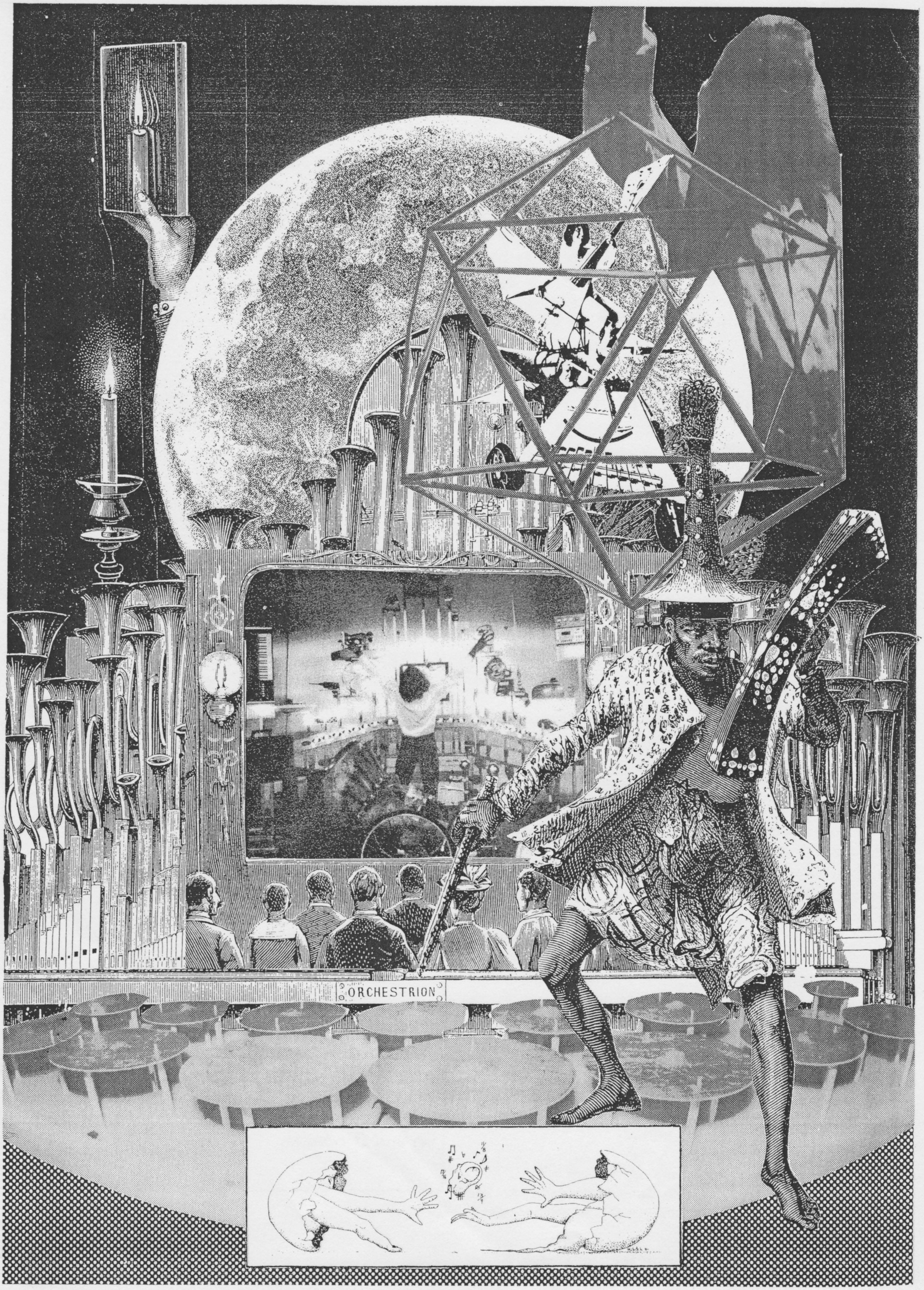
INTERVAL

Exploring The Sonic Spectrum

Winter **81 — 82**


ORCHESTRION

This magazine is dedicated to the father of contemporary microtonality, Harry Partch, whose spirit and troubled rage continue to influence and inspire those who carry on in the exploration of the harmonic series.

INTERVAL/Exploring the Sonic Spectrum, sponsored by **Interval Foundation**, is a quarterly publication growing out of the flowering of creative activity in the microtonal field. In the years since the death of the leading pioneer, Harry Partch, a variety of new instruments, scales and compositions has been created. INTERVAL is a forum for ideas, a showcase for new hardware and most importantly a vehicle for communication bringing artists together in a common cause.

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Interval Foundation, 860 Third Ave., San Diego, CA 92101, (714) 239-1713, a charitable non-profit corporation (State and Federal approval), benefits those individuals and organizations that are working with expanded musical materials (scales and instruments especially), and integrated art forms. This performance space is available for touring groups. Jonathan Glasier, Director; Judith Essex, Assistant Director; Janet Bicknese, Public Relations; Pat Moore, Treasurer.

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Inside Cover: "Noises from the Second Step Ribitch
Top to Bottom: John Gibbon's dodecahedron, Arthur Frick's Arc Harp, Frick's Hummer, Paul Dresher's Bonang, Interval Foundation Logo

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Photo by Grace Bell
Back Cover Photo: Interval Studio — Marty Kranzberg

Interval Readers:

I was recently in Mexico City attending an International Biophysics-Biochemistry Congress and had the opportunity to renew my acquaintance with Srta. Dolores Carrillo-Flores, the daughter of Julián Carrillo, Mexico's pioneering microtonal composer, theorist and instrument designer. Srta. Carrillo is a concert pianist who has performed and lectured about her father's music throughout the world. Currently, she is the president of the Mexican branch of Jeunesses Musicales, Juventudes Musicales de Mexico, an international organization devoted to furthering musical activities by young performers and composers.

Srta. Carrillo invited me to the Carrillo home in the suburb of San Angel, an old town a few minutes drive from Chapultepec Park in downtown Mexico City. She demonstrated the 96-tone Harmony Harp which doubles as a calibrated monochord for tuning the famous Carrillo metamorphosing pianos, which she also played for me. These are a set of fifteen specially built instruments, with standard keyboards, tuned to 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9, 1/10, 1/11, 1/12, 1/13, 1/14, 1/15, and 1/16 tones. Afterwards, we went out into the garden to inspect a studio which is being built to house the pianos, scores, books and papers of her father. When completed early next year, this studio will provide space for musicians and scholars to come and work with the instruments and other materials of this seminal microtonalist. I envy anyone who has the opportunity to do so, not only because of my own interest in Carrillo's music. for it was a chance hearing of his *Prelúdio a Colón* which first introduced me to microtonality, but also because the studio and the Carrillo home are located in a lovely traditional neighborhood, situated in the midst of modern dynamic Mexico City.

There are plans for a microtonal music festival to be held next year in Mexico to commemorate the completion of the studio. This would be a wonderful opportunity to become reacquainted with Carrillo's music now that the majority of his recordings are out of print. Persons interested in working at the studio or wishing more information on the proposed festival should write Srta. Dolores Carrillo-Flores, Santisimo 25, Mexico 20, D.F., Mexico.

John H. Chalmers, PhD.
Houston, Texas

Ivor Darreg

8 December 1981

OPEN LETTER

The other day I received a letter from a friend in far-off New Hampshire, Buzz Kimball, enclosing Lester Trimble's article in the 29th November issue of New York Times Magazine section, *The Unsung American Composer*. "Unsung" all right—I didn't even know who Lester Trimble was! Well how could I? There is practically no communication channel for serious American composers to exchange ideas, and the article itself explains well enough what the situation is about getting orchestral pieces performed. It ends on a sad allegorical note. It might have been written in 1881 instead of 1981—there has been no progress in the symphony orchestra and concert-hall scene for a very long time. Just change a few names and it would apply to 50 or 75 or 100 years ago.

However, we needn't be quite that sad; the article leaves out some important facts. It discusses the standard symphony orchestra, which, as you know, is composed of obsolete instruments and furthermore has not admitted even long-established instruments of certain kinds and never any really new instruments.

In December,1929, which was 52 years ago, Percy Grainger, the Australian composer, wrote a piece on that problem, of introducing such instruments as the saxophone, the harmonium or reed-organ, or a group of pianos, or the marimba and vibraphone, into the orchestra. Obviously this has hardly happened either. That kind of innovation was the hallmark of the jazz groups and other popular bands.

If we were to put a dateline of December 1981 on Percy Grainger's article, it would go right through unchallenged. They might even think he was still alive, so contemporary does his plea seem. If they had read his *Free Music* affair, which called for the use of Thereminvoxes, then they would be sure it was up to date.

The problem stated by Lester Trimble could be summed up in one word: FEEDBACK. By playing only dead composers, and by choking up the communication channels with music from European countries written in the past, they manage to evade the idea of composers getting any response from their listeners. Then the live people—the conductor and the performers—receive that feedback and response which is really the due of the composer! So when someone writes NOW for orchestra, almost everyone in the chain that has been interposed between composer and listener not only has forgotten about feedback, but may not even realize its importance or necessity. The people in this chain of intermediaries have been PROGRAMMED to ignore many things. It would be next to impossible to correct a wrong of that kind which has endured for a century. Hence the pessimistic tone of Trimble's writing.

The limitations of the standard instruments of the standard orchestra, and of the pipe organ and the piano, have prevented all musical progress beyond a certain point. Well, not a definite date, but this instrument and then that one reached a stage of ripeness, and then beyond that point it was getting overripe—such is the fate of the piano. With thousands of composers round the world exploring everything they could for all this time, there was bound to be an exhaustion of harmonic resources within the standard 12-equal-steps-per-octave tuning, and an exhaustion of possible effects on each instrument, unless you are willing to put up with absurd extremes such as sawing the lid of a grand piano with the pedal held down, or bowing a violin on the wrong side of the bridge, or taking a flute apart and making flopping noises with its keys, or blowing half of a trombone. These are *mild* examples.

Foundation Notes

The House Is Still Standing

The house of Interval is still standing, after a current deluge of eviction notices over the past two months. The Interval Studio at 860 Third Avenue, in downtown San Diego, is one of the last buildings standing in a fifteen block area bordering on the old "skid row" section. The Horton Plaza project will transform the area into an elegant 800,000 square foot retail complex with office buildings, including a 700-room hotel.

The Knights of Pythias building (back cover) is owned by the Centre City Development Corporation (CCDC) which is administering the project. This body has leased this building and the group of adjacent buildings to Community Arts of San Diego, which has rented to Interval, The San Diego Repertory Theater and other arts organizations and individual artists. Because of delays in financing, the groundbreaking ceremony has seen numerous delays. Those delays allow Interval and the other arts organizations to flourish at lower rental rates than are available in the rest of the city. Currently we have been promised the space until March 15th, although our constant search for a new home continues.

Interval has a full slate of activities at the second story annex of the Knights of Pythias building, which program has continued from May 1st, 1980. The first program was the second annual Exhibition/Festival for New Instrumental Resources (catalogue available, $3). Since that time Interval has developed a full schedule of classes, including dance, music and poetics, as well as concerts produced and created by the Interval Performing Ensemble, and Dance Jam, the creative dance experience for everyone, every Friday night.

The "house" in the title refers not only to the building, but to the people in the Interval organization who have created productions of improvisational dance and music, and are developing material from a humanistic transpersonal framework. The humanistic aspect stems from our process of equality, artist to artist. In the improvisational process, all artists must respect each other in order to perform creatively together. These people in the Interval family and extended family comprise the house, and will continue to perform when the present studio has been razed. *Interval* magazine has benefitted by the continued growth of the activities at 860 Third Avenue. This magazine depends on the continued support of both the local activities and the national subscribers. A membership campaign will be detailed in the coming winter issue. We are slowly catching up on our production of the magazine and by sometime next spring or summer, we will be coming out at the beginning of each quarter.

At the year-end board meeting, four new members were elected to the board of directors. The president's gavel was handed from Will Parsons to Jonathan Glasier. Also elected were Judith Essex (vice-president), Paul White (secretary) and Elizabeth Glasier (treasurer). The seven-member board also includes San Diego Repertory Theater co-director Douglas Jacobs, and scientist-musician Ted Melnechuk.

Interval had its first successful fundraiser on October 13th. The San Diego Repertory Theater donated a pre-opening night of their production of *Elephant Man* to Interval. The money will be used toward our relocation effort. Thank you, Rep.

Recently two visitors from far away showed up on the same day. John Catler, a studio musician from New York City, plays 9 and 31 equal guitar. Mr. J. E. Marie (see Vol. 1, No. 4 page 5) came to San Diego from Nice, France, via Mexico City, where he was visiting Dolores Carrillo. The news is that sometime late next year there will be a microtonal festival to dedicate the Carrillo Museum.

COMING EVENTS

The Sonic Art Exhibition at Cal State San Bernardino will feature instrument makers coming from both the music and visual arts fields. The event will open on February 13th at Cal State, and Valley College (also in the San Bernardino area). Included in the exhibit will be workshops and performances, beginning with a concert by Cris Forster, on February 13th, at 8:00. Susan Rawcliffe will give a concert of Ocarina music on February 24th, from 12 noon to 1 PM. On March 2nd Chris Banta will demonstrate marimba making, bar tuning and acoustics, beginning at 12 noon, at the wood shop at the Cal State campus. On March 10th, Bob Bates will give a concert at 12 noon. For further information contact Marlin Halvorson at the Art Department (714) 887-7459 at the Cal State campus.

What is a *Mean* Tone?

by Ivor Darreg

WHAT IS A MEAN TONE?

My Webster's Collegiate Dictionary (older edition) has at least 18 meanings for the word *tone*. It also has about 18 meanings for the word *mean*! Under these circumstances, it is no wonder that everybody gets confused. Now couple the two words together and you have a *real* mess. Then use the compound term, with or without hyphen, or "solid" as the printers say, and nobody agrees on that either: *mean tone mean-tone meantone*—all are found in books.

Much the same situation about these words exists in foreign languages. It all started by the Ancient Greeks having too many meanings for their word from which our tone was derived. It's had 2000 years to get worse!

However, once we decide to explore beyond 12 equally-spaced pitches per octave, we have to deal with this confusing term. During the 17th and 18th centuries, many keyboard instruments, especially pipe organs, were tuned in some kind of meantone temperament, and with the current revival of the harpsichord, tuners are just beginning to be asked for it. This is one of the few places where the interests of music history buffs and contemporary composers coincide, and if we play our cards right, we could effect an agreement.

The phrase *meantone temperament* can mean a range of systems, or a family of tunings; but ordinarily it is understood to mean the ¼-comma temperament, so let us describe that first. Unlike other writers on this subject, my interest is the future rather than the past, so what it *will* mean is more important here than what it may have meant in 1700 or so. In particular, I strongly disapprove attempts to use meantone temperament with only 12 pitches per octave. The antiquarians and traditionalists will hate me to pieces for this, but let 'em scream their heads off! Most of the prejudice against meantone temperament stems from that very restriction to 12 tones/octave, which has crippled musical progress. If all you want is nostalgia, seek it elsewhere.

Gbb	Dbb	Abb	Ebb	Bbb	Fb	Cb	Gb
Db	Ab	Eb	Bb	F	C	G	D
A	E	B	F#	C#	G#	D#	A#
E#	B#	Fx	Cx	Gx	Dx	Ax	Ex

Fig. 1

Our ordinary nomenclature for musical pitches is based on an infinite series of fifths, usually reckoned up and down, i.e. sharp- and flat-wards, from C as zero or starting point.

If the fifths are just, i.e. exactly 3:2 ratio, then this series extends *forever* in both directions. The customary distortion of this state of affairs is the cheapest one that is musically of any value or use: viz. to remove a six-hundredth of an octave from each fifth, so that now the twelfth fifth up, B#, or the twelfth fifth down, D*bb*, will exactly coincide with the C we started with. This is the 12-tone equal temperament in common use today. This creates a circle of twelve fifths. It also means that whereas an infinite series of fifths fits our conventional notation and nomenclature perfectly, now with only 12 pitches we have lots of redundant names for the same pitch:

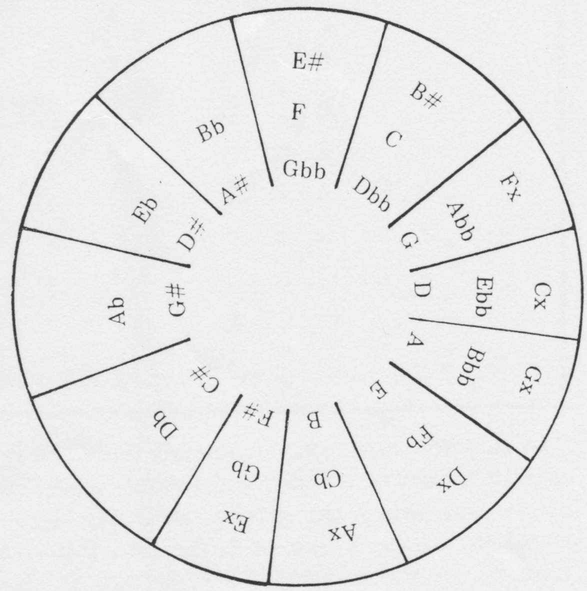


Fig. 2 Circle of fifths in 12 equal

These redundant names, such as A### B# C D*bb* E*bbbb* and so on forever, are usually called *enharmonics*, which is a very serious deadly-confusing misnomer. We need "enharmonic" to describe the small intervals used by the Ancient Greeks. Why not call them *equivalents* or *synonyms* in systems like 12 17 19 31 etc.?

Back to that infinite line of fifths which does not close a circle at all. Don't criticize me for infinity; I realize just as you do, that only the fifths from about A*bb* to Gx will appear in any ordinary music—indeed some people start "respelling" with those equivalents-in-2-tone before they get to double sharps or flats. So let's focus down now on a few fifths: say A*b* E*b* B*b* F C G D A E G F# C# G# D#.

If they were just, G# would be about 1/8 tone sharper than A*b*. That's fine for melody. Violinists use this kind of a scale very often. Now let's sound C and E of this series together. It will not be a just major third with 5:4 ratio, but a Pythagorean or sharp major third of 81:64 ratio and quite harsh in normal qualities of tone. Otherwise stated, Pythagorean intonation and its close imitation, 12-equal, favor melody and spoil harmony, sacrificing major and minor thirds for the sake of good fifths. The worshipper of 12-equal says: "Look at our excellent fourths and fifths! Only 1/600 of an octave out of tune and nobody can hear that in any real music." You are never allowed to learn that there are such things as smooth restful just major thirds, with exact ratio 5:4.

Suppose now that we take that line of fifths, or a small portion of it, and set the new notes that do not belong to it, major thirds of true 5:4 ratio away from it, forming other lines of fifths:

	G_1	B	D^1#	
	C_1	E	G^1#	
	F_1	A	C^1#	
	B_1	D	F^1#	
C_2b	E_1b	G	B^1	D^2#
F_2b	A_1b	C	E^1	G^2#
B_2bb	D_1b	F	A^1	C^2#
E_2bb	G_1b	Bb	D^1	F^2#
	C_1b	Eb	G^1	

Fig. 3 Central Part of the Web of Fifths and Thirds.

The sub- and superscript numerals there are approximately ninths of a tone, and usually called *commas* above and below the pitches with the same letter-name in the next line of fifths, and this comma is that of Didymus, not of Pythagoras, so don't get them mixed up.

Ouch! A double infinity! A plane surface of tones instead of just a thin line. That's too many. Such is the problem raised by just intonation. If we want pure thirds and pure fifths we demand an impossible number of tones per octave for a keyboard instrument, beyond a narrow range of modulations. But it sounds so much more smooth and soothing and restful than 12-tone-equal. (Music therapy, since it is never done in just intonation, has never been tried. The poor patients get only restless 12-tone-equal, which disturbs them all the more.)

12-tone sacrificed thirds for the sake of fifths. What if we take the converse position? What if we sacrifice fifths for the sake of thirds? How about that?

Meantone temperament to the rescue. Look at Fig. 3 again: look at the pair of tones called D and D_1 up there. The interval between C and D is usually called a whole-tone. Or a major second. In just intonation, there are at least two kinds of whole-tones. $C:D_1$ has the ratio 10:9, while C:D has the ratio 9:8. If we now look at the other part of a major third, in this case $D_1:E_1$ and $D:E_1$, we get the same two kinds of whole-tones; i.e. it takes, in a justly-intoned scale, one of the narrow and one of the wide whole-tones to make up the major third. To play, even in the scale of C major, we need *two* kinds of D, a comma 81:80 apart. Otherwise the chord D F A will be horribly out of tune.

Only recently has it been feasible and affordable to build electronic organs or program computers to give us enough just pitches to produce worthwhile music, free to modulate over a range of keys. It is impossible and too expensive if it were possible, to build pianos with that capability, and nobody would have the patience to tune them. This is why meantone temperament as well as just intonation have been *streng verboten* for some two centuries. Musical instrument manufacturers know only two clefs, which look like this: $ and ¢.

The question of how closely "free" instruments, such as voice, violin, cello, etc. approach just intonation is too big a subject to digress here. It can be taken up in other articles, or better by recordings.

Other than resigning ourselves to the ordinary 12 equally spaced pitches, how can we reduce the number of notes that just intonation requires? Many alternatives exist, but here we are concerned with the Meantone Family of Temperaments.

The interval 81:80, the comma of about 1/9 tone, which appears in even a small just-intonation array, is rather small for a melodic interval. If we choose the perfect major thirds of 5:4 ratio, and elect to sacrifice the fifths for their sake, then we take the line of fifths C G D A E (open strings of violin and viola, for example, give those fifths) and rob each fifth of ¼ comma, say 1/37 ordinary whole-tone. 1/222 octave is down to the microscopic, surely. So two of these shrunk fifths will give a new kind of whole-tone, C to D, and since it is halfway between the two just whole-tones in size, it is called a MEAN tone. This is the so-called Geometric mean, not the average of arithmetic. But as far as musicians need be concerned, it is half of a just major third of 5:4 ratio. So a meantone-tempered instrument will have perfect octaves and just major thirds, and some other intervals will be distorted to make this come out right. Now our Web of Fifths and Thirds in Fig. 3 shrinks back to a single line of fifths in Fig. 1, although now these are meantone-tempered fifths, and will beat if sustained on an organ in a normal tone-quality. Their error is roughly 2½ times that of the 12-tone fifths, in the same direction, i.e. too flat by a tiny amount.

We get rid of those commas completely by distributing their error among the notes being tuned.

In so doing, we gain restfulness and serenity, but lose the punch and zing in melody. (Well,that's not entirely so.) Instead of a doubly-infinite plane of pitches, we have a singly-infinite line of them. Our name-system and staff accommodate them perfectly. No problem. The Pythagorean difference between C♯ and D♭ is much smaller than the meantone difference between those pitches. So now, in meantone temperament the difference is big enough to be a usable melodic interval. About a fifth-tone.

It cannot be ignored. The circle of fifths does not exist in meantone. It fails to close at the twelfth fifth by this much larger amount. C-sharp is not the same as D-flat. They are now independent and the term *Augmented Seventh* becomes a new interval instead of 12-tone utter nonsense.

Before we go on: In the line of just or pure fifths, the Pythagorean system, B♯ is sharper than C by 1/8 tone; but in meantone temperament, B♯ is FLATTER than C by 1/5 tone.

I know it's confusing, but that's the truth. Both systems fit present notation perfectly, and that makes the confusion worse. Don't let this purely visual problem of names for notes keep you from enjoying the non-12 systems. I never composed for eyes. Maybe other people do.

Now let's explore other meantone systems. It is possible to use other fractions of a comma as the amount by which the fifth is flattened. For practical playing of worthwhile music, perhaps anything from 1/3 comma to a small fraction (theoretically, flattening by about one-tenth comma will get us close to the ordinary 12-tone system). "Meantone" used without any qualifications is generally understood to be the ¼-comma system just described. The 1/3-comma system has the *minor* third just instead of the major third, while the 1/5-comma meantone has the major *seventh* just instead of the major third. The 1/6-comma system would have its augmented fourth just, and so on to less-important intervals that would be just, so we don't have to bother for the moment.

Back to one-quarter comma. Let's see about where we might close a circle of fifths instead of that philosophically-troublesome infinite line of fifths. Huygens, the important physicist who invented the ship's chronometer and worked with telescopes, discovered in the 17th century that this circle of fifths almost closes at the 31st fifth. An extremely slight tinkering with the meantone fifths will give us the 31-tone *equal* temperament, which cannot be heard to be any different from straight ¼-comma meantone. Organs so tuned and guitars so fretted already exist, and there are compositions to play on them. Furthermore there is a vast meantone keyboard literature and many other existing compositions playable in 31-tone. I have published fretting-tables and used them.

Now let's go wolf-hunting: time to smash a few myths. Book after book on music has a story that goes something like this: "In olden times keyboard instruments were tuned in Just Indignation or Mean Tone, probably so-called because they were so out of tune that they expressed anger when played. Later in the 18th century along came Johann Sebastian Bach and he invented Equal Temperament, which of course means a calm unruffled disposition. Meantone instruments had wolves in them which howled fearfully when one tried to play in the bad keys. Bach took out his trusty musket and shot them dead, so we have been much better off since. He wrote pieces in all the keys to prove Equal Temperament the winner."

. . . Well maybe not quite like that, but equally far from the truth. The wolves were the harsh dissonance heard when playing a fifth such as G♯ and E♭, or a third such as B and E♭ instead of being able to play G♯ and D♯ or B and D♯ of the meantone system, which sound smooth enough. The wolf was a compulsory mistake created by having only 12 keys per octave. If there was no D♯ key, then E♭ had to be played instead and was woefully out of tune with G♯ or B above-mentioned. There was room on some organs and harpsichords to provide both pitches, and this was occasionally done. On the clavichord, pitches can be bent to some extent, subduing the wolf in some cases. A 31-tone guitar or organ has no wolves unless you deliberately play wrong notes as above outlined. If you tune 12 notes of meantone on today's pianos, you will hear lots of wolves if you get too far from C major. The expense and mechanical difficulties of providing more than 12 keys per octave 200 years ago forced most people to resign themselves to 12-tone equal. Bach did not invent it; it had already existed quite some time before on lutes and other fretted instruments. Numerous attempts were made to compromise between meantone and 12-equal, and since there were no precision tuning devices in those days, they must have been applied inaccurately.

Two of the meantone systems above come pretty close to certain equal temperaments, so we don't have to consider them separately: the 19-tone equal is inaudibly different from 1/3-comma meantone, so for all practical purposes they are identical. The 1/5-comma meantone is almost the same as 43-tone equal, so again there is no reason to have any distinction between them in practice. The Partchian 43-tone UNEQUAL system must not be confused with 43-tone-equal, however, since there would be little if any resemblance in sound.

Since these meantone temperaments make distinctions between C♯ and D♭, their diatonic and chromatic semitones are of different size. This causes many traditional authors to call them UNequal temperaments. We have seen how inaccurate this term can be, since the mean tone is an equal halving of the major third in each meantone system, otherwise it couldn't be called *mean*. When the 19, 31, and 43 systems are almost identical with certain meantone temperaments, and they are equal temperaments, "unequal" can be a misleading misnomer.

Many truly unequal temperaments are possible, and have been written about. A reasonably-sized selection of just pitches will necessarily be somewhat unequally spaced. It is true that meantone temperament crippled by using only 12 of its pitches on a standard keyboard instrument, is quite unequally-spaced, but if you add a few more notes the pattern becomes much more logical.

Backward-looking traditionalists want meantone temperament revived, but they amputate all the pitches beyond twelve so that you hear a den of wolves and the practical musicians of today can sneer at it and demand that you quit that nonsense. The traditionalists want all the *problems* of the earlier centuries revived along with the tuning system, and don't want you or me or any other composer to write anything new in meantone. With friends like that, who needs enemies? They are defeating their own purpose.

Time for us to get down to practical matters. Let the dilettanti argue with each other. The diatonic semitone, such as F-sharp to G or B to C, in meantone systems is larger than it is in 12-tone, and even larger than the similar interval in just intonation. Let's leave the math to another article. What matters here is that violinists and others do exactly the opposite thing—they are taught, as I was by my cello teacher, to sharpen all the leading-tones. To make the diatonic semitones *smaller* than those of 12-tone-equal. This sharpening gives brilliance, snap and sparkle. Examples would be the mordent-like figure which was Bach's trademark, or the usual chromatics in melodies. See Fig. 4.

Fig. 4 Diatonic semitones

In an organ recital using meantone, over a century ago, "great objection was taken to the flatness of the leading-notes." Well, do we have to be slaves to the written notation, just because some antiquarian hamstrings us? If you carry meantone out to enough pitches, or if you have a 31-tone guitar or organ, the remedy is very simple—play the next pitch higher than the notation calls for, as shown in Fig. 5:

Fig. 5

In Prof. Fokker's notation this could be written as in Fig. 6:

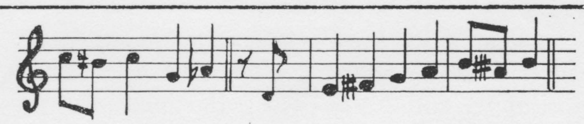


Fig. 6

if that would make you feel any better.

New Approaches to Pentatonic Notation

by Chris Banta

NEW APPROACHES TO PENTATONIC NOTATION

© 1981 by Christopher Banta

The Pentatonic scale is a fascinating institution. It has such soothing character with its oriental flavor; and it is a refreshing change from the traditional twelve tone, even though it has intervals wider than that of the whole-tone scale. Dissonances are seemingly impossible to achieve whether they are two note intervals or large chord clusters.

The Pentatonic is primarily of Eastern origin and undoubtedly passed on from generation to generation, it becomes a music of feeling and sensation. Many years must be devoted to its understanding for a creative interactive relationship needed for expression. From the Gamelan improvisation to the strict structure of the African Amadinda rhythms, the Pentatonic has quite a variety of styles and methods, even with its finite five notes. This is due to the time required for its expansion as with ours to the twelve-tone. Both have a ways to go before exhaustion.

As Western musicians look for further expression, it becomes necessary to document their findings and creations, hopefully with compatible languages (such as our Western notation technique). We all grow up and are taught a five-line staff that holds different types of notes, clefs and meters. This is necessary for capturing a melody, an idea, and most importantly a feeling.

Anyhow, as I was working on a new musical instrument called the Pentamarimba, I noticed that the layout of blank bars could become somewhat confusing. They lacked some kind of reference point for proper orientation. Numbering the bars could work, but something was needed to capture the eye's attention like the black keys do on the piano. Instant reference points are necessary for indicating a place to start from or return to.

Here are some methods for conveying the five tone equal scale using Western ideas. All methods deal with identifying the notes plus a corresponding staff.

METHOD 1

We will use percussion bars similar to the marimba for an illustration. Indelible dots are marked or placed on the numbers one and three bars (Fig. 1). This could be done by using a dowel plug imbedded into the wood. The spacing is one followed by two, one then two, and so forth. Octaves now become easy to spot and intervals of any size can be recognized almost instantly.

An appropriate staff for this first system would be twin three line staves (Fig. 2). The treble clef sign represents the notes of a higher register while the bass clef represents the lower register. The middle "C" ledger line could relate to some sort of mid-scale starting or reference point. (Five tone equal does not follow any Western standard, so the tonic could be an arbitrary frequency.) As shown, the Pentatonic scale fits very conveniently on three lines. Octaves alternate from line to space just like Western notation. Rhythm figures would be written exactly the same as our Western method. But, like anything new, this method would require familiarization and of course practice.

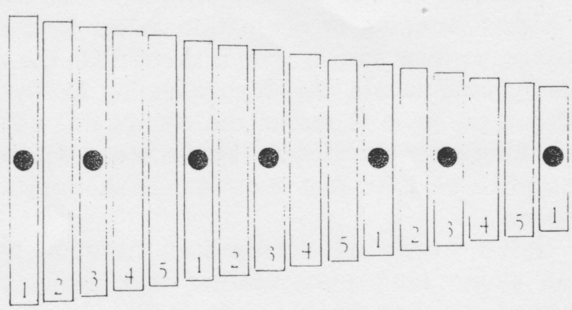


Fig. 1

Fig. 2

METHOD 2

The primary purpose of this method is to maintain the sharps, flats, and naturals concept like traditional notation. Reference dots would fall on the numbers two, four, and five bars (Fig. 3). This takes on a similarity to the black keys on the piano. Bar numbers one and three (which represent the white keys) would require sharps, flats and naturals to sound the two, four and five notes. Just like the piano, this creates enharmonic equivalents. For example, a 1♯ would be the same as a 2♭. Similar to a C♯ sounding like a D♭.

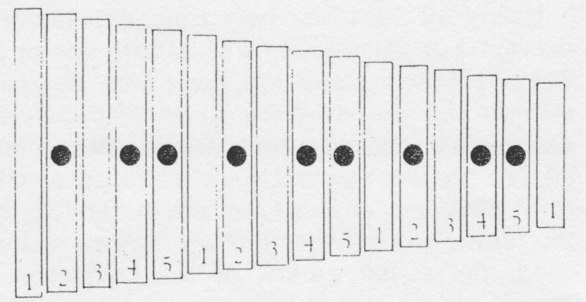


Fig. 3

A staff for this method would take on a relationship of the number one note corresponding to a line (any line) and the number three note corresponding to a space (any space). Fig. 4A shows the use of a two line staff that will hold an octave's worth of notes. A chromatic version of the five note scale is shown. Ledger lines can be added above and below the staff as needed. Fig. 4B shows the use of a five line staff which would offer an additional range of more than four octaves. The numbers one and three notes occupy this staff. The theoretical middle "C" point could start anywhere on the staff which is similar to the floating alto clef. Both high and low register scales could fit on this format.

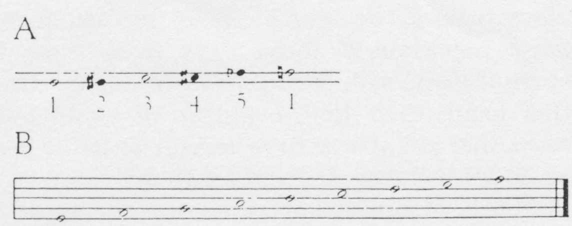


Fig. 4

METHOD 3

Method three is probably the simplest of all. Reference dots are marked on the numbers one and two bars (Fig. 5). By utilizing a traditional music staff, notes one and two would correspond to two lines. Notes three, four, and five would occupy only the spaces immediately above (Fig. 6).

Cont. Pg. 23

MUSICAL STRINGS

PART I

Ivor Darreg

MUSICAL STRINGS

Nearly all musicians have some experience with stringed instruments; most of us own one or more. Before people made strings, there were the sinews of animals and the stringlike fibres of plants, so the history of strings goes back beyond human reckoning. To produce musical tones, a string generally has to be stretched, so most music historians begin with the hunter's bow—once archery became well-developed, the varied sounds of the bowstring under tension would have been heard and then our natural impulse to experiment would have led to the invention of all manner of stringed instruments.

There are so many books on the history of musical instruments now, and most of them are illustrated, so we need not duplicate their information. Suffice it to say that the cataloguing of stringed instruments is very difficult, simply because the *names* in different languages are so misleadingly confused: one name will mean several instruments or several instruments will have the same name. Or both at once! This makes the history of what instruments had what kinds of strings on them obscure. We will never really know certain parts of the string-story; some of it has to be filled in by Educated Guesses.

For instance, the term *chord*, derived from ancient Greek *khordē*, which primarily meant *gut*. We won't be too much out of line if we assume that the Ancient Greeks used gut strings on their instruments. Knowing from our own experience how gut strings behave, we won't expect too much micrometric precision in those days from those early experimenters with stringed instruments. On the other hand, their long centuries of continued use proves that gut strings have certain desirable properties, so we will respect them for that.

Enough of history; we are more concerned with gut strings of today. Let's reassure all the cat-fanciers—musical strings are made of sheep-gut, and the "cat" name is either a wornout joke or something to do with the pochette or *kit*, a tiny 3-stringed fiddle used by dancing-masters. For a cello D string, it takes 40 or more individual fibres, twisted together. Naturally, on a doublebass the strings have even more fibres to make up the larger diameters. Gut strings are still used to some extent, and besides the violin family they may be found on viols and some harps. A few really fussy classical guitarists often use them despite the breakage and expense; and of course the players of 16th-century instruments like the lute or theorbo may insist on them.

The main objection to gut strings is really safety: when they break they can injure the hand, or face in the case of a violinist. Being made up of multiple twisted fibres, they may go "false" before they completely break. So for most people gut strings are now almost entirely replaced with nylon or similar synthetic material. Some of the aforementioned classical guitarists may use silk strings in certain places. We may be fairly confident that researchers in their laboratories around the world are already working on other synthetic materials that may overcome any alleged disadvantages of nylon for musical strings. The possibilities are so vast in chemistry that we have to be optimistic about this. To get technical for a moment, gut and silk are protein-based, while nylon, the principal substitute for them, is a nitrogen-containing long-chained polymer, so in some respects it resembles the protein fibres.

Some fairly recent experiments in France were alleged to show that gut strings on violins had a different kind of elastic behavior than nylon has, therefore the subsidiary tones were different. All these materials are elastic and they stretch after pulling up to pitch, so have to be retuned. They tend to have a higher damping or dissipation factor than metal strings, so their sustain-time is shorter. On the violin family instruments, this high damping factor is an advantage, since it means the strings will not ring too long after the bowing stroke stops. Of course the price paid for that is extremely short pizzicato notes.

Nylon strings are usually monofilament, that is one single solid piece, rather than many fibres twisted together. They can be made of many filaments if desired. They are much more uniform than gut strings, so are more predictable in behavior.

Strings are produced in different gauges. In this country the string diameter is expressed in thousandths of an inch, while abroad it is expressed in millimeters, and we are gradually converting to the metric system, so both systems will be found in use. In addition to the above gauges, the spring-steel music wire used for strings is often sold by arbitrary gauge numbers—these numbers, however, are gradually going out of use. Ordinary iron, copper, brass, and bronze wire is often sold by B & S gauge numbers which do not coincide with the music-wire gauge—indeed, these numbers run in the opposite direction! Thus for our musical strings there will be four incompatible series of numbers involved. Instrument-builders should take care. Don't say we didn't warn you. Some fine Utopian day in the future, every string will be gauged in millimeters.

Cont. on pg. 19

An Interview with Terry Riley

by Jonathan Glasier

Terry Riley, Jonathan Glasier

INTERVAL INTERVIEW WITH TERRY RILEY

This interview took place at the University of California at San Diego a day after the Terry Riley concert at Mandeville Auditorium on May 30, 1981. The first part of the concert was traditional Indian music: one, two and three part singing with tamboura and tabla accompaniment. The second part of the concert was solo organ, although Terry Riley's masterful use of delaying and other layering techniques produced a sound tapestry which gave the effect of more than one player.

JG: How and when did your influence by Indian music come about?

TR: It started through North African music and also my interest in the music of the Middle East. In 1970 I became a disciple of Pandit Pran Nath and had a formal introduction to Indian music at that time. Before that I had had only a casual acquaintance with the music.

JG: What was it that drew you to the music?

TR: It was a kind of "space" thing. The mystical quality that takes you out into that unknown land. By nature I was always attracted to it and wanted to express myself in that manner. India was always the mother of this idea and is the oldest tradition that goes into "inner space." I always felt that it was my favorite. Of course all music has that spatial feeling to some degree, but most other music reverts back to the body, the physical plane, which brings you out of the spiritual.

JG: What would your idea of a perfect setting for a concert be? I'm interested to know because last night's performance was in a huge hall. I felt that something was lacking in the intimacy I wanted to feel with the Indian portion of the evening.

Because of its devotional nature it is music for a person to sit down with, to get away from the world: especially in the Western world there is a certain social atmosphere and expectations for being entertained in a certain way. People come in from busy lives full of scurrying activity and are not prepared to accept the spiritual, devotional attitude of the music. Consequently, if they are not dazzled by the sound immediately, they get up and walk out as some did last night.

TR: Singing this music is best in a smaller hall or home where microphones are not needed. You have a more intimate relationship with the people on stage and a more responsive audience.

The acoustics for the organ, on the other hand, were very good and the point is that organs are made for larger halls. People's attention is more easily brought to the music because it sort of surrounds them and puts them in a more comfortable mood.

JG: I did feel more comfortable with the organ. The information that came out was from a naturally electronic source. Maybe that's the difference. I'd like to talk about the crossover between the traditional Indian music and the music you create on your organ. Could you begin by explaining about the duets. Is that a traditional form?

TR: Yes, two people singing together.

JG: And sometimes three?

TR: Usually it is one to three people singing. Often a master will sing with two of his disciples, or two brothers will sing together. It is often a family thing. It is a way of intuitive interplay. It is a great form of singing where each person can take inspiration from the other and you are listening to and singing to each other at the same time.

time.

JG: I noticed that you often ended singing in unison. I wondered whether that was by accident or design.

TR: We choose to sing in unison a lot to enforce each other's tone, to make it broad and warm.

JG: The svara?

TR: Yes, the svara means pitch.

JG: And many times you are singing the names of the pitches?

TR: Sometimes we use a form of solfeggio called "sargam" which is the term for the group of syllables. There is a very good tradition on how to use these syllables in the music to express certain emotions.

JG: How did you develop your style which seems to have that same ongoing reverie as the Indian style and yet it has a western quality too?

TR: We have to look at both mediums to see why they come out differently. One is the singing—the voice is a very fluid and flexible instrument. It can slide between two notes and create a constantly changing harmonic structure. The organ, on the other hand, has twelve (not equal) pitches and the movement between pitches is quite limited.

JG: You do have portamento capabilities.

TR: The Yamaha has a touch sensitive keyboard which means that you can move the tone up and down (within limits) at the rate you want.

JG: It gives you a lot of expression.

TR: It is so much more like a violin. The fact that I have only twelve tones means that I have to substitute something for the fluidity of the voice, even though I want to sing through the organ. Some of the substitutions are movements of the drone. In Indian classical music you have a chord in the tamboura—a diad or a triad, the fundamental (always doubled) the fifth, seventh or maybe the fourth degree. With the organ my drone is sometimes more complex and takes on somewhat of a figured bass or chordal-like progression that also carries a rhythmic cycle, the number of beats that each pattern carries. In singing, of course, that is done by the tabla giving out the certain number of beats in each cycle. So that correlates to the left hand in the organ.

JG: You have an extra bass section, but it is difficult to see. We were saying while we were packing up the instrument how nice it would be to have some sort of mirror to see what the hands are doing during performances. You had a figured bass going on throughout that first long piece you played on the organ. Were you playing that constantly or was there some sort of sequencing going on?

TR: No, there was never anything generated outside of what I am playing except there is a digital delay which is a one-term echo which repeats. That can only repeat what I play and in miliseconds after. So I am playing everything that is heard.

JG: But it seems that there are so many layers of music being woven into the tapestry—

TR: Well, there is nothing else going on. The reason it sounds very rich, of course, is that you have two extra layers of sound created by the two channels of delay. That makes it richer. The reason I use it is to enrich the texture of the total harmony. It reinforces the tuning too and makes it almost like an antiphonal choir, because of the way the speakers are placed in the room.

JG: I don't see how you keep it all straight in your mind.

TR: I don't like to keep it too much on the mind. When I play I just go on automatic pilot and try to enjoy it. I work a lot of it out as a daily thing. And although it is improvised, it has been planned and worked over thoroughly—especially now that I have added the voice with the organ and things are getting even more complex.

JG: "Embroidery" is the piece with voice and organ. Where did it come from?

TR: I spent a lot of my life living around Chinatowns in different places—New York and San Francisco—I've always been attracted to that atmosphere. It started with just the sound of the word "China." The first two lines of the poem came to me just like that, "China man in Chinatown enchanted with an Ancient Chinese Gown Sits Down."

JG: Alliterative .

TR: That was the first line that came to me and from there on it was like a dream that kept adding on all the time like a story.

The thing about singing in English is that you have to look for words that have the same richness as the music. This is an added element that I find very exciting to work with, and it has given me a kind of kick. I love to sing and I realized that I couldn't play the organ all the time by itself so I would have to integrate it.

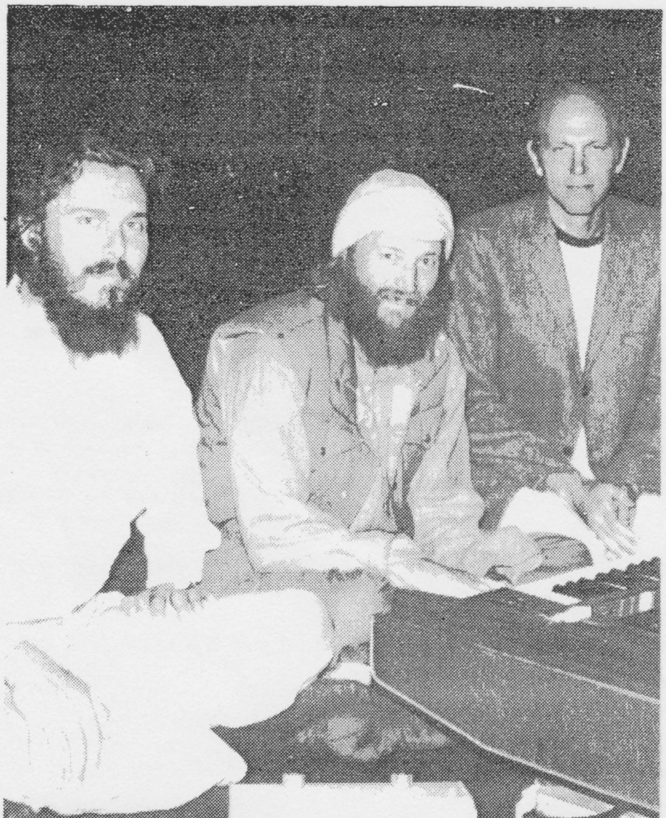
JG: So where will this new aspect of performance take you?

TR: I don't know where it all will go. Last night was a totally new concert for me—singing in traditional Indian style, solo organ and vocal with organ. I feel it will all find a place. Maybe I won't do them all in every concert.

JG: My thinking is that Western audiences have so many preoccupations about what an "entertaining" evening is supposed to be about, and mental tapes that say "OK. I'm sitting here giving my time, so entertain me." Whereas Indian music requires a different "head set."

TR: You know, I don't consider myself an entertainer. I might be partly an educator, but I don't want to be a lecturer. I do want the audience to be able to go along with me as far as I'm presenting my work in a very honest way.

Now if they are not able to sit there long enough to even get in to it, it means that we are not able to meet on that ground. Now I could go out right away and grab them with the organ, and leave the Indian section until later, but I felt like taking the risk to do the simple and pure thing first—pure raga. Then I could be myself throughout the concert.



L to R: Joe Saranda, Terry Riley, Christopher Woods

JG: Right. Then you didn't feel upset about people leaving during the concert?

TR: Yes I did. Any performer is affected by people getting up and leaving during his performance, because he has put forth a great deal of work and effort and there is hope that the people will be taken away on the same wave of inspiration. When people get up and walk out it affects the performer's concentration as well as that of the other people in the audience. By the same token it is a bit of an initiation for all of us. Not all the things we do together are just jumping up and down and clapping and being happy. A lot of our relations are meaningful. Somebody who even got ten minutes still might have enough to compare his next experience to. So they get something real and that is what is important.

JG: And?

TR: Well, if you add the drums and the excitement right off, and get the people all excited, you can never take them into that deeper expression.

You have to start from a pure place yourself, because no man can say that I can entertain you now and become holy later. It doesn't work that way because a musician is a very difficult thing to become on any level. It is a very naked and open place, especially when you are making it up as you go along. If the musician cannot get into that place himself, he can have no hope of carrying the others along.

JG: Part of the problem with "entertainment" is that it is looked upon by most as a means of escape, right?

TR: The experience of life to me is not running after experiences because ultimately the big thing about our lives is our death. Preparation for that moment is the important thing. The question is, how are we going to face that moment? Are we going to be looking for our next entertainment or are we going to be looking inside to see who we really are. This kind of music says a lot about that, because it means that you are content on being where you are at the time and allowing it to develop not according to your will but the will of the higher source—God or Buddha or what ever you want to call it. I'm trying to be receptive as a musician. I'm not trying to prove something or show the audience something special.

JG: Music is much more than the playing of notes or even "singing" on an instrument. It is the "process" of creation. When that process of creation is transferred, then something special is going on. I noticed, for example, that in one piece especially, there was no cadenza or dramatic ending to the piece that said, "This is the end, folks." All of a sudden it was just over.

TR: That happens to me all the time. I'm into a piece and all of a sudden I have ended up in a back alley and I am dumped off.

Terry Riley

JG: Yes, I felt that.

TR: After that organ piece I was let off so I said "OK, I'm here." I came down from where I was. I often feel like I'm on a jet or a train and I am being transported, but I'm not the pilot. The pilot is someone else.

JG: Right. I feel that in my own improvisation process.

TR: Sometimes that pilot can take you to some incredible places. Shri Ramakrishna says that "I am the machine and You are the operator. If you think this way, great things will happen." And those higher powers come and go. Sometimes they let you down. That has happened in a concert, but it's real. But if I went four (IV), five (V), one (I) at the end it would just be a mental tape—sometimes I do. Sometimes it is a beautiful ending that lets you down softly and sometimes we crash.

JG: It seems that in the ending of that piece last night you didn't crash but were just left somewhere.

TR: Perhaps it was a bailout.

JG: I understand that your organ is tuned in a semi-just C scale. You did change keys a couple of times but basically it was monophonic.

TR: It was basically C. There are only two pieces that I don't play in C, because I sing in C and I feel more comfortable in C. I've been in C my whole life. The intervals I'm using on the organ are the just C major and minor scales (Ptolemy) with some exceptions using the 7/4 for the seventh degree and the 7/6 for the third degree.

JG: Instead of the 6/5?

TR: Instead of the 6/5, but in some pieces I do use the 6/5 too. I use both. Sometimes I will use a tuning where the third degree will be a 7/6 and the fourth degree will be a 3/2 higher than the 7/4 ($7/4 \times 3/2 = 21/16$). I've been experimenting with shifting the tunings around between some songs—I am writing what I call *Songs From the Old Country*. One of those tunings is in Pythagorean, which you know gives you a sharp third, especially in the minor. I am finding out that there is always a give and take on the keyboard. In just intonation some intervals come out well and others don't. You can't ever seem to get it perfect all the way unless you have enough tones to the octave, like fifty, which would give you about all you would ever need.

JG: Have you ever thought of using the Motorola Scalatron? The one with the generalized keyboard would give you up to 31.*

TR: I'm not familiar with that keyboard. Looks as though it might be difficult to get used to.

JG: Not as difficult as you might think. And you can immediately change from one scale to another, which is especially great for demonstration purposes. Too bad that they have closed down operations. I don't know of another synthesizer or organ that has preprogramable pitch capabilities.

TR: I can't really speak for the instrument because I haven't tried it, but hopefully something will come around to be adapted into general practice. A lot of what I would like to do I feel is limited on the standard keyboard. Sometimes I want another interval and would like to have it but I realize everything has its limitations.

*Only three Scalatrons with generalized keyboards exist: one on the west coast belonging to George Secor, one in the midwest at the University of Illinois in Ben Johnston's office and one at Queens College in New York which Joel Mandlebaum uses for composing. There are six preprogramable scales on the instrument with 1024 different pitch possibilities.

RESONATORS Part II C.C. Banta

RESONATORS
Part 2
How to Tune and Measure Them

 by Christopher C. Banta

Acoustic resonators have a fundamental frequency in which only a small amount of energy is needed to excite or set the system into resonation. It is at this point the system exhibits its maximum amount of energy and amplitude. However, the external motivating force must have the exact same frequency as the system, otherwise the resonating system will not be set into motion.

Acoustic systems whether they are loudspeaker enclosures or resonators require some kind of tuning for optimum performance. In the case of the resonator, tuning will cause it to respond to a specific fundamental frequency. The result will:

1. Amplify a sound source when the source is located above the opening. (Similar to a marimba bar suspended over a resonator.)
2. Absorb any sound whose frequency matches the resonant frequency of the resonator.

The resonator actually performs both of these functions simultaneously, but for the sake of the musical instrument, we are interested only in the first result. So, what becomes important is the position and direction of the motivating sound source.

COLUMN OR TUBE RESONATORS

The tube type resonator represents an acoustic system whose wavelength is a *proportional segment* of the tube's length. In the tube, the resonating frequency is controlled by length not volume. The basic regulating factor for the tube is:

To lower pitch— increase length
To raise pitch—shorten length

This applies to all tubes, both ½λ and ¼λ resonators. (See RESONATORS, Part 1, INTERVAL Summer 1981.) Since higher frequencies have shorter wavelengths, the same applies to tube resonators. The shorter the resonator, the higher the pitch. The longer the wavelength, the lower the pitch or slower the frequency. To halve a frequency of a tube, whether it is open at both ends or closed at only one end, the length must be doubled. To double the frequency, the length must be cut in half. This phenomenon lends itself very nicely for adjustments of the column length.

TUNING METHODS

The following are tuning methods that can be used to adjust the column length.

—To raise pitch (shorten column)
- Method 1. Slider (Fig. 1A). Tube must be longer than desired length.
- Method 2. Remove a portion of the tube. Too permanent.
- Method 3. Flare the opening. Applicable only to round tubes.
- Method 4. Stopped ¼λ resonators: push stopper in (Fig. 5A).

—To lower pitch (lengthen column)
- Method 1. Slider (Fig. 1A). Tube must also be longer than desired length.
- Method 2. Physically add length.
- Method 3. Cover a portion of the opening (Fig. 1B).
- Method 4. Stopped ¼λ resonators: pull stopper out (Fig. 5A).

All methods have a limited range which they cover. For instance, to significantly lower an existing frequency, a new length altogether would be necessary.

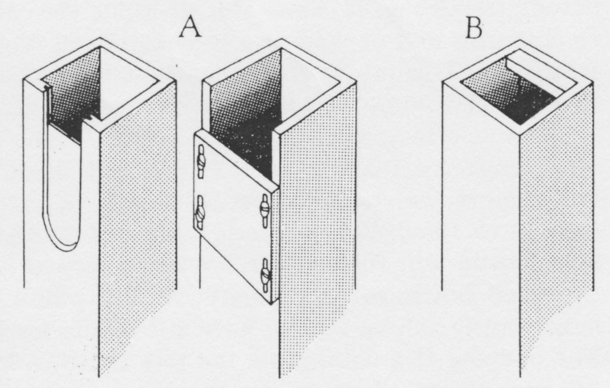


Fig. 1 Tube tuning slides

MITERING

Mitering is a method of bending or changing direction of the column so that it will conform to smaller spaces (Fig. 2). This is a practice pipe organ builders have done for centuries. In bass marimbas, the longer resonators would have to be mitered in order to keep the instrument at a playable height. Resonators could be neatly tucked underneath the bars. Mitering also has no effect on sound output or frequency, but abrupt corners tend to make travel of the internal wave less efficient.

HELMHOLTZ RESONATORS

It should be noted that the Helmholtz resonator represents an acoustic system that is *small* in comparison to its wavelength. The frequency of this type of system is controlled by volume, not by any single dimension such as length, width, or depth.

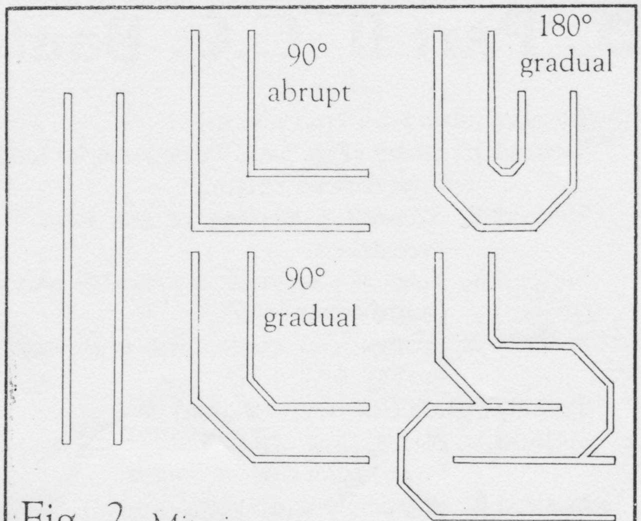


Fig. 2 Mitering

The basic regulating factor for the Helmholtz resonator is:

To lower pitch 1. Increase internal volume and/or
2. decrease opening area.

To raise pitch 1. Decrease internal volume and/or
2. increase opening area.

When an external sound source matches the resonator's frequency, it causes the air inside the cavity to compress and expand at a predetermined rate or frequency. This rate is controlled by a ratio of area to internal volume. An analogy can be used to describe the effect more clearly. A large bottle has more capacity than a small bottle and therefore holds more water. Both bottles require a certain time to be filled. With a steady stream of water, the large bottle will fill to capacity much slower than the small bottle to its capacity. At this point, the larger bottle can be said to have a lower frequency. The opening also determines the rate to which they fill and empty. A large opening can accept water faster thus filling to capacity quicker (high frequency). A smaller opening can't accept the water as fast and will take longer to fill (lower frequency). The same would hold true for emptying the bottles. Here is a situation where any combination can be employed. For example, a bottle with a large opening and a small capacity can fill and empty very rapidly, while a larger bottle with a small opening will take much longer.

Here are some rules to be noted:

To halve an existing frequency, you have to:
1. Decrease the opening area to one-fourth its original size.

or

2. Increase the internal volume by four times.

To double an existing frequency, you have to:
1. Increase the opening area four times.

or

2. Decrease the internal volume to one-fourth its original size.

AMPLITUDE

If we have a cavity with an internal volume of 1034 cu. in. with an opening area of nine sq. in., the resonant frequency will be approximately 100Hz. This represents the optimum resonant frequency you can get from this opening-to-volume ratio. To increase the loudness or amplitude you need a resonator with a larger opening and a proportionally larger internal volume. Now, there is a certain degree to which you can vary the resonant frequency. If you want to lower the resonance from 100Hz down to 95Hz, this size resonator can probably accommodate it without too much loss of loudness. But, to go down to around 70Hz would be out of the question. There would be a significant loss of amplitude thus resulting in attenuated output no matter what size your primary sound source is (Fig. 3). It is this reason alone why the Helmholtz resonator has only a limited range or latitude to which it can respond faithfully to a frequency.

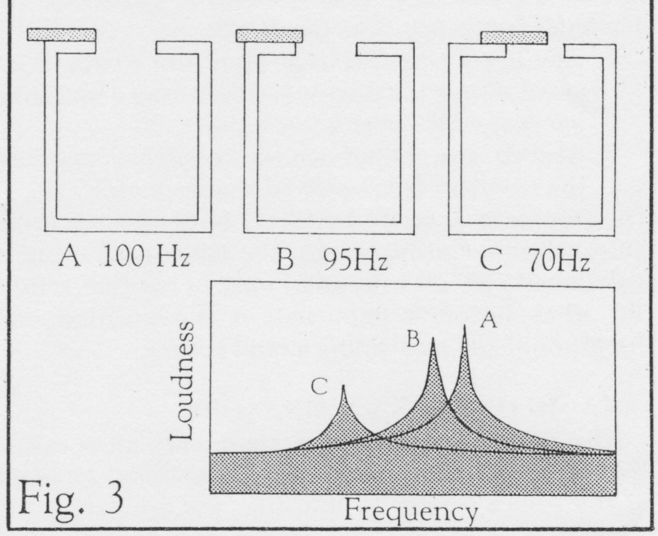


Fig. 3

METHODS OF TUNING

Method 1: Control of the opening

A simple sliding mechanism can be mounted on top of the resonator, partially covering the opening (Fig. 4). The hole should be about 30% longer or larger. Now, by sliding the cover over the opening a little bit at a time, you will hear a slight lowering of the pitch. Slap the side of the resonator and hold the opening close to your ear. The resonant frequency will come forth. Do not hold the opening too close, otherwise your head will create additional flattening of the pitch.

Method 2: Control of the volume

What is necessary in this method is to have control over the displacement of volume. One way would be to build a resonator with a duct and stopper (Fig. 5B). The stopper can be pushed in or pulled out, causing a displacement of volume, thus raising or lowering the pitch. Another way that can help an oversized resonator is by throwing small pieces or blocks of wood into the resonator. You will create displacement of the internal volume, but of course, too much wood will raise the resonance too high.

Method 1 is the primary way to tune a Helmholtz resonator. Method 2 is secondary and should be done as a last resort.

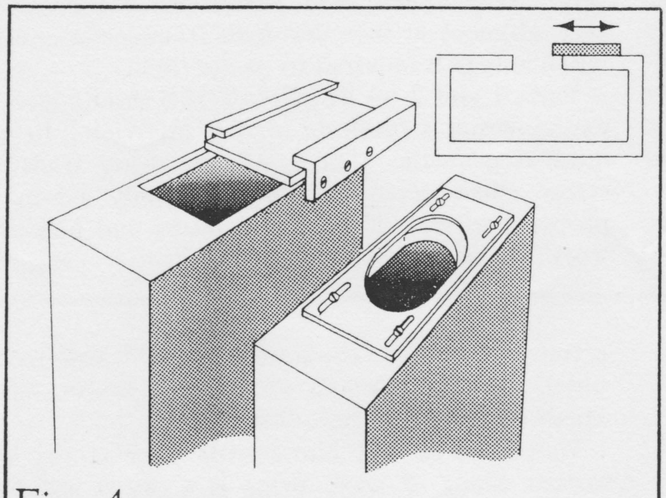


Fig. 4 Helmholtz tuning slides

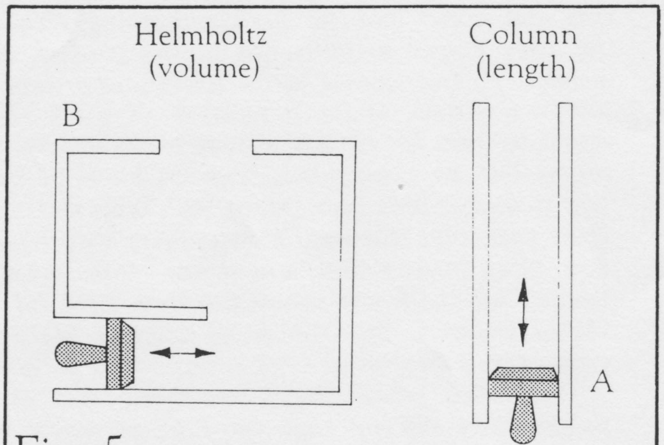


Fig. 5 Tuning stoppers

MEASURING WHAT YOU'VE TUNED

The ear is a remarkable mechanism for hearing distinct pitches and tones, but unfortunately it is not as accurate as a Strobe tuner. It is extremely difficult to remember *exact* frequencies, especially with lower tones. This is where electronic test equipment is essential. Test equipment is not complicated and can become an invaluable tool due to its ability to measure the results with extreme accuracy.

There are four pieces of equipment that can be used for testing purposes. They are:

1. Audio oscillator—generates a continuously variable test tone from 20Hz to 20KHz.
2. AC Voltmeter—a voltage measuring device.
3. Frequency counter—used to actually count the cycles per second, then display the quantity.
4. Strobe tuner—an accurate tuning device.

Some peripheral equipment will also be necessary.

1. Audio amplifier—a voltage boosting device.
2. Loudspeaker—may be open or enclosed, but should have a frequency response from 30Hz to 1KHz.
3. Microphone—preferably the small lavalier variety which offers little or no displacement when inserted into the resonator.

Fig. 6A shows a simple method of verifying pitch (not frequency) using a Strobe tuning device. The stroboscopic lines on the spinning disc represent the exact pitch when standing perfectly still. This works in conjunction with a dial that indicates the notes of the scale and another dial that gives inbetween steps that are measured in cents (hundredths of a semitone). A microphone is connected to the strobe tuner and placed near the opening of the resonator. Now, the side or bottom of the resonator can be slapped, thus causing a momentary tone burst or boom tone to emanate from the opening. The strobe will show an instantaneous indication until the tone burst dies out. The stroboscopic lines will move to the right or to the left if the resonator is sharp or flat from desired pitch. Tuning adjustment will correct this.

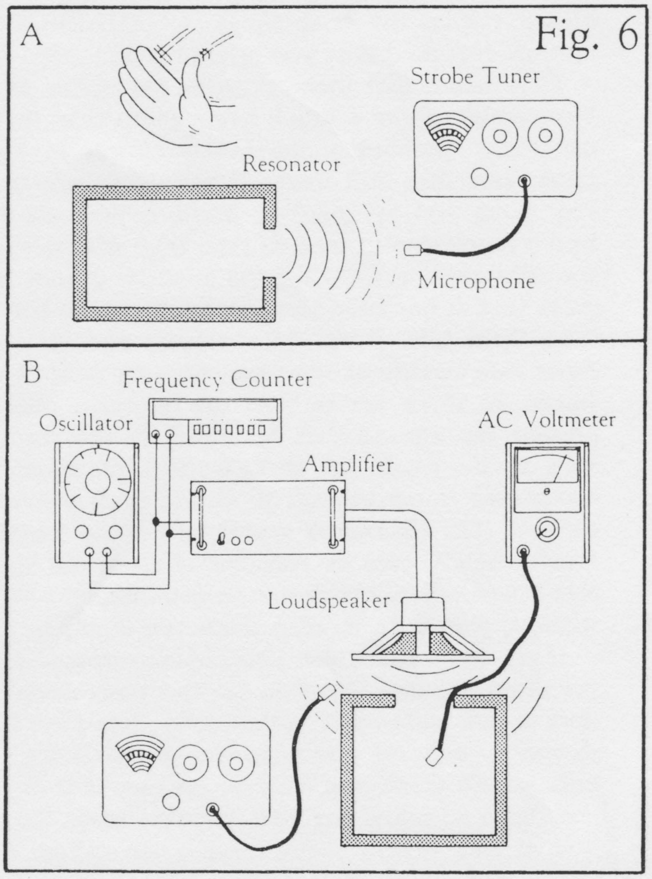


Fig. 6

Fig. 6B shows a more accurate method for checking the tuning and frequency of the resonator. The block diagram indicates how the test equipment is connected and this is basically how it works: The *oscillator* produces a sine wave test tone which is fed into the *amplifier*. The amplifier drives the *loudspeaker* which audibly reproduces the test tone and conveys this energy into the opening of the *resonator*. The *frequency counter* gives better resolution of the dial markings on the oscillator and is necessary for frequency measurements. The *microphone* is placed inside the resonator and then connected to the *AC voltmeter* which visually indicates an increase or decrease in voltage. The increase of voltage is the increase of energy or pressure picked up by the microphone when the resonator nears its resonant frequency. The *strobe tuner* is used to verify the tuning pitch of the resonator, but only when the needle on the AC voltmeter has reached its peak. Do not peg the scale.

During the tuning process, both types of resonators will have to be constantly monitored for controlled results.

A word of CAUTION! The energy *inside* the resonator is extremely powerful and can produce a very dangerous sound level to a small microphone, especially when approaching the point of resonance. Keep the level of the loudspeaker to a minimum or very soft volume at best. Remember, resonators are very efficient at their resonant frequencies and not much energy is required to excite them.

Parts 1 and 2 on RESONATORS should give the experimenter a foothold on this interesting field of musical acoustics. There will be many trials and errors encountered, but this can only aid in the proper understanding of resonators and how they work.

Strings

Cont. from pg. 11

The frequency (fundamental pitch in hertz or vibrations per second) of a string is governed by its mass and stiffness. Obviously, tightening a string increases the stiffness or restoring force, and winding something over the string increases its mass. Memorize the following: To tune a string an octave higher (twice the frequency), QUADRUPLE the tension. Not double as you might think.

That means that those valuable old violins, which were designed for a much lower pitch than that in use today—perhaps a whole-tone lower in many cases, and then still lower if certain people tuned "by guess and by gosh" in those days—must now bear a much greater tension than they were designed for. The tension on 12-string acoustic guitars is so great that it has been the custom for some time to tune them low. Some of the lutes and viols and other instruments of the past were very delicate and fragile, so if we are to read the notation with the present assumption that Middle A is 440 Hz, perhaps all the music for these instruments should be transposed down enough to ensure their continued survival. The alternative would be for the constructors of new copies or versions of these old instruments to beef up the design to withstand the higher tension, and/or to shorten the active string lengths.

If you are making new stringed instruments, allow for some increased tension in your basic design, so they won't collapse if accidentally tuned too high. Actually, some of the historical pitches were very high, so the traditionalists who are sure of their data may have to allow for that in some cases. To give you an idea of how string tension can add up, early pianos had relatively thin strings and used much the same kind of wire as comparable harpsichords. In the later 19th century, pianos went from wooden to metal frames, used tighter and thicker strings, then special high-carbon spring steels were developed, and the tension for a concert grand went over 20 tons! It's probably more than that now. Even the raising of a piano's pitch from 435 to 440 Hz will add half a ton of tension to the frame. Now this rise from an older standard (French pitch) to a newer one is about a tenth of a whole-tone.

Harpsichords and clavichords were strung with various kinds of wire. Brass is a rather indefinite term, meaning an alloy of copper and zinc, but it comes in different proportions, and can be made soft and rather limp, or hard and springy. Today, the alloy known as phosphor bronze is often used instead. It, too, comes in different proportions of alloying metals. Quite a number of other alloys could be used for musical strings—some metallurgist might like to experiment. Various kinds of harps and psalteries have been strung with brass and in the Near East some still are. Contemporary harpsichords and clavichords often are strung with brass or bronze for the lower notes and then steel for the higher registers. The timbre of brass or bronze as compared with that of steel is noticeably different.

Obviously, when the harpsichord was at its height, they did not have the kind of spring steel that is available today, so when iron or earlier steel was used for strings, the tone was different. Don't be too finicky about all this: when building such instruments today, design for today's materials, since they are available and less expensive, and the modifications of timbre to get something suitable for early music can be made in other ways. What I really mean here is that an exact cookbook copy of an ancient harpsichord is probably not worth the trouble—new music is being written for harpsichords and they are no longer mere revivals and strictly-museum stuff. Not long ago I heard a broadcast of an allegedly "authentic copy" clavichord which sounded like a twangy bluegrass banjo with a terrific jazzy snap, and I am sure the early composer

alleged authentic clavichords often sound like something with all the expressive delicacy and tender sentiment of an electric typewriter. Of course that might have been the performer.

Cont. Next Issue

INTERVALS IN RECENT WRITINGS—A REVIEW
Including the *New Grove Dictionary of Music and Musicians*

by Douglas Leedy

It is an encouraging sign for the art of music that in recent years there has been a rising awareness of and interest in systems of pitches and intervals other than those provided by twelve-tone equal temperament (here abbreviated 12/ET). There are a lot of possible reasons for this: the general loosening of inhibitions toward musical materials in the last three or four decades; the influence of electronic media; a healthy renaissance of historical tuning and temperaments as part of the early music revival; the profound influence—going back at least a century—of non-Western musics. All these (and surely there are others) have at least begun to expand our hearing—"stretch our ears"—in the most salubrious way.

Disdain for, discomfort—or even disgust—with the intervals of 12/ET has led a fair number of composers along other paths lately, though the rejection of the 12/ET system is still looked on by many as reckless, antisocial, nihilistic, unrealistic, iconoclastic, rebellious behavior. This view may have a certain validity in the sense that not a few of us who have chosen other paths have been of a feisty if not rebellious nature.

The development of two serenely individualistic musicians and the discovery and adoption by them of other systems of intonation—in both cases based on just intervals—has been well documented in two recent articles: La Monte Young, "A Father Figure for the Avant-Garde," by Robert Palmer, in *The Atlantic Monthly* of May, 1981, and "Terry Riley," by Joel Rothstein, in *Down Beat*, also May, 1981. (An extensive interview with Young that took place in 1978 has been published in the Canadian periodical *Parachute*, 19 (Summer 1980), pp. 4-19.) Young and Riley came from similar American-west backgrounds in jazz piano and saxophone, with a similar practical, empirical attitude toward music and a healthy irreverence for certain domineering "schools" of twentieth-century composition, especially that rooted in academia.

They both had significant encounters with the academic world as graduate students at the U.C.-Berkeley of the early '60s, in a truly wondrous confrontation that the present writer was privileged to witness and take part in, at least in a small way. Both Riley and Young experienced, over a time, the revelation of what could be referred to as the "manifestations of truth" inherent in the purely tuned intervals, and they both perfected their practical grasp of just intonation, combined with techniques of extensive melodic improvisation, in many years of study (still continuing, evidently) with the eminent Hindustani vocalist, Pandit Pran Nath. (Pran Nath may turn out to be one of the most influential figures in twentieth-century American music.)

Riley has remained in California, teaching at Mills College and performing, both vocally with Pran Nath, and in his superb raga-improvisation concerts on a tunable Yamaha organ with drone and tape delay. Young lives and works in New York now, performing with his artist wife Marian Zazeela in mixed-media concerts, and on his specially tuned Bösendorfer concert-grand piano, in a large work (work-in-progress?), *The Well-tuned Piano*, recordings of which one hopes may soon be available. (Incidentally, Young has been able to get financial support from foundations that fund not musicians, but artists-sculptors, who seem to attract much more money; he may indeed make history as the most lavishly subsidized composer of all time, performances and archiving of his work being reportedly funded in perpetuity.) Both Young and Riley use selected pure intervals up through the 7-series in both harmonic and melodic contexts; the tunings, taking into account the Indian influence, seem empirically derived, the context diatonic.

The most important composer to use a system based on just intervals, Harry Partch, also wrote what is probably the most important book on tunings and their influence on music. If not the most important, *Genesis of a Music* (2nd ed., 1974, Da Capo Press) is the most fascinating and enjoyable to read (and read again). Partch, in his mordant style, not only describes the origins of his own system, but gives us a splendid, useful, and comprehensive historical survey of tuning theory and practice in East and West, with Partchian asides. (But INTERVAL readers surely know this book backwards and forwards.)

Musicians should also be aware of Lou Harrison's elegant small book, *A Music Primer*, which gives much insight into the practical use of just intervals in diatonic systems of various tunings. Harrison's influence as a teacher will surely become more and more evident in the next few years, especially through his "American Gamelan," developed and built with his partner, Bill Colvig.

There is some doubt whether these musicians would call, or have called, themselves "microtonalists." If not, then the non-12/ET movement seems still to be in search of a suitable name. All of us seem to have different approaches (the most common link being diatonicism); some use just intervals only, and some favor equally-tempered systems of various orders*; some are eclectics, too, like the present writer, who favor just intervals, but sometimes temper some, either from the use of a specific historical temperament, or in order to take advantage of the softening or shimmering effect of beats, as is found in certain Balinese gamelan music. "Microtonalism" just doesn't seem descriptive of these techniques or results, as many musicians have complained, but we'll probably have to make do with it until someone thinks of a better name, or until our onomatomania subsides.

One of the most remarkable aspects of the study of tuning and temperament is its venerable age; surely it is one of man's oldest scientific pursuits, along with the closely related theories of the movement of celestial bodies. A stimulating new view of ancient writings can be found in two recent books by Prof. Ernest G. McClain of Brooklyn College, *The Myth of Invariance* (Shambhala, 1976), and *The Pythagorean Plato* (Nicholas Hays, 1978). In the first book, McClain examines specific passages, and, in particular, certain recurring numbers in the Rig Veda, the Egyptian Book of the Dead, the book of Revelation, in dialogues of Plato, and elsewhere; he seems to find a continuous spiritual and metaphysical tradition that expresses itself symbolically through music and tuning systems. In the second book, which is tougher going but no less fascinating, McClain focuses very minutely on the late writings of Plato, taking his cue from a literal interpretation of a sentence out of the *Republic*: "Education in music is most sovereign, because more than anything else rhythm and harmony find their way to the inmost soul." He convincingly claims that for Plato, "as for his Hindu predecessors, *sound* [nāda] was the primary guide to 'interiority.'" The reader may be surprised to learn that Plato, for various reasons, seems to have favored equal temperament, at least as a theoretical model; of his idealized nation-states, only Atlantis foundered and was lost, because, according to McClain's interpretation, "it was gorged with luxuries," represented by the voluptuous intervals, especially thirds, of just tuning, and this doomed it to destruction. In chapter eleven of *The Myth of Invariance* there is a summary of the main points of the later book; but both, though not necessarily light reading, are fascinating and highly recommended.

Devotees of historical tunings have been favored recently with an abundance of books and articles on the subject, from the theoretical, historical, and practical points of view. The principal modern ancestor of all these is J. Murray Barbour's classic, *Tuning and Temperament* (1951; reprint, 1972, Da Capo), a remarkable book that sets out not only the history of the subject from the Greeks through nineteenth-century Europe, but also practical calculations and interpretations of the important historical tunings and temperaments, from sources that vary from vague instructions to specific divisions of the monochord. The fact that Barbour evaluates each system according to how close it comes to 12/ET, and the rumor that he never actually heard any other tuning do not detract from the impressiveness of his accomplishment nor from the utility of his study.

A "practical" companion to the Barbour book, and apparently based on it, is Owen Jorgensen's *Tuning the Historical Temperaments by Ear* (Northern Michigan University Press, 1978).** Though he garbles history and offers no insights on the quintessential connection between temperament and musical style, Jorgensen does give tuning instructions for over eighty historical tunings and temperaments, and one experimental temperament ("5 and 7 equal"). For practical use, however, the present writer recommends the following as basic material for the enthusiast of historical temperaments:

Klop, G. C. *Harpsichord Tuning*. Garderen, Holland, 1974; available from Sunbury Press, Raleigh.

Barnes, John. "Bach's Keyboard Temperament," *Early Music* 7:2 (April, 1979), pp. 236-249.

Lindley, Mark. "Instructions for the Clavier Diversely Tempered," *Early Music* 5:1 (January, 1977), pp. 18-23.

Not all of INTERVAL's readers may be aware that a number of fine organ builders, both in America and in Europe, have abandoned 12/ET and are using temperaments that are more suited to the instrument musically and historically, such as Kirnberger III or Werckmeister III (both of the ¼-comma unequal variety). Three such builders have recently built meantone instruments in the United States: one by Fritz Noack at the New England Conservatory of Music, with standard 12-note octave; one by John Brombaugh at Oberlin Conservatory (Ohio) with 15 notes in most octaves; and one by Charles Fisk at Wellesley College (Wellesley, Mass.), with 14 notes per octave (the extra notes are accommodated on a standard keyboard by sharps split back/front). These instruments sound quite different from the organ as most people know it (Fokker enthusiasts excepted), and the great beauty and variety of their consonances and dissonances should surely inspire the composition of new music for them.

Two more exceptional books should be mentioned briefly for those who may not know them: Arthur Benade's *Fundamentals of Musical Acoustics* (Oxford University Press, 1976) should be in the library of everyone with an interest in its fascinating subject; Benade's treatment of scales and other pitch relationships includes historical tunings, Indian and Indonesian music, as well as information of practical value to the musical instrument inventor/builder.

Intervals, Scales and Temperments, by Llewellyn S. Lloyd and

Hugh Boyle (St. Martin's Press, 1978) has reappeared in a second edition. Lloyd's essays are fine reading, full of insight, and Boyle gives an excellent technical introduction into the subject that is especially good for the uninitiated. Boyle takes up, as part of an interval-resource comparison, regular systems of 19, 31, 50 and 53, in addition to 12/ET and the main historical temperaments.

Historical temperament buffs will also be pleased with the amount of information collected in the *New Grove Dictionary of Music and Musicians* (1980), mainly in articles by Mark Lindley (v. "Equal Temperament," "Interval," "Just Intonation," "Pythagorean Tuning," "Temperament"). It is, however, quite a shock to discover that these twenty brand new encyclopedic volumes on music from A through Z, the last word in music scholarship to all human culture, whether ancient or modern, effectively ignore microtonalism, just intonation, or orders of equal temperament other than twelve as a contemporary musical resource. It is hard to believe that the editor of the *New Grove* would either deliberately, or through oversight or misdirection, ignore the powerful forces in music that now compel increasing numbers of composers and performers to discard twelve-tone equal temperament; but there are those who maintain a deaf faith in the false idea that 12/ET represents the ultimate development in pitch resources. And, of course, a very important—politically, if not musically—part of this century's creative capital is invested in a system that presupposes the superiority, and in fact the total domination, of 12/ET. (Perhaps Lindley himself means to give us a clue to the editorial policy of the *New Grove* in the introductory paragraph to "temperaments," writing, "Equal temperament . . . is the standard Western temperament today except among specialists in Renaissance and Baroque music.")

Articles on our heretical composers seem singularly lacking in relevant information concerning their intervallic habits: under "La Monte Young" and "Terry Riley" we find no mention of just intonation, central though it is to the work of those men. The importance of Harry Partch's work is acknowledged in an article by Paul Earls (though only those pitches of his 43-tone hierarchy from 1/1 through 9/8 are given, as if the rest of the system could be deduced therefrom); two excellent photographs of the composer and some of his instruments are printed, but Partch rates less than half as much space as a roughly contemporary American composer, Roy Harris—a tacit judgment on the relative significance of Partch's contribution to music that one could justifiably find fault with.

A greater disappointment, however, is the article "Lou Harrison," by Ned Rorem. Leaving aside that to this reviewer its tone bordered on the insulting, there is no mention in it of just intonation, nor does the word "gamelan" appear at all. No music after 1969 is listed (How can this be? Harrison is an active, published composer), a bibliography is for all practical purposes lacking (Are there really no articles on Harrison and his music? If not, then for so important a composer should not the *New Grove* make up for the lack?), and the *Music Primer* previously mentioned, in which Harrison lays out his practice and philosophy so clearly and eloquently, is ignored.

There are no articles in the dictionary at all under "Ivor Darreg" or "Pran Nath". (For such a large undertaking as *The New Grove*, the lead time is measured in years, and certainly omissions and lack of up-to-the-minute citations are forgivable; but bibliographical citations as late as 1979 appear in some articles. And one would think, too, that timeliness might be more important—though perhaps more difficult—in articles about living, changing musicians than for deceased and rather more static ones.)

More helpful in a way are the topical articles (but don't look under "Theory and Theorists" if you are after any information on the present subject; don't look under "Equal Temperament" either—the only number mentioned there is 12). "Just Intonation" is mainly an historical survey and an interesting one, dealing primarily with problems of designing keyboard instruments in a just disposition; the mention in passing of "H. Partch, the Motorola Scalatron Corporation and others" seems almost gratuitous, but there is a good description of the work of Eivind Groven, and a useful bibliography (readers should note that Ben Johnston's significant articles on just tuning appear in the eponymous entry).

"Microtone," by Lindley and Paul Griffiths, starts out by defining the lead word as "any musical interval or difference of pitch smaller than a semitone." From this one would expect the article to concentrate on the quarter-tone and other similar divisions, and it does, stressing the work of Haba, Carrillo, Boulez, and others. The authors mention the existence of microtones in just tuning as well, and state that "just natural intervals have also been used by, for example [in addition to Partch], Eiving [sic] Groven, Ben Johnston and La Monte Young." There's no hint of how these intervals are used, and the implication seems to lurk for the unwary and uninitiated that microtonal composers all write with teeny, tiny intervals.

Finally, there is the article "Interval" itself, the basis of which is a table of intervals "smaller than a tritone" with sizes in ratios, where possible, and in cents, "according to various systems of intonation that have been proposed for Western music since the Middle Ages." This table includes just and Pythagorean intervals, several forms of meantone (1/6-, 1/5-, 1/4-, and 2/7-comma), and equal temperaments with 12, 19, 31, 43, 53, and

55 divisions. The septimal ratios are also given as approximations to major third (9/7), minor third (7/6) and whole tone (8/7); unfortunately, approximations to the septimal ratios themselves in the various systems are not given.***

It might be helpful to point out that the "comma" unidentified in the table is the syntonic comma, and that the entry for "chromatic semitone" under 1/6-comma temperament should read "25/24 + 5/6 comma." This writer doesn't respond very positively to the opening sentence of the entry, which defines "interval" as "the distance between two pitches," as he has always thought of it as the *musical relationship* of two pitches separated by the distance in question. Perhaps this is nit-picking, perhaps not. A considerable amount of useful information has, in any case, been assembled in a useful format in this article; interesting hints of much more lurk between its lines, in fleeting implications, such as, "no doubt the harmonic distinction between 9:8 and 10:9 may be featured in certain kinds of music, such as in India. . . ." Or, "elaborate codifications of intervals have been developed on the basis of ratios involving . . . prime numbers larger than 5, a vulnerable aspect of such theories often being their relation to practice." Practice has often changed, and will continue to change; I am acquainted with Western musicians who hear and recognize the difference between 9/8 and 10/9, for example, who can sing 7/6 and 11/10 intervals, and use them in their music. Are we ready for these changes? Lindley seems to suggest an answer in the concluding paragraph of his article, "Just Intonation," when he writes, "the recently achieved technological feasibility of just intonation on keyboard instruments [may be] but a step to its musical emancipation, and . . . further steps are likely to depend on the resourcefulness of composers who may be inclined, in the future, to discover and exploit its virtues."

Emancipation of the consonance! What will these radicals think of next?

15 August 1981
Portland, Oregon

*An interesting evaluation of equal temperaments from 1 to 120 intervals per octave on the basis of the quality of the 3/2, 5/4, 6/5, and 7/4 intervals has been made by Dirk de Klerk in "Equal Temperament," *Acta Musicologica* 51 (1979), pp140-150. Among his conclusions is that 34/ET and 46/ET are as good as Mercator (53/ET) for 3/2, 5/4, and 6/5, and that 46/ET also has a very good 7/4.

**Reviewed by George Secor in INTERVAL 1:1 (Spring, 1978), pp 10-12.

***Taking 8/7 (231.17 cents) as a representation of the 7-series, we find it well approximated in both 31/ET (6/31 octave, 232.26 cents) and ¼-comma meantone (a diminished third, e.g., $G^{\#}$-B^{b}, will be 234.22 cents), as well as 53/ET (10/53 octave, 226.4 cents). The 7-series intervals are fairly well approached in 43/ET and 51/ET, as one can see in the de Klerk article mentioned in a previous footnote.

Pentatonic Notation

cont. from pg 10

SUMMARY

Each method has its own advantages and undoubtedly some disadvantages. Method 3 uses no sharps and flats and can fit onto a traditional staff. Method 2 is a good method for those who can relate to sharps and flats efficiently. Method 1 is perhaps the purest approach to five equal by borrowing just a little bit from the traditional system.

The intention of this writing is to lay down some kind of groundwork as a basis for other ideas and methods to stem from. It should be remembered that these new approaches are general concepts and specific detailing is obviously necessary in perfecting such systems. It is also interesting to note that a system that takes an Eastern philosophy and applies it to Western standards is recognizing certain ideals from two different cultures. When a system is easily understood and works well, it becomes a logical addition as well as an alternative to our twelve-tone. Finally, it seems that there are similar approaches which can be used for microtonal and other lesser than twelve scales.

Fig. 6

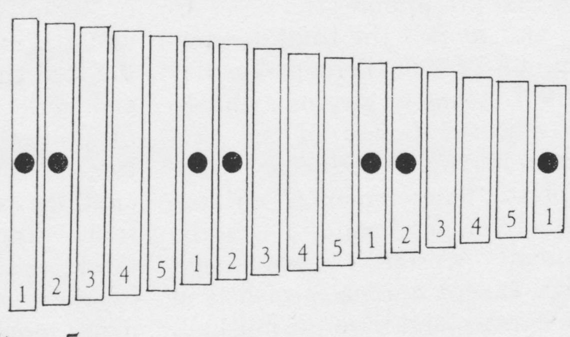
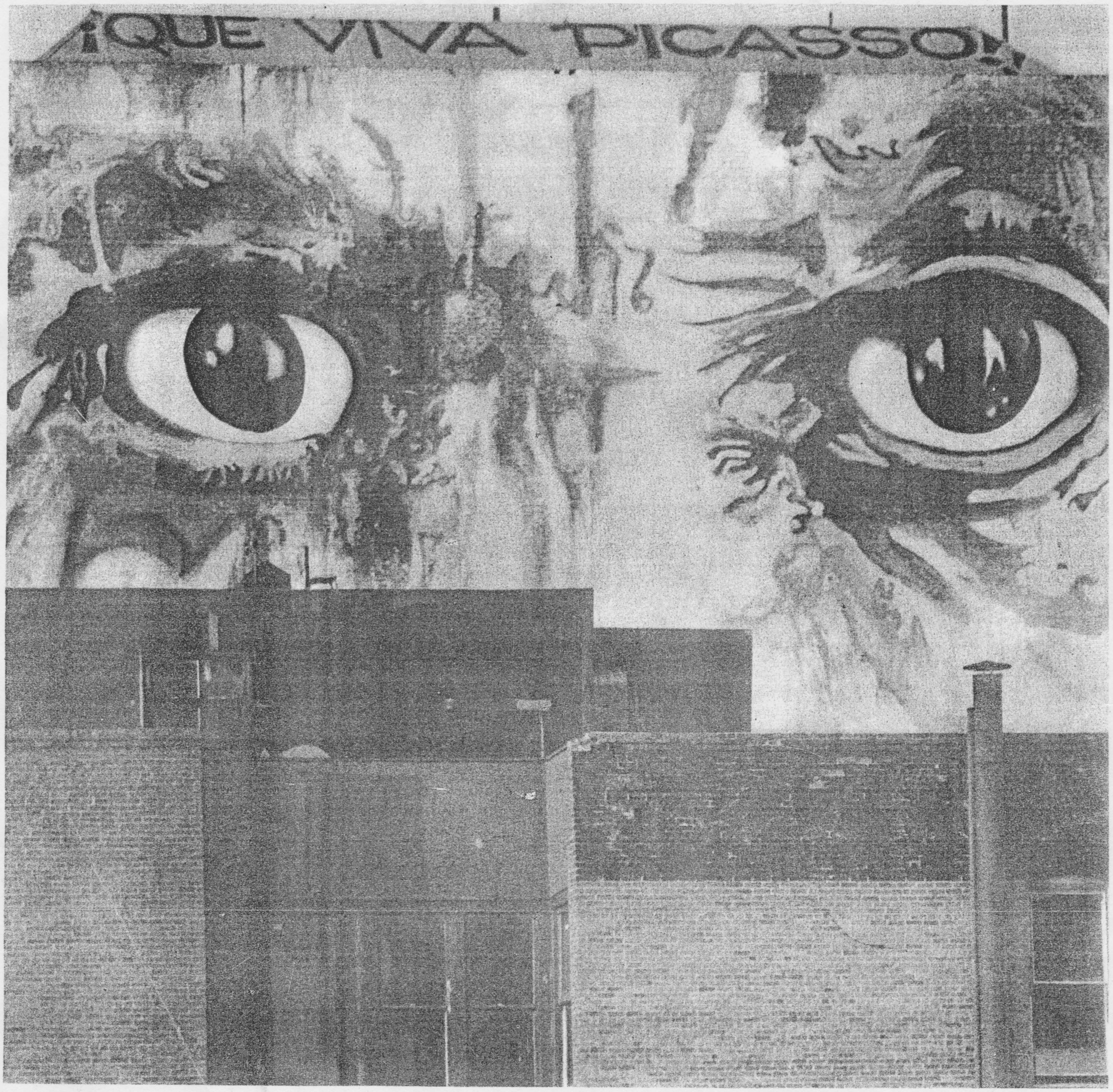


Fig. 5



"Art is not the application of a canon of beauty but what the instinct and the brain can conceive beyond any canon."
—Pablo Picasso—

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