More on the Tuning of the "Archicembalo"

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More on the Tuning of the *Archicembalo*

By HENRY W. KAUFMANN

SEVERAL DISCUSSIONS OF THE TUNING of Nicola Vicentino's *archicembalo*[1] have not succeeded in clarifying all the problems connected with this instrument. With the aid of a seventeenth-century treatise by Lemme Rossi, his *Sistema musico overo musica speculativa*,[2] some additional light can now be thrown on the question.

Vicentino's instrument is provided with two keyboards, each containing three ranks or orders of keys, placed in removable frames. There are sixty-nine jacks in the first keyboard and sixty-three in the second, making a total of one hundred thirty-two keys in all. The accompanying diagram (Figure 1)[3] shows the disposition of the six orders of keys within the two keyboards and the notation used by Vicentino for each sound. The names of the notes make clear the progression from one order to the next, the denomination of each note in the succeeding orders being derived from the name of the note in the first order that served as its point of origin. Thus, in moving from *A la mi re primo* (A, in the first order) to the second order, the notation is given as G-sharp but the note is called *A la mi re secondo*.[4] Similarly, *E la mi primo* (E, in the first order) moves to *E la mi secondo* (E-flat, in the second order), then to *E la mi terzo* (D-sharp, in the third order), etc. In other words, Vicentino prefers to think of the location of his notes with reference to the keyboard rather than to the staff.

The first order[5] is made up entirely of white keys that correspond to those found in most keyboard instruments. The second order contains the black keys most frequently used in the sixteenth century. In

[1] The *archicembalo* is described in detail in Book Five of Nicola Vicentino's *L'antica musica ridotta alla moderna prattica* (Rome, 1555); facsimile reprint, ed. Edward E. Lowinsky, Documenta Musicologica, Erste Reihe, XVII (Kassel: Bärenreiter, 1959). The discussion of the tunings can be found in James Murray Barbour, "Equal Temperament: Its History from Ramis (1482) to Rameau (1737)" (unpublished Ph.D. diss., Cornell University, 1932), pp. 60-76; Paul Robert Brink, "The Archicembalo of Nicola Vicentino" (unpublished Ph.D. diss., The Ohio State University, 1966), pp. 85-154; Henry W. Kaufmann, *The Life and Works of Nicola Vicentino*, Musicological Studies and Documents, 11 (Rome: American Institute of Musicology, 1966), pp. 165-172.

[2] (Perugia: Angelo Laurenzi, 1666).

[3] This diagram was prepared with the help of Mr. Floyd Sumner of Rutgers University.

[4] Instead of the more usual *G sol re ut sustentato*. Cf. Vicentino, *op. cit.*, fol. 103ᵛ.

[5] The following description of the six orders of the *archicembalo* is based on Vicentino, *op. cit.*, fols. 101 and 101ᵛ.

modern terms, these would include F-sharp, G-sharp, B-flat, C-sharp, and E-flat. The keys of the second order are split and raised to provide for the third order, which is then completed by the insertion of shortened black keys between the semitones E-F and B-C. This order contains the less commonly used semitones: G-flat, A-flat, A-sharp, B-sharp, D-flat, D-sharp, E-sharp.

The second frame begins with the fourth order, which contains the same white keys as the first order, but pitched a minor enharmonic diesis higher. This new pitch, equal to one-half the value of the minor semitone,[6] is represented notationally by a dot over the note. The fifth order supposedly stands in the same relationship to the fourth as the second to the first. In the latter case, however, both major and minor semitones occur, whereas in the former only major or minor semitones are found.[7] The notes of the fifth order are G-flat, A-flat, B-flat, D-flat, and E-flat, all a minor enharmonic diesis higher than the corresponding notes in the second and third orders, and hence notated with the enharmonic dot. The sixth order resembles the first diatonic order by using plain notes unmodified by accidentals for its pitches, but is a comma (= half an enharmonic diesis) higher in sound than the first order. The notes are G, A, B, D, and E, with the symbol of a comma over each note. Apparently Vicentino originally planned to include shortened black keys for C and F in the sixth order, since he occasionally refers to these notes in his book. Obviously they were omitted because there was no accommodation possible for the necessary jacks.[8]

The first two orders are apparently tuned in a kind of meantone temperament "according to the use of the other [keyboard] instruments, with the fifths and fourths somewhat shortened . . ."[9] The tuning of the third order proceeds around the circle of "shortened" fifths: for the sharp keys, he starts with A in the second order (A^2), moves a fifth higher into the third order on E^3, down an octave and up another fifth to B^3, down an octave and up a fifth to $F^{2 \text{ in } 3}$, [10] up a fifth to $C^{2 \text{ in } 3}$ and

[6] Derived from dividing the tone into five parts or dieses, three for the major semitone and two for the minor semitone.

[7] Between the first and the second orders, major or minor semitones are found both in ascending or descending patterns; between the fourth and fifth orders, major semitones occur only in an ascending pattern, minor in a descending pattern. Vicentino suggests an easy way to remember the notations of these semitones. The minor semitone is smaller than the major, hence will lie *nearer* to its point of origin, that is, either on the same line or the same space, *e.g.* F to F-sharp, A to A-flat. The major semitone, as the larger interval, will be located farther away, that is, on an adjacent line or space, *e.g.* A to B-flat, G to F-sharp. *Ibid.*, fol. 102.

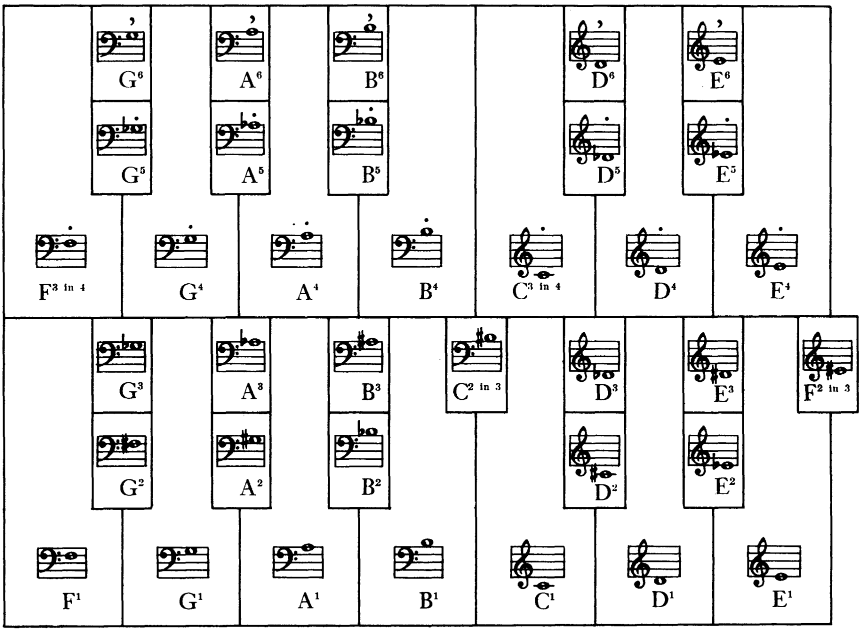
[8] Cf. *ibid.*, fols. 109^v, 133^v.

[9] ". . . secondo l'uso de gli altri stromenti con le quinte & quarte alquanto spontate. . . ." *Ibid.*, fol. 103^v. Vicentino's basic tuning of the *archicembalo* is given on fols. 103^v-104.

[10] Erroneously given as *E la mi terzo* instead of *F fa ut secondo in terzo ordine*, *ibid.* Vicentino's treatise abounds in typographical errors. Sometimes entire parts of

Figure 1

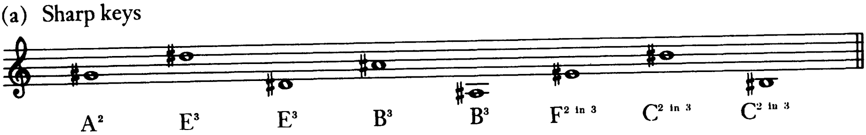
Vicentino's *Archicembalo*



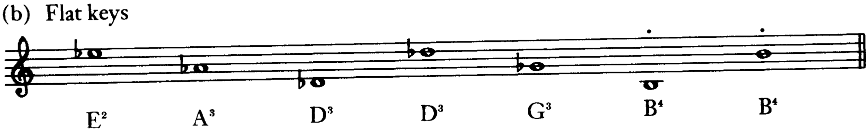
then down another octave; for the flat keys, he begins with E^{2}, descends by a fifth to A^{3}, and another fifth to D^{3}, then up an octave and down a fifth to G^{3}, ending a fifth lower on B^{4} (= C-flat).[11] In Vicentino's notation, the tuning would be represented as in Example 1.

Ex. 1

(a) Sharp keys

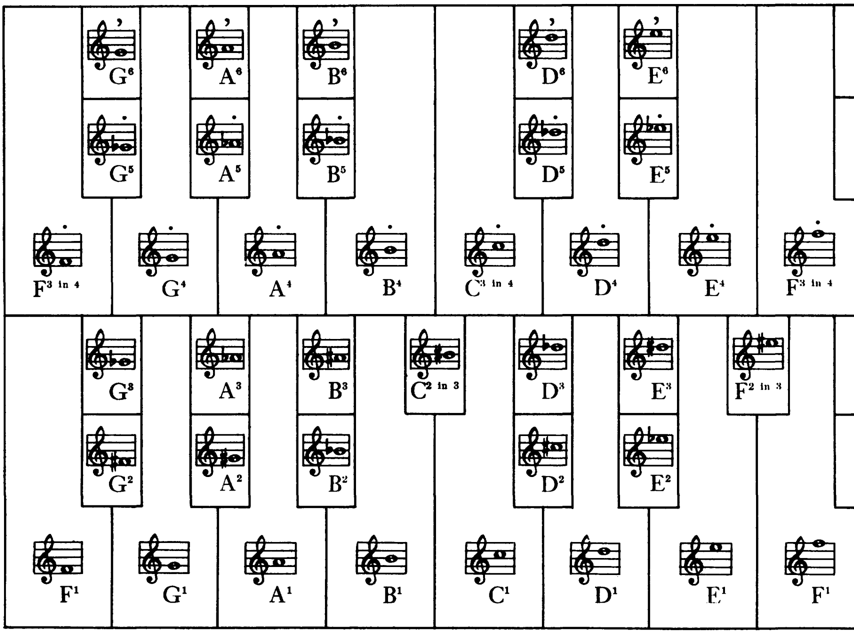


(b) Flat keys



sentences are omitted, but the context will supply the correct reading. In other cases, an error in the text will be corrected by the use of the right note in the example, or an error in the example will be rectified by a correct statement in the body of the text.

11 Vicentino himself identifies B^{4} with C-flat. In describing the fifth below G^{3}, he identifies the note as B^{4} in the text, but writes a C-flat in the example, *ibid.*, fols. 109 and 109^{v}. This could imply that Vicentino not only uses enharmonic notation for the



The meantone temperament most suitable for this tuning would be that of Aron in which the fifths are tempered by ¼ comma. The comma used is the syntonic or Didymic comma, the difference between a just major third with the ratio 5:4 and a Pythagorean major third with the ratio 81:64. Lemme Rossi, in his *sistema participato*,[12] extends this tuning to a closed system of nineteen tones, sufficient to include all the notes in Vicentino's first keyboard. A comparison of this system with the tuning given by Rossi for Vicentino's *archicembalo*[13] will show how closely the two tunings are related. (Table 1) The ¼ comma temperament will thus be used for the tuning of the fifths in the remaining orders of the *archicembalo*.

Vicentino recommends that the tuning of the fourth order be postponed until that of the fifth has been completed. He begins the tuning of the fifth order with *C fa ut secondo in terzo ordine* ($c^{2\text{ in }3}$) and seems to progress by "shortened" fifths as before, but his terminology is obviously incorrect. The fifth above $c^{2\text{ in }3}$ is described as *F fa ut quinto, in quinto ordine*, which is contrary to his previous statement that F, because

order containing a differential of a diesis, but that he also employs the term in its modern sense, as a form of pitch equivalency.

[12] Rossi, *op. cit.*, p. 83.

[13] *Ibid.*, p. 86.

TABLE I

Lemme Rossi, *Sistema musico* (1666), pp. 83, 86

	Sistema participato		Vicentino	
Note name	String length	= Cents	String length	= Cents
A	20736	1200	20736	1200
A♭	21667	1124	21684	1122.6
G#	22187	1083	22174	1083.9
G	23184	1007	23188	1006.5
G♭	24225	930.7	24249	929
F#	24806	890	24797	890.4
F	25920	813	25931	813
E#	26542	773	26517	774.2
E	27734	697	27730	696.8
E♭	28980	620.5	28999	619.3
D#	29676	579	29655	580.6
D	31008	503	31011	503.2
D♭	32400	427.3	32429	425.8
C#	33178	386	33162	387.1
C	34668	310	34679	309.7
B#	35499	269.2	35463	270.9
B	37095	193	37084	193.6
B♭	38760	117	38781	116.1
A#	39690	76	39657	77.5
A	41472	0	41472	0

it moves a semitone to E in the natural diatonic order, can only be found in three orders instead of the customary six.[14] The next fifth leads to another unexplained location on the keyboard, *C sol fa quinto*, which is then followed by the easily identifiable A^5, E^5, and B^5. It would therefore

[14] Vicentino, *op. cit.*, fol. 103. The same is also true for C.

seem that *F fa ut quinto* really means G^5 and *C sol fa quinto*, D^5, the two unaccounted-for notes in the fifth order.[15] Notationally this tuning can be represented as in Example 2.

Ex. 2

The fifth order is then used to accomplish the tuning of the fourth. Starting with *B fa ♮ mi quinto* (B^5), Vicentino moves into the fourth order on F$^{3 \text{ in } 4}$ and then continues around the circle of "shortened" fifths to produce the other notes. (Example 3)

Ex. 3

The tuning of the sixth order is not given at this time. All that is said about this last order is that its pitches are a comma above those of the diatonic, which would mean that this order serves as an intermediate pitch between the first and fourth orders, since the comma is equivalent to one-half of the minor enharmonic diesis. The sixth order is, however, considered in a second or alternate tuning offered by Vicentino, based on the perfect fifth.[16]

This "puzzling doctrine of the perfect fifth," as Barbour calls it,[17] states that the last three orders can be tuned with the first three by means of this interval. In other words, the perfect fifth of any note in the first order can be found in the fourth order, and the same would be true of the relationship of the second to the fifth orders and the third to the sixth. Unfortunately, the distance between these related orders is not the same so that the fifths would not all be of the same size. The only solution would be to understand the term "perfect" in a relative sense.

Such an interpretation is implicit in Vicentino's concept of interval structure. In addition to the "common" intervals, Vicentino describes

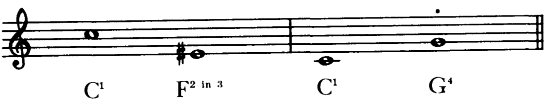
[15] It is possible to consider that for *F fa ut quinto, in quinto ordine* is meant *F fa ut sustentato quinto, in quinto ordine*, that is, F-sharp, expressed enharmonically (in the modern sense) as G-flat with the dot of diesis (=G^5). Similarly, *C sol fa quinto* could mean *C sol fa sustentato quinto*, that is, C-sharp, expressed enharmonically as D-flat with dot (=D^5). In other words, the fifth order indicates a type of enharmonic equivalent of the second order, just as the fourth order is related to the first. Cf. *supra*, notes 4 and 11.

[16] *Ibid.*, fols. 104 and 104^v.

[17] Barbour, *op. cit.*, p. 67.

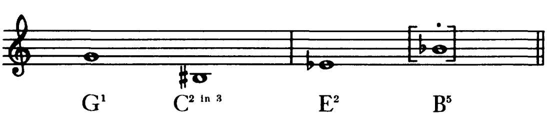
related intervals that are of larger or, less usually, smaller size.[18] The two most common alterations of the usual intervals are called *propinqua* and *propinquissima*. The term *propinqua* refers to the addition of an enharmonic diesis to a consonance, *propinquissima* to the addition of a comma to a consonance.[19] Although these terms are most often used in connection with thirds and sixths, Vicentino does mention the *propinqua* fifth twice, from C^1 down to F$^{2 \text{ in } 3}$, and from C^1 up to G^4, [20] each a diesis larger than the normal "shortened" fifth. (Example 4)

Ex. 4



Two other fifths described in the treatise, each augmented by a diesis, are actually called perfect fifths: G^1 down to C$^{2 \text{ in } 3}$, and E^2 up to B^5.[21] (Example 5) On the basis of this "perfect" fifth, augmented from the meantone fifth by a diesis, the relationship between the first and fourth orders becomes clearer. Starting with any note in the first order,[22] this fifth will be found in the fourth order. The remaining notes of the fourth order can similarly be tuned above those of the first, or can be derived

Ex. 5



by going around the circle of "shortened" fifths once the fourth order has been reached initially.[23] (Example 6)

The only parallel relationship between the second and fifth orders occurs between E^2 and B^5. Once B^5 has been reached, it is possible to tune the remaining notes in the fifth order by descending "shortened" fifths. (Example 7) Other connections between orders two and five cannot be found.

[18] Most of the intervals are made larger in size than the "common" ones, but a few are smaller. Among these are the minor thirds A^6 to C^1, B^6 to D^1, the major third B^6 to E^3, all a comma smaller than their "normal" counterparts. Other intervals with a similar diminution by a comma are theoretically possible.

[19] Vicentino, *op. cit.*, fol. 109^v. For another interpretation of the term *propinquissima* see below.

[20] *Ibid.*, fol. 118^v.

[21] *Ibid.*, fols. 108^v, 112. In the latter example, the text calls for *B fa b mi sesto*, but since there is no B-flat in the sixth order, *B fa b mi quinto*, or B^5, must have been the note intended.

[22] Except B.

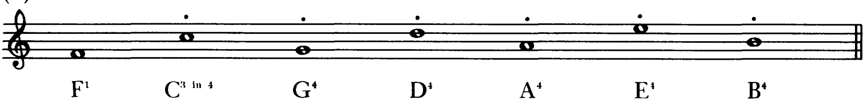
[23] Only F$^{3 \text{ in } 4}$ is unaccounted for in this latter method of tuning, around the circle of ascending "shortened" fifths. This tone can, however, be reached by tuning down a "shortened" fifth from C$^{3 \text{ in } 4}$. F$^{3 \text{ in } 4}$ can also be tuned as a diesis-augmented fifth above B^2 (B-flat), i.e. from the second (!) order.

Ex. 6

(a)

or

(b)



No perfect fifth by diesis-augmentation is possible between the third and the sixth orders. One fifth a comma larger than the "shortened" fifth of meantone tuning, from G^3 to B^6, can be deduced theoretically between these two orders. Once B^6 is attained, the remaining notes of

Ex. 7

the sixth order can be tuned in a descending circle of "shortened" fifths. (Example 8)

The only other fifth existing between these two orders is an extremely large interval, a diesis and a comma greater than the "common"

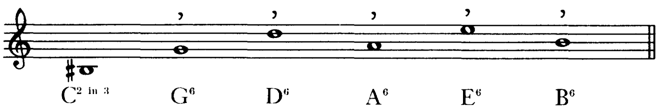
Ex. 8

fifth. Vicentino gives no specific example of such a fifth, although it is possible to conceive of it theoretically by analogy. Among the intervals mentioned by Vicentino are some thirds and sixths that are a diesis and a comma larger than the usual intervals.[24] Three of these are actually named *propinquissima* in the text. Normally this term indicates an interval a comma larger than the usual consonance. In these cases, however, the usual interval has already been augmented a diesis, and the term *propinquissima* indicates an addition of still another comma to this already enlarged consonance. If the possibility of such a large interval is extended to the fifth, a relationship between the third and sixth orders is theoretically attainable. Starting from $C^{2\text{ in }3}$ in the third

[24] Cf. for example A^6 to $F^{3\text{ in }4}$ (large minor third), A^6 to $C^{3\text{ in }4}$ (large minor sixth), B^3 to D^6 (large major third), B^5 to D^6 (large minor third), and B^5 to G^6 (large minor sixth). The latter three are further identified as *propinquissima*.

order, a fifth augmented by a diesis and a comma is reached on G^6. From this note, the others in the sixth order can be tuned.[25] (Example 9) Thus Vicentino's second tuning, relating the first and fourth, second and fifth, and third and sixth orders, is possible, but much more complicated and involuted than his first tuning.

Ex. 9



Actually the usual *propinquissima* fifth, only a comma larger than the "shortened" or "common" fifth,[26] is much more frequently employed by Vicentino, and is, in fact, almost consistently labeled "perfect" in the treatise. This gives still another possible tuning relationship between the orders of the *archicembalo*. In the seventeenth chapter of Book Five of *L'antica musica* . . ., Vicentino states that a note in the first order will find its perfect fifth in the sixth order, if the interval ascends, "and the same sixth order will serve the fourth order to make perfect fifths, when said perfect fifths descend . . ."[27]

Vicentino has stated that the main purpose of the comma and the diesis was "to aid a consonance."[28] It seems logical, then, to assume that his use of the term "perfect" for his alternate tunings of the *archicembalo* was intended only in a general sense and not as a specific description of interval size. In fact, the various possible adjustments of intervals made it possible to play along with all kinds of instrumental combinations. Vicentino specifically mentions lutes and viols that were tuned in equal temperament "con la divisione de i semitoni pari. . . ." These equal semitones cause "errors" when playing with other instruments whose semitones are unequal, but the *archicembalo* can correct these "defects" because of its microtonal divisions.[29]

In essence, the complete tuning of the *archicembalo* manifests a tendency toward equal multiple division or equal temperament. "Some . . . varieties of mean-tone tuning should not be called unequal . . . be-

[25] Other fifths between the third and sixth orders with this diesis and comma augmentation can be found from F$^{2\ in\ 3}$ down to A^6, E^3 down to G^6, C$^{2\ in\ 3}$ down to E^6, and B^3 down to D^6.

[26] See *supra* p. 90.

[27] ". . . . & il medesimo sesto ordine servirà al quarto ordine à far le quinte perfette, quando discenderà dette quinte perfette. . . .," *ibid.*, fol. 109^v. Among the perfect fifths from the first to the sixth order can be found A^1 to E^6, G^1 to D^6, E^1 to B^6, D^1 to A^6, C^1 to G^6, all but the first actually labeled perfect. From the fourth to the sixth order is found E^4 to A^6, similarly labeled perfect. D^4 to G^6, B^4 to E^6, and A^4 to D^6 are also theoretically possible.

[28] ". . . . per aiutare una consonanza. . . . ," *ibid.*, fol. 18.

[29] *Ibid.*, fol. 146^v.

cause if they are extended to a large enough number of tones they form a complete cycle, just as equal temperament does."[30] Vicentino's 31-tone tuning presents just such a complete cycle. Lemme Rossi has given a diagrammatic representation of this tuning according to string lengths.[31] From these string lengths, the value of each tone of the cycle in cents can be derived. (Table II) It will be seen that each diesis amounts to from 38.6 to 38.74 cents, and thus, for all intents and purposes, is uniformly equal.

TABLE II

The Tuning of Vicentino's *Archicembalo* according to Lemme Rossi (1666)

Note name	String length	= Cents	Note name	String length	= Cents
A	20736	1200	D#	29655	580.6
*A♭	21205	1161.3	*D	30325	541.9
A♭	21684	1122.6	D	31011	503.2
G#	22174	1083.9	*D♭	31712	464.6
*G	22676	1045.2	D♭	32429	425.8
G	23188	1006.5	C#	33162	387.1
*G♭	23713	967.7	*C	33912	348.4
G♭	24249	929	C	34679	309.7
F#	24797	890.4	B#	35463	270.9
*F	25358	851.5	*B	36264	232.3
F	25931	813	B	37084	193.6
E#	26517	774.2	*B♭	37923	154.8
*E	27117	735.5	B♭	38781	116.1
E	27730	696.8	A#	39657	77.5
*E♭	28357	658.1	*A	40554	38.7
E♭	28999	619.3	A	41472	0

Note: * = 1/5 tone or diesis higher

[30] Barbour, *op. cit.*, p. 17.
[31] Rossi, *op. cit.*, p. 86.

Rossi makes some rather interesting remarks about this tuning relating it to mean-tone temperament:[32]

1. The tone between G and A is really a mean tone. It is less than 9:8 but greater than 10:9. Vicentino's tone is equal to 193 cents as compared to 204 cents for 9:8 and 182 cents for 10:9. It is practically the same as Aron's mean tone.

2. The major semitone between G-sharp and A is little different than that of the "common" temperament. Aron's major semitone equals 117 cents; Vicentino's, 116.1 cents.

3. The minor semitone between A-flat and A is similarly little differentiated. Aron's minor semitone equals 76 cents, Vicentino's 77.4 cents.

4. The diesis between A-flat with the enharmonic dot (=*A♭) and A equals 38.7 cents. This is smaller than the diesis in the proportion 128:125, which equals 41.2 cents. Rossi remarks, however, that this diesis is greater than that of Ptolemy.

Similar calculations are derived for the minor and major third, the fourth, and the fifth, which Rossi states bluntly as being smaller than the perfect fifth by a temperament of one-quarter of a comma.

In effect, the tuning of the *archicembalo*, derived from meantone temperament and leaning towards equal temperament, allowed, because of its microtonal intervals, an adjustment to other contemporary tunings, since interval size could be varied in innumerably subtle ways. It also made possible an attempt to reinterpret ancient tunings for the modern ears of the Renaissance.[33] Those like Doni[34] who criticized Vicentino for his misunderstanding of Greek theory lost sight of the fact that his avowed purpose was not to revive ancient music but to interpret it so that it could be "reduced to modern practice," as the title of his treatise proclaims.

The novel and visionary concepts evoked by Vicentino's imagination remain witness to the battle of those original musical spirits of sixteenth-century Italy who fought for a new and contemporary art. From their struggles emerged the free chromatic style of the *seconda prattica* of the seventeenth century and the stablilization of tuning into the equal temperament of more modern times.

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32 *Ibid.*, pp. 86-87.

33 Cf. the similarity in the tuning of Eratosthenes' enharmonic and that of Vicentino. See J. Murray Barbour, *Tuning and Temperament* (East Lansing, 1953), p. 16.

34 See especially Io: Baptistae [Giovanni Battista] Doni . . . *De praestantia musicae veteris* (Florence: typis Amatoris Massae Forolivien, 1647), p. 22.