longer to learn to play the 31-tone guitar at a fast tempo (*allegro*) or to play it fluently; this wss so even though I had the use of a 31-tone guitar five years before I re-fretted other guitars to the 19-, 22-, and 24-tone systems.

Moods, concluded

It is likely that other persons will have a similar experience; so comparisons between the various systems are apt to be biassed without any deliberate intention to distort the results.

Similar considerations apply to violins, the various kinds of keyboards possible, etc.

The computer performance on synthesizers of new themes composed specially for each system should reduce the bias of such a system-timbre comparison.

But please don't wait for the results of such elaborate tests! I have already supplied you with enough system-mood information in this article to give you a good start.

When introducing new people to non-12 music, it is well to remember that the moods of the various systems may be compatible with, or may conflict with, someone's personality. The rejection of xenharmonics by certain individuals may have something to do with their introversion/extraversion/ambiversion scores, or with their attitudes at the time of exposure.

Don't be too disheartened, then, if someone doesn't like your 31-tone performance or recording; they might be the kind of person who will be 'turned on' by 17 or 19.

* * * And vice versa! Many people are not going to be in the mood for a given mood at a particular time; they may change their minds later.

It will take the co-operation of many persons for quite some time to come, to map out the vastness of xenharmonic territory.

Instruments

In *Xenharmonic Bulletin No. 3*, of November, 1974, on page 2, a new instrument is mentioned. The 'twin' to it has just been completed, so a more detailed description is in order. Besides, that, a third instrument is under construction as this is being written, and will be complete long before you get to read this issue.

Indeed, there may be more similar instruments—it all depends upon availability of materials, time, and how many other people would like to have such an instrument, and most of all, upon whether anyone else would care to build them under my supervision.

The first two instruments are extensions, expansions, enlargements, and extrapolations of the Hawaiian steel guitar idea. The third instrument is a contrabass steel guitar.

Very well, what has this to do with xenharmonics? The steel guitar happens to be a popular instrument which at the same time is suited to just intonation and to what I have been calling justified or tempered temperaments. Putting it more bluntly, the steel guitar has 'snuck' just intonation into the musical world by the back door.

Despite the 12-tone fret-pattern painted or silk-screened onto the non-fingerboards of virtually all Hawaiian steel guitars in existence, this fret-chart is by its very nature a mere *guide*, not a precision pitch-determiner-and-quantizer.

The *parallax* error in reading the fret-graduations on the board beneath the strings will guarantee continual deviation and inaccuracy in the placement of the steel. This is similar to the error in reading the position of the needle on a voltmeter, since that needle must be an appreciable distance above the surface of the dial which bears the numbered scale.

However much of a disadvantage and problem this may be in the world of electrical measuring equipment, it is a fortunate and happy circumstance where steel guitars are concerned! The ear and not the eye becomes the arbiter of where that 'steel' goes, and this results in just intonation or at least something superior to 12-tone equal temperament, more often than not.

The orthodox uptight world of serious music has of course looked down its collective nose at the Hawaiian steel guitar with a haughty contemptuous sniff, ever since the instrument was invented: indeed they have carefully pretended it never existed!

Let me concede here and now that there have been two good reasons for criticizing the steel guitar: its abuse by untalented novices who do not have sufficient sense of pitch, or who have not been trained; and the restriction of the first commercial models of the instrument to an A-major chord.

Also, at the time when the instrument first became popular, the gulf between serious music and popular music was a much wider chasm than it is today; and the imitation-Hawaiian stuff played on the first steel guitars was definitely not in the mainstream of the jazz or standard or popular music of that time; it was off to one side and something of a novelty or special effect.

INSTRUMENTS, continued

During the postwar period and the fifties, the instrument was more or less forgotten. More recently, it has come back in improved forms. Various means have been resorted to to permit playing minor chords, for instance; seventh or eighth strings have been added to the original six.

For a while there was a vogue for double, or even triple , necks so that two or three sets of strings could have different tunings.

Finally, someone borrowed the pedals from the elegant status symbol of the late 19th-century concert stage, the Érard double-action harp, and the *pedal steel guitar* was born.

Those pedal instruments which I have had a chance to examine had two or three sets of ten strings each. The pedals affected only a few of the 20 or 30 strings, raising them a semitone, as on the conventional concert harp, where the pedals raise all the strings of a given name one or two semitones, depending on whether the pedal is locked into the first or second notch. (Ex.: F-flat to F and then F-sharp.)

In effect, this is a case of the 12-tone tuning trying to tame or discipline the steel guitar, by installing something on it that alters the pitch one-twelfth of an octave.

I wonder what Partch would have said about this: "Expletive Deleted" no doubt. Of more practical importance, the drawbacks of the pedal guitar are that it is less portable, since it must be on a stand of some kind; and it is fabulously expensive—in the kilobuck region I would presume.

The reason I describe it here, is to clue you in on the 'state of the art' as the patent attorneys or technical journals would say; to indicate the place my new instruments or modifications of them might come to occupy in the contemporary context. Some of you may prefer to go in some other direction than I have.

Also, in a bulletin of this kind where I can't include all kinds of pictures of instruments and where the readers will be of such widely different walks of life, I have to describe my new instruments in terms of what commercial products they resemble, giving similarities as well as differences.

One desirable aspect of the pedal instrument's design is the clean break from the hourglass silhouette and separate neck of the Spanish guitar, since these features are no longer necessary for an amplifying instrument with so many strings, however attractive they may be for regular acoustic Spanish guitars.

But it would be better still if this new affair and perhaps the other forms of the Hawaiian steel guitar were called by some new name or names —vroomola or maxiwiz or sliggit or whabajee come to mind as possibilities—or maybe we can even cook up a different name for each instrument.

The Spanish guitar is digital and the Hawaiian guitar is analog, to put it in modern data-technology lingo. Surely this profound difference is more justification for giving them distinct names, than the calling of the same instrument a *dulcimer* or a *psaltery*, depending on whether its strings are struck or plucked.

This lack of a really distinctive name may be one of the reasons why the steel guitar is not adequately described in reference works, and why no one seems to consider its use in the more serious kinds of musical composition.

You cannot write for it in the same way you would write for Spanish guitar, and to make matters worse, much of the music and instruction material for it is published in a tablature or nonstandard notation, convenient for some performers but devilishly difficult for the composer. As for me I gladly play the instrument, but I will not write for it in that tablature! I promise that I won't emulate Partch in inventing special notations or tablatures for my new instruments.

There are other ways out of the situation.

Back to the matter of just intonation:

Because the vast majority of steel guitars are "electric", i.e., they have electromagnetic pickups built in, and are amplified, and further because the amplifiers used for such instruments generally have what is called *intermodulation distortion* by sound and electronic engineers (it was called beat-tones or combinational tones or difference-tones by the acousticians of yore), the sounding of two or more pitches at the same time will cause the sounding of additional pitches as well. Difference tones of the first order are the strongest, being equal in frequency to the difference of the two original frequencies, hence the name. These may interact with their generators, producing difference tones of second and higher orders. This used to be textbook stuff, mostly confined to physics labs.

INSTRUMENTS, continued >>

Now, everyone can hear it. You know how loud the rock groups play these days, with their high-power amplifiers. Then there are tinny $8.95 record-players and those ubiquitous transistor radios, all with their quota of intermodulation distortion. (The engineer's modulation has nothing to do with the musical term modulation.)

Even the summational tone, which was extremely rare and mostly a mathematical theorist's curiosity, can be heard nowadays.

The summational tone has a frequency equal to the sum of the two tones generating it, and when heard, is more annoying than difference tones.

Tempered intervals produce false combinational tones, which make the music harsh and coarse. So with the coming of the steel guitar and its amplifier, there is almost a compulsion to tune the chords just, so that the combinational tones for the major chord will be a true bass, and the combinational tones from minor and other chords will be more tolerable. It greatly improves the general effect to have justly-intoned chords; everything sounds 'cleaner'. It improves the mood.

Over 110 years after Prof. Helmholtz argued and pleaded for some use of just intonation to get rid of those false combinational tones, he is having his revenge in a manner he could never have foreseen. The electronic organs and amplified everything are taking care of that!

So the just intervals and chords have survived in various nooks and crannies of the musical world, and now the alleged villain, intermodulation distortion, bane of all hi-fi addicts, is encouraging some steel-guitar players to tune their strings to exact integer ratios although they may not be conscious of so doing.

Very well; the steel-guitar idea is current, and this instrument is well-suited to demonstrating just intonation, and it can be combined with other instruments, and thanks to amplification, nobody else can drown it out.

Your friendly neighborhood pawn-shop probably has one; so, fellow-experimenters, what are you waiting for? It's a valuable addition to any music theorist's laboratory.

A while ago I acquired some pieces of wood suitable for instrument-building, but only lately have I had time and facilities to go ahead with them.

I was curious to know how far the steel-guitar idea could be carried. Last year, when I built the first four-sided instrument with really long strings (810, 900, and 1200 millimeters' vibrating length instead of the standard acoustic guitar's 650 mm and the usual Hawaiian guitar's stingy 570), I was most pleasantly surprised, and many of my visitors have been favorably impressed. The steel, for those who haven't played on a Hawaiian guitar yet (I understand the instrument is little known outside the North American zone) is a rod smoothly polished on its business end and long enough to be a movable bridge for all the guitar's strings. Something like an overgrown clavichord tangent.

I call attention to this resemblance in order to fill your head with some dangerously imaginative, heretical ideas.

Since my instruments are much wider than standard, and the contrabass will be really wide, the steels have to be longer and heavier. The rod doesn't have to be steel: brass, aluminum, aluminum tubing, glass rod, all work with different effects.

You might even get some interesting muffled tones with a wooden 'steel' if I may be pardoned such an expression. Bowing the strings is difficult but sometimes possible. Violinists please note!

My first instrument has this tuning on one side, giving major and minor chords, with the shared bass notes in the center:



(This is actual pitch, not octave-lower)

With the steel, you can go up about three octaves from those F major and F minor chords, and the 'natural harmonics' are spectacular.

Give the instrumant a quarter-turn, to a narrow side, and it has a chord of the ninth, thus:



In ratios, 2:3:4:5:6:7:8:9:10.

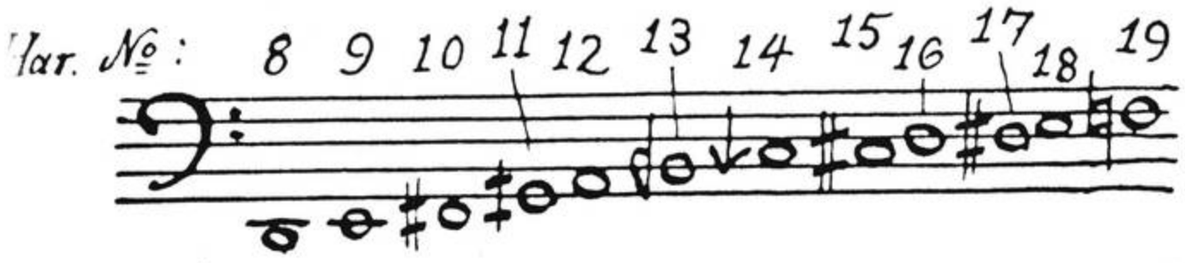
All chords are just!

This chord in just intonation, with its lower harmonic or subminor or natural seventh and its two major seconds, (8:9 and 9:10), takes this

INSTRUMENTS, continued

instrument out of the silly syrupy cliché cocktail-bar class. No longer can the uptight concert-hall or academic musicians dismiss the steel guitar with such withering contempt!

Another quarter-turn and you get a Harmonic Series, numbers 8 through 19:



Notation here is just a practical expedient; I am not trying to force it upon you.

This is reader's, demonstrator's, and explainer's notation, not a part copied out for a professional performer: hence my bass clef at actual pitch instead of the Spanish guitarists' treble clef to be played an octave lower than written.

This Harmonic Series contains the minor-ninth chord as well as the Yasser Hexad's theoretical just form. Did Scriabin, or didn't he?

This is the wide side (90 mm).

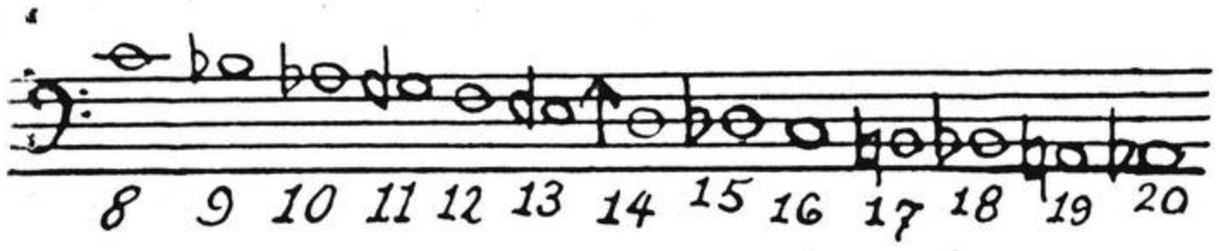
The last quarter-turn brings us to 8 long strings in 2 groups of 4, tuned to:



The very long, very thin tenor E strings have an intriguing sitar buzz throughout the compass. This is a narrow side (65 mm wide).

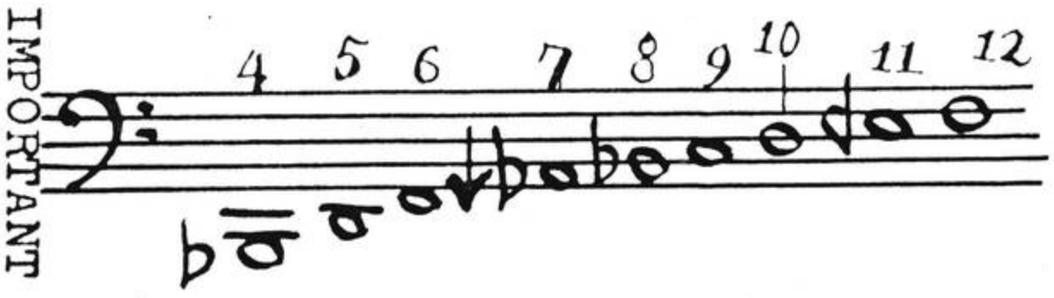
The second instrument is on a very similar board the same size as the first, 1400 mm long, (4 ft 7 in.) 65 x 90 mm cross-section. It has 45 strings, while the first instrument has only 41.

On a wide side is a *Subharmonic Series* or as some theorists have said, 'undertone series'—I do not intend to imply, of course, that undertones exist as components of a complex tone as overtones do. What I mean is that the members of a subharmonic series have some high tone as their partial-in-common—in the present case, 'double high C', 3 octaves above Middle C, 2112 Hz.
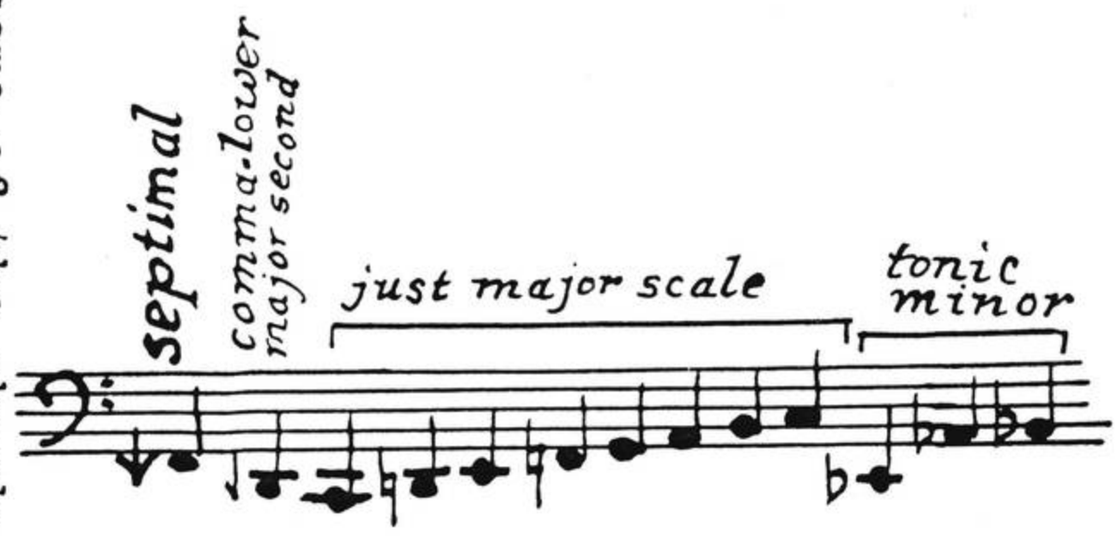


I was able to squeeze in 13 strings for the 8th to 20th subharmonics of that double-high C, inclusive.

A quarter-turn brings us to a chord of the harmonic eleventh on a narrow side:

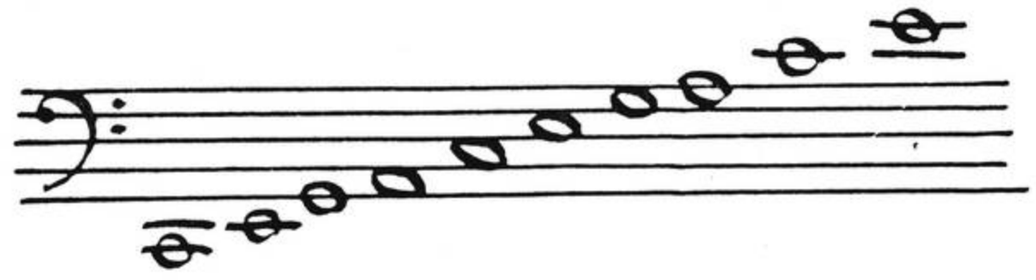


The steel of course transposes this tuning to *any pitch whatsoever* for about three octaves.

Another quarter-turn gives a wide side again, with a just diatonic major scale, the three flats for the tonic minor, the grave or comma-lower [10:9] major second, and the septimal sub-fourth for a 'natural' dominant seventh chord. [4:5:6:7]



The remaining, narrow, side has a chord of the added sixth which seems to be conventional for the pedal steel guitars discussed above. No doubt this is because the major and relative minor are contained in it.



Socalled piano-wire or music-wire is used for the strings, in sizes from 0.2 mm (.008 inch) to the sizes used in the treble register of pianos, about 1 mm (.039 inch). It would be much better if guitar wound strings were obtainable in long lengths, but so far I have not found any. If you are willing to content yourself with a shorter instrument, a wide selection of 'custom gauge' elect ic guitar strings is available at music stores. Their length seldom goes beyond one meter (39 3/8 inches), and then a considerable proportion of this is used up at the tuning-pins or -gears, and below the bridge at the anchor points or tailpiece.

Amplification will be through magnetic pickups.

IMPORTANT 1980 NOTICE: More instruments have been built with still other tuning-schemes--design is NOT frozen.

INSTRUMENTS, concluded

However, the wood is resonant enough to make the instruments clearly audible in a living-room, and to permit recording through an ordinary microphone.

The strings are tuned with standard piano tuning-pins, and while not as tight as piano strings, the tension is much higher than that in a regular guitar. My estimate would be nearly a ton on each instrument. The heavy tuning-gear-pegs that would have been needed would have been so fantastically expensive as to put the whole project out of the question entirely!

The main reason for putting strings on all four sides of the instrument is to balance this great tension. Another reason is that this gets the greatest variety of chords into a small space and easily-carryable form. The alternative, of course, is to use metal frames and some kind of easily-demountable stands for several of them.

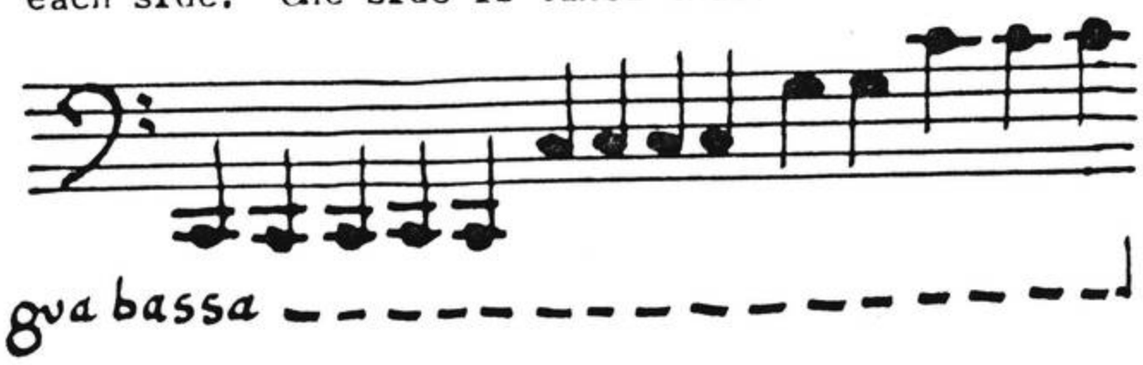
The tuning scheme shown above is not necessarily the absolute final version for the life of the instruments, although it likely will remain as it is. If more tunings are needed, more instruments will be built.

I am not going into exhaustive detail on certain aspects of these instruments, simply because they are accidents of circumstance, or have to do with *my* needs at this time, and would not apply to a similar instrument built the way *you* want it.

For instance, the exact length of the strings and locations of the bridges, and spacing between adjacent strings and height of bridges are all *ad hoc*. I found two suitable old boards and wanted to get the most out of them for my present purposes and as a demonstration of what unsuspected possibilities lie in the steel-guitar principle.

Now that that has been accomplished, both sooner and better than I anticipated, other instruments can be built with 'variations on the theme' over a very wide range of parameters. Only in the event of mass-producing instruments will there be necessity to clamp on the constraints and juggle with the limitations.

Now for an important variation of this idea: the third instrument is a contrabass, as I said before. While writing this I have completed it. It is 2 meters long (6 ft 7 in) and has 28 strings, 14 on each side. One side is tuned thus:

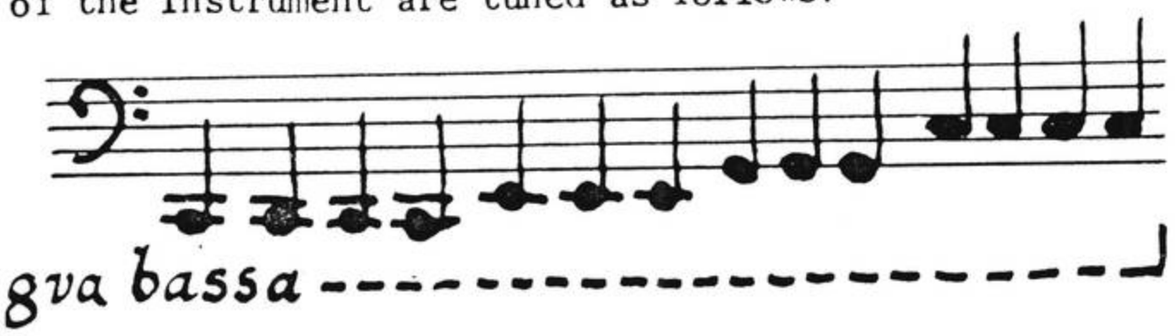


That is to say, five strings in unison sound Contra C=33 Hz, and the remaining groups of strings sound its second, third, and fourth harmonics, so that any note for more than two octaves up from that can be played with a wide steel with a 'chorus effect' and with the 16′-8′-4′-5$\frac{1}{3}$′ 'ensemble effect' available on the pedal keyboard of many pipe organs and some electronic organs.

In thousands of conventional orchestra scores, the cello and double-bass parts are yoked together in octaves, or as the organist would say, 16- and 8-foot pitches, for long passages. This new instrument imitates that effect very well indeed.

It should be obvious that a large loudspeaker unit in a big enclosure is required to reproduce these low tones—tiny portable equipment simply will not do! The amplifying pickups used will be described in a later issue. For practicing, the wooden board has enough resonance to give soft tones without any amplification, especially when the instrument is laid on a wooden table or bench.

At present, the 14 strings on the second side of the instrument are tuned as follows:



This gives a just major chord to which steel guitar players are accustomed. Many other tunings are possible, especially to give a scale on the open strings and/or a selection of 'natural harmonics'.

The steel-guitar principle—sliding a movable bridge along a string or group of strings—makes frets useless and unnecessary and so is an ideal means of escaping the fetters of 12-tone temperament. Those who are experienced with instruments of the violin family will not need fret-charts on the board beneath the strings. Other persons will want such charts, painted on the board, attached to the metal frame, or on plastic or cardboard to lay on the board underneath the strings, and since this is just another way of using fretting-tables, I will discuss it in later issues when furnishing such tables.

The steel guitar in whatever form is not a frequency-standard or precision instrument; it has to be tuned from such a standard. That does not keep it from being an expressive and valuable musical instrument.

It deserves a better future than the mere retailing of trivial background and the aimless sliding which has given it such a bad name in the past. § THE END §