These are the first and last pages of the first draft of "Exposition of Monophony" — enlarged

EXPOSITION OF MONOPHONY

By

Harry Partch

San Francisco

May 20, 1928

This envelope contains a copy of the 1933 draft of "Exposition of Monophony" (also, 2 pages of 1928 draft notarized) and a more or less compl[ete] record of the evolution and presentation of the system "Monophony" and the music written i[n] it — also, three dated designs of Ratio Keyboard, the[...] nota[rized] — also pictures o[f] charts, ada[pted] viola, an[d] ratio keyb[oard] model. (Pag[es] 37, 49).

Harry Par[tch]

"Exposition of Monophony" was written and rewritten, completed at the following times and places:

May 20, 1928
1166 Clay St.
San Francisco

Oct. 21, 1930
828 Camp St.
New Orleans

Oct. 2, 1931
175 6th St.
San Francisco

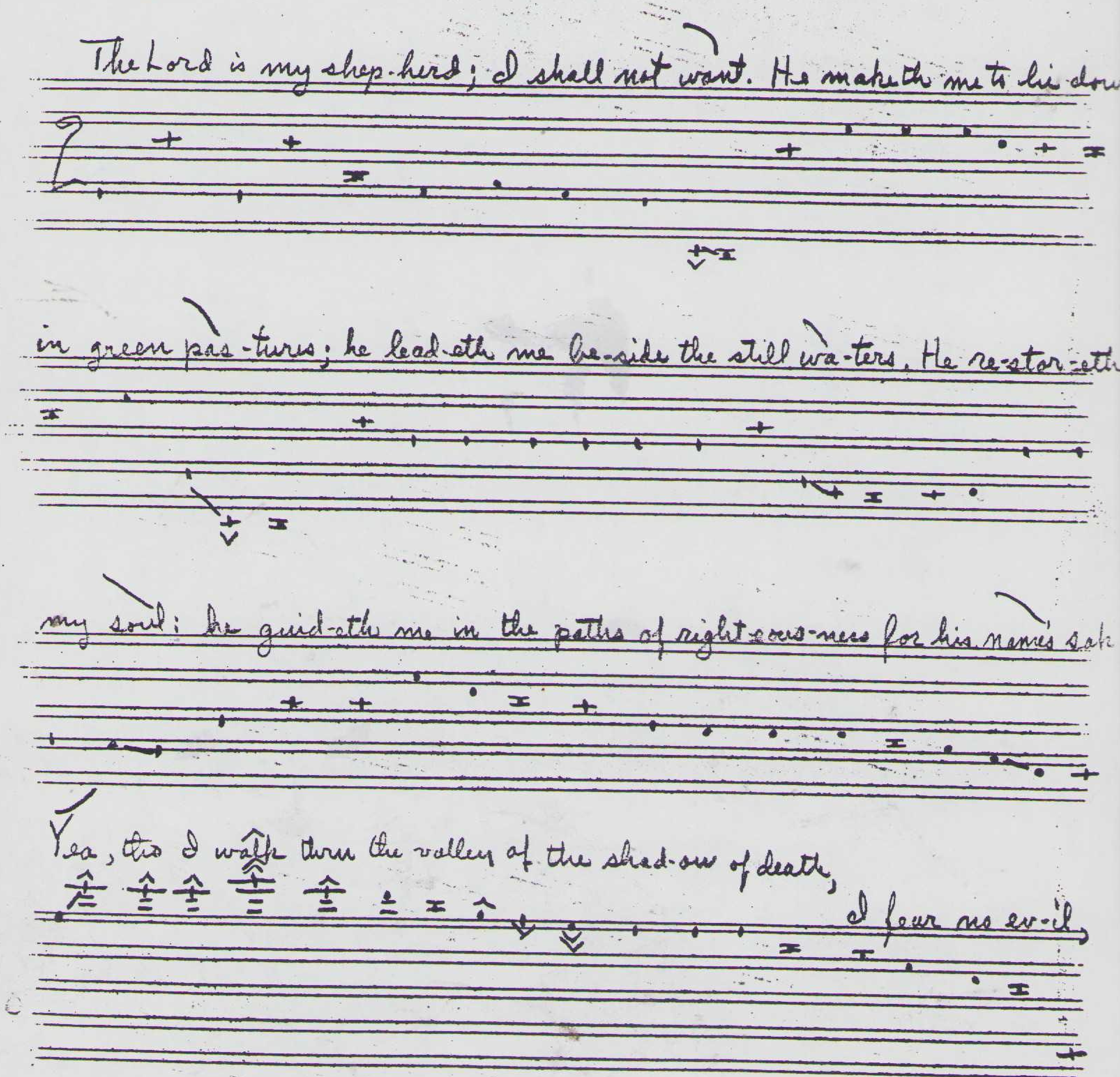
Aug. 24, 1932
Visalia, Cal.

June 8, 1933
327 So. Hope St.
Los Angeles

FOREWORD

Thruout the history of music there has been a slow and only half-recognized revelation of the universe of tone created by the overtone series. This work is an attempt to found the theory of music definitely on the origin of intervals. It is an exposition of the so-far-accepted in the light of that origin and a disclosure of a further small part of its universe. Understanding of musical structure does certainly devolve upon an understanding of this one source of tonal relationships. Without this, a true knowledge has only chance existence in the arbitrary, traditional, or intuitive.

An experiment in using the spoken inflection of another person as the basis of a song was made by the author. At his request Cantor Reuben Rinder of San Francisco recited the 23rd Psalm. The pitch of the spoken words was duplicated on the adapted viola and notated. ~~The ends of falling inflections were arbitrarily determined and certain other small changes were made in the interest of a more effective song. The notated inflections follow:~~



Picture 37

NOTATION AND INSTRUMENTS

The Staff

The staff capable of 37 tones to the 2/1 contains 18 lines, five pairs of which are visible; the other four pairs are assumed and occur alternately between the five.

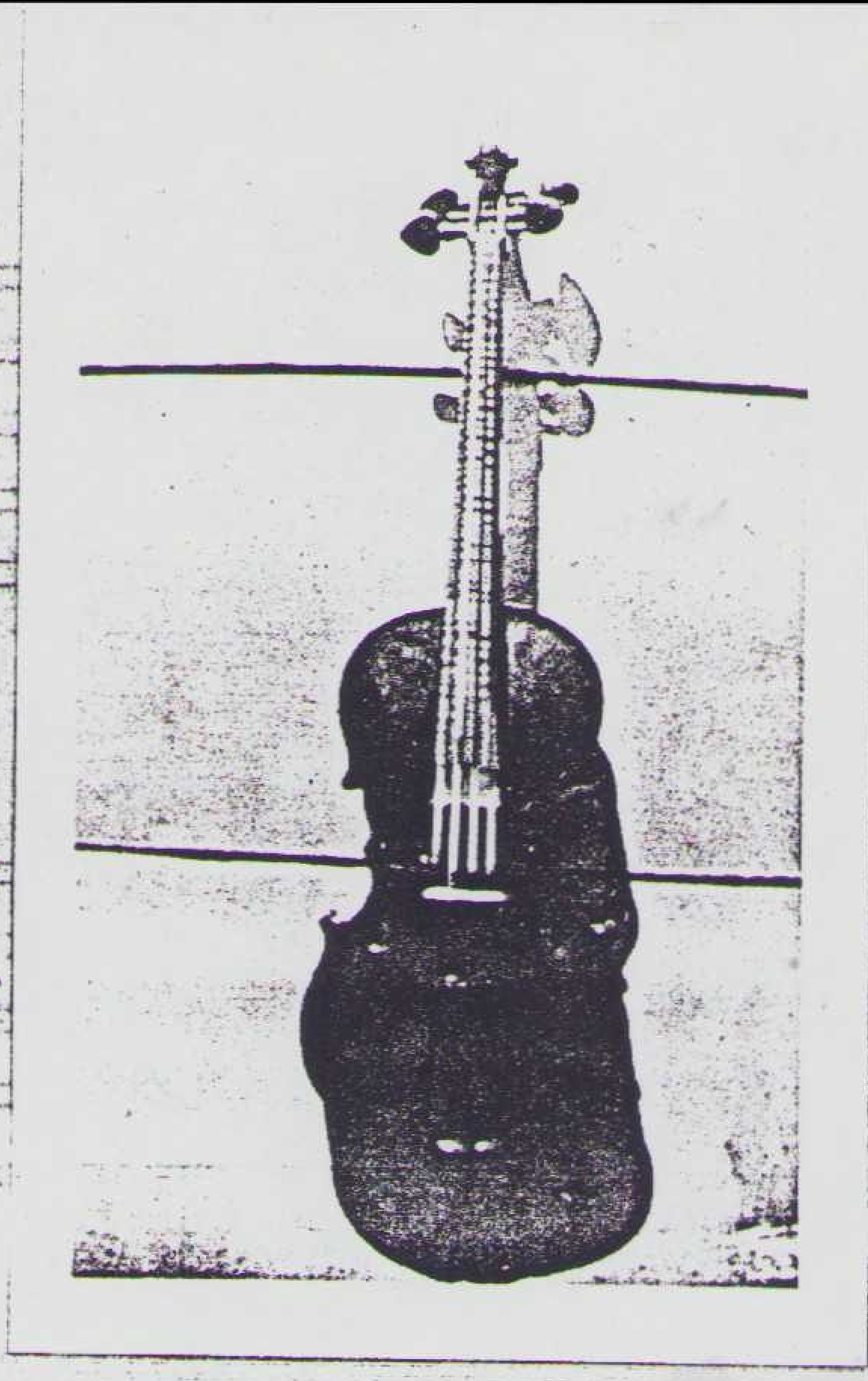
Any certain point on the staff is identified as a ratio. The number source of intervals is thereby retained in the graphic notation.

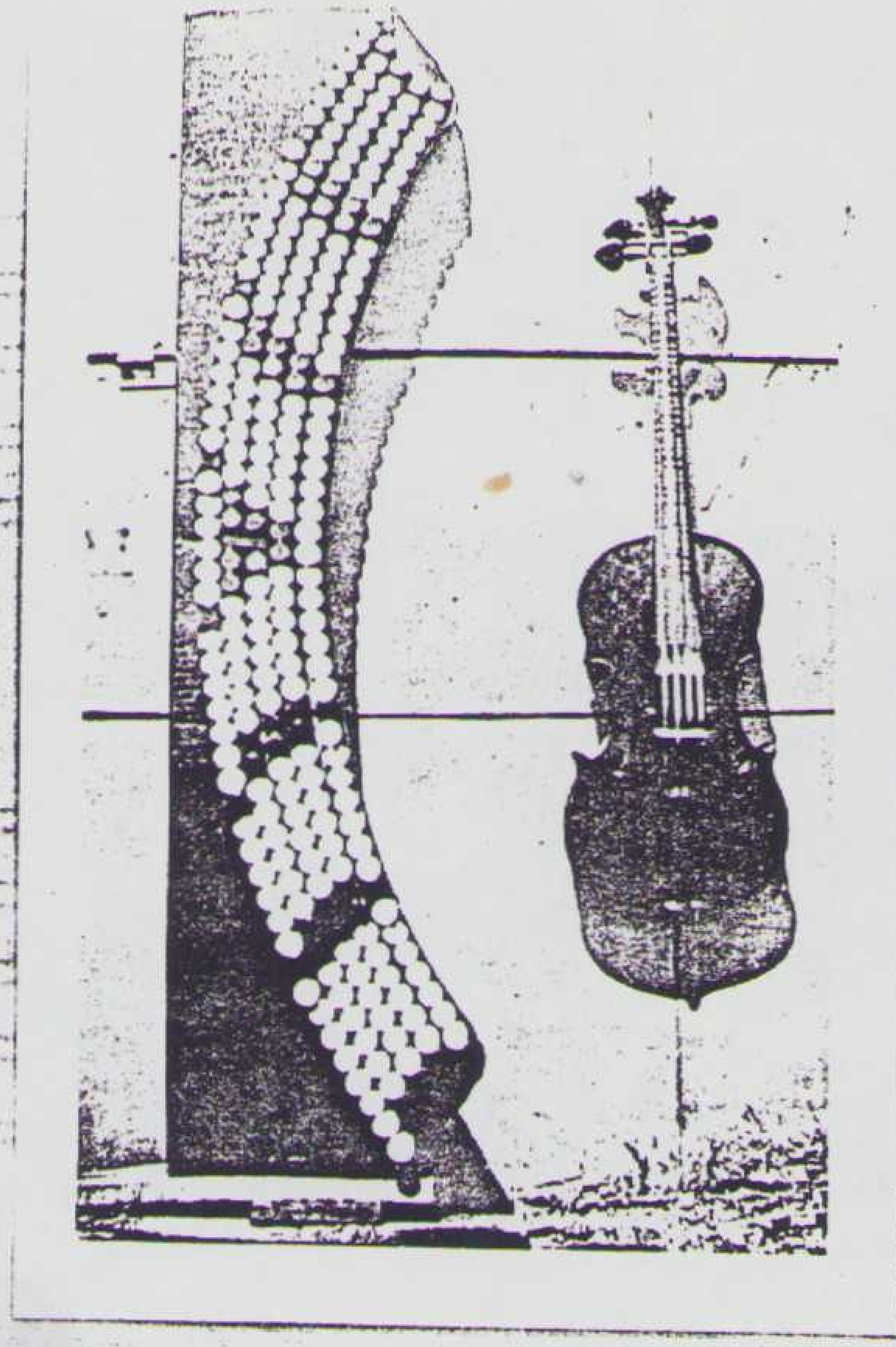
Four of the six more complex ratios to divide wide intervals are allocated. The space between the middle pair of visible lines contains no note. Every ratio has its inversion in the reverse corresponding point in the other half of the staff. The large 1 shows that the range of pitch is the first 2/1 of the instrument on which the scales are to be played; a large 2 indicates the second 2/1, etc.

A mark ∧ may be used over a note to denote a "c" variation upward, and ∨ to denote the same downward; two of them would denote a "b" variation, three a "bc", and so on, thus providing for the more complex ratios.

A notation for rhythm allowing great complexity is explained by Henry Cowell in his book, New Musical Resources. This could be used in conjunction with the staff in place of the ordinary limited rhythmic notation.

Adapted Viola (Monophone)





Model of Ratio Keyboard
for [illegible] Viola

The fingerboard of the viola was begun in Santa Rosa, Cal., in June, 1928, and attached by Edw. Benton in New Orleans in April, 1930. There are 29 indications for ratios within the 2/1 (octave), corresponding to my 1928 theory of the more essential tones. The other ratios were comparable to those. The indicated ratios are 1, $\frac{33}{32}$, $\frac{21}{20}$, $\frac{15}{14}$, $\frac{12}{11}$, $\frac{10}{9}$, $\frac{8}{7}$, $\frac{7}{6}$, $\frac{6}{5}$, $\frac{11}{9}$, $\frac{5}{4}$, $\frac{9}{7}$, $\frac{4}{3}$, $\frac{11}{8}$, $\frac{7}{5}$, $\frac{10}{7}$, $\frac{16}{11}$, $\frac{3}{2}$, $\frac{14}{9}$, $\frac{8}{5}$, $\frac{18}{11}$, $\frac{5}{3}$, $\frac{12}{7}$, $\frac{7}{4}$, $\frac{9}{5}$, $\frac{11}{6}$, $\frac{28}{15}$, $\frac{40}{21}$, $\frac{64}{33}$.

The model of the keyboard was begun Nov. 7, 1932 and completed Dec. 28, 1932, at 304 So. Marengo Ave., Pasadena, Cal. It is constructed of enameled thread spools, the ends filled with plastic wood, and corrugal board varnished.

corrugated.

simplicity. (4/3 has greater urge than 15/8 as 4/3 is simpler than 15/8. However, the resolution is no stronger. See next law.)

Third, the urge in a departure tone is also in proportion to its proximity. (The urge of 4/3 to 5/4 is certainly greater than 4/3 to 3/2. Also, the urge 8/5 to 3/2 is greater than the urge 5/3 to 3/2. 4/3 to 5/4 and 15/8 to 1 have the same resolution interval but they are probably equally powerful because the former has the strongest departure tone moving to the weakest triad tone, while the latter has a weaker departure tone moving to the strongest triad tone.

Resolutions are tantalizing because the same conditions in one tonality are found in no two instances. Only a synthesis of the three laws can satisfactorily explain the phenomenon.

That the ear can be educated against natural resolutions proves nothing. The Caucasian ear for 300 years, more or less, has been educated against natural tones thru an artificially tempered scale, and yet because of that indulgence its artificiality is no more tolerable to the logical minded. The fact that the ear is so susceptible to tonal divergence should be a greater incentive to guide it in progressive logical paths.

Overtone--

C		D		E		F		G		A		B		C
1		$\frac{9}{8}$		$\frac{5}{4}$		$\frac{4}{3}$		$\frac{3}{2}$		$\frac{5}{3}$		$\frac{15}{8}$		1
	$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$	

F		G		A		Bb		C		D		E		F
$\frac{4}{3}$		$\frac{3}{2}$		$\frac{5}{3}$		$\frac{16}{9}$		1		$\frac{9}{8}$		$\frac{5}{4}$		$\frac{4}{3}$
	$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$	

Ab		Bb		C		Db		Eb		F		G		Ab
$\frac{8}{5}$		$\frac{16}{9}$		1		$\frac{16}{15}$		$\frac{6}{5}$		$\frac{4}{3}$		$\frac{3}{2}$		$\frac{8}{5}$
	$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$	

Undertone--(Descending)

C		Bb		Ab		G		F		Eb		Db		C
1		$\frac{16}{9}$		$\frac{8}{5}$		$\frac{3}{2}$		$\frac{4}{3}$		$\frac{6}{5}$		$\frac{16}{15}$		1
	$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$	

G		F		Eb		D		C		Bb		Ab		G
$\frac{3}{2}$		$\frac{4}{3}$		$\frac{6}{5}$		$\frac{9}{8}$		1		$\frac{16}{9}$		$\frac{8}{5}$		$\frac{3}{2}$
	$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$	

E		D		C		B		A		G		F		E
$\frac{5}{4}$		$\frac{9}{8}$		1		$\frac{15}{8}$		$\frac{5}{3}$		$\frac{3}{2}$		$\frac{4}{3}$		$\frac{5}{4}$
	$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$	

The fundamental under tonality, in usual terminology, with the triad C-Ab-F, would be F minor; the 3/2 tonality, with the triad G-Eb-C, C minor; the 5/4 tonality, with the triad E-C-A, A minor. Confusion can be avoided by forgetting the alphabetical nomenclature and remembering that the ratios 3/2 and 5/4, because of the 2 and 4 as under numbers, are the fundamentals of under tonalities (1-2-4-8 are always indicative of fundamentals) and that the triad tones descend the exact reverse of over triads.

For the interval 9/8 measure 1/9 of the length from the nut and mark it. When that stop is made the sounding part completes 9 vibrations in the time required for 8 vibrations of the whole. Parts of the string to be marked off for the other intervals are:

For the interval 6/5 -- 1/6
5/4 -- 1/5
4/3 -- 1/4
3/2 -- 1/3
8/5 -- 3/8
5/3 -- 2/5
16/9 -- 7/16
15/8 -- 7/15
2/1 -- 1/2

If the instrument is a violin or viola it shou be held between the kn when played, to more accu ly make the stops.

The Undertone Series

The undertone series is the intrinsic source of every musical interval. Diatonic intervals can be explained equally well thru undertones. They exist within overtones and vice versa.

Given the same fundamental, middle C, the C below makes 1/2 vibration in the same length of time, the second F below 1/3, the second C 1/4, and the third Ab 1/5 vibration.

Thinking always downward, the intervals in their order are C to C, 1 to 1/2, or 1/2, the octave; C to F, 1/2 to 1/3, transposed within the 1/2 and expressed 2/3 (it makes 2/3 vibration in the length of time necessary for the fundamental to make 1), still C to F; F to C, 1/3 to 1/4, transposed within the 1/2 and expressed 3/4, or C to G, creating the tone G; C to Ab, 1/4 to 1/5, transposed, 4/5, still C to Ab; F to Ab, 1/3 to 1/5, transposed, 3/5, C to Eb;

scale theory. Four intervals with the unison are called perfect, eight major and minor, and one either augmented 4th or diminished 5th.

The names should indicate the four types of interval reactions. These suggest themselves:

Intervals of Power (Perfect): $\frac{1}{1}, \frac{2}{1}, \frac{3}{2}, \frac{4}{3}$;

Emotional Intervals (Corresponding to major and minor 3rds and 6ths): $\frac{7}{6}, \frac{6}{5}, \frac{11}{9}, \frac{5}{4}, \frac{14}{11}, \frac{9}{7}$, and their inversions, $\frac{12}{7}, \frac{5}{3}, \frac{18}{11}, \frac{8}{5}, \frac{11}{7}, \frac{14}{9}$;

~~Psychic~~ Intervals of Suspense (Corresponding to augmented 4th or diminished 5th): $\frac{11}{8}, \frac{7}{5}$, and inversions, $\frac{16}{11}, \frac{10}{7}$;

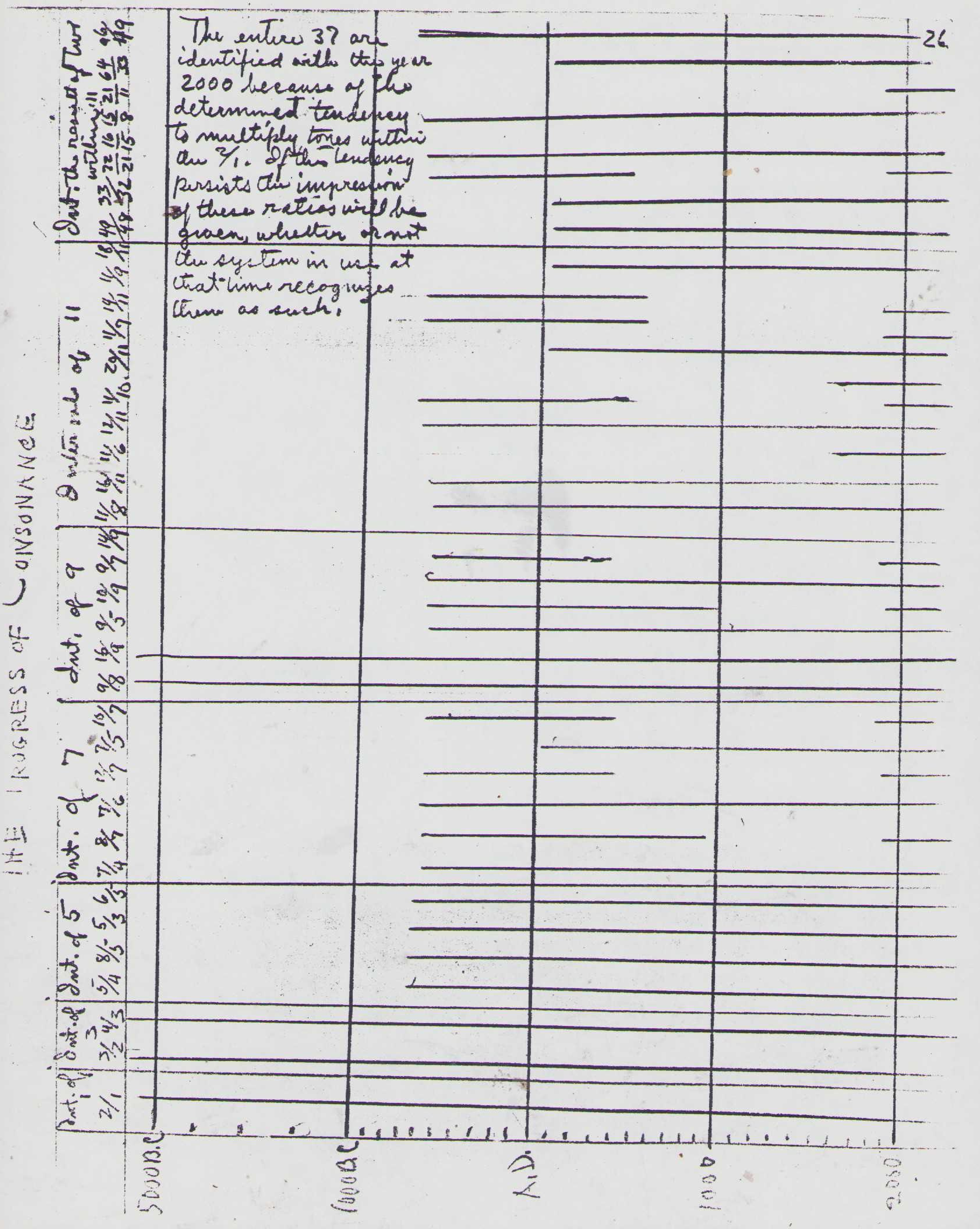
Intervals of Approach (Corresponding to major and minor 7ths and 2nds): $\frac{49}{48}, \frac{33}{32}, \frac{22}{21}, \frac{16}{15}, \frac{12}{11}, \frac{11}{10}, \frac{10}{9}, \frac{9}{8}, \frac{8}{7}$, and inversions, $\frac{96}{49}, \frac{64}{33}, \frac{21}{11}, \frac{15}{8}, \frac{11}{6}, \frac{20}{11}, \frac{9}{5}, \frac{16}{9}, \frac{7}{4}$.

The Table of Relationships serves both purposes stated in the first paragraph of this chapter. Example of the first purpose: a progression by a 14/9 interval (horizontal columns at top and bottom) downward from the tone 11/8 (vertical columns at either side) gives the tone b16/9. All progressions are given downward; a 14/9 upward from 11/8 would be found by using the inversion of 14/9, 9/7, giving the tone 16/15c.

Example of second purpose: the interval from the tone 11/8 (vertical) downward to the tone 14/9 (horizontal) is a "b" smaller than 16/9. The interval from 11/8 upward to 14/9 is found by reversing the ratios: 14/9 (vertical) downward to 11/8 (horizontal) is a "b" larger than 9/8.

The table uses the six ratios to divide wide intervals suggested on page 21.

The entire 37 are identified with the year 2000 because of the determined tendency to multiply tones within an 2/1. If this tendency persists the impression of these ratios will be given, whether or not the system in use at that time recognizes them as such.



~~To prove this phenomenal causation~~

The genuineness of the 12-tonalities is convincingly demonstrated by showing how one of them exists within the fundamental series. The 8/5-tonality will serve as an example. 5-10-20-40-80 is the series of likenesses that creates the intrinsic series. (Similar intervals are of the same width: the 2/1s, for example, 1 to 2, 2 to 4, 4 to 8, 5 to 10, 10 to 20, etc., are given the same paper extent.)

1 2

(2) 3 4

(4) 5 6 7 8
8/5
(1)

(8) 9 10 11 12 13 14 15 16
16/10
(8/5)
(2/1)

(16) 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
24/20 32/20
(6/5) (8/5)
(3/1) (4/1)

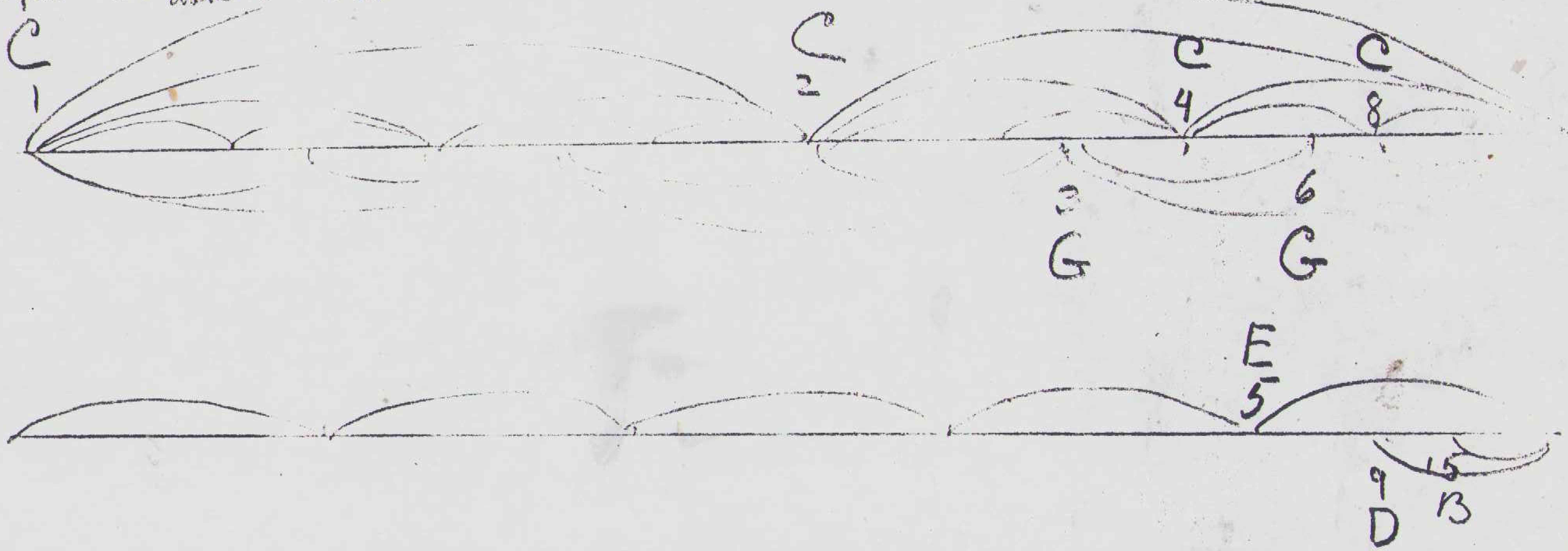
(32) 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
40/40 48/40 56/40 64/40
(5/5) (6/5) (7/5) (8/5)
(5/1) (6/1) (7/1) (8/1)

(64) 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
72/40 80/80 88/80
(9/5) (10/10) (11/10)
(9/1) (10/1) (11/1)

(The upper slurs show the 5 series of likenesses, the under ones the intervals taken from that series, while the lowest ratios in parentheses reveal the 5 overtone series in its pristine form: 1, 2/1 3/1, 4/1, 5/1, etc.)

OVERTONE SERIES

A string is represented three times. The first shows how it vibrates as a whole and how it divides itself to create the 2nd, 4th, 8th, 3rd and 6th overtones. The second shows the 5th, 9th and 15th overtones. In the third every interval between the overtones is transposed within the extent 1–2, or 2/1, and the [illegible] points the string would be stopped to produce them shown.

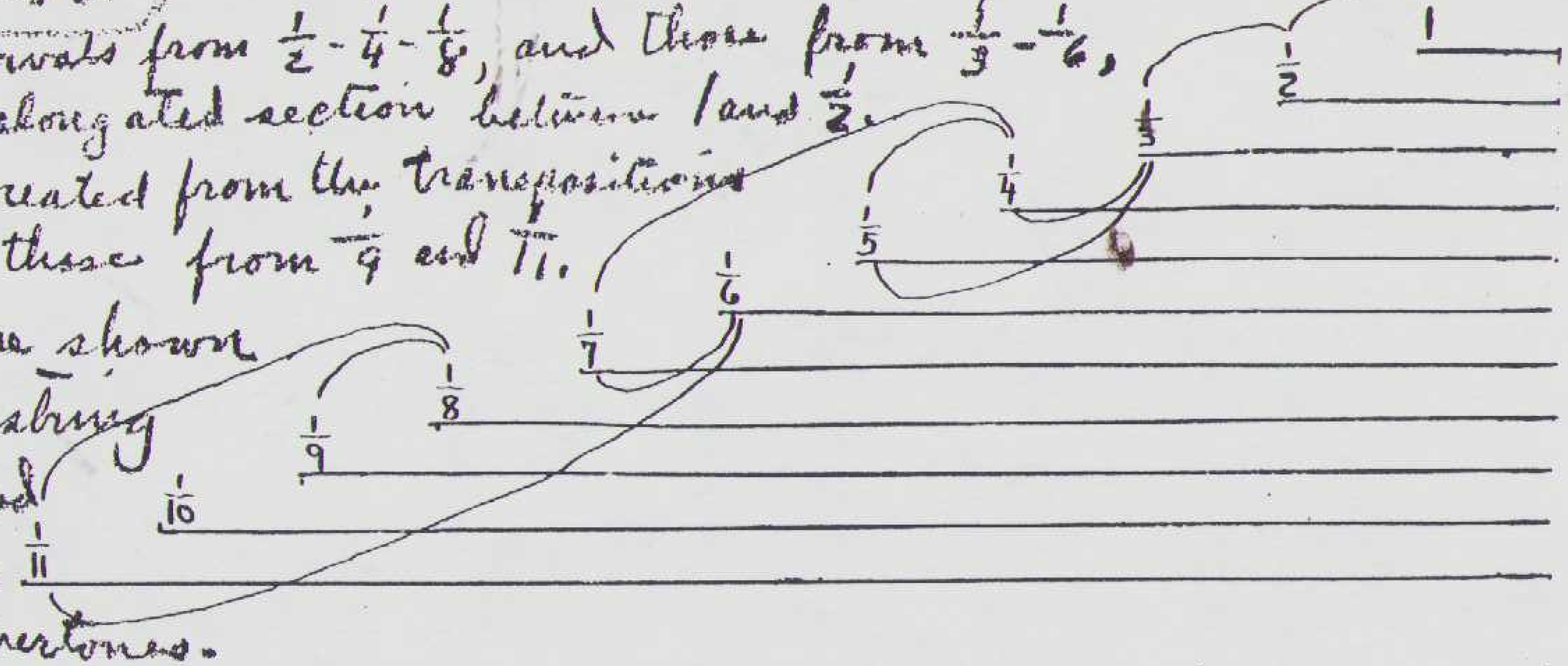


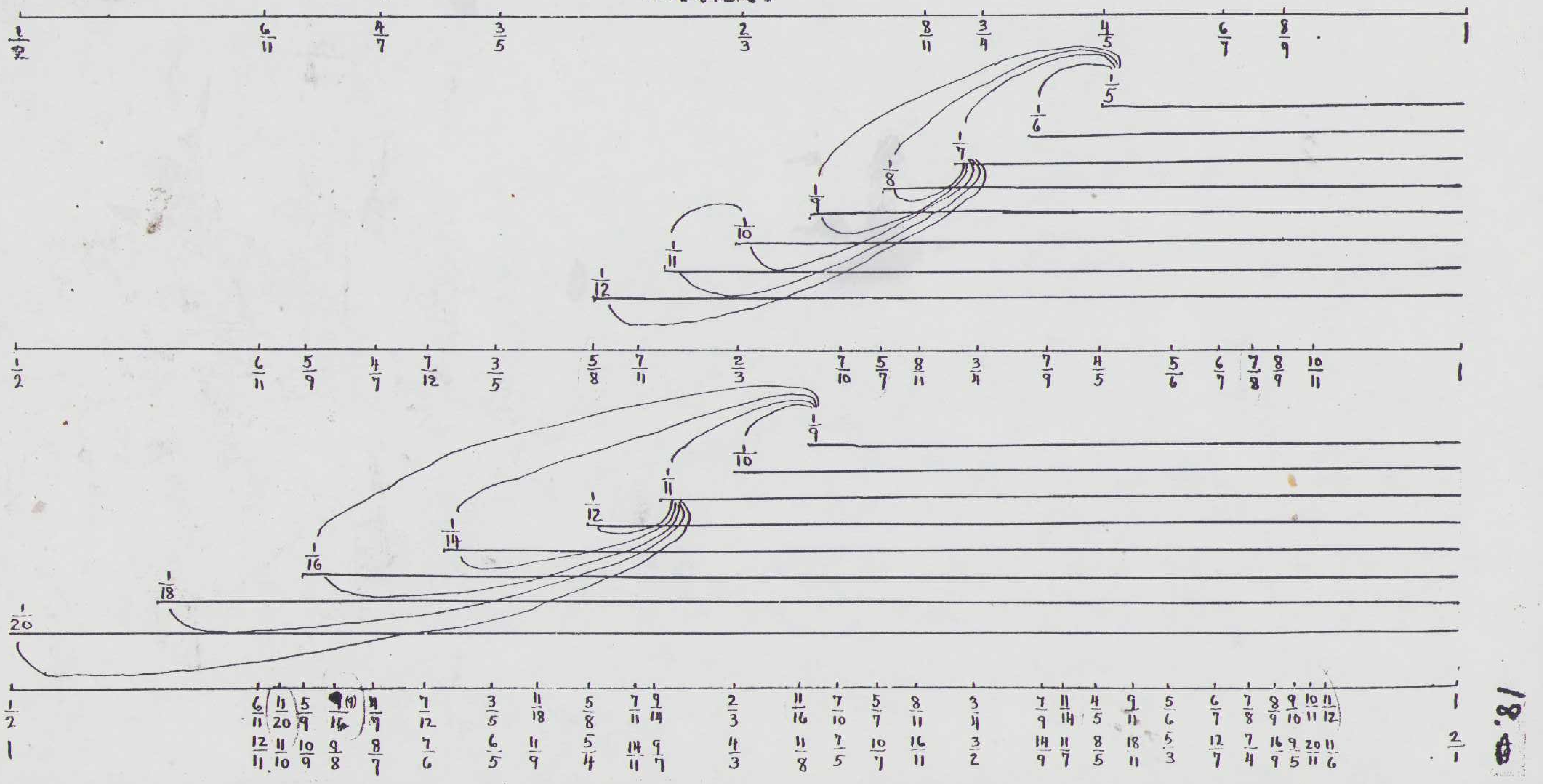
Major	C	D	E	F	G	A	B	C
	1	9/8	5/4	4/3	3/2	5/3	15/8	2/1
	1	16/15	6/5	4/3	3/2	8/5	16/9	2/1
Minor	C	D♭	E♭	F	G	A♭	B♭	C

group. Consider that half a string 20 inches long makes 1 vibration: then all of it makes $\frac{1}{2}$ vibration (under first group—for lack of space only the half between 1 and $\frac{1}{2}$ is shown)

THE UNDERTONE SERIES Three I/II

The first group represents transposition of intervals from $\frac{1}{2}$-$\frac{1}{4}$-$\frac{1}{8}$, and those from $\frac{1}{3}$-$\frac{1}{6}$, creating under tonalities, and indicated in the elongated section between 1 and $\frac{1}{2}$.
The second group shows the under tonalities created from the transpositions from $\frac{1}{5}$-$\frac{1}{10}$ and from $\frac{1}{7}$; and the third group, those from $\frac{1}{9}$ and $\frac{1}{11}$.
The accumulated 29 intervals within $\frac{1}{11}$ are shown at the bottom at the exact points to stop the string to produce them, and, finally, they are transposed a 2/1 up, into overtone notation, and are proved to be the same as those having their source in overtones.





The following table is self-explanatory:

Interval	Number of cents it contains	Number of c's it contains
28/27	62	15
33/32	53	13
36/35	49	12
45/44	39	10
49/48	36	9
50/49	35	8
55/54	32	8
56/55	31	8
64/63	27	7
81/80	21	5
99/98	17	4
100/99	17	4
121/120	14	4

Those intervals between tones that are simplest are easily apparent. 8/5 to 9/5 is the interval 9/8; 11/9 to 11/7 is 9/7; 5/4 to 5/3 is 4/3. Many of the relations are complex: 9/8 to 4/3 is 32/27. A computation shows that 32/27 is 21 cents, about "ac", smaller than 6/5. The relation of 9/8 to 4/3 is then expressed in relation to 6/5, a ratio that is known: ac6/5. All necessary computations are made and the variations shown in the Table of Relationships.

There is a legitimate doubt whether or not the average ear can distinguish between a tone and its "c" variation. To actually hear such variation in the simplest intervals, 2/1, 3/2 and 4/3, is possible since the phenomenon known as beats, resulting from these intervals only slightly off proportion, is quickly noticeable. In the more complex intervals, especially in the 7s, 9s and 11s, the "c" variation is without practical value. Therefore, in the great majority of instances an interval with a "c" variation will be considered the unaltered interval. To assume that "b" is distinguishable is tenable since it is about 1/12 of a semitone, or 1/150 of the 2/1.

The 37 intervals fall naturally into four classes. The classes of necessity are named arbitrarily. There is the beginning of a classification in tempered

~~To prove this phenomenal causation~~

The genuineness of the 12-tonalities is convincingly demonstrated by showing how one of them exists within the fundamental series. The 8/5-tonality will serve as an example. 5-10-20-40-80 is the series of likenesses that creates the intrinsic series. (Similar intervals are of the same width: the 2/1s, for example, 1 to 2, 2 to 4, 4 to 8, 5 to 10, 10 to 20 etc., are given the same paper extent.)

1 2

(2) 3 4

(4) 5 6 7 8
8/5
(1)

(8) 9 10 11 12 13 14 15 16
16/10
(8/5)
(2/1)

(16) 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
24/20
(6/5)
(3/1)
32/20
(8/5)
(4/1)

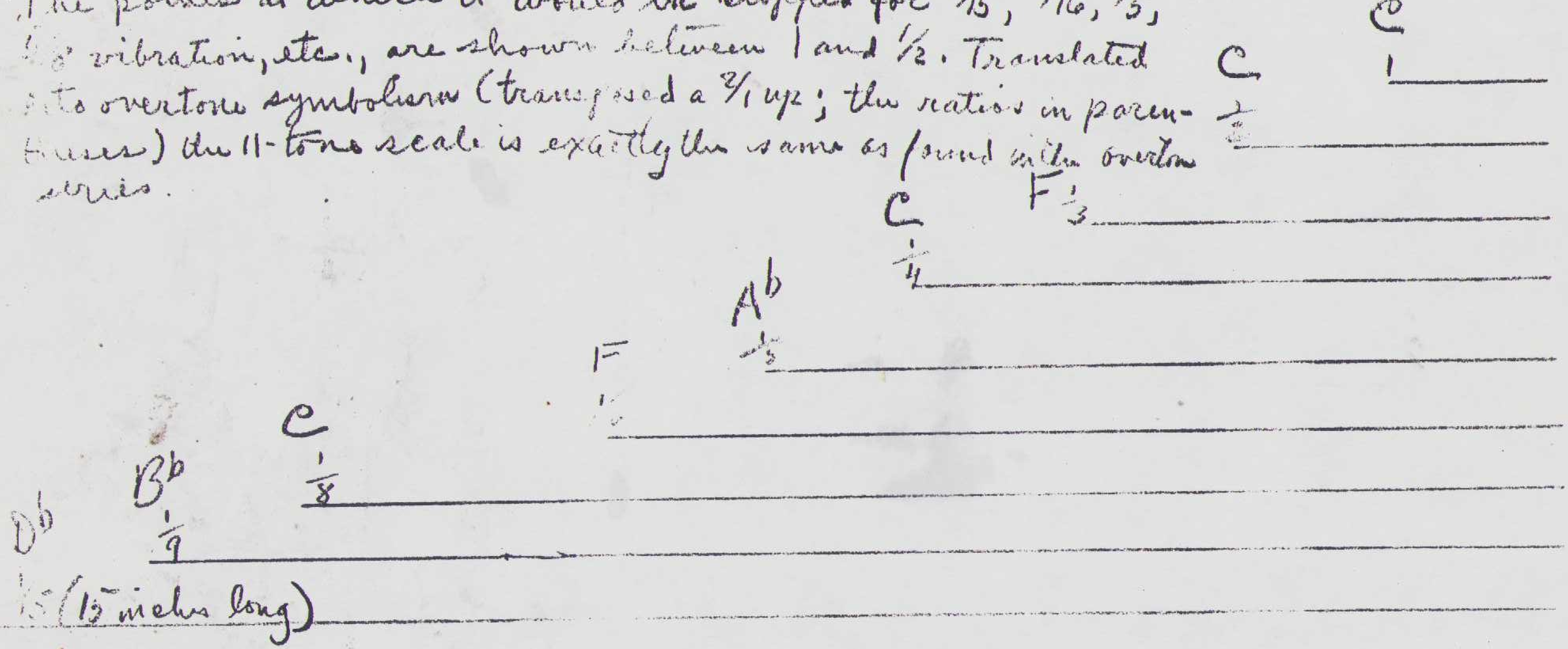
(32) 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
40/40
(5/5)
(5/1)
48/40
(6/5)
(6/1)
56/40
(7/5)
(7/1)
64/40
(8/5
(8/1

(64) 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
72/40
(9/5)
(9/1)
80/80
(10/10)
(10/1)
88/80
(11/10)
(11/1)

(The upper slurs show the 5 series of likenesses, the under ones the interval taken from that series, while the lowes ratios in parentheses reveal the 5 over tone series in its pristine form: 1, 2/ 3/1, 4/1, 5/1, etc.)

UNDERTONE SERIES.

... 1 inch long makes ... certain length of time. The lengths of strings necessary to make ½, ⅓, ¼ vibration, etc., in the same time are shown. Now consider that a string is 10 inches long (at bottom of page) and that half of it makes 1 vibration; then all of it makes ½ vibration. The points at which it would be stopped for 8/15, 9/16, 3/5, ... vibration, etc., are shown between 1 and ½. Translated into overtone symbolism (transposed a 2/1 up; the ratios in parentheses) the 11-tone scale is exactly the same as found with the overtone series.



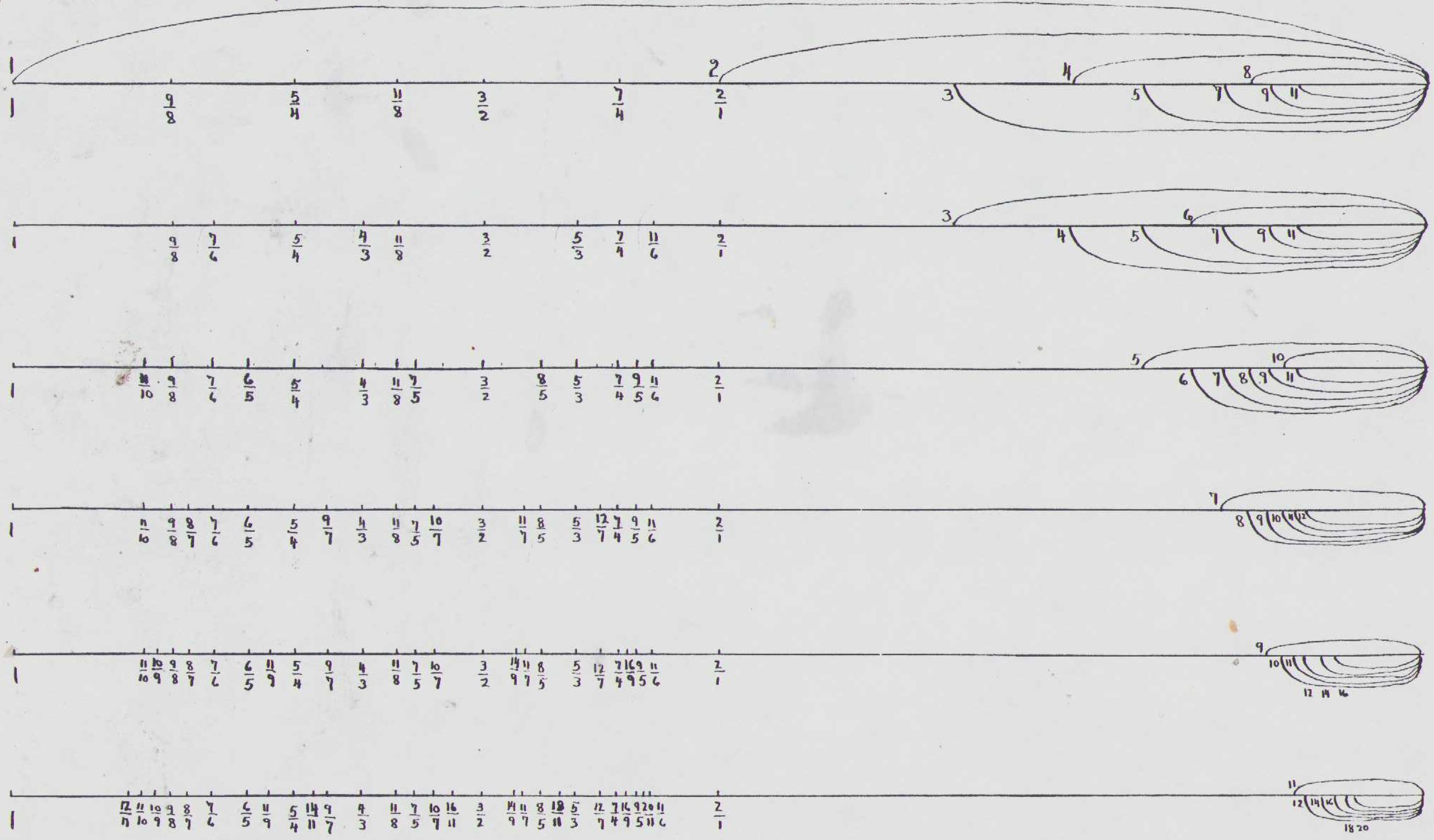
Majar

C (1) ½ — D (9/8) 9/16 — E (5/4) 5/8 — F (4/3) 2/3 — G (3/2) 3/4 — A (5/3) 5/6 — B (15/8) 15/16 — C (2/1) 1

½ (1) C — 8/15 (16/15) D♭ — 3/5 (6/5) E♭ — 2/3 (4/3) F — 3/4 (3/2) G — 4/5 (8/5) A♭ — 8/9 (16/9) B♭ — 1 (2/1) C Minor

A string is represented six times, a representation for each of the six over tonalities. The first shows the intervals thru 11 taken from 2, 4 and 8, and transposed within 2/1; the second the intervals thru 11 taken from 3 & 6; the third, those from 5 and 10, and the fourth, fifth and sixth, those from 7, 9 and 11. The ratios are carried down from each previous representation. The exact points to stop the string to produce the 29 intervals within 11 are therefore shown at the bottom. Notice the wide intervals at either end,

THE OVERTONE SERIES (2) thru 11



'retuned', as necessary, either to its just intonation or to its equally tempered intonation." A scale is built on "some sort of 'common denominator'" that is of "no practical use whatever" and is therefore "retuned" to one of two other intonations. In defending Siamese 7-tone temperament (page 122) the observation is made that "in problems of art actual facts have to be considered in preference to theoretical premises." The "actual facts" are that perfect fifths have been used in every nation of the world, so far as is known, untempered, and the "theoretical premises" are that because 7-tone temperament is now practiced in Siam that it should become the model for evolution of musical theory for the whole of civilization.

Continue random quots: the 12 regular degrees of supra-tonality are "live and individual" which "character is certainly lacking in the anemic and neutralized atonal scale (12-tone temperament) since its component ~~parts~~ intervals are rigorously levelled in comparison to the series of supra-diatonic whole steps and half steps." There is a saying that if he is given enough rope a man will hang himself.

On pages 233 to 237 Yasser roughly outlines "musical monism" (corresponding to monophony). I quote from page 236; "Were musical art of rational and not of emotional origin, the division into consonances and dissonances would be unnatural. Music then would be monistic instead of dualistic, from the viewpoint of harmony. It is highly probable that it would be directly based, in that case, on the series of overtones . . ." The supplement to chapter ~~12~~ XI, which covers 30 pages, is an exposition of supra-tonality in various types of just intonation(that is, in intonation based on overtones), none of which is actually used, but which apparently form the basis of the system's chord formations. The 7/4 interval is called a "falsonance" in the diatonic scale (because it is false to the scale): "But the very same interval will not be a falsonance in relation to the supra-diatonic extra 3.

or C-D-F-G-Bb-C. They may be seen in the ratios of the diatonic scales, explained immediately following.)

The intervals of the diatonic scales have their genesis within 5. The first of those intervals is the octave, 2/1, into which all the other intervals must be transposed to make them musically available. In a practical system of music the octave of a tone can have no identity; it is simply double the number of vibrations. A system is evolved for one octave, of which every other is a duplication.

The next interval is C to G, 2 to 3, or 3/2, the perfect fifth. It is transposed down an octave and is still C to G. The next is G to C, 3 to 4, or 4/3, which must be transposed within the 2/1, the distance of a perfect 12th, and becomes C to F, the same 4/3 relationship, thus creating the tone F. C to E, 4 to 5, or 5/4, transposed down two octaves within the 2/1, remains C to E. G to E, 3 to 5, or 5/3, transposed within the 2/1, down a perfect 12th, becomes C to A, the same 5/3 relationship, creating the tone A.

The odd-numbered of the overtone series are the only identities. The octave of G, 3, is G, 6. Then without drawing further from the series there is the interval E to G, 5 to 6, or 6/5, transposed to 1, the distance of an octave and a major 10th, giving the interval C to Eb, the same relationship. And there is also the interval E to C, 5 to 8, or 8/5 (8 is the octave of 4), which, transposed to 1, an octave and a major 10th, creates the interval C to Ab, the same relationship.

The words interval, ratio, relationship, tone, are practically synonymous in this exposition. A tone implies a ratio to its fundamental, and an interval is a ratio, or relationship.

To avoid confusion these simple intervals should be recognized by their ratios. Hereafter they will be used without translation to tempered scale

Interval Scales--

9. 2/1s, or octaves, are only 7/8ths inch wider than on the piano, easily encompassed by most hands.

10. All other intervals that could be played on the piano are probably simpler to play than on the piano except those approximating the 3/2, or perfect 5th.

Position--

11. The position of the hand, with each finger slightly higher than the other and making the natural arc of the fingers, is a very easy one and because of the circular keyboard is as much without strain at the ends as in the middle.

COLOR ANALOGY

There has been no attempt to draw a true color analogy. At least the one below is very different from the Helmholtz parallel. The keys are colored for only one reason--to break the expanse of white so that the eye may quickly single out one of them. This was deemed necessary even tho the ratios are painted on the keys.

The colors indicate a tone's possibilities as a true overtone or undertone according to whether they are upper or lower in the following analogy:

White--indicates 1, a fundamental, the inherence of all overtones and their reflection, undertones--the presence of all colors.

Red--the 3rd partial, or dominant of the tonality--the dominant color.

Blue--the 5th partial, or mediant,

Yellow--the 7th partial, the only remaining partial unsubmerged by another (see bottom of page 50, "Exposition of Monophony", showing extents of influence according to the degrees of the fabric they would include)--the only remaining primary color.

Orange--the 9th partial, closely related to the 3rd partial ($\frac{3}{2} \times \frac{3}{2} = \frac{9}{8}$, or, $\frac{2(4)}{3(3)} \times \frac{2}{3} = \frac{4(16)}{9(9)}$), or red, and of a strange consonance with the 7th, or yellow.

Violet--the 11th partial, submerged in the magnetic fields of both the 3rd partial, red, and the 5th, blue. (See page 51, "Exposition of Monophony".)

Pale tints--the keys so colored, 21/16, 15/11, 22/15, and 32/21, were placed to divide wide intervals, are distant in relation to the other tones (beyond the 11th partial limit), and are not to be considered strong partials.

BLACK ~~Gray~~--the keys so colored are integrals of the Perpetual Tonal Descent and Ascent beyond the 11th partial and require separate discussion.

LINES OF PROGRESSION THRU PERPETUAL TONAL DESCENT AND ASCENT

Successions of ratios were chosen that would give a series of intervals somewhat similar to, no wider or narrower in their aggregate than, a corresponding portion of the essential ratios. (See keyboard fabric below.) The successions are such that if a pedal could be used to raise certain tones and another to lower the same and certain other ones, the 2nd, 3rd, 4th and 5th keys on the right side, first pattern, and the 1st key, To whom it may concern:

The keyboard represented by the within drawing and specifications was originated and designed by me about April 25th, 1932.

Harry Partch

STATE OF CALIFORNIA, } ss.
County of Tulare

On this 3rd day of SEPTEMBER in the year One Thousand Nine Hundred and THIRTY-TWO before me J. P. GANNON, a Notary Public, in and for the County of Tulare, personally appeared HARRY PARTCH

known to me to be the person whose name is

lower	2nd Key		higher
56/55 : 55/54	50/49 : 49/48		45/44

lower	3rd Key	higher
36/35	33/32	28/27

lower	4th Key	higher
25/24	22/21	21/20

5th Key	higher
16/15	15/14

6th Key	higher
12/11	11/10

and in the reverse way in the Ascent. The idea could also be used to divide the two wide 36/35s with the ratios 32/27 and 27/16.

KEYBOARD FABRIC

The table shows the intervals between ratios of the keyboard and the number of cents each contains: (Also, approximately, the corresponding degrees of the Tempered scale.)

G				G#			A			Bb
1	49/48	33/32	22/21	16/15	12/11	10/9	9/8	8/7	7/6	6/5
	49/48	99/98	64/63	56/55	45/44	55/54	81/80	64/63	49/48	36/35
	36 cents	17 cents	27 cents	31	39	32	21	27	36	49

			B			C				C#
(6/5)	11/9	5/4	14/11	9/7	21/16	4/3	15/11	11/8	7/5	10/7
	55/54	45/44	56/55	99/98	49/48	64/63	45/44	121/120	56/55	50/49
	32	39	31	17	36	27	39	14	31	35

			D			Eb			E	
(10/7)	16/11	22/15	3/2	32/21	14/9	11/7	8/5	18/11	5/3	12/7
	56/55	121/120	45/44	64/63	49/48	99/98	56/55	45/44	55/54	36/35
	31	14	39	27	36	17	31	39	32	49

		F			F#				G
(12/7)	7/4	16/9	9/5	11/6	15/8	21/11	64/33	96/49	1
	49	64	81	55	45	[illegible]	[illegible]	[illegible]	[illegible]

Red--the 3rd partial, or dominant of the tonality--the dominant color

Blue--the 5th partial, or mediant, completing the triad--also completing the color triad, white, red and blue.

Yellow--the 7th partial, the only remaining partial unsubmerged by another (see "Magnets and Satellites" under "V Adductions" in "Exposition of Monophony")--the only remaining primary color.

Orange--the 9th partial, closely related to the 3rd partial ($\frac{3}{2} \times \frac{3}{2} = \frac{9}{8}$ or $\frac{2}{3}(\frac{4}{3}) \times \frac{2}{3} = \frac{4}{9}(\frac{16}{9})$) or red, and of a strange consonance with the 7th, or yellow.

Violet--the 11th partial, submerged in the magnetic fields of both the 3rd partial, red, and the 5th, blue. (See "Magnets and Satellites".)

Pale tints--the keys so colored, 21/16, 15/11, 22/15, and 32/21, were placed to divide wide intervals, are distant in relation to the other tones (beyond the 11th partial limit) and are not to be considered strong partials.

Gray--the keys so colored are integrals of the Perpetual Tonal Descent and Ascent beyond the 11th partial and require separate discussion.

LINES OF PROGRESSION THROUGH PERPETUAL TONAL DESCENT AND ASCENT

Successions of ratios were chosen that would give a series of intervals

There are two slight variations in ratio sequence in the two yellow, or 7, two orange, or 9, and two violet, or 11, scales from that generally accepted as the theoretic diatonic scales. (See discussion of diatonic scales under "III History" in "Exposition of Monophony".)

8. Scales of other cultures, Grecian modes, the 22-tone Indian chromatic, the 17-tone Arabian, and others, may be played very approximately. (See scales listed in "III History".)

Interval Scales--

9. 2/1s, or octaves, are only 7/8ths inch wider than on the piano, easily encompassed by most hands.
10. All other intervals that could be played on the piano are probably simpler to play than on the piano except those approximating the 3/2, or perfect 5th.

Position--

11. The position of the hand, with each finger slightly higher than the other and making the arc of the fingers, is a very natural one and because of the circular keyboard is as much without strain at the ends as in the middle.

COLOR ANALOGY

There has been no attempt to draw a true color analogy. At least the one below is very different from the Helmholtz parallel. The keys are colored for only one reason--to break the expanse of white so that the eye may quickly single out one of them. This was deemed necessary even though the ratios are painted on the keys.

The colors indicate a tone's possibility as a true overtone or undertone according to whether ~~it is~~ they are upper or lower in the following analogy:

White--indicates 1, a fundamental, the inherence of all overtones and their reflection, undertones--the presence of all colors.

2. A chromatic scale of 20 tones within the 2/1 somewhat equally divided may be easily played by striking the 1st, 3rd and 5th keys in the first pattern, the 2nd and 4th keys in the second pattern, and so on alternately through the keyboard.

3. A chromateic scale of 12 tones within the 2/1 quite well proportioned may be easily played by striking the 1st and 4th keys of the first pattern and the 2nd key of the second pattern and so on alternately.

4. A chromatic scale of 10 tones within the 2/1 may be easily played by finding another pattern and reversing the direction. The four arcs in blue pencil describe the new pattern with arrows indicating the reverse direction for ascent.

5. True ratio scales of eight tones may be played on any one of the tiers by staying on that tier, just as one would play the white keys of the piano.

6. Combinations of any of the above scale plans could produce scales of any number of tones within 39 that one would care to name.

7. Six of the so-called diatonic major scales and six diatonic minor scales, inherent in the fabric, each of seven tones, are mostly as simple of execution as on the piano, and, of course, unlike the piano's scales they exist in true ratios. For the major the colored circles on the right, and for the minor the colored circles on the left, show the scales according to this plan; (Find the beginning, or fundamental, and follow the scale by its color circles.)

Black--fundamental major and minor scales

GENERAL DESCRIPTION

The five-finger pattern of the hands is duplicated eight times within the 2/1, or octave, extent--one pattern for the right hand on the right side, and the reverse pattern for the left on the left side--making 40 keys within the easy span of a single hand. The eight keys within the angle of the two central red pencil marks, where the right pattern descending and the left pattern ascending merge, are duplicates of others higher and lower. They are placed merely to facilitate playing. The tone 1, or fundamental, is duplicated in each 2/1, both because it completes the final pattern in each 2/1 and because it facilitates playing. The ~~eight~~ four 2/1s of keys describe an arc about the player, with the five rows tiered each 3/8ths of an inch above the other. An explanation and drafts of a mechanical means of producing tones are not included because one has not definitely been chosen. There are several available apart from strings that are also practical.

ADVANTAGES

Scales--

1. The chromatic scale of 39 tones within the 2/1 is a simple five-finger exercise through the whole extent of the keyboard. The largest interval between degrees, 36/35, which occurs twice, between 7/6 and 6/5, and 5/3 and 12/7, is just $3\frac{1}{2}$ times as wide as the smallest, 121/120, which occurs twice, between 15/11 and 11/8, and 16/11 and 22/15. Apart from these the largest is about twice as large as the smallest. (See keyboard fabric below.) The ~~two~~ four arcs in red pencil describe the first two of these five-finger patterns on each side. Arrow indicates the order to be se...

STATE OF CALIFORNIA,
City and County of San Francisco } ss.

On this 26th day of May, in the year One Thousand Nine Hundred and Twenty Eight before me, MATTIE G. STIRLING a Notary Public in and for the City and County of San Francisco, State of California, residing therein, duly commissioned and sworn, personally appeared Harry Partch. known to me to be the same person whose name is subscribed to the within instrument, and he duly acknowledged to me that he executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal at my office in the City and County of San Francisco, the day and year in this certificate first above written.

Mattie G. Stirling
Notary Public in and for the City and County of San Francisco, State of California.

0 to 5

5 to 32

33 to 0

(1) The fundamental octave of

(2) The next higher.

Etc.

A tone flatted c

b

bc

a

ac

ab

abc

aa

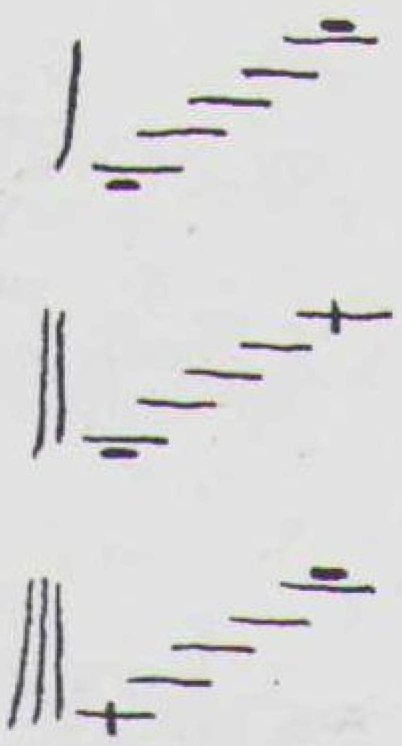
A tone sharped c

b

Etc.

O Indeterminate rest.

Finis



0 to 5

5 to 32

33 to 0

1 The fundamental octave of the instrument.
2 The next higher.
Etc.

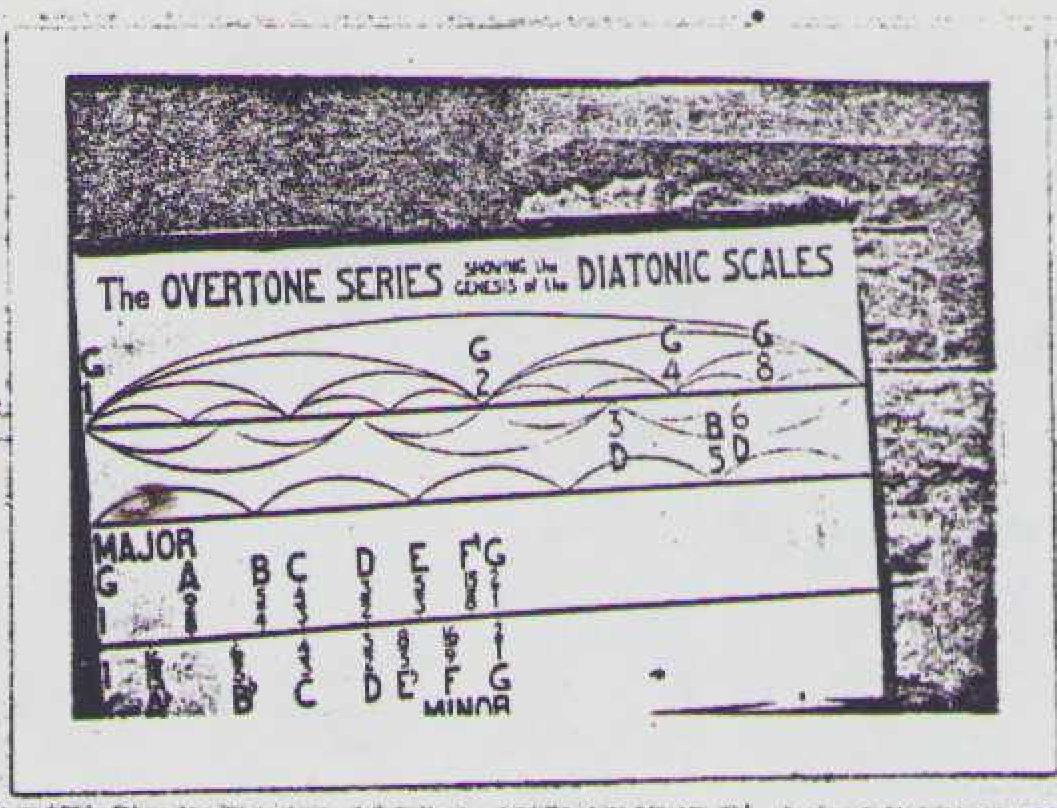
A tone flatted c
b
bc
a
ac
ab
abc
aa
A tone sharped c
b
Etc.

O Indeterminate rest.

Finis

Harry Partch

1.



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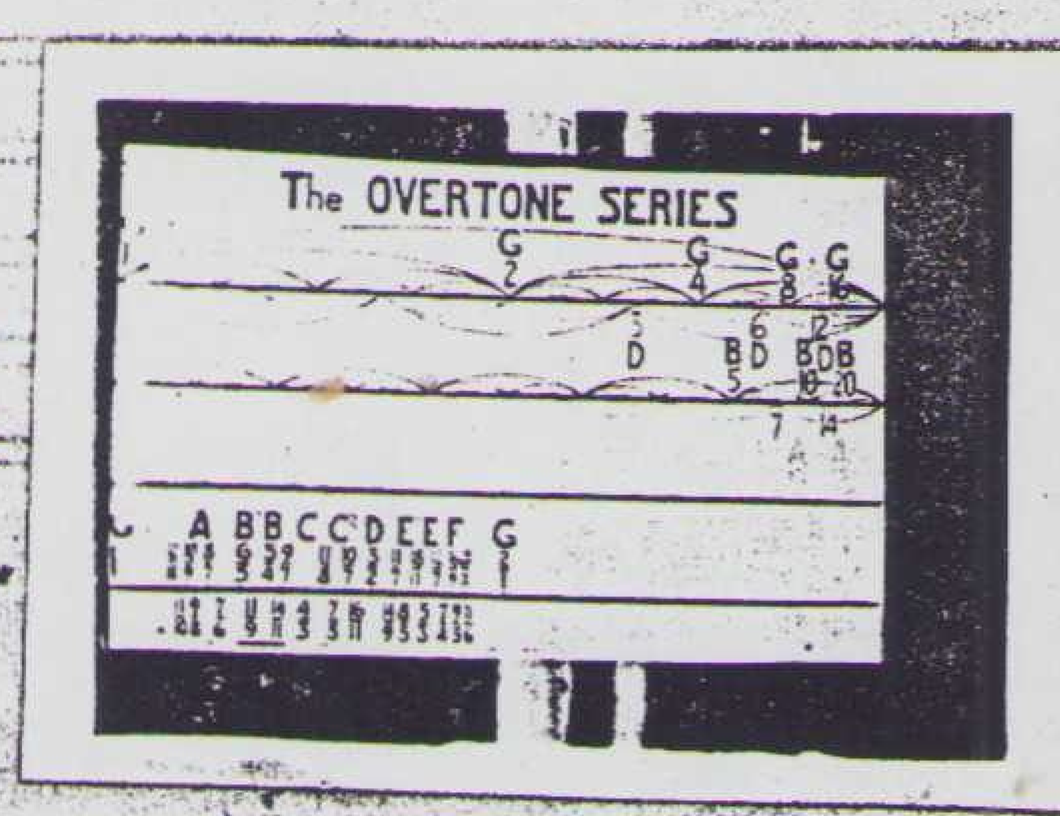

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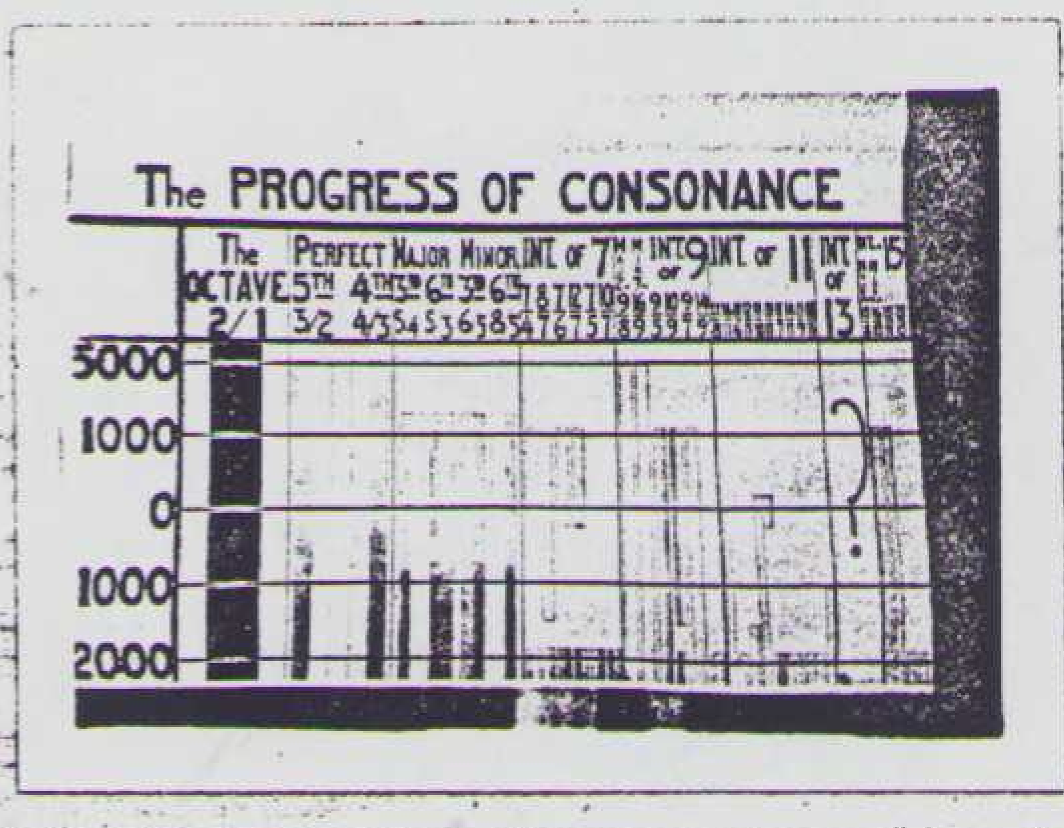

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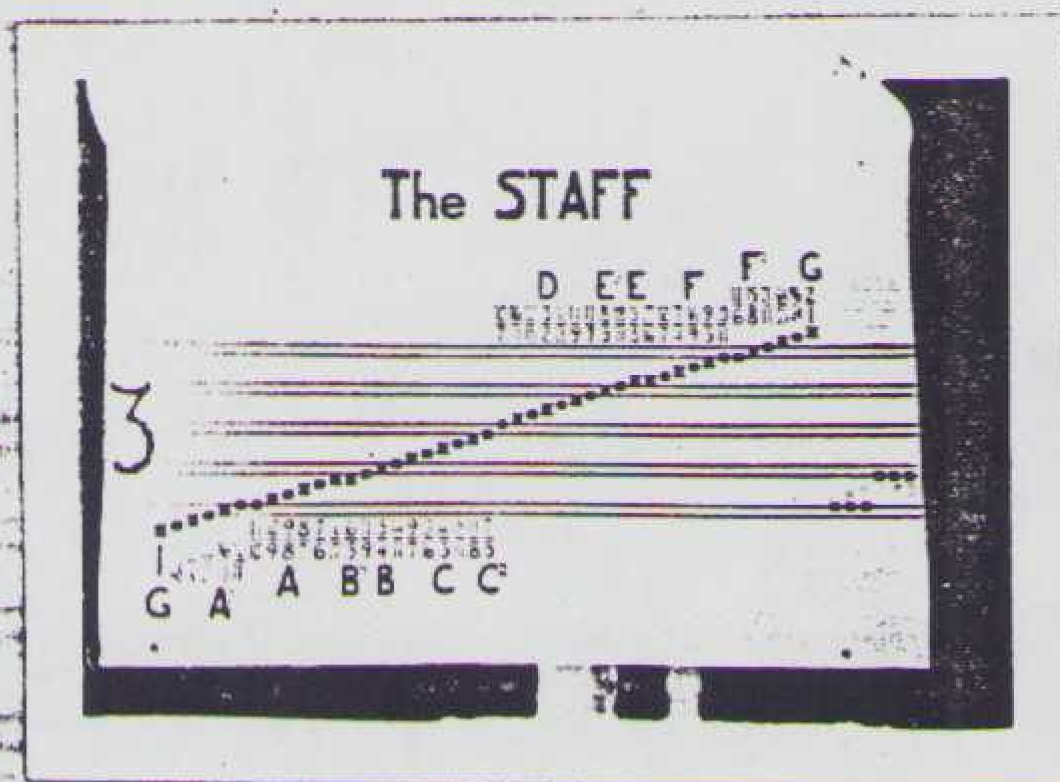


5.

Pictures of Charts used in Oral Exposition of Monophony in Pasadena and Los Angeles Demonstrations, February–June, 1933

Following are the songs created on the principles explained and thru Monophony:

~~Fourteen~~ Seventeen poems by Li Po, eighth century Chinese, from the translation by Shigayoshi Obata. (The numbers of the poems in Obata's book are in parentheses.) Completed at the given dates and places:

The Long-Departed Lover (5) Dec. 1930, New Orleans.

On the City Street (32) Aug. 1931, Santa Rosa, Cal.

An Encounter in the Field (38) Aug. 1931, Santa Rosa

The Intruder (56) Aug. 1931, Santa Rosa

On Ascending the Sin-ping Tower (107) October 15, 1931, San Francisco

In the Springtime on the South Side of the Yangtze Kiang (73) Dec 9, 1931, San Fra[illegible]

The Night of Sorrow (17) Dec. 17, 1931, San Francisco

On Hearing the Fute in the Yellow Crane House (119) Feb. 17, 1932, San Francisco

On Hearing the Flute at Lo-cheng One Spring Night (120) Feb. 17, 1932, San Franci[illegible]

A Dream (Title in translation: His Dream of the Skyland: A Farewell Poem, 77) Feb. 29, 1932, San Francisco.

On Seeing Off Meng Hao-jan (40) — Jan. 1931, New Orleans — Rewritten Nov. 14, 1932, Pasadena, Ca

With a Man of Leisure (30) - Jan. 1931, New Orleans, - Rewritten Jan 16, 1933, Pasadena

A Midnight Farewell (112) Jan. 17, 1933, Pasadena.

On the Ship of Spice-wood (1) April, 1931, New Orleans — Rewritten Jan 15, 1933, Pasad[illegible]

Two Psalms: 137th (By the Rivers of Babylon) August, 1931, Santa Rosa, Cal.

23rd (The Lord Is My Shepherd), on the interpretation of Cantor Reuben Rinder Jan 5, 1932, San Francisco

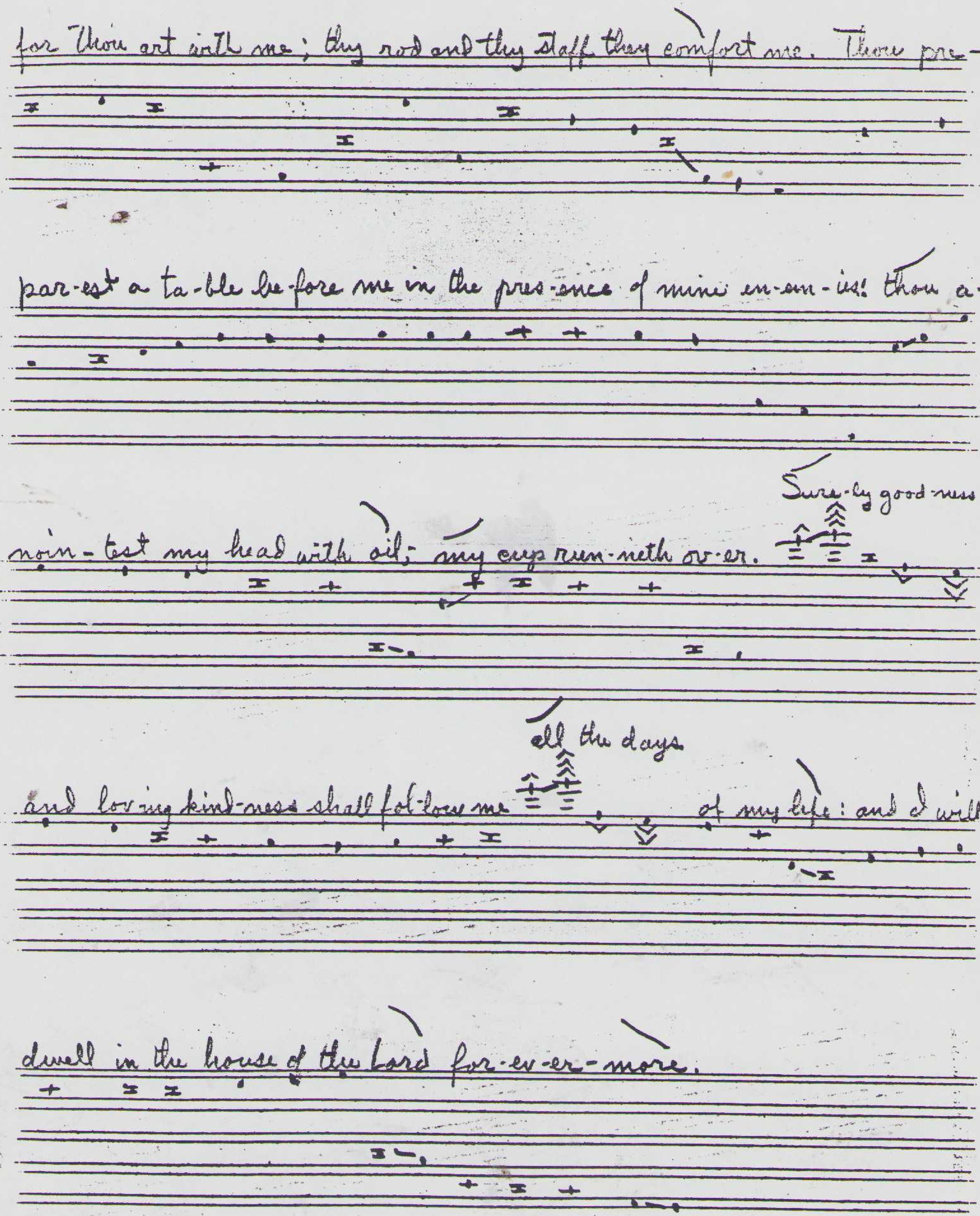
The "Potion Scene", Soliloquy of Juliet, from Shakespeare's Romeo and Juliet. Dec 29, 1931, San Francisco — Rewritten October, 1932, Pasadena.

The last five of the Li Po lyrics and the "Potion Scene" have accompaniment for viola with part of the bridge lowered so that the three highest strings may be played at once.

To Bertha Knisely — Before the Cask of Wine (98) Aug. 7, 1933, Gloucester, Ma

By the Great Wall (49) Aug. 8, 1933, Gloucester, Mass.

To Richard Buhlig — I Am a Peach Tree (69) Aug. 10, 1933, Gloucester, Mas


for Thou art with me; thy rod and thy staff they comfort me. Thou pre-
par-est a ta-ble be-fore me in the pres-ence of mine en-em-ies! thou a-
noin-test my head with oil; my cup run-neth ov-er.
Sure-ly good-ness
and lov-ing kind-ness shall fol-low me
all the days
of my life: and I will
dwell in the house of the Lord for-ev-er-more.

String Family ~~Guitar~~ Adaptation

Proportions of string length measured from nut for stops

on 2/3 ~~4/3(C)~~ string	for scale degrees	on fund. ([illegible]) string	for scale degrees	on 3/2([illegible]) string	for scale degrees	on 9/4 ~~[illegible]~~ string	for scale degrees
0	4/3	0	1	0	3/2	0	9/8
1/45	15/11	1/49	49/48	1/64	32/21	1/64	8/7
1/33	11/8	1/33	33/32	1/28	14/9	1/28	7/6
1/21	7/5	1/22	22/21	1/22	11/7	1/16	6/5
1/15	10/7	1/16	16/15	1/16	8/5	7/88	11/9
1/12	16/11	1/12	12/11	1/12	18/11	1/10	5/4
1/11	22/15	1/10	10/9	1/10	5/3	13/112	14/11
1/9	3/2	1/9	9/8	1/8	12/7	1/8	9/7
1/8	32/21	1/8	8/7	1/7	7/4	1/7	21/16
1/7	14/9	1/7	7/6	5/32	16/9	5/32	4/3
5/33	11/7	1/6	6/5	1/6	9/5	7/40	15/11
1/6	8/5	2/11	11/9	2/11	11/6	2/11	11/8
5/27	18/11	1/5	5/4	1/5	15/8	11/56	7/5
1/5	5/3	3/14	14/11	3/14	21/11	17/80	10/7
2/9	12/7	2/9	9/7	29/128	64/33	29/128	16/11
5/21	7/4	5/21	21/16	15/64	96/49	41/176	22/15
1/4	16/9	1/4	4/3	1/4	1	1/4	3/2
7/27	9/5	4/15	15/11	13/49	49/48	67/256	32/21
3/11	11/6	3/11	11/8	3/11	33/32	31/112	14/9
13/45	15/8	2/7	7/5	25/88	22/21	25/88	11/7
19/63	21/11	3/10	10/7	19/64	16/15	19/64	8/5
5/16	64/33	5/16	16/11	5/16	12/11	5/16	18/11
23/72	96/49	7/22	22/15	13/40	10/9	13/40	5/3
1/3	1	1/3	3/2	1/3	9/8	11/32	12/7
17/49	49/48	11/32	32/21	11/32	8/7	5/14	7/4
35/99	33/32	5/14	14/9	5/14	7/6	47/128	16/9
4/11	22/21	4/11	11/7	3/8	6/5	3/8	9/5
3/8	16/15	3/8	8/5	17/44	11/9	17/44	11/6
7/18	12/11	7/18	18/11	2/5	5/4	2/5	15/8
2/5	10/9	2/5	5/3	23/56	14/11	23/56	21/11
11/27	9/8	5/12	12/7	5/12	9/7	215/512	64/33
5/12	8/7	3/7	7/4	3/7	21/16	109/256	96/49
3/7	7/6	7/16	16/9	7/16	4/3	7/16	1
4/9	6/5	4/9	9/5	9/20	15/11	22/49	49/48
5/11	11/9	5/11	11/6	5/11	11/8	5/11	33/32
7/15	5/4	7/15	15/8	13/28	7/5	163/352	22/21
10/21	14/11	10/21	21/11	19/40	10/7	121/256	16/15
13/27	9/7	31/64	64/33	31/64	16/11	31/64	12/11
31/63	21/16	45/96	96/49	43/88	22/15	79/160	10/9
1/2	4/3	1/2	1	1/2	3/2	1/2	9/8

--Finis--

Adapted Viola

Only one instrument has been adapted to Monophony thus far. It has a viola body and ~~an elongated~~ fingerboard permitting greater accuracy in making the stops. It was deliberately planned for a string length of 20 inches. 29 of the 37 intervals are computed by the string length and indicated on the fingerboard by tiny brass brads and marks. The lowest string, making the same vibrations per second as the 'cello G, is chosen as fundamental. The four strings are tuned in the ratios 1-3/2-9/4-27/8, a 2/1 below those of the violin. The instrument is held between the knees when played.

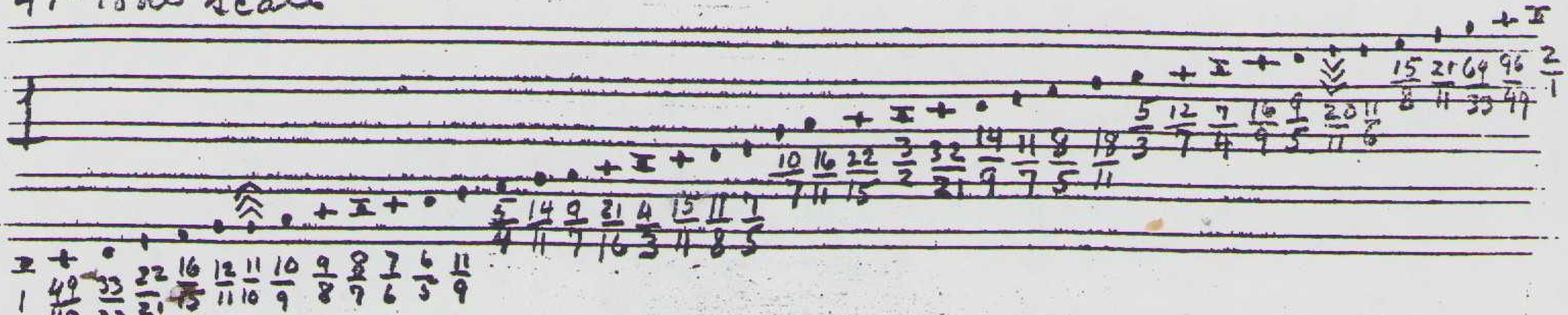
The G fundamental will probably be changed with the development of instruments for ensemble. The keyboard, described below, must have its fundamental as middle tone with three or four 2/1s extending above and below. Therefore, to give a median range of pitch, middle C would seem a better fundamental.

A family of strings--high, middle, low, tuned to the ratios 2/3-1-3/2-9/4 with 1 in the high instrument the same as middle C, 1 in the middle instrument a 2/1 below, and 1 in the low instrument a 2/1 below that--might supplement the keyboard.

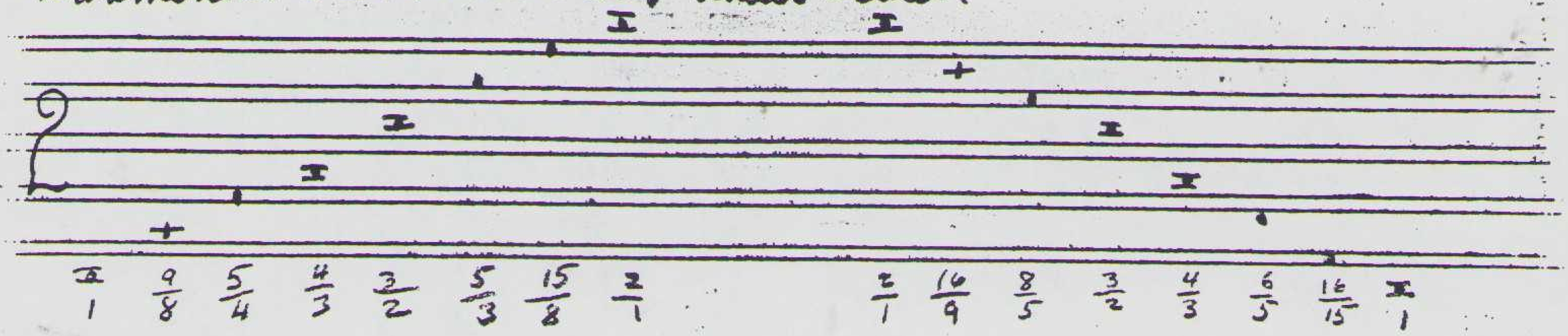
It is important for intervals to be heard in the simultaneous sounding of their tones. The marked fingerboard of the instrument for which instructions were given in the first chapter should be prepared for double stopping for two of its strings, at least. The proportions of string length to measure for the string above ~~or below~~ that chosen as fundamental are given in the following table:

(The computations for the new string are all made on the basis of its ratio to the fundamental. ~~If the 3/2 string is chosen~~ The next higher tone to the 3/2 open string is 14/9. The relation of 14/9 to 3/2 is 28/27. Then 1/28 of the length from the nut is the position for the stop for the tone 14/9. W hen stopped the string makes 28 vibrations while the whole (3/2) makes 27, but, also, the stopped string makes 14 vibrations while the fundamental string makes 9.)

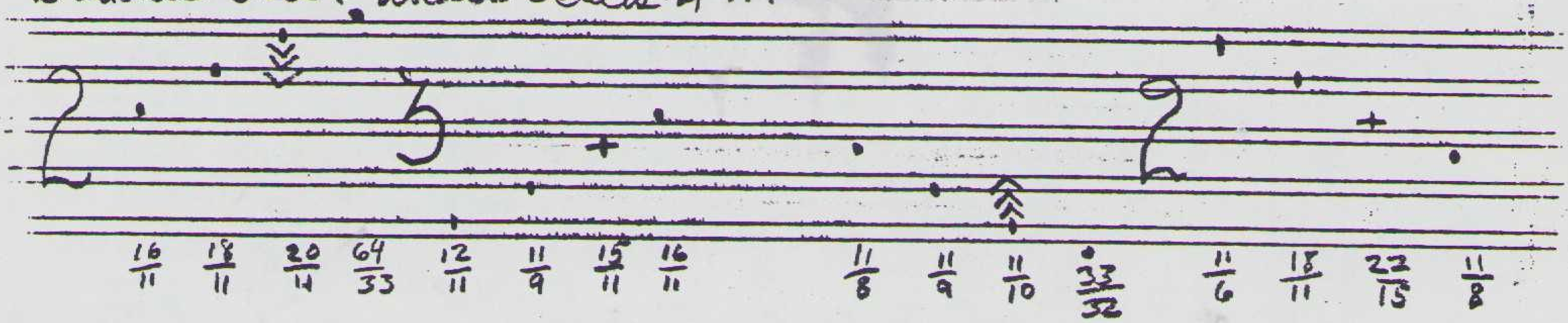
41-Tone scale



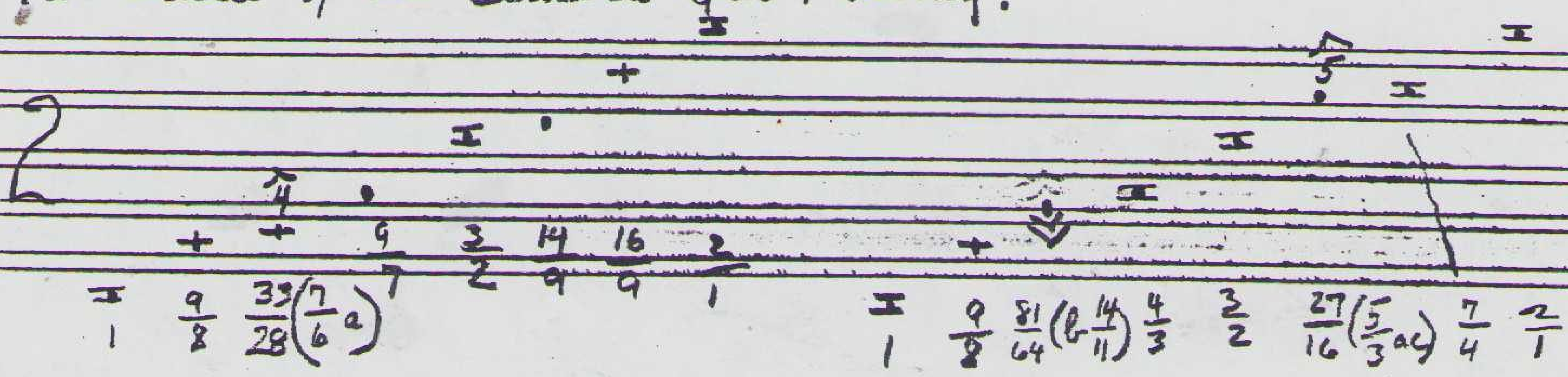
Fundamental Diatonic Over and Under Scales:



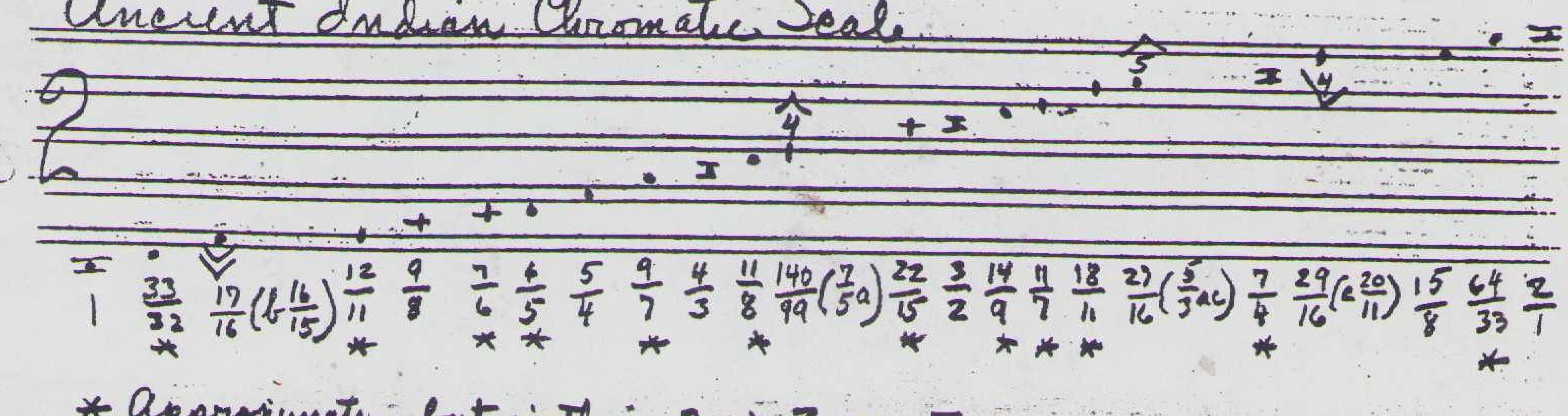
Diatonic Over + Under Scales of 11:



Two Scales of the Cithara after Ptolemy:



Ancient Indian Chromatic Scale



* Approximate, but within 2 or 3 cents.

NOTATION AND INSTRUMENTS

The Staff

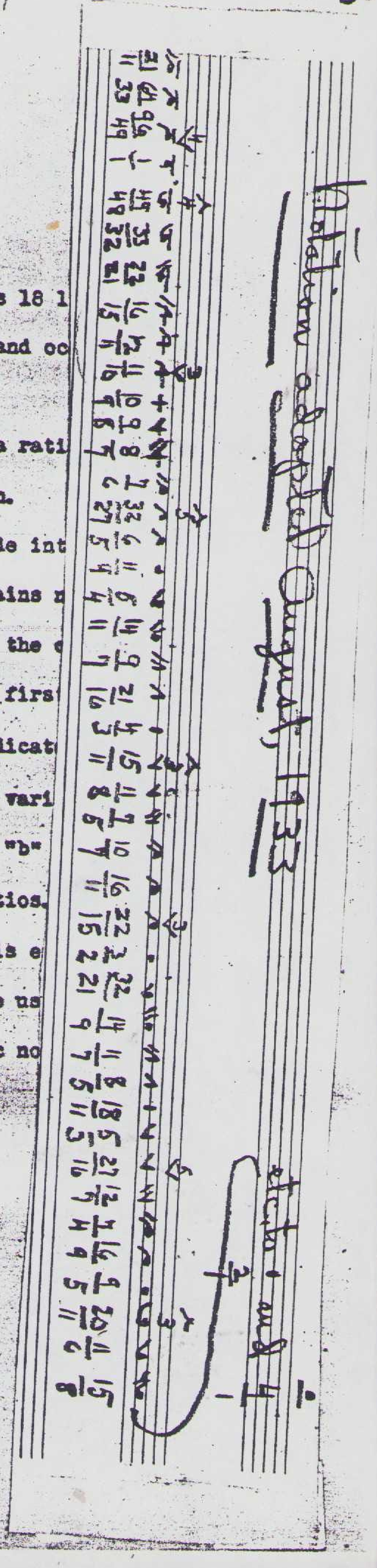
The staff capable of 37 tones to the 2/1 contains 18 l of which are visible; the other four pairs are assumed and oc between the five.

Any certain point on the staff is identified as a rati of intervals is thereby retained in the graphic notation.

Four of the six more complex ratios to divide wide int The space between the middle pair of visible lines contains n has its inversion in the reverse corresponding point in the staff. The large 1 shows that the range of pitch is the firs ment on which the scales are to be played; a large 2 indicat

A mark ∧ may be used over a note to denote a "c" vari to denote the same downward; two of them would denote a "b" "bc", and so on, thus providing for the more complex ratios.

A notation for rhythm allowing great complexity is e Cowell in his book, New Musical Resources. This could be us with the staff in place of the ordinary limited rhythmic no



Because of this most natural resolution the first condition, that is, an impression of the triad tones, may not apply at all but be inferred. Then the departure, paradoxically, is the beginning.

In pure melody, utterly without harmonic support, the same observations hold since the effect of harmony is given in successive tones.

The corresponding chord in the under tonalities is especially interesting because it has all the power of the over chord, being a perfect reflection, and has been comparatively ignored.

The simplest departure tone in the fundamental under tonality is 3/2, in the 3/2 tonality 9/8, and in the 5/4 tonality 15/8. Therefore, the under dominant 7th chord in the first tonality would be (descending) 4/3(F), 16/15(Db), 16/9(Bb), 3/2(G), resolving to 4/3(F), 1(C), 1(C), 8/5(Ab), the tonality of 1 under (called F minor). The leading tone, the 7th downward from 1, resolves downward to 1, and the 7th of the dominant chord (downward) resolves upward to the 3rd of the tonic chord (downward).

It is an interesting problem to construct the corresponding chords in the other two over and two under tonalities and to make their resolutions.

It is the purpose of this work to state and illustrate fundamental principles. Other chord combinations and their resolutions may be discovered as necessity arises for further corroboration of the theory.

Three laws crystallize from the foregoing observations:

First, the attraction a triad tone exerts is in inverse proportion to its ratio to 1. (The attraction the 3 identity exerts is 1/3 that of 1, and the 5 identity 1/5 that of 1. The urge in 9/8 for resolution to 1 in the fundamental over tonality is greater than the urge of 5/3 to 3/2, practically the same distance away, even tho 5/3 is a simpler departure tone.)

Second, the urge to resolution in a departure tone is in proportion to its plest 5/3. The simplest in the 4/3 tonality is 16/9 (16/9 4/3 4/3); the simplest in the 8/5 tonality is 16/15 (16/15 8/5 2/3, or 4/3).

This tone is best illustrated in the chord known as the dominant 7th. The dominant tone (3/2 in the fundamental over tonality) alone, that is, without a simultaneous or successive impression of the 3rd and 5th of the chord, has comparatively little urge. Its urge to 1 is greater than the urge of the other triad tone, the mediant, because it is simpler. The addition of the 3rd and 5th of the chord (15/8 and 9/8 in the fundamental over tonality) strengthens the urge because they are a perfect simulation of the triad tones on the dominant (3/2), thus preserving a feeling of the tonality while introducing a departure.

It is true that 15/8 and 9/8 are the 15 and 9 identities of the fundamental over tonality, but they are in simpler relation to 3/2 than to 1. (15/8 is a 5/4 interval with 3/2 and a 15/8 interval with 1. 9/8 is a 3/2 interval with 3/2 and a 9/8 interval with 1.) Therefore they induce the feeling of a departure. (This is not true of the 7 and 11 identities. Not being multiples of simpler numbers they are in closer relation to their fundamental than to the other identities of the tonality.)

However, even the dominant triad (3/2-15/8-9/8 in the fundamental over tonality) without the added 7th is comparatively impotent. With the 7th (4/3 in fundamental over tonality), the simplest tone of departure, it has the most compelling urge of any musical chord. With the addition of the 9th (5/3 in fundamental over tonality) there is included the next simplest tone of departure.

It is also natural that departure tones should find most satisfaction in resolution to the closest triad tones. The 3rd of the chord (15/8 in the fundamental over tonality) resolves to the tonic (1), the 5th of the chord (9/8) also to the tonic (9/8 is as close to 5/4 but the urge to 1 is naturally stronger); the 7th of the chord (4/3) to the mediant (5/4), and the 9th of the chord (5/3) to the dominant (3/2).

Fundamentals	C	f	a	F	c	Ab
C						
f	dominant; subdominant minor					
a	relative major; relative minor	submedinat minor; sharp mediant minor				
F	dominant; subdominant	tonal minor; tonal major	mediant; submediant			
c	tonal major; tonal minor	subdominant minor; dominant minor	submediant; mediant	subdominant; dominant minor		
Ab	mediant major; flat submediant major	submediant; mediant	chromatic minor; chromatic major	submediant major; flat mediant major	mediant; submediant	

Limits to this work must be drawn. It is not designed to include an analysis of generally accepted musical theory. However, the above table is corroborated in one particular; Ab to a is the most complex relation; compare 8/5 to 5/4.

The Phenomenon of Resolution

There are two conditions prerequisite to an urge for resolution: first, an impression of a tonality--an impression is gained thru the 1-3-5 identities of a tonality, in other words, thru the triad tones. Later it will be seen that the 7-9-11 identities may be, in diminishing importance, part of the impression of a tonality. The second condition is a departure from the tonality. The introduction of tones other than the triad tones instantly creates the urge for resolution. The urge is satisfied in a return to the triad tones

It is natural that the simplest tone of departure should create the most compelling urge. The simplest tone in the fundamental over tonality other than the triad tones is 4/3 (it is composed of the simplest numbers), the next sim-

After leaving diatonic intervals and discussing the 37 monophonic intervals it will be impossible to translate except in relation to them. Therefore it will be advantageous to discard all translation after this chapter.

There are only three ratios, or intervals, between degrees--9/8, 10/9, 16/15. 9/8 and 16/15 have been explained as intervals of the diatonic scales. The simplicity of the relationship of their tones is therefore accepted. 10/9 is also the result of two simple intervals--a 5/3 and a 4/3--$\frac{5}{3} \times \frac{4}{3} = \frac{20}{9}$, or, reduced a 2/1, $\frac{10}{9}$. It is the theoretic small whole tone, which is an 81/80 interval narrower than 9/8.

The six triads and their scales should be played on the instrument which has been prepared with marked stops, and the exact relation of each ratio to its two tonalities studied.

Tonalities are to each other as their fundamentals. A table of tonality relationships follows:

Funda-mentals						
1 over						
1 under						
5/4	5/4	5/4				
4/3	4/3	4/3	16/15			
3/2	3/2	3/2	6/5	9/8		
8/5	8/5	8/5	32/25	6/5	16/15	
Funda-mentals	1 over	1 under	5/4	4/3	3/2	8/5

The relationships are all simple, comparatively, of course, except 8/5 to 5/4 with the relationship 32/25. Compare this analysis with the ordinary understanding of tonality relationships. (C is 1. Capitals major, small letters minor. The relation of the horizontal to the vertical as fundamental is given first--then the reverse.)

1-1/3-1/5, are transposed into the 2/1 from the fundamental series of likenesses, that is, from 2, and 4, and from 1/2 and 1/4. The fundamental over triad is 1-5/4-3/2, C-E-G, having 1-5-3 over a constant 1 (1-4-2 are identical). The under triad is 1-8/5-4/3, C-Ab-F, having 1-5-3 beneath a constant 1 (1-8-4 are identical).

In the overtone series there were two transpositions from the 3 series, 4/3 and 5/3. 4 indicates a 1, or fundamental; 5 a 5th overtone, and 3/3, or 1, a 3rd overtone: there is a constant lower 3. The triad is then 4/3-5/3-1, F-A-C, a new tonality. The corresponding under triad is 3/2-6/5-1(3/3), G-Eb-C, having 2 (or 1)-5-3 as undertones of the tonality, and a constant upper number 3.

There are two transpositions from 5 in the overtone series, 8/5 and 6/5. 8 indicates the fundamental of an overtone series; 5/5, or 1, a 5th overtone, and 6 a 3rd overtone, all having a lower constant 5. The triad is then 8/5-1(5/5)-6/5, Ab-C-Eb. The corresponding undertone triad is 5/4-1(5/5)-5/3, E-C-A, having 4 (or 1)-5-3 as undertones and a constant upper 5.

The six triads:

Overtone			Undertone (Descending)		
Fund.	5th	3rd	Fund.	5th	3rd
1 (C)	5/4 (E)	3/2 (G)	1 (C)	8/5 (Ab)	4/3 (F)
4/3 (F)	5/3 (A)	1 (C)	3/2 (G)	6/5 (Eb)	1 (C)
8/5 (Ab)	1 (C)	6/5 (Eb)	5/4 (E)	1 (C)	5/3 (A)

It is perfectly apparent that a ratio on its face reveals its possibilities. One knows instantly that the tone 5/3 is either the 5th overtone, or mediant, of the tonality whose fundamental is 4/3, or the 3rd undertone, or dominant, of the tonality whose fundamental is 5/4.

The six diatonic scales according to the groupings of tones given before and showing the intervals between degrees:

Overtone--

C		D		E		F		G		A		B		C
1		9/8		5/4		4/3		3/2		5/3		15/8		1
	9/8		10/9		16/15		9/8		10/9		9/8		16/15	

F		G		A		Bb		C		D		E		F
4/3		3/2		5/3		16/9		1		9/8		5/4		4/3
	9/8		10/9		16/15		9/8		9/8		10/9		16/15	

Ab		Bb		C		Db		Eb		F		G		Ab
8/5		16/9		1		16/15		6/5		4/3		3/2		8/5
	10/9		9/8		16/15		9/8		10/9		9/8		16/15	

Undertone--(Descending)

C		Bb		Ab		G		F		Eb		Db		C
1		16/9		8/5		3/2		4/3		6/5		16/15		1
	9/8		10/9		16/15		9/8		10/9		9/8		16/15	

G		F		Eb		D		C		Bb		Ab		G
3/2		4/3		6/5		9/8		1		16/9		8/5		3/2
	9/8		10/9		16/15		9/8		9/8		10/9		16/15	

E		D		C		B		A		G		F		E
5/4		9/8		1		15/8		5/3		3/2		4/3		5/4
	10/9		9/8		16/15		9/8		10/9		9/8		16/15	

The fundamental under tonality, in usual terminology, with the triad C-Ab-F, would be F minor; the 3/2 tonality, with the triad G-Eb-C, C minor; the 5/4 tonality, with the triad E-C-A, A minor. Confusion can be avoided by forgetting the alphabetical nomenclature and remembering that the ratios 3/2 and 5/4, because of the 2 and 4 as under numbers, are the fundamentals of under tonalities (1-2-4-8 are always indicative of fundamentals) and that the triad tones descend the exact reverse of over triads.

The very fact that a ratio must have two numbers is proof that it is a potential dual identity. It is not meant that a tone can be considered an overtone and undertone at once; rather, that a tone at once has the possibility of both. The mind must work in diametric directions to comprehend this; for overtones up, for undertones down.

The germ of this theory was discovered in the 16th century by Giuseppe Zarlino, Franciscan monk, who expounded the polarity of major and minor. It was his theory, ~~since~~ later generally accepted, that the major is naturally an ascending scale, and that the minor naturally descends with intervals the exact reverse. Such are the scales taken from their source in the overtone or undertone series: C-D-E-F-G-A-B-C, ascending, for major, and C-Bb-Ab-G-F-Eb-Db-C, descending, for minor. It is rather an arbitrary grouping, and quite variable. It is preferable to think of the 11 tones as a single body susceptible of many groupings. The arrangement of the intervals does not matter so long as the triad tones are retained, C-E-G for major, and C-Ab-F for minor.

The discovery of Zarlino is completely corroborated in that the 1-3-5 identities of the overtone series form the major triad, and the 1-1/3-1/5 of the undertone series the minor. Hereafter the word over will imply a major tonality, and under a minor tonality.

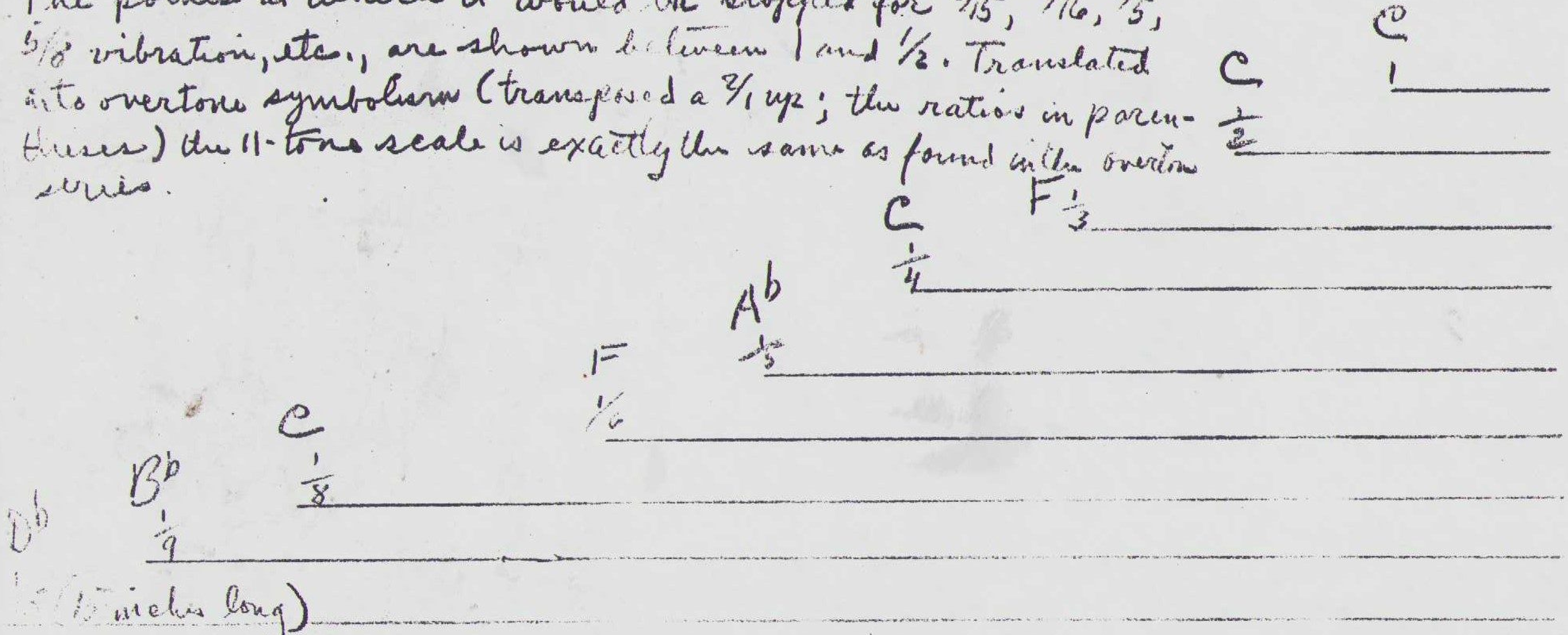
The Six Tonalities

There are six varieties of transpositions within the 2/1, those from 1 (or 2-4-8) 3 and 5 over, and from 1 (or 1/2-1/4-1/8), 1/3 and 1/5 under. Analysis of these reveals the six tonalities existent within the 11 tones of the diatonic scales.

The triads expounded above are the fundamental over and under. They are fundamental because the triad tones that reveal their identities, the 1-3-5 and

UNDERTONE SERIES.

A string 1 inch long makes 1 vibration in a certain length of time. The lengths of strings necessary to make 1/2, 1/3, 1/4 vibration, etc., in the same time are shown. Now consider that a string is 10 inches long (at bottom of page) and that half of it makes 1 vibration; then all of it makes 1/2 vibration. The points at which it would be stopped for 8/15, 9/16, 3/5, 5/8 vibration, etc., are shown between 1 and 1/2. Translated into overtone symbolism (transposed a 2/1 up; the ratios in parentheses) the 11-tone scale is exactly the same as found in the overtone series.



Major

C	D	E	F	G	A	B	C
	(9/8)	(5/4)	(4/3)	(3/2)	(5/3)	(15/8)	(2/1)
	9/16	5/8	2/3	3/4	5/6	15/16	1

8/15	3/5	2/3	3/4	4/5	8/9	1

times as fast as 1, creating the 15th overtone, the fourth B above middle C. One of the two new intervals is then C to B, 8 to 15, or 15/8, the major 7th. Transposed down three 2/1s it is still C to B. Patently, it is the result of a 5/1 and a 3/1, or a 5/4 and a 3/2--$\frac{5}{4} \times \frac{3}{2} = \frac{15}{8}$.

The 15th overtone also allows the interval B to C, 15 to 16, or 16/15, the minor 2nd. Transposed within the 2/1, the distance of three 2/1s and a major 7th, the interval is C to Db, the same relationship. The analysis is--$\frac{8}{5} \times \frac{4}{3} = \frac{32}{15}$, or $\frac{16}{15}$.

It becomes evident that ratios with both numbers multiples of simpler numbers are the result of two intervals represented by those simpler numbers.

There are the ratios of four more intervals to know:

9/8 -- major 2nd	15/8 -- major 7th
16/9 -- minor 7th	16/15 -- minor 2nd

The 11 diatonic intervals, showing the intervals between degrees:

C		Db		D		E		Eb		F		G		ab		a		Bb		B		C
1		16/15		9/8		6/5		5/4		4/3		3/2		8/5		5/3		16/9		15/8		2/1
	16/15		135/128*		16/15		25/24		16/15		9/8		16/15		25/24		16/15		135/128*		16/15	

*About a 17/16 interval.

Each interval has its inversion: the inversion of 3/2 is 4/3, of 5/4 8/5, of 6/5 5/3, of 9/8 16/9, of 16/15 15/8.

There is only one way to appreciate these intervals; that is to hear them. Accurately measure the string length from nut to bridge of any unfretted string instrument. The interval 2/1 will be ½ the string length. ~~There~~ (at that point on the fingerboard under the lowe make an incision or scratch at right angles to the string ~~on the fingerboard~~. The interval 16/15 is produced by measuring 1/16 of the length from the nut; put a mark there. When the string is depressed at the mark the sounding part makes 16 vibrations in the time required for 15 vibrations of the whole string.

nomenclature. The intervals are:

2/1 -- octave	5/4 -- major 3rd
3/2 -- perfect 5th	5/3 -- major 6th
4/3 -- perfect 4th	6/5 -- minor 3rd
	8/5 -- minor 6th

There are then left to discover only the major and minor 7ths and 2nds, occurring at the beginning and end of the scale. These are the result of ~~the addition of~~ two intervals within 5. The third of the string, which creates 3, divides into three parts, each part vibrating three times as fast as the third, or nine times as fast as 1, creating the 9th overtone, the fourth D above middle C in the series given before. One of the two possible new intervals is then C to D, 8 to 9, or 9/8, the major 2nd, which transposed down three 2/1s, is still C to D. Analyzed, it is the result of two 3/1s, or 3/2s--$\frac{3}{2}\times\frac{3}{2}=\frac{9}{4}$, or $\frac{9}{8}$.

It should be clearly understood that any ratio with a lower number less than half the larger is wider than a 2/1, and that doubling the lower is merely making the interval narrower by a 2/1. Doubling the upper widens the interval by a 2/1. Halving has the reverse effects.

The 9th overtone also allows the interval D to C, 9 to 16, or 16/9, the minor 7th. Analyzed, it is the result of two 4/3s--$\frac{4}{3}\times\frac{4}{3}=\frac{16}{9}$. Transposed within the 2/1, the distance of three 2/1s and a major 2nd, it becomes C to Bb, the same relationship.

The pentatonic scale is built from the intervals within 3, 1-4/3-3/2-2/1 (C-F-G-C), and the wide intervals 1-4/3 and 3/2-2/1 are divided by intervals that are the result of two intervals within 3, 9/8 and 16/9 (D and Bb).

The fifth of the string, which creates the 5th overtone, divides into three parts, each third vibrating three times as fast as the fifth or fifteen or C-D-F-G-Bb-C. They may be seen in the ratios of the diatonic scales, explained immediately following.)

The intervals of the diatonic scales have their genesis within 5. The first of those intervals is the octave, 2/1, into which all the other intervals must be transposed to make them musically available. In a practical system of musi the octave of a tone can have no identity; it is simply double the number of vibrations. A system is evolved for one octave, of which every other is a duplication.

The next interval is C to G, 2 to 3, or 3/2, the perfect fifth. It is transposed down an octave and is still C to G. The next is G to C, 3 to 4, or 4/3, which must be transposed within the 2/1, the distance of a perfect 12th, and becomes C to F, the same 4/3 relationship, thus creating the tone F. C to E, 4 to 5, or 5/4, transposed down two octaves within the 2/1, remains C to E. G to E, 3 to 5, or 5/3, transposed within the 2/1, down a perfect 12th, becomes C to A, the same 5/3 relationship, creating the tone A.

The odd-numbered of the overtone series are the only identities. The octave of G, 3, is G, 6. Then without drawing further from the series there is the interval E to G, 5 to 6, or 6/5, transposed to 1, the distance of an octave and a major 10th, giving the interval C to Eb, the same relationship. And there is also the interval E to C, 5 to 8, or 8/5 (8 is the octave of 4), which, transposed to 1, an octave and a major 10th, creates the interval C to Ab, the same relationship.

The words interval, ratio, relationship, tone, are practically synonymous in this exposition. A tone implies a ratio to its fundamental, and an interval is a ratio, or relationship.

To avoid confusion these simple intervals should be recognized by their ratios. Hereafter they will be used without translation to tempered scale

Exposition of Monophony

THE 11 DIATONIC INTERVALS

The Overtone Series

It is not important whether one chooses to say that musical intervals have their source in the ratios of simple numbers, as did Pythagoras of Samos in the sixth century B. C., or that their source is in the overtone series, the phenomenon discovered by Marin Mersenne, French monk of the seventeenth century. The result is the same. Because a more graphic analysis is possible, intervals will be explained as having their source in ~~the~~ overtones ~~series~~. This work is called Exposition of Monophony in recognition of a single tone and its overtones ~~series~~.

Just intonation is any system of tuning with intervals exactly the same as the intervals of the overtone series. Therefore, the name Monophony might apply to any system of just intonation.

The tone of a string that makes one vibration in a certain length of time will be called fundamental, or 1. It is known that while the string is making one vibration it is also dividing itself in half, each half vibrating twice in the same length of time, creating the second overtone, or 2, the octave, the simplest and strongest of all intervals, 2/1; that it divides itself in three parts, each third vibrating three times in the same length of time, creating the third overtone, or 3; into four parts, creating the fourth overtone, or 4, the octave of 2, or the second octave of 1, and into five parts, creating the fifth overtone, or 5.

On the piano, if middle C is fundamental, the octave above is 2, the second G above 3, the second octave above 4, and the third E above 5.

The intervals of the pentatonic scale, one of the first used by man, have their genesis within 3. (They are expressed in the ratios 1-9/8-4/3-3/2-16/9-2/1,