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*Chromatische und enharmonische Musik und
Musikinstrumente des 16. und 17. Jahrhunderts*

Kolloquium der Schola Cantorum Basiliensis, Hochschule für
Alte Musik Basel, und des Musikwissenschaftlichen Instituts
der Universität Basel am 9. April 2002

*Chromatic and Enharmonic Music and Musical
Instruments in the 16th and 17th Centuries*

Proceedings of a colloquium presented by the Schola Cantorum Basiliensis,
Hochschule für Alte Musik Basel, and the Institute of Musicology at the
University of Basel on April 9th 2002

Einleitung

Zu den zentralen Themen der europäischen Musik am Beginn der Neuzeit gehörte bekanntlich die Auseinandersetzung mit der Antike, deren wichtigste Folgen das monodische, generalbassbezogene Komponieren und die «Erfindung» der Gattung Oper waren. Im gleichen Kontext wurden seit der Mitte des 16. Jahrhunderts auch Versuche unternommen, die drei antiken Tongeschlechter (Genera) Diatonik – Chromatik – Enharmonik und das System antiker Oktavgattungen (Tonoi) für die Musikpraxis wieder nutzbar zu machen. Ein entscheidender Antrieb dafür war, dass die «meravigliosi effetti», die wunderbaren Wirkungen, von denen antike Autoren im Rahmen der Ethos-Lehre berichteten, auf den Gebrauch eben jener Genera zurückgeführt wurden.

Während heute nur noch die Tongeschlechter Dur und Moll bekannt sind, bezeichnen die damaligen Genera unterschiedliche Intervallordnungen von Tetrachorden, also Viertongruppen im Rahmenintervall einer Quarte: Diatonik meint dabei eine «natürliche» Folge von Ganz- und (diatonischen) Halbtönen, gleichsam die Untertasten einer Klaviatur (z.B. A - H - C - D). Chromatik weist «unnatürliche», chromatische Halbtöne auf (A - B - Des - D). Beides ist noch im herkömmlichen Rahmen, etwa auf einem Tasteninstrument, darstellbar, wenn die Stimmungsproblematik (ein Cis müsste zu einem Des umgestimmt werden etc.) einmal ausser Acht gelassen wird. Enharmonik hingegen verwendet kleinere Intervallschritte, die ahistorisch, aber anschaulich als Vierteltöne oder Mikrointervalle bezeichnet werden (ein enharmonischer Tetrachord enthält A - ein um ein Mikrointervall erhöhtes A - Des - D). Bei der Adaption der antiken Genera für die Musik des 16. und 17. Jahrhunderts ging es allerdings um einen grösseren Tonraum als um den einer Quarte, die Genera sollten zudem auf allen Tonstufen eingesetzt werden können und bei mehrstimmigen Kompositionen sollten auch Konsonanzen auf allen diesen Tonstufen möglich sein. Damit musste der Tonvorrat stark erweitert werden, im chromatischen Tonsystem auf mindestens 19 (statt der üblichen 12) Stufen innerhalb einer Oktave, im enharmonischen System ergaben sich noch weitergehende Differenzierungen. Die Realisierung solcher «vieltönigen» Skalen erforderte entsprechende Anpassungen in der Notation und die Einrichtung von Instrumenten mit zusätzlichen Tasten oder Bündeln; nur Blasinstrumente (wie Zink und Posaune), bundlose Streichinstrumente (wie die Violine) und die menschliche Stimme galten als fähig zur unmittelbaren Darstellung aller Genera. Zudem ergaben sich neue Perspektiven für die zentrale Problematik der musikalischen Stim-

mungen und Temperaturen. Somit wirkte die – bislang zudem unterschätzte – experimentelle Beschäftigung mit Chromatik wieder auf die herkömmliche Musik zurück.

Im Bereich der Alten Musik bzw. der Historischen Aufführungspraxis gibt es wohl nicht mehr allzu viele «weisse Flecken» (wenn auch die bereits kolorierten Partien noch weiter auszuarbeiten sind). Chromatische und enharmonische Musik der Renaissance und des Barock gehören sicherlich zu den Gebieten, die ein bislang ungenutztes Potential für innovative Ansätze bereit halten. Diesem Thema und seinen Chancen für die Historische Aufführungspraxis der Gegenwart widmete sich ein Kolloquium der Schola Cantorum Basiliensis, Hochschule für Alte Musik, und des Musikwissenschaftlichen Instituts der Universität Basel, das am 9. April 2002 in der Musik-Akademie Basel stattfand. Den Anlass gab ein grösseres Forschungsprojekt zum Thema an der Universität Basel, den Rahmen bildete die Zusammenführung von Wissenschaft und Praxis. Die Veranstaltung war im übrigen, trotz lange bestehender Kontakte der beiden Institute, die erste offizielle Zusammenarbeit im Rahmen eines gemeinsamen Projekts, im Sinne eines Beginns, dem weitere gemeinsame Vorhaben folgen sollen.

Zu dem überraschend gut besuchten Kolloquium versammelten sich Referenten (Musikwissenschaftler, Musiker und Instrumentenbauer) aus Italien, Deutschland, den Niederlanden und der Schweiz. Die hier nun auch im Druck vorgelegten Beiträge widmen sich grundsätzlichen Fragen, wie einleitend derjenige von Rudolf Rasch über die verschiedenen Beweggründe, aus denen heraus überhaupt Tasteninstrumente mit mehr als zwölf Tasten pro Oktave gebaut wurden. Der Frage, wie solche Tasteninstrumente mit vierzehn, neunzehn oder gar 31 Tasten (*Cimbalò cromatico* oder *enarmonico* etc.) heute als praktikabel angesehen werden können, gilt ein weiterer Beitrag von Rudolf Rasch. Beziehen sich diese Überlegungen auf die historischen und theoretischen Grundlagen der Instrumente, so stellt Denzil Wraight die tatsächlich erhaltenen Tasteninstrumente der genannten Art vor, woran bereits deutlich wird, dass es sich um konkrete Musikpraxis und nicht nur um irrelevante theoretische Experimente handelte. Einen weiteren Schritt in diese Richtung geht der Beitrag von Patrizio Barbieri, der die enharmonischen Diskussionen vor dem Hintergrund vokaler und instrumentaler Intonationspraktiken beleuchtet. Da Teile dieses Referats bereits im Druck vorliegen, wurde der vorliegende Beitrag in Richtung von «vieltönigen» Systemen für mitteltönige und reine Stimmungen erweitert. Den Bogen von den Tasteninstrumenten, die wegen ihrer spektakulären Gestalt die zwar sichtbarste, aber nicht die einzige Form solcher Experimente darstellen, zu den Streichinstrumenten und zu konkreter Musik und ihrer Aufführungspraxis schließt abschliessend der Beitrag von Martin Kirnbauer, indem er

die römische Situation zu Beginn des zweiten Drittels des 17. Jahrhunderts vorstellt.

Während des Kolloquiums standen zwischen den Referaten Klangdemonstrationen und Konzerte von Bob van Asperen, Johann Sonnleitner, Studierenden der Schola Cantorum Basiliensis sowie dem Gambenensemble *The Earle His Viols* (mit der Sängerin Evelyn Tubb und der Harfenistin Marie Nishiyama), in denen die ästhetische Dimension der Thematik sinnlich erfahrbar wurde. Dieser Aspekt muss im Rahmen dieses Kolloquiumsberichtes leider fehlen, war aber ein wichtiges und überzeugendes Argument für die Relevanz des gesamten Themas.

Die Veranstaltung des Kolloquiums und die Veröffentlichung der Beiträge wäre nicht ohne vielfältige Hilfen möglich gewesen. Ein grosser Dank für die nicht nur ideelle Unterstützung des Vorhabens gilt den beteiligten Institutionen, der Schola Cantorum Basiliensis (namentlich Peter Reidemeister) wie dem Musikwissenschaftlichen Institut der Universität Basel (namentlich Wulf Arlt). Die Finanzierung wurde ermöglicht dank dem grosszügigen Engagement der Freiwilligen Akademischen Gesellschaft Basel, der National-Versicherung und der Schweizerischen Musikforschenden Gesellschaft, Sektion Basel. Dank gebührt weiter den Instrumentenbauern André Extermann und Florian Sonnleitner, die spezielle Tasteninstrumente für des Kolloquium bereit stellten. Denzil Wraight besorgte freundlicherweise die Durchsicht der Übersetzungen. Allen Autoren sei abschliessend für ihre unkomplizierte und konstruktive Mitarbeit gedankt, der Schweizerischen Musikforschenden Gesellschaft und namentlich Joseph Willimann für die Möglichkeit zur Drucklegung.

Die hier versammelten Beiträge überschneiden sich teilweise und bieten manchmal auch kontroverse Darstellungen. Dies ist aber weder Missgeschick noch mangelnder Koordination zuzuschreiben, sondern Ausdruck einer lebendigen Debatte, die verschiedene Perspektiven auf denselben Gegenstand zulässt. Die Veranstalter des Kolloquiums und Herausgeber des Tagungsberichtes hoffen, durch die Veröffentlichung eine weiterführende Debatte anzustossen, die die musikwissenschaftliche Forschung wie die musikalische Praxis gleichermassen stimulieren wird.

Basel, im Dezember 2002

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Introduction

One of the central themes of European music at the beginning of the Modern Age was the critical examination of Antiquity, of which the most important results were monody, composition using a continuo bass and the «invention» of opera. In the same context, attempts were also undertaken from the middle of the 16th century to render the three ancient modes usable for contemporary musical practice, i.e. the diatonic, chromatic, and enharmonic genera, as well as Antiquity's system of octave species (Tonoi). A decisive impulse for this were the «meravigliosi effetti», the marvellous effects, of which authors of Antiquity reported in connection with moral philosophy, to whom the use of these modes was traced back.

Whereas nowadays only the major and minor modes are known, the genera of that time indicate different tetrachords, that is, groups of four notes within the framework of a fourth. Diatonic refers to a «natural» series of whole tones and (diatonic) semitones, the notes of a keyboard, so to say, from A-B-C-D. The chromatic genus has «unnatural» chromatic semitones (A-B flat-D flat-D). Both of these can be demonstrated with the usual means, such as on a keyboard instrument, if we neglect the problems of tuning (C sharp must be retuned to a D flat). The enharmonic genus, however, uses smaller intervals that can be called (anachronistically but for the purposes of illustration) quarter tones or micro-intervals. An enharmonic tetrachord contains: A-A raised by a microinterval-D flat-D. In adapting the genera of Antiquity for the music of the 16th and 17th centuries the need was for a larger range of intervals than a fourth, the genera needed to be used on any note, and polyphonic compositions required consonances for all these notes. In order to achieve this the range of notes had to be substantially increased, in a chromatic system to at least 19 intervals in an octave (instead of the usual 12) and in an enharmonic system there were still further divisions. Realising such «multi-note» scales required corresponding alterations in the musical notation and the equipping of instruments with additional keys or frets. Only wind instruments (such as the cornet and trombone), fret-free string instruments (such as the violin), and the human voice were considered suitable for performing the genera. In addition there were new perspectives on the central problem of tuning. In this way, the experimental occupation with the chromatic genus had its effect on normal music in a way which has been as yet underestimated.

In the branch of early music or historical performance practice there are surely not too many «blank squares» (even if the filled-in ones still require further work). Chromatic and enharmonic music of the Renaissance and

Baroque certainly belong to the areas which contain an as yet unused potential for innovative approaches. A colloquium of the Schola Cantorum Basiliensis, Hochschule für Alte Musik, and of the Institute of Musicology, University of Basel devoted to this subject and the opportunities for historical performance practice took place on 9th April 2002 in the Musik-Akademie Basel. The occasion for this was a larger research project on the same theme in the University of Basel; the setting was created by the uniting of the study and performance of music. Despite contacts over a long period, this meeting was actually the first, official joint project marking the beginning of other cooperative endeavours.

Speakers came from Italy, Germany, the Netherlands, and Switzerland (musicologists, musicians, and instrument builders) to what was a surprisingly well-attended colloquium. The papers appearing in print here are concerned with fundamental questions, such as the initial contribution by Rudolf Rasch on the various motives why keyboard instruments were built with more than twelve keys per octave. The question why keyboard instruments with fourteen, nineteen, or even 31 keys (*Cimbalo cromatico* or *enarmonico* etc.) can be seen today as usable in practice is the subject of a further paper by Rudolf Rasch. If these considerations are concerned with the historical and theoretical foundations of the instruments, Denzil Wraight presents the surviving keyboard instruments of this type, from which it becomes clear that we are concerned with actual musical practice and not simply with irrelevant theoretical experiments. Patrizio Barbieri's contribution takes a further step in this direction and sheds light on the vocal and instrumental background in the discussion of the enharmonic. Since parts of this paper were already in press the contribution in this volume was extended to include multitone systems for meantone and just intonation. The link from the keyboard instruments, which on account of their spectacular form are the most visible but not the only type of such experiments, to the bowed string instruments, to actual music and performance practice is last of all forged by Martin Kirnbauer's contribution, which presents the situation in Rome at the beginning of the second third of the 17th century.

During the colloquium musical demonstrations and concerts by Bob van Asperan, Johann Sonnleitner, students of the Schola Cantorum Basiliensis, as well as the viol consort *The Earle His Viols* (with the singer Evelyn Tubb and the harpist Marie Nishiyama) enabled the aesthetic dimension of the subject matter to be heard and experienced. This aspect unfortunately has to be omitted from the colloquium proceedings although it was an important and convincing argument for the relevance of the whole theme.

The promotion of the colloquium and the publishing of the papers would not have been possible without several sources of assistance. Considerable gra-

titude is due to the participating institutes and not simply for their moral support of the endeavour, the Schola Cantorum Basiliensis (in particular Peter Reidemeister) as well as the Institute of Musicology, University of Basel (especially Wulf Arlt). The financing was made possible thanks to the generous efforts of the Freiwillige Akademische Gesellschaft Basel, the National-Versicherung, and the Schweizerische Musikforschende Gesellschaft, Basel branch. Furthermore thanks are due to the instrument makers André Extermann and Florian Sonnleitner who put special keyboard instruments at the disposal of the colloquium. Denzil Wraight kindly checked the translations. Lastly, all authors are thanked for their uncomplicated and constructive collaboration and the Schweizerische Musikforschende Gesellschaft (notably Joseph Willmann) for the possibility of publishing the proceedings.

The papers collected here overlap each other to an extent and sometimes offer controversial presentations. This is the result neither of mishap nor lack of coordination but the expression of a lively debate which allows different views of the same subject. The organisers of the colloquium and publisher of the papers hope through this publication to give impetus to a continuing debate that will stimulate musicological discussion as well as performance practice.

Basel, December 2002

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On terminology for diatonic, chromatic, and enharmonic keyboards

Rudolf Rasch

When dealing with keyboards with more than twelve keys per octave often the designations «chromatic» or «enharmonic» keyboard or related terms (such as *cimbalo cromatico*) are used, both historically and in present-day publications. Rarely, if ever, is it made clear, however, which criteria are used to decide whether a keyboard is chromatic or enharmonic, or perhaps even both. In this paper it will be attempted, for the sake of clarity in discussions on this subject, to formulate well-reasoned criteria as how to answer the question of under which circumstances a keyboard may be called diatonic, chromatic or enharmonic.

The definition proposed in the *New Grove Dictionary of Music and Musicians*, calling every keyboard «enharmonic» with more than twelve sounding pitches per octave, seems too simple,¹ especially since, for example, it contradicts historical situations in which keyboards having between 12 and 19 notes per octave are termed *cimbalo cromatico* or something like it. Instead, it seems better to try to retain the familiar triad diatonic-chromatic-enharmonic, a triad introduced two and a half millenia ago in Greek music theory in order to distinguish between the three ways of forming a tetrachord and thus to define tonal systems with various intervals (the diatonic, chromatic, and enharmonic genres), which are still used as key concepts in present-day music theory, albeit with meanings and connotations differing from the original Greek ones. Between the Greek antiquity and today the three terms have been used in a variety of ways that is too large to summarise here. This variety, however, allows us to use the terms with a certain liberty and to mould them according to our wishes and necessities.

1 Nicolas Meeùs, «Enharmonic keyboard», in: *New Grove Dictionary of Music and Musicians*, Second Edition 8 (2001), pp. 248–250.

Keyboards with up to twelve notes per octave

Let us first have a look at the ordinary, twelve-note keyboard, consisting of seven lower keys, representing the diatonic degrees of the scale of C major, and five upper keys, representing their chromatic inflections. The diatonic degrees may be ordered according to their relation in the row of fifths in the following way:

F - C - G - D - A - E - B

In such an order D takes the central place. One could see the seven degrees as the outcome of a process starting with D and progressing by adding notes at a fifth's distance alternately at the right and left sides, first A, then G, etc. until F as the last added note. One could construct a keyboard with just these seven diatonic degrees. There seems no other possibility than to call such a keyboard a *diatonic keyboard*.

Despite its simplicity there is already some variety in a diatonic keyboard. The steps between C-D, D-E, F-G, and G-A are called diatonic whole tones; the steps B-C and E-F are diatonic semitones. If the notes are placed in a simple ascending order with D as the centre, then the arrangement is again symmetrical:

A B C D E F G

So far the basic design of the diatonic keyboard, with its five diatonic whole-tone steps and two semitone steps.

What happens if the keyboard is further extended by adding notes with the interval of a fifth from the outer notes in the first row (F-B) as given above? The first note added is F $\sharp$, the second B $\flat$, the third C $\sharp$, the fourth E $\flat$, and the fifth G $\sharp$. Already the addition of the first note, F $\sharp$, introduces a novel element in the layout of the keyboard: from F to F $\sharp$ a new kind of interval is formed, the *chromatic semitone*. In fact, it is formed as a complement to the diatonic semitone (F $\sharp$ -G) within the compass of a diatonic whole tone (F-G). Two semitone steps, namely a diatonic semitone step and a chromatic semitone step, replace a single whole-tone step. The addition of the other notes (B $\flat$, C $\sharp$, E $\flat$, G $\sharp$) has similar consequences: with each addition a whole tone is divided into a diatonic and a chromatic semitone. The diatonic keyboard had five whole-tone steps so that after the addition of five extra notes all five whole-tone steps have been transformed into a diatonic-chromatic semitone pair. The total number of notes is now twelve and the keyboard that has emerged now is of course the common twelve-note keyboard. The twelve notes can be ordered in a line of fifths:

$E\flat - B\flat - F - C - G - D - A - E - B - F\sharp - C\sharp - G\sharp$

or in an ascending order of pitch, usually called a chromatic order, which may begin with C:

$C - C\sharp - D - E\flat - E - F - F\sharp - G - G\sharp - A - B\flat - B - C.$

The expansion of the keyboard from seven to twelve keys has on the one side removed all diatonic whole tone steps and on the other side introduced chromatic semitones. If the steps of the ascending scale are considered, the diatonic semitones comprise a majority of seven. A minority of five chromatic semitones complements them. When considering nomenclature, there are reasons to use the term diatonic as well as chromatic for a 12-note keyboard. A decision on which term should be preferred will be postponed until later in this contribution, after extensions of the keyboard beyond the twelve-note design have been considered.

From 12 to 19 notes per octave

What happens if notes are added to the keyboard in addition to the twelve-note design? The note that completed the twelve-note keyboard was $G\sharp$, so the next note should be added at the «left» side of the line of fifths, that is, $A\flat$. The positioning of this note brings a number of problems not yet encountered before. To begin with, it should be remarked that its pitch ($A\flat$) is very near the previously last added note ($G\sharp$), whatever method is chosen to tune the keyboard. The question is now whether the added $A\flat$ is lower in pitch than the already present $G\sharp$ or higher. (Having $A\flat$ and $G\sharp$ with equal pitches seems to be excluded because it does not make sense to add a key with a pitch that is already available.) The outcome of the comparison of the pitches of $G\sharp$ and $A\flat$ depends in fact on the size of the fifths that has been chosen for the tuning of the keyboard. For the sake of simplicity, it will be assumed that all fifths in the keyboard are of equal size, whether or not they conform to the theoretical size of the frequency ratio 2:3 or 701.955 cents. With such equal fifths, it transpires that the added $A\flat$ has a higher pitch («is higher») than $G\sharp$ if (and only if) the size of the fifths is smaller than the size of the fifths in equal temperament, which is as ratio 1: $2^{7/12}$ or, logarithmically, 700 cents. If the size of the fifths is larger than the equal-temperament size, the pitch of the newly added $A\flat$ will be lower than $G\sharp$. That means, for example, that the latter relation will hold when the fifths are just.

For the theory of the keyboard the pitch relation between $G^\sharp$ and $A^\flat$ is of principal importance. Let us first consider the case when the fifth of the tuning is larger than the fifth of equal temperament. In that case $A^\flat$ falls between G and $G^\sharp$ and splits this interval into $G-A^\flat$ and $A^\flat-G^\sharp$. The first interval ($G-A^\flat$) is a diatonic semitone, but what should we call the second? If we leave the semitone and whole-tone designations for a moment and adopt the terminology used for the larger intervals, the interval $A^\flat-G^\sharp$ is nothing but a *downward diminished* second. Since with a fifth larger than equal-tempered the diminished second is an interval of «negative» size (meaning the $A^\flat$ is lower than $G^\sharp$), a nominally downward diminished second causes the pitch to rise. It is tempting to call this interval an *enharmonic semitone*, as a continuation of the terminology with diatonic and chromatic semitone, but we will not do so, because the interval is not a semitone. Instead, it could be called the *enharmonic interval*, since it represents the interval between notes that are enharmonically equivalent in 12-note equal temperament.

The addition of further notes beyond the $A^\flat$, that is, $D^\sharp$, $D^\flat$, $A^\sharp$, and $G^\flat$, causes the other chromatic semitones of the twelve-note keyboard to be split one by one into a pair of a diatonic semitone and a downward diminished second. Since the twelve-note keyboard contains five chromatic semitones, the process of splitting them is completed with the addition of the fifth extra note. The total number of notes has now increased to seventeen. If the notes are ordered in an ascending sequence, the result is:

C - $D^\flat$ - $C^\sharp$ - D - $E^\flat$ - $D^\sharp$ - E - F - $G^\flat$ - $F^\sharp$ - G - $A^\flat$ - $G^\sharp$ - A - $B^\flat$ - $A^\sharp$ - B - C

Keyboards may be constructed and tuned along these lines, but they are not very practical. In fact, this construction seems illogical, since it adds diatonic intervals at the cost of chromatic intervals. If further notes are added above the seventeenth, even more complicated situations arise. The next added note, for example, which is $E^\sharp$, splits the diatonic semitone $F-G^\flat$ into $F-E^\sharp$ (a downward diminished second, causing a higher pitch) and $E^\sharp-G^\flat$ (a doubly-diminished third). Since there are twelve diatonic semitones in the 17-notes keyboard with fifths larger than in equal temperament, the process repeats itself twelve times, until a 29-note keyboard is reached. Historical examples of chromatic and enharmonic keyboards have not adhered to this construction principle, so that we will not pursue keyboards based on tunings with fifths larger than the equal-tempered fifths.

To keep the discussion simple and understandable, it is better to assume that the fifths are smaller than those in equal temperament, such as the ones in meantone temperament and in the various 1/5- and 1/6-comma tempe-

raments.² In this case the added $A\flat$ splits the diatonic semitone $G\sharp-A$ into two parts, the intervals $G\sharp-A\flat$ and $A\flat-A$. The second interval is a chromatic semitone, the first a diminished second, which we have met and described above. Only here it is a «positive» interval in the sense that the second note, derived from the higher natural, has a higher pitch. Summarising, the addition of an extra note to a twelve-note keyboard splits one of the diatonic semitones into a chromatic semitone (which could also be called an augmented unison) plus a diminished second.

The addition of further notes beyond the $A\flat$, that is, $D\sharp$, $D\flat$, $A\sharp$, $G\flat$, $E\sharp$, and $C\flat$, causes the diatonic semitones of the twelve-note keyboard to be split one by one into a pair consisting of a chromatic semitone and a diminished second. Since the twelve-note keyboard contained seven diatonic semitones, the process of splitting them is completed with the addition of the seventh extra note, by which the total number of notes has increased to nineteen. With eighteen notes in the octave, there is still one diatonic semitone (namely, $B-C$), with nineteen notes there are only chromatic semitones (twelve of them) and diminished seconds (seven).

From 19 to 31 notes per octave

What happens when the process of adding notes with the interval of a fifth is continued after having added the nineteenth note? After all, there is no diatonic semitone left over that can be split into two parts. Let us first consider the 19-note keyboard with the notes in ascending pitch order:

$C - C\sharp - D\flat - D - D\sharp - E\flat - E - E\sharp - F - F\sharp - G\flat - G - G\sharp - A\flat - A - A\sharp - B\flat - B - C\flat - C$

The process of adding notes to this keyboard can be viewed by analogy with the addition of notes to the 12-note keyboard: the addition of each note splits a particular interval into two parts. And just as the addition of notes to the 12-note keyboard splits diatonic semitones into chromatic semitones and diminished seconds (the latter interval not being present in a 12-note keyboard), the addition of notes to a 19-note keyboard splits the chromatic semitones into two parts, namely the diminished second (already present in the keyboard) and another one not yet present. To see how this new interval should be called, one may consider the first added note, the $B\sharp$.

2 I say «various temperaments» because the tempering of the fifth can be expressed in fractions of both the ditonic comma (of 24.5 cents) and the syntonic comma (of 22.5 cents).

It can be shown that in the case of equal fifths which have a size in between the equal-tempered size (tempered nearly 2 cents) and the size of the fifth if tempered with a third of a syntonic comma (about 7 cents), $B^\sharp$ is higher than C^b but lower than C . In other words, $B^\sharp$ will split the chromatic semitone C^b - C into two parts. These two parts are C^b - $B^\sharp$ and $B^\sharp$ - C , respectively. In the latter interval we recognize the diminished second (as between $G^\sharp$ and A^b); the former interval (C^b - $B^\sharp$) is a downward interval (since the diatonic degree of B is below that of C) of negative size (since $B^\sharp$ is higher than C^b). Since B - C is a minor second, $B^\sharp$ - C may be called a diminished second, $B^\sharp$ - C^b a doubly diminished second, and therefore C^b - $B^\sharp$ a *downward doubly-diminished second*. This nomenclature may look disturbingly complex, but is in fact completely logical and consistent with standard interval terminology.³

A 19-note keyboard has 12 chromatic semitones. That means that a chromatic semitone can be split twelve times into a pair of an upward singly diminished second and a downward doubly-diminished second. This process is started with the addition of $B^\sharp$, which splits the chromatic semitone C^b - C , and is continued with the addition of F^b , $F^\sharp$, B^b , $C^\sharp$, E^b , $G^\sharp$, A^b , $D^\sharp$, D^b , and $A^\sharp$, and is completed with the addition of G^b . With the addition of the latter note the last chromatic semitone (the one between F and $F^\sharp$) has been split into two smaller intervals. The keyboard has now 31 notes or keys per octave. The full series of 31 notes per octave looks as follows:

$C - D^b - C^\sharp - D^b - C^\sharp - D - E^b - D^\sharp - E^b - D^\sharp - E - F^b - E^\sharp - F - G^b - F^\sharp - G^b - F^\sharp - G - A^b - G^\sharp - A^b - G^\sharp - A - B^b - A^\sharp - B^b - A^\sharp - B - C^b - B^\sharp - C$

The reader will believe me when I say that the process can be continued after the 31-note keyboard, and that the addition of the 32nd note will split the diminished second into two parts (because there are no chromatic semitones left over to be split). Since there are nineteen diminished seconds in a 31-note keyboard, the process of splitting them into two smaller intervals may be continued until a keyboard with fifty notes per octave is reached. After that, it is the turn for the «downward doubly-diminished seconds» to be split, of which there are 31 in a 50-note keyboard. Comple-

3 The consistency appears for example from the addition of the (upward) diminished second and the downward doubly-diminished second to a chromatic semitone (or augmented unison). The addition of an upward and a downward form of the same interval as far as diatonic degrees are concerned, results in some kind of unison. «Doubly diminished downward» corresponds to «doubly augmented upward», so that «doubly diminished downward» plus «singly diminished upward» add up to «singly augmented upward», which describes the quality of a chromatic semitone.

tion of this process will lead to an 81-note keyboard. The reader will forgive me for not pursuing in detail this line of consideration further than the 31-note keyboard.

Keyboards with seven to 31 notes per octave

We have started our overview of the interval composition of keyboards with a seven-note keyboard, with only diatonic semitones and diatonic whole tones. For the sake of theoretical description it may be useful to look at how keyboards would be constructed with even fewer than seven notes per octave. A theoretical keyboard with one note per octave (only Ds), would have only octaves between neighbouring notes, one with two notes (D and A) one fifth and one fourth within a single octave. Similarly, a three-note keyboard (D, G, A) would have two fourth and one major second (or diatonic whole tone), a four-note keyboard (D, E, G, A) one fourth, one minor third and two major seconds, a five-note keyboard (C, D, E, G, A) two minor thirds and three major seconds, a six-note keyboard (C, D, E, G, A, B) one minor third, four major seconds, and one minor second (or diatonic semitone).

The examples of keyboards with fewer than seven notes per octave make clear that the seven-note keyboard is the smallest or simplest one having only steps of major and minor seconds. This makes the seven-note keyboard our lower limit of interest. Above we have set the 31-note keyboard as the upper limit of our interest, so that from now on our discussion will cover the range of keyboards with 7 to 31 notes per octave. Table I, which is appended to this article, lists the interval composition of these keyboards, that is, the numbers of the various types of step intervals which occur in them. By «step interval» is meant the interval between a key and its next higher (or lower) key.

Each keyboard described so far corresponds to a collection of notes or pitches. Keyboards with notes that can be ordered in unbroken lines of fifths may be called *rational keyboards* because of their rational design: since Western music by and large is tonal and employs keys at distances of a fifth among them, a closed row of fifths seems to be a rational starting point for whatever keyboard. Keyboards may be called *symmetrical keyboards* if the note D has the central position in the row of fifths. In all examples we have presupposed a rational and symmetric keyboard design.

Table I makes clear some especially intriguing properties of keyboards. First, for keyboards of any number of notes (per octave) there are two or three different step intervals between neighbouring notes. Most often there are three different intervals, only a few special ones have simply two types of

intervals: the seven-note keyboard with only diatonic whole tones and semitones, the twelve-note keyboard with the diatonic and chromatic semitones, the nineteen-note keyboard with chromatic semitones and diminished seconds, and the 31-note keyboard with diminished seconds and «downward doubly-diminished seconds».

If one looks at the occurrence of specific step intervals in keyboards of a varying number of notes, it is seen that certain intervals have a maximum number of appearances in a keyboard with a specific number of notes. They then have one appearance less with every note added to or removed from the keyboard. So the diatonic whole tone reaches its maximum number of appearances in the keyboard with seven notes, the diatonic semitone in one with twelve notes, the chromatic semitone in one with nineteen notes, and the diminished second in one with thirty-one notes. These keyboards are just the ones with only two types of step intervals. The maximum numbers of the various step intervals are five (diatonic whole tones in a 7-note keyboard), seven (diatonic semitones in a 12-note keyboard), twelve (chromatic semitones in a 19-note keyboard), and nineteen (diminished seconds in a 31-note keyboard).

The above observations single out the keyboards with 12, 19, or 31 notes per octave as cases of special interest. It may not come as a surprise that in historical and the present discussion of keyboard design these keyboards have received by far the most attention, much more than, say, keyboards with 13, 14, 18, 20, or 30 notes per octave. They are special also in having the property that they can be easily tuned in equal temperament and especially in such an equal temperament that operates with a single circle of fifths with quite acceptable tempering. If a 12-note keyboard is tuned with equal fifths, familiar 12-note equal temperament is the result, with a fifth tempered by $1/12$ of a ditonic comma (or 1.955 cents). A circular equal temperament with 19 notes has fifths tempered by 7.218 cents, which comes very close to one third of a syntonic comma (7.169 cents). A circular equal temperament with 31 notes has fifths tempered by 5.181 cents, a value very close to that of quarter-comma meantone temperament (5.377 cents). (The correspondences have been noted ever since the seventeenth century.) These observations give rise to some interesting additional statements: for keyboards with more than 12 notes ordinary 12-note equal temperament is useless, because all additional keys will have pitches that are equal to those already present in the 12-note keyboard. For keyboards with more than 19 notes per octave, tuning with fifths that are tempered by $1/3$ of a comma is useless for the same reason: no new pitches will be created this way. And for keyboards with more than 31 notes per octave meantone tuning is useless.

If one tries to construct circular equal temperaments with other numbers of notes per octave than 12, 19, or 31, the result will consist either of mul-

multiple circles of fifths or of single circles with large temperings (often positive, that is, enlarging the fifth), or both.⁴ The keyboards other than those with 12, 19, or 31 notes per octave may of course be tuned with equal fifths, but in these cases the fifths in the keyboard do not form a single, closed circle.

Diatonic, chromatic, and enharmonic keyboards

It is time to return to the initial question of this article, that is, of when we should call a keyboard diatonic, chromatic or enharmonic. The above considerations have explained the principles of multi-note keyboards, but not yet answered the basic question. Three basic strategies are possible when defining these categories and using the data available in Table I.

The first strategy can be called the *conservative strategy*. It tells us to call a keyboard diatonic as long as there is at least one diatonic step between two neighbouring notes; in the same way a keyboard may be called chromatic as long as there is at least one chromatic step, and enharmonic only if there is no diatonic or chromatic step in the keyboard. With this strategy, keyboards with up to 18 notes per octave are diatonic, keyboards with 19 to 30 notes per octave are chromatic, and keyboards with 31 or more notes per octave are enharmonic. Since this is clearly at variance with practice and intuition, this seems not to be a wise strategy.

The second strategy can be called the *progressive strategy*. It requires us to call a keyboard chromatic as soon as there is a single chromatic interval, and enharmonic as soon as there is a single enharmonic interval. From this procedure only keyboards with seven or fewer notes per octave are diatonic. Keyboards with 8 to 12 notes per octave are chromatic, and keyboards with 13 or more notes are enharmonic. Keyboards with 20 or more notes introduce a new interval, so that we should have another, new adjective designating these keyboards. This strategy looks as impractical as the first one.

A third strategy may be labelled the *perfectionist strategy*. This tells us to denote any quality (diatonic, chromatic, enharmonic) in the type of the keyboard. A 12-note keyboard is then diatonic-chromatic, keyboards with 13 to 18 notes are diatonic-chromatic-enharmonic, one with 19 notes is chromatic-enharmonic, the ones with more than 19 notes are chromatic-enharmonic and beyond. This strategy looks cumbersome.

4 See Rudolf Rasch, «The unification of tonal systems, or About the circle of fifths», in: *Journal of New Music Review* 29 (2000), pp. 319–334.

Table I. Numbers of step intervals in keyboards with 7 to 31 notes per octave.

Number of notes	Last added note	Diatonic whole tones	Diatonic semi-tones	Chromatic semi-tones	Diminished seconds	Downward doubly diminished seconds
7	F	5	2	0		
8	F $\sharp$	4	3	1		
9	B $\flat$	3	4	2		
10	C $\sharp$	2	5	3		
11	E $\flat$	1	6	4		
12	G $\sharp$	0	7	5	0	
13	A $\flat$		6	6	1	
14	D $\sharp$		5	7	2	
15	D $\flat$		4	8	3	
16	A $\sharp$		3	9	4	
17	G $\flat$		2	10	5	
18	E $\sharp$		1	11	6	
19	C $\flat$		0	12	7	0
20	B $\sharp$			11	8	1
21	F $\flat$			10	9	2
22	F $\sharp\sharp$			9	10	3
23	B $\flat\flat$			8	11	4
24	C $\sharp\sharp$			7	12	5
25	E $\flat\flat$			6	13	6
26	G $\sharp\sharp$			5	14	7
27	A $\flat\flat$			4	15	8
28	D $\sharp\sharp$			3	16	9
29	E $\flat\flat$			2	17	10
30	A $\sharp\sharp$			1	18	11
31	G $\flat\flat$			0	19	12

In view of the above possible strategies, it seems best to formulate a practical rule that is at the same time clear and simple, tries to conform as much as possible to existing usage, avoids the extremes of the conservative, progressive, and perfectionist strategies, and is connected with the basic properties of the keyboards, namely the various step intervals comprised in them. Before doing so, we will focus on the keyboards that represent the maximum appearances of diatonic, chromatic, and enharmonic steps that is, keyboards with 12, 19, or 31 notes per octave. In those keyboards a particular step interval reaches its maximum number of appearances: the diatonic semitone in the 12-note keyboard, the chromatic semitone in the 19-note keyboard, and the enharmonic interval in the 31-note keyboard. The keyboards with 7, 12, 19, or 31 notes per octave lay the foundations for further elaborations of the keyboard design. The addition of a note to one of these special keyboards always means the introduction of a new kind of interval: the chromatic semitone when the seven-note keyboard is further developed, the diminished second when the 12-note keyboard, the downward doubly-diminished second when a 19-note keyboard, and a further enharmonic interval when the 31-note keyboard is being developed into one with one note more to the octave. This suggests that it may be wise to adopt a double nomenclature for the keyboards with 7, 12, 19 or 31 notes per octave. They delineate groups of keyboards with fewer or more note per octave and can be considered as belonging to both the categories with fewer notes and more notes, or, in the same (or opposite?) vein belonging to neither of them. We will adopt a procedure that assigns the special keyboards to both the group with fewer notes and the group with more notes.

These observations lead to the following rules:

- A keyboard with up to and including twelve notes will be called *diatonic* because in this range the addition of a note increases the number of diatonic semitones until it reaches its maximum of seven in a 12-note keyboard (and decreases the number of diatonic whole tones until they have completely vanished in the 12-note keyboard). Analogy with the chromatic and enharmonic categories would restrict the diatonic keyboards to the range from seven to twelve notes per octave.
- A keyboard with 12 to 19 notes will be called *chromatic*, because the addition of a note increases the number of chromatic semitones until it reaches its maximum of twelve in a 19-note keyboard (and decreases the number of diatonic semitones until they have completely vanished in the 19-note keyboard).
- Finally, a keyboard with 19 to 31 notes will be called *enharmonic*, because the addition of a note increases the number of enharmonic steps until it reaches its maximum of nineteen in a 31-note keyboard (and decreases the

number of chromatic semitones until they have completely vanished in the 31-note keyboard).

- By the procedure chosen a 12-note keyboard is called *both* diatonic and chromatic, and a 19-tone keyboard *both* chromatic and enharmonic. The choice of the designation is determined by the context of the discussion.

This strategy gives, it seems, a satisfactory solution for keyboards from seven to 31 notes, but leaves open how to call keyboards with six or fewer notes per octave (a rather academic question) and how to call keyboards with more than 31 notes or keys per octave, a less academic question, but so far one with less urgency than the nomenclature for keyboards from seven to 31 notes.

Abstract

This article addresses the question of when to call a keyboard diatonic, chromatic, or enharmonic. It investigates the intervals that can be found between adjacent notes of keyboards with 7 to 31 keys per octave. It appears that keyboards with 12, 19, and 31 keys per octave enjoy a special position within the whole range in that they contain only two different types of interval between adjacent keys. The other keyboards have three such different intervals. It is concluded that the term «diatonic keyboard» may be used for keyboards with 7 to 12 keys per octave, «chromatic keyboard» for those with 12 to 19 keys per octave, and «enharmonic keyboard» for those with 19 to 31 keys per octave. From this proposal the keyboards with 12 or 19 keys per octave have double designations, which seems to conform to historical and present-day practice.

Zusammenfassung

Der Beitrag geht der Frage nach, wann eine Tastatur als diatonisch, wann als chromatisch und wann als enharmonisch bezeichnet werden kann. Dazu untersucht es die Intervalle, die zwischen benachbarten Noten auf Tastaturen mit 7 bis zu 31 Tasten pro Oktave gefunden werden können. Es stellt sich heraus, dass Tastaturen mit 12, 19 oder 31 Tasten pro Oktave eine bevorzugte Stellung einnehmen, indem sie nur zwei unterschiedliche Arten von Intervallen zwischen benachbarten Tasten aufweisen. Alle übrigen Tastaturen weisen drei verschiedene Intervalltypen auf. Es ergibt sich die Schlussfolgerung, dass der Begriff «diatonische Tastatur» nur für Tastaturen mit 7 bis 12 Tasten benutzt werden mag, «chromatische Tastatur» für solche mit 12 bis 19 Tasten pro Oktave und «enharmonische Tastatur» für solche mit 19 bis 31 Tasten pro Oktave. Nach diesem Vorschlag gibt es für Tastaturen mit 12 wie mit 19 Tasten pro Oktave eine doppelte Bezeichnung, was sowohl mit historischer wie mit heutiger Nomenklatur / Praxis konform zu gehen scheint.

Why were enharmonic keyboards built? – From Nicola Vicentino (1555) to Michael Bulyowsky (1699)¹

Rudolf Rasch

The 12-note diatonic-chromatic keyboard may be called one of the success stories in the history of Western music. Ever since its invention at some point in the fifteenth century, its design has remained basically unchanged. It has been the basic playing device for traditional keyboard instruments such as the organ, the harpsichord, the pianoforte, and the clavichord, all of them used abundantly in historical and present-day times, often as the 'leading instruments' of the time. In addition the design has, for many centuries already, been applied to instruments of other categories such as the carillon, the accordion, keyed percussion, and electronic instruments of various designs.

From its early history, however, theorists and builders have thought it necessary to improve this seemingly perfect design by drafting or constructing keyboards with a larger number of keys and therefore pitches per octave, from just a few more than the traditional twelve to a real proliferation, up to fifty or even more. It is difficult to give an exact estimate of the number of keyboard designs proposed in history as extensions of the simple 12-note model. Instruments with raised keys split into two keys were built from the late fifteenth century onwards. The earliest instruments with a number of keys that is substantially larger than twelve, say, 19 or more, were built around the middle of the sixteenth century. A continuous stream of later examples followed them, through all the succeeding centuries. In all, hundreds of them may have been built and presumably new designs are still being developed today. This contribution will deal primarily with the enharmonic keyboards developed during the first one and half centuries of its existence. The designs that are easily available from this period such as the ones described by Nicola Vicentino, Gioseffo Zarlino, Martino Pesenti, Michael Praetorius, Joan Albert

1 I want to thank Denzil Wraight (Cölbe, Germany) for the discussions concerning various details of this contribution; they have been essential for solving a number of problems in a satisfactory manner. Thanks also go to Bob van Asperen (Bennebroek, Netherlands) and Martin Kirnbauer (Basel, Switzerland) for their careful reading of the final draft and for their helpful remarks on several details.

Ban, Giovanni Battista Doni, Marin Mersenne, Athanasius Kircher, etc. present already a range that may be taken as representative for the variety of enharmonic keyboards in general.

The more keys are added on top of the basic 12-note design, the more complicated they are to play on or to compose music for them that is to be played. Keyboards with just a few extra keys resemble in general the 12-note design fairly closely. This resemblance applies more or less to keyboards with no more than 19 notes per octave. In general, keyboards with 12 to 19 notes per octave may be called *chromatic keyboards*.² Keyboards with 19 or more notes, however, look so different from than their 12-note precursors that they cannot be played without special training. They are the genuine enharmonic keyboards and they will be the primary concern of this article. Note that the 19-tone keyboard is counted in both the categories of chromatic and enharmonic keyboards. This is done intentionally since it shares some characteristics with the keyboard designs having fewer notes per octave and other features with designs having more than 19 notes.³ In a few cases, however, attention will also be paid to keyboard designs with fewer than 19 keys per octave, such as Zarlino's 17-note and René Descartes's 18-note design.

It is then a valid question to ask what the reasons were why people occupied themselves with such complicated matters as enharmonic keyboards, because it must have been obvious to everybody that the simple 12-note standard solution served the needs of so many musicians already so well.

Musical instruments are always built to satisfy the specific needs of their builders or users. Therefore, if we want to understand the why of enharmonic keyboards we should look at the motivation or motivations of the designers and builders of such instruments. Since musical needs and the corresponding musical preoccupations have changed throughout the entire history of music, one should not be surprised to find behind the history of enharmonic keyboards not a single motivation but rather a number of motivations, which developed over time, in connection with the preoccupations of the time's musical practice, thought, and theory.

Evidence of several kinds is available for writing the history of the enharmonic keyboard in general. Surviving enharmonic instruments and written texts describing, and sometimes depicting such instruments are the most

2 About these keyboards see especially Denzil Wraight & Christopher Stenbridge, «Italian Split-Keyed Instruments with Fewer than Nineteen Divisions to the Octave», in: *Performance Practice Review* 7/2 (1994), pp. 150–181.

3 See my contribution «On Terminology for Diatonic, Chromatic, and Enharmonic Keyboards» in this volume.

important sources for our knowledge of the enharmonic instruments. Additional information may be derived from archival documents and musical scores. In this contribution, which rather deals with the «why» of the enharmonic instruments than the «how», most use will be made from written information. There the designer perhaps tell us the reason why the pursued such a complicated art, an art, after all, that induced Zarlino to quote the following lines from Alciato's *Emblemata*:⁴

«Difficile est, nisi docto homini tot tendere chordas.»

Difficult it is, except for a learned man to play on so many strings.

The present article is organized in six sections, each of which takes an author and his main publication dealing with enharmonic keyboards as its point of departure. The earliest source examined in such a way is Nicola Vicentino's *L'antica musica ridotta all moderna pratica*, published in Rome in 1555, the latest Michael Bulyowsky's *Neu-erfundenes vollkommenes fünff-faches Clavier* published in Stuttgart in 1699. The present overview will not discuss every single case of an enharmonic keyboard proposed or built in the one and half centuries from about 1550 to about 1700. An exhaustive treatment of the topic is not to be expected. To begin with, we will refrain of a detailed discussion of the various multi-note keyboards proposed in the writings of Giovanni Battista Doni, notably his *Compendio del trattato* (Rome 1635) and his *Annotazioni sopra il compendio* (Rome 1640), despite the interest they have regarding the subject matter of the present article. The attentive reader undoubtedly will notice more examples missing. It must be said also that in a number of cases enharmonic keyboards are described without an explicit or implicit motivation being given for it. They are just presented as the only way to build an instrument.

Nicola Vicentino:

L'antica musica ridotta all moderna pratica (Rome 1555)

The earliest enharmonic keyboards date, as far as we know, from the middle years of the sixteenth century. The first elaborate description of such an instrument was published by the somewhat wayward Italian composer and theorist Nicola Vicentino in his remarkable treatise entitled *L'antica musica ridotta alla moderna pratica* (Ancient music brought back to modern

4 Gioseffo Zarlino, *Le institutioni harmoniche*, Venice: (no publisher) 1558, p. 143 (see also Figure 1 below).

practice) and published in Rome in 1555.⁵ Vicentino called his instrument the *archicembalo*, which can be literally translated as 'arch-harpsichord'. Ever since its first description Vicentino's *archicembalo* has functioned as a kind of archetypal enharmonic instrument. No discussion of the subject can forgo mentioning the *archicembalo*.

Presumably the *archicembalo* was already built in 1555.⁶ But unfortunately Vicentino does not tell us who built the instrument, or when or where, as Zarlino did for example concerning his instrument in *Le istituzioni harmoniche* of 1558 (see below) and half a century later Fabio Colonna in *La sambuca lincea* of 1620 (see below). Vicentino provided, however, in his *L'antica musica*, detailed descriptions and drawings that give us a clear picture of what the instrument looked like, how it was constructed and what it intended to make possible. By 1561 the *archicembalo* was supplemented with an *arciorgano* of similar construction, as far as the keyboards were concerned.⁷ The basic design of the *archicembalo* and the *arciorgano* is that of a harpsichord with two manuals, each of which had three rows of keys: one row of lower keys, and two rows of raised keys.

Vicentino's *L'antica musica* is an entirely verbal (and often verbose) book, without any figure or formula. This certainly makes for ease of reading but leaves open a certain number of questions, one of which is the tuning of the *archicembalo*. From what is indeed clear it may be concluded that the three rows of keys of the lower manual and the lower two rows of the upper formed together a 31-note keyboard, with 31 pitches per octave, which can be ordered

5 Nicola Vicentino, *L'antica musica ridotta alla moderna pratica* (Rome: Antonio Barre, 1555). Facsimile edition, ed. by Edward E. Lowinsky, Kassel 1959 (= Documenta Musicologica Erste Reihe 17). English translation with introduction and notes by Maria Rika Maniates as *Ancient Music Adapted to Modern Practice*, New Haven 1996 (= Music Theory Translation Series). The classical introduction to Vicentino's life and work is Henry W. Kaufmann, *The Life and Works of Nicola Vicentino (1511-c.1576)*, [Rome] 1966 (= Musical Studies and Documents 11). About the tuning of the *archicembalo* see also Henry W. Kaufmann, 'More on the Tuning of the Archicembalo', in: *Journal of the American Musicological Society* 23 (1970), pp. 84–94; Peter Niedermüller, 'La musica cromatica ridotta alla pratica vicentiniana: Genus, Kontrapunkt und Musikalische Temperatur bei Nicola Vicentino', in: *Neues Musikwissenschaftliches Jahrbuch* 6 (1997), pp. 59–90, and Denzil Wraight's contribution 'The *cimbalo cromatico* and other Italian string keyboard instruments with divided accidentals' to the present volume.

6 See Wraight, 'The *cimbalo cromatico*', in this volume.

7 Described by Vicentino in his *Descrizione dell'arciorgano* (Venice: Nicolo Bevilacqua, 1561), translated in Johannes Wolf, 'Das Arciorgano des Nicola Vicentino (1561)', in: *Der deutsche Instrumentenbau. Zeitschrift für Instrumentenbau und Instrumentenkunde* 35 (1900), pp. 299–302, and in Henry W. Kaufmann, 'Vicentino's Arciorgano: An Annotated Translation', in: *Journal of Music Theory* 5 (1961), pp. 32–53.

in a scale of 31 steps of equal size. The tuning of the uppermost row of the upper keyboard is not entirely clear, but seems to stand apart from the tuning of the five lower rows; we will not occupy ourselves with it. So Vicentino's archicembalo may be seen as a 31-note keyboard.⁸

The 31-note system is not so far removed from the ordinary 12-note system as it may look like at first sight. Most pitches of the 12-note system have an easy and satisfactory counterpart in the 31-note system. The 7-note diatonic scale is represented by pitch with the numbers 0, 5, 10, 13, 18, 23, 28, and 31, if the 31 pitches are just given a sequential number, starting with zero for C. An important difference between the 12-note and 31-note systems is that the 31-note system has different keys for the sharps and flats that are played with the same key on a 12-note keyboard. In the 31-note system the chromatic semitone covers two steps, the diatonic semitone three. That gives C $\sharp$ key 2, D $\flat$ key 3, D $\sharp$ key 7, E $\flat$ key 8, etc. The 31-note system provides new pitches in the middle of every chromatic semitone, that is, one between C and C $\sharp$ (namely, key 1), between D $\flat$ and D (key 4), between D and D $\sharp$ (key 6), between E $\flat$ and E (key 9), etc.

How did come Vicentino to construct and tune a 31-note keyboard? The answer lies in the imitation of the ancient enharmonic genus. Theorists of the fifteenth and sixteenth centuries had remarked that the Greek enharmonic genus did not have a role in the contemporary tonal system, but in this humanistic time many music theorists, Vicentino among them, could not withstand the lure of the enharmonic genus. The theory of the enharmonic genus was an extension of that of the diatonic and chromatic genera.

The diatonic genus could simply be represented by a tetrachord such as

B - C - D - E

The chromatic tetrachord came into being by lowering the second highest note from D to C $\sharp$:

B - C - C $\sharp$ - E

To make an enharmonic tetrachord, the second highest note was lowered again, now to C, which led to a lowering of the third highest note to a position between C and B, a position that we will call B+ for the moment:

B - B+ - C - E

8 See also Patrizio Barbieri, «I temperamenti ciclici da Vicentino (1555) a Buliowski (1699): Teoria e pratica *Archicembalística*», *L'Organo* 21 (1983), pp. 129–208, especially pp. 160–166.

How can exact pitch values given to these notes? The answer to this question is far from easy. As easy as it is to propose the diatonic, chromatic, and enharmonic genera, so is it difficult to provide exact pitches for the notes involved in them. Of course, the pitches chosen depend on the tuning system adopted. But this very observation is the beginning of all the difficulties. Should one adopt the tuning system(s) from Greek music theory or one of those in contemporary (sixteenth-century) theory or practice? Vicentino choose a solution that was in agreement with the mainstream of contemporary (sixteenth-century) music theory.

Sixteenth-century interval theory is dominated by a system that is called *just intonation* today. Its starting points are the octave with the frequency ratio 1:2, a fifth with 2:3, and a major third with 4:5. From this it is easily derived that the fourth represents a ratio of 3:4, the minor third of 5:6, the major sixth of 3:5, the minor sixth of 5:8. One of the peculiarities of the system is that for the dissonant intervals several ratios are always in use, depending on how the interval was derived as the summation and subtraction of consonant intervals. For the major second or whole tone the ratios 8:9 (major whole tone; 204 cents) and 9:10 (minor whole tone; 182 cents) are in use. For the minor second or diatonic semitone the ratio 15:16 (112 cents) is the basic one, for the chromatic semitone the ratio 24:25 (71 cents).

Which interval ratios should be chosen for the various tetrachords as sketched above? The fourth 3:4 (B-E), the major third 4:5 (C-E), and the minor third 5:6 (C $\sharp$ -E) are not difficult to decide upon. The problems arrive with the whole tones and smaller intervals. The whole tones in the diatonic tetrachord are usually taken as one major whole tone (8:9; D-E) and one minor whole tone (9:10; C-D), the semitones in the chromatic tetrachord as the diatonic semitone 15:16 (B-C) and the chromatic semitone 24:25 (C-C $\sharp$). So far, so good. But what to do with the enharmonic intervals, or the position of B+ between B and C? A solution here is particularly difficult since any traditionally available way failed here to divide an interval into two smaller intervals of comparable rank. The major third could be divided into two whole tones (one major, one minor), the (major) whole tone could be divided into two semitones, one diatonic, one chromatic. For the major (diatonic) semitone no such obvious division was available.

Instead, it was unavoidable that the difference in size between the two types of semitones, the diatonic and the chromatic, would play a part. The major whole tone (204 cents) and the minor whole tone (182 cents) differ between them by a syntonic comma, which is with its 22 cents by no means negligible, but in size small (about one tenth) in comparison with the two types of whole tones themselves. The difference in size between the chromatic and diatonic semitones is, however, of a much more drastic nature. The smaller of the two semitones is the chromatic, which, with its ratio 24:25,

equals 71 cents. The diatonic or major semitone has a ratio of 15:16, which equals 112 cents and which prevents the two semitones being seen as more or less of the same size. It is better to say that the sizes of the chromatic and the diatonic semitones are more or less in the proportion of 2:3. We have demonstrated this ratio with the help of cents, but the sixteenth-century scientist may have done the same with arithmetical methods.

The large difference between the chromatic and diatonic semitones made it possible to use the chromatic semitone as an interval to divide the diatonic semitone. After all, what remained when the diatonic semitone (112 cents) was diminished by a chromatic semitone (71 cents), was still an interval of substantial size, namely 41 cents. This interval has a ratio of 125:128 and is commonly known as the minor diesis or, in short, the *diesis*.⁹ If indeed the chromatic semitone is used to divide the diatonic semitone into two parts, this can be done in two ways. First, the lower interval can be the chromatic semitone, the higher one the diesis:

B - chromatic semitone - B $\sharp$ - diesis - C

The $\langle B+ \rangle$ has now been named B $\sharp$, because is it a chromatic semitone higher than B. A second way to divide the diatonic semitone is to have the chromatic semitone as the higher interval. In that case the intervening note $\langle B+ \rangle$ can be called C $\flat$, since it is a chromatic semitone lower than C:

B - diesis - C $\flat$ - chromatic semitone - C

Since the diesis and the chromatic semitone are roughly in the proportion of 1:2, combining both types of division leads to a division of the diatonic semitone into three more or less equal intervals:

B - diesis - C $\flat$ - [...] - B $\sharp$ - diesis - C

The consequences of the double division of the diatonic semitones are enormous, since it makes the generalization over the entire keyboard possible. A diatonic semitone now equals three small «parts», a chromatic semitone two. If all diatonic and chromatic semitones are constituted of these «parts», the entire octave has $7 \times 3 + 5 \times 2 = 31$ «parts». If the «parts» are, for practical purposes, considered to be of equal size, the entire keyboard is now one with 31 pitches per octaves, more or less laid out in a regular series of ascending (or descending) pitches. In other words, it transforms the 12-note keyboard into a 31-note keyboard. Vicentino calls the 31 parts that make up an octave *dieses*. By doing this he gives the term *diesis* a slightly different meaning than

9 The major diesis is the difference between four minor thirds and an octave, and has the ratio 625:648 (63 cents).

it had in traditional theory. In the latter it strictly has the size of 125:128 (or 41 cents); it arises as the difference between an octave and the sum of three just major thirds. For Vicentino a diesis was a small step, 31 of which formed an octave. If the steps are all taken as having equal sizes, this diesis has the size of 39 cents (or 38.710 cents to be more exact), a little less than the traditional diesis (which has the size of 41.059 cents if the same order of exactness is applied).

This is what Vicentino must have done, although one looks in vain in his book to find an explicit derivation. Where it comes to the enharmonic tetrachord, Vicentino applies only the division of the diatonic semitone with the smaller interval (the diesis) on the lower position.¹⁰

Vicentino notated the enharmonic pitches by adding dots over notes. A note with a dot above it is one diesis higher than the corresponding note without diesis. The dot is placed on top of all natural notes and sharps and flats. This simple addition suffices to provide a full notation for the 31-note scale, as is clear from the following example, where the successive pitches or keys have been numbered from zero onwards (the dots have been placed behind the note names instead of on top of them):

0: C 1: C· 2: C[#] 3: D^b 4: D^b· 5: D 6: D· 7: D[#] 8: E^b 9: E^b· 10: E

Looking back at the reasoning given above, it will be clear that the construction of Vicentino's keyboard resulted from a coincidence not foreseen by the Greek theorists who had launched the enharmonic tetrachord about one thousand years before. For them the semitone of the enharmonic tetrachord was to be divided into two parts that were in principle equal and could be called dieses. The division of an interval strictly in equal parts is carried out by the so-called geometrical division. If realized in numerical terms, the method requires a root extraction, a procedure not yet readily available in the sixteenth century. Vicentino followed sixteenth-century principles of interval construction out of just-intonation ratios, which implied the use of ratios with small integers. This way of working does not allow the division of an interval into two equal parts. Therefore, all interval divisions in sixteenth-century music theory are unequal divisions, such as the division of the octave in the fifth and the fourth, the division of the fifth in the major and minor thirds, the division of the major third in the major and minor whole tones, and the division of the whole tone in the diatonic and chromatic semitones. This principle was now extended to the division of the diatonic semitone into two unequal parts, the chromatic semitone (also called the chromatic diesis) and the diesis (or enharmonic diesis).

10 Vicentino, *L'antica musica*, fol. 15.

Vicentino's treatise is interesting because it not only describes the enharmonic genus and the 31-note scale as theoretical concepts, but puts them into practice as well. On the one hand he designed the archicembalo to produce enharmonic pitches as sound, on the other he composed music in the enharmonic genus, which was printed in *L'antica musica*. In all there are four such pieces, all for four voices: «Musica prisca caput» (with phrases in the diatonic, chromatic and enharmonic genera respectively, 48 *brevis* measures), «Soav'e dolc'ardore» (a 14-measure fragment entirely enharmonic), «Dolce mio ben» (a 26-measure fragment entirely enharmonic), and «Madonna il poco dolce» (a 44-measure fragment entirely enharmonic).¹¹ In these compositions the enharmonic tetrachord is not used as a melodic figure. Instead, the enharmonic pitches are used to raise certain major and minor chords by a diesis that as a whole sound «normal» internally. This creates melodic intervals in the various voices that are one diesis larger or smaller than the «normal» melodic interval. When this is done to the «dominant chord» before a «tonic chord» a «sharp» leading-note is created, one that is a minor semitone removed from the tonic (instead of a major semitone).

Appendix 1 of this article contains a transcription in keyboard notation of «Soav'e dolc'ardore». It is clearly seen in it that there is an alternation of chordal blocks of *brevis* or semibreve length that are shifted upward by a diesis and blocks which are not shifted, again of *brevis* or semibreve length. It is not as difficult to play this or Vicentino's other compositions on the archicembalo as it may look at first sight. The non enharmonic passages may be played on the lower manual in a fairly normal way: one has only to distinguish carefully between sharps and flats that are served by the same key on 12-note instruments. The enharmonic passages are played on the upper manual again simply as usual because the fourth rank is a diesis-raised repetition of the first rank. The fifth rank provides the flats for the naturals of the fourth rank. Only there are no diesis-raised sharps on the upper manual. Vicentino has thought of this and has replaced them in his compositions by ordinary flats of the next higher natural, to be played on the third rank of keys, of the lower manual.

So Vicentino's motivation for building the archicembalo may be summarized in the following succinct phrase: the archicembalo was constructed in order to make audible the enharmonic pitches of Greek music theory.

11 These pieces are edited in Kaufmann, *Life and Works*, pp. 140–146; in Barbieri, «I temperamenti», pp. 170–173; in Alexander Silbiger (ed.), *Nicola Vicentino: Four enharmonic madrigals for four voices (Rome, 1555)*, Utrecht 1990 (= Corpus Microtonale 33); and in Maniates, *Ancient Music*, pp. 209–222.

Gioseffo Zarlino: Le istituzioni harmoniche (Venice 1558)

The Venetian music theorist Gioseffo Zarlino has earned his place in the early history of the enharmonic keyboard from an instrument that he had made by Dominico da Pesaro in 1548. If it is difficult to say whether Zarlino's instrument is older than that of Vicentino; at least it is the earliest enharmonic instrument for which a date is known. It is described and pictured in *Le istituzioni harmoniche* (first published in 1558) in the section that follows the description of the enharmonic tetrachord so that it may nearly be taken for granted that the purpose of the instrument was – as Vicentino's – to illustrate the enharmonic tetrachord or the enharmonic genus in general.

The chapter in which the enharmonic keyboard is discussed is Capitolo 47 of the *Seconda Parte* of *Le istituzioni harmoniche*. It is towards the end of the *Seconda Parte*, which is devoted to the pitch systems of music. First the antique system is described including the various tetrachords and genera; they have been constructed according to the principles of Pythagorean tuning, with the just fifth (with ratio 2:3) as the basis of everything. Thereafter modern elements are included, such as just intonation intervals and Zarlino's keyboard temperament based on fifths that are tempered by 2/7 of a syntonic comma. Finally, Zarlino returns to the tetrachords and describes how the notes of the chromatic and the enharmonic tetrachords may be inserted in a just-intonation framework.

The chromatic tetrachord is 'solved' in Chapter 46 in the following way:¹²

60 E	Hypate meson
	Trihemituono [= minor third: 60:72 or 5:6]
72 [C]#	Lychanos hypaton
	Semituono minore [= minor or chromatic semitone 72:75 or 24:25]
75 C	Parhypate hypaton
	Semituono maggiore [= major or diatonic semitone 75:80 or 15:16]
80 H	Hypate hypaton

The enharmonic tetrachord is similarly treated in the next chapter (47) and is solved in this way:¹³

300 a	Mese
	Sesquiquarta [= major third: 300:375 or 4:5]
375 F	Lychanos meson
	Supertripartiente 125 [= minor diesis 375:384 or 125:128]
384 [E] V	Parhypate meson
	Sequivalentesima quarta
	[= minor or chromatic semitone 72:75 or 24:25]
400 E	Hypate meson

¹² Zarlino, *Le istituzioni harmoniche* (1558), p. 138.

¹³ Zarlino, *Le istituzioni harmoniche*, p. 140.



Figure 1. Zarlino's enharmonic harpsichord, as depicted on p. 143 of *Le istituzioni harmoniche* (Venice 1558).

These notes, Zarlino continues, are suitable on a musical instrument if only one makes sure that there are fifths, fourths, major or minor thirds above or below them. Otherwise they cannot be used as consonant intervals. He suggests that the reader has built an instrument to his (Zarlino's) design so that he can experiment with the chromatic and enharmonic genera:¹⁴

«Potrà adunque ciascuno per lo avenire fabricare uno istrumento alla simiglianza di quello ch'io hò mostrato; il quale sarà comodo, & atto a servire alle modulationi, & harmonie di ciascuno delli nominati generi; Et questo non parerà ad alcuno difficile: percioche uno de tali istrumenti feci fare io l'anno di nostra salute 1548. in Vinegia, per vedere, in qual maniera potessero riuscire le harmonie Chromatiche, & le Enharmoniche; & fu un Clavicembalo, & è anco appresso di me, il quale fece Maestro Domenico Pesarese fabricatore eccellente di simili istrumenti.»

Therefore one will from now on be able to build an instrument such as I have shown, which will be useful and fit to perform the modulations and harmonies of each one of the mentioned genere. And this will not be deemed difficult by anyone, for I had one of such instruments made in Venice, in the year of our Lord 1548, in order to see in what way one could realize the chromatic and enharmonic harmonies. And it was a harpsichord and I still have it in my possession; it was made by Master Domenico da Pesaro, an excellent maker of that sort of instruments.

On the next page there is a depiction of the instrument (see Figure 1). It gives a single-manual keyboard over two octaves only, with all the raised keys split into two (next to one another). In addition, there are two single extra raised keys, one between E and F and one between B and C. The enharmonic keys (that is, the ones missing in 12-note keyboards) are supposed to be red. All together it is a 19-note keyboard.

Until relatively recently it has been generally assumed (also by me) that the picture of the keyboard matched the information about the Domenico da Pesaro harpsichord given by Zarlino in his text one page earlier. Christopher Stenbridge first established convincingly that the instrument referred to in the text did not fit the picture and could instead better be viewed as an instrument having a keyboard with 24 pitches per octave.¹⁵ There are several reasons for this. First, Zarlino states in his text also that on the instrument¹⁶

14 Zarlino, *Le institutioni harmoniche*, p. 140.

15 Christopher Stenbridge, «The *Cimbalo cromatico* and Other Italian Keyboard Instruments with Nineteen or More Divisions to the Octave (Surviving Specimens and Documentary Evidence)», in: *Performance Practice Review* 6/1 (1993), pp. 33–59, especially pp. 43–54; see also Wright, «The *cimbalo cromatico*», in this volume.

16 Zarlino, *Le institutioni harmoniche*, p. 140.

«non solamente li Semituoni maggiori sono divisi in due parti, ma anche tutti li minori.»

not only the major semitones are divided into two parts, but also all the minor semitones.

The latter division is certainly not applied to the instrument depicted. If we interpret «all the minor semitones» as «all the minor semitones of a 12-note keyboard», the instrument must have, in addition to the ones depicted, keys between C and C $\sharp$, between E $\flat$ and E, between F and F $\sharp$, between G and G $\sharp$, and between B $\flat$ and B. The resulting pitches could be called D $\flat\flat$, D $\sharp\sharp$, G $\flat\flat$, A $\flat\flat$, and A $\sharp\sharp$. It would require all the whole tones of the diatonic scale (of C major), namely C-D, D-E, F-G, G-A, and A-B, to be divided into four parts, as Zarlino remarked in the 1573 revision of the *Istitutioni*.¹⁷ The total number of keys would then be 24.

That there were indeed five extra keys is confirmed by the description of the instrument that the seventeenth-century blind Venetian composer Martino Pesenti (c1600-c1648) provided in the preface of his *Correnti, gagliardi, e balletti diatonici, trasportati parte cromatici, e parte henarmonici ... Libro quarto, Opera decimaquinta* (Venice: Alessandro Vincenti 1645).¹⁸ The preface is reproduced in Appendix 2 of this article. In it Pesenti mentions two enharmonic instruments, one built by Vito Trasuntino in 1601, and another one «invented by Zarlino, and built by Dominico da Pesaro in 1548». Pesenti had known both instruments and played on both of them. Neither instrument has survived, but obviously the latter instrument is the one described in Zarlino's *Istitutioni*. Trasuntino has become particularly well known because he is the builder of one of the few surviving enharmonic harpsichords of the decades around 1600, the *Clavemusicum omnitonum* that survives in the Museo Civico, Bologna.¹⁹

After reciting the histories of the instruments, he goes on to describe them both, comparing them, key by key. As said before, Pesenti's description provides five keys that are not present in the picture in Zarlino's *Istitutioni*, which he gives the names of C $\sharp\sharp$, D $\sharp\sharp$, F $\sharp\sharp$, G $\sharp\sharp$, and A $\sharp\sharp$. Their pitches do divide chromatic semitones into two parts, but not always the same as mentioned above, when interpreting Zarlino's phrase about them on face value. The pitch names given by Pesenti would point to the chromatic semi-

17 Gioseffo Zarlino, *Istitutioni harmoniche*, Venice: Francesco dei Franceschi 1573, p. 164: «ma anche li minori, di maniera che ogni Tuono viene ad essere diviso in quattro parti.»

18 See Carl Morey, «The Diatonic, Chromatic, and Enharmonic Pieces by Martino Pesenti», in: *Acta Musicologica* 38 (1966), pp. 185–189.

19 Inv.-no. 1766; a playable copy is in the Germanisches Nationalmuseum, Nuremberg, MI 533.

tones D $\flat$ -D, E $\flat$ -E, G $\flat$ -G, A $\flat$ -A, and B $\flat$ -B as the ones to be divided. It is difficult to decide whether our guess was the choice of pitches meant by Zarlino, or Pesenti's listing. After all, when Pesenti first played on the instrument, it was out of tune, while, being blind, he could not see which keys were red. In favor of Pesenti's interpretation is that the pitches in it can be ordered into a single line of fifths: after E $\sharp$ and B $\sharp$ follow F $\sharp\sharp$, C $\sharp\sharp$, G $\sharp\sharp$, D $\sharp\sharp$, and A $\sharp\sharp$. When Charles Burney saw the instrument in Venice in 1771, in the house of the widow of the composer Giovanni Battista Pescetti, there Zarlino's handwritten tuning instructions pasted to the back of the nameboard.²⁰ One must assume that the instructions were there also when Pesenti investigated the instrument and that someone has read them for him. So for the moment Pesenti's description should be accepted as the best one available.

After having compared both instruments, Pesenti stated his preference for Zarlino's, because it is «il più regolato del tutto» (of all the most conforming to the rules). He quotes the passage from the 1573 revision of the *Istitutioni harmoniche* where the instrument is described and which we have quoted above. The final lines of Pesenti's preface are remarkable. First he apologizes that he has not composed a toccata that would pass from the diatonic via the chromatic to the enharmonic genus and would then return via the chromatic back to the diatonic. He has not done so «because it is difficult to find oneself a harpsichord with all the three afore-mentioned genera.» Nevertheless, he continues, he has presented the various *correnti*, *gagliarde* and *balletti* in the chromatic and enharmonic genera since these can be played on lutes and viols, instruments encompassing (in his opinion) the chromatic and enharmonic genera. Unfortunately he did not start a discussion of how the enharmonic (or even the chromatic) pitches should be realized on these instruments. It does not seem very sensible to perform them on lutes or viols fretted in 12-note equal temperament, which leaves only the alternative that Pesenti must have thought of lutes and viols fretted in 31-note equal temperament. One could wish for a confirmation for this thought.²¹

«Wherein the Most Compleat Harmony was heard»: The Viola da Gamba in Chromatic and Enharmonic Music in Seventeenth-Century Rome», in: Susan Orlando (ed.), The Italian Viola da Gamba. Proceedings of the International Symposium on the Italian Viola da Gamba, Magnano 29 April – 1 May 2000, Solignac & Turin 2002, pp. 34–51.

20 Burney copied the instructions, but he did not publish them, as he intended to do. Neither the original instructions nor Burney's copy has survived. See Percy A. Scholes (ed.), *Dr. Burney's Musical Tours in Europe, Volume I: An Eighteenth Century Musical Tour in France and Italy*, London 1959, p. 189.

21 See about possible additional frets on the viol for enharmonic music Martin Kirnbauer, «Wherein the Most Compleat Harmony was heard»: The Viola da Gamba in Chromatic and Enharmonic Music in Seventeenth-Century Rome», in: Susan Orlando (ed.), *The Italian Viola da Gamba. Proceedings of the International Symposium on the Italian Viola da Gamba, Magnano 29 April – 1 May 2000, Solignac & Turin 2002*, pp. 34–51.

Finally there is a music example «after Zarlino» with the enharmonic tetrachords on B, e, b, e1, and a, on a single staff with seven lines. The enharmonic pitches use the simple cross «x» as accidental. I assume that the music example is based on Zarlino's enharmonic monochord depicted on p. 116 of *Le institutioni harmoniche*.²² The pitches in Pesenti's example are exactly those in Zarlino's monochord. Looking at that picture, for example, makes clear why the a-d1 tetrachord has been put at the rightmost end of Pesenti's example. Pesenti may have taken the sign «x» (which is missing in Zarlino's monochord, which has no musical notation at all) from other illustrations of the *Istitutioni*.

Although we now know by Pesenti's description that Zarlino's keyboard had 24 keys per octave, this raises more questions than it answers. The big question especially is that of why Zarlino needed a 24-note instrument to let him hear the enharmonic genus. A 19-note keyboard as depicted would have served this aim very well, since it provides enharmonic tetrachords of the kind described by Zarlino on all the seven degrees of the diatonic scale:

B - B $\sharp$ - C - E

C - C $\sharp$ - D $\flat$ - F

D - D $\sharp$ - E $\flat$ - G

E - E $\sharp$ - F - A

F - F $\sharp$ - G $\flat$ - B $\flat$

G - G $\sharp$ - A $\flat$ - C

A - A $\sharp$ - B $\flat$ - D

The 19-note design that is depicted in *Le institutioni harmoniche* is much more regular than the actual 24-note design of the instrument. At least some instruments with 19 keys per octave have been built during the decades around 1600, of which the *Clavicymbalum universale*, described by Michael Praetorius in his *Syntagmatis musicum tomus secundus* (Wolfenbüttel 1619) is the most famous.²³

But one looks in vain for a motivation Zarlino's addition of the five keys added to the 19-note design. All Zarlino mentions is that the keyboard may illustrate the enharmonic genus and that it splits diatonic and chromatic semitones into two parts. Whereas he is comprehensive and verbose every-

22 That is, page 116 in the first edition, of 1558. Pesenti almost certainly used the revision of the *Istitutioni* issued in 1573.

23 According to Praetorius the *Clavicymbalum universale* was built in Vienna around 1590 and in 1619 in the possession of Carolus Luython in Prague. See *Syntagmatis musici Tomus secundus*, Wolfenbüttel: Elias Holwein 1619, chapter 40, pp. 63–66. For further 19-note harpsichords, see Wraight, «The cimbalo cromatico», in this volume.

where else in his writings, he is sketchy and indirect here. On the near 350 pages of the *Istitutioni* one or two pages more to explain the keyboard would not have made much difference. The only reason that I can think of for Zarlino's vagueness is his wish not to be associated with Vicentino and the latter's *archicembalo*. This may also be implied in the words that follow the description and praise of his instrument:²⁴

«Et ancora che se ne potessero fare degli altri con diverse divisioni; nondimeno io credo, che da loro si possa cavare poca utilità: perciocche in loro senza alcuna necessità sono moltiplicate le chorde; le quali (oltre le mostrate) non sono atte ad esprimere altri concetti, più dilettevoli, che quelli che fanno udire quelle, che sono collocate nel mostrato istrumento; i quali veramente sono Diatonici, over Chromatici, o pure Enharmonici.»

And although it would be possible to make other instruments with several divisions, they would prove, none the less, of little purpose, for in them the strings are multiplied without necessity, which [strings] (except the ones shown [in my instrument]) are not fit to express other consorts of sounds more delightful than those which the strings render audible that are placed together in the instrument shown, which really are in the diatonic, chromatic, or enharmonic genera.

What is striking is that Zarlino mentions compositions using enharmonic pitches in one breath with those having chromatic and diatonic pitches, as if enharmonic compositions were to be found abundantly. Perhaps these sentences must be seen as an indirect criticism of Vicentino, who is never mentioned by Zarlino, let alone his ideas discussed.

An advantage of a 24-note keyboard over a 19-note one is that the 24-note keyboard does not only provide enharmonic tetrachords based on the natural notes, but also such tetrachords on the raised keys:

C# - C## - D - F#

D# - D## - E - G#

F# - F## - G - B

G# - G## - A - C#

A# - A## - B - D#

But it is difficult to see what use Zarlino could have made of this. True, it allows full major scales on all ordinary sharps and on E# and B#. But on the flats's side D $\flat$ is the furthest out with a full major scale. The scale of G $\flat$ is prevented by the absence of a C $\flat$.

Trasuntino's instrument of 1601, as described by Pesenti, allowed of course a few more enharmonic tetrachords, namely those on E#, B#, B $\flat$, and E $\flat$, and an equal number of extra major scales. His keyboard falls only three

24 Zarlino, *Le institutioni harmoniche* (1558), pp. 140–141.

keys short of Vicentino's 31-note keyboard, on which, of course, enharmonic tetrachords are possible on all degrees, including the 'enharmonic notes' themselves. That Trasuntino's instrument was to be tuned in meantone temperament can be derived from a remark by Pesenti that is puzzling at first sight. After having described Trasuntino's instrument he says that there are two keys between B and C, namely B $\sharp\sharp$ and C $\flat$, that make up a major, that is, diatonic semitone. Strictly speaking the interval B $\sharp\sharp$ -C $\flat$ is not a diatonic semitone. But if it is taken as three steps (C $\flat$ -B $\sharp$ -C-B $\sharp\sharp$) in a 31-note octave it is a diatonic semitone in a 31-note tuning, and therefore in meantone tuning.

Pesenti's preface was to introduce a set of thirty pieces, all of them first presented in the diatonic genus, using such normal keys as F, C, and G major and G, D, and A minor, just the standard keys of meantone temperament. Each piece is followed by a transposition into the chromatic genus (eleven times) or enharmonic genus (19 times). Most of the 'chromatic keys' are remote keys with flats; most of the 'enharmonic keys' are remote keys with sharps. It is not clear why the keys with the flats are called chromatic, the ones with sharps enharmonic.

If one lists all the tonic keys of Pesenti's chromatic and enharmonic pieces, there are 19. Except C $\flat$ and F $\flat$, all pitches that are either naturals or sharps or flats have been used as tonic, for both a major and a minor key. This set of tonic pitches corresponds with the set of pitches normally present in a 19-note keyboard of the time, that is, with E $\sharp$ and B $\sharp$, but without C $\flat$ and F $\flat$. The question now is whether all of Pesenti's pieces would be playable on Zarlino's keyboard. The elaborate description of the keyboard suggests that they would indeed, but this is too simple an answer. A closer look of Pesenti's pieces tells us, namely, that they can be played on Zarlino's harpsichord if one is willing to retune one or both of the E $\sharp$ and B $\sharp$ keys into F $\flat$ and C $\flat$ when needed. (On Trasuntino's harpsichord they could be played without this retuning.) Some pieces would require a rather far-out key signature (if notated), frequently of more than seven sharps. This is the case for A $\sharp$ major (10 sharps), B $\sharp$ minor (9 sharps), B $\sharp$ major (12 sharps), D $\sharp$ major (9 sharps), E $\sharp$ minor (8 sharps), E $\sharp$ major (11 sharps), and G $\sharp$ major (8 sharps). An example of a diatonic composition turned into a chromatic is given in Appendix 3; the conversion of a diatonic composition into an enharmonic is illustrated in Appendix 4.

There is a missed chance in Pesenti's *Correnti, gagliardi, e balletti*. Having major and minor keys on 19 pitches in the octave results in a set of 38 keys or tonalities, 19 major and 19 minor. Pesenti's six diatonic keys and the 30 chromatic plus enharmonic keys add up to 36 at most, leaving two keys unused. Which keys are missing? In fact, three keys are missing, since one key is present twice: A major, which is to be found among the chromatic and the enharmonic pieces. The placement of an A major piece among the

chromatic pieces seems to be a mistake: it is the only piece there with a scale having sharps and no key signature. All other chromatic pieces have scales with at least two flats and a key signature of two flats. Missing is D major as far as keys with sharps are concerned, and D $\flat$ minor and G $\flat$ minor of the keys with flats. With these keys included Pesenti would have created a complete «well-tempered enharmonic clavier». None the less Pesenti's set is remarkable and it is an important testimony in the history of the enharmonic genus.

Let us return to Zarlino. In the *Sopplimenti musicali*, published in 1588, in Chapter XI of the *Libro quarto*, Zarlino presented another multi-note keyboard.²⁵ It shows an entirely different design and serves an entirely different aim than the 24-note keyboard described in the *Istitutioni* of thirty years earlier. Perhaps the new keyboard should be rather called a chromatic keyboard, since it differs from normal keyboards only in the doubled D key and three split raised keys, the ones between D and E, F and G, and A and B.

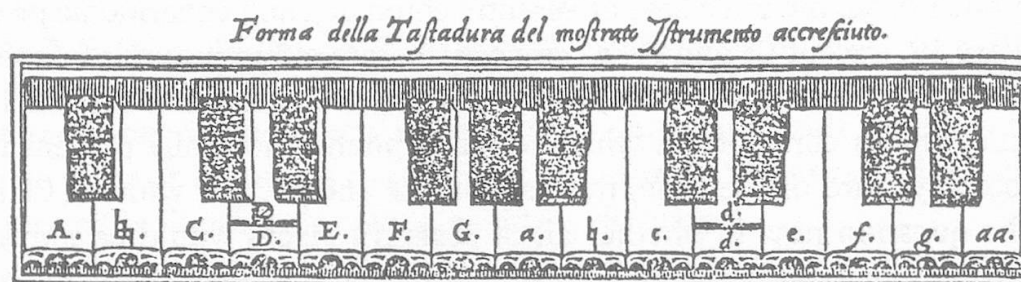


Figure 2. Zarlino's *Istrumento accresciuto*, a multi-note just-intonation keyboard, as depicted in the *Sopplimenti musicali* (Venice 1588), p. 156.

Zarlino himself called it his *Istrumento accresciuto* (increased instrument). A table lists monochord string lengths and from these it is clear the instrument is to be tuned in just intonation, with just or untempered fifth and major thirds.²⁶ This is all in opposition to the tempered tunings described by Zarlino from 1558. An analysis of the figures given by Zarlino for his just intonation keyboard reveals the following scheme of just fifths and major thirds (note names are modern):²⁷

25 Gioseffo Zarlino, *Sopplimenti musicali*, Venice: De' Franceschi 1588, p. 156.

26 Zarlino, *Sopplimenti*, p. 155.

27 Zarlino gives 13834 instead of 13824 for C $\sharp$.

	F# 10368	C# 13824	G# 9216		
	D 12960	A 8640	E 11520	B 7680	F# 10240
Eb 12150	Bb 8100	F 10800	C 14400	G 9600	D 12800
				Eb 12000	Bb 8000

This not a very efficient system of just intonation, but it has several important characteristics. There are just fifths between all of the twelve scale pitches, and there are just major thirds upon all notes except B, F#, C#, and G#. To achieve this a number of notes must be present twice, namely Eb, Bb, D, and F#. But the system is inefficient by the double Eb: nothing is gained by it, while now a true D# is missing. With the design, however, Zarlino introduced a new class of enharmonic keyboards, if we may call them so, namely the class of multi-note just intonation keyboards. They are characterized by the extra keys over the normal keyboard (such as the double Eb, Bb, D, and F#) to provide just consonant intervals, keys to replace other keys, not to form small intervals with them (they do of course, but that is not their purpose). An essential difference with the archicembalo-like instruments is therefore that they have multiple keys that address essentially only one note in the musical scale. This type of keyboard will be met again when the enharmonic keyboards of Mersenne are being discussed.

Francisco Salinas: De musica libri septem (Salamanca 1577)

Early discussions of the archicembalo are relatively rare. It looks as if Vicentino was somewhat frowned upon as a theorist, which is not so difficult to understand in view of the rather eccentric positions he took. Francisco Salinas, in his *De musica libri septem* of 1577 was one of the few who paid attention to Vicentino's archicembalo, although he was clearly opposed to the ideas behind its tuning.²⁸ In Liber III the various genera are discussed, including the enharmonic. Tonal systems are constructed which have up to and including 24 notes per octave (all in just ratios, with many pairs a comma or diesis apart) and tuning with fifths tempered by 1/3, 1/4, or 2/7 of a comma. In Chapter XXVII of Liber III the archicembalo is discussed.²⁹ The chapter is ominously headed 'De prava constitutione cuiusdam instrumenti, quod in Italia citra quadraginta annos fabricari coeptum est, in quo reperitur omnis tonus in quinque partes divisus' (About the wrong constitution

28 Francisco Salinas, *De musica libri septem*, Salamanca: Gastius 1577. Facsimile ed. by Macario Santiago Kastner, Kassel 1958 (= Documenta Musicologica Erste Reihe 13).

29 Salinas, *De musica*, pp. 164–166.

of a certain instrument that was begun to be built in Italy fewer than forty years ago, in which every tone is found divided into five parts). In the first sentence of the chapter it is remarked that the instrument was called *archicymbalum*, but Vicentino is nowhere mentioned. The question also is what is exactly meant by *«fabricari coeptum est»* or *«has begun to be built»*. If this phrase is taken literally, it may mean either that the instrument was unfinished or that the first specimen was built less than forty years before and that later examples were built since. The second alternative seems to be the more plausible of the two, and that would mean that Salinas spoke about the archicembalo as a kind of instrument, not as just one specific example.

Salinas had a rather good idea about what the archicembalo was like. He lucidly described the circular nature of the tuning. Some well-known musicians held the instrument in esteem:³⁰

«Èò quod omnis in eo sonus habet omnia intervalla, atque omnes consonantiae (ut sibi videntur) infernè, & supernè, & post certam periodum ad eundem, aut aequivalentem sibi sonum post 31 intervalla reditur. Si sint dieses in diapason; si semitonia minora, in disdiapason; si majora, in trisdiapason: & sic in tot diapason, quot diesibus intervallum constabit tricies, & semel repetitum.»

Because every note of it has all intervals, and all consonances (as they appear) below and above, and after a certain time every note returns to the same, or to an equivalent one, after 31 intervals. If it concerns dieses, [31 of them make up] the octave; if minor semitones, the double octave; if major semitones, the triple octave, and so will an interval that is repeated 31 times make up so many octaves as it contains dieses.

He nevertheless rejected the idea of having an octave divided in 31 dieses of equal size. He observed that two dieses could never form a minor semitone, neither in just intonation nor in any type of tempered tuning, which is true if no other interval is accepted as a diesis than the one with the ratio 125:128. He remarked that the diesis of the 31-note system was smaller than the diesis of 125:128 (which is true) and also smaller than the corresponding interval in any of the tempered tunings he described. To begin, the interval $C^\sharp-D^\flat$ is exactly 125:128 in meantone temperament, where the fifth is tempered by one fourth of a comma. In the *«Zarlino temperament»* (with the fifths tempered by 2/7 of a comma) the interval $C^\sharp-D^\flat$ equals the diesis of 125:128 plus 3/7 of a syntonic comma (or $41+9=50$ cents), in the *«Salinas temperament»* (with the fifths tempered by one third of comma) the diesis plus a syntonic comma (or $41+22=63$ cents). Systems with fifths tempered less than one quarter of a comma could produce a *«diesis»* smaller than that of 125:128, but Salinas did not consider these. Salinas admitted

30 Salinas, *De musica*, p. 164.

that a whole tone could be divided in five equal intervals by a geometrical division, but such a fifth part of a whole tone was, at least in his eyes, not a diesis.

From his denial of the possibility of the division of an octave in 31 equal parts, Salinas gradually shifted to a comparison of the 31-note equal division with the intervals on a multi-note keyboard of his own. He had already mentioned the instrument earlier in the Liber III of his *De musica*:³¹

«Sed omnium perfectissimum est, quod ego Romae faciendum curavi, et hic habeo Salmanticae, in quo utrumque reperitur instrumentum, tam perfectum, quam id, quo utimur, imperfectum, et alterius alterum potest fieri collatio, et in utroque tria melodiarum genera maxima cura, atque diligentia perfectissime demonstrantur.»

But the most perfect [instrument] of all is the one that I had made in Rome and that I have here in Salamanca. In it both kinds of instruments are found, both the perfect one, and the imperfect one (which is the one used), and one can compare the one with the other, and in both of them the three melodic genera can be demonstrated perfectly and with care and diligence.

The quotation seems to point to some kind of double instrument, one contraption that houses two more or less independent keyboards. That this is indeed the case, becomes clear when the instrument is mentioned again, in the discussion of the relative merits of the 31-note equal division versus just or tempered systems:³²

«Nam in tribus primis ordinibus accomodavi temperamentum instrumenti participati, et in tribus supremis perfecti; sonis C litera signatis fixis manentibus, et ad unisonantiam temperatis, quo ex utriusque collatione possit (ut Ptolemaeus ait) legitimum ab spurium, et imperfectum a perfecto discerni.»

For in the three lower rows I have accommodated the tempered instrument, and in the three upper rows the perfect, while the notes called C remained fixed, and tuned as unisons, so that from their mutual comparison one can (as Ptolemy said) distinguish between the genuine and the false, or between the imperfect and the perfect.

So Salinas's instrument was a kind of *archicembalo*, with the three lowermost rows tuned in some kind of temperament and the three uppermost in just intonation. Both three-row manuals were in a sense complete keyboards by themselves. How many keys per octave had these manuals? Three rows of keys can in principle accommodate 21 keys per octave, but there are reasons to believe that both three-row manuals of Salinas's instrument had 19 keys per octave. When discussing the tuning of the *archicembalo*, Salinas stated

31 Salinas, *De musica*, p. 127.

32 Salinas, *De musica*, p. 166.

that he could not add a fifth above «*Enharmonicum*» (=B $\sharp$), because that note («*inter G molle enharmonicum et G diatonicum*»: between G $\flat$ and G, that is, F $\sharp\sharp$) did not have any consonance. In the other direction his series of fifths stopped at G $\flat$, «*ubi terminatur genus enharmonicum*» (where the enharmonic genus ends). Adding a further fifth, C $\flat$, would have to take place on the fourth row of in instrument, as would F $\flat$, but it would give the same imperfection as the F $\sharp\sharp$. This seems to confirm that Salinas's instrument had two manuals with three rows of keys and 19 keys per octave on each manual, an arrangement that, strikingly, is similar to the layout of the keyboard of Vicentino's archicembalo.³³

Another argument that can be used to support the notion that Salinas adhered to keyboards of not more than 19 keys per octave is the observation that with a tempering of the fifth by one third of a comma, the one seemingly preferred by Salinas, it does not make sense to have more than 19 keys. If one were to expand the row of fifths after B $\sharp$, the next pitch, F $\sharp\sharp$, would be undistinguishable from G $\flat$, C $\sharp\sharp$ from D $\flat$, and so on. On the flats' side, C $\flat$ would be practically equal to B $\sharp$, F $\flat$ to E $\sharp$, and so on. Finally, it may be mentioned that Salinas's enharmonic genus in just intonation has 19 notes per octave if the comma pairs are considered as the same note, something necessary in a tempered system.³⁴

The observation that the double 19-note design is thus common to both Vicentino's and Salinas's keyboards makes one wonder if perhaps one was constructed after the example of the other. The time frames usually adopted for the construction of the instruments overlap completely: Salinas's is said to have been built in Rome between 1538 and 1553, Vicentino's in Rome before 1549, but perhaps already in the decade 1538–1547.³⁵ Perhaps Salinas's instrument was first meant to be a copy of Vicentino's. It was the archicembalo «that was begun to be built fewer than forty years ago». Salinas tried to tune his instrument according to the opinion of the inventor of the archicembalo.³⁶ Doing so he found the disquieting imperfection of the fourth and fifth rows as a consequence of the extension of the row of fifths beyond B $\sharp$ or G $\flat$. Then he changed his mind and tuned the two manuals as two separate keyboards, with the C as common tone. Now just and tempered tuning could be compared as easily as wished. These observations seem to point to a precedence of the 31-note archicembalo.

33 It may be remarked that the C $\flat$ and F $\flat$ are on the fourth row of Vicentino's archicembalo, as B and E raised by a diesis.

34 See Salinas, *De musica*, p. 122.

35 See Wraight, «The *cimbalo cromatico*», in this volume.

36 Salinas, *De musica*, p. 165: «quoties illud iuxta eius autoris positionem temperare volebam.»

Salinas realized that not all instrumentalists could afford having enharmonic keyboards built. He concludes his discussion of the archicembalo with a plea for at least adding D $\sharp$ and A $\flat$ to keyboards that were as usual for the rest, especially in the middle octaves, the ones below and above middle C.³⁷ His arguments for that was not the expansion of the tonal space of the instrument, but the opportunity it gave to transpose the ordinary church modes. With these four extra keys, he said, the first mode can be played from F (with the A $\flat$) or E (with the D $\sharp$), the fourth mode from G, etc.

Fabio Colonna: La sambuca lincea (Naples 1618)

Despite Zarlino's implicit and Salinas's explicit criticisms and despite the complexity of its construction, as a musical instrument the archicembalo, understood as a keyboard with, let us say, at least 24 keys to an octave (to distinguish it from the 19-note design), was some sort of a success. Apart from the ones built for Vicentino and Zarlino, there are the Trasuntino instruments, the ones for Scipione Stella and Fabio Colonna, and several more Italian examples from the first half of the seventeenth century. During the later seventeenth century and the eighteenth century similar instruments were built outside Italy, in the Germanic countries. The Stella and Colonna instruments have been extensively described in a booklet by Fabio Colonna entitled *La sambuca lincea*, published in Naples in 1618.³⁸ In the book Colonna provides drawings of the keyboards of the instrument. Let us see how Colonna defends the design of his instrument:³⁹

«Habbiamo anco detto Istromento Musico perfetto, poiche vi si ritrova la divisione del Tuono in più minute parti del Semituono minore, & differenti dalla divisione de gli altri, dalla quale dipende la cognitione delle Terze maggiori, & minori; non dichiarate, ne tenute per consonanti dagli Antichi, con tutto che da quelle certamente si dimostri la varietà delli tre gen[er]i di Musica, & particolarmente il Chromatico, & Enarmonico altrimenti dolcissimo, & come riferisce Vitruvio, molto grave & di eccellente autorità: che da Moderni Musici è stato stimato incantabile, & però disusato. Il che nel progresso si vedrà essere non meno cantabile del Chromatico, & da quello nella dolcezza, & gravità differire: & questo per beneficio del nostro Istromento, & sua divisione nelli Tuoni, & et parti di quelli.»

37 Salinas, *De musica*, p. 166.

38 Fabio Colonna, *La sambuca lincea, ovvero Dell'istromento musico perfetto Libri III*, Naples: Constantino Vitale, 1618. Facsimile reprint Sala Bolognese 1980 (= Bibliotheca Musica Bononiensis II 152). Facsimile reprint «con annotazioni critiche manoscritte di Scipione Stella (1618–22)» and an introduction by Patrizio Barbieri, Lucca 1991 (= Musurgiana 24).

39 Colonna, *La sambuca lincea*, pp. 2–3.

We have called this a perfect musical instrument too, because you find there the division of the whole tone in smaller parts than the minor semitone, different from the divisions of the other [instruments], from which [division] depends the realization of the major and minor thirds, which the Ancients neither mentioned nor held as consonances, in spite of the fact that they certainly determine the variety of the three musical genera, and in particular the chromatic and the enharmonic, [the last of which is] sweet in a different way, and – as Vitruvius has written – very solemn and most majestic; which [however] Modern Musicians have considered unsingable and is therefore not used. Henceforth it will be seen to be no less singable than the chromatic genus, and not to differ from it in both sweetness and gravity, and that thanks to our instrument, and its division of the tones, and the parts thereof.⁴⁰

Colonna brings together here two elements of different origin: the major and minor thirds that could be constructed on every note of the scale (and that were not yet part of ancient music theory) and the diatonic, chromatic and enharmonic genera (rejected by the contemporary musicians) that are possible on his instruments. Just major and minor thirds were part of contemporary music theory, but not of ancient. The enharmonic genus was part of ancient music theory, but not of contemporary thinking. By combining the two elements Colonna took the best of both worlds.

The construction of the keyboards of Colonna's «Sambuca Lincea» with six rows of keys and of Padre Scipione Stella's harpsichord with eight rows of keys has been discussed in the literature already several times.⁴¹ No further discussion is needed here. It may only be remarked that Stella's design is clearly based on the double 19-note design as used by Vicentino and Salinas. Only the two manuals have each been enlarged by a fourth rank of keys that mostly has keys that are four dieses higher (a distance corresponding to the double sharp in a 31-note environment) than the left-adjacent natural key. Colonna's design is a double 21-note design.

It is interesting, however, to spend a few words on Colonna's use of the enharmonic tetrachord, which deviates in several respects from his predecessors. We have seen above that in sixteenth-century interval theory the

40 This translation has benefited from a prior translation by Riccardo Pergolis (Battaglia Terme, Italy).

41 See for example Lynn Wood Martin, «The Colonna-Stella *Sambuca Lincea*: An enharmonic instrument», in: *Journal of the American Musical Instrument Society* 10 (1984), pp. 5–21; Patrizio Barbieri, «La sambuca lincea di Fabio Colonna e il tricembalo di Scipione Stella: Con notizie sugli strumenti enarmonici del Domenichin», in: *Atti del Convegno Internazionale di Studi Napoli, 11–14 aprile 1985*, ed. by Domenico D'Alessandro & Agostino Ziino, Rome 1987 (= *Miscellanea Musicologia* 2), pp. 167–216; and Barbieri's introduction to the facsimile edition.

division of an interval into two equal parts does not play a role. The means, both conceptual and arithmetical, were lacking for that operation. Intervals were always divided unequally. If an interval was split into two parts, there were therefore always two arrangements of intervals and pitches: one with the smaller interval below and the larger above, and one with the larger interval below, and the smaller above.

Zarlino typically made use of interval divisions that place the larger interval below. The chromatic tetrachord starts from below with the diatonic semitone, followed by the chromatic semitone (and by a minor third). The enharmonic tetrachord starts from below with the diatonic semitone, followed by the diesis (and the major third). Vicentino let his chromatic tetrachord start from below with a diesis. Colonna deviated from this principle by describing two variants for both the chromatic and the enharmonic tetrachord: one with the smaller interval below and the larger above, and one with the larger interval below and the smaller above. Tetrachords of the first type are called *molle* (which we will translate by 'low'), tetrachords of the second type *intenso* ('high'). Colonna also provided numerical values (monochord string lengths) for the pitches of the chromatic and enharmonic tetrachords. The diatonic tetrachord, for example, has the following pitches:

B 2000 - C 1882 $\frac{6}{17}$ - D 1666 $\frac{2}{3}$ - E 1500

Colonna's string-length values are not derived from certain choices for the size of semitones, whole tones, etc., but were determined by his wish to use only string lengths that satisfy a certain arithmetical condition, namely, that the length for the note and that of the remainder of the string formed some kind of consonant ratio between them, an unfounded and in fact dubious principle, which nevertheless provided a set of ratios that sufficed to produce a scale of some 30-odd pitches per octave.⁴² The values for D and E as shown above conform the just-intonation ratios 5:6 and 3:4. The value for C has the ratio of 16:17 if compared with B.

The string lengths and cents values for the first pitches of his scale are, for example:

C	1:1	2000		0 cents
Cx	192:197	$1949 \frac{47}{197} =$	1949.239	45 cents
C#	24:25	1920		71 cents
D $\flat$	16:17	$1882 \frac{6}{17} =$	1882.353	104 cents
D $\natural$	10:11	$1818 \frac{2}{11} =$	1818.182	165 cents
D	8:9	$1777 \frac{7}{9} =$	1777.778	203 cents

42 For an explanation of Colonna's method see Barbieri's introduction to the facsimile, pp. xii-xviii and xxxvii-xliv.

In a perfectly equal 31-note scale the cents vaules would have been 39, 77, 116, 155, and 194 cents. Colonna's choices show deviations up to about 10 cents, in either direction. This is considerable in view of the about 40 cents unit of the system.

Colonna's two chromatic tetrachords are realized on the following ways:

molle: B 2000 - B $\sharp$ 1920 -	C $\sharp$ 1777 7/9 - E 1500
intenso: B 2000 -	C 1882 6/17 - C $\sharp$ 1777 7/9 - E 1500

The two enharmonic tetrachord are described as follows:

molle: B 2000 - Bx 1949 47/197 -	C 1882 6/17 - E 1500
intenso: B 2000 -	B $\sharp$ 1920 - C 1882 6/17 - E 1500

Although Colonna's intervals are not an equal division of the octave in 31 parts, the steps in the sequence B - Bx - B $\sharp$ - C - Cx - C $\sharp$ - Db - D $\flat$ [C $\sharp\sharp$] D and so on are treated virtually as steps of equal size. (Colonna uses the cancellation sign $\flat$ for the lowering of a pitch of a natural by one step.)

At the end of his book Colonna gives examples of short four-part compositions that illustrate the low and high chromatic and enharmonic tetrachords. The well-known composer Ascanio Mayone had provided him with them, without having seen the instrument. The examples illustrating the enharmonic tetrachords are brief four-part settings in score notation. They differ both from Vicentino's and Pesenti's compositions in that the enharmonic tetrachord appears in the melodic lines of the four voices.⁴³ The examples for the enharmonic genus are transcribed in the contribution of Bob van Asperen in this volume.

In addition, there is a somewhat longer *Esempio della circulatione*, a kind of prelude beginning with a G major chord and then proceeding by cadences via C major, F major, B $\flat$ major, and so on through the entire circle of 31 until the final G major cadence is reached.⁴⁴ Although Colonna nowhere mentions let alone describes meantone temperament in any explicit way, the *Esempio* makes it clear that Colonna's tuning and therefore his instrument could be very well used for the generalization of meantone temperament.

43 Mayone's compositions are reproduced in two-staff keyboard notation in Barbieri's introduction to the facsimile, pp. lxii-lxvii. See also the contribution by Bob van Asperen, «Consonant or dissonant? – Reflections at the keyboards of a Clavemusicum Omnitonum, cimbalo cromatico, and cembalo naturale», in this volume.

44 Colonna, *La sambuca lincea*, pp. 103–110. Modern edition by Rudolf Rasch in *Fabio Colonna: Esempio della circulatione, for 31-tone keyboard (1618)*, Utrecht 1985 (= *Corpus Microtonale 3*), and in Barbieri's introduction to the facsimile, pp. lvii-lxii.

Marin Mersenne: Harmonie universelle (Paris 1636)

The universal scholar Marin Mersenne discussed, in his *Harmonie universelle*, keyboards with more than twelve keys per octave both in connection with the organ and the harpsichord. *Proposition V* of the *Livre troisieme des Instrumens à cordes* begins with the remark that:⁴⁵

«Il est certain que l'on peut faire une aussi grande diversité de Claviers, comme il y a de differens Systemes.»

It is certain that one can make as many different keyboards as there are different systems.

Which is certainly true. He then presents a 12-tone keyboard tuned in just intonation that can be analyzed as the following grid of just fifths and just major thirds (note names are ours):

D 3240	A 2160	E 2880	B 1920
B $\flat$ 2025	F 2700	C 3600	G 2400
G $\flat$ 2631 $\frac{1}{4}$	D $\flat$ 3374	A $\flat$ 2250	E $\flat$ 3000

This survey tells us that all the raised keys have been interpreted as just major thirds below a natural, or, in other word, as flats. After this a second keyboard is shown in which the raised keys are interpreted as sharps (except the B $\flat$).⁴⁶ A just-intonation analysis results in the following diagram:

F $\sharp$ 2592	C $\sharp$ 3456	G $\sharp$ 2304	D $\sharp$ 3072
	A 2160	E 2880	B 1920
B $\flat$ 2025	F 2700	C 3600	G 2400
			D 3200

This scheme has, as is easily seen, an irregularity in that the F $\sharp$ (2592) is chosen as a just major third above the D from the first keyboard (3240), whereas in the second keyboard another D has been chosen (3200). The reason for the substitution of the D is not difficult to see: in just intonation it is impossible to have all naturals in one row of just fifths. In the first keyboard there is a 'jump' from G 2400 to D 3240 which is a fifth diminished by a syntonic comma. If a just fifth between G and D is desired, the D must be 3200, but this shifts the comma-diminished fifth to the position D-A. Many just-intonation schemes therefore have a double D. Obviously Mersenne

45 Marin Mersenne, *Harmonie universelle, contenant La théorie et la pratique de la musique*, Paris: Sébastien Cramoisy 1636–1637. Facsimile edition of Mersenne's own copy with introduction by François Lesure, Paris 1975; *Livre troisieme des Instrumens à cordes*, p. 117.

46 Mersenne, *Livre troisieme des Instrumens à cordes*, p. 117.

wanted to use the second keyboard to show the second D. Strangely enough the key between A and B is still a B $\flat$ with string length 2025, which would be a just major third with the missing D 3240. The two keyboards both have twelve keys; five of them have different pitches. Mersenne would not have been himself without combining the two keyboards into one, which has, however, only sixteen keys.⁴⁷ There is only one D, that of the first keyboard.

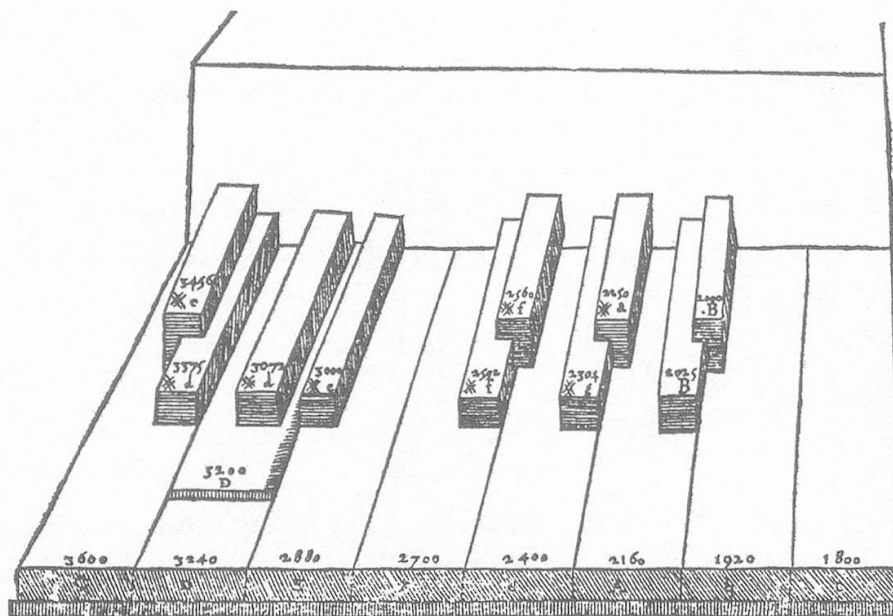


Figure 3. Marin Mersenne's «Clavier Harmonique, Parfait de 19 marches sur l'Octave, commençant par C sol ut» (Harmonic keyboard, perfect, in 18 steps in the octave, beginning with C) in his *Harmonie universelle* (Paris 1636), Livre sixiesme des Orgues, p. 352. Mersenne included the concluding octave key in his count, so that the picture actually shows an 18-note keyboard.

Mersenne resumes the discussion of keyboards with more than twelve keys in *Proposition XXII* of the *Livre sixiesme des Orgues*.⁴⁸ If we are to believe the caption of this proposition, these multi-note keyboards help us «understand the perfection of the diatonic, chromatic and enharmonic genera». First the three keyboards discussed for the harpsichord are repeated, the first two in reversed order, but now Mersenne expanded the keyboard slightly by omitting the G $\flat$ of the system and adding comma-lowered D, F $\sharp$, and B $\flat$. The result is a keyboard with 18 pitches per octave, to be arranged in the following grid of just fifths and major thirds (see Figure 3):

⁴⁷ Mersenne, *Livre troisieme des Instrumens à cordes*, p. 118.

⁴⁸ Mersenne, *Livre sixiesme des Orgues*, p. 349.

F# 2592	C# 3456	G# 2304	D# 3072	
D 3240	A 2160	E 2880	B 1920	F# 2560
Bb 2025	F 2700	C 3600	G 2400	D 3200
	Db 3375	Ab 2250	Eb 3000	Bb 2000

The design resembles that of Zarlino's just intonation keyboard, but is more regular and therefore more efficient. With only two notes more than Zarlino's sixteen it has a row of fourteen just fifths. Thirteen notes have just major thirds above them. Mersenne defends this design with the following words:⁴⁹

«C'est pourquoy je veux adjouster un Clavier avec les marches nécessaires pour faire toutes les consonances dans leur justesse, car encore que les dix-neuf marches de son octave soient, ce semble, plus difficiles à toucher que les treize des autres Claviers, néantmoins la perfection de l'harmonie, et la facilité qu'il y a à accorder les Orgues qui usent de ce quatriesme Clavier, recompense abondamment la difficulté du toucher, que les Organistes pourront surmonter dans l'espace de huit jours, ou dans for peu de temps.»

This is why I want to add a keyboard with the keys needed to produce all the consonances in their justness, for, although eighteen⁵⁰ keys per octave seemingly are more difficult to play on than the twelve of other keyboards, none the less the perfection of the harmony and the ease with wich organs can be tuned that use this fourth keyboard abundantly compensate the difficulty in playing, which the organist can overcome in a week or in a very short time.

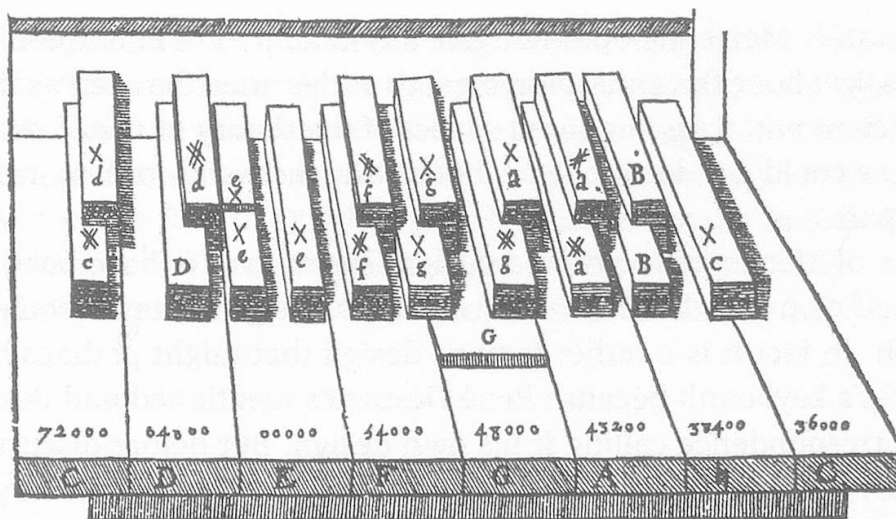


Figure 4. Mersenne's «Clavier parfait de vingt-sept marches sur l'Octave» (Perfect keyboard with 27 steps in the octave) as depicted in the *Harmonie universelle* (Paris 1636), Livre sixiesme des Orgues, p. 356. In the present article this is called a 26-note keyboard.

49 Mersenne, *Livre sixiesme des Orgues*, pp. 351–352.

50 Mersenne writes «dix-neuf» (19) here, but he always includes the completing octave note in the count of how many keys there are in an octave.

Mersenne did not stop at the 18 keys per octave. In the next proposition (Proposition XXIII) the keyboard design is extended first to 26 and eventually to 31 keys per octave.⁵¹ The following motivation is given for the developments of the 26-tone keyboard (see Figure 4):⁵²

«Quant à l'utilité que l'on peut tirer de ce Clavier, elle est fort grande, car il fait voir très-exactement les intervalles des trois genres de Musique, & donne une plus grande lumière à l'harmonie, que tout ce que les Grecs & le Latin en ont escrit: de sorte que si l'on enseigne la Musique, ils pourront comprendre les plus subtiles raisons de toutes sortes de compositions, & de concerts dans fort peu de temps, & chanter des airs Enharmoniques aussi aysément que les Chromatiques & les Diatoniques. Je laisse plusieurs autres utilitez dont se pourront adviser les Organistes, s'ils usent de ce Clavier, sur lequel ils feront quantité de beaux passages & de gentillesses, qu'il ne peuvent trouver sur les Claviers ordinaires.»

Regarding the use one may have of this keyboard: this is quite ample, for it shows exactly the intervals of the three musical genera, and illuminates better the harmony than everything that the Greek and Latin authors have written about it, so that, if one is teaching music, they [the pupils] will be able to understand all the subtle proportions of all sorts of compositions and ensemble pieces in a very short time, and sing enharmonic airs as easily as chromatic and diatonic. I pass over several other uses that the organist will be able to think of, if they use this keyboard, on which they will produce many fine and gracious passages that they cannot find on the ordinary keyboards.

Unfortunately Mersenne does not give any examples of enharmonic music. His remarks about the enharmonic genus rather must be seen as lipservice to an ancient and time-honoured aspect of the theory of music. As a music theorist he could not do without it, but clearly there was for him no practical counterpart.

None of Mersenne's keyboard designs seems ever to have been realized by himself or on his behalf, but the 18-note design deserves some further attention. In fact it is a rather famous design that might perhaps be called 'Descartes's keyboard' because René Descartes mentioned and described it in his correspondence calling it his own design. But before discussing that letter we must pay attention to a practical realization of it (which preceded the letter) on a harpsichord made on the order of Joan Albert Ban, a Catholic priest and amateur musician living in Haarlem (Netherlands). Ban had constructed a theory of musical rhetoric in which every minute detail of the text had to be expressed in the music.⁵³ He conveyed his theories to friends like

51 Mersenne, *Livre sixiesme des Orgues*, Proposition XXIII, pp. 353–358.

52 Mersenne, *Livre sixiesme des Orgues*, p. 357.

53 Daniel Pickering Walker, «Joan Albert Ban and Mersenne's Musical Competition of 1640», in: *Music and Letters* 57 (1976), pp. 233–255.

Constantijn Huygens in The Hague, René Descartes who was at that time living in various places in Holland, and later in correspondence with Marin Mersenne in Paris. Because Ban's theories were far too extreme to be practical, he usually met with responses ranging from reluctance to rejection, but his dealing with music left behind a few interesting experiments. In order to express the musical rhetoric rightly, a strict just tuning was required. For Ban all the intervals had specific affective bearings, but only when they were exactly in tune. In a letter written to Constantijn Huygens on 18 August 1636 he wrote:⁵⁴

«Gradus sonituum sunt semitonia, ac toni. Blandimentum omne in apotome, semitono majori, est. Ferocitas seu animositas in diesi seu semitono minori. Utrumque κατ'ἐξοχὴν chromatico ac diatonico modulamine. Tonus major durior, minor tonus mitior est. Hinc intervalla sonituum nascuntur. Ditonus, ob binos tonos, est durus ac incitativus. Semiditonus seu tertia minor, ob adjunctum tono semitonium, lenis. Quarta omnino dura ac tetrica, aspera, mordax est.»

The steps of the sounds are semitones and whole tones. All sweetness is in the apotome or major semitone. There is ferocity and animosity in the diesis or minor semitone. Both are essential in chromatic and diatonic composition. The major whole tone is harder, the minor whole tone softer. From this the [larger] intervals between notes arise. The major third is stern and inciting, because of the two whole tones. The minor third is flexible, because of the semitone added to the whole tone. The fourth is quite hard and harsh, and rough and biting.

Descartes suggested to Ban to have a harpsichord constructed with a multi-note keyboard representing all the desired pitches and intervals in just intonation. Ban acted in accordance with Descartes's suggestion and had an 18-note just-intonation built in 1639.⁵⁵ It is described and depicted in a brief treatise written by Ban in Dutch and published in Amsterdam in 1643 as *Kort sangh-bericht*.⁵⁶ The description makes it clear that Ban's keyboard had the same design and tuning as Mersenne's 18-note keyboard (see Figure 5).

54 Letter in Leiden, University Library, Codex Huygenianus 37.

55 See Ban's letter to Constantijn Huygens of 16 October 1639, partly edited in Willem Jozef Andreas Jonckbloet & Jan Pieter Nicolaas Land, *Musique et musiciens au XVII^e siècle: Correspondance et oeuvre musicales de Constantin Huygens*, Leiden 1882 (= Maatschappij tot bevordering der Toonkunst, Uitgave 11), pp. lxxvii-lxxviii; and Cornelis de Waard (ed.), *Correspondance de P. Marin Mersenne, religieux minime VIII*, Paris 1963, pp. 536–538.

56 Joan Albert Ban, *Kort sangh-bericht*, Amsterdam: Lodewijk Elsevier 1643. Reproduced in facsimile in Joan Albert Ban, *Zangh-Bloemzel (theoretical part) & Kort sangh-bericht*, with an introduction by Frits Noske, Amsterdam 1969 (= Early Music Theory in the Low Countries 1).

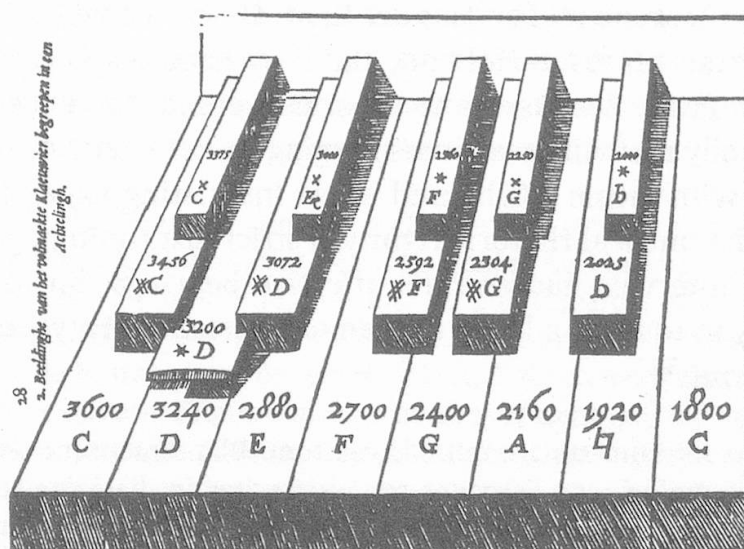


Figure 5. Joan Albert Ban's 18-note keyboard as depicted in his *Kort sangh-bericht* (Amsterdam 1643), p. 28.

Ban not only had a just-intonation keyboard built, he also composed music using the specific just-intonation pitches, a volume with three part settings for soprano, tenor, and bass (and figured bass) of Dutch poetic texts. The music was printed as *Zangh-bloemzel* in 1642, before the treatise; unfortunately only the alto and bass voices have survived.⁵⁷ A few fragments of the soprano part can be found in the *Kort sangh-bericht*. If the three-part setting of these fragments is reconstructed, it appears that the vertical sonorities are kept just but the melodic intervals within the voices repeatedly are a comma too large or too small.⁵⁸ That means that in *composing* the music the specific tuning scheme of the instrument was not observed. Afterwards a number of B $\flat$ s, Ds, and F $\sharp$ s were changed to provide just chords. Actually, the procedure could not repair the occasional situations where a single B $\flat$, D, or F $\sharp$ had to sound successively against notes that required a different intonation of the respective B $\flat$, D, or F $\sharp$.

Descartes wrote about his keyboard design in a letter, of which it has been unknown for a long time to whom it was addressed or when it was written. The original letter, probably written in Latin, has not survived. The text of the

57 Joan Albert Ban, *Zangh-bloemzel*, Amsterdam: Lodewijk Elsevier, 1642. The lengthy theoretical introduction is included in the facsimile edition mentioned in the previous note. Ban's correspondence with Constantijn Huygens makes clear that the *Zangh-bloemzel* was not disseminated before the spring of 1643; the *Kort sangh-bericht* may have not been issued before Ban's death on 27 July 1644.

58 See Rudolf Rasch, «Ban's Intonation», in: *Tijdschrift van de Vereniging voor Nederlandse Muziekgeschiedenis* 33 (1983), pp. 75–99.

letter is known through the French translation that Claude Clerselier published in 1667 in the third volume of his edition of the letters of Descartes.⁵⁹ Clerselier provided neither an addressee nor a date. The editor of the later *Œuvres* by Descartes, Charles Adam, considered Constantijn Huygens as the addressee of the letter and 1646 as the year of writing.⁶⁰ But the letter does not fit into the exchange of letters between Huygens and Descartes of that year. It was Cornelis de Waard who showed that the letter was written to Andreas Colvius, a Dutch-reformed minister in the city of Dordrecht in Holland, and it had to be dated 6 July 1643.⁶¹ De Waard had found a transcription by Colvius that overlapped the letter as edited by Clerselier.⁶² It seems as if Colvius had transcribed just the technical information in the letter, and that Clerselier translated just those sections that he deemed interesting for a general readership. Both versions, Colvius's and Clerselier's, are included with English translations in Appendix 5.

Colvius's extract begins by describing the diatonic, chromatic, and enharmonic tetrachords. Descartes shows his independence from traditional music theory by defining the chromatic and enharmonic tetrachords with the smaller intervals as adjacent to the *upper* note of the tetrachord, not the lower note as was usual before him. So his chromatic tetrachords are D-F-F[#]-A and E-G-G[#]-A, the enharmonic tetrachord is given as C-E-E[#]-F. The diesis of 125:128 is given as the typical interval for the enharmonic tetrachord. There is, however, barely any relation between the theory of the tetrachord and the design of his keyboard. The latter was, in his view, restricted to the diatonic and chromatic genera and made use of major and minor whole tones, major and minor semitones, the enharmonic diesis [=125:128] and the comma [=80:81]. These intervals are indeed the ones found between adjacent keys, either naturals or raised keys. No arrangements of notes in tetrachord structures are provided.

Clerselier's edition included a sketch of the keyboard, while Colvius's extract contains a listing of the string lengths for the various notes. Both the drawing and the listing correspond to the depictions of the 18-note just-intonation keyboard as given by Mersenne (Figure 3) and Ban (Figure 5). There is no doubt that the three men (Mersenne, Ban, Descartes) discussed

59 Claude Clerselier, *Lettres de Mr Descartes*, Paris: Charles Angot 1667, pp. 587–588 (no. 104).

60 Charles Adam & Paul Tannery (eds.), *Oeuvres de Descartes IV: Correspondance IV*, Paris 1901, pp. 678–679 (no. 476bis).

61 Cornelis de Waard, «Sur le destinataire et la date à attribuer à une lettre de Descartes sur une épinette parfaite», in: *Revue d'Histoire des Science* 3 (1950), pp. 251–255.

62 Colvius's transcription is in Leiden, University Library, Codex Latinus 284 (Adversaria Andreae Colvii), fols. 76v–77v.

the same design. In both versions of Descartes's letter it is explained which key to choose in order to make sure that the resulting sonority would conform to a just-intonation ratio. The lower D had to be used in combination with F or A, the higher D with G or B $\flat$, the C $\sharp$ with A or E, the D $\flat$ with F, etc.

The method of designating keys requires some explanation. Capital letters denote naturals, in the sequence C, D, D $\cdot$, E, F, G, A, $\natural$. Raised keys are designated by lower-case letters c, d, f, g, and b (or $\flat$) for the keys right of C, D, F, G, and A respectively. The raised keys always occur in pairs; the higher one is identified by the addition of a dot. For the pairs f-f $\cdot$ (F $\sharp$) and b-b $\cdot$ (B $\flat$) the difference between the two notes is a comma, for the pairs c-c $\cdot$, d-d $\cdot$, and g-g $\cdot$ it is a diesis, so that c = c $\sharp$, c $\cdot$ = D $\flat$, d = D $\sharp$, d $\cdot$ = E $\flat$, g = G $\sharp$, and g $\cdot$ = A $\flat$.

Colvius's transcription is concluded with a rather unusual suggestion how to tune the lute, namely by just major thirds. Since three just major thirds together are short of an octave by one diesis, the third major third has to be enlarged by a diesis. The proposal, however, makes sense if the pitches of the keyboard are to be transferred to the lute since by following it the comma pairs would be on the same positions on the various strings. Tuning the strings with major thirds would mean to have them as B $\flat$ -D-F $\sharp$. It is to be doubted, however, if this was ever tried on a lute.

The lesson to learn from the discussion of these multi-note just-intonation keyboard designs is that music theory and musical practice clearly began to diverge here. Just intonation was the basis of contemporary interval theory (which it had been since the sixteenth century and would remain until well into the eighteenth), but it could not be put into practice. A just diatonic scale can only be constructed if one accepts either at least one clearly imperfect fifth or a double realization of, for example, the D. Both options were untenable for musical practice. Mersenne, Ban, and Descartes worked out the second option for their keyboards, which they successively connected with the concept of the enharmonic genus, but essentially to no avail.

Michael Bulyowsky: Neu-erfundenes vollkommenes fünff-faches Clavier (Stuttgart 1699)

The Slovak nobleman Michael Bulyowsky (c1650–1713) is perhaps the least known of the various theorists and authors discussed in this article. He left his native country as a youth and spent the rest of his life in the South Western part of the German area, in places like Strasbourg, Durlach (now part of Karlsruhe), Oehringen, Pforzheim, and Stuttgart. He left three notable traces in the history in music. In 1675 he started the compilation of a manuscript that eventually contained the largest number of keyboard suites of Johann Jacob Froberger ever found in a single source; the same manuscript

also includes a suite for harpsichord of his own composition.⁶³ The second feat is that he published in 1681 a brief treatise defending the use of keyboards with 19 notes per octave for the organ.⁶⁴ And the third is that he designed and had constructed a harpsichord with 31 notes per octave. The instrument is described in several publications, all of them rather short. The first of these is a pamphlet published in Stuttgart in 1699 under the title *Neu-erfundenes vollkommenes fünff-faches Clavier* (Newly invented perfect fivefold keyboard).⁶⁵ It describes a harpsichord with a keyboard including five rows of keys, one row of ordinary lower keys and four rows of raised keys the one behind the other and all together between every adjacent pair of the lower keys. Already from the title it is clear that it is a keyboard with 31 pitches per octave, which have to be tuned to a regularly ascending series of pitches. (Bulyowsky speaks of 32 pitches per octave, by including the completing octave pitch in the count.) Two steps in such a series constitute a chromatic semitone, three a diatonic semitone. The size of the step is called a *comma* but nowhere exact sizes of the intervals as ratios or string lengths are provided. But for a 31-note keyboard with equal division there is no other choice than a very close approximation of meantone tuning when expanded beyond the 12-note range as far as possible.

Browsing through his pamphlet, Bulyowsky's goal for building this instrument becomes immediately clear. It is meant to make it possible to play all sharps and flats, and all double sharps and double flats without having to resort to wolf intervals. In a generalized meantone tuning only the major thirds are just consonant intervals, but it is certainly true that in a 31-note keyboard all intervals sound indiscernably close to their correct meantone size. To illustrate his point, Bulyowsky presents two musical compositions, apparently scored for two violins and figured bass. The first one is in F minor and illustrates the ample use of flats that is possible with the

63 Now Dresden, Sächsische Landesbibliothek, Ms. 1-T-595. See Rudolf Rasch & Pieter Dirksen, «Eine neue Quelle zu Johann Jacob Frobergers Claviersuiten: Michael Bulywoskys Handschrift», in: *Musik in Baden-Württemberg* 8 (2001), pp. 133–153. Complete modern edition by Rudolf Rasch in: *Vingt en une suites pour le clavecin de Johann Jacob Froberger et d'autres auteurs*, Stuttgart 2000 (= Convivium Musicum 5).

64 Michael Bulyowsky, *Brevis de emendatione organi musici tractatio – Kurtze Vorstellung von Verbesserung des Orgelwercks*, Straßburg: Johann Eberhard Zetzner 1680.

65 Michael Bulyowsky, *Neu-erfundenes fünff-faches Clavier, bestehend aus fünff Reyhen der Palmulen, und so genandten Clavium, dessen eine gantze Octav XXXII. Commata begreiff, so alle in geometrischer continuen und ungetrennten Progression aufeinander gehen*, Stuttgart: Paul Treu, 1699. See also Barbieri, «I temperamenti», pp. 185–189.

new keyboard, the second one is in E major, to illustrate the use of sharps. Appendix 6 transcribes the two pieces into modern notation.⁶⁶

In the final section of his 1699 pamphlet Bulyowsky discusses the defects of ordinary keyboards, certainly having in mind harpsichords tuned in meantone temperament. These defects, presented against the background of the perfection of his instrument, are the main topic in two pamphlets that appeared in 1711 in Durlach entitled *Fünffaches vollständiges Transponier-Clavier, in einigen seinen Tugenden vorgestellt* and *Tastatura quinqueformis panarmonico-metathetica, suis quibusdam virtutibus adumbrata* respectively.⁶⁷ In fact, these two pamphlets are translations of one another. The texts consist of little more than the explanation of seven defects of the ordinary keyboards followed by no fewer than eighteen advantages of his own 31-note keyboard. In general, the defects and advantages are rightly described, but it must be remarked that many of them are nothing else than saying the same thing again in a different way or viewed from a different angle. The defects of the ordinary, 12-note meantone keyboards may be summarized as follows:

1. On many keys no chromatic or diatonic semitones, whole tones, major or minor thirds, and so on, are available.
2. There are many wolf intervals.
3. No circulation of keys through a circle of fifths is possible.
4. The intervals cannot be tuned equally.
5. On the raised keys one cannot play a theme without wolf intervals.
6. One cannot start a piece on an arbitrary degree.
7. The calculation of the intervals is entirely wrong, except for the just octave.

Bulyowsky needed no fewer than eighteen virtues to praise his own instrument:

1. There is a single progression of commas through the keyboard.
2. The 'fivefold transposing keyboard' can be used on all occasions.
3. There are no wolves in the keyboard.
4. A theme can be presented through all keys.
5. Music can be transposed with every interval.
6. It is easy to learn to play on the transposing keyboard.
7. The usual interval nomenclature can be used for it.
8. The usual notation (with single and double sharps and flats) can be used.
9. The usual bass figuring can be used.

66 Earlier transcriptions are to be found in Barbieri, «I temperamenti», pp. 188–189.

67 Both printed and published in Durlach by Theodorus Hecht, 1711.

10. The usual interval definitions can be used.
11. It is easy to tune the instrument.
12. The calculation of interval sizes is easy.
13. All theorists so far have failed to recognize the simplicity of the design.
14. With help of monochord string lengths one can calculate the lengths of organ pipes.
15. Whoever can play on an ordinary keyboard, can also play on the 31-note keyboard.
16. The 31-note keyboard is the only one with a full progression of pitches.
17. Keyboards with less than 31 notes are incomplete and imperfect.
18. Keyboards with 31 notes but not in equal progression are imperfect as well.

Most modern performers and scholars will agree with the advantages of a 31-note keyboard as far as it is an expansion of a meantone keyboard: there are no wolves and one can transpose without limit. But unfortunately the disadvantages when it comes to building such instruments or playing on it outweigh by far the advantages and can be seen as prohibitive. In the eighteenth century ordinary twelve-note equal temperament became more and more common because it equally had no wolves and allowed unlimited transposition. The just major third was easily sacrificed.

In closing this section about Bulyowsky's 31-note harpsichord it must be mentioned that the instrument inspired a later composer, Friedrich Suppig, to write a piece for it. It is titled «Appendix» since in its sole source it concludes a large keyboard piece entitled *Fantasia* and progressing through all 24 major and minor keys. That source is a dedication manuscript dated 24 June 1722 and offered to the government of the city of Dresden.⁶⁸ The author seems to have been an amateur musician; nothing more is known about him that that he was bookkeeper at a mirror factory in Costebrau (near Klettwitz) and that he was the father of the later famous theatre actor Sebastian Friedrich Suppig (who died in 1750).⁶⁹ The «Appendix» is a kind of prelude that explores a number of chord sequences that make use in a clever way of the

68 Now Paris, Bibliothèque du Conservatoire, Ms. Rés. F 211. See the facsimile edition Friedrich Suppig, *Labyrinthus musicus – Calculus musicus – Facsimile of the manuscripts Paris, Bibliothèque du Conservatoire, Rés. F 211–212 (Dated Dresden, 24 June 1722)*, edited by Rudolf Rasch, Utrecht 1990 (= Tuning and Temperament Library 3). See also Rudolf A. Rasch, «The musical circle: From Alfonso to Beethoven, (I-II)», in: *Tijdschrift voor Muziektheorie* 2 (1997), pp. 1–17 and 110–133, pp. 111–114.

69 See the introduction to the facsimile edition of Suppig's *Labyrinthus musicus*.

circulating possibilities of the 31-note keyboard. Musically, it is, however, of little value. As far as we know Suppig knew of Bulyowsky's instrument through the latter's publications and has never had the possibility to play on it.

Conclusion

Reading the preceding sections will have made several things clear. First of all, the design of enharmonic keyboards has always been closely connected with the theory of music, more than with musical practice. The various designs have given rise to lengthy discussions in writing by their inventors (and in modern literature), but to very few musical compositions. The musical compositions that can be connected with enharmonic keyboard design, such as Vicentino's enharmonic madrigals, Mayone's examples for Colonna's instruments, Pesenti's dances, Ban's three-part Dutch songs, and the compositions for Bulyowsky's keyboard, are very diverse in nature and have never become the prototypes of ensuing traditions. All of them have remained isolated examples, experiments with little follow-up, if any. The inventors' first examples were seldom followed by further attempts by other composers. Even theorists rarely developed a scheme presented by a precursor. In general every proposal for an enharmonic keyboard instrument was a singular proposal, with a theoretical framework of its own. Only Pesenti's use of Zarlino's design, Ban's and Descartes's uses of Mersenne's 18-note design (if it was not invented by Descartes), and Suppig's composition for Bulyowsky's instrument show that sometimes theorists or composers did follow the leads of their predecessors.

One thing that occurs again and again in all discussions of enharmonic keyboard design, at least through the first century of it, from about the middle of the sixteenth century until the middle of the seventeenth, is the *enharmonic tetrachord*. The weight of ancient music theory pressed hard on the minds of the sixteenth-century music theorist, and the latter would do his utmost best to incorporate as many elements of ancient music theory as possible into their own contemporary concepts. At first sight the enharmonic tetrachord seems to resist inclusion in sixteenth-century music theory, but on a closer look the enharmonic tetrachord is not such an alien element at all. For the sixteenth-century music theorist, the diatonic tetrachord of Greek music theory could be easily recognized in the system of natural notes (including the B^b) as codified in the hexachord system. Sixteenth-century polyphony contains many C[#]s, F[#]s, and G[#]s as leading notes to the finals D, G, and A. Together with the E^b, all these notes figured on the standard keyboard of the time, probably already tuned in meantone tuning. The stand-

ard keyboard included many chromatic tetrachords, such as B-C-C[♯]-E, D-E[♭]-E-G, E-F-F[♯]-A, and so on. This all made the Greek chromatic tetrachord an easy part of sixteenth-century music theory.

The enharmonic tetrachord comes into the play when and where one needed an extra raised key between two naturals, for example a flat, where the regular key would produce the sharp. This process is nicely formulated by Francisco Salinas. At the end of his discussion of the enharmonic notes, he remarks that there are pieces that require three flats, while the ordinary keyboard only provides two (B[♭], E[♭]).⁷⁰ The third flat required would be the A[♭]. To create this pitch (and a key for it), one has to divide the diatonic semitone from G[♯] to A into two parts, one part (A[♭]-A) being a chromatic semitone, or chromatic diesis as Salinas calls it, the other part an enharmonic diesis (G[♯]-A[♭]). This action creates the enharmonic tetrachord G[♯]-A[♭]-A-C[♯]. Splitting other raised keys adds more enharmonic pitches and enharmonic tetrachords to the keyboard. The splitting created two smaller intervals that were unequal in size, even rather unequal in size. In Greek music theory the small intervals of the enharmonic keyboard may also be of unequal size, but the procedures adopted in the sixteenth century are not to be found there.

At this stage the sixteenth-century theorist must have realized that there was a strange parallelism between these enharmonic intervals and the intervals of meantone tuning. Music theory preferably worked with intervals tuning according to just intonation, and this led to a major third of 4:5 (386 cents), a minor third of 5:6 (316 cents), a whole tone in two sizes (a major one of 8:9 or cents 204 cents, a minor of 9:10 or 182 cents), a diatonic semitone of 15:16 (112 cents) and a chromatic semitone of 24:25 (71 cents). The diesis, the interval that was the result of the enharmonic division, equals 125:128 (or 41 cents).

Meantone tuning is based on the just major third of 4:5 (386 cents). That makes the whole tone (the true «mean tone», the geometric mean between the major and minor whole tones) equal to 193 cents, the diatonic semitone equal to 117 cents, and the chromatic semitone equal to 76 cents. It is easily seen that especially the semitones differ very little in size from those of just intonation. Meantone tuning has, exactly as just intonation, a diesis with the ratio 125:128 (41 cents) as the interval between, for example, C[♯] and D[♭]. Although it is nowhere formulated explicitly, it cannot have escaped the sixteenth-century theorist that many intervals of meantone tuning corresponded relatively closely to those of just intonation, not only regarding the major third – which was just – but also regarding the smaller intervals, especially the diatonic and chromatic semitones and the diesis.

70 Salinas, *De musica*, pp. 126–127.

One further coincidence helped the sixteenth-century theorist. The diesis, the chromatic semitone, and the diatonic have sizes that can roughly be compared to one another as 1 (diesis, 41 cents) to 2 (chromatic semitone, 71 cents) to 3 (diatonic semitone, 112 cents), if the unit is defined as something just below 40 cents. These proportions made it possible to incorporate these intervals and all larger intervals (which were nothing but sums of these smaller intervals) into one system with, as the smallest unit, a not-exactly-defined diesis having a size somewhat less than 40 cents. At least, this is what Vicentino did. The approximative character of this approach could be hidden by the clever abstinence from all figures and from all calculation or further arithmetic or mathematics. His approach is 'informal' as far as strict interval size is concerned. The price he had to pay was that it had become impossible to speak about just ratios because that would involve the introduction of figures, ratios, and so on. Salinas was not willing to sacrifice his arithmetical foundations and could therefore give no place to the 31-note equal division.

The success of meantone tuning on simple 12-note keyboards was thus readily extended to its expansion in the domain of the equal divisions, thanks to the possibility of incorporating the enharmonic tetrachord in it. That meant that the 31-note archicembalo could develop into some kind of standard design. In order to play diatonic music in the sixteenth and early seventeenth centuries, a 12-note keyboard in meantone tuning sufficed, with the raised keys tuned to C#, Eb, F#, G#, and Bb. For chromatic music an extension of the keyboard with a number of raised keys split into two would be helpful.⁷¹ Diatonic music could, of course, also be played on these instruments. For enharmonic music keyboards were required with at least 19 keys per octave; optimal would be a keyboard with a 31-note octave, in other words, a true archicembalo. Such an instrument was:

«Modulis diatonicis, cromaticis, et enarmonicis a docta manu tactum»
for playing diatonic, chromatic, and enharmonic music, by a learned hand,

as the nameboard of Trasuntino's *Clavemusicum omnitonum* of 1606 proudly tells us. Unfortunately, enharmonic repertoire is so extremely scarce. Note the use of the word 'doctus' (learned) that reminds us of the quotation from Alciatus that Zarlino appended to the picture of his enharmonic harpsichord and that was reproduced in the introduction of this article.

71 See Christopher Stemberge, «Music for the *Cimbalo Cromatico* and Other Split-Keyed Instruments in Seventeenth-Century Italy», in: *Performance Practice Review* 5/1 (1992), pp. 5–43.

In fact, the 31-note archicembalo would outlive the enharmonic tetrachord. In the discussions of their just-intonation keyboards by Mersenne, Ban, and Descartes the enharmonic tetrachord is still mentioned from time to time, to add authority to their arguments. But it does not serve a real purpose any more. In their just-intonation structures there are no repeating tetrachords. The development of just-intonation keyboards seems to have stopped after the middle of the seventeenth century and with it the connection between the enharmonic tetrachord and enharmonic keyboard design. Not so the 31-note keyboard design.

Even if the building of archicembali in Italy stopped largely after the middle of the seventeenth century, several comparable instruments were built on the other side of the Alps.⁷² Especially through Christiaan Huygens's work the relation between meantone tuning and 31-note equal tuning received a sound theoretical foundation.⁷³ Bulyowsky's *Transponir-Clavir* was built in Stuttgart by the end of the seventeenth century, a pianoforte with six rows of seven keys in 31-note tuning about a century later.⁷⁴ These instruments served the generalization of meantone tuning, without the burden of the enharmonic tetrachord.

72 Fritz Zobeley, *Rudolf Franz Erwein Graf von Schönborn (1677–1754) und seine Musikpflege*, Würzburg 1949 (= Neujahrsblätter der Gesellschaft für Fränkische Geschichte 21), p. 25, relates that at some point around 1700 Elector Palatine Johann Wilhelm, residing in Düsseldorf, donated three 31-note keyboards to the Emperor, to the Grand Duke of Toscana, and to *Musikdirektor* Fekler respectively. I have this information from Martin Kirnbauer (Basel).

73 See Christiaan Huygens, «Lettre touchant le cycle harmonique», in: *Histoire des Ouvrages des Sçavans* (October 1691), pp. 78–88. Reproduction in facsimile with introduction as *Le cycle harmonique* (Rotterdam 1691), *Novus cyclus harmonicus* (Leiden 1724), edited by Rudolf Rasch, Utrecht 1986 (= Tuning and Temperament Library 6). Huygens's ideas about the relation between meantone tuning and the 31-note equal division had already been worked out in manuscript thirty years before, in 1661.

74 See Martin Vogel, *Die Lehre von den Tonbeziehungen*, Bonn 1975 (= Orpheus-Schriftenreihe zu Grundfragen der Musik 16), pp. 304–308.

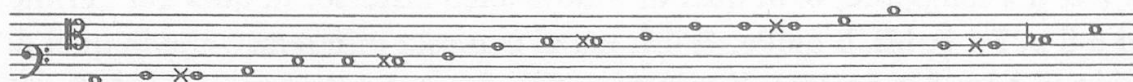
Appendix 2

The preface of Martino Pesenti's *Correnti, gagliarde, e balletti diatonici, trasportati parte cromatici, e parte henarmonici ... Libro quarto, Opera decima-quinta* (Venice 1645). The text has been previously edited in G. Gaspari [and others], *Catalogo della biblioteca del Liceo Musicale di Bologna*, Volume IV, Bologna 1905, pp. 136–137; Claudio Sartori, *Bibliografia della musica strumentale italiana stampata in Italia fino al 1700*, Florence 1952, pp. 392–393, and (partly, until the Zarlino quotation, but with English translation) in Stemberge, «The cimbalo cromatico», pp. 47–49. For better readability the text has been slightly edited here, as regards punctuation, use of capitals, accents, and u/v spelling.

«A professori di musica, per maggior intelligenza.

Si ritrovava l'anno 1621 appresso l'Illustrissimo Sig. Nicolò de Rossi all'hora Residente di sua Maestà Cesarea in Venetia un Clavicembalo di mano di Vido Trasentino [sic] fabricato l'anno 1601, il quale era Diatonico, Cromatico, & Henarmonico, e perchè con occasione d'haver io servitù con quell'Illustrissimo Sig. mi comandò à dover tasteggiare detto Clavicembalo, se bene fosse mal acconcio, per non haver mai potuto trovare (doppo la morte dell'Autore) chi gli[e] lo cordasse; mi risolsi, eccittato da sommo desiderio di servire un tanto mio Padrone, di accordarlo, se bene fuori di mia professione, e nell'oprar ritrovai, che dall'A, La, mi, re, ascendendo sino al G, Sol, re, ut era ogni corda col B molle, & il #, & anco il # maggiore; Continuai à tenerlo accordato sino l'anno 1634, che passò all'altra vita il detto Illustrissimo Residente. Il che causò, che il detto Clavicembalo fù mandato all'Imperatore, se bene per certo accidente rimase à Trieste, dove credo si ritrovi anco al presente. Il che mi fu di grandissimo ramarico vedendomi privo dell'essercitio di Stromento così stravagante, e degno. Pure bisognò haver pazienza sino l'anno 1641, quando mi capitò alle mani il Clavicembalo inventato dal Zerlino, e fabricato da Domenico da Pesaro l'anno 1548, il quale fu il primo Clavicembalo, che fosse mai fabricato col Diatonico, Cromatico, & Henarmonico. Si può parangonare [sic] quel di Vido à quel del Zerlino. Prima nell'A, La, mi, re vi è il b molle, il # & il # maggiore, & in quel di Vido è anco l'istesso. In quel del Zerlino vi è il b, Fa, b, Mi, b molle, & il #, ma vi è questa differenza, che in quel di Vido vi è un # maggiore di più. Al c, Sol, fa, ut del Zerlino vi è il #, & il # maggiore. In quel di Vido vi è il b molle, il #, & il # maggiore. In D, La, sol, re del Zerlino, vi è il b molle, il # & il # maggiore, & in quel di Vido vi è l'istesso. In E, La, mi del Zerlino vi è il b molle, & il #, in quel di Vido vi è il b molle, il #, & il # maggiore. Nel F, Fa, ut del Zerlino vi è il #, & il # maggiore, in quel di Vido vi è il b molle, il # & il # maggiore. In G, Sol, re, ut del Zerlino vi è il b molle, il #, & il # maggiore, & anco in quel di Vido è l'istesso. Di maniera

che nascono in quel di Vido doi corde fra il b, Fa, b, Mi & il c, Sol, fa, ut, cioè il # maggiore, di b, Fa, b, Mi, & il b molle di c, Sol, fa, ut che è semituono maggiore. Nascono anco in quel di Vido doi corde tra E, La, mi & F, Fa, ut il # maggiore d'E, La, mi & il b molle di F, Fa, ut, semituono parimente maggiore. hò parangonato [sic] li doi detti Clavicembali, accio possino vedere i Musici, che intendono più di me, la differenza, che vi è tra l'uno, e l'altro. A mio senso ellegerei [sic] più tosto il Clavicembalo del Zerlino come il più regolato del tutto, e qui sotto riporterò le sue formali parole. Dove tratta dell' Institutioni Henarmoniche libro 2, Capitolo 47:⁷⁵ «Potrà adunque [ciascuno]⁷⁶ per l'avenire fabricare un stromento alla simiglianza di quello che io hò mostrato, il quale sarà comodo, & atto à servire alle modulationi, & harmonie di ciascuno delli nominati tre generi, & questo non sarà ad alcun difficile, percioche uno de tali Stromenti feci fare io l'anno di nostra salute 1548, in Venetia, per vedere in qual maniera potessero riuscir le Harmonie Cromatiche, & le Henarmoniche, & fù un Clavicembalo, & è anco appresso di me. Il quale fabricò maestro Domenico Pesarese, raro et eccellente Fabricatore di simili stromenti, nel quale non solo li semituoni maggiori sono divisi in doi parti, ma anco li minori, di maniera che ogni tuono viene ad esser diviso in quattro parti & ancor che se ne potessero fare de gli altri con diverse divisioni, nondimeno da loro si haverebbe poca utilità.» Questo sono le parole che hà detto il Zerlino. Mà veniamo alla conclusione. hò composto le Correnti, Gagliarde, e Balletti, & le hò fatte Diatoniche trasportate parte Cromatiche, e parte Henarmoniche, acciò ogn'uno possi vedere tutti tre li generi. Dovevo fare una Toccata passando gentilmente dal Diatonico, al Cromaticho, & all'Henarmonico, ritornando in dietro [d]all'Henarmonico, al Cromatico & al Diatonico, che unendo insieme tutti tre li generi sarebbero stati soavi da sentirsi; ma non l'hò composta, perche è difficile il ritrovarsi un Clavicembalo con tutti tre li predetti generi, ma è ben vero, che le Correnti, Gagliarde, e Balletti si possono sonare sopra i Liuti, & Viole, havendo tali stromenti il Cromatico & l'Henarmonico. hò messo per ordine il Cromatico, & l'Henarmonico uno dietro l'altra, acciò possi vedere ciascuno la differenza che tra l'uno, e l'altro si trova. Hà posto il Zerlino questo segno dell'H[en]armonico.



75 Pesenti quotes from Zarlino, *Istitutioni harmoniche* (1573 edition), pp. 163–164. The quotation entirely follows Zarlino's text except spelling details.

76 The word «ciascuno», which occurs at this place in Zarlino's text, is missing in Pesenti's quotation.

Et io in veci dell'Henarmonicho posto il # ordinario, perche li stampatori non si ritrovano havere il detto segno. Martino Pesenti»

English translation:⁷⁷

To the professors of music, for a better understanding.

In 1621 there was in the house of the Illustrious Signor Nicolò de Rossi, at that time Ambassador of his Imperial Majesty in Venice, a harpsichord made by Vido Trasuntino in 1601, which was diatonic, chromatic, and enharmonic. And, as I was at the service of that most illustrious noble Lord, he ordered that I should play the said harpsichord, although it was in bad condition, because it had never been possible to find (after the death of the maker) someone who would tune it. Moved by the strongest wish to serve such a master as mine, I decided to tune it, although that was not my profession, and in so doing I discovered that from A upwards until G every note had its flat, its sharp, and its double sharp. I kept it in tune until 1634, when the illustrious Ambassador passed away. Because of this, the said harpsichord was sent to the Emperor, although, owing to a certain accident it remained in Trieste, where I believe it still is. And for this reason I was greatly distressed as I saw myself deprived of the practice on so extraordinary and worthwhile an instrument. And yet I had to bear the situation until 1641 when I happened to lay my hands upon the harpsichord invented by Zarlino and made by Domenico da Pesaro in 1548, which was the first harpsichord ever made with the diatonic, chromatic, and enharmonic genera. Vido's instrument may be compared to Zarlino's. First, concerning the A, there are the flat [A^b], the sharp [A[#]], and the double sharp [A^{##}], and in Vido's instrument it is the same. In Zarlino's there are the B, the flat [B^b], and the sharp [B[#]], but here there is a difference, because Vido's instrument also has the double sharp [B^{##}]. Regarding the C, Zarlino's instrument has the sharp [C[#]] and the double sharp [C^{##}]. In Vido's instrument, there are the flat [C^b], the sharp [C[#]], and the double sharp [C^{##}]. Regarding the D, Zarlino's instrument has the flat [D^b], the sharp [D[#]] and the double sharp [D^{##}], and Vido's is the same in this respect. For the E, Zarlino's instrument has the flat [E^b] and the sharp [E[#]]; in Vido's there are the flat [E^b], the sharp [E[#]], and the double sharp [E^{##}]. For the F, Zarlino's instrument has the sharp [F[#]] and the double sharp [F^{##}]; in Vido's there are the flat [F^b], the sharp [F[#]], and the double sharp [F^{##}]. For the G, Zarlino's instrument has the flat [G^b],

77 This translation greatly benefited from remarks and comments made by Riccardo Pergolis (Battaglia Terme, Italy) in response to the author's earlier version.

But I have used the ordinary #, instead of this enharmonic [sign], since no printer is supplied with such type. Martino Pesenti

Appendix 3

Diatonic and chromatic versions of Pesenti's *Corrente Prima*, from his *Correnti, gagliarde, e balletti ... Libro quarto, Opera decimaquinta* (Venice 1645)

Corrente Diatonica Prima (p.4):

The image displays a musical score for a piece titled "Corrente Diatonica Prima" from a 1645 Venetian publication. The score is written for a single melodic line on a five-line staff, using a treble clef and a key signature of one flat (B-flat). The time signature is 3/4. The music is organized into six systems, each containing two staves. The first system begins with a key signature change from B-flat to A-flat. Measure numbers 7, 13, 20, 27, and 34 are indicated at the start of their respective systems. The notation includes various note values (quarter, eighth, and sixteenth notes), rests, and accidentals (sharps and flats). The piece concludes with a double bar line and repeat dots at the end of the sixth system.

Appendix 3 (sequ.)

L'Istessa Corrente Cromatica (p. 5):

The musical score is written for piano and consists of six systems of music. Each system is in 3/4 time and the key signature has two flats (B-flat major). The first system begins at measure 1. The second system begins at measure 7. The third system begins at measure 13. The fourth system begins at measure 20. The fifth system begins at measure 27. The sixth system begins at measure 34. The score concludes with a double bar line and repeat dots at the end of the sixth system.

Appendix 4

Diatonic and enharmonic versions of Pesenti's *Corrente duodecima*.*Corrente Diatonica Decima Terza* (p. 28):

Three systems of musical notation for *Corrente Diatonica Decima Terza* (p. 28). The first system shows measures 1-7. The second system, starting at measure 8, includes a repeat sign. The third system, starting at measure 16, ends with a double bar line. The music is in 3/4 time, featuring a treble and bass staff with various note values and accidentals.

L'Istessa Corrente Henarmonica (p. 29):

Three systems of musical notation for *L'Istessa Corrente Henarmonica* (p. 29). The first system shows measures 1-7. The second system, starting at measure 8, includes a repeat sign. The third system, starting at measure 17, ends with a double bar line. The music is in 3/4 time, featuring a treble and bass staff with various note values and accidentals, including some chromatic alterations.

Appendix 5

René Descartes's letter to Andreas Colvius, 6 July 1643, about his just-intonation keyboard. The letter survives in two rather divergent readings. One is an excerpt in Latin made by Andreas Colvius in Dordrecht, presumably not long after receipt of the letter, now in Leiden, University Library, Codex Latinus 284, fols. 76v–77v. The other is a (partial?) French translation by Claude Clerselier, published in his *Lettres de Mr Descartes ... Tome troisieme et dernier* (Paris: Charles Angot, 1667), no. 104, pp. 587–588. Colvius's version has been edited previously by Cornelis de Waard in «Sur le destinataire et la date à attribuer à une lettre de Descartes sur une épinette parfaite», in: *Revue d'Histoire des Sciences* 3 (1950), pp. 251–255, Clerselier's version in Charles Adam & Paul Tannery (eds.), *Œuvres de Descartes IV: Correspondance IV* (Paris 1901), pp. 678–679 (no. 476bis).

Colvius's transcription:

Musica est triplex: Diatonica, Chromatica, Enharmonica.

Diatonica procedit per tonos et semitonia, qualia reperiuntur in scalâ vulgari: *ut, re, mi, fa, sol, la*; ubi *mi* et *fa* est semitonium majus; cætera sunt integri toni.

Chromatica, ut intelligitur ex Ptolomæo, procedit per tertiam minorem et per duo semitonia, unum majus et alterum minus, quæ simul faciunt quartam: *re, fa, #[fa], sol*; vel: *mi, sol, #sol, la*.

Enharmonica procedit per tertiam majorem et semitonium minus et *diæsin*, quæ vocatur *enharmonica*, quæ est ut 125:128, id est, si fides sit 128 partium et inde 125^{am} premas, facies *diæsin* enharmonicam. Itaque sic procedit verbi gratiâ: *ut, mi, #mi, fa*.

Intervalla quibus utuntur diatonica et chromatica sunt: 1. Tonus major et minor, 2. Semitonium majus et minus, 3. Dicesis enharmonica et comma. Hæc intervalla sunt paulatim minora et majora.

In instrumentis musicis, ut perfecta sint et accurata, octava ex meâ sententiâ dividi debet in 18 intervalla, quæ sunt 4 semitonia majora, 8 minora, 3 diæses enharmonicæ et tria commata, quæque disponantur modo sequenti:

F	C	1800	$\sharp$	f	2592
E	$\sharp$	1920	B	F	2700
	$\flat$ [.]	2000	A	E	2700
	comma			d[.]	3000
	$\flat$	2025		d	3072
D	A	2160	G[.]	D[.]	3200
	g[.]	2250		comma	
	g	2304	G	D	3240
C	G	2400		c[.]	3375
$\sharp$ [.]	f[.]	2560		c	3456
	comma		F	C	3600

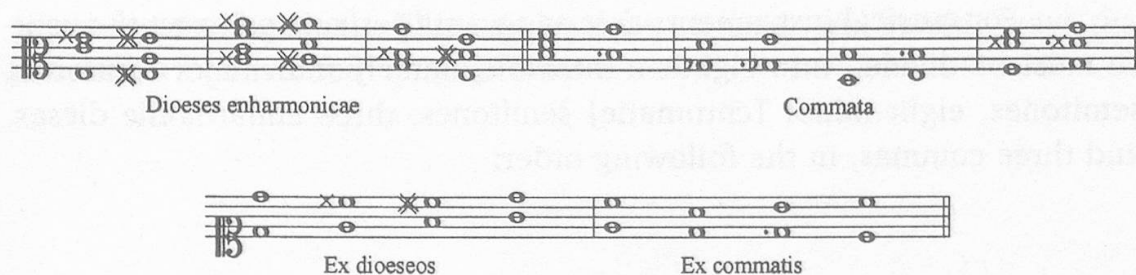
Nempe in monochordo, si totus nervus exhibeat sonum C, sitque partium 3600, ejusdem partes 3456 exhibebunt sonum c, et sic de cæteris.

Notandum autem est ex his divisionibus sive chordis, illas quæ pertinent ad genus diatonicum nempe: C, D, E et G, A et $\sharp$, esse præcipuas, et reliquas omnes ad ipsas ita referri, ut nulla planè sit admittenda, nisi cum aliquâ ex illis consonantiam efficiat.

Item notandum duas quasque quas eodem caractere notavimus, pro unis quodammodo esse sumendas vel simul usurpandas. Sed utendum esse D superiori si velimus ut consonet cum G, vel $\sharp$, D verò inferiori ut consonet cum A vel F, item $\flat$ superiori ut consonet cum G, $\flat$ inferiori ut consonet cum F, c cum E vel A, d. cum G, d cum $\sharp$, f. cum $\sharp$, f cum A, g. cum F vel C, g cum E. Ex quibus per enumerationem facile cognoscitur nullum intervallum in musicâ posse optari, quod non in tali instrumento reperiatur.

Hæc autem intelligenda de cantilenis quæ canuntur per [$\sharp$]. Pro iis autem quæ canuntur per $\flat$ molle, oportet tantum substituere F in locum C, et reliquos characteres consequenter immutare.

Intervallum diæseos enharmonicæ, itemque intervallum commatum, videntur posse cantari in locis sequentibus. Oportet autem ut notæ præcedentes vel subsequentes præparent auditum ad illa dignoscenda vocemque ad illa canenda; quod videtur fieri posse his et similis modis qui à practicis melius poterunt inveniri.



Porro, ad testudinem bene ordinandam, vellem incipere divisionem à commate, et efficere ut primus nervus à 2^o distaret 3^a majori, 2^{us} à 3^o 3^a majori, tertius à 4^o tertiâ majori unâ cum diœsi enharmonicâ. Tres enim tertiæ majores simul junctæ, differunt ab 8^a hac unâ diœsi enharmonicâ, seu unâ cum illâ diœsi complent octavam. Ideo autem à commate divisio testudinis et monochordi et cujuscunque instrumenti incipitur commodius, quia hâc ratione in subtilissimam chordarum (quæ et maximè pulsatur et per cujus longitudinem longissimè decurritur) inciderent omnia tria commata. Incipere autem divisionem instrumenti à commate, est ponere primum intervallum ita, ut digitus in eo positus, faciat comma cum chorda liberè tactâ. Est autem comma dimidium toni majoris et minoris. Nec unquam rite canendo aut instrumento ludendo, licet continuatâ serie ascendere per duos tonos majores, sed alternatim q[uidem] per majorem et minorem.

Hæc sunt Domini de Cartes.

English translation:

Music is in three genera: the diatonic, chromatic, and enharmonic.

The diatonic genus has whole and half steps, as in the usual scale: C, D, E, F, G, A, where between E and F there is a semitone (or half step); the other steps are whole tones.

The chromatic genus, after Ptolemy, consists of a minor third, followed by two semitones, the one large, the other small, which together make up a fourth: D, F, F[#], G, or E, G, G[#], A.

The enharmonic genus has a major third, a small semitone and a diesis, which is called the enharmonic diesis, which it has the ratio 125:128, that is, when a string is divided into 128 parts and one presses on the 125th part of it, the resulting sound is an enharmonic diesis. For example in the sequence C, E, E[#], F.

Intervals that are found in the diatonic and chromatic genera are: 1. the major and minor whole tones; 2. the major and minor semitones; and 3. the enharmonic diesis and the comma. These intervals are sometimes smaller, sometimes larger.

For musical instruments that one wants perfect and exact the octave must be divided into eighteen intervals, namely four major [diatonic] semitones, eight minor [chromatic] semitones, three enharmonic dieses, and three commas, in the following order:

F	C	1800	B	F $\sharp$	2592
E	B	1920	B	F	2700
	B $\flat$	2000	A	E	2700
	comma			E $\flat$	3000
	B $\flat$	2025		D $\sharp$	3072
D	A	2160	G	D	3200
	A $\flat$	2250		comma	
	G $\sharp$	2304	G	D	3240
C	G	2400		D $\flat$	3375
B	F $\sharp$	2560		C $\sharp$	3456
	comma		F	C	3600

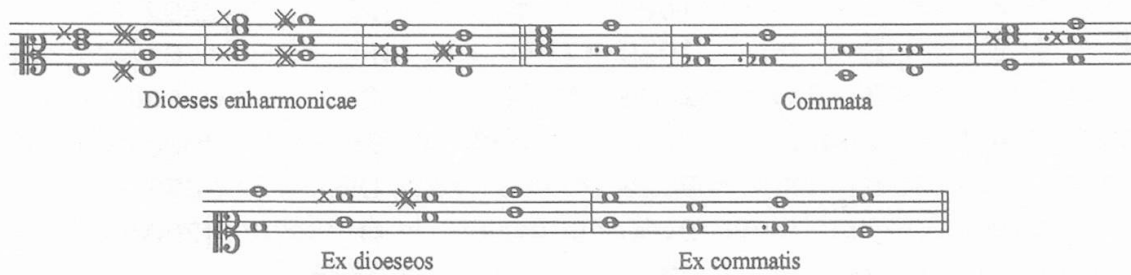
For, if on a monochord the whole string of 3600 parts produces the note C, 3456 parts will produce the C $\sharp$, and so on with the other ones.

It must be remarked that from these notes the ones that concern the diatonic genus (namely C, D, E, and G, A, B) are the most important, and all notes must be connected to these in such a way there will always be a consonance.

It be also remarked that everywhere where there are two notes with the same letter these notes refer to the same note in a certain sense, as if they can freely be interchanged. But we must use the high D when there is a consonance with G or B, whereas the low D forms a consonance with A or F. Similarly the high B $\flat$ forms a consonance with G, the low B $\flat$ with F, the C $\sharp$ with E or A, the E $\flat$ with G, the D $\sharp$ with B, the [high] F $\sharp$ with B, the [low] F $\sharp$ with A, the A $\flat$ with F or C, the G $\sharp$ with E. From this enumeration it appears clearly that there is no interval wanted in music that is not to be found on such an instrument.

These things must be kept in mind for melodies that are sung without a flat in the key signature. For melodies with the key signature of a flat one must put the F on the place of the C, and change all the note names accordingly.

The interval of the enharmonic diesis, and also that of the comma, can be sung at various places as shown below. It must be done in such a way that the preceding or subsequent notes prepare the ear to distinguish them, and the voice to sing them. This can be done in these and similar ways that can better be invented by musicians:



In addition, in order to tune a lute well, I would like to start the division with a comma, and go on in such a way that the first string differs from the second one by a major third, and the second one from the third [also] by a major third, and the third one from the fourth by a major third plus an enharmonic diesis. For three major thirds in succession differ by this enharmonic diesis from the octave, or, in other words, with that enharmonic diesis they make the octave complete. And therefore the division of the lute, or a monochord, or whichever instrument, may be set up more easily from the comma, since by this procedure the three commas are placed on the most sensitive part of the string, which is plucked the strongest and sounds the longest by its length. To begin the division of the instrument with the comma means that the first interval is set in such a way that the string, when the finger is placed upon it, creates the interval of a comma with the open string. A comma is the difference between the major and minor whole tone. In no manner of singing or playing on an instrument is it permitted to ascend over two major whole tones, but one has to alternate between major and minor whole tones. Written this way by Descartes.

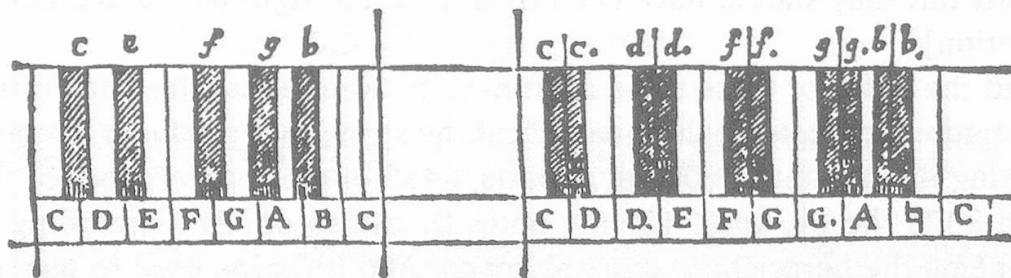
Clerselier's edition:

Monsieur,

Je ne receus vostre dernière que Lundy matin, une heure après avoir envoyé celle que je vous écrivis Dimanche au soir, ce qui est cause que je n'y adjoutay point mon système pour faire un instrument de musique qui soit parfait; car je ne pensois pas que vous le voulussiez encore voir, et je sçay bien que vous n'en avez aucun besoin pour l'espinette que vous voulez faire faire à Mademoiselle vostre fille, car, pour l'âge où elle est, il ne faut chercher que les choses les plus faciles, et ce système est beaucoup plus difficile que le vulgaire. Mais vous en pourrez aisément juger, car le voicy:

A sçavoir, au lieu qu'on a coustume de diviser l'octave en douze parties, pour les instrumens ordinaires, il faut icy la diviser en dix-huit. Comme, par

exemple, aux espinettes les marches d'une octave sont ainsi disposées, etc., et elles le devraient estre ainsi, etc..



Et les sons de ces marches doivent avoir entr'eux mesme proportion que les nombres icy mis; en sorte que, si la corde qui fait le son C estoit divisée en 3600 parties égales, 3456 de ses parties donneroient le son c, et 3375 le son c., et 3240 le son D, et ainsi des autres. Et c'est suivant cela qu'il faut accorder cette espinette. Et on s'en peut servir pour jouer toutes les mesmes pièces qu'on joue sur les autres, sans qu'il soit besoin d'y rien changer, sinon qu'il faut prendre garde que, quand on veut se servir de la feinte c avec A ou E, il faut prendre le premier c, et que, quand on s'en sert avec F, il faut toucher le second c., et qu'il faut toucher le premier D avec A ou F, et D. avec G ou $\sharp$, et d avec $\sharp$, et d avec G, et f avec A, et f. avec $\sharp$, et g avec E, et g. avec F ou C, et enfin b avec F, et b. avec G, ce qui s'entend pour les pièces qu'on joue en B quarré. Et pour celles qu'on joue en B mol, il ne faut que mettre F au lieu de C, G et G., au lieu de D et D., et ainsi de suite. Et ce que j'ay dit icy d'une octave, se doit entendre de tout le clavier, dans lequel toutes les octaves doivent estre divisées l'une comme l'autre.

Je suis, [etc.]

English translation:

Dear Sir,

I received your last letter only Monday morning, an hour after I had sent the letter that I wrote Sunday night, which is the reason that I have not added my system for a perfect musical instrument, for I thought you did not want to see it any more, and I am sure you do not need it at all for the keyboard you want to have made for your daughter [Agneta Colvius], for whom one must, considering her age, only select the most easy things, and this system is much more complicated than the usual one. You can readily form an opinion about it on account of the following:

Namely, instead of dividing the octave into twelve parts, as in ordinary instruments, one has to divide it into eighteen parts. For on the harpsichords the steps in an octave are laid out as follows: [See the left part of the above illustration] But they should have been thus: [See the right part of the above illustration]

And the notes of these steps must have between them the same ratios as the figured indicated below, namely, if the string that produces the note C is being divided into 3600 equal parts, 3456 of these parts produce the C $\sharp$ and 3375 the D $\flat$, and 3420 the notes D, and so on. And according to this scheme the harpsichord must be tuned. And it can be used to play all the pieces that one can play on [ordinary] instruments, without having to change anything. Only one has to take into account that, if one wants to use a C $\sharp$ or D $\flat$ with A or E, one has to use the first raised key after the C, and if one wants to make a combination with F one must play the D $\flat$, which is the second raised key. And also that one must use the low D together with the A or the F and the high D with the G or the B, and the D $\sharp$ with B, and E $\flat$ with G, and the [low] F $\sharp$ with A and the [high] F $\sharp$ with B, and the G $\sharp$ with E, and the A $\flat$ with F or C, and finally the [low] B $\flat$ with F and the [high] B $\flat$ with G, which applies to pieces that are played without key signature. For the pieces with the key signature of one flat the F may take the place of C, and low and high G those of low and high D, and so on. And everything I have explained for a single octave, must be extended over the entire keyboard, where all the octaves have to be divided in the same way.

I am, [etc.]

Appendix 6

Michael Bulyowsky's compositions for his 31-note keyboard, included in his *Neu-erfundenes vollkommenes fünff-faches Clavier* (Stuttgart 1699)

Und zwar erstlich in Cantu Molli (pp. 13–16):

The image displays a musical score for a 31-note keyboard, specifically for the piece "Cantu Molli" (pp. 13–16). The score is written in three systems, each containing three staves (treble, alto, and bass clefs). The key signature is one flat (B-flat), and the time signature is common time (C). The notation includes various musical symbols such as notes, rests, and accidentals. Fingerings are indicated by numbers 1 through 7. The score is divided into measures, with measure numbers 7, 13, and 17 marked at the beginning of their respective systems. The notation is complex, reflecting the unique 31-note structure of the instrument.

Abstract

This article deals with the motivation that 16th- and 17th-century designers and builders of enharmonic keyboards had in constructing their instruments. Discussed are instruments, or descriptions of instruments, by Nicola Vicentino, Gioseffo Zarlino, Martino Pesenti, Francisco Salinas, Fabio Colonna, Marin Mersenne, Joan Albert Ban, René Descartes, and Michael Bulyowsky. Several of the instruments can be classified as «archicembali» by reason of their having 31 pitches per octave, the number which Vicentino's famous archicembalo had. Other instruments had 19 or 24 pitches per octave. The earliest examples were built to demonstrate the Greek enharmonic tetrachord, or «enharmonic music» in general (Vicentino, Zarlino, Pesenti, Colonna). A 31-note division could also function as an expansion of meantone tuning and as a result of this feature the division remained in use after the connection with the enharmonic tetrachord had become obsolete in music and music theory, by the mid 17th century. Multi-note, just-intonation keyboards such as described by Zarlino, Mersenne, Ban, and Descartes, basically served the rendering of consonant intervals in their just form. Appendices to the article present enharmonic compositions by Vicentino, Pesenti, and Bulyowsky, as well as texts about enharmonic keyboards by Pesenti and Descartes.

Zusammenfassung

Der Beitrag beschäftigt sich mit den Motivationen, die hinter den enharmonischen Instrumenten stehen, die im 16. und 17. Jahrhundert erdacht und gebaut wurden. Diskutiert werden Instrumente bzw. deren Beschreibungen von Nicola Vicentino, Gioseffo Zarlino, Martino Pesenti, Francisco Salinas, Fabio Colonna, Marin Mersenne, Joan Albert Ban, René Descartes und Michael Bulyowsky. Einige dieser Instrumente können als «archicembali» bezeichnet werden, da sie – genau wie Vicentinos berühmtes Archicembalo – 31 Tonstufen pro Oktave aufweisen, andere Instrumente hingegen haben 19 oder 24 Töne pro Oktave. Die frühesten Exemplare wurden gebaut, um das griechische enharmonische Tetrachord darstellen oder generell «enharmonische Musik» darauf spielen zu können (Vicentino, Zarlino, Pesenti, Colonna). Eine 31-tönige Unterteilung konnte zugleich als Erweiterung der mitteltönigen Stimmung dienen und, als Ergebnis davon, blieb diese Unterteilung auch noch in Gebrauch, als die Verbindung mit dem enharmonischen Tetrachord in Musik und Musiktheorie im 17. Jahrhundert obsolet wurde. Vieltönige Instrumente mit reiner Stimmung, wie sie etwa von Zarlino, Mersenne, Ban, und Descartes beschrieben wurden, dienten hauptsächlich zur Darstellung von konsonanten Intervallen in reiner Form. Anhänge zu dem Beitrag bieten enharmonische Kompositionen von Vicentino, Pesenti, und Bulyowsky, sowie Dokumente für die enharmonischen Tasteninstrumente von Pesenti und Descartes.

Consonant or dissonant? – Reflections at the keyboards of a *Clavemusicum Omnitonum*, *cimbalo cromatico*, and «*cembalo naturale*»

Bob van Asperen

Eager to explore on a real multiple-division instrument the sonority of intriguing compositions such as the *Esempi* in Fabio Colonna's *Sambuca Lincea* (Naples, 1618), composed by no less than Ascanio Mayone, organist to the Royal Chapel at Naples, and the *Sonata VII Stravagante, e per il cimbalo cromatico* by Gianpietro del Buono (Palermo, 1641), I was determined to grasp the chance of this colloquium to pursue and deepen my earlier experience in this field.¹ In particular the presence of a 19-note per octave, single-strung harpsichord by André Extermann, Givrins (Switzerland), after an Italian model, tuned in meantone temperament created a welcome opportunity and a necessary tool for realising this aim.

The layout of its keyboard (see figure 1, p. 96) represented for me a transitional stage, so to say, between my earlier experiments and later experience with the *Clavemusicum Omnitonum*. This last instrument was made in Venice in 1606 by Vito Trasuntino (owned now by the Museo Civico, Bologna), to which Dieter Krickeberg kindly introduced me during a visit to the *Germanisches Nationalmuseum* in Nuremberg in the late 1980s when the instrument was there for conservation. The copy made in the restoration workshop on that occasion by Friedemann Hellwig – unfortunately still

1 As a board member of the «Huygens-Fokker Foundation» for microtonality (both old and modern), Haarlem, The Netherlands, I presented works for arcicembalo by Giovanni Maria Trabaci, Ascanio Mayone and Carlo Gesualdo at the Foundation's home the Teyler's Museum, Haarlem (in the late 1970s) and later at «De IJsbreker», Amsterdam (see *Stichting Huygens-Fokker Jaarboek* 1994, pp. 21–28). In the first stage a «normal» harpsichord after Ruckers by Rainer Schütze, Heidelberg, with two eight-foot stops was used, tuned in meantone and provided with knee-levers to enable changes into the «tons éloignées», necessarily in an incongruous timbre. Later an Italian instrument with broken octave and two split keys per octave by Bruce Kennedy, now owned by the Conservatory of Amsterdam, was available. Its two eight-foot stops could here be used in an «expressive» way.

At the core of the Foundation's interest in the 31-tone division (calculated c1661 by Christiaan Huygens, the mathematician) is the museum's musical treasure, the 31-tone organ with two manuals and pedal designed by Prof. Adriaan Fokker. The instrument was dismantled recently to find a new home in the «IJsbreker» Concert Hall in the future.



Figure 1

Section of keyboard of the 19-tone harpsichord by André Extermann

(Photo by M. Kirnbauer)

only one of two or three such instruments – was ready at that time and could be used to try and record some of the *Kyrie eleison Esempli* from the *Sambuca Lincea*, an unforgettable musical experience, alien and uncomfortable as it felt at first. In an attempt to revive Luzzaschi's skill at this enharmonic keyboard I thought it important to make an effort to reproduce and possibly record at least the existing, handed down repertoire written for it, even possibly to pave the way for new experiments.

At this point it seems appropriate to distinguish the musical use, on the one hand of what was a Renaissance interpretation of the old Greek genera – unfamiliar to musicians of our day – as demonstrated in Mayone's examples, and on the other hand the *durezze* and *stravaganze* experiments based on the Renaissance modal/tonal system.

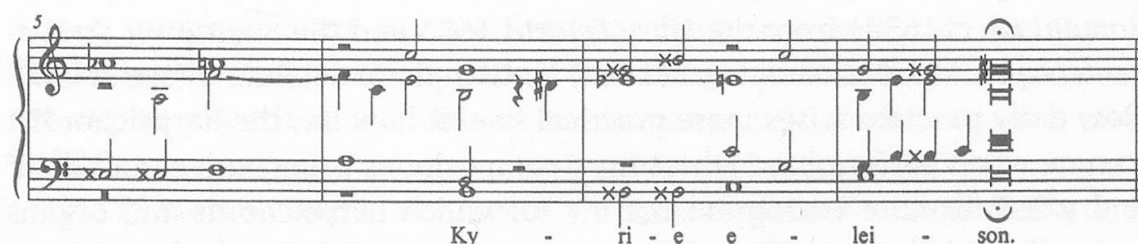
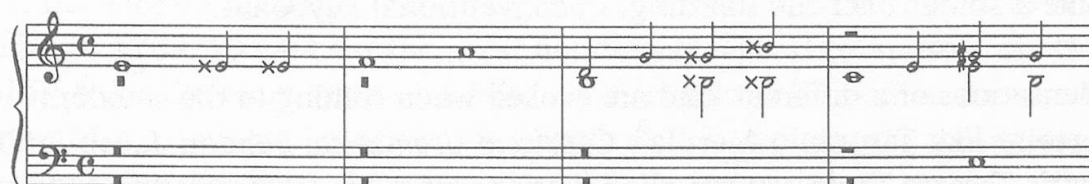
To begin with the first, more neglected, category: as an initiation for the audience (and for the player as well) into this unknown field, still veiled in mystery, I performed two of these *Kyrie eleison* (see figure 2a and 2b) in a variant with repetition, as a response to Martin Kirnbauer's enthusiastic comments on the Trasuntino recording, in order to give, so to speak, the ear a second chance. The – literally – unheard melodic progression of a *grado enarmonico* from b to c^b at the opening of the first fragment – instantly followed by the interval $e - f^b$ (the second tone of each being tuned «on the spot» as a perfect major third under e^b and a^b , respectively) caused a physical

Figure 2

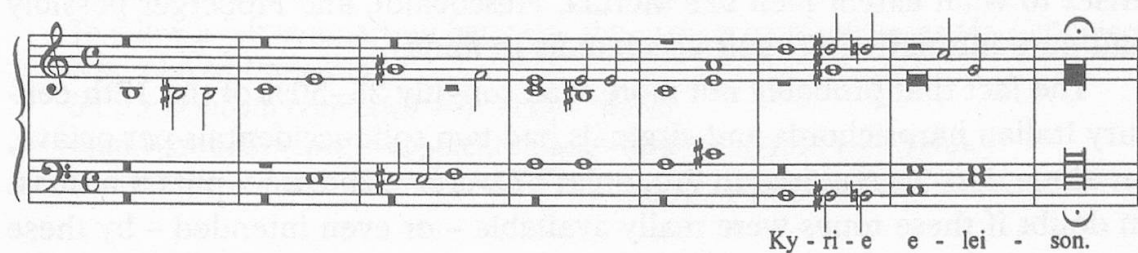
Ascanio Mayone's examples of the enharmonic tetrachords, as included in Fabio Colonna's *La sambuca lincea* (Naples 1618), transcribed by Rudolf Rasch.



(a) *Enarmonico molle osservato nel soprano conforme il Tetracordo, & Ottocordo* (p. 92)



(b) *Enarmonico molle osservato in fuga da quattro parti* (p. 93)



(c) *Esempio dell'Enarmonico intenso con 4 parti* (p. 94)

reaction: it seemed, particularly by means of a carefully chosen fingering allowing an effective «over-legato», to force our ears open and make, so to say, our blood curdle at the same time. Would Plato have applauded to a *symphonia* of this type in his ideal state? *Mutatis mutandis* one could, when pursuing these experiments, risk coming upon «forbidden» modes, causing panic and hostility ...

When these musical scraps pass through the fingers – one has the consciousness of rediscovering that remnant of (this time authentic) Greek musical culture, the Seikilos song or the Leiden fragments – it occurs to the player that the physical interference, both vertically (the harmonies) and particularly horizontally (in terms of voice leading), touches a string in our soul, till then unknown. «Normal» chromatism seems colorless after this experience. Thanks to the instrument builder, the vibration of the strings, initiated by that primary, dull, and in itself uninteresting pluck, is amplified and sublimated by skillful application of these divine gifts of nature: cypress and spruce.

One imagines a similar emotion went through the minds of the friends of the Accademy when Mayone showed his innovative creations, ordered by Colonna: in our mind's eye we see his fingers – like ours now – wriggling like a spider over the dazzling, unconventional keyboard.

Sensations of a different kind are evoked when coming to the «modern» repertoire like Tarquinio Merula's *Capriccio Cromatico*, Johann Jacob Froberger's *Toccata VI da sonarsi alle Levatione* from his *Libro secondo* 1649, the *Lamento per la dolorosa perdita della Real Maestà di Ferdinando IV, Ré de Romani &c* (†1654) from the *Libro Quarto* 1656 and the *Sonata VII Stravagante, e per il cimbalo cromatico* (1641) by Gianpietro del Buono (see below). Now daily practice raises more practical issues: how has the harpsichordist to tune when performing 17th-century compositions using both e^b and $d^\sharp$, a^b and $g^\sharp$? Still more vexing are the d^b 's for which harpsichords and organs normally did not provide separate keys. The availability of the 19-tone instrument removes, in principle, all inconvenience. But still here the question arises to what extent men like Merula, Frescobaldi, and Froberger possibly had pure intonation of their accidentals in mind.

The fact that probably not more than roughly 25–50% of the 17th-century Italian harpsichords and virginals had two split accidentals per octave, let alone d^b 's – as required in Froberger's *Levatione Toccata* – puts it at least in doubt if these tones were really available – or even intended – by these composers.² On this point the colloquium discussion revealed that there was not a consensus.

2 This data was kindly communicated by Denzil Wraight; see also his article in this volume «The *cimbalo cromatico* and other Italian string keyboard instruments with divided accidentals».

It seems the harshness of an unaccentuated, or an even relatively accentuated diminished fourth replacing the usual pure major third, e.g., $b - d^\sharp$ in the tone of e , creates in the so-called «uninformed» public an impression of a certain «expressiveness». It was this aspect of «dissonant» dissonance that was brought forward for discussion by the inclusion in the programme of Froberger's Elevation-Toccata and his *Lamento* for Ferdinand IV on a «cembalo naturale» after an Italian model with two eight-foot stops by Gianfranco Facchini, Ravenna, in meantone tuning, having a chromatic keyboard and no split keys.

In this context it is interesting to note two remarks from Italian sources from the early 18th century when meantone tuning was still often used, both mentioned by Patrizio Barbieri during the Colloquium. In an interview with the Florentine harpsichord maker Bartolomeo Cristofori by Scipione Maffei in 1709/10 we hear the great builder say: «good composers use the wolffifth for the expression of *il falso e 'l disgustoso*». The other statement comes from Giovanni Francesco de Capelli, 1723: «we use the wrong keys when playing $d^\sharp$ s».³

Also it is enlightening to note Chistiaan Huygens' preference for e^b as a (melodic) «leading note» in e-minor as having «quelque chose de plus tendre et plus plaintif, que $E - D^\sharp - E$ » in his manuscript *Les divers modes*, after 1672.⁴

As in more universal matters of art appreciation, we do not hesitate to listen in this delicate question to the «general public» as well, whose judgement is, also here, surely not without importance ...

To allow a fair comparison between the various interpretations Merula's piece was played three times:

on the *cembalo cromatico* «correctly» (pure),

than «correctly» with «superchromatic» ornamentation (see below)

and on the *cembalo naturale* «as it comes», i.e. consonant and dissonant.

3 Patrizio Barbieri, «L'accordatura strumentale in Toscana: proposte e contrasti da V. Galilei a Cristofori (c. 1580–1730)», in: *Musicologia Humana. Studies in Honor of Warren and Ursula Kirkendale*, ed. by Siegfried Gmeinwieser, David Hiley & Jörg Riedlbauer, Firenze 1994 (= *Historiae Musicae Cultores*, Biblioteca 74), pp. 209–232, particularly p. 221.

4 See Patrizio Barbieri, «Il temperamento equabile nel periodo frescobaldiano» in: *Girolamo Frescobaldi nel IV Centenario della Nascita, atti di convegno internazionale di studi (Ferrara, 9–14 settembre 1983)*, ed. by Sergio Durante and Dinko Fabris, Firenze 1986 (= *Quaderni della Rivista Italiana di Musicologia* 10), pp. 387–423, especially p. 414, note 63.

An essential factor influencing the acceptability of the «harsh» performance of these *passi duriusculi* (leaving aside for a moment consonant, pure performance of these *blue notes* as resulting in «surrogates» for the dissonances without any notable effect) is the quality of the resonance of the instrument and its disposition (number of registers). This instrumental premise is of course a great help to the performer's aspiration towards integration of these tones: he might seek for a certain musical «preparation» in the act of playing, which begs, so to speak, for the listener's special attention and creating together with him a certain expectation.

Another aspect of the luxury of these additional accidentals now available is the possibility of applying them sometimes in an enriching way by changing notated accidentals into enharmonic ones – following Vicentino's advice in his *L'antica musica ridotta alla moderna prattica* (1555),⁵ – or even adding «super-chromatic» (Frans Brüggen) tones incorporated in freely invented ornamentation at times.

As a pleasant surprise, giving so to say a historic justification of this «modern» experiment after the event, Patrizio Barbieri's quotation of Angelini Bontempi, 1695 (active in Perugia, Venice and Copenhagen) showed examples of improvised «microtonal» passing notes.⁶

To conclude, I would like to return now to the actual repertoire of the 19-tone instrument with a last word on Del Buono's *Harpsichord Sonata*, based on that graceful hymn *Ave maris stella*, which occupies a special place as one of the 14 very first Sonatas in music history intended specifically for the *cembalo*, «Signor di tutti l'istromenti del mondo» as his *collega arcicembalista* Giovanni Maria Trabaci called the instrument (see figure 3).⁷

As an oasis of calm in the midst of the diligent, at times even laborious counterpoints of the other sonatas, these pages take us on a journey, when performed on the 19-tone harpsichord with its both warm and lovely decaying curve of tone, during which its surprising alterations regularly touch us and

5 See Alexander Silbiger's translation on p. 8 of the introduction to his edition *Four enharmonic madrigals* by Nicola Vicentino, Utrecht 1990 (Corpus Microtonale 33).

6 Giovanni Andrea Angelini Bontempi, *Historia musica*, Perugia 1695, 158; see Patrizio Barbieri, «Violin intonation: a historical survey», in: *Early Music* 19/1 (1991), pp. 69–88, p. 80, and Patrizio Barbieri's article in this volume.

7 «...,+ in lei si possono sonare ogni cosa con facilità.» Giovanni Maria Trabaci, in *Il secondo libro de ricercate & altri varij capricci*, Naples 1615, at the heading of the *Partite artificiose sopra il Tenor de Zefiro*.

enchant us. In addition to the normal three sharps and two flats, the presence here of the pitches of $d^\sharp$, $a^\sharp$, a^b , and d^b results in the use of 16 tones in the octave, culminating in a daring though strictly functional confrontation of the two musical opponents, a^b versus $g^\sharp$ at the final cadence: the silent meditation having a character principally of resignation, showing occasional bursts of rebelliousness or even trepidation, of an unique Neapolitan visionary.

As a composer he shows more wisdom than many of his colleagues of today, concluding his declaration «A i benigni lettori» with the commendatory phrase: «For the rest I trust to the *giudicio del buon Sonatore* ...».

Figure 3 (p. 102–104)

Gioanpietro del Buono, «Sonata Strauagante, e per il Cimbalo Cromatico» (from *Canoni, Oblighi et Sonate in varie maniere sopra l'Ave Maris Stella*, Palermo 1641), no. 7, transcribed by Martin Kirnbauer with suggestions and emendations by Bob van Asperen and Martin Kirnbauer (original accidentals, modern adaptions in brackets).

Figure 3

Sonata VII. Strauagante, e per il cimballi cromatico

G.P. Del Bono (1641)

The musical score is presented in four systems, each with four staves. The first staff of each system is in treble clef, the second in alto clef, the third in tenor clef, and the fourth in bass clef. The key signature is one sharp (F#), and the time signature is common time (C). The score includes various note values, rests, and accidentals. A final asterisk (*) is placed above the last note of the bass staff in the fourth system.

* B T.14,4: notiert f(#)

15

* * * *

19

* * *

22

* * *

25

* * * *

* B T.15,5: Note fehlt / ** B T.20,5: notiert H

29



33



37



40



* C Schlussnote Terz zu hoch notiert

The *cimbalo cromatico* and other Italian string keyboard instruments with divided accidentals

Denzil Wraight

It is the aim of this article to present an overview of the Italian string keyboard instruments built with additional divided accidentals for the purpose of increasing the range of consonant intervals available to the player. Speaking with the terminology of archaeology, the intention is to expose the foundations more clearly in order that a better appreciation of the subject matter may be achieved. The reasons why split sharps were provided is not discussed here in detail, this being the subject of other papers by Rudolf Rasch and Patrizio Barbieri in this volume.

The earliest use of divided accidentals in Italian keyboard instruments is recorded in Italian church organs, the oldest known being that in Cesena cathedral where in 1468 Andrea Molighi added three semitones «with perfect thirds».¹ Thus, the use of split sharps to provide better tuned thirds than would otherwise have been provided by the tunings used in this period is a practice which can be traced throughout the 16th and 17th centuries in Italian organ building. Usually it was for $d\sharp/eb$ and $g\sharp/ab$ that divided keys were provided and this practice also has its counterpart in string keyboard instrument making, evidence for which is presented below.

There is another line of development which is found more in string keyboard instruments than in organs: that of multiple split notes in order to provide for tunings requiring 19 notes or more in the octave. Following a definition introduced by Rasch, any instrument where the diatonic semitone in a tetrachord is divided can be referred to as an instrument incorporating the enharmonic genus.² Thus, keyboards incorporating an $E\sharp$ and $B\sharp$ could be referred to as «enharmonic» instruments although there is also a usage from around 1600 which calls these a «*cimbalo cromatico*». However, actual usage was somewhat inconsistent so that stipulative definitions will clash

1 Carlo Grigioni, «Maestri organari nella Romagna» in: *Melozzo da Forlì – Rassegna d'arte romagnola*, Forlì 1937, p. 159, quoted by Stembridge in Denzil Wraight & Christopher Stembridge, «Italian Split-Keyed Instruments with Fewer than Nineteen Divisions to the Octave», in: *Performance Practice Review* 7/2 (1994), pp. 150–181, p. 162, note 27.

2 See Rudolf Rasch, «Why were enharmonic keyboards built? From Nicola Vicentino (1555) to Michael Bulyowsky (1699)» in this volume for further discussion of this matter.

with the historical use of the term during the period when these instruments were conceived.³

Firstly, a list of Italian string keyboard instruments is presented, most of which could be called *enharmonic* (as defined above), of which only three instruments survive; the remainder are significant for the history of music and therefore require to be noted. This list is restricted to instruments which were *built* rather than being merely theoretical expositions. The *arciorgani* produced under Vicentino's direction have been included since they complement the description of Vicentino's œuvre and the *archicembalo*.⁴ Comments on the list have mostly been restricted to describing briefly the instruments and referring the reader to the available literature. In the case of Zarlino and Vicentino the instruments have not been adequately described until now and the length of treatment is therefore longer.

Secondly, a list of surviving Italian string keyboard instruments is presented which documents the additional chromatic keys used in harpsichords and virginals. My contribution to this field has been to examine the surviving instruments, establish the original compasses, and discover by which maker they were produced. Many Italian instruments underwent modifications from around 1700 onwards which obscured the fact that split sharps were originally provided. It has been possible to identify some unsigned work, thereby increasing our understanding of the time and the place where these instruments were made.⁵ Thus, a clearer focus has resulted which shows the significance of Florence and Rome as centres of this type of musical instrument making activity.

3 Documentary accounts refer to the instrument played by Luzzasco Luzzaschi in Ferrara as both a «certo strumento Inarmonico», reported in Elio Durante & Anna Martelotti, *Cronistoria del Concerto delle Dame Principalissime di Margherita Gonzaga D'Este*, Florence 1989 (= Archivum musicum, Collana di studi A), p. 193 (doc. A178), and as «Un'instrumento cromatico con due tastadure una sopra l'altra» (Este inventory of 21.10.1598, see Durante & Martelotti, *Cronistoria*, p. 205 [doc. A209]).

4 The enharmonic organs which Emilio de' Cavalieri was associated with in Florence are a significant part of the history of enharmonic instruments, but will not be discussed here. See Warren Kirkendale, *Emilio de' Cavalieri «Gentilhomme romano». His life and letters, his role as Superintendent of all the arts at the Medici Court, and his musical compositions. With addenda to «L'Aria di Fiorenza» and «The Court Musicians in Florence»*, Florenz 2001 (= *Historiae Musicae Cultores* 86), ch. 5, which also includes a survey of enharmonic instruments and music. I am obliged to Martin Kirnbauer for drawing my attention to this reference.

5 Denzil Wraight, *The stringing of Italian keyboard instruments c.1500-c.1650*, Ph.D. dissertation, Queen's University of Belfast 1997 (Ann Arbor: UMI, 1997, order no. 9735109). My earlier list of instruments with split sharps appeared in Wraight & Stemberge, «Italian Split-Keyed Instruments», pp. 150–160.

List of instruments, with more than 14 notes per octave

SALINAS	<i>Archicymbalum</i> c1538–1547 31/octave <i>instrumentum perfectum</i> 1538–1553 24/octave? [instrument heard in Florence 1538–1559]
ZARLINO	1548 (Dominico da Pesaro, Venice) 24/octave before 1558, 16/octave, just intonation
VICENTINO	<i>archicembalo</i> probably c1546–1549 31/octave <i>arciorgano</i> built in Rome c1549–1552 31/octave possibly another <i>archicembalo</i> by 1561 2nd <i>arciorgano</i> (Vincenzo Colombo, Venice) by 1561 3rd <i>arciorgano</i> built in Milan c1575
TRASUNTINO	1591 C-c ³ 19/octave 1601 28/octave 1606 C-c ³ <i>Clavemusicum Omnitonum</i> 31/octave
STELLA	1592–1618 <i>tricembalo</i> 31/octave
COLONNA	<i>sambuca lincea</i> Naples 1618: clavichord 31/octave
FABBRI	1631 C/E-c ³ (B [#] -f ² 19/octave)
ZAMPIERI	1634–35 (Orazio Albani, Rome) 31/octave?
DELLA VALLE	c1638–39 Della Valle (built by Giovanni Pollizini, Rome)
POLLIZINI	1649 <i>tricembalo</i>
NIGETTI	3 instruments: 1. c1640 with 2 keyboards 2. c1644, 5 rows of keys, only «white notes» 3. 1670 with 5 keyboards, 31/octave
SABBATINI	c1650 38/octave, just intonation

Comments on the list

SALINAS: Francisco Salinas, the blind Spanish priest and organist tells us in his *De Musica* published in 1577 that «fewer than forty years ago» there was an instrument called an «archicymbalum» by its inventor, which had 31 intervals in the octave.⁶ The dating is vague, but since Salinas came to Rome in 1538 and would presumably have said «fewer than 30 years ago» if the date had been after 1547, we may tentatively infer a timeframe some 30–40 years previously, i.e., comprising the years 1538–1547.⁷ It is not stated who made the instrument, but the turn of phrase used would be curiously oblique if it had been referring to Salinas' own instrument. It appears more likely to be a reference to Vicentino's *archicembalo*, especially because the division of the octave into 31 intervals matches that described by Vicentino. If this is the case it is a further clue to the date of Vicentino's instrument, which is discussed below.

Salinas' own instrument, presumably a harpsichord, is mentioned briefly as having been constructed in Rome but being in Salamanca at the time of writing his treatise.⁸ Since Salinas went to Rome in 1538 and obtained an appointment to the Duke of Alba in Naples from 1553–1558 before a further position was granted to him at Sigüenza in Spain in January 1559, it appears probable that his harpsichord would have been made in Rome during 1538–1553.⁹ «Many keyboard instruments are arranged according to this [enharmonic] genus (such as that which I remember having heard at Florence). But the most perfect of all is that instrument which I ordered made in Rome, which I now have with me in Salamanca. On this, both the perfect

6 «De prava constitutione cuiusdam instrumenti, quod in Italia citra quadraginta annos fabricari coeptum est, in quo reperitur omnis tonus in quinque partes divisus CAP. XXVII Non silentio praetermittendum arbitror instrumentum quoddam, quod in Italia, citra quadraginta annos fabricari coeptum est, ab eius autore, quisquis ille fuit, Archycymbalum appellatum.» Francisco Salinas, *De Musica*, Salamanca 1577, p. 164. This is quoted with an Italian translation in Patrizio Barbieri, «I Temperamenti Ciclici da Vicentino (1555) A Buliowski (1699): Teoria e Pratica «Archicembalistica»», in: *L'Organo* 21 (1983), pp. 129–208, pp. 138–139.

7 Barbieri, «I Temperamenti», p. 158, suggests the dates 1538–1540.

8 Salinas, *De Musica*, book III, ch. VIII, p. 127.

9 Biographical details are taken from Robert Stevenson, «Salinas» in: *The New Grove Dictionary*, London, 1980, pp. 420–421. Patrizio Barbieri also kindly communicated the biographical details supplied by Perez (cited in «Salinas»).

instrument as well as the imperfect one which we use can be found, and a comparison of one to the other can be made.»¹⁰

Since these remarks about the instrument appear at the end of the chapter introducing the enharmonic genus, Palisca suggested that Salinas' keyboard had a 24-note division.¹¹ As Barbour states, the enharmonic genus described is just intonation with a chromatic range from G $\flat$ to B $\sharp$.¹² Five of the keys, D, F $\sharp$, G $\flat$, A $\sharp$, and B $\flat$ are provided in two pitches, separated by a syntonic comma (ratio 80:81 or 21.5 cents). Salinas' obvious preference for just intonation and the didactic function of comparison with the «imperfect» instruments that he mentions, strongly suggests that his enharmonic octave division represents one keyboard of Salinas' harpsichord. By the «imperfect instrument» for the other keyboard Salinas apparently refers to a tempered tuning and with at least one divided sharp. The enharmonic keyboard would have appeared as in fig. 1 (with the exact pitch designation of the doubled notes omitted as a simplification). Both keyboards are discussed in more detail by Patrizio Barbieri.¹³

10 Translation by Arthur Daniels, «Microtonality and Mean-Tone Temperament in the Harmonic System of Francesco Salinas, Part 2», in: *Journal of Music Theory* 10 (1965), pp. 234–243, p. 243.

11 See Claude V. Palisca, «Salinas», in: *MGG* 11 (1963), cols. 1302–1306, col. 1305. Karol Berger, *Theories of Chromatic and Enharmonic Music in Late 16th Century Italy*, Ann Arbor, MI. 1980 (= *Studies in Musicology* 10), p. 54, has suggested that Salinas' instrument had the 15-note range described on p. 117 of *De Musica*, which discussed the chromatic genus although he also cites Salinas' description of the instrument from the section on the enharmonic genus that discusses the 24-note octave division. No reason was given to prefer the 15-note interpretation. Stevenson, «Salinas», p. 421 suggests that Salinas' harpsichord had 19 notes, without citing any evidence for this.

12 J. Murray Barbour, *Tuning and Temperament*, East Lansing, MI. 1953, p. 108.

13 See Patrizio Barbieri, «The evolution of open-chain enharmonic keyboards c1480–1650» (in this volume). I am indebted to Patrizio Barbieri for his analysis of Salinas' text. See also Rasch, «Why were enharmonic keyboards built?» (in this volume). Christopher Stemberge and Willard Martin have constructed an interpretation of Salinas' instrument with 21 notes per octave, omitting E $\sharp$, B $\sharp$ the second G $\flat$ s and A $\sharp$ s and providing two Gs and Bs (personal communication).

tional notes without any practical use (probably a passing reference to Vicentino's *archicembalo*) he then continues to relate that in 1548 he had an instrument constructed which would serve for demonstrating harmonies in the realm of music, just as a «touchstone» tests silver and gold.¹⁶ This instrument, built by Domenico da Pesaro, was provided with major and minor semitones which were divided into two parts in such a way that the whole tone was divided into four parts.

Willi Apel in 1967 and Lynn Wood Martin in 1984 appear to have been the first to have correctly reported the compass as having 24 notes per octave, albeit only in passing.¹⁷ Christopher Stemberge discussed the instrument in detail and with the assistance of Pesenti's description of the instrument established that the instrument had a 24-note compass.¹⁸ In the literature it has mostly been recorded that the harpsichord had a compass with 19 notes in the octave.¹⁹ Stemberge clarified the problem noting that this confusion has arisen partly because an illustration appears showing a 19-note division of the octave (fig 2).²⁰ Zarlino appears to refer in the 1558 edition to this *illustration* as the model of harpsichord which could be constructed by others

16 The simile with the touchstone is in the 1589 edition, but not in the 1558 edition.

17 Willi Apel, *Geschichte der Orgel- und Klaviermusik bis 1700*, Kassel etc. 1967, p. 476 (this reference was kindly provided by Riccardo Pergolis); Lynn Wood Martin, «The Colonna-Stella Sambuca lineea, an enharmonic keyboard instrument», in: *Journal of the American Musical Instrument Society* 10 (1984), pp. 5–21, p. 6, note 4, apparently drawing on Pesenti's description of the compass.

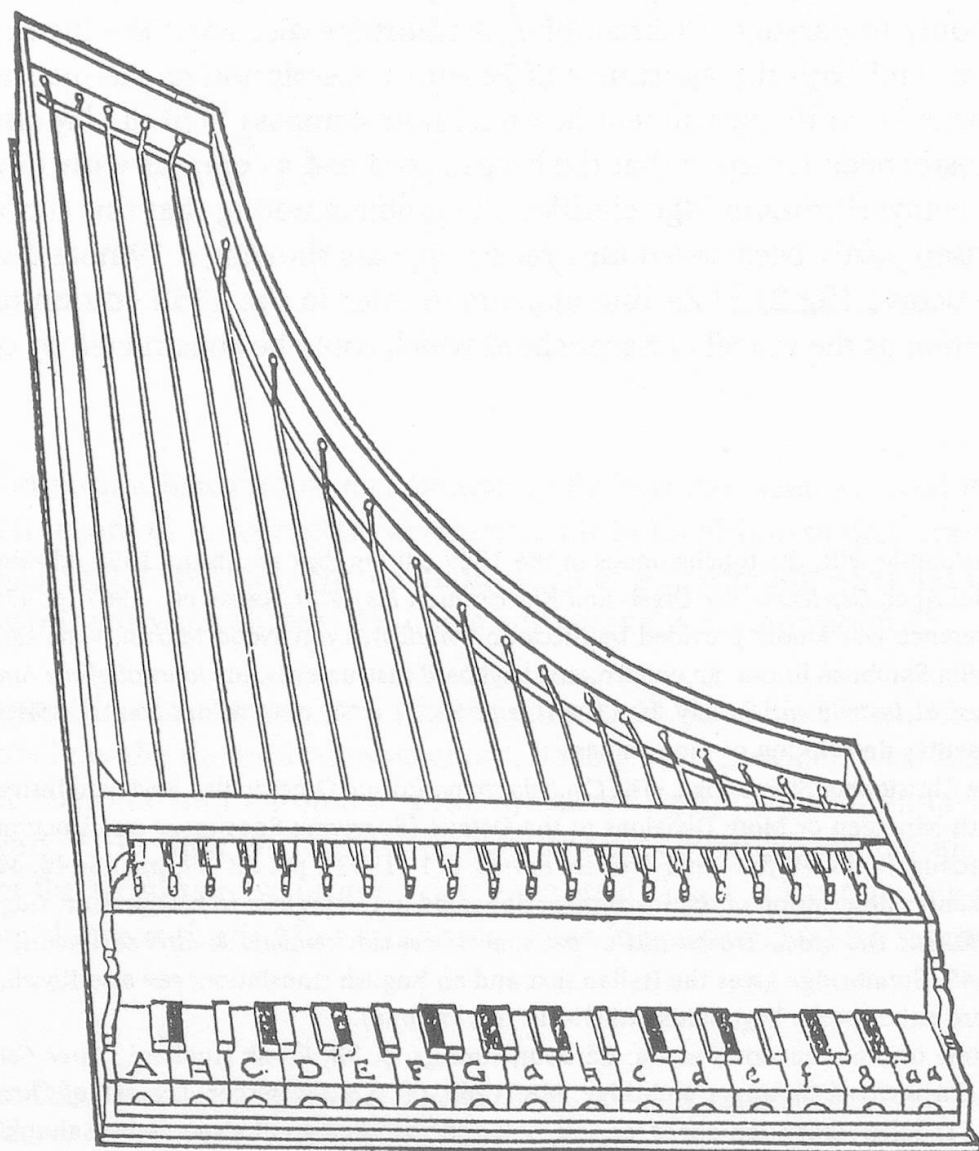
18 See Christopher Stemberge, «The Cimbalò cromatico and Other Italian Keyboard Instruments with Nineteen or More Divisions to the Octave (Surviving Specimens and Documentary Evidence)», in: *Performance Practice Review* 6/1 (1993), pp. 33–59, pp. 45–46. Martino Pesenti's description of the instrument appeared in the preface to his *Corrente, Gagliarde, e Balletti Diatonici, Trasportati ... per sonarsi nel clavicembalo & altri strumenti*, Venice 1645. Stemberge gives the Italian text and an English translation; see also Rasch, «Why were enharmonic keyboards built?» (in this volume).

19 A few of the main sources are: Barbour, *Tunings*, p. 33; Frank Hubbard, *Three Centuries of Harpsichord Making*, Cambridge, MA. 1965, pp. 32–33; Berger, *Theories of Chromatic*, p. 51; John Henry van der Meer, «Partiell und vollständig enharmonische Saitenklaviere zwischen 1548 und 1711», in: *Das Musikinstrument* 36/7 (1987), p. 16; Mark Lindley, «An Historical Survey of Meantone Temperaments to 1620», in: *Early Keyboard Journal* 8 (1990), p. 31; my perpetuation of the error in «Harpsichord, 2. The Renaissance, (i) Italy», in: *Early Keyboard Instruments*, London 1989 (The New Grove Musical Instrument Series), p. 23.

20 See Stemberge, «The Cimbalò cromatico», pp. 45–46. Stemberge inferred that Zarlino's instructions called for a 27-note keyboard, computing the notes necessary to give corresponding major and minor thirds above every string, starting with a compass containing 19 notes per octave.

(«fabricare uno strumento alla simiglianza di quello ch'io hò mostrato»), but in the 1589 edition «mostrato» (shown) has been changed to «descritto» (described). However, the misunderstanding is not simply a confusion since Berger argues that Zarlino's tonal system *requires* 19 notes.²¹

Fig. 2: Zarlino, illustration of a 19-note keyboard (from Zarlino, *L'Istitutioni Harmoniche*, 1558, p. 141)



²¹ See Berger, *Theories of Chromatic*, p. 51. This matter will not be discussed here.

That Zarlino specifically states the major and minor semitones should be divided into two parts has seldom been mentioned by commentators.²² If we were to take Zarlino's statement of the 1558 edition literally about dividing the major and *all* the minor semitones into *two* parts there could be as many as 31 divisions in the octave, with each tone divided into five parts. A 19-note octave division would suggest dividing the whole tone into three parts. However, the additional information (in later editions) that semitones should be divided in such a way so that the tone should be divided into *four* parts defines the compass as 24 notes, although it does not tell us which minor semitones should be divided.²³ Thus, part of the inaccuracy concerning the description of this instrument appears to result from scholars consulting the original, 1558 edition which is imprecise in its wording, a vagueness later corrected by Zarlino.

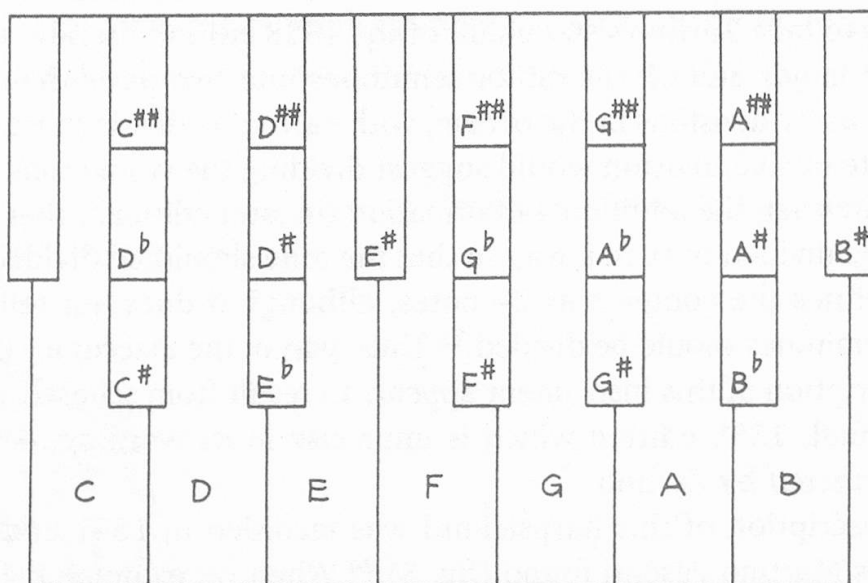
A description of this harpsichord was recorded in 1641 and shows us the notes Martino Pesenti found (fig. 3).²⁴ When we examine the tuning in order to discover which minor semitones should be divided it appears that Zarlino thought in terms of extending the series of fifths from B $\sharp$ through to A $\sharp\sharp$, i.e., dividing the small semitones on the «sharp side» of the tone.

22 In the 1558 edition the phrase: «nel quale [in the Clavicembalo] non solamente li semitoni maggiori sono divisi in due parti, ma anche tutti li minori.»; Zarlino, *L'Istitutione*, p. 140 (1558 edition), p. 171 (1589 edition). Sibyl Marcuse, *A Survey of Musical Instruments*, New York 1975, p. 287, mentions the semitones, as does Kirkendale, *Emilio de' Cavalieri*, p. 147, and Barbieri, «The evolution» (in this volume), who compares the differences between the two editions. Rasch, «Why were enharmonic keyboards built?» (in this volume), has also drawn attention to this matter.

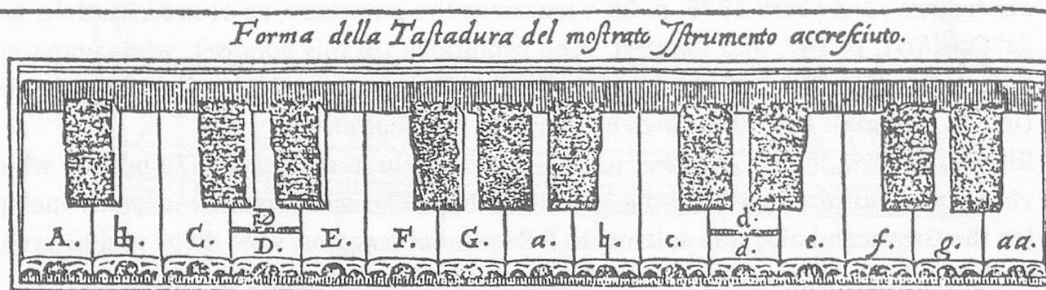
23 Kirkendale, *Emilio de' Cavalieri*, p. 147, provides the text of the 1573 edition which is virtually identical with that of the 1589 edition, p. 171, which latter version is: «nel quale [in the Gravecembalo] non solamente li Semitoni maggiori sono divisi in due parti, ma anche i minori, di maniera ch'ogni Tuono viene ad essere diviso in quattro parti.»

24 Stembridge, «The Cimbalo cromatico», pp. 44–55 with Pesenti's Italian text and a correct translation into English. Kirkendale, *Emilio de' Cavalieri*, p. 147, also mentions this but incorrectly states that Pesenti acquired the instrument, mistranslating the key phrase «quando me capitò alle mani», which Riccardo Pergolis assures me means only that he came across the instrument and was able to examine it. Rasch, «Why were enharmonic keyboards built?» (in this volume), discusses the instrument and presents a complete translation of Pesenti's text.

Fig. 3: Zarlino, 24-note keyboard (Domenico da Pesaro, 1548)



We may ask how it was that Pesenti was able to give the exact tuning of the notes. The answer appears to be supplied by Charles Burney's account of finding the instrument in Florence in 1770 in the possession of Signora Moncini: «I copied Zarlino's instructions for tuning it, from his own handwriting, on the back of the foreboard [...]». ²⁵ The information on the nameboard may also have been the source for Pesenti's claim that this was the first harpsichord made with the diatonic, chromatic, and enharmonic. Whether this instrument still exists is unknown.

Fig. 4: Zarlino, just intonation keyboard (from Zarlino, *Sopplimenti Musicali*, 1588, p. 156)

25 Charles Burney, *The present state of music in France and Italy*, London 1773, p. 253, quoted in Hubbard, *Three Centuries*, p. 33. Barbieri, «The evolution» (in this volume), corrects the name to Mancini and supplies the information that her deceased husband, Giovanni Battista Pescetti, was second organist at the basilica of San Marco, Venice.

In his *Sopplimenti Musicali* of 1588 Zarlino related how he had ordered another harpsichord to be constructed, one which was an example of just intonation.²⁶ A drawing of the keyboard and a table of the intervals between the notes leaves no doubt as to what was intended: a compass with two d notes separated by a syntonic comma (ratio 80:81), having perfect fifths and thirds, with two e $\flat$, f $\sharp$, and b $\sharp$ notes (fig. 4). This is the same version of just intonation as Salinas described, except for the doubled e $\flat$ notes.²⁷ This instrument does not belong in the same category as Zarlinos's other (1548) harpsichord which extended the *tempered* tuning beyond the normal range of accidentals; this one merely supplies the normal range but with consonant thirds. This, or Salinas' harpsichord, must be the earliest Italian string keyboard instrument made for just intonation with split keys of which we presently have any record. Since Fogliano published his monochord in 1529 showing the octave division with two ds, separated by a comma, it is possible that others before Salinas and Zarlino had produced similar instruments.²⁸

VICENTINO: Vicentino's enharmonic harpsichord, the *archicembalo* is well known through his publication which included measurements of certain parts and drawings showing the keyboards.²⁹ It is not recorded when Vicentino first had such an instrument built, but a medal shows the *archicembalo* together with an *arciorgano*.³⁰

We do not know when Vicentino entered into the d'Este employment, but it may have been in the mid 1540s. Vicentino may have brought the *archicembalo* with him to Ferrara, but it is more likely that it was constructed before he left for Rome with his employer, Cardinal Ippolito d'Este, where

26 Gioseffo Zarlino, *Sopplimenti Musicali*, Venice 1588, p. 154: «poi che già molti anni sono iti, ch'io feci fabricarne uno con molto maggior numero di chorde & di Tasti, che non hanno i communi, al modo che si vede nella Tastatura posta dopo il seguente esempio». See also Barbieri, «The evolution», § 3.1 (in this volume).

27 See Salinas, *De Musica*, p. 117 and Berger, *Theories of Chromatic*, pp. 53–55, is one of the few commentators to have mentioned this instrument. See also Barbieri, «The evolution» (in this volume), who explains the use of the doubled e $\flat$ notes in § 5.1.

28 Ludovico Fogliano, *Musica Theorica*, Venice 1529, p. XXXIV^v. See also Barbieri's discussion of Hothby's instrument in «The evolution», § 5.2 (in this volume).

29 Nicola Vicentino, *L'Antica Musica Ridotta Alla Moderna Prattica*, Rome 1555, fols. 99–102.

30 See Barbieri, «I Temperamenti», p. 161, for a reproduction of this medal. Martin Kirnbauer informs me the most detailed information concerning the medal is to be found in Davide Daolmi, *Don Nicola Vicentino Arcimusico in Milano. Il beneficio ecclesiastico quale risorsa economica prima e dopo il Concilio di Trento. Un caso emblematico*, Lucca 1999 (= Quaderni dell'Archivio per la Storia della Musica in Lombardia 1), pp. 193–216.

he was resident by the autumn of 1549.³¹ Alternatively it might have been made under Vicentino's supervision in Ferrara after his return from Rome, which was evidently by late 1555, although Salinas' dating, suggested as 1538–1547 and mentioned above, speaks against this. However, when we consider the significance Vicentino attaches to consigning details of the archicembalo to posterity, and describing himself on the plaque beside the dedication in the *L'Antica Musica* as the inventor of the *archicembalo*, it seems unlikely that this instrument was merely on the drawing board at the time of his publication in 1555.³² From my understanding of the design principles of 16th-century harpsichords I infer that these measurements were derived by Vicentino from an *actual* instrument and do not represent the blueprint.³³ Indeed, the fact that he agreed to teach five or six persons of Cardinal Ridolfi's household in October 1549 to sing chromatic and enharmonic genera, together with Galilei's later testimony about the necessity of having keyboard accompaniment in performing enharmonic music so that the singers would not lose their way, suggests that he had the *archicembalo* with him in Rome.³⁴ This would also have enabled Salinas, who was also in Rome (see above), to have heard the instrument. Thus, we may infer that the *archicembalo* had probably been constructed before 1549.

Some details of the constructional information and dimensions are consistent with harpsichords made in Venice, which was a noted centre of musical instrument making in the 16th century. However, these are too involved to warrant further investigation here. Vicentino had studied with Adrian Willaert in Venice and Vincenzo Colombo, who worked in Venice, later built an *arciorgano* for him. Thus, it is not improbable that the maker of the *archicembalo* should have worked in Venice.

According to Bottrigari an *arciorgano* was also built for Cardinal Ippolito d'Este in Rome and Vicentino supervised the construction of another *arciorgano*.

31 This date is given for Vicentino's arrival in Rome by Henry W. Kaufmann, *The Life and Works of Nicola Vicentino (1511-c.1576)*, s.l 1966 (= Musical Studies and Documents 11), pp. 15–48, from which other dates below concerning Vicentino are drawn.

32 See Vicentino, *L'Antica Musica*, fol. 100r.

33 The reasoning behind this opinion is too complicated for discussion here and includes unpublished work in progress.

34 See Kaufmann, *The Life and Works*, p. 22 and Vincenzo Galilei, *Discorso intorno all'uso dell' Enharmonio [sic] et di chi fusse autore del Cromatico*, in Florence, Biblioteca Nazionale Centrale, Ms. Galileiani 3, fols. 3r–34v, fols. 9r–10r. The original text with English translation is given in Berger, *Theories of Chromatic*, p. 150 and p. 73 respectively.

gano in Milan shortly before he died, c1576.³⁵ It seems likely that Vicentino supervised the construction of the *arciorgano* in Rome, in which case this may have occurred during the period 1549–1552, or at the latest by 1555, and therefore may have been the first such *arciorgano*.³⁶

In addition to these two *arciorgani*, rather more details are known of an instrument made by Vincenzo Colombo of Venice by 1561 for Vicentino, which was evidently unknown to Bottrigari.³⁷ This had 126 pipes and two keyboards compared with the 132 notes of the *archicembalo*. The omission of six notes suggests that some of the longer, bass pipes may have been omitted for practical reasons. From the length of the longest pipe, given by Bevilacqua as seven feet, we may calculate that the lowest note would have sounded a C at a pitch of $a^1 = 411$ Hz, or at about $a^1 = 440$ Hz.³⁸

In the broadsheet describing the *arciorgano*, it is mentioned that Vicentino also had a harpsichord [*clavicembalo*] which was constructed in a similar fashion to the *arciorgano* and offered his services in teaching singers with these instruments.³⁹ By January 1563 Vicentino was no longer in the cardinal's employment so this proposed programme of teaching implies that there was a second *archicembalo* and already in his possession, since he could hardly have expected to have loaned out the Ferrara *archicembalo* of his

35 There has been some confusion about these instruments: Kaufmann, *The Life and Works*, p. 47, quotes Bottrigari as referring to the construction of an *archicembalo* in Milan. Christopher Stemberge in «The Cimbalo cromatico», p. 56, gives the details correctly. Maria Rika Maniates, *Ancient Music Adapted to Modern Practice*, New Haven, CT. & London 1996 (= Music Theory Translation Series), p. li, note 90, mentions both the *arciorgani* described by Bottrigari then double counts one of the *arciorgani* as an *archicembalo* under construction in Milan.

36 Between November 1552 and June 1554 the Cardinal and his entourage were in Siena. Stemberge, «The Cimbalo cromatico», p. 56, assumes that the Colombo instrument was the first *arciorgano*.

37 Johannes Wolf, «Das Arciorgano des Nicola Vicentino (1561)», in: *Der deutsche Instrumentenbau. Zeitschrift für Instrumentenbau und Instrumentenkunde* 35 (1900), pp. 299–302, and Henry W. Kaufmann, «Vicentino's *arciorgano*; an annotated translation», in: *Journal of Music Theory* 5 (1961), pp. 32–53, contain Nicolo Bevilacqua's [Bevilacqua in the original] description of the instrument, written in Venice. A facsimile of the broadsheet is given in Kaufmann, *The Life and Works*, p. 173.

38 The calculation is based on the Venetian foot of 347.7 mm., but the pitch depends on whether Bevilacqua gave the speaking length of the pipe (= 410 Hz) or the whole length including the foot (= approximately 440 Hz). As the closest point of comparison I have taken the speaking length of the F pipe of Lorenzo da Pavia's chamber organ built in 1494 that stood at $a^1 = 455$ Hz (± 4 Hz), as I have determined from replica pipe experiments. See also Stemberge, «The Cimbalo cromatico», p. 56, who suggests a compass of F-f³.

39 Kaufmann, «Vicentino's *arciorgano*», p. 39.

former employer, who at this time was in France. Galilei's record that Vicentino played his enharmonic music many times in the principal Italian cities shows that he had an instrument at his disposal around 1560. Thus, it appears probable there was at least another *archicembalo* and possible that the Ferrara instrument was the original *archicembalo*.

Luzzaschi's prowess in performing on Vicentino's *archicembalo* is well known from Bottrigari's account in 1594 of musical life at the Este court in Ferrara.⁴⁰ This information also makes clear that the vaguely-described «certo strumento Inarmonico» played by Luzzaschi in Ferrara was one of Vicentino's *archicembali*.⁴¹ Whether it was the original *archicembalo* cannot be conclusively established, even though Bottrigari and Artusi speak of the Ferrara *archicembalo* as if it were the only one Vicentino had caused to be made.⁴² It is to be presumed that Cardinal Ippolito had financed the construction of *this* instrument because it remained at the disposal of the court and was not taken by Vicentino when he left the Este employment c1560.

In any event it seems that the instrument Luzzaschi played was acquired by Antonio Goretti (a nobleman of Ferrara) between 1598 and 1602, as is briefly related by Artusi.⁴³ This occurred after the death of Alfonso II in 1597,

40 Hercole Bottrigari, *Il Desiderio*, Venice 1594, p. 41; translated by Carol MacClintock, s.l. 1962 (= Musicological Studies and Documents 9), pp. 1–62, pp. 50–51.

41 The reference to the «certo strumento Inarmonico» is found in Durante & Martelotti, *Cronistoria*, p. 193 (cited in note 3) and Stemberge, «The *cimbalo cromatico*», p. 56, who suggests the possible identity of this instrument, that played by Luzzaschi, and Vicentino's *archicembalo*.

42 For Bottrigari, see note 40; for Artusi see following note.

43 Georg Kinsky, «Kurze Oktaven auf besaiteten Tasteninstrumenten», in: *Zeitschrift für Musikwissenschaft* 2 (1919), pp. 71–72, (as Martin Kirnbauer has kindly reminded me) and Sibyl Marcuse, *A Survey*, p. 288, both refer to Artusi, without work or page reference as stating this. In Giovanni Maria Artusi, *L'Artusi overo delle imperfettioni della moderna musica*, Venice 1600, there is the «TAVOLA DELLE MATERIE PIU PRINCIPALI CONTENUTE NELLOPERA [sic]» where Artusi writes «Antonio Goretti tiene lo Instrumento di D. Nicola», with a page reference «1[illegible].b», (probably 15 b.), to which Martin Kirnbauer has re-directed my attention. On this page Artusi mentions an «Istrumento fatto secondo la divisione di Don Nicola Vicentino». This latter reference is ambiguous whether the *Istrumento* was *actually* Vicentino's or merely a harpsichord made following his idea. Given the clear statement «Goretti tiene lo strumento di D. Nicola» the probability must be that Artusi believed this to be *the* Vicentino *archicembalo*, although as argued above, it may only have been one of them. Bottrigari also records in a letter of 1602 that Goretti had acquired the instrument, indicating that he had read this information, presumably in Artusi's book, so Bottrigari cannot be regarded as an independent source of information on the change of ownership. See Berger, *Theories of Chromatic*, p. 159, note 53, who quotes this letter.

the last of the Este line in Ferrara. The timing is correct for this assumption, since an inventory in 1598 records an «instrumento cromatico con due tastadure una sopra l'altra» was at the court, although there is no mention of Vicentino or the maker of the instrument.⁴⁴ In a further inventory of the same year «Un Clavicimbalo cromatico con due testadure» is recorded, yet in an inventory of 1601 three of these instruments are not listed, suggesting that two of them and the «clavicimbalo cromatico» had been disposed of.⁴⁵

As Kinsky noticed, at least part of Goretti's collection was purchased by the Innsbruck court of Archduke Sigmund Franz and we know that in 1653 Hofpfennigmeister Johann Heinrich Steiger was sent to Italy to buy «ein Khunstkammer mit allen Instrumenten» from Lorenzo Goretti, Antonio's heir.⁴⁶ It appears probable that Vicentino's instrument is the one recorded in an inventory of 1665 after the Archduke's demise as «a double instrument with 2 keyboards all black keys are split, of cypress. The author who made it is called *Caesar de Pollastris* from Ferrara: has a cover which is red on the inside and green outside».⁴⁷ Again we find mention of two keyboards, an essential feature of Vicentino's *archicembalo* and rare in Italian harpsichords and the information that *all* the black notes are split. These two pieces of information are sufficient to identify beyond any reasonable doubt the instrument in Innsbruck as Goretti's *archicembalo*. It is unlikely that the two claviorgani in Cricca's inventory of 1598 with split sharps could be the Pollastris harpsichord since they are not recorded as having two keyboards.⁴⁸ One of these still survives (see W366 described below), but originally had only two divided accidentals per octave.

Of the instrument maker Caesar de Pollastris nothing is known beyond this inventory reference. The implication of the Innsbruck inventory that he came from Ferrara cannot be relied upon since another instrument in the same inventory is described as «von Ferrara», indicating merely that it came from the former Este collection.

44 See an Este inventory of 21.10.1598, in Durante & Martellotti, *Cronistoria*, p. 205 (no. 2805).

45 Durante & Martellotti, *Cronistoria*, p. 209 (doc. A210) and p. 212 (doc. A217).

46 See Kinsky, «Kurze Oktaven», p. 74, note 1, and Walter Senn, *Musik und Theater am Hof zu Innsbruck. Geschichte der Hofkapelle vom 15. Jahrhundert bis zu deren Auflösung im Jahre 1748*, Innsbruck 1954, p. 334.

47 See Franz Waldner, «Zwei Inventarien aus dem XVI. und XVII. Jahrhundert über hinterlassene Musikinstrumente und Musikalien am Innsbrucker Hofe», in: *Studien zur Musikwissenschaft* 4 (1916), pp. 128–147, p. 131: «Ein doppelts Instrument mit 2 Clavirn, so alle schwarz brochne Claves haben von Cypress. Der Author, der es gemacht, heißt *Caesar de Pollastris* von Ferrara; hat ein inwendig rot und auswendig grienes Fuetrall».

48 Durante & Martellotti, *Cronistoria*, pp. 208–209 (doc. A210).

Thus, it is probable that the Ferrara *archicembalo* played by Luzzaschi was acquired by Goretta and then bought by the Innsbruck court. Nothing is known of the ultimate fate of this Vicentino *archicembalo* but in 1768 it was still in Innsbruck, having been recorded in inventories of 1741 and 1768. After this it may have been sold or stolen, together with other instruments in the collection.⁴⁹

Fig. 5: Vicentino, *archicembalo* keyboard (from Barbieri, «I Temperamenti», p. 163)

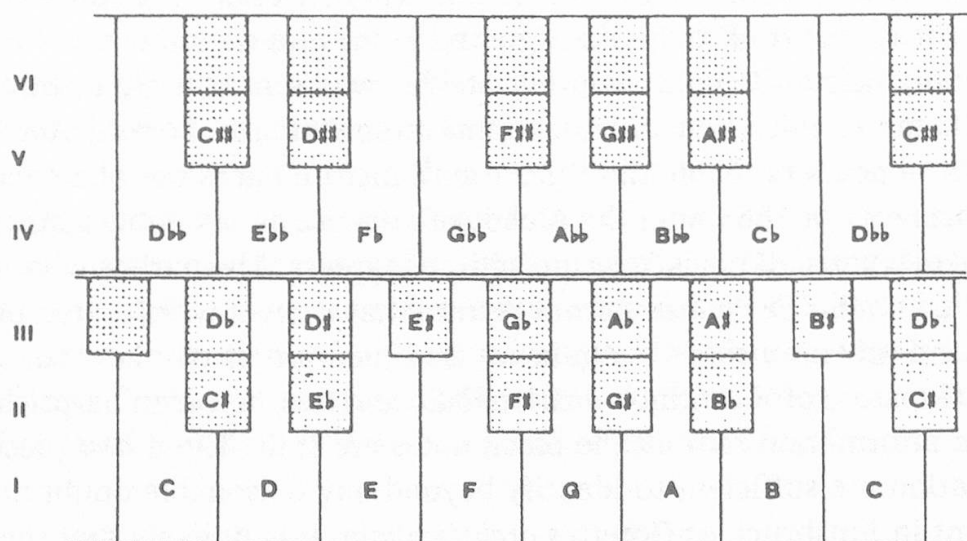


Fig. 5 shows the two keyboards of Vicentino's drawings but in Patrizio Barbieri's presentation which names all the notes as sharps or flats of their diatonic reference, rather than Vicentino's less easily understood method.⁵⁰ The sixth rank of keys is only employed in the second tuning when ranks IV-VI are to be tuned to yield perfect fifths to their counterparts on the lower keyboard.⁵¹

49 See Senn, *Musik und Theater*, pp. 340–341. Gerhard Stradner has kindly given me the benefit of his experience with these early Austrian inventories in tracing this history.

50 Barbieri, «I Temperamenti», pp. 160–168. The main sources dealing with the tuning are: Kaufmann, *The Life and Works*, pp. 163–174, and Henry W. Kaufmann, «More on the Tuning of the Archicembalo», in: *Journal of the American Musicological Society* 23 (1970), pp. 84–94; Marco Tiella, «The archicembalo of Nicola Vicentino», in: *English Harpsichord Magazine* 1 (1975), pp. 134–144; Mark Lindley, «Chromatic systems (or non-systems) from Vicentino to Monteverdi» (review of Berger, *Theories of Chromatic*), in: *Early Music History* 2 (1982), pp. 385–391. Maniates' translation, *Ancient Music*, is a useful aid in this context.

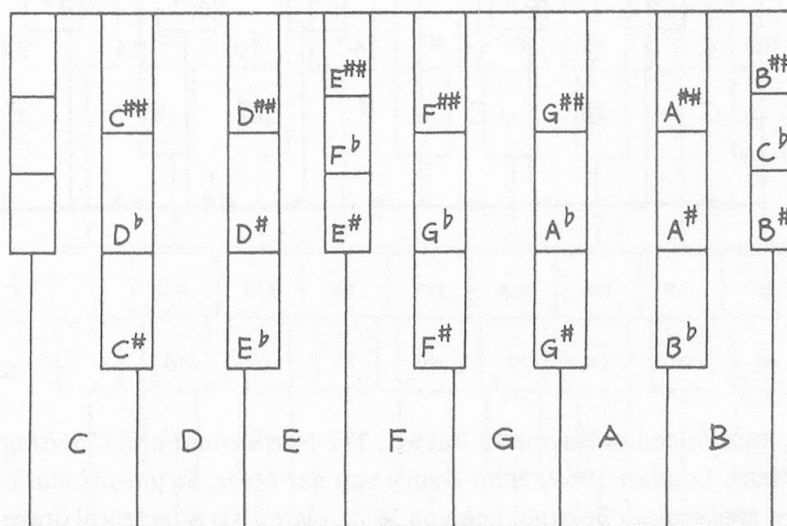
51 See Vicentino, *L'Antica Musica*, book V, ch. VI and especially Lindley, «Chromatic systems», who discusses intricate questions of the tuning.

TRASUNTINO: Three enharmonic instruments are known to have been made by «Vito de Trasuntinis» (as he usually signed his name on instruments), whose family name was Frassonio. Born 1526 in Treviso, he died some time after 1606 and was one of the most renowned Venetian string keyboard instrument makers of the 16th century, who was also called upon to judge the work of organ makers.⁵²

A Trasuntino harpsichord dated 1591 has only recently come to light again.⁵³ Although the original keyboard no longer survives it was established during its restoration by Christopher Nobbs that the original compass would have been C-c³ with 19 notes in each octave, i.e. with sharps and flats for each accidental key and E[#] and B[#]. This would have been identical with Vicentino's lower keyboard (fig. 5) and has not been illustrated separately.

In 1601 Trasuntino made another harpsichord whose existence is now only known through Martino Pesenti's description recorded in 1645, to which Christopher Stemberge has drawn attention.⁵⁴ Fig. 6 shows the keyboard described by Pesenti with its 28 notes per octave. The difference between Zarlino's instrument and this one is the provision of E^{###} and F^b as well as B^{###} and C^b. Strictly speaking we do not know the exact position of the notes, but the placement of F^b behind E[#] agrees with the order indicated on the *Clavemusicum Omnitonum*.

Fig. 6: 1601 Vito Trasuntino, 28-note keyboard



52 See Renato Lunelli, *Der Orgelbau in Italien*, Mainz 1956, p. 191 on Trasuntino's organ activity citing Caffi; Wraight, *The stringing*, part 2, pp. 291–292; Donald H. Boalch, *Makers of the Harpsichord and Clavichord 1440–1840*, 3rd ed. by C. Mould, Oxford 1995, p. 195 for further biographical details.

53 Ian Pleeth Collection, England.

54 Martino Pesenti, *Corrente*, introduction; Stemberge, «The Cimbalo cromatico», pp. 46–54. Kirkendale, *Emilio de' Cavaliere*, p. 149, conflates this instrument with the 1606 *Clavemusicum Omnitonum*.

One of the best known enharmonic instruments is the *Clavemusicum Omnitonum* made in 1606 for Camillo Gonzaga.⁵⁵ This tuning with 31 divisions for the octave yields a whole tone with five parts, as discussed by Michael Thomas.⁵⁶ The museum drawing of this instrument is an important record, but I know of only one description in print of the order of the keys, given by Claudio di Vérolì.⁵⁷ Since a monochord was made by Trasuntino to indicate the tuning, the intended pitch of each note is known and is shown in fig. 7. On this drawing Trasuntino's numbering has been included in order that the reader may be sure of understanding the actual pitch of these rare notes, e.g. that D $\flat\flat$ is lower in pitch than C $\sharp$.

Fig. 7: 1606 Vito Trasuntino, 31-note octave division *Clavemusicum Omnitonum*

	2		10		15		20		28	
	D $\flat\flat$		D $\sharp\sharp$		G $\flat\flat$		A $\flat\flat$		A $\sharp\sharp$	
	5		7	12	18		23		25	30
	C $\sharp\sharp$		E $\flat\flat$	F $\flat$	F $\sharp\sharp$		G $\sharp\sharp$		B $\flat\flat$	C $\flat$
	4		8	13	17		22		26	31
	D $\flat$		D $\sharp$	E $\sharp$	G $\flat$		A $\flat$		A $\sharp$	B $\sharp$
	3		9		16		21		27	
	C $\sharp$		E $\flat$		F $\sharp$		G $\sharp$		B $\flat$	
1		6	11	14	19	24	29			
C		D	E	F	G	A	B			

55 Photos are reproduced in Raymond Russell, *The Harpsichord and Clavichord*, 2nd ed. by Howard Schott, London 1959; John Henry van der Meer, *Strumenti musicali europei del Museo Civico Medievale di Bologna*, Bologna 1993, plate 141. A technical drawing is available from the Germanisches Nationalmuseum, Nuremberg, where the instrument was conserved. A conference was devoted to the study of this instrument and the music of the period in the Germanisches Nationalmuseum, Nuremberg in July 1985, but no conference proceedings were published. Lewis Jones has also given papers on this instrument at the Warburg Institute, London (private communication).

56 Michael Thomas, «The Development of the Tuning and Tone Colour of an Instrument made in Venice about 1500», in: *English Harpsichord Magazine* 1 (1975), pp. 145–153.

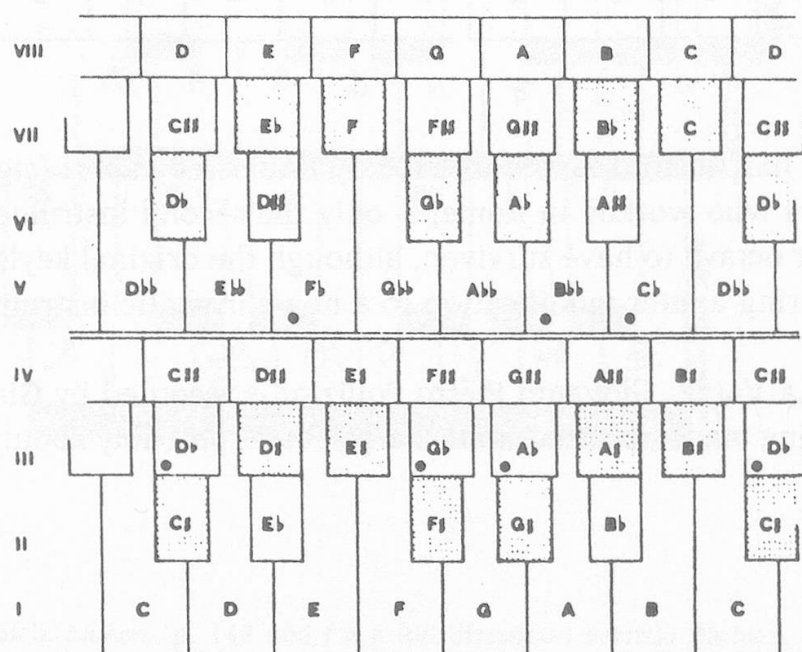
57 Claudio di Vérolì, *Unequal Temperaments and their Role in the Performance of Early Music*, Buenos Aires 1978, pp. 238–239. The instrument is conflated in the text with Vicentino's *archicembalo*. B $\sharp$ and C $\flat$ are not given in their correct positions.

From this drawing it is clear that the notes of Vicentino's *archicembalo* and the *Clavemusicum Omnitonum* are nominally the same but merely arranged in a different way: Vicentino uses two keyboards where Trasuntino provides extra split accidentals.

A general principle to be observed in Italian keyboards with split sharps is that the accidental *usually* employed is at the front of a divided key, the one less commonly used is placed further back. In the *Clavemusicum Omnitonum* the double sharps and double flats are also ordered analogously to this scheme. In Vicentino's *archicembalo*, however, the double sharps are all to be found in one row, as is also the case for Zarlino's harpsichord and the 1601 Trasuntino instrument.

STELLA: A visit in 1594 to Ferrara with Gesualdo apparently inspired Scipione Stella to construct an enharmonic instrument, which was described by Fabio Colonna in 1618. Fig. 8 shows Stella's keyboard which has 52 notes distributed over eight rows of keys.⁵⁸ This instrument is technically a fretted clavichord, which reduces the number of strings required.

Fig. 8: Stella, 31-note octave division (interpreted by Barbieri, «*La Sambuca Lincea*», p. 179)



58 See Patrizio Barbieri, «*La Sambuca Lincea di Fabio Colonna e il Tricembalo di Scipione Stella, Con notizie sugli strumenti enarmonici del Domenichino*», in: *La Musica a Napoli Durante il Seicento*, Atti del Convegno Internazionale di Studi, Napoli, 11–14 aprile 1985, ed. by Domenico Antonio D'Alessandro & Agostino Ziino, Rome 1987, pp. 176–187. I would like to thank Patrizio Barbieri for supplying a copy of this and some other articles cited here.

COLONNA: Colonna's own keyboard is shown in fig. 9, reported in the same volume as his description of Stella's keyboard. The *sambuca lincea* was built for Colonna by Francesco Beghini.⁵⁹ Both Stella's and Colonna's keyboards utilise a 31-note division of the octave and have been extensively described and analysed by Martin and Barbieri.⁶⁰

Fig. 9: Colonna, 31-note octave division *Sambuca Lincea* (interpreted by Barbieri, «La Sambuca Lincea», p. 179

VI		D	E	F	G	A	B	C	D	
V		CII	DII	EI	FI	GII	AII	BI	CII	
IV		D♭	E♭	F	G♭	A♭	B♭	C	D♭	
III		CI	DI	EI	FI	GI	AI	BI	CI	
II		D♯	E♯	F♯	G♯	A♯	B♯	C♯	D♯	
I		C	D	E	F	G	A	B	C	

FABBRI: The harpsichord, made in 1631 by Francesco Fabbri (signed Franciscus Faber) who worked in Rome, is only the second instrument having 19 notes per octave to have survived, although the original keylevers were removed during a later modification to a non-chromatic instrument.⁶¹

DONI / DELLA VALLE: Giovanni Pietro Pollizini is recorded by Giambattista Doni as having made an enharmonic harpsichord, probably about 1638–39,

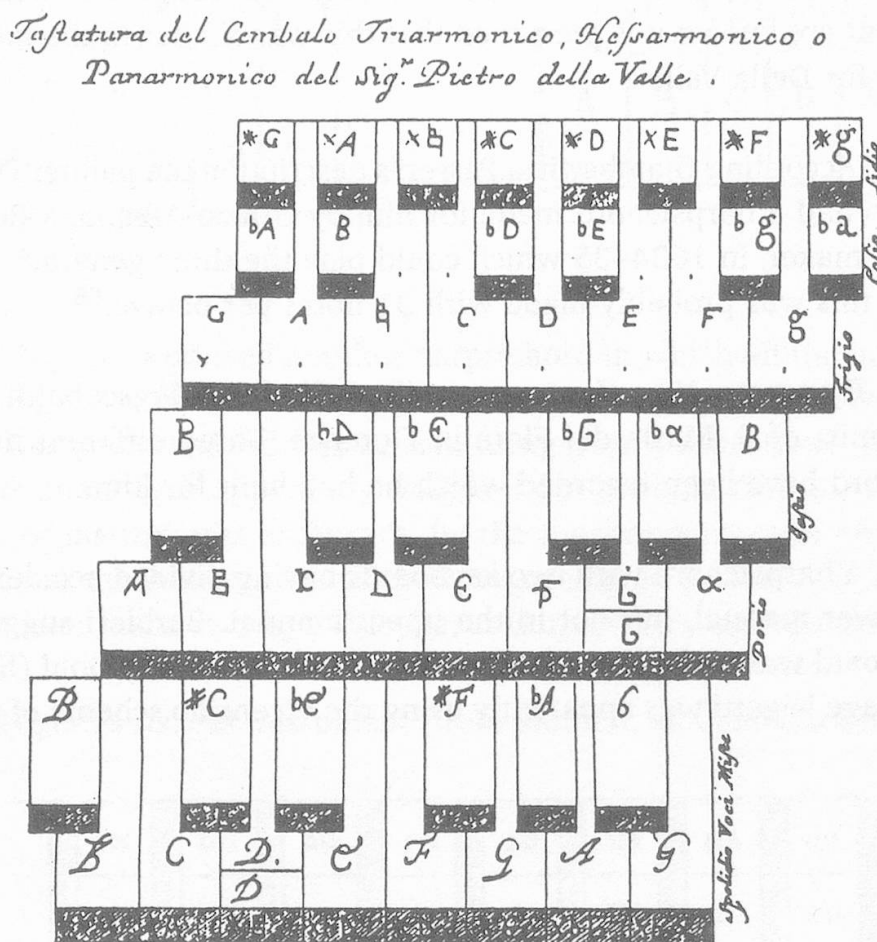
59 Fabio Colonna, *La Sambuca Lincea*, Naples 1618, p. 76. Beghini was paid 60 ducats for this instrument in 1621; see Barbieri, «La Sambuca Lincea», p. 199, who kindly drew this to my attention.

60 Martin, «The Colonna-Stella», and Barbieri, «La Sambuca Lincea», pp. 168–176.

61 Only a modified keyboard of a third instrument survives, as discussed under Giovanni Boni?, no. 2826 Collezione degli Strumenti Musicali, Rome, below. For evidence of Fabbri's activity in Rome see Patrizio Barbieri, «Cembalario, organaro, chitarraro e fabbricatore di corde armoniche nella «Polyanthea technica» di Pinaroli», in: *Recercare* 1 (1989), pp. 123–210, pp. 150–151.

from a design by Pietro Della Valle (1586–1652).⁶² He was following Doni's *cembalo triarmonico* described in 1635 which incorporated Doni's ideas of the ancient Greek modi and genera.⁶³ Doni published a drawing of the Della Valle keyboard (fig. 10), but Barbieri relates that contrary to the indications of the drawing, a tempered tuning was used rather than the doubled d keys, which imply just intonation.⁶⁴

Fig. 10: Della Valle, *triarmonico* (from Barbieri, «Gli Strumenti», p. 109)



62 See Boalch, *Makers*, p. 149 and for a full discussion Patrizio Barbieri, «Gli Strumenti Poliarmonici di G.B. Doni e il Ripristino dell'Antica Musica Greca (c.1630–1650)», in: *Analecta Musicologica* 30 (1998), pp. 89–91; p. 89, note 23 includes biographical details of Pollizini and instrument inventories.

63 Giovanni Battista Doni, *Compendio del Trattato de' generi e de' modi della musica*, Rome 1635, p. 43. See also Martin Kirnbauer, «Si possono suonare i Madrigali del Principe» – Die Gamben G. B. Donis und chromatisch-enharmonische Musik in Rom im 17. Jahrhundert» (in this volume).

64 Patrizio Barbieri, «Gli Strumenti Poliarmonici», p. 90, drawing on Doni gives this and other details of the instrument.

At this point we can note that Doni mentions harpsichords which he describes as *panarmonici*, built in Ferrara, Naples and Messina, with four, six, or even eight keyboards.⁶⁵ The reference to Ferrara may refer to a Nigetti harpsichord in Goretti's collection, and Naples may refer to Stella and Colonna's instruments. However, such instruments which are clearly Sicilian have not been identified.

POLLIZINI: A second instrument with three keyboards was made in 1649 by Pollizini and sent to Giovanni IV of Portugal.⁶⁶ Although no details of the instrument are known it is presumed that this was similar to the instrument he made for Della Valle.

ZAMPIERI: According Giambattista Passeri's description the painter Domenico Zampiero had a harpsichord made for him by Orazio Albana, a Roman instrument maker, in 1634–35 which could play the three genera.⁶⁷ Barbieri suggests this was probably made with 31 notes per octave.⁶⁸

NIGETTI: Francesco Nigetti was a pupil of Girolamo Frescobaldi and the first organist of S. Maria del Fiore in Florence. Three different models of harpsichord have been recorded which he had built for him.

1. c1640, a harpsichord with two keyboards having divided accidental keys in the lower manual, but not in the upper manual. Barbieri suggests that this keyboard was probably similar to one of those shown by Doni (fig. 11).⁶⁹ At this stage Nigetti was apparently using the Vicentino scheme of two keyboards.

65 Giovanni Battista Doni, *Annotazione sopra il Compendio de' Generi e de' Modi della Musica*, Rome 1640, p. 68, quoted and discussed in Patrizio Barbieri, «La Sambuca Lincea», pp. 213–214.

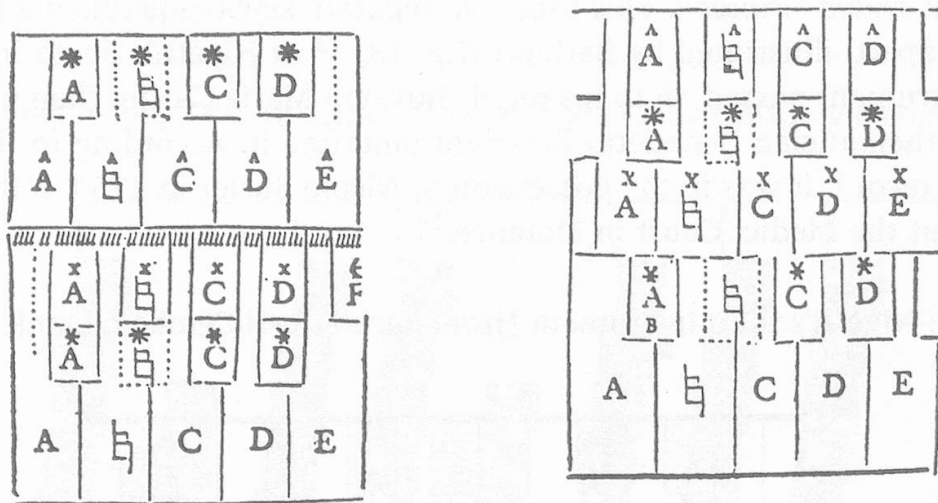
66 See Barbieri, «Gli Strumenti», p. 91.

67 Giambattista Passeri, *Vite de' pittori scultori ed architetti che hanno lavorato in Roma – Morti dal 1641 fino al 1673*, Rome 1772, p. 44. This can be found in a modern edition by Jacob Hess, *Die Künstlerbiographien von Giovanni Battista Passeri*, Leipzig & Vienna 1934, p. 67. Two virginals and four harpsichords can be attributed to Albana, but none has split keys. For details see Wraight, *The stringing*, part 2, pp. 16–20.

68 See Barbieri, «La Sambuca Lincea», pp. 209–214.

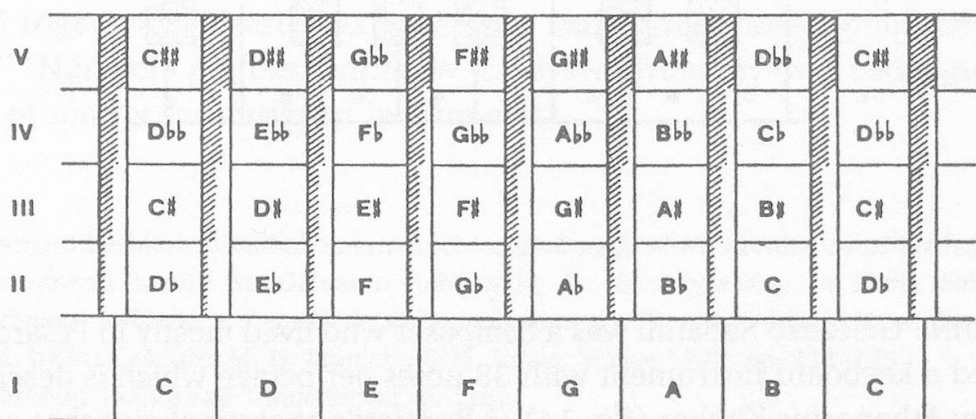
69 See Patrizio Barbieri, «Il Cembalo Onnicordo di Francesco Nigetti in due Memorie Inedite di G.B. Doni (1647) e B. Bresciani (1719)», in: *Rivista Italiana di Musicologia* 22 (1987), pp. 57–60. Nigetti's instruments are also discussed in a shorter version by Barbieri, «I Temperamenti», pp. 177–179.

Fig. 11: Nigetti's first instrument (from Barbieri, «Il Cembalo Onnicordo», p. 60)



2. c1644 Nigetti produced another harpsichord in which all the notes were white, i.e., the accidentals were not distinguished by a different colour. Barbieri has reconstructed this version using Doni's indications (fig. 12).⁷⁰ This instrument was apparently bought from Antonio Goretti, the noted collector of instruments in Ferrara, by the Innsbruck court in 1653 at the same time as the Pollastris harpsichord was acquired (see above).⁷¹ This instrument later found its way to Vienna, as Gerhard Stradner has described.⁷²

Fig. 12: Nigetti's second instrument (from Barbieri, «Il Cembalo Onnicordo», p. 61)



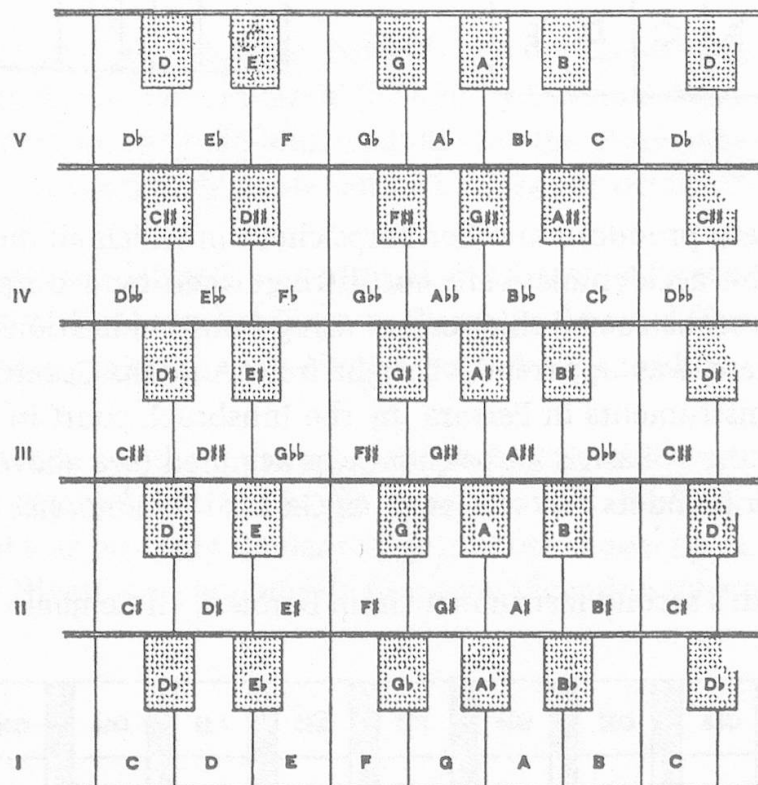
⁷⁰ See Patrizio Barbieri, «Il Cembalo Onnicordo», pp. 59–68.

⁷¹ See Senn, *Musik und Theater*, p. 340: «ein anderes Instrument mit vielen Clavieren [«5 Tastaturen» = gestrichen] von weißem Elfenbein, worauf die Florentinische Wappen und in der Mitte des Auctoris Francisci Nigetti Namen».

⁷² Gerhard Stradner, «Saitenklaviere in österreichischen Inventaren», in: *600 Jahre Cembalo-bau in Österreich*, ed. by Alfons Huber, Tutzing 2002, pp. 329–342.

3. 1670 is the date of the last version, which according to the Latin inscription on the nameboard was made using Vicentino's division of the octave and was called «Proteo». This used five separate keyboards tuned a fifth of a tone apart, illustrated by Barbieri (fig. 13).⁷³ At Nigetti's death in 1681 the instrument passed on to his pupil Giovanni Maria Casini, then in 1719 the mathematician Benedetto Bresciani inherited it. According to the last known record, it was in the possession of Nicolò Susier in 1754, a theorbo player at the Medici Court in Florence.⁷⁴

Fig. 13: Nigetti's third instrument (from Barbieri, «Il Cembalo Onnicordo», p. 54)



SABBATINI: Galeazzo Sabatini was a composer who lived mostly in Pesaro and devised a keyboard instrument with 38 notes per octave which is described only by Athanasius Kircher (fig. 14).⁷⁵ Barbieri's analysis shows that according to Kircher's information this instrument had a tone divided into five

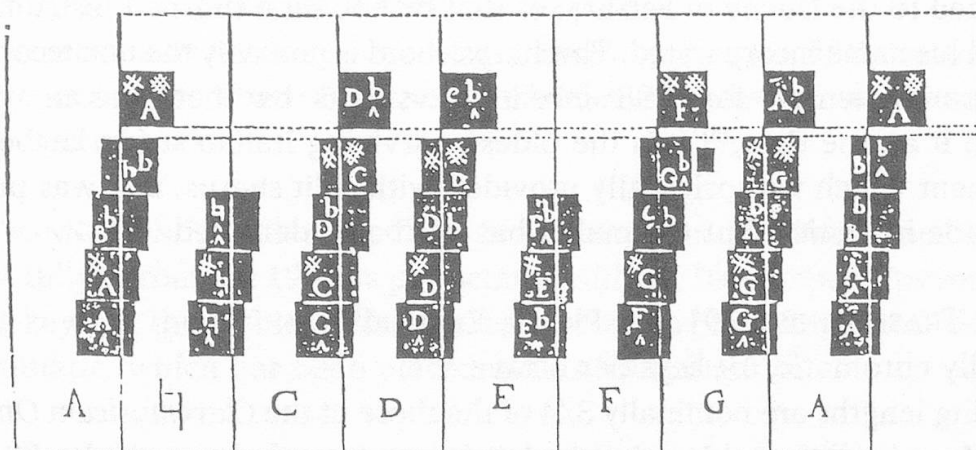
73 See Barbieri, «Il Cembalo Onnicordo», pp. 53–57.

74 See Barbieri, «Il Cembalo Onnicordo», pp. 68–76.

75 Athanasius Kircher, *Musurgia universalis*, Rome 1650, pp. 460–461.

parts, but unlike Vicentino's *archicembalo* did not have a tempered tuning.⁷⁶ Thus, this instrument represents another example of just intonation, as also discussed by Barbour.⁷⁷

Fig. 14: Sabbatini, 38-note octave division (from Kircher, *Musurgia universalis*, p. 461)



Complete list of surviving Italian string keyboard instruments originally provided with more than 12 notes per octave

Harpsichords

This survey includes three instruments already mentioned above, but they have been entered again here in order that all surviving harpsichords are listed together.⁷⁸ These lists supersede and correct ones I published earlier.⁷⁹ (Numbers prefixed with a W are drawn from my own catalogue and used primarily for unsigned instruments).

76 Patrizio Barbieri, «Cembali enarmonici e organi negli scritti di Athanasius Kircher – Con documenti inediti su Galeazzo Sabbatini», in: *Enciclopedia in Roma barocca – Athanasius Kircher e il museo del Collegio Romano fra Wunderkammer e Museo Scientifico*, ed. by M. Casciato, M. G. Ianniello & M. Vitale, Venice 1986, pp. 111–128.

77 Barbour, *Tuning and Temperament*, p. 110.

78 In order to save space I have not given a reference for each instrument to my thesis, Wright, *The stringing*, part 2 of which contains further details of all the instruments. An instrument signed 1670 Tollenari, in the Landesmuseum, Stuttgart, now has the following compass:

C-c³ + D^b, D[#], d^b, d[#]

The keyboard is new and the compass implausible; it has only been included here for the sake of completeness. There is no evidence this was originally built with split sharps.

79 Wright & Stemberge, «Italian Split-Keyed Instruments», pp. 152–157.

W366 FERRARA c1559–97, Schloß Köpenick, Berlin

C/E-c³ + F#, G#, d#, ab, d#¹, ab¹, d#²

From an analysis of the measurements and building methods in this and Venetian instruments it is now possible to confirm this compass. The name-board has been skillfully altered to include the initials of Alfonso II which leads to hypotheses that the instrument may have been ordered before he succeeded to the Duchy of Ferrara, or that he bought a finished instrument and had his name incorporated. This harpsichord is probably the one recorded in a Ferrara inventory for 1598 since it shows signs that there was an organ beneath it at one time.⁸⁰ It is the oldest, surviving Italian string keyboard instrument which was originally provided with split sharps, and was probably made in Venice, but the maker has not been identified.

VITI DE TRASUNTINIS 1591, Ian Pleeth, England⁸¹

C-c³ fully chromatic, 19 keys per octave

The string lengths are nominally 3/4 of the those of the *Clavemusicum Omnitonium* (see below) and it appears that it was intended to sound a fourth higher than the 1606 instrument.

VITO DE TRASUNTINIS 1606, Museo Civico, Bologna, no. 1766

C-c³ 31 keys per octave *Clavemusicum Omnitonium*

At least two reproductions of the instrument have been made: in the Germanisches Nationalmuseum, Nuremberg and by Lewis Jones, London.

GIOVANNI BONI 1619, Musée Instrumental, Conservatoire Royale, Brussels, no. 1603

C/E-c³ + F#, G#, d#, ab, d#¹, ab¹, d#²

80 See Durante & Martellotti, *Cronistoria*, p. 208 (doc. A210), where two instruments are described that fit the Schloß Köpenick harpsichord: «Un'istromento con li semitoni tagliati tutto lavorato di groppi con il suo organo sotto, n.1

Un'istromento da li semitoni tagliati, tutto di groppi, con il suo organo sotto, n.1»

On p. 207 (doc. A209bis), the third instrument is given as «Un istromento a doi registri e l'organo sotto» which would correspond to the Schloß Köpenick instrument since it surely did not have the three registers which are mentioned for the second instrument in this inventory.

81 This information was kindly supplied by Christopher Nobbs. «Viti» is the spelling he gives for the inscription.

GIOVANNI BONI 1619 [A]⁸² Vizcaya, Florida

C/E-c³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹, d^{♯2}

This instrument has an original Orazio Albana 1645 signature on the name-board which has been taken from another instrument.

GIOVANNI BONI c1619 [A], Alexander McKenzie of Ord, England

GG(AA?)-c³ + F[♯], G[♯], d[♯], ab, a[♯], d^{♯1}, ab¹, a^{♯1}

This instrument is remarkable for the multiple division of the natural keys in the bass. The exact designation of the bass notes has not been clearly determined.

GIOVANNI BONI?, Collezione degli Strumenti Musicali, Rome, no. 2826

C-c³ fully chromatic 19 keys per octave, without D^b and perhaps some divided keys in the treble. This may just be a modified keyboard, originally chromatic, which has been placed in this instrument.⁸³

W325 c1620 Anon., Russell Collection, Edinburgh, no. 2⁸⁴

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹, d^{♯2}

Although the maker of this harpsichord has not been identified a Roman or Florentine origin is possible, with Florence being more likely.

PASQUINO QUERCI c1625 [A], Musikinstrumenten-Museum, Leipzig, no. 75

C/E-c³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

This was previously known as a Zenti harpsichord dated 1653 (or 83) but a comparison of moulding profiles has revealed that it was produced in Querci's workshop.

82 The [A] abbreviation indicates that I have attributed an instrument to the maker indicated. For further details see Wraight, *The stringing*, Part 2.

83 See van der Meer, «Partiell und vollständig», p. 16. The harpsichord was originally made with 19-notes/octave, but according to Stembridge, «The Cimbalo cromatico», p. 37 note 6, citing Grant O'Brien, «there are no signs that the harpsichord ever had 19 divisions to the octave; the key-frame has clearly been cut at the bass end to make it fit into the harpsichord.» Stembridge describes how the present keyboard (not the harpsichord) appears to have been made from one which was originally intended to have been fully chromatic C-c³ «but without D^b and possibly without some of the chromatic keys in the top octave.» The present order of the naturals (as altered by GBC [=Giovanni Battista Boni, Cortona?]) with three divided keys in the bass octave, according to Barbieri, «Cembalaro», p. 137, example g is thus:

BB^b

AA BB D

GG C E F (hereafter normally)

84 W325 is a reference number in my catalogue; see Wraight *The stringing*, part 2, p. 327.

STEFANUS BOLCIONIUS 1627, Russell Collection, Edinburgh, no. HT1-SB1627.4
C/E-c³ + d[♯], a[♯], d^{♯1}, ab¹

This compass description was produced by Grant O'Brien following a detailed analysis of the construction of the instrument.⁸⁵

W139 1630 G.A., Collezione degli Strumenti Musicali, Rome, no. 1187
C/E-c³ + d[♯], a[♯], d^{♯1}, ab¹, a^{♯1}, d^{♯2}

This compass is given by John Henry van der Meer who found the missing keys for g[♯]/ab unusual.⁸⁶

FABBRI (FABER) 1631, Germanisches Nationalmuseum, Nuremberg, MIR 1072
C/E-c³ fully chromatic B[♯]-f²

This harpsichord is signed Franciscus Faber. The original compass of C/E-c³ was established by examination of the original balance pin holes, which show that the fully chromatic range was only from B[♯]-f².⁸⁷

FABBRI (FABER) Barbetta Restaurant, New York

C/E-c³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹, d^{♯2}, + a[♯]?

The compass is given as C/E-c³ with eight divided keys by Laurence Libin and Kathryn Shanks.⁸⁸

FRANCISCUS MARCHIONUS 1666, Yale, New Haven, no. 4882.61

C/E-c³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

According to Boalch all the sharps were divided, but Hubbard gives them thus.⁸⁹ Marchioni was from Florence but built this instrument in Rome. If this date is correct it is the last known Italian string keyboard instrument of this type.⁹⁰

85 Grant O'Brien, «Towards establishing the original state of the three-manual harpsichord by Stefano Bolcioni, Florence, 1627, in the Russell Collection of Early Keyboard Instruments, Edinburgh», in: *Galpin Society Journal* 53 (2000), pp. 168–200.

86 Van der Meer, «Partiell und vollständig», instrument no. 131.

87 Van der Meer, «Partiell und vollständig», instrument no. 21. The total number of notes is 65, and not 68 as reported by van der Meer, as corroborated by an independent, later examination; see Stemberge, «The *Cimbalo cromatico*», p. 36.

88 Laurence Libin & Kathryn L. Shanks, «A harpsichord from Sorrento», in: *Early Music* 18/2 (1989), pp. 216–218, p. 216.

89 See Boalch, *Makers*, p. 110; Hubbard, *Three Centuries*, p. 36.

90 See also Barbieri, «The evolution» in this volume, note 87 for details of Sarti's instrument in 1779–84.

W730 Collezione degli Strumenti Musicali, Rome (?no. 1868)

C/E-c³ + F[#], G[#], d[#], ab, d^{#1}, ab¹, d^{#2}

The compass given by van der Meer.⁹¹

Documentary evidence

The following two harpsichords are only known from a Florentine inventory of 1700.⁹²

DOMENICO DA PESARO 1566

The entry lists a compass of C/E-a² with 50 keys and F[#], G[#]. This would probably have been the following:

C/E-g², a² + F[#], G[#], d[#], ab, d^{#1}, ab¹, d^{#2} + a[#], a^{#1}

It was probably still an unmodified instrument in 1700. The measurements show it has a length similar to another Dominicus harpsichord but that the width is larger by the amount of the extra keys involved.⁹³ This is a rare indication of the manufacture of instruments in Venice with split sharps.

GIROLAMO ZENTI 1653

GG-c³ + d[#], ab, d^{#1}, ab¹, d^{#2} (probable)

It is unusual that a harpsichord whose compass extends to GG has split sharps.

Two Neapolitan harpsichords with split sharps are recorded in Cardinal Aldobrando's household in 1603.⁹⁴

Another claviorganum with split sharps is recorded in the same Ferrara inventories as W366 mentioned above.⁹⁵

A harpsichord is mentioned in a Ferrara inventory of 1598 as having split sharps.⁹⁶

91 Van der Meer, «Partiell und vollständig», instrument no. 125.

92 See Vinicio Gai, *Gli strumenti musicali della corte medicea e il museo del conservatorio 'Luigi Cherubini' di Firenze*, Florence 1969, p. 8. (Dominicus), p. 7 (Zenti).

93 See Wraight, *The stringing*, Part 2, p. 151, the instrument numbered W437.

94 See Frederick Hammond, *Girolamo Frescobaldi*, Cambridge, MA. 1983, p. 364, note 28.

95 See note 80. This instrument is one of the two cited by Stembridge in Wraight & Stembridge, «Italian Split-Keyed Instruments», p. 161.

96 Cited by Stembridge, «Italian Split-Keyed Instruments», p. 160. This is no. 2804 in Durante & Martellotti, *Cronistoria*, 205 (doc. A209), dated 21 October 1598, «Un instrumento adorato con la tastadura tagliata da due registri, n.1» but this might be one of the instruments mentioned above (see note 80), without reference to the organ. Slight differences in the descriptions of each inventory make it difficult to track the instruments.

A list of surviving virginals with more than 12 notes per octave

STEFANUS BOLCIONIUS 1629 [A], Deutsches Museum, Munich, no. 9231

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

This was previously known as «Petrus Centamin 1711» but is signed on the reverse of the nameboard «Stefanus Bolcionius Pratensis 1629» and a moulding comparison confirms that Bolcioni was the maker.

STEFANUS BOLCIONIUS 1627 [A], Musée de la Musique, Paris, no. E.980.2.638

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹, d^{♯2}

Formerly known as «Viti de Trasuntinis 1601» from a faked signature, but there is also a faded one by Bolcioni. Moulding comparisons also confirm he was the maker.

STEFANUS BOLCIONIUS 1641 [A], Musikinstrumenten-Museum, Leipzig, no. 09.279

C/E-f³ + F[♯], G[♯], ab, ab¹

Signed «Stefanus bolcionius Pratensis 1641».

STEFANUS BOLCIONIUS 16?? [A], Washington, DC, no 60.1392

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

«Ionnes Batt Boni da Cortona fecit Anno 1617» is on the nameboard but a moulding comparison shows that Bolcioni was probably the maker.

W451 POGGI [A], Musée Instrumental, Conservatoire Royale, Brussels, no. 1596

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

W440 POGGI [A], Musikmuseet, Stockholm

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

W327 POGGI [A], Russell Collection, Edinburgh, no. 45

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

W21 POGGI [A], Liverpool Museum (accession no. 1967.161.13)

C/E-f³ + F[♯], G[♯], d[♯], ab, d^{♯1}, ab¹

This has a faked signature «Baffo 1581».

Documentary evidence

A Florentine inventory at the Medici Court of October 1640 records two spinette with five split sharps which were probably made by Bolcioni and might therefore have had the following compass:⁹⁷

C/E-f³ + F[♯], G[♯], d[♯], a^b, d^{♯1}

From these surviving instruments it is clear that the additional accidentals were usually d[♯] and a^b. When a further accidental was provided it was usually a[♯], indicating that the circle of fifths was extended in the direction of the sharps rather than complementing all the diatonic notes with major and minor thirds, which would have required a d^b. It is usual that when additional d[♯] and a^b notes were provided the short octave bass was complemented with F[♯] and G[♯]. Only occasionally do we find Italian instruments which have F[♯] and G[♯] in the bass octave without additional split keys.⁹⁸

When we consult the list of virginals it is apparent that all of the instruments were built in Florence by only two makers, Bolcioni and Poggi around 1620–1641. This corrects an earlier view of the œuvre according to which the work was also Venetian, formed before the new attributions were available. It can be estimated how popular such virginals with split sharps were in Florence, since these eight instruments represent a quarter of the virginals we can be sure were made in Florence in the same period. The four instruments which Bolcioni and Poggi each provided with divided sharps represent half of Bolcioni's known virginal output and a quarter of Poggi's recorded production.

In a similar fashion we can see the strong representation of the eight Roman harpsichords among the 17 instruments listed here. When we compare the number Roman harpsichords having split sharps with the *total* Roman harpsichord production for the same period, then 8 of the instruments (out of a total of 14) shows an even stronger preference for divided

97 Frederick Hammond, «Musical Instruments at the Medici Court in the Mid-Seventeenth Century», in: *Analecta Musicologica* 15 (1975), pp. 202–19, p. 204, also cited in Wraight & Stembridge, «Italian Split-Keyed Instruments», p. 161: «Stefano Strumentaio Dua Spinette stauatr:e della Cassa con cinque semituoni spezzati». Riccardo Pergolis suggests reading this as «due spinette staccate della cassa», i.e. not attached, or inner-outer instruments in our modern parlance. Patrizio Barbieri, «Gli Strumenti Poliarmonici», p. 89 note 23, has established that the terminology «attacato alla cassa» indicated in Rome an instrument which is not separable from its apparent outer case, or false-inner-outer as we now call it.

98 One example is the oval-shaped *spinetta* recorded in an inventory (see Gai, *Gli Strumenti*, p. 10) by Bartolomeo Cristofori of 1690 with the compass C/E-c³ and F[♯], G[♯].

keys. Florentine harpsichords are less well represented with only two or three instruments.

The weighting which these statistics give to the popularity of instruments with split sharps could easily be substantially altered if it were possible to assign more of the several unsigned virginals and harpsichords to Roman or Florentine production. Nevertheless, the data available suggests that the manufacture of virginals and harpsichords with split sharps formed a significant part of the instrument makers' output in the first half of the 17th century.

Abstract

The article is a succinct survey of the whole field of the construction of Italian string keyboard instruments with divided accidentals. Twenty three multi-keyed instruments made between c1548 and c1650 are listed and briefly described together with illustrations of the keyboards used. These document the experiments with enharmonic instruments made by Vicentino and others. A complete checklist of surviving Italian instruments (15 harpsichords and 8 virginals) is presented. The recent identification of unsigned instruments now shows the extent that instrument making in Florence and Rome contributed to this œuvre between c1620 and c1650.

Zusammenfassung

Der Beitrag gibt einen knappen Überblick über italienische besaitete Tasteninstrumente mit geteilten Obertasten. Dreiundzwanzig «vieltönige» Instrumente, die zwischen etwa 1548 und 1650 gebaut wurden, werden kurz beschrieben, zusammen mit Abbildungen der verschiedenen Tastaturen. Sie dokumentieren die Experimente mit enharmonischen Tasteninstrumenten, wie sie von Vicentino und anderen in dieser Zeit angestellt wurden. Darüber hinaus wird eine vollständige Liste aller erhaltenen italienischen Instrumente dieser Art (fünfzehn Cembali und acht Virginalen) gegeben. Die unlängst erfolgte Zuschreibung von unsignierten Instrumenten zeigt, dass sich vor allem Instrumentenbauer in Rom und Florenz zwischen etwa 1620 und 1650 daran beteiligten.

Erweiterte Mitteltönigkeit und erweitertes Tonsystem: Frescobaldis *Cento Partite*, 12- und 19-tönig sowie neue Musik, 24-tönig

Johann Sonnleitner

Im Rahmen des Kolloquiums ging es in diesem Beitrag in erster Linie darum, Frescobaldis *Cento Partite sopra Passacagli* (1637) in verschiedenen Intonationen zu hören. Diese meisterhafte Variationenreihe über das fallende Tetrachord bzw. die bis zum Quint-Ton aufsteigende Skala ist für Hörübungen besonders geeignet, weil darinnen sowohl Diatonik und als auch Chromatik in reichem Ausmass und in den phantasievollsten Formen vorkommen und ausserdem, weil in diesem Werk Tonarten berührt werden, die in der damaligen Zeit noch weitgehend «tabu» waren.

Als Anhang zu dieser gar nicht theoretisch gemeinten, sondern möglichst am sinnlichen Phänomen bleibenden Darstellung eines historischen Meisterwerkes, wurde noch kurz die Gelegenheit wahrgenommen, auf einen zeitgenössischen musikalischen Ansatz hinzuweisen, den der Komponist und Musikforscher Heiner Ruland (*1943) ausgearbeitet hat. Dabei geht es durch die Einbeziehung der höheren Primzahl-Töne 7, 11, 13 in gewisser Weise um eine ähnliche Situation wie im Übergang vom Mittelalter zur Neuzeit. Damals wurde durch die Einbeziehung der Primzahl 5 (Naturterz 4:5) die vorher herrschende pythagoräische Tonordnung aus reinen Quinten aufgebrochen und die mitteltönige Terzenstimmung geboren. In den späteren «wohltemperierten» Zirkel-Stimmungen ringen die Terz und die Quint um einen Ausgleich. Auf dieser Grundlage kann nun versucht werden, durch die Einbeziehung der seinerzeit nur in der Volksmusik lebendigen, aber in der Hochkunst noch verpönten Intervalle die Stagnation unseres derzeitigen Tonsystems zu überwinden.

Für die Phänomenstudien standen drei Cembali und eine Art Clavichord zur Verfügung:

- 1.) Ein italienisches Cembalo in mitteltöniger Stimmung mit 19 Tönen, gebaut von André Extermann (Givrins 1999).
- 2.) Ein weiteres italienisches Cembalo in normaler mitteltöniger Stimmung mit 12 Tönen, gebaut von Gianfranco Facchini (Ravenna).
- 3.) Ein flämisches Cembalo in einer Zirkelstimmung (nach Valotti).
- 4.) Ein Klavikantal mit 24 Tönen pro Oktave. Dabei handelt es sich um eine Neuentwicklung auf der Grundlage des *Cymbal d'amour* von G. Silbermann (Clavichord mit doppelter Länge der Saiten, die in der Mitte von

der Tangente angeschlagen werden), gebaut von Florian Sonnleitner (Dornach 2001).

Als einleitende Übung wurden einzelne Basstöne angeschlagen, mit der Heiterkeit erregenden Frage, ob dies «Dur» oder «Moll» sei? Durch das Entdecken der reinen Dur-Terzen im Oberton-Klangmantel wurde man dafür sensibilisiert, erstens wie homogen Dur-Akkorde klingen, zweitens wie hingegen in jedem Molldreiklang ein Konflikt zwischen der Dur-Terz aus dem Obertonklang und der gespielten Moll-Terz ausgefochten wird. Drittens wie in leeren Quint-Klängen gleichsam in «homöopathischer» Verdünnung Dur erklingt, obwohl es gar nicht gespielt wird. Und viertens wie auf dem Instrument in ungleichschwebender Temperierung jede Tonart durch ein spezifisches «Vibrato» charakterisiert ist.

Dann wurde der 1. Teil der *Cento Partite* von G. Frescobaldi in drei Versionen gespielt:

1.) In erweiterter Mitteltönigkeit, 19-tönig:

Jeder Ton wie notiert, alle Akkorde, auch die der extremen Tonarten f-moll, As-Dur, b-moll und Des-Dur klingen genau so rein wie die normalen mitteltönig gestimmten Tonarten. Im Grunde merkt der Hörer kaum, dass der Bezirk der üblichen Tonarten überschritten ist. Alle Konsonanzen klingen «gleich schön».

2.) In normaler Mitteltönigkeit, 12-tönig:

Die letzten sieben Variationen des ersten Teiles werden gespielt unter «uneigentlicher» Verwendung der Tasten. Ein notiertes as und des werden durch ein gestimmtes gis und cis «ersetzt». Dadurch wird das Verlassen des Tonarten-Paradieses und das Betreten des Bereiches der Tabu-Tonarten schmerzlich bewusst.

Beispiel 1:

Frescobaldi, *Cento partite* (Rom 1637, p. 78) Variationen 43–44

(Var.43) 111

(Var.44) 115

(Var.45)

Es tritt auch ein hochinteressantes Phänomen im Zusammenhang mit den beiden Septakkorden in Variation 43 und 44 auf (siehe Notenbsp.1). Die Septime $b - as$ wird, weil as durch das als Naturterz zu e gestimmte gis ersetzt wird, so tief, dass es beinahe so rein wie eine Naturseptime 4:7 erklingt und mit den übrigen Dreiklangstönen wunderbar verschmilzt. Eine seltsame Umkehrung der Verhältnisse: notierte Konsonanzen klingen drastisch gespannt und notierte Dissonanzen verschmelzen harmonisch!

- 3.) Der entsprechende Abschnitt erklingt auf einer Zirkelstimmung (nach Valotti: 6 Quinten $-1/6$ Komma aufwärts zwischen f und h , die übrigen 6 Quinten rein):

Die Haupt-Tonarten behalten noch etwas von der mitteltönigen Charakteristik, die Extrem-Tonarten bleiben durch scharfe Terzen deutlich fühlbar.

Ausdrücklich wurde betont, dass mit diesen vergleichenden Hör-Studien keineswegs bestimmt werden will, welche Version die historisch «richtige» ist. Es ging um das Anregen einer hingebungsvollen Beschäftigung mit den klingenden Elementen, einem lange Zeit sinnenden Verweilen, dann werden die Phänomene ans Herz wachsen und geben jeder Interpretation, unabhängig von der gewählten Stimmung, eine ungeahnte Kraft.

In ähnlicher Weise wurden auch der zweite und der dritte Teil der *Cento Partite* gespielt mit Hinweisen darauf, wie sehr die jeweils gewählte Intonation die Spielweise eines sensiblen Spielers beeinflussen kann. Die durch «uneigentlichen» Gebrauch der Tasten-Töne entstehenden hochgespannten «Leit-Töne» bzw. die tiefgespannten «Gleit-Töne» (man verzeihe diese Ausdrucksweise einer späteren Aesthetik!) können so durch entsprechende Agogik zu wahren «Leid-Tönen» werden oder aber auch, nach historisch belegten Rezept, durch Trillerchen vertuscht werden.

Zum Schluss des Beitrages wurde versucht, eine Brücke zu schlagen von den Bemühungen der Alten Meister zu dem oben genannten Ansatz zur Erweiterung unseres Tonsystems durch Heiner Ruland. Als man in der Renaissance die Musik der griechischen Antike für die moderne Zeit fruchtbar machen wollte, hatte man hauptsächlich an eine Strömung der altgriechischen Musik angeknüpft, die mit einer gewissen Berechtigung als die «apollonische» bezeichnet wurde. Unsere herkömmlichen Kirchentonarten mit den durch verschieden gelagerten Ganz- und Halbtonschritten gestalteten Tetrachorden hängen damit zusammen. Vicentino und andere beschäftigten sich aber mit noch differenzierteren Skalen. Diese gehen zurück auf altgriechische Chromatik und Enharmonik.

Solche fallenden Tetrachorde wurden auf dem 24-tönigen Instrument (*Klavikantal*) vorgespielt:

1. Ein diatonisches Tetrachord: c, b, as, g (siehe auch *Cento Partite*)
2. Ein chromatisches Tetrachord: c, a, as, g
3. Ein enharmonisches Tetrachord: c, as, vierteltönig vertieftes as, g

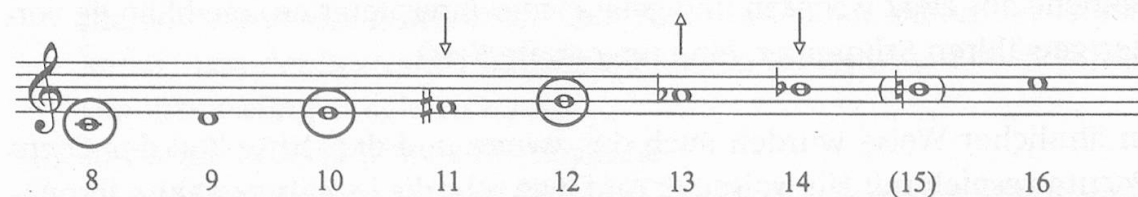
Der andere Strom der altgriechischen Musik betrifft die «dionysischen» Aulos-Skalen, die von Kathleen Schlesinger zu Beginn des 20. Jahrhunderts erforscht wurden. Diese haben ihre Grundlage in Ausschnitten der sogenannten «Untertonreihe». Eine dieser Aulosskalen wurde gespielt (siehe Notenbeispiel 2a):

Beispiel 2a: «Aulos-Skala»



Beispiel 2b: «Alphorn-Skala»

(8. bis 16. Partialton der Naturton- oder Obertonreihe)

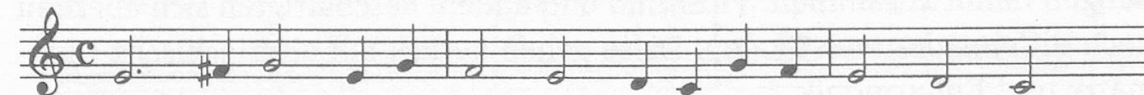


In ihr ist ein «f-moll»-Akkord verborgen. Musik aus dieser und ähnlichen, verwandten Skalen findet sich in nordischer und osteuropäischer Volksmusik. Spiegelt man diese Intervallverhältnisse, so erscheint die Alphorn-Skala (siehe Notenbeispiel 2b), die ihre zahlenmässige Verankerung in der Naturton- oder Obertonreihe (8. bis 16. Partialton) hat.

Auch die Alphornskala erklang auf dem *Klavikantal*. Die Intervalle opfern in der vierteltönigen Temperierung wohl ihre völlige Natur-Reinheit, können aber durch den Anschlag auf dem Clavichord-ähnlichen Instrument wieder «bereinigt» werden.

Es ist hinzuweisen auf die italienische Volksweise «Girolmeta», die von Frescobaldi in seinen *Fiori musicali* zu einem Capriccio verarbeitet wurde (Notenbeispiel 3).

Beispiel 3: Volksweise «Girolmeta»



Der Übergangston zwischen Terz und Quint wird auf entsprechenden Volksinstrumenten als 11. Oberton (sogenanntes Alphorn-Fa) intoniert, der zwischen f und fis liegt. Frescobaldi schreibt im Steigen der Melodie fis und im Fallen f. Dabei ist von Vorteil, dass in der mitteltönigen Stimmung f ein hoher Ton, fis aber ein tiefer Ton ist, was den Verhältnissen der Alphornskala sich annähert.

Zur Exemplifizierung des erweiterten Tonsystems konnte aus Zeitgründen nur ein ganz kurzes Übungsstück aus einem Zyklus von Heiner Ruland gebracht werden (siehe Beispiel 4 im Anschluss). In diesem kommt von den «neuen» Intervallen nur die Quart 8:11 vor, und dies in zwei Formen:

1. im Sinne von A-Dur, als «goldener Mittelweg» vom Terzton cis zum Quintton e, also weder als d noch dis, sondern dazwischen als «di» und
2. im Sinne von a-moll, zwischen dem Terzton c und dem Grundton a vermittelnd, also weder als h noch b, sondern als vierteltönig vertieftes h, genannt «he».

Dass dieser Übergangston in Dur zwischen Terz und Quint liegt, in Moll aber zwischen Terz und Grundton, wird verständlich, wenn Moll nicht als eine Parallel-Erscheinung von Dur aufgefasst wird, sondern als dessen Spiegelung: vom Grundton ausstrahlende Dur-Gebärde bzw. zum (im Zentrum der Skala liegenden) «Grundton» sich einziehende Moll-Gebärde.

Die Sexte 8:13 und die Septime 4:7 treten in diesem allerersten Übungsstück noch nicht auf, werden in den weiteren Stücken der Reihe nach eingeführt und erleben in Rulands reichem vokalen und instrumentalen Werk ihre volle Entfaltung.

Sicherlich sind die erweiterte Mitteltönigkeit bei Frescobaldi und das erweiterte Tonsystem bei Ruland nicht direkt in Parallele zu setzen. Deutlich handelt es sich da und dort um verschiedene Situationen und Tendenzen. Bei Frescobaldi geht es um die Ausweitung des Bereiches der damals üblichen Tonarten. Dabei bleibt fraglich, ob er entweder mit der Rein-Intonation aller Dur-Terzen gerechnet hat, oder ob er die Beschränkung der normalen Mitteltönigkeit künstlerisch ausgenutzt hat oder sogar schon mit Ausgleichstimmungen gearbeitet hat. Letzteres hat ja in der weiteren Entwicklung stattgefunden und führte schliesslich zum Ausspielen des gesamten Zwölfkreises der Töne. Bei Ruland geht es um die weitere Ausgestaltung dieses Zwölfkreises durch die Einbeziehung von Intervallqualitäten, die in der Volksmusik verschiedener Länder und Epochen leben bzw. lebten und die für die Zukunft fruchtbar gemacht werden können.

So wie die vielen Möglichkeiten der ungleichschwebenden, «wohltemperierten» Stimmungen seit Werckmeister und Bach die Transposition der üblichen Dur- und Moll-Skala in alle Tonarten erlaubte und dabei auf eine feine Differenzierung des Tonartencharakters nicht nur verzichten musste, sondern diese bis ins Klangliche hinein erst so recht auszugestalten wusste, so bleibt auch beim 24-tönigen Zirkel aus der Quart 8:11 der herkömmliche Quintenzirkel selbstverständlich erhalten, kann auch tonarten-differenziert eingestimmt werden und taugt in der Praxis doch für das sanft temperierte Spiel der «Alphorn- und Aulos-Skalen» in allen 12 Tonarten. In beiden Fällen, ob nun bei der Erweiterung der mitteltönigen Tonordnung oder bei der Erweiterung unseres Tonsystems im Sinne Rulands, geht es darum, in künstlerischer Arbeit gewisse zeit- und bewusstseinsbedingte Begrenzungen von innen her zu überwinden zugunsten einer Weiterentwicklung unserer Tonwelt.

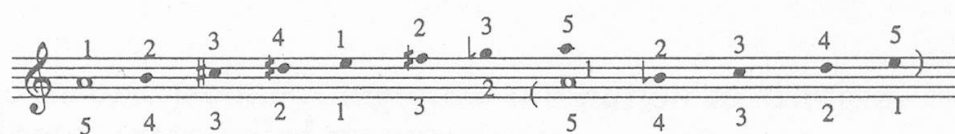
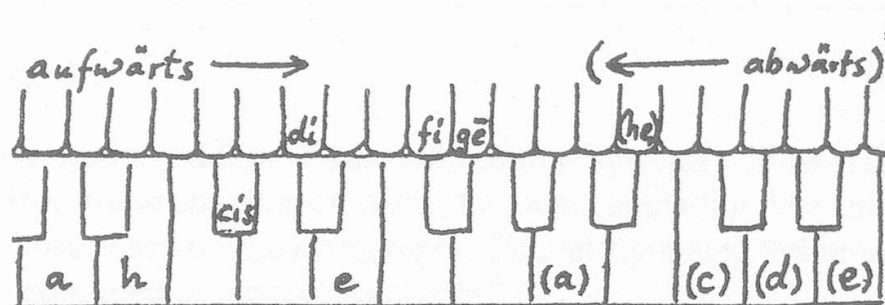
Beispiel 4:

Heiner Ruland, «Sonntag» (aus dem Hohenfriedler Orgelheft. Sieben kleine Übe- und Spielstücke zu den Wochentagen für Vierteltonorgel), 1985.

Beispiel 4:

Hermann Pfrogner zugeeignet

Sonntag A-Dur (a-moll)



(Töne von * bis *)

strahlend, froh

♯ = vierteltönige Erhöhung
 ♭ = vierteltönige Erniedrigung

The evolution of open-chain enharmonic keyboards c1480–1650

Patrizio Barbieri

Only just intonation and meantone enharmonic systems will be taken into account below: these are all open-chain, i.e., non-circulating. The circulating ones, i.e., those based on the many types of Equal Tempered Systems (ETS), have been examined in a previous article.¹

1. Basic theory: from Pythagorean intonation to sistema partecipato, later called meantone

1.1. The Pythagorean system in use up to the 15th century was generated from a chain of perfect 5ths: the customary twelve notes of the octave could be obtained with the scheme illustrated in Table 1, the zero exponents signalling that each successive note has been reached by a pure, that is, a beatless 5th. This scheme produced major 3rds (e.g., C⁰-E⁰) enlarged by a syntonic comma (ratio 81:80, $\cong$ 21.5 cents; hereinafter called simply a comma) compared to the consonant ratio 5:4, and minor 3rds (e.g., C⁰-E^{b0}) narrowed by the same amount, with reference to their consonant ratio 6:5.

Table 1 – Pythagorean tuning with harmonic range E^b-G[#]

... E^{b0} B^{b0} F⁰ C⁰ G⁰ D⁰ A⁰ E⁰ B⁰ F^{#0} C^{#0} G^{#0} ...

In the Renaissance, when such intervals began to be used harmonically, theoreticians tried narrowing one 5th in each four by exactly a comma, as a means of keeping all the major 3rds and three-quarters of the minor ones consonant. For example, one might narrow the 5ths B^b-F, D-A, and F[#]-C[#], obtaining the tuning of Table 2.

1 Patrizio Barbieri, «I temperamenti ciclici da Vicentino (1555) a Buliowski (1699): teoria e pratica «archicembalistica»», in: *L'organo* 21 (1983), pp. 129–208.

Table 2 – Typical just intonation

	$C^{\sharp-2}$	$G^{\sharp-2}$	...	
	A^{-1}	E^{-1}	B^{-1}	$F^{\sharp-1}$
F^0	C^0	G^0	D^0	
...		E^b+1	B^b+1	

Here the exponents indicate the cumulative alterations of pitch, in commas, with respect to the Pythagorean scale of Table 1. With this kind of exponential notation one can indicate whether a note is a comma lower or higher than its pitch in Pythagorean intonation, thereby clearly identifying all the possible consonant major and minor triads. For example, in $C^0-E^{-1}-G^0$, E must be a comma lower (therefore⁻¹) than its pitch given by Pythagorean intonation (Table 1) in order to be a just major 3rd with C^0 and a just minor 3rd with G^0 . Conversely in $C^0-E^b+1-G^0$, E^b must be a comma higher than its Pythagorean pitch for the same reasons (therefore⁺¹). It can also be seen that D has neither the just minor 3rd nor the just 5th above, the dissonances being, respectively, D^0-F^0 and D^0-A^{-1} . Moreover, now we have two kinds of tone: major (e.g., $C^0-D^0 = 9:8$) and minor (e.g., $D^0-E^{-1} = 10:9$). In fact some tones are formed by two just 5ths ($C^0-G^0-D^0$), while others present one of the two 5ths narrowed by one comma ($D^0-A^{-1}-E^{-1}$).

From the historical perspective, Bartolomeus Ramis de Pareja (1482) was the first theoretician to become aware of the evolution of the intonation towards just ratios.² Almost fifty years later, Ludovico Fogliano (1529) is credited with introducing the doubled Ds and Bbs, separated by a comma, in order to supply the just D-A and Bb-F 5ths of the diatonic genus (Table 3).³

Table 3 – Fogliano's just intonation (1529)

	D^{-1}	A^{-1}	E^{-1}	B^{-1}	
B^b0	F^0	C^0	G^0	D^0	
				B^b+1	

2 On this subject see Mark Lindley, «Fifteenth-Century Evidence for Meantone Temperament», in: *Proceedings of the Royal Musical Association* 102 (1975–76), pp. 37–51. In Italian texts the term «sintonico» is usually found where in English one speaks of «just» (intonation or tuning).

3 Ludovico Fogliano, *Musica theórica* [...], Venezia: De Sabio 1529, fol. 34v; Giovanni Battista Doni, *Annotazioni sopra il compendio de' generi e de' modi della musica* [...], Roma: Fei 1640, p. 40 («conforme all'inventione del Fogliano»).

1.2. The practical problem in performance was to avoid the dissonant, narrowed 5ths, such as D^0-A^{-1} . In vocal intonation this could be obtained by transforming, when needed, the same tone from major to minor or vice versa (e.g., C^0-D^0 , C^0-D^{-1}), but, analysed statistically, after a few of these manipulations this could cause a notable pitch alteration, up or down, since commas added might not be compensated by those subtracted. The Venetian mathematician and amateur composer Giovanni Battista Benedetti – in a letter to his friend Cipriano de Rore, published in 1585 – is the first author to draw attention to this pitch shift, providing also two extreme examples of its surprising effects (Ex. 1).⁴

Ex. 1: Giovanni Battista Benedetti (1585): pitch shift due to just intonation. If all intervals are intoned purely the pitch will shift:

(a) upwards by 1, 2, 3, 4 commas, because the upper voice is going up by a major tone (T) and down by a minor one (t).

(b) downwards by 1, 2, 3 commas, because in this case the upper voice is going down by a major semitone (S) and up by a minor one (s).

System (a) intervals: T, t, +1, +2, +3, +4

System (b) intervals: S, s, -1, -2, -3

System (a) pitch names (top to bottom):
 G^0 A^0 A^0 G^{+1} G^{+1} A^{+1} A^{+1} G^{+2} G^{+2} A^{+2} A^{+2} G^{+3} G^{+3} A^{+3} A^{+3} G^{+4} G^{+4} G^{+4}
 D^0 D^0 E^0 D^{+1} D^{+1} E^{+1} E^{+1} D^{+2} D^{+2} E^{+2} E^{+2} D^{+3} D^{+3} E^{+3} E^{+3} D^{+4} D^{+4} D^{+4}
 G^0 D^0 C^{+1} G^{+1} D^{+1} C^{+2} G^{+2} D^{+2} C^{+3} G^{+3} D^{+3} C^{+4} G^{+4} D^{+4} C^{+4} G^{+4} D^{+4}

System (b) pitch names (top to bottom):
 D^0 $C^{\#-2}$ $C^{\#-2}$ D^{-1} E^{-2} D^{-1} $C^{\#-3}$ D^{-2} E^{-3} D^{-2} $C^{\#-4}$ D^{-3} E^{-4} D^{-3}
 G^0 G^0 A^{-1} D^{-1} G^{-1} G^{-1} G^{-1} A^{-2} D^{-2} G^{-2} G^{-2} G^{-2} A^{-3} D^{-3} G^{-3}
 G^0 E^{-1} A^{-1} G^{-1} E^{-2} A^{-2} G^{-2} E^{-3} A^{-3} G^{-3}

4 Giovanni Battista Benedetti, *Diversarum speculationum mathematicarum, et physicarum liber*, Torino: Bevilacqua 1585, p. 279. Later on, this pitch shift was also mentioned by Vincenzo Galilei, *Discorso intorno all'opere di messer Gioseffo Zarlino da Chioggia [...]*, Firenze: Marescotti 1589, p. 121. A computer assisted performance of the above examples was provided on the occasion of my paper on «Fretted strings versus vocal intonation: Enharmonic proposals in the Baroque» at the colloquium in Basel.

On the other hand, with regard to keyboard instruments, the problem could be solved in two ways:

1. By splitting the bottom key of the narrowed 5ths into two notes separated by a comma (Ex. 2).
2. By transforming both major and minor tones into a *mean tone* and thus unifying the split keys that are separated by a comma. This could be achieved through one of the many kinds of «meantone» temperament, of which the best known was 1/4-comma meantone (Table 4). This tuning left untempered one of the main intervals of the original just intonation scale, the major 3rd. Instead of narrowing one 5th in each four by a comma (thereby changing it to a dissonant interval), each one of the four 5ths was narrowed by 1/4-comma.

Ex. 2: The same score of Ex. 1, but intoned according to the tuning of Table 2: the pitch will be stable, but a 5th (D^0-A^{-1}) or a 4th ($A^{-1}-D^0$) will be mistuned by one comma. A solution could be to use the intonation of Table 3, shifting from D^0 to D^{-1} (and vice versa) when necessary.



G°	A-1	A-1	G°	G°
D°	D°	E-1	E-1	D°
G°	D°	C°	C°	G°



D°	C#-2	C#-2	D°	D°	E+1	D°
G°	G°	A-1	D°	G°	G°	
G°	E-1	A-1	A-1		G°	

Table 4 – Quarter-comma temperament (meantone)

	$C\sharp^{-7/4}$	$G\sharp^{-2}$	...	
	$A^{-3/4}$	E^{-1}	$B^{-5/4}$	$F\sharp^{-6/4}$
$F^{+1/4}$	C^0	$G^{-1/4}$	$D^{-2/4}$	
...		$E\flat^{+3/4}$	$B\flat^{+2/4}$	

1.3. The first theoretician who endeavoured to provide a quantitative interpretation of the $1/4$ -comma meantone is the above mentioned Ludovico Fogliano (1529). Referring to Table 3 he rather naively unified the two Ds into a single geometrical mean ($D^{-1/2}$), though correctly making use of a graphical construction reported in Euclid's *Elementa*; the same operation was then extended by him to the two B $\flat$ s.⁵

Other kinds of meantone, leading to imperfect consonances more or less close to the just ratios, were those narrowing each of the 5ths by $2/7$ or $1/3$ -comma. And even these two provided tones of only one size, that is, a mean between the major and the minor, which is indeed a feature common to all «regular» temperaments (i.e., to those narrowing by the same amount each one of the tuned 5ths). Gioseffo Zarlino – who in 1558 and in 1571 was the first to provide a quantitative evaluation both of the $2/7$ and $1/4$ -comma temperaments and also mentioned the $1/3$ -comma variant – surprisingly enough repeatedly states that only the $1/4$ -comma tuning produced tones of one size.⁶ The first to clearly state that all the three temperaments were provided with a mean tone was Francisco Salinas (1577).⁷

At least since 1496, such temperaments were simply called «partecipazione», or «sistema partecipato».⁸ According to the mathematician Lemme

5 Fogliano, *Musica theorica*, fol. 35v.

6 Further on the subject see below. Zarlino's slip has already been remarked by Roberto Airoldi, *La teoria del temperamento nell'età di Gioseffo Zarlino*, Cremona: Turris 1989, pp. 57 and 106.

7 Francisco Salinas, *De musica libri septem* [...], Salamanca: Gastius 1577, p. 143ff. Further on, on p. 164 Salinas correctly observes that — in passing from $1/3$ - to $2/7$ - to $1/4$ -comma — the ratio of temperament of the major tone / minor tone tends to 1, through a harmonic progression.

8 See e.g.: Franchino Gaffurio, *Practica musice*, Milano: Lomazzo 1496, fol. ddIv (Lib. III, Cap. III); Fogliano, *Musica theorica*, fol. 35v; Giovan Maria Lanfranco, *Scintille di musica* [...], Brescia: Britannico 1533, pp. 131–136. In this regard it is curious recalling that, according to Giuseppe Unicornio, a mathematician from Bergamo writing in 1598, still in his time some ancient organs were preserving the harsh 3rds and 6ths of their original Pythagorean tuning, being «senza partecipazione»: Patrizio Barbieri, «An Unknown 15th-century French Manuscript on Organ Building and Tuning», in: *The Organ Yearbook* 20 (1989), pp. 5–20, p. 20.

Rossi (1666), this designation was due to the fact that the systems thus obtained were taking the most advantageous «parts» (i.e., features) from both the Pythagorean (with equal-sized tones) and just intonation (with just 3rds and 6ths).⁹ That this kind of temperament was in fact regarded as a true «system» is confirmed by the German Joachim Junge (1587–1657), who lists together the following:

- «Scala diatonica vetus» (= Pythagorean)
- «Scala diatonica nova» (= Just Intonation)
- «Scala diatonica reformata» (= 1/4-comma)¹⁰

The term «meantone temperament», which today many authors apply only to the 1/4-comma version, is instead of a much later date.¹¹

1.4. The above considerations refer only to keyboard instruments. That this tempered intonation could be shared also by unaccompanied singers was highly debated in the late 16th century by Zarlino and Vincenzo Galilei, the former blatantly stating that a strict just intonation was sung, the latter – on the contrary – that just intonation was not strict, but somehow tempered.¹² Without going into detail, it may be noted that Zarlino's position is in any case contradictory. In fact he states that «all» consonances are sung pure, even the comma-affected 5ths, without taking into account that in this way (1) there should have been a more or less marked pitch shift (see Ex. 1), or, (2) if the singers, in order to avoid both the mistuned consonances and the

9 Lemme Rossi, *Sistema musico overo musica speculativa* [...], Perugia: Laurenti 1666, p. 58: «Onde per tor via l'ineguaglianza de' tuoni, si venne a formare un nuovo Sistema, che chiamano temperato, o' partecipato, partecipando dell'uno, e dell'altro Diatono espliciti; poichè quanto all'haver'i tuoni eguali è simile al Diatono Ditonio [= Pythagorean], e nel resto poco si discosta dal Sintono».

10 Joachim Jungius, «Harmonicae definitiones», in: Id., *Praecipuae opiniones physicae* (posthumous work), Hamburg 1679, fol. [B4]v. Junge was a polymath: in 1618 he went to Padova, where he graduated in medicine; Robert Eitner, *Biographisch-Bibliographisches Quellen-Lexicon* V, Leipzig: Breitkopf & Härtel 1901, p. 311.

11 According to Airoldi, *La teoria del temperamento*, p. 8, it seems to have been employed for the first time by Pierre Galin (1818). But it is only with Alexander J. Ellis' famous *Additions* to his English translation of Hermann L.F. Helmholtz, *On the sensations of tone* [...], London: Longmans 1885, p. 433, that the term «meantone» became the standard equivalent of «1/4-comma temperament». On the general application of this term to schemes with tempered major 3rds, see Mark Lindley, *Lutes, Viols and Temperaments*, Cambridge: Cambridge University Press 1984, p. 43.

12 Vincenzo Galilei, *Dialogo della musica antica et della moderna*, Firenze: Marescotti 1581, pp. 30–31; Gioseffo Zarlino, *Sopplimenti musicali* [...], Venezia: De' Franceschi 1588, pp. 130–152, especially p. 148.

pitch shift, had resorted to intoning the comma step (see the double D met with in Ex. 2), the effect should likewise have been unpleasant and troublesome, as Zarlino himself describes in regard to a musical instrument he had had made with split keys separated by a comma (see §3.1 below).¹³

Zarlino's acrimony with his former pupil Galilei was also embittered by the fact that, in the *Dialogo* (1581), the latter had expounded the 2/7-comma temperament without crediting Zarlino for its discovery. The only «new» contribution by Galilei – also this time without mentioning that it was due to another author (Salinas) – is that even in the 2/7-comma version all tones are of the same size, a feature that favoured his assumptions regarding the actual vocal intonation.¹⁴ As for the other details, Galileo's quantitative treatment of temperaments shows that in this field he was not perfectly at ease.¹⁵ Zarlino, on the other hand, never acknowledged his oversight. In the 1589 reprint of the *Dimostrazioni harmoniche*, he adroitly corrects the passages containing errors without any warning:¹⁶

1571 ed.

[p. 221] così in questo temperamento [2/7-comma] si ritrovano due tuoni l'uno maggiore dell'altro

[p. 266] Et perché quelli [= i tuoni] della partecipazione fatta nelle Istitutioni sono differenti l'uno dall'altro per una settima parte di uno comma

1589 ed.

[p. 200] retiene in sé l'equalità de i tuoni

[p. 242] Et perché i tuoni della detta partecipazione dimostrata nelle Istitutioni, non sono differenti l'un dall'altro di proportionione

13 Gioseffo Zarlino, *Le institutioni harmoniche* [...], Venezia: (no publisher) 1558, p. 125 (without the temperament, the comma step should have been used many times, «il che non solamente difficoltà al sonatore; ma etiandio poco diletto a gli ascoltanti haverebbe apportato: perché in cotal caso si haverebbe udito un non so che di tristo, che haverebbe fatto non poco fastidio») and p. 127. See also Gioseffo Zarlino, *Dimostrazioni harmoniche* [...], Venezia: De' Franceschi 1571, p. 220 («si udiva un non so che di poco buono»).

14 Galilei, *Dialogo*, p. 33.

15 Patrizio Barbieri, «L'accordatura strumentale in Toscana: proposte e contrasti da V. Galilei a Cristofori (c. 1580–1730)», in: *Musicologia humana. Studies in honor of Warren and Ursula Kirkendale*, ed. by Siegfried Gmeinwieser, David Hiley & Jörg Riedlbauer, Firenze: Olschki 1994, pp. 209–232, pp. 212–213. About equal temperament, not only his ideas were not at all clear, but he is also providing tricky numerical calculations: see Airoldi, *La teoria del temperamento*, pp. 142–144.

16 For the 2nd ed. see: Gioseffo Zarlino, *Le dimostrazioni harmoniche* [...], in: Id., *De tutte l'opere* [...], vol. II, Venezia: De' Franceschi 1589.

1.5. If in Table 4 we add further tempered 5ths, in order to extend the chain beyond its customary range E^b - $G^\sharp$, we begin to split the diatonic (i.e., major) semitones into two unequal parts, thus entering into the field of the enharmonic genus (Table 5). In this way we obtain an open chain in which two notes enharmonically equivalent (like $G^\sharp$ - A^b and $D^\sharp$ - E^b) are separated by the so-called «enharmonic diesis», the flattened note being higher in pitch than its sharpened equivalent. Both in just intonation and $1/4$ -comma temperament the ratio of frequencies corresponding to this microinterval is 128:125 ($\cong$ 41.1 cents), about a fifth of a tone. In §2 keyboards actually built according to such schemes will be examined.

Table 5 – Meantone tuning extended to the enharmonic (*cimbalo cromatico*)

			$E^\sharp$	$B^\sharp$	...	
		$C^\sharp$	$G^\sharp$	$D^\sharp$	$A^\sharp$	
	A	E	B	$F^\sharp$		
	F	C	G	D		
D^b	A^b	E^b	B^b			
		...	G^b			

1.6. The *partecipationi* we have so far obtained are merely due to the removal of the comma, and therefore to the unification of the split keys that were separated by a comma. If we were to go further along this path, we could remove the enharmonic diesis, therefore unifying enharmonically split keys like $G^\sharp$ - A^b , $B^\sharp$ - C , etc. Thus, we would obtain an equal temperament, in which the octave is divided into 12 acoustically-equal semitones (i.e., semitones with the same frequency ratio), a system nowadays described as ETS 12 (= Equal Tempered System 12). Already in Salinas (1577) we come across this twofold approach to the theory of temperaments, which – according to Lemme Rossi (1666) – is leading to the three classes of keyboards listed in Table 6.¹⁷ However Salinas says that his just intonation keyboard had only three rows of keys, like its tempered version, because he does not count the row of the «commas» (§3.1).

17 Salinas, *De musica*, p. 167; Rossi, *Sistema musico*, pp. 82 and 88.

Table 6 – The three classes of keyboards

System	Tones	Semitones	Rows of keys	Remarks
Just inton.	Two sizes	Four sizes	Four: diatonic, sharps, flats, commas	Both tones and semitones of different size
Meantone	One size	Two sizes	Three: diatonic, sharps, flats	Unification of tones only
Equal temp.	One size	One size	Two: diatonic, sharps=flats	Unification both of tones and semitones

Furthermore, it may be observed that:

1. Within the customary range of the eleven tuned 5ths, even meantone tuning can be considered an «equal temperament», having all its harmonic intervals equally tempered.¹⁸
2. Even dissonant intervals like the «wolf 5th» $G^\sharp-E^\flat$ – exceeding the just 5th by a little less than an enharmonic diesis – could have come in handy, being sometimes employed by experienced musicians for special effects: see, e.g., Juan Bermudo (1555) and Bartolomeo Cristofori (1709–10).¹⁹

2. Meantone enharmonic keyboards: towards fifths of a tone

2.1. *From the first split keys up to the «cimbalo cromatico».* The first known example of these extra notes comes from the organ of Cesena cathedral and is dated as early as 1468. In 1480 the new organ of the cathedral of Lucca had its middle octaves furnished with split keys for the $E^\flat/D^\sharp$ and $G^\sharp/A^\flat$, the customary range $E^\flat-G^\sharp$ was thus extended by a 5th at both ends.²⁰ As we will see in §5.1, especially the $A^\flat$ was needed by church organists. In some cases, according to the choice of the performer, the two split keys could

18 In mid-18th-century this had been already remarked and new temperaments invented also for giving variety to the different keys: Patrizio Barbieri, «Il «migliore» sistema musicale temperato: querelles fra Estève, Romieu e altri accademici francesi (c. 1740–60)», in: *L'organo*, 27 (1991–92), pp. 31–81, pp. 52 and 57.

19 Juan Bermudo, *Declaracion de instrumentos musicales* [...], Ossuna: De Leon 1555, fol. 47r-v; Barbieri, «L'accordatura strumentale», p. 221 (on Cristofori). See also Doni, *Annotazioni*, p. 173.

20 Denzil Wraight & Christopher Stenbridge, «Italian Split-Keyed Instruments with Fewer than Nineteen Divisions to the Octave», in: *Performance Practice Review* 7/1 (1994), pp. 150–181, pp. 162 and 169.

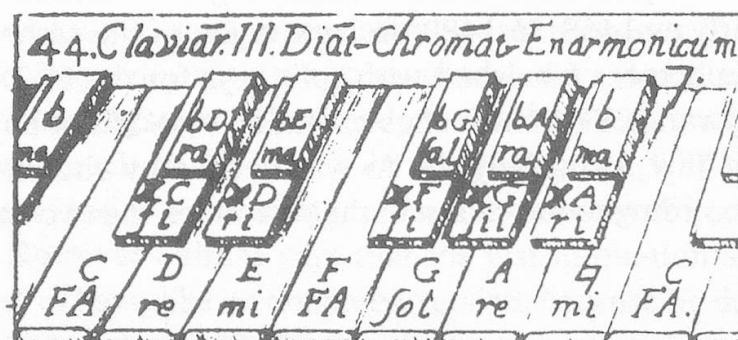
be added only on the sharp side of the chain of tempered 5ths, e.g., the keyboard sketched in Fig. 1 by the Dutchman Joannes van der Elst (1657).²¹ Moreover, this splitting could involve all the five black keys, bringing the total range to $G\flat-A\sharp$ (Fig. 2a).²² With two more extra sharps (between E-F and B-C) the extension could be brought to $G\flat-B\sharp$, thus obtaining the so-called *cimbalo cromatico* (see Table 5 above). Although this specific designation begins to be found only from 1609 (Ascanio Mayone) onwards, such a kind of keyboard was already known to Vicentino (1555), Zarlino (1558), and Salinas (1577); its keys were arranged in three *ordini*, i.e., rows.²³ On Salinas, see also §3.1 below.

Fig. 1: Joannes van der Elst (1657): Claviarium II (harmonic range $E\flat-A\sharp$).



Fig. 2a:

Joannes van der Elst (1657): Claviarium III (harmonic range $G\flat-A\sharp$).



21 Joannes van der Elst, *Notae Augustinianae* [...], Gand: Graet 1657, fig. 33. In Italy, on the contrary, no instrument is known to have had $D\sharp$ s and also $A\sharp$ s without also having $A\flat$ s: see Wraight & Stembridge, «Italian Split-Keyed Instruments», p. 171.

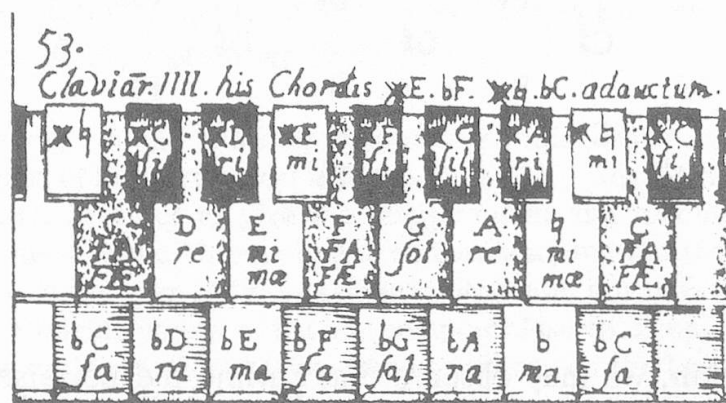
22 Van der Elst, *Notae Augustinianae*, fig. 44.

23 Beside the contributions by Rudolf Rasch and Denzil Wraight in this volume see Christopher Stembridge, «Music for the *Cimbalo Cromatico* and Other Split-Keyed Instruments in Seventeenth-Century Italy», in: *Performance Practice Review* 5/1 (1992), pp. 5–43; Id., «The *Cimbalo cromatico* and Other Italian Keyboard Instruments with Nineteen or More Divisions to the Octave (Surviving Specimens and Documentary Evidence)», in: *Per-*

In the normal keyboards *all* tones were simply split into a major and a minor semitone. In the *cimbalo cromatico*, on the other hand, *all* major semitones were in their turn split into a minor semitone and an enharmonic diesis. In so doing, apart from the C^bs and F^bs, every diatonic note was thus provided with its sharp and flat. In Fig. 2b van der Elst adds also the missing C^bs and F^bs, bringing the whole range to F^b-B[#].²⁴

Fig. 2b:

Joannes van der Elst (1657): Claviarium IV (harmonic range F^b-B[#]).



2.2. From the «cimbalo cromatico» to the «archicembalo». Just after presenting an illustration of a harpsichord whose harmonic range is that of a *cimbalo cromatico*, Zarlino adds that in 1548 he had had a harpsichord made – by Domenico da Pesaro, who also happened to be a friend of his – which we now know was a still more complex harpsichord. In fact, according to the 1558 edition of the *Istitutioni harmoniche*, even «all» its minor semitones

formance Practice Review 6/1 (1993), pp. 33–59. On the *cimbalo cromatico* see also Patrizio Barbieri, «La Sambuca Linea di Fabio Colonna e il Tricembalo di Scipione Stella. Con notizie sugli strumenti enarmonici del Domenichino», in: *La musica a Napoli durante il Seicento*, ed. Domenico Antonio D'Alessandro & Agostino Ziino, Roma: Torre d'Orfeo 1987, pp. 167–216, pp. 187–190. A *cimbalo cromatico*, with an attempt to calculate its tempered string lengths, is also provided by Michael Keller, *Monochordum* [...], Neisse: Schubart 1636, cap. VI.

24 Van der Elst, *Notae Augustinianae*, fig. 53. The key-disposition of this keyboard somehow recalls the one of Francesco Nigetti's *Cembalo onnicordo* (2nd version, c1644) and Doni's *Cembalo pentarmonico*: Patrizio Barbieri, «Il Cembalo onnicordo di Francesco Nigetti in due memorie inedite di G. B. Doni (1647) e B. Bresciani (1719)», in: *Rivista italiana di musicologia* 22 (1987), pp. 34–113, pp. 59–63.

1558 ed., p. 140

il quale fece Maestro Dominico Pesarese fabricatore eccellente di simili istrumenti; nel quale non solamente li semituoni maggiori sono divisi in due parti, ma anche tutti li minori.

1589 ed., p. 171

il quale fabricò Maestro Dominico Pesarese, raro et eccellente fabricatore di simili istrumenti; nel quale non solamente i semituoni maggiori sono divisi in due parti, ma anche i minori, di maniera ch' ogni tuono viene a essere diviso in quattro parti

The last mention of this instrument is by Charles Burney, who examined it when in Florence (September 1770):²⁸

At Florence, I found the harpsichord of Zarlino, which is mentioned in the second part of his *Harmonical Instructions*, p. 140. This instrument was invented by Zarlino, in order to give the temperament and modulation of the three *genera*, the diatonic, chromatic, and enharmonic; and was constructed, under his direction, in the year 1548, by Dominico Pesarese: it is now in the possession of Signora Moncini, widow of the late composer Pescetti. I copied Zarlino's instructions for tuning it, from his own hand-writing, on the back of the foreboard; but I shall reserve them, and the particular description of this curious instrument, for the *History of Music*, to which they more properly belong.

So, Zarlino's harpsichord was then owned by Maria Rosa Mancini (not «Moncini»), widow of the composer Giovanni Battista Pescetti.²⁹ It should be mentioned that Pescetti – son of the organ builder Giacinto – in his last years was 2nd organist of the basilica of San Marco, Venice (the same in which Zarlino had been *maestro di cappella*).³⁰ Though Burney did not keep the promise to publish Zarlino's tuning directions in his *General history of music*, Pesenti's survey fills in this gap, although we still lack a description of its actual key disposition.

In the same passage, Pesenti adds that from 1621 up to 1634 – when in Venice – he usually played and kept in tune a harpsichord made in 1601 by Vito Trasuntino. This instrument was like Zarlino's, but with four more

28 Charles Burney, *The present state of music in France and Italy* [...], London: Becket 1771, pp. 253–254.

29 Mario Fabbri, «Giovanni Battista Pescetti e un concorso per maestro di cappella a Firenze», in: *Rivista italiana di musicologia* 1 (1966), pp. 120–126, p. 124.

30 Sandro Dalla Libera, «Cronologia musicale della Basilica di San Marco in Venezia – IV», in: *Musica Sacra*, series II, 6 (1961), pp. 133–135.

128:125 is a rational quantity, while $2^{1/31}$ is irrational. He thus showed himself unable to recognise that – with a slight correction which is almost undetectable to the ear as far as individual consonances are concerned, although not at all negligible as a whole in the long chain of 5ths – 1/4-comma temperament and the ETS 31 were *de facto* the same thing.³⁴

3. On this subject, Zarlino was more cautious and never directly criticized Vicentino's tuning from the mathematical and consonance point of view. In fact – in the 1/4-comma temperament, which he seems to prefer – his 1548 bisection of the minor semitones would have yielded Vicentino's «fifths of a tone».³⁵ In the *Istitutioni*, after mentioning the harpsichord Domenico da Pesaro had made for him, he limits himself to saying that introducing further divisions would have led to useless additions, maybe alluding to Vicentino.³⁶ Moreover, it should be recalled that he was in close contact with Vincenzo Colombo, a distinguished organ builder operating in Venice, who had made monochords for Zarlino himself, Claudio Merulo, and perhaps Ettore Ausonio, a professional mathematician and also an amateur music theorist of the Venetian environment (Fig. 3):³⁷ since Colombo had built an *Arciorgano* for Vicentino, it is likely that Zarlino was informed about its tuning.³⁸

34 Salinas, *De musica*, pp. 164–166. And this though Salinas were the first to clearly expound the features of the ETS 31. The first author to recognise that the string-lengths of the ETS 31 were very close to those of the 1/4-comma was Lemme Rossi, in 1666: Barbieri, «I temperamenti ciclici», pp. 159 and 181, respectively.

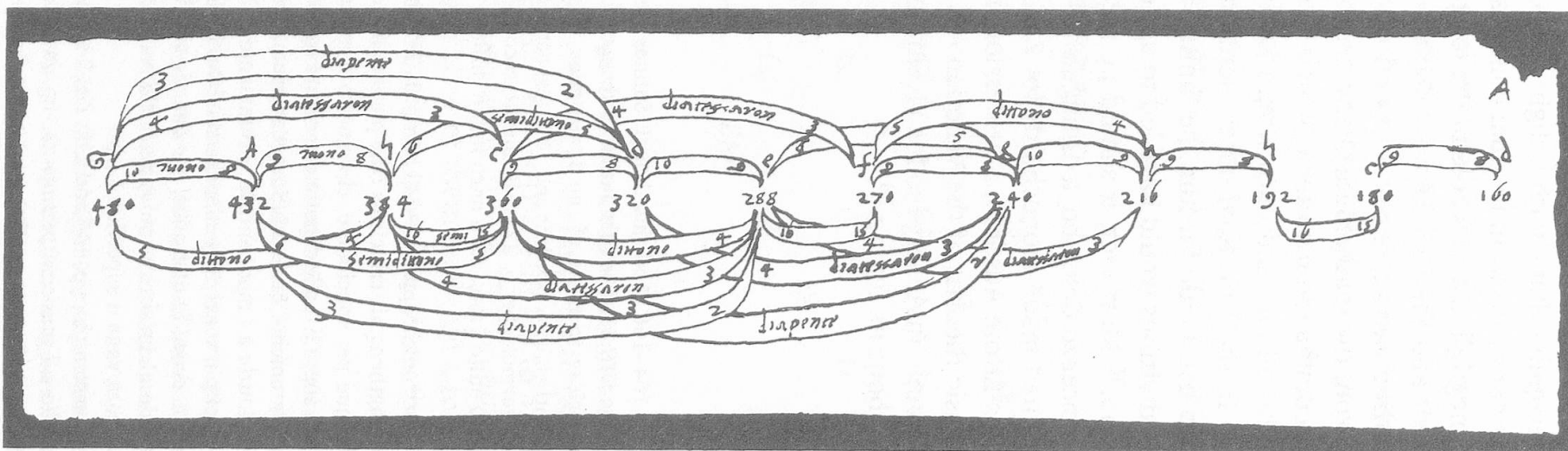
35 Zarlino, *Dimostrazioni harmoniche*, p. 221: «Et questo secondo temperamento [i.e., the 1/4-comma] è molto all'udito grato: nè è anco molto difficile da fare: sì come sono gli due altri».

36 Zarlino, *Le institutioni harmoniche*, pp. 140–141. On p. 172 of the 1589 ed., always of the *Istitutioni*, he even strengthens his criticisms (the phrases in *italic* are not present in the 1558 ed.): «Dirò adunque per concludere, che questo è un'istrumento [i.e., Domenico Pesarese's harpsichord], sopra il quale si potrà essercitare ogni ottimo sonatore, non solamente nell'harmonie diatoniche; ma etiandio nelle chromatiche, et nell'enharmiche, quando potrà e saprà ridurle à i modi antichi, overamente quando à i nostri tempi potranno riuscir migliori, et più soavi di quello, che si odono in *alcune sgarbate compositioni d'alcuni compositori moderni*. Et dirò anco, che quando si volesse aggiungere al numero delle mostrate chorde alcun'altra chorda; *perciocchè molte se ne possono aggiungere*; senza dubbio sarebbe cosa vana e superflua [...]».

37 Zarlino, *Dimostrazioni harmoniche*, pp. 146 and 219. Fig. 3 belongs to I-Ma Ms. G.136.Inf.: Ausonius Hector, *Scholia ad musicam pertinentia*, no date, loose sheet (on the back: «Charta datami da Maestro Vincenzo dall'Organi»).

38 Barbieri, «I temperamenti ciclici», pp. 160–161 and 195.

Fig. 3: Manuscript drawing of a diatonic just intonation sent by the organbuilder Vincenzo Colombo to the mathematician Ettore Ausonio (Venice, mid 16th-century): see footnote 37. It refers to the scale $C^0-D^0-E^1-F^0-G^0-A^1-B^1-C^0$. The string-lengths happen to be the same of Fogliano's *Musica theorica* (1529), to which the final zero has been taken off.



F^{#-2} G^{#-2} G^{#-2}

40 Salinas, *De musica*, p. 126.

40 Salinas, *De musica*, p. 126.

24 to 19 per octave (all the tempered systems he presents through his treatise have this number of keys). He also says that the enharmonic genus is contained in the chain of 5ths $G^b-B^\sharp$, stressing – in chapter XX – that its number of keys per octave is 24 if untempered, 19 if tempered:⁴¹

Quo pacto decem et sex soni generis Chromatici, et Enharmonij vigintiquinque instrumenti perfecti, ad tredecim, et viginti imperfecti per Participationem (quam vocant) reducantur. Cap. XX.

In which way the 16 sounds of the chromatic genus and the 25 of the enharmonic, in the perfect instrument, can be reduced to 13 and 20, respectively, in the imperfect one, through the so-called temperament. Chapter XX. [Salinas divides the C-to-C octave, counting twice the C]

During his stay in Rome (c1538-58) he also had had made an enharmonic keyboard instrument. In fact – alluding to the organ of Santa Maria Novella, Florence, furnished with split keys only for the $G^\sharp/A^b$ and $E^b/D^\sharp$ – he says:⁴²

Et plurima instrumenta Musica ex his, quae per alba, et nigra plectra pulsantur, secundum hoc genus disposita sunt (qualia memini me audire Florentiae) sed omnium perfectissimum est, quod ego Romae faciendum curavi et hîc habeo Salamanticae. In quo utrumque reperitur instrumentum, tam perfectum, quam id, quo utimur, imperfectum; et alterius ad alterum potest fieri collatio: et in utroque tria melodiarum genera maxima cura, atque diligentia perfectissime demonstrantur.

Many musical instruments, among those which are played pressing their white and black keys, present this genus [i.e. the enharmonic] (of this type I remember I listened to in Florence). But the most perfect of all is the one I had had made in Rome, which now I have here in Salamanca. In this one can be found together the two instruments, i.e. both the perfect, and the one we are using, the imperfect; and each one can be compared with the other, and both of them show – with the highest perfection, and with the greatest exactness and care – the three genera of melody.

As recalled above (§2.2), Salinas did not approve of Vicentino's *Archicembalo* (whose building, he observes, had started less than forty years before). He says that «he tried many times» to put into practice this kind of tuning, but – outside the harmonic range $G^b-B^\sharp$ (the same as the *cimbalo cromatico*, we can add) – his attempts were unsuccessful. In fact his problems begin

41 Salinas, *De musica*, pp. 146–162 (chapter XX on p. 151).

42 Salinas, *De musica*, p. 127; reference to Santa Maria Novella organ on p. 80. On his stay in Rome see José María Álvarez Pérez, «El organista Francisco de Salinas. Nuevos datos a su biografía», in: *Anuario musical* 18 (1963), pp. 21–44, p. 22.

just «in the row they call the 4th», and so he stresses once again that the enharmonic genus starts from the G^b and «ends» («*terminatur*») in the $B^\sharp$. Certainly he made some mistakes in tuning the 4th and 5th orders, because he concludes:⁴³

Quae quoniam plus nimio non meas solum, sed omnium etiam aures offendebat, cognovi, huiusmodi temperamentum ab omni harmonica ratione, tam perfecti, quam participati instrumenti prorsum abhorrere: et mutavi consilium. Nam in tribus primis ordinibus accomodavi temperamentum instrumenti participati, et in tribus supremis perfecti; sonis C litera signatis fixis manentibus, et ad unisonantiam temperatis, quo ex utriusque collatione posset (ut Ptolomaeus ait) legitimum ab spurio, et imperfectum a perfecto discerni.

As it was highly upsetting not only my own, but also the ears of all the other people, I realized that such a tuning was absolutely far away from all harmonic ratios, both of the perfect and of the tempered instrument: so I changed my mind. In fact in the first three rows I set the tuning of the tempered instrument, while in the three upper [rows, the tuning of] the perfect one. The sounds marked with the letter C were fixed and tuned in unison, so that in comparing the two [keyboards] one could see (as Ptolemy says) the difference between the just from the false, and the perfect from the imperfect.

So, this multitone harpsichord was still furnished with two keyboards and three rows of keys in each one of them, like the *Archicembalo*. It was offering the above mentioned «perfect» just tuning system in the upper keyboard (Salinas says that even this one presented «three rows» of keys, thus not counting the row of the commas). The «three rows» of the lower one – like in Vicentino's instrument – were instead providing its tempered equivalent, the «imperfect instrument» (i.e. the *cimbalo cromatico*). Recalling that – among the three meantone temperaments mentioned in §1 above – he judged the 1/4-comma to be «much more suited to keyboard instruments», the tuning of his version of the *archicembalo* can be reconstructed (Table 10).⁴⁴ Being the Cs of the two keyboards in unison, he could thus present listeners with the difference between all the «perfect» and «imperfect», i.e. pure and tempered, intervals of his own enharmonic system. In

43 Salinas, *De musica*, pp. 164-166. On p. 85 he says that on the instrument he had had made in Rome both the major and the minor tone could be heard.

44 Salinas, *De musica*, p. 154, title of chapter XXII: «De tertio instrumentorum imperfectorum temperamento [i.e. the 1/4-comma], quod multo quam duo superiora [i.e. the 2/7- and 1/3-comma], et intellectu facilius, et instrumentis accomodatius esse videtur». And again, p. 154: «Videtur, etiam ad instrumentis fabricandis accomodatius».

Table 10 – Tuning of Salinas' double harpsichord (c1538–58)

UPPER KEYBOARD: 3 ROWS:

«Instrumentum perfectum»

		A [♯] -3	E [♯] -3	B [♯] -3		
	F [♯] -2	C [♯] -2	G [♯] -2	D [♯] -2	A [♯] -2	
D ⁻¹	A ⁻¹	E ⁻¹	B ⁻¹	F [♯] -1		
B ^b 0	F ⁰	C ⁰	G ⁰	D ⁰		
G ^b +1	D ^b +1	A ^b +1	E ^b +1	B ^b +1		
			G ^b +2			

LOWER KEYBOARD: 3 ROWS

«Instrumentum imperfectum» or «participatum»

		E [♯] -11/4	B [♯] -3			
	C [♯] -7/4	G [♯] -2	D [♯] -9/4	A [♯] -10/4		
A ^{-3/4}	E ⁻¹	B ^{-5/4}	F [♯] -6/4			
F ^{+1/4}	C ⁰	G ^{-1/4}	D ^{-2/4}			
D ^b +5/4	A ^b +1	E ^b +3/4	B ^b +2/4			
		G ^b +6/4				

1618 Vicente Espinel reports that he saw Salinas playing it in Salamanca, «working wonders» with his hands.⁴⁵

3.2. *Galeazzo Sabbatini*. Following in the steps of Vicentino's «fifths of a tone», a still more complex keyboard – somehow based on the untempered division of the octave up to the enharmonic diesis, and in some places going even further – is the harpsichord by Galeazzo Sabbatini, furnished with 38 keys per octave. Its string lengths are provided by Kircher's *Musurgia* (1650). Anyway these are not fully reliable, and this is indirectly confirmed by the fact that, a few years later, Sabbatini described its tuning in a table, now lost, attached to a letter to Kircher himself (1653). Likewise lost is a manuscript treatise

45 Vicente M. Espinel, *Vida de Marcos de Obregón*, ed. Samuel Gili Gaya, Madrid: Espasa-Calpe 1940, II, p. 158: «Yo lo vi tañer el instrumento de tecla que dejò en Salamanca, en que hacía milagros con las manos; pero no le vi reducirlo a que voces humanas le ejecutasen, habiendo en el coro de Salamanca en aquel tiempo grandes cantores de voces y habilidad, y siendo maestro aquel grande compositor Juan Navarro».

by Sabbatini – the *Scintille armoniche* –, dealing with his and others' enharmonic keyboards, as well as related compositional practice.⁴⁶

3.3. *Mersenne, Descartes, Ban, and van der Elst.* Apart from some experiments involving the ETS 19, 24, and 31,⁴⁷ the multitone keyboards mentioned in §2 were not used in France. Starting with Mersenne (1636), we only come across a few modifications of Salinas' «perfect» system, some with extra notes added, some with a few ones removed.

Table 11 – Two proposals for «improving» Salinas' system:

– roman = Salinas (1577)

– roman + bold = Mersenne (1636-7)

– roman + bold + *italic* = Albertini (before 1636)

				$A^{\sharp-3}$	$E^{\sharp-3}$	$B^{\sharp-3}$		
	A^{-2}	E^{-2}	B^{-2}	$F^{\sharp-2}$	$C^{\sharp-2}$	$G^{\sharp-2}$	$D^{\sharp-2}$	$A^{\sharp-2}$
F^{-1}	–	G^{-1}	D^{-1}	A^{-1}	E^{-1}	B^{-1}	$F^{\sharp-1}$	
	A^b0	E^b0	B^b0	F^0	C^0	G^0	D^0	
		G^{b+1}	D^{b+1}	A^{b+1}	E^{b+1}	B^{b+1}		
					G^{b+2}			

Let us begin with those presenting extra notes added (Table 11). Mersenne's *clavier parfait* (Fig. 5) is merely Salinas' «perfect system» enlarged by adding two more tones, both harmonically useless (G^{-1} and E^b0).⁴⁸ Though the E^b0 turns out to be the same as in Zarlino's (Table 9), the true reason for these doubled notes separated by a comma will be seen below. The *Harmonie universelle* also reports a still more enlarged Salinas' system, up to 31 notes per octave, without any mention of its inventor.⁴⁹ According to a manuscript treatise by Juan Carmuel Lobkowitz (1606–1682), this was due to a certain «Albertinus nobilis italus» (also its string lengths are labelled:

46 On the subject see Patrizio Barbieri, «Cembali enarmonici e organi negli scritti di Kircher. Con documenti inediti su Galeazzo Sabbatini», in: *Enciclopedia in Roma Barocca. Athanasius Kircher e il Museo del Collegio Romano tra Wunderkammer e museo scientifico*, ed. Maristella Casciato, Maria Grazia Ianniello & Maria Vitale, Venezia: Marsilio 1986, pp. 111–128, pp. 118–125.

47 Barbieri, *I temperamenti ciclici*, pp. 149–150, 153, 156, 173–175.

48 Marin Mersenne, *Harmonie universelle* [...], Paris: Cramoisy 1636, «Traité des instrumens à cordes», pp. 354–356. Fig. 5 has been drawn from the facsimile edition of Mersenne's own copy, with autograph annotations: Paris: C.N.R.S. 1965, III, manuscript table.

49 Mersenne, *Harmonie universelle*, «Traité des instrumens à cordes», p. 357.

«Scala Musicae Panharmonicae ad mentem Albertini»⁵⁰ As shown in Table 11, Albertini's five extra notes are similarly useless.

Unlike the above enlarged schemes, of more practical use seem to have been keyboards in which some notes of Salinas' perfect system were removed. If reduced to only 18 keys per octave, we have a keyboard illustrated by Mersenne himself in the *Harmonie universelle* and also in his manuscript additions to this treatise (Fig. 5 above). In October 1639 the very same keyboard was put into practice by Joan Albert Ban, in Haarlem (Table 12).⁵¹ Ban got to know about Mersenne's division through René Descartes and – always on Descartes' advice – also published some music based on the shades of this just tuning.⁵²

Table 12 – Ban and Descartes keyboards:

– roman = Ban (1639)

– roman + *italic* = Descartes (1639–46)

		<i>F^{♯-2}</i>	<i>C^{♯-2}</i>	<i>G^{♯-2}</i>	<i>D^{♯-2}</i>		
<i>G⁻¹</i>	<i>D⁻¹</i>	<i>A⁻¹</i>	<i>E⁻¹</i>	<i>B⁻¹</i>	<i>F^{♯-1}</i>		
<i>B^{b0}</i>	<i>F⁰</i>	<i>C⁰</i>	<i>G⁰</i>	<i>D⁰</i>			
	<i>D^{b+1}</i>	<i>A^{b+1}</i>	<i>E^{b+1}</i>	<i>B^{b+1}</i>			

According to Ban himself, his «perfect keyboard» («*volmaekte Klauwier*») was copied several times by others.⁵³ One of these copies can now be traced: according to the above mentioned manuscript by Caramuel, who in those years spent some time in Flanders, a harpsichord with a tuning that turns out to be the same was one kept in the «treasure» (i.e. Wunderkammer) of a certain «Prince of Rosemberg» (it is labelled «De Rosembergi Abaco»).⁵⁴

Ban's keyboard was based on the C-to-C octave. Mersenne offers also a second version of this very same division, based on the F-to-F octave, thus

50 Barbieri, «Cembali enarmonici», p. 118; Id., «Juan Caramuel Lobkowitz (1606–1682): Über die musikalischen Logarithmen und das Problem der musikalischen Temperatur», in: *Musiktheorie 2* (1987), pp. 145–168, p. 158.

51 Ban's instrument presents almost the same key disposition printed in Mersenne, *Harmonie universelle*, «Traité des instrumens à cordes», p. 352. In Fig. 5 Mersenne, perhaps for the player's convenience, shifted one of the two comma-splitted Ds in the row of the black keys.

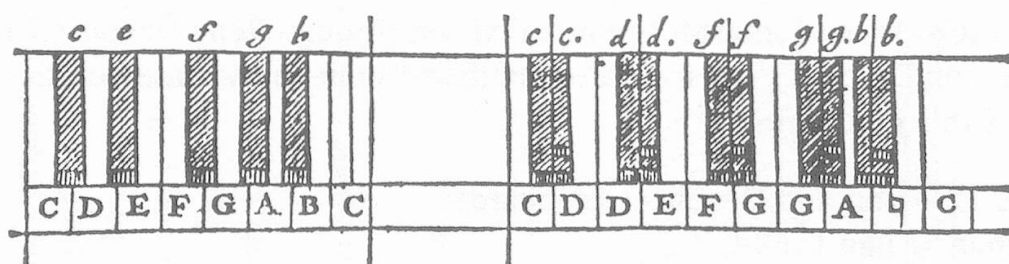
52 For a thorough survey on the subject see Rudolf Rasch, «Ban's intonation», in: *Tijdschrift van de Vereniging voor Nederlandse Muziekgeschiedenis*, 33 (1983), pp. 75–99.

53 Rasch, «Ban's intonation», pp. 82–83.

54 Barbieri, «Cembali enarmonici», p. 117; Id., «Juan Caramuel Lobkowitz», p. 157.

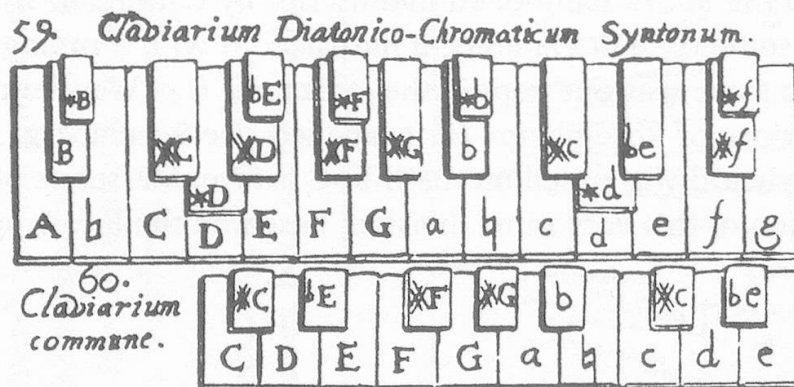
lowering by a 5th its harmonic range ($G^{b+1}-G^{\sharp-2}$) as well as the three doubled notes separated by a comma (E^{b+1}/E^{b0} , G^0/G^{-1} , B^{-1}/B^{-2}).⁵⁵ Descartes – in a letter of July 1643 – presented Ban's C-to-C keyboard, but inexplicably with both D^{-1} and G^{-1} present (see Fig. 6, Table 12, and Mersenne's Table 11).⁵⁶

Fig. 6: René Descartes (1643): proposal of a (harmonically useless) G^{-1} added to Ban's keyboard.



Ban's keyboard seems to have been well known by another Dutch theorist: in fact the *Claviarium Diatonico-Chromaticum Syntonum* by Joannes van der Elst (1657) turns out to have the same tuning, apart from having had both the A^b and D^b removed (Fig. 7).⁵⁷ Johann Voigt Moritz – dealing

Fig. 7: Joannes van der Elst (1657): Ban's keyboard with both A^b and D^b removed (compared to a common 12-note one).



55 Mersenne, *Harmonie universelle*, «Traité des instrumens à cordes», pp. 352–353.

56 Fig. 6 has been drawn from René Descartes, *Epistolae* [...], ed. Clerselier, III, Amsterdam: Tip. Blaviana 1683, p. 387. On the subject see: *Oeuvres de Descartes*, ed. Charles Adam & Paul Tannery, IV, Paris: Cerf 1901, pp. 678–683; Rasch, «Ban's intonation», p. 92 (also on an enlarged version of Descartes' keyboard proposed by Pieter Hellingwerf, Amsterdam 1718), and – especially on Descartes' letter – Rasch, «Why were enharmonic keyboards built?» (in this volume).

57 Fig. 7 has been drawn from Van der Elst, *Notae Augustiniana*, fig. 59 and 60. See also Rasch, «Ban's intonation», p. 92.

with the «Anatomia claviaturae chromaticae, et diatonicae, et partim enharmonicae» – in 1719 added an $A\sharp^{-2}$ to Ban's division on the other side of the chain of 5ths.⁵⁸

Table 13 – Giovanni Valentini's (?) keyboard

		$F\sharp^{-2}$		$C\sharp^{-2}$		$G\sharp^{-2}$		$D\sharp^{-2}$
			A^{-1}		E^{-1}		B^{-1}	
$B\flat^0$	F^0		C^0		G^0		D^0	
$G\flat^{+1}$	$D\flat^{+1}$		$A\flat^{+1}$		$E\flat^{+1}$			

As far as just intonation keyboards are concerned, without any doubt Fogliano and Salinas chose the most rational pattern. To abandon it meant to obtain Mersenne's useless additions or, from bad to worse, unplayable keyboards like the one of Table 13, which offers highly dissonant major and minor triads on D. Caramuel ascribes this keyboard to a «Valentinus Archimusicus Caesareus» (probably Giovanni Valentini, Kapellmeister at the Viennese court of Ferdinand III, a composer himself). He adds that it was also adopted by a certain «Cunradus organista apud Bavaros» (maybe Caspar Conrad, organist in Öttingen, Bavaria). Anyway one could also imagine some oversight by Caramuel in reporting its string lengths, it being highly improbable that a musician like Valentini would approve a harpsichord providing such dissonant chords.⁵⁹

4. The problem of fretted instruments

In lutes and viols, enharmonic notes raised problems – both of feasibility and performance – still worse than those already met with in keyboard instruments. Some brief considerations are presented below regarding the three possible classes of fretting arrangements.

58 Johann Voigt Moritz, *Conclave thesauri magnae artis musicae* [...], Praga: Labaun 1719, pp. 43–44 (anyway, Ban is not mentioned).

59 Barbieri, «Cembali enarmonici», p. 117; Id., «Juan Caramuel Lobkowitz», p. 157. Besides, Giovanni Valentini was the author of an «enharmonic» sonata a 5: Warren Kirkendale, *Emilio de' Cavalieri «Gentilhomme romano». His life and letters, his role as Superintendent of all the arts at the Medici Court, and his musical compositions. With addenda to «L'Aria di Fiorenza» and «The Court Musicians in Florence»*, Florenz: Olschki 2001 (= *Historiae Musicae Cultores* 86), p. 154.

4.1. *Just intonation*. Apart from a semi-just fretting experimented with by Thomas Salmon (1688–1705), a true just intonation seems to have been put into practice only on Giovanni Battista Doni's set of «prepared» viols (1636–40).⁶⁰ Joan Albert Ban too seems to have adapted a lute (and maybe also a viol) with his just intonation fret arrangement.⁶¹ It may be observed that, in the case of the lute, the space between two frets yielding doubled notes (separated by a comma) would have been only a few millimetres, depending on the part of the neck on which they were placed.

4.2. *Meantone*. In such temperaments there are two kinds of semitone, major (e.g. G-A $\flat$) and minor (e.g. G-G $\sharp$), their difference being equal to the enharmonic diesis (i.e., G $\sharp$ -A $\flat$): therefore mistuned octaves of the type G $\sharp$ -A $\flat$ are always to be feared in meantone-tuned fretted instruments (Table 14).

Table 14 – Meantone tuning on a lute in D

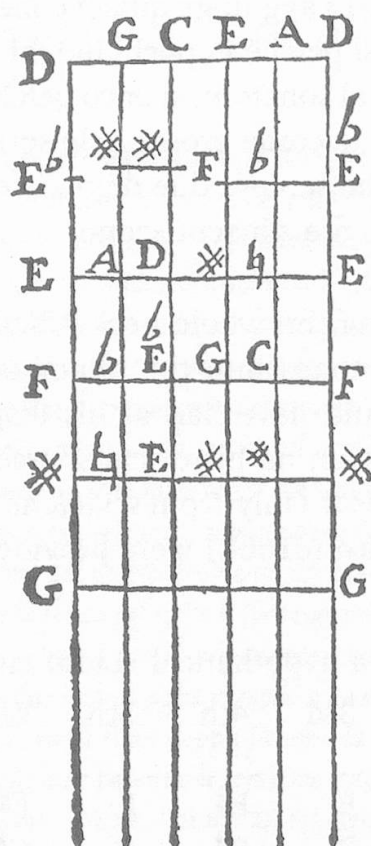
	open	1st	2nd	3rd	4th	5th	6th	7th	8th	fret
string										
D ^{treble}	E $\flat$	E	F	F $\sharp$	G	G $\sharp$	A	B $\flat$		
A	B $\flat$	B	C	C $\sharp$	D	D $\sharp$	E	F		
E	F	F $\sharp$	G	G $\sharp$	A	A $\sharp$	B	C		
C	D $\flat$	D	E $\flat$	E	F	F $\sharp$	G	A $\flat$		
G	A $\flat$	A	B $\flat$	B	C	C $\sharp$	D	E $\flat$		
D ^{bass}	E $\flat$	E	F	F $\sharp$	G	G $\sharp$	A	B $\flat$		

In order to avoid such drawbacks, lutes and viols sometimes were provided with a few *tastini*, i.e., short ivory frets not crossing the whole neck. In De Chales' (Fig. 8), A $\flat$ and D $\flat$ are thus turned into G $\sharp$ and C $\sharp$, which according

60 On Salmon, see Lindley, *Lutes*, pp. 68–69; Patrizio Barbieri, «Conflitti di intonazione tra cembalo, liuto e archi nel «concerto» italiano del Seicento», in: *Studi Corelliani*. IV, ed. Pierluigi Petrobelli & Gloria Staffieri, Firenze: Olschki 1990, pp. 123–153: 132–4. On Doni: Patrizio Barbieri, «Gli strumenti poliarmonici di G.B. Doni e il ripristino dell'antica musica greca (c.1630–1650)», in: *Analecta musicologica* 30 (1998), pp. 79–114, p. 84; Martin Kirnbauer, «Wherein the most compleat Harmony was heard: The Viola da Gamba in Chromatic and Enharmonic Music in Seventeenth-Century Rome», in: *The Italian Viola da Gamba. Proceedings of the International Symposium on the Italian Viola da Gamba, Magnano 29 April – 1 May 2000*, ed. by Susan Orlando, Solignac: Editions Ensemble Baroque de Limoges & Torino: Manzoni 2002, pp. 34–51; see also the contribution by Martin Kirnbauer in this volume.

61 Rasch, «Ban's intonation», pp. 82–83.

Fig. 8: Claude-François Milliet de Chales (1674): «common» fretting for a viola da gamba, with tastini at the position of the 1st fret.



to him was the «common» tuning and fretting.⁶² Besides De Chales, Doni too confirms that such *tastini* were mainly placed at the position of the first fret, in order to narrow the major semitone.⁶³ At this place on a viola da gamba neck, the space corresponding to the enharmonic diesis would not be at all negligible, being around two centimetres. In any case, Doni himself stresses that the non-uniformity of gut-strings and their inharmonicity seriously hindered the perfect intonation of such notes.⁶⁴

62 Claude-François Milliet de Chales, *Cursus seu mundus mathematicus*, III, Lyon 1674, pp. 37–38: «varie a variis ad concentum revocant chordae; commune tamen illius systema proferam divisionemque manubrij».

63 Doni, *Annotazioni*, p. 29: «Quelli che aggiungono un tastino alle viole, lo sogliono mettere immediatamente dopo il capotasto».

64 Giovanni Battista Doni, *Compendio del Trattato de' generi e de' modi della musica*, Roma: Fei 1635, pp. 45–46. On the above problem of inharmonicity in instruments with fingerboards see Patrizio Barbieri, «The inharmonicity of musical string instruments (1543–1993). With an unpublished memoir by J.-B. Mercadier (1784)», in: *Studi musicali* 27/2 (1998), pp. 383–419, pp. 407–412.

per mezzo di questi strumenti [Doni's *viole diarmoniche*] si potranno far sentire cotali melodie nella loro perfettione; il che non riesce ne' comuni quando bene vi s'aggiunga qualche mezzo tasto che divida ogni semituono maggiore, sì perché in pochi luoghi servono, et gl'altri recano impedimento notabile al sonatore; sì anco perché calcandosi egualmente, et al medesimo segno le corde grosse, e le sottili, non egualmente alterano il suono; né anche sempre due d'una istessa grossezza tastate nel medesimo sito, parimente s'inacutiscono.

If extra gut frets – crossing the whole neck – had been added in order to divide all the major semitones into the minor ones and the enharmonic diesis, the performer would have had at his disposal the range of notes shown in Table 15. However, no historical source ever mentions what we could call a *liuto cromatico*! Only Doni's *Violone panarmonico* and Pietro Salvetti's *Lirone enarmonico* (c1668) were provided with a few frets of this kind.⁶⁵

Table 15 – The tuning of a hypothetical «Liuto cromatico»

open string	1st	2nd	3rd	4th	5th	6th	7th	fret
D ^{treble}	D [#]	E ^b	E	E [#]	F	F [#]	G ^b	
A	A [#]	B ^b	B	B [#]	C	C [#]	D ^b	
E	E [#]	F	F [#]	F ^{##}	G	G [#]	A ^b	
C	C [#]	D ^b	D	D [#]	E ^b	E	E [#]	
G	G [#]	A ^b	A	A [#]	B ^b	B	B [#]	
D ^{bass}	D [#]	E ^b	E	E [#]	F	F [#]	G ^b	

Table 16 – Vicentino's proposal for tuning a lute with his ETS 31

open string	1st	2nd	3rd	4th	5th	6th	7th	8th	fret
D ^{treble}	E ^{bb}	D [#]	E ^b	D ^{##}	E	F ^b	E [#]	F	
A	B ^{bb}	A [#]	B ^b	A ^{##}	B	C ^b	B [#]	C	
E	F ^b	E [#]	F	G ^{bb}	F [#]	G ^b	F ^{##}	G	
C	D ^{bb}	C [#]	D ^b	C ^{##}	D	E ^{bb}	D [#]	E ^b	
G	A ^{bb}	G [#]	A ^b	G ^{##}	A	B ^{bb}	A [#]	B ^b	
D ^{bass}	E ^{bb}	D [#]	E ^b	D ^{##}	E	F ^b	E [#]	F	

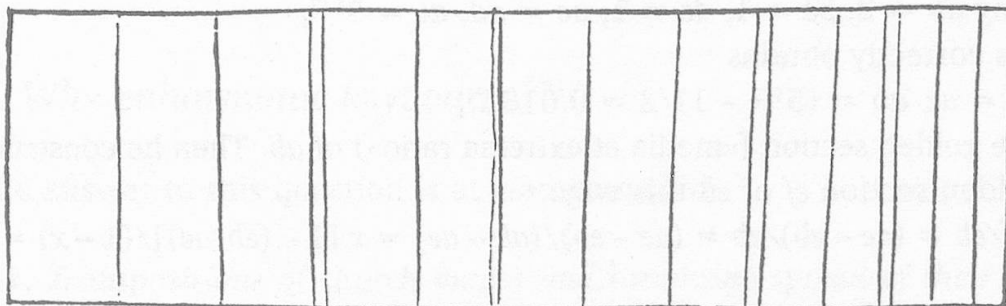
65 Barbieri, «Gli strumenti poliarmonici», pp. 91, 102, 110 (on Doni); Id., «L'accordatura strumentale», pp. 227–232 (on Salvetti).

4.3. *Equal Tempered Systems*. In 1555 Nicola Vicentino suggested tuning a lute like his *Archicembalo* (Fig. 9).⁶⁶ Thus, all the minor semitones of Table 15

Fig. 9: Nicola Vicentino (1555): proposal for a lute fretting according to his Equal Tempered System 31.

Dichiar. sopra li difetti del Liuto, e delle viole d'arco, et altri stromenti cō simili diuisioni. C. LXVI. All'inuentione delle uiole d'arco, et del liuto fin hora sempre s'ha sonato con la diuisione de i semitoni pari, et hoggi si suona in infinitissimi luoghi, oue che nascono due errori, uno che le consonanze delle terze, & in certi luoghi delle quinte non sono giuste; & l'altro errore è quando tali stromenti suonano con altri stromenti, che hanno la diuisione del tono partito in due semitoni, uno maggiore, et l'altro minore non s'incontrano, di modo che mai schiettamente s'accordano quando insieme suonano. Hora la diuisione del Liuto dè essere in questo modo diuisa, prima col semitono maggiore, & poi col minore; & cō si dè seguire per semitono maggiore et minore, & poi maggiore per finire essa quarta: & se si uorrà far la diuisione Enarmonica, se diuiderà il semitono maggiore in tre parti, & il minore in due, come tali diuisioni sono nel tono del nostro stromento, & la medesima diuisione occorrerà nelle uiole d'arco, et le uiole con tre corde senza tasti, che si suonano con l'arco saranno bonissime, che farà ogni diuisione, & per stromenti da fiato, i Tromboni saranno mirabili quando saranno con diligenza suonati. Hora qui sotto scriuo due linee lunghe, in modo d'un manico di liuto, & diuiderò quelle con i semitoni maggiori & minori, & le linee doppie saranno la diuisione ordinaria, e le linee semplici saranno l'aggiunte delli Diesis. che faranno li semitono mag. et min. quando si uorranno.

Diesis mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. di.m. di.mi. di.mi.



Longhezza di una Quarta diuisa in 13. Diesis Enarmonici tutti minori.

To no. To no. Semitono.

would have been bisected, giving rise to octaves divided into 31 acoustically equal «fifths of a tone» (Table 16). As shown above (§2.2), this particular kind of equal temperament (ETS 31) provided almost pure major thirds (e.g. Ebb-Gb, D#-F##, D##-Abb=F###). Furthermore – unlike the tunings of Table 14 and 15, which are not Equal Tempered Systems – it offered the performer the possibility of shifting the pitch of a chord merely by shifting

66 Vicentino, *L'antica musica*, fol. 146v. About the «Diesis enarmonici minori» see note 33 above.

his hand, without changing the relative position of the fingers. Also the tuning of Table 15, if put into practice with a meantone tuning practically coincident with the 1/3-comma (1/2.98-comma), would provide a particular kind of equal temperament, the ETS 19, whose octaves are divided into 19 acoustically equal «thirds of a tone» (and so the lonely F $\sharp\sharp$ on the 4th fret would turn into a common G $\flat$).

In any case both ETS 31 and 19 were awkward systems, never put into practice in fretted instruments. The simplest solution was to resort to the well known 12-notes-per-octave equal temperament (ETS 12), merely removing the enharmonic diesis (see Salinas' second level of temperament, §1.6 above).

4.4. *Salinas' equal-temperament fretting of the lute.* In order to divide the octave into twelve geometrical mean parts a few methods were suggested, in the late 16th century, mainly by Vincenzo Galilei and Zarlino.⁶⁷ Salinas also set himself to solve this geometrical problem, though achieving only an ingenious but useless solution, as stressed by Zarlino in a letter to Bernardino Baldi (1589) and even later by the polymath Claude Hardy (1636).⁶⁸ Let us briefly explain this attempt in modern mathematical terms.⁶⁹

In Fig. 10, ab is the string-length of the lute, from nut (b) to bridge (a).

Being $ab = 2$, $bc = 1$, $dc = 1$, $ae = ad$, $ac = 5^{1/2}$,

Salinas correctly obtains

$$x = ae/ab = (5^{1/2} - 1)/2 = 0.618...,$$

i.e., the golden section («media et extrema ratio») of ab . Then he constructs the golden section ef of eb this way:

$$ef/eb = (ae - eb)/eb = (ae - eb)/(ab - ae) = x [1 - (eb/ae)]/(1 - x) = x,$$

67 Lindley, *Lutes*, pp. 21 and 24–26. On the use of the mesolabium for this purpose (as suggested by Zarlino) and of the proportional reduction compass (according to Galilei's rule) see Patrizio Barbieri, «Il mesolabio e il compasso di proporzione: le applicazioni musicali di due strumenti matematici (1558-1675)», in: *Musica, scienza e idee nella Serenissima durante il Seicento*, ed. Francesco Passadore & Franco Rossi, Venezia: Fondazione Levi 1996, pp. 201–220, pp. 201–207 and 219–220.

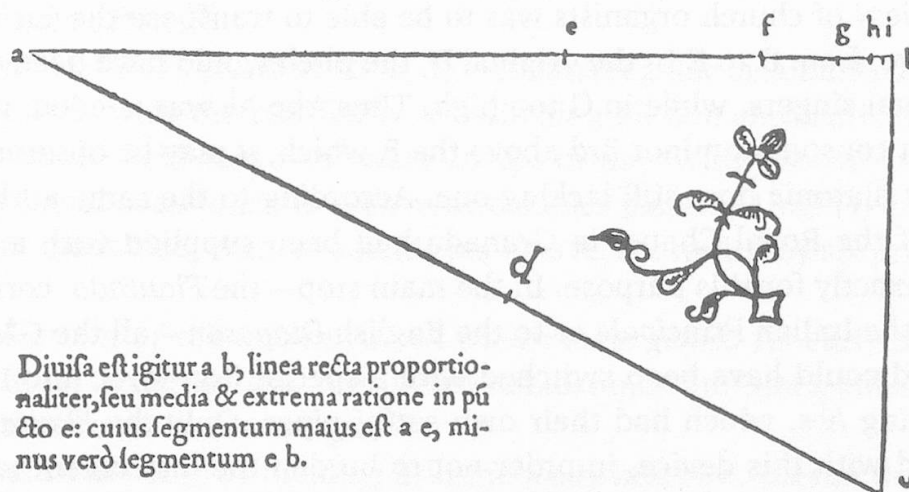
68 On Zarlino see Bernardino Baldi, *Vite inedite di matematici italiani* [...], ed. Enrico Narducci, Roma: Tipografia delle scienze matematiche e fisiche 1887, p. 171 (*Bullettino di bibliografia e di storia delle scienze matematiche e fisiche*, XIX, July–November 1886, off-print). On Hardy: Mersenne, *Harmonie universelle*, «Traité des intrumens à cordes», pp. 224–225. Claude Hardy belonged to Mersenne's entourage, and also left a manuscript French translation of Zarlino's *Istitutioni harmoniche*: Marin Mersenne, *Correspondance* [...], ed. by Cornelis de Waard, I, Paris: Presses Universitaires de France 1945, pp. 187–188.

69 Salinas, *De musica*, p. 173.

being, but *only* for a golden section, $ae/ab = eb/ae = x$. Salinas then applies the same division to fb , gb , hb , etc.

Thus, the above construction is valid only for the golden section, and not for all the other possible ratios (like $1:2^{1/12}$, needed for the ETS 12). Although only approximate, a working method – still based on the golden section – for applying equal temperament to the neck of a lute was devised by William Brouncker in 1653.⁷⁰

Fig. 10: Francisco Salinas (1577): proposal for a lute fretting according to a progression based on the golden section



5. Why enharmonic keyboards?⁷¹

The answer to this question is at least threefold.

5.1. *Transpositions of church modes and increasing spread of their «major mode» version.* Around 1500 the usual harmonic range was still either $E^b-G^\sharp$ or $A^b-C^\sharp$.⁷² According to Ramis de Pareja (1482) some musicians preferred the $G^\sharp$ because it was good for «Landino's» cadential progressions of the type $b-g^\sharp^1 \rightarrow a-a^1$.⁷³ In 1555 Juan Bermudo reported that «some barbarian performers» («algunos barbaros tañedores») modified the melodic pattern of the 1st mode by introducing the so-called «diatessaron intenso» ($D-E-F^\sharp-G / A-B-C^\sharp-D$) and the same «species» of 4th was also applied to the 4th mode ($E-F^\sharp-G^\sharp-A$). Their explanation was that in this way both «sounded bet-

70 Lindley, *Lutes*, pp. 33–36.

71 See also Rasch, «Why were enharmonic keyboards built?» (in this volume).

72 On the problem see: Lindley, «Fifteenth-Century Evidence», pp. 46–47; Wraight & Stemberge, «Italian Split-Keyed Instruments», pp. 163 and 171.

73 Lindley, «Fifteenth-Century Evidence», p. 47.

ter». ⁷⁴ Indeed the modern «major mode» was already beginning to extend its domain into the modes based on all the diatonic notes of the octave, strengthening the need of the above mentioned three sharps. Turning to the E $\flat$, on the other side of the chain of 5ths, we may observe that (1) in *fugato* counterpoint the «diatonic» note B $\flat$ needed the 5th below or 4th above, and (2) there being no church mode on the B, the D $\sharp$ – according to Pietro Aron (1529) – was «little used» (and so the B was the only diatonic note which did not require the major 3rd upwards). ⁷⁵ However, we may add that a D $\sharp$ would be needed for the cadences in the pieces in E.

As far as the A $\flat$ is concerned, Bermudo relates that «one of the great necessities» of church organists was to be able to transpose the 1st mode a 3rd above, from D to F. In the original D, the pitch would have been too low for normal singers, while in G too high. Thus, the A $\flat$ was needed, in order to give a consonant minor 3rd above the F, which, it may be observed, was the only diatonic note still lacking one. According to the same author, the organ of the Royal Chapel in Granada had been supplied with a special device exactly for this purpose. In the main stop – the *Flautado*, corresponding to the Italian *Principale* or to the English *Diapason* – all the G $\sharp$ s of the keyboard could have been switched with a special iron lever into the corresponding A $\flat$ s, which had their own set of pipes. Only the *Flautado* was provided with this device, in order not to burden the instrument with too many pipes. Also in some Italian organs, which unlike Granada's instrument were equipped with split keys, the pipes for the extra semitones were only supplied for one or two stops. ⁷⁶

It is worth recalling that a revival of Granada's solution was recorded in mid-18th-century England, where some instruments were equipped with keyboards of the normal type, but with the possibility of shifting the eleven-5ths compass by hand-operated stops. For example, the harpsichord Kirkman made to plans by Robert Smith, or the famous organ installed at the Found-

74 Bermudo, *Declaracion*, fol. 67r.

75 Pietro Aron, *Toscanello in musica* [...], Venezia: De Vitali 1529, cap. 40: the black key between D and E is tuned as an E $\flat$ instead than a D $\sharp$, «because of the organists, who prefer to give the 3rd minor to the C, than the 3rd major to the B, being the B little used by them».

76 Bermudo, *Declaracion*, fol. 89v; Wraight & Stembridge, «Italian Split-Keyed Instruments», pp. 170–171. The above mentioned practice is documented in the following two Italian organs. (1) Mesagne (Brindisi), instrument built by Tommaso Mauro for the «Chiesa Collegiata» (1648): ten stops, but «eight semitoni spezzati» (D/F $\sharp$, E/G $\sharp$, plus six unspecified enharmonic splittings) only for the *Principale 8'* and *Flauto in ottava fusulato*; see Luisa Cosi, «Organi e organari in terra d'Otranto nei secoli XVII e XVIII», in: *Musicisti nati in Puglia ed emigrazione musicale tra Seicento e Settecento*, Roma: Torre d'Orfeo 1988, pp. 117–138, p. 127. (2) Florence, Cathedral (1649): «tasti rotti» only for the *Principale*; see Barbieri, «Il Cembalo onnicordo», p. 67.

ling Hospital in London (1768), again inspired by the theories of Smith, who had died only a few months earlier. On this second instrument the player could opt for any one of the three harmonic ranges: $E\flat$ - $G\sharp$ (the common one), F - $A\sharp$, or $D\flat$ - $F\sharp$.⁷⁷ By the end of the century the same idea was extended to pianos, which used more convenient pedal levers and adopted solutions similar to those being applied to harps in the same period. The following instruments are particularly relevant in this connection:

- Charles Clagget's *Royal Teliochordon* (1790–91), which was a device that could also be applied to grand pianos so that by using two extra pedals, the normal range $E\flat$ - $G\sharp$ could be supplemented with five further sharps or five further flats.⁷⁸
- William Hawkes's piano of 1808, 1/6-comma regular meantone, 17 notes per octave, with the possibility of switching all five chromatic notes of its (normal) keyboard into either sharps or flats with just one pedal.
- Lastly David Loeschmann's even more complex piano of 1809 (1/4-comma regular meantone, with 24 sounds per octave, controlled by six pedals).⁷⁹

5.2. *The revival of the ancient Greek enharmonic genus.* As early as 1666 Lemme Rossi remarked that during the Renaissance the Greek enharmonic had been restored in two stages:⁸⁰

1. The «ancient» one, by dividing arithmetically into two «diesis» the minor semitone of the three tetrachords of the Greek Perfect System: B - C - D - E , E - F - G - A , and A - $B\flat$ - C - D . The quartertones $B\times$, $E\times$, $A\times$ thus obtained did not give rise to any consonant chord, so maybe they were employed only melodically, as ornamentations or *portamento* effects. It is in this way that they were treated by Emilio de' Cavalieri and by the Roman papal singers in the first half of the 17th century.⁸¹

77 Alexander C.N. Mackenzie of Ord, *Keyboard temperament in England during the eighteenth and nineteenth centuries*, Unpublished Thesis, University of Bristol, September 1979, pp. 94–95.

78 Charles Clagget, *The Royal Teliochordon Stop*, London [1791].

79 Henry Liston, *An essay on perfect intonation*, Edinburgh 1812, pp. 141–142; Mackenzie of Ord, *Keyboard temperament in England*, pp. 180–181. It is worth recalling that, still in 1885, the English concertina was tuned in meantone (= 1/4-comma temperament), and its harmonic range had 14 notes, from $A\flat$ to $D\sharp$: Helmholtz, *On the sensations of tone*, p. 434 (Addition by A.J. Ellis).

80 Rossi, *Sistema musico*, pp. 76–78.

81 Kirkendale, *Emilio de' Cavalieri*, p. 156; Patrizio Barbieri, «Violin intonation: a historical survey», in: *Early music* 19/1 (1991), pp. 69–88, p. 80. This kind of employment of the enharmonic was still in use at the end of the 18th century: Patrizio Barbieri, «G.B. Orazi's Enharmonic Flute and its Music (1797–1815)», in: *The Galpin Society Journal* 52 (1999), pp. 281–304, pp. 290–292.

2. The «modern» one, by setting in consonant counterpoint the enharmonic steps (like G[#]-A^b) of the keyboards shown in §§2-3 above.

Concerning their practice, the oldest extant source is an undated *Epistola* by John Hothby (died 1487), the English music theorist who was also in Italy. He tells us that he owned an instrument furnished with enharmonic keys:

E notate anchora bene che sopra li instrumenti che si fano ogidì il enharmonio non ce, ma cum la voce si fa al mancho uno de li semitonii minimi pur menti di meno. Io [ho] uno instrumento il quale lo ha interamenti, che altrimenti tal generatione sarebbe indarno trovata e anchora il nostro Boetio e li altri harebeno fallito.

He says the extra keys for the B^x, E^x, and A^x were coloured in red – in addition to the white and black ones – and that such notes gave rise to «melodies» with intervals so narrow that the ear could hardly detect them.⁸²

Another reference to an early revival of the chromatic and enharmonic is supplied by Pietro Aron. In 1516 he reports that his teacher – the Bolognese Giovanni Spataro – had written a composition in honour of Pope Leo X, «the tenor [part] of which contained the chromatic and enharmonic genera». This piece – though disapproved of by some well known Italian composers, because of its unusual intervals – was sung with delight by Aron himself and other friends of Spataro.⁸³ Collating the above information, we can infer that this piece is to be dated 1513–16, but we cannot know whether it was based on Hothby's enharmonic division, or on the consonant treatment of split keys, already present in a few organs of his day, as seen in §2.1 above, although not yet in those of the basilica of San Petronio, where in 1512 Spataro had been appointed *maestro di cappella*.⁸⁴

82 I-Fn Ms. Magl. XIX.36, fols. 74–78, published in Johannis Octobi, *Tres tractatuli contra Bartholomeum Ramum*, ed. Albert Seay, Roma: American Institute of Musicology 1964 (= Corpus Scriptorum de Musica 10), pp. 79–92, pp. 85, 91–92, and 87: «le lor melodie sono tanto strete e serrate che l'orechio apena senti le loro differentie».

83 Pietro Aron, *Libri tres de institutione harmonica* [...], Bologna: in aedibus Benedicti Hectoris 1516, fol. 22v: «[Ioannes Spatarius Bononiensis] modulationem proxime in laudem Leonis decimi pontificis maximi edidit, quam ego et vidi, et libenter cecini. In cuius tenore chromaticum genus complexus est, et enarmonicum, licet a nonnullis non parvi nominis Italis musicis explosa fuerit, quia inconsuetae atque reconditae modulationis rationem minime inveniebant, quam nos tamen amici eius invenimus, atque cecinimus».

84 Only in 1528 Lorenzo da Prato's organ of the basilica seems to have been furnished with these extra keys: Oscar Mischiati, «Documenti sull'organaria padana rinascimentale. I: Giovanni Battista Facchetti», *L'organo* 22 (1984), pp. 23–160, pp. 47 and 75–76.

It should be mentioned that – as late as around 1632–33 – Giovanni Battista Doni set exactly Hothby's three enharmonic notes in the *facies posterior* of his *Lira Barberina*: in fact the second and final tuning of this instrument presented the frets arranged according to a meantone temperament, but with the semitones B-C, E-F, and A-B $\flat$ split into two arithmetically equal quartertones.⁸⁵ He also provided a short essay on the Diatonic-Chromatic-Enharmonic genera, daringly superimposing their descending tetrachords in a three-part counterpoint (Ex. 3). As for his *Lira Barberina*, here Doni confirms that – in order to obtain the correct ancient quartertones – the major semitones should be split into two arithmetical parts, and not tuned like those of the multitone keyboards of §2 (i.e., with consonant major 3rds, e.g., C $\sharp$ -E $\sharp$). In such a way, «terze mezzane» should have been obtained, i.e., (very dissonant) «neutral» 3rds midway between the major and the minor ones.⁸⁶

In any case, it is Vicentino who – already as early as the end of the 16th century – has been credited with the revival of the chromatic and enharmonic genera. His was the first documented attempt related to the above mentioned «second stage», i.e., to the setting of the enharmonic steps in consonant counterpoint. However, he did not respect strictly the original tetrachordal form of the three Greek genera, mixing them together and hence composing in a style then called «misto». The compositions in strict style were, on the contrary, called «semplici».⁸⁷ Apart from the philologist Doni, the first – and also the last – musician to have left a documented attempt in the field of these chromatic and enharmonic «composizioni semplici» was Ascanio Mayone (1618).⁸⁸

5.3. *The «Stylus metabolicus»*. The term «enharmonic» was also used with another meaning. Martino Pesenti – in his above mentioned work (1641) – presents diatonic pieces transposed into keys with three to seven flats (which he calls «cromatico») and with one sharp to two double sharps (which he calls «enarmonico».⁸⁹ Referring to a descending scale such as F-E $\flat$ -D $\flat$ -C $\flat$ -B $\flat$ -A $\flat$ -G $\flat$ -F, in 1638 also Domenico Mazzocchi had pointed out

85 Barbieri, «Gli strumenti poliarmonici», p. 85.

86 Giovanni Battista Doni, *Lyra Barberina*, I, Firenze: Tip. Caesarea 1763, pp. 406 and 410. A computer assisted performance of this composition was provided with my paper during the colloquium in Basel.

87 Zarlino, *Dimostrazioni harmoniche*, pp. 213 («composizioni diatoniche, cromatiche o enarmoniche semplici», or «miste») and 276.

88 Barbieri, «La Sambuca lincea», pp. 190–193. See also van Asperen, «Consonant or dissonant?», and Rasch, «Why were enharmonic keyboards built?» (in this volume).

89 Kirkendale, *Emilio de' Cavalieri*, p. 156. See Rasch, «Why were enharmonic keyboards built?» (in this volume).

Ex. 3: Giovanni Battista Doni (c1632–40): counterpoint with the three ancient Greek genera superimposed, from his *Lyra Barberina* (1763), I, p. 410 (transcription by M. Kirnbauer).

Diagram illustrating counterpoint with the three ancient Greek genera superimposed, from Giovanni Battista Doni's *Lyra Barberina* (1763), I, p. 410 (transcription by M. Kirnbauer).

The diagram shows three staves, each representing a different Greek genus:

- Diatonico** (Top staff): Treble clef, C major key signature, common time signature. The melody consists of eighth and quarter notes.
- Cromatico** (Middle staff): Treble clef, C major key signature, common time signature. The melody consists of half and whole notes.
- Enarmonico** (Bottom staff): Bass clef, C major key signature, common time signature. The melody consists of half and whole notes.

The diagram is divided into four systems, each starting with a measure number (4, 7, 10, 13) in the left margin. Each system contains three staves, showing the progression of the counterpoint across the three genera.

that it could still be called enharmonic, though not respecting the true melodic pattern of that genus.⁹⁰ In fact this scale is nothing else than a section of a G major scale transposed down by a minor semitone.

According to Athanasius Kircher, the abrupt introduction of so many accidentals in a composition merely denotes a modulation (or a transposition) and not the use of the enharmonic. Clearly drawing the term from Doni's treatises (who uses the term «note metaboliche», i.e., modulating notes), he adds that such compositions are to be placed in a class whose name should be «Stylus metabolicus».⁹¹ Besides quoting compositions by Doni himself, Pietro Heredia, Pietro Della Valle, Carlo Gesualdo da Venosa, Domenico Mazzocchi, and Benedetto Narducci, he provides an example by Giacomo Carissimi, in which – when in the text the expression of joy turns into tears – the key turns respectively from F major into F minor and from B $\flat$ major into B $\flat$ minor (Ex. 4).

Towards the end of the 17th century split keys disappeared, the new tonal system requiring the unification of the sharps and the enharmonically equivalent flats. In §5.1 we have seen that only in Great Britain, still up to the 1810's, enharmonically doubled notes were sometimes maintained, even on the pianos.⁹² In Italy, on the contrary, the last surviving keyboard instruments originally made with split keys are dated 1665 and 1666.⁹³ Nigetti's last instrument was made in 1670, and this made his fellow-citizen Orazio Ricasoli Rucellai thinking that «maybe in the centuries to come the voice gradation will widen still more» (c1665–73).⁹⁴ But just the opposite was true: as far as we know, only Giuseppe Sarti – in 1779–84, when he was

90 Domenico Mazzocchi, *Dialoghi e sonetti*, Roma: Zannetti 1638, pp. 175 and 181 («non-dimeno adoprandosi alcune parti di esso accomodate al Diatonico, pur tali compositioni si potranno chiamare enarmoniche»).

91 Doni, *Compendio*, p. 62; Athanasius Kircher, *Musurgia universalis*, I, Roma: Corbelletti 1650, pp. 672–675 («De mutatione modi, sive toni, sive stylo metabolico»).

92 Of such a kind, still in 1799 were even «the Temple [church] organ and one at Lord Uxbridges»: John Wall Callcott, *A critical examination of the musical theory of Kirnberger*, [London] Feb. 8, 1799 (GB-Lbl Ms. Add. 27648, p. 97).

93 Wraight & Stembridge, «Italian Split-Keyed Instruments», pp. 168 and 156, respectively. A Willem Hermans organ in Sant'Agnese in Agone (Rome, piazza Navona), in 1667–68 was made with «tasti spezzati», although it is not clear if they were the D/F $\sharp$, E/G $\sharp$ in the short octave or the usual enharmonic splittings: I-Rdp Mandati di pagamento 1671-V, no. 897 (September 1671): «E più per filo di ferro grosso e filo di otone per la reductione delli tasti spezzati, scudi 1.50».

94 Orazio Ricasoli Rucellai, *Segue il Timeo. Delle musiche proporzioni*, [Florence] no year; I-Fn Ms. Cl. II.III.269, fol. 157r: «e oggi si vede, che da musici di più alto sapere ogni dì si spezzano, e suddividono i tasti delli strumenti, e degli organi, e forse co' secoli avvenire s'andrà più ampliando la graduazione delle voci».

Ex. 4: Giacomo Carissimi's example of «stylus metabolicus», according to Athanasius Kircher, *Musurgia universalis* (1650), p. 673 (transcription by M. Kirnbauer).

The musical score consists of three systems, each with three staves (treble, alto, and bass clef). The time signature is 3/4. The key signature has one flat (B-flat). The lyrics are: "E' pur da pian - de - re, e' pur da ri - ge - re, e' pur da pian - ge - re, de - re,". The score includes various musical notations such as trills (tr.), slurs, and specific interval markings (6, 4, 3, b, 8, 7) below the staves.

maestro di cappella in Milan's cathedral – directed the construction of both a harpsichord (by the Elli brothers) and of an organ (by the «celebrated Fontana») with split keys.⁹⁵

5.4. *Transposing keyboards.* Regarding the Equal Tempered Systems, it should be recalled that enharmonic divisions had also been employed merely for transposing a normal keyboard in microtonal steps, in order to match the pitch of other instruments, e.g., Carl Luython's *Clavecymbalum universale* and Iacopo Ramerino's transposing harpsichord. Together with the possibility of «circulating», in the second half of the 17th century this was even

95 Patrizio Barbieri, «Giuseppe Sarti fisico acustico e teorico musicale», in: *Giuseppe Sarti musicista faentino*, ed. Mario Baroni & Maria Gioia Tavoni, Modena: Mucchi 1986, pp. 221–240, p. 232.

the only practical use of Vicentino's ETS 31, as shown by Francesco Nigetti's *Cembalo onnicordo* (Florence, 1640–70) and Cristiaan Huygens' transposing keyboard (Paris, c1669).⁹⁶

6. Conclusions

6.1. Owing to practical performance problems, the just tuning system had to be tempered. The first quantitative exposition of such operations can be ascribed to Zarlino (1558–71), but it was Salinas (1577) who established that in each of the regular temperaments (later called «meantone») all tones had the same size.

6.2. Diatonic-chromatic, meantone-tuned keyboards normally provided only major and minor semitones. Their extension into the enharmonic – a genus used above all in Italy – can be divided into four progressive steps: (1) division of a few major semitones only (giving rise to widespread split keys like G[♯]/A^b and E^b/D[♯], at either end of the chain of 5ths, thus giving to all diatonic notes both the major and minor 3rd), (2) division of all the major semitones (*cimbalo cromatico*), (3) further divisions, beginning to penetrate into the minor semitones' domain (an enterprise started by Zarlino), (4) division of all the minor semitones (Vicentino's *Archicembalo*).

6.3. Just intonation enharmonic keyboards, on the other hand, were built almost exclusively for demonstration purposes. See Salinas' double harpsichord, providing his just intonation «perfect» system in the upper keyboard (24 keys per octave) and the very same system, but tempered, in the lower one (19 keys per octave in three rows, which happens to be a *cimbalo cromatico*). From Salinas' just intonation «perfect» system stem the proposals by Mersenne, Descartes and their Flemish and Dutch followers (among them Joan Albert Ban is the only one to have put just intonation into practice, even compositionally).

6.4. The employment of meantone tuning to fretted instruments required the introduction of the awkward system of the so-called *tastini* and for this reason equal temperament was generally preferred. To this end different, yet correct methods were suggested by Vincenzo Galilei and Zarlino, but on the contrary, Salinas' ingenious construction – based on the golden section – has proved useless for this purpose.

96 Barbieri, «I temperamenti ciclici», pp. 153–155, 178, 184 and 203.

6.5. The introduction of the above mentioned enharmonic keys was due to three factors: (1) the transposition of church modes, for the convenience of singers, (2) the revival of the ancient Greek enharmonic genus, put into practice in two stages, (3) the increasing spread of transpositions and modulations in a single composition, a style that – even in 1650 – Kircher classed as *Stylus metabolicus*.

L'evoluzione delle tastiere enarmoniche a catena aperta c1480–1650

Patrizio Barbieri

In questa sede saranno presi in considerazione solo i sistemi enarmonici sintonici e mesotonici: entrambi sono del tipo a catena aperta, cioè non circolanti. Quelli circolanti, basati sui numerosi tipi di sistema equabile (ETS = *Equal Tempered Systems*), sono stati esaminati in un precedente articolo.¹

1. I fondamenti teorici: dal sistema pitagorico a quello «partecipato», oggi detto «del tono medio»

1.1. Il sistema pitagorico adottato fino al secolo XV era generato da una catena di 5^e perfette: le dodici note dell'ottava potevano quindi essere ottenute con lo schema di Tabella 1 (gli zero in esponente significano che ogni nota viene accordata in 5^a pura, cioè senza battimenti, rispetto alla precedente). Tale procedimento dava luogo a 3^e maggiori (ad es. C⁰-E⁰) eccedenti di un comma sintonico ($= 81:80 \cong 21.5$ cents, da ora in poi chiamato semplicemente «comma») rispetto al loro rapporto consonante 5:4, e 3^e minori (ad es. C⁰-E^{b0}) ristrette della stessa quantità, sempre con riferimento al loro rapporto consonante 6:5.

Tabella 1 – Sistema pitagorico con ambito armonico E^b-G[#]

... E^{b0} B^{b0} F⁰ C⁰ G⁰ D⁰ A⁰ E⁰ B⁰ F^{#0} C^{#0} G^{#0} ...

Nel rinascimento, quando tali intervalli cominciarono a essere impiegati armonicamente, i teorici pensarono di restringere di un comma una 5^a ogni quattro, al fine di rendere consonanti tutte le 3^e maggiori e tre quarti delle minori. Restringendo ad esempio le 5^e B^b-F, D-A e F[#]-C[#] si otterrebbe il sistema sintonico di Tabella 2.

1 Patrizio Barbieri, «I temperamenti ciclici da Vicentino (1555) a Buliowski (1699): teoria e pratica «archicembalistica»», in: *L'organo* 21 (1983), pp. 129–208.

Tabella 2 – Sistema sintonico con lo stesso ambito armonico di Tabella 1

	$C\sharp^{-2}$	$G\sharp^{-2}$	...	
	A^{-1}	E^{-1}	B^{-1}	$F\sharp^{-1}$
F^0	C^0	G^0	D^0	
...		$E\flat^{+1}$	$B\flat^{+1}$	

In tale schema gli esponenti indicano, con riferimento alla scala pitagorica di Tabella 1, l'alterazione cumulativa in commi dell'altezza delle singole note. Detta notazione permette di individuare facilmente tutte le possibili triadi consonanti, maggiori e minori. Ad es., in $C^0-E^{-1}-G^0$ l'E dev'essere un comma più grave (e quindi -1) rispetto a quello di Tabella 1, e ciò al fine di dare luogo a una 3^a maggiore col C e a una 3^a minore col G entrambe consonanti. In $C^0-E\flat^{+1}-G^0$, l'E $\flat$ dev'essere invece innalzato di un comma (e quindi $+1$) per le stesse ragioni. Si può anche immediatamente constatare che al di sopra del D non c'è nè 3^a minore nè 5^a pura, essendo dissonanti rispettivamente D^0-F^0 e D^0-A^{-1} . Notiamo inoltre che ora i toni sono di due specie: grande (ad es. $C^0-D^0 = 9:8$) e piccolo (ad es. $D^0-E^{-1} = 10:9$): infatti alcuni di essi sono composti da due 5^e pure ($C^0-G^0-D^0$), mentre in altri una delle due 5^e è ristretta di un comma ($D^0-A^{-1}-E^{-1}$).

Sotto l'aspetto storico, Bartolomeo Ramis de Pareja (1482) risulta essere il primo teorico a essersi accorto dell'evoluzione dell'intonazione verso rapporti sintonici, nei quali cioè sono consonanti anche le 3^e e le 6^e.² A Ludovico Fogliano, che operò una cinquantina di anni dopo (1529), è stata invece sempre riconosciuta la paternità dell'introduzione dei D e B $\flat$ sdoppiati commaticamente, al fine di reintegrare la purezza delle due 5^e diatoniche D-A e B $\flat$ -F (Tabella 3).³

Tabella 3 – Sistema sintonico di Fogliano (1529)

	D^{-1}	A^{-1}	E^{-1}	B^{-1}	
$B\flat^0$	F^0	C^0	G^0	D^0	
				$B\flat^{+1}$	

2 Sull'argomento vedi Mark Lindley, «Fifteenth-Century Evidence for Meantone Temperament», in: *Proceedings of the Royal Musical Association* 102 (1975-76), pp. 37-51.

3 Ludovico Fogliano, *Musica theorica* [...], Venezia: De Sabio 1529, fol. 34v; Giovanni Battista Doni, *Annotazioni sopra il compendio de' generi e de' modi della musica* [...], Roma: Fei 1640, p. 40 («conforme all'inventione del Fogliano»).

1.2. Nella pratica esecutiva il principale problema era costituito dalla dissonanza delle 5^e ristrette, come ad es. D^0-A^{-1} . Nell'intonazione vocale a ciò si poteva ovviare trasformando uno stesso tono, all'occorrenza, da grande a piccolo, o viceversa (ad es. $C^0-D^0 \rightarrow C^0-D^{-1}$), ma dopo alcune di queste manipolazioni ciò poteva causare una anche considerevole alterazione, in crescere o in calare, del corista di partenza (i commi aggiunti non venendo infatti statisticamente compensati da quelli sottratti). Il matematico veneziano (nonché compositore dilettante) Giovanni Battista Benedetti – in una lettera al suo amico Cipriano de Rore, pubblicata nel 1585 – risulta essere il primo a segnalare la possibilità di tale deriva del corista, fornendo anche due esempi limite dei suoi sorprendenti effetti (Es. 1).⁴

Es. 1: Giovanni Battista Benedetti (1585): deriva del corista di riferimento causata dall'intonazione sintonica. Se tutti gli intervalli vengono intonati puri, detto corista slitterà:

- (a) verso l'acuto di 1, 2, 3, 4 commi, dato che la voce superiore sale di un tono grande (T), mentre invece è costretta a scendere di un tono piccolo (t);
 (b) verso il grave di 1, 2, 3 commi, dato che in questo caso la voce superiore scende di un semitono grande (S), ma è costretta a risalire tramite un semitono piccolo (s).

The image shows two systems of musical notation. The first system is labeled with 'T' and 't' above the notes, indicating a shift towards the acute. The second system is labeled with 'S' and 's' above the notes, indicating a shift towards the grave. Below the notation are two rows of letter names corresponding to the notes.

System 1 (Acute shift):

G°	A°	A°	G+1	G+1	A+1	A+1	G+2	G+2	A+2	A+2	G+3	G+3	A+3	A+3	G+4	G+4	G+4
D°	D°	E°	D+1	D+1	E+1	E+1	D+2	D+2	E+2	E+2	D+3	D+3	E+3	E+3	D+4	D+4	D+4
G°	D°	C+1	G+1	D+1	C+2	C+2	G+2	D+2	C+3	C+3	G+3	D+3	C+4	C+4	G+4	D+4	D+4

System 2 (Grave shift):

D°	C#-2	C#-2	D-1	E-2	D-1	C#-3	D-2	E-3	D-2	C#-4	D-3	E-4	D-3				
G°	G°	A-1	D-1	G-1	G-1	A-2	D-2	G-2	G-2	A-3	D-3	G-3	G-3				
G°	E-1	A-1	A-1	G-1	E-2	A-2	A-2	G-2	E-3	A-3	A-3	G-3	G-3				

4 Giovanni Battista Benedetti, *Diversarum speculationum mathematicarum, et physicarum liber*, Torino: Bevilacqua 1585, p. 279. Successivamente, a tale inconveniente accennerà anche Vincenzo Galilei, *Discorso intorno all'opere di messer Gioseffo Zarlino da Chioggia* [...], Firenze: Marescotti 1589, p. 121. Una realizzazione informatizzata di tali due esempi è stata fatta ascoltare in occasione della mia relazione su «Fretted strings versus vocal intonation: Enharmonic proposals in the Baroque» al colloquio in Basilea.

Per quanto invece riguarda gli strumenti da tastò, il problema poteva venire risolto in due modi:

- Sdoppiando commaticamente la nota inferiore delle 5^e ristrette (Es. 2).
- Trasformando i toni grande e piccolo in un unico tono medio, unificando in tal modo le summenzionate note commaticamente sdoppiate. Ciò poteva venire ottenuto tramite uno dei molti tipi di temperamento mesotonico, fra i quali il più noto era quello che restringeva ogni 5^a di 1/4 di comma, alterazione tale da lasciarla ancora consonante (Tabella 4). Quest'ultimo tipo di accordatura lasciava inoltre intatto uno dei più importanti intervalli della scala sintonica di partenza: la 3^a maggiore (infatti, invece di restringere di un intero comma una 5^a ogni quattro, ciascuna di tali quattro 5^e veniva ristretta di 1/4 di comma).

Es. 2: Le stesse note dell'Es. 1, ma intonate secondo lo schema di Tabella 2: questa volta il corista rimarrà stabile, ma una 5^a (D^0-A^{-1}) e una 4^a ($A^{-1}-D^0$) saranno scordate di un comma. Una soluzione consisterebbe nel servirsi dell'intonazione di Tabella 3, passando dal D^0 al D^{-1} (e viceversa) quando necessario.

G°	A-1	A-1	G°	G°
D°	D°	E-1	E-1	D°
G°	D°	C°	C°	G°

D°	C#-2	C#-2	D°	D°	E+1	D°
G°	G°	A-1	D°	G°	G°	
G°	E-1	A-1	A-1			G°

Tabella 4 – Temperamento del quarto di comma (o del «tono medio», o «mesotonico»)

	$C\sharp^{-7/4}$	$G\sharp^{-2}$	...	
	$A^{-3/4}$	E^{-1}	$B^{-5/4}$	$F\sharp^{-6/4}$
$F^{+1/4}$	C^0	$G^{-1/4}$	$D^{-2/4}$	
...		$E\flat^{+3/4}$	$B\flat^{+2/4}$	

1.3. Il primo teorico che cercò di formulare una interpretazione quantitativa del «quarto di comma» fu il già citato Ludovico Fogliano (1529). In modo piuttosto semplicistico, sia pure facendo correttamente uso di una costruzione grafica fornita dagli *Elementi* di Euclide, egli infatti unificò i due D di Tabella 3 in un unico medio geometrico ($D^{-1/2}$); identica operazione fu poi da lui estesa ai due $B\flat$.⁵

Altri due tipi di tono medio, nei quali 3^e e 6^e continuavano a rimanere più o meno prossime ai loro rapporti sintonici, erano quelli che restringevano di 2/7 o di 1/3 di comma ognuna delle 5^e della catena. Anche in ciascuno di essi i toni erano di un unico formato, intermedio tra il grande e il piccolo, caratteristica del resto comune a tutti i temperamenti «regolari» (cioè a quelli che restringono della stessa quantità ognuna delle 5^e). Gioseffo Zarlineo – che nel 1558 e 1571 fu il primo a fornire una descrizione quantitativa sia del «quarto» che del «due settimi di comma», nonché un accenno al «terzo di comma» – sorprendentemente afferma (e anche ripete) che solo il primo dei tre dava luogo a toni fra loro uguali.⁶ Solamente con Francisco Salinas (1577) ci si cominciò a rendere conto che tale caratteristica era comune anche agli altri due.⁷

5 Fogliano, *Musica theorica*, fol. 35v.

6 A riguardo vedi il §1.4. La svista di Zarlineo è stata già rilevata da Roberto Airoldi, *La teoria del temperamento nell'età di Gioseffo Zarlineo*, Cremona: Turris 1989, pp. 57 e 106.

7 Francisco Salinas, *De musica libri septem* [...], Salamanca: Gastius 1577, p. 143 sgg. Più avanti, a p. 164, Salinas fa correttamente osservare che — passando dall'1/3 al 2/7 e al 1/4 di comma — il rapporto tra il temperamento del tono grande e quello del tono piccolo tende all'unità, attraverso una progressione armonica.

Almeno a partire dal 1496 tali temperamenti venivano semplicemente designati col termine «partecipazione», oppure «sistema partecipato».⁸ Secondo il matematico Lemme Rossi (1666) tale denominazione era dovuta al fatto che i sistemi così ottenuti «partecipavano» delle più favorevoli caratteristiche sia del sistema pitagorico (toni di un solo formato) che del sistema sintonico (3^e e 6^e consonanti).⁹ Che tale tipo di temperamento fosse di fatto considerato alla stregua di un vero e proprio «sistema» viene confermato dal tedesco Joachim Junge (1587-1657), che mette fianco a fianco la

«Scala diatonica vetus» (= pitagorica),

«Scala diatonica nova» (= sintonica),

«Scala diatonica reformata» (= «quarto di comma»)¹⁰

Il termine «temperamento del tono medio», col quale oggi molti autori intendono designare il solo «quarto di comma», appare invece in epoca assai più tarda.¹¹

1.4. Le considerazioni di cui sopra sono pertinenti solo agli strumenti da tasto. La possibilità che tale intonazione temperata fosse proprio quella di cui si servivano anche i cantanti non accompagnati costituì il tema di un acceso dibattito, verso la fine del Cinquecento, tra Zarlino e Vincenzo Galilei: il primo

8 Vedi ad es.: Franchino Gaffurio, *Practica musice*, Milano: Lomazzo 1496, c. ddIv (lib. III, cap. III); Fogliano, *Musica theorica*, c. 35v; Giovan Maria Lanfranco, *Scintille di musica* [...], Brescia: Britannico 1533, pp. 131-136. A tale riguardo è curioso ricordare che, secondo il matematico bergamasco Giuseppe Unicornio, ancora al suo tempo (1598) alcuni organi antichi conservavano le aspre 3^e e 6^e della loro accordatura pitagorica originale, essendo «senza participatione»: Patrizio Barbieri, «An Unknown 15th-century French Manuscript on Organ Building and Tuning», in: *The Organ Yearbook* 20 (1989), pp. 5-20, p. 20.

9 Lemme Rossi, *Sistema musico overo musica speculativa* [...], Perugia: Laurenti 1666, p. 58: «Onde per tor via l'ineguaglianza de' tuoni, si venne a formare un nuovo Sistema, che chiamano temperato, o' partecipato, partecipando dell'uno, e dell'altro Diatono esplicati; poichè quanto all'haver' i tuoni eguali è simile al Diatono Ditonico [= pitagorico], e nel resto poco si discosta dal Sintonico».

10 Joachim Jungius, «Harmonicae definitiones», in: Id., *Praecipuae opiniones physicae* (opera postuma), Amburgo 1679, c. [B4]v. Junge si interessò a varie discipline: nel 1618 fu anche a Padova, dove si laureò in medicina; Robert Eitner, *Biographisch-Bibliographisches Quellen-Lexicon* V, Leipzig: Breitkopf & Härtel 1901, p. 311.

11 Secondo Airoidi, *La teoria del temperamento*, p. 8, esso sembra sia stato per la prima volta impiegato da Pierre Galin (1818). Ma è solo con le famose *Additions* di Alexander J. Ellis alla traduzione in inglese del trattato di Hermann L.F. Helmholtz, *On the sensations of tone* [...], London: Longmans 1885, p. 433, che il termine «tono medio» («meantone») divenne l'equivalente standard di «temperamento del quarto di comma». Sull'estensione generalizzata di tale termine a schemi aventi le 3^e maggiori temperate vedi Mark Lindley, *Lutes, Viols and Temperaments*, Cambridge: Cambridge University Press 1984, p. 43.

afferitava categoricamente che i cantanti seguivano il rigoroso sistema sintonico descritto nei suoi trattati, il secondo – al contrario – che tale sintonico veniva intonato non rigidamente, ma in maniera elastica e in qualche modo temperata.¹² Pur non entrando nel merito della questione, c'è da rilevare che la tesi di Zarlino è in ogni caso contraddittoria. Infatti egli afferma che «tutte» le consonanze, anche le 5^e ristrette di un comma, vengono intonate pure, senza considerare che in tal modo (1) si sarebbe dovuta registrare una più o meno marcata deriva del corista (vedi l'Es. 1), oppure (2) se i cantanti – al fine di evitare sia le consonanze danneggiate dal comma, sia la summenzionata deriva del corista – avessero deciso di intonare i salti commatici (vedi i D sdoppiati dell'Es. 2), l'effetto sarebbe stato egualmente «fastidioso» e «tristo», come lo stesso Zarlino rileva riferendosi a uno strumento musicale da lui fatto costruire proprio con detti sdoppiamenti commatici (vedi, più avanti, il §3.1).¹³

L'acrimonia di Zarlino nei riguardi del suo ex-allievo Galilei fu inoltre inasprita dal fatto che, nel *Dialogo* (1581), quest'ultimo aveva illustrato il «due settimi di comma» senza riconoscere la paternità della scoperta a Zarlino: il solo «nuovo» contributo di Galilei – che anche questa volta si dimentica di ricordare che esso era in realtà dovuto a un altro autore (Salinas) – consiste nell'aver fatto rilevare che anche nel «due settimi di comma» i toni sono fra loro uguali, prestazione che veniva incontro alla sua tesi sull'intonazione vocale effettivamente praticata.¹⁴ Per il resto, la trattazione quantitativa dei temperamenti fornitaci da Galilei rivela che in tale campo egli non doveva certamente trovarsi a suo agio.¹⁵ Zarlino, dal canto suo, non riconobbe mai la sua svista. Nella seconda edizione delle *Dimostrazioni harmoniche*

12 Vincenzo Galilei, *Dialogo della musica antica et della moderna*, Firenze: Marescotti 1581, pp. 30–31; Gioseffo Zarlino, *Sopplimenti musicali* [...], Venezia: De' Franceschi 1588, pp. 130–152 (in particolare p. 148).

13 Gioseffo Zarlino, *Le institutioni harmoniche* [...], Venezia: s.e. 1558, p. 125 (senza il temperamento si sarebbe dovuto introdurre «spesse volte» l'intervallo di comma, «il che non solamente difficoltà al sonatore; ma etiandio poco diletto a gli ascoltanti haverebbe apportato: perché in cotal caso si haverebbe udito un non so che di tristo, che haverebbe fatto non poco fastidio») e p. 127. Vedi anche Gioseffo Zarlino, *Dimostrazioni harmoniche* [...], Venezia: De' Franceschi 1571, p. 220 («si udiva un non so che di poco buono»).

14 Galilei, *Dialogo*, p. 33.

15 Patrizio Barbieri, «L'accordatura strumentale in Toscana: proposte e contrasti da V. Galilei a Cristofori (c. 1580–1730)», in: *Musicologia humana. Studies in honor of Warren and Ursula Kirkendale*, a cura di Siegfried Gmeinwieser, David Hiley & Jörg Riedlbauer, Firenze: Olschki 1994, pp. 209–232, pp. 212–213. Per quanto poi riguarda il temperamento equabile, non solo i risultati cui perviene nel *Dialogo* non sono esatti, ma nei calcoli insinua un errore che non sembra fortuito: vedi Airoldi, *La teoria del temperamento*, pp. 142–145.

(1589) «aggiusta» infatti disinvoltamente i passi errati senza alcuna avvertenza:¹⁶

ed. 1571

[p. 221] così in questo temperamento [il 2/7 di comma] si ritrovano due tuoni l'uno maggiore dell'altro

[p. 266] Et perché quelli [= i tuoni] della participatione fatta nelle Istitutioni sono differenti l'uno dall'altro per una settima parte di uno comma

ed. 1589

[p. 200] retiene in sé l'equalità de i tuoni

[p. 242] Et perché i tuoni della detta participatione dimostrata nelle Istitutioni, non sono differenti l'un dall'altro di proportion

1.5. Se in Tabella 4 – al fine di allargare l'usuale ambito $E\flat$ - $G\sharp$ – aggiungiamo ulteriori 5^e temperate, iniziamo di conseguenza anche a dividere in due parti ineguali i semitoni grandi, cioè quelli diatonici (Tabella 5). Entriamo così nel dominio del genere enarmonico, dato che per la prima volta incontriamo note enarmonicamente equivalenti (come $G\sharp$ - $A\flat$ e $B\sharp$ - C) che fra loro risultano essere separate da un intervallo detto «diesis enarmonico», del quale la nota diesata costituisce la base. Sia nel sistema sintetico puro che in quello temperato col «quarto di comma» il rapporto di frequenza corrispondente a tale microintervallo è 128:125 ($\cong$ 41.1 cents), equivalente a circa un quinto di tono. Nel §2 verranno esaminate le tastiere costruite secondo schemi di questo tipo.

Tabella 5 – Temperamento mesotonico allargato all'enaarmonico («cimbalo cromatico»)

			$E\sharp$	$B\sharp$	...	$A\sharp$
		$C\sharp$	$G\sharp$	$D\sharp$		
	A	E	B	$F\sharp$		
F	C	G	D			
$D\flat$	$A\flat$	$E\flat$	$B\flat$			
		...	$G\flat$			

1.6. Le «partecipazioni» finora illustrate sono semplicemente dovute alla «distribuzione» del comma, e quindi all'unificazione dei tasti sdoppiati cromaticamente. Proseguendo su questa strada, si potrebbe «distribuire» anche il diesis enarmonico, e quindi unificare i tasti sdoppiati enarmonicamente, come $G\sharp$ - $A\flat$, $B\sharp$ - C , ecc.: si otterrebbe così il temperamento equabile, nel quale

16 Riguardo alla 2a ed. vedi Gioseffo Zarlino, *Le dimostrazioni harmoniche* [...], in: Id., *De tutte l'opere* [...], vol. II, Venezia: De' Franceschi 1589.

l'ottava è suddivisa in 12 semitoni fra loro acusticamente uguali, sistema che oggi si designa anche con l'acronimo ETS 12 (= Equal Tempered System 12). Già in Salinas (1577) troviamo questa originale duplice impostazione della teoria del temperamento, la quale – secondo Lemme Rossi (1666) – porta alle tre categorie di tastiera illustrate in Tabella 6.¹⁷ Nel §3.1 vedremo però che Salinas limiterà a tre anche gli ordini della sua tastiera a intonazione sintonica, non contando quello dei «commi».

Tabella 6 – I tre sistemi di accordatura delle tastiere

<i>Sistema</i>	<i>Toni</i>	<i>Semitoni</i>	<i>N°. di ordini della tastiera</i>	<i>Osservazioni</i>
Sintonico	Due tipi	Quattro tipi	Quattro: diatonico, diesis, bemolli, commi	Toni e semitoni di ampiezze differenti
Mesotonico	Un tipo	Due tipi	Tre: diatonico, diesis, bemolli	Unificazione dei soli toni
Equabile	Un tipo	Un tipo	Due: diatonico, diesis=bemolli	Unificazione sia dei toni che dei semitoni

Si può inoltre osservare che:

- Entro i limiti dell'usuale ambito delle undici 5^e della catena anche i temperamenti mesotonici possono essere considerati «equabili», essendo i loro intervalli armonici temperati nello stesso modo.¹⁸
- Anche un intervallo dissonante come la cosiddetta «5^a del lupo» G[#]-E^b – eccedente di quasi un diesis enarmonico rispetto alla 5^a pura – poteva tornare utile, essendo talvolta impiegata da abili musicisti per particolari effetti: vedi ad es. Juan Bermudo (1555) e Bartolomeo Cristofori (1709–10).¹⁹

17 Salinas, *De musica*, p. 167; Rossi, *Sistema musico*, pp. 82 e 88.

18 Ciò era stato già rilevato verso la metà del Settecento, quando nuovi temperamenti «irregolari» furono ideati anche col dichiarato proposito di conferire un carattere distintivo alle singole tonalità: vedi ad es. Patrizio Barbieri, «Il «migliore» sistema musicale temperato: querelles fra Estève, Romieu e altri accademici francesi (c. 1740–60)», in: *L'organo* 27 (1991–92), pp. 31–81, pp. 52 e 57.

19 Juan Bermudo, *Declaracion de instrumentos musicales* [...], Ossuna: De Leon 1555, fol. 47r-v; Barbieri, «L'accordatura strumentale», p. 221 (su Cristofori). Vedi anche Doni, *Annotazioni*, p. 173.

2. Tastiere enarmoniche mesotoniche: verso i quinti di tono

2.1. *Dai primi tasti spezzati al «cimbalo cromatico».* La prima menzione documentata di tali note «supplementari» risale al 1468 e fa riferimento all'organo della cattedrale di Cesena. Si sa inoltre che nel 1480 le ottave centrali del nuovo organo della cattedrale di Lucca furono dotate di tasti spezzati per l'E $\flat$ /D $\sharp$ e il G $\sharp$ /A $\flat$ (l'usuale ambito E $\flat$ -G $\sharp$ veniva così esteso di una 5^a ad entrambe le estremità).²⁰ Come vedremo nel §5.1, specialmente l'A $\flat$ era richiesto dagli organisti liturgici. In taluni casi, a seconda delle esigenze del committente, i due tasti spezzati potevano venire aggiunti solamente nell'estremità superiore della catena di 5^e: vedi ad es. la tastiera di Fig. 1, riportata dal fiammingo Joannes van der Elst (1657).²¹ Tale spezzatura poteva inoltre essere estesa a tutti e cinque i tasti neri, portando così l'ambito a G $\flat$ -A $\sharp$ (Fig. 2a).²² Con due ulteriori diesis (tra E-F e B-C) detto ambito poteva venire allargato a G $\flat$ -B $\sharp$, cioè proprio a quello caratterizzante il cosiddetto «cimbalo cromatico» (Tabella 5). Sebbene tale specifica denominazione venga documentata solo a partire dal 1609 (Ascanio Mayone), tastiere di tale genere – i cui tasti si presentavano disposti in tre ordini – erano già note a Vicentino (1555), Zarlino (1558) e Salinas (1577).²³ Su quest'ultimo autore torneremo però nel §3.1.

20 Denzil Wraight & Christopher Stenbridge, «Italian Split-Keyed Instruments with Fewer than Nineteen Divisions to the Octave», in: *Performance Practice Review* 7/1 (1994), pp. 150–181, pp. 162 e 169.

21 Joannes van der Elst, *Notae Augustinianae* [...], Gand: Graet 1657, fig. 33. In Italia, al contrario, non si conosce alcuno strumento che sia stato dotato dei D $\sharp$ e degli A $\sharp$ senza che fossero presenti anche gli A $\flat$: vedi Wraight e Stenbridge, «Italian Split-Keyed Instruments», p. 171.

22 Van der Elst, *Notae Augustinianae*, fig. 44.

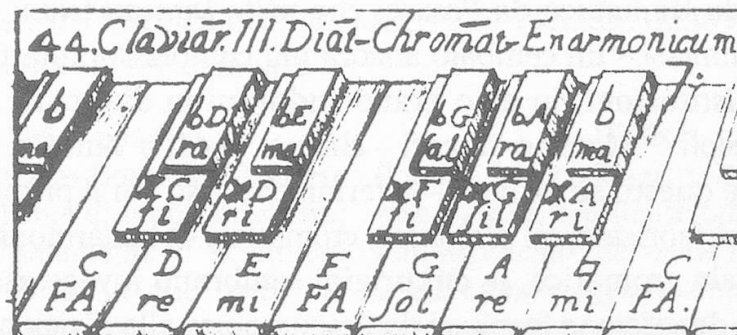
23 Oltre ai contributi di Rudolf Rasch e di Denzil Wraight (in questo volume), vedi Christopher Stenbridge, «Music for the *Cimbalo Cromatico* and Other Split-Keyed Instruments in Seventeenth-Century Italy», in: *Performance Practice Review* 5/1 (1992), pp. 5–43; Id., «The *Cimbalo cromatico* and Other Italian Keyboard Instruments with Nineteen or More Divisions to the Octave (Surviving Specimens and Documentary Evidence)», in: *Performance Practice Review* 6/1 (1993), pp. 33–59. Sul *cimbalo cromatico* vedi inoltre Patrizio Barbieri, «La *Sambuca Lincea* di Fabio Colonna e il *Tricimbalo* di Scipione Stella. Con notizie sugli strumenti enarmonici del Domenichino», in: *La musica a Napoli durante il Seicento*, a cura di Domenico Antonio D'Alessandro & Agostino Ziino, Roma: Torre d'Orfeo 1987, pp. 167–216, pp. 187–190. Un *cimbalo cromatico*, unitamente a uno schematico tentativo di calcolarne le lunghezze di corda vibrante, si trova anche in Michael Keller, *Monochordum* [...], Neisse: Schubart 1636, cap. VI.

Fig. 1: Joannes van der Elst (1657): «Claviarium II» (ambito armonico Eb-A#).



Fig. 2 a:

Joannes van der Elst (1657): «Claviarium III» (ambito armonico Gb-A#);

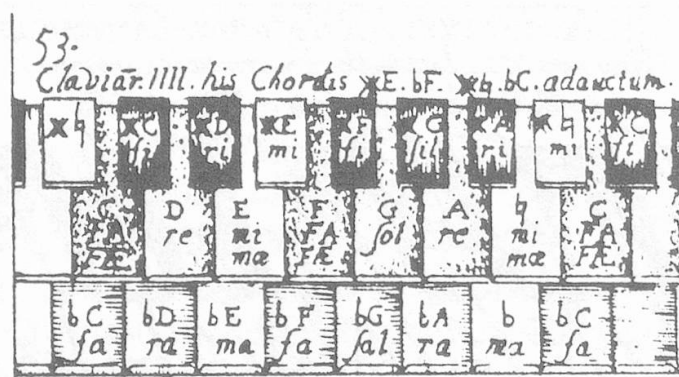


Nelle comuni tastiere *tutti* i toni si trovavano divisi semplicemente in due semitoni, piccolo e grande. Nel cimbalo cromatico, invece, *tutti* i sette semitoni grandi (cioè i cinque dei toni più i due diatonici E-F e B-C) venivano a loro volta suddivisi in semitono piccolo e diesis enarmonico: così facendo, con l'eccezione dei C^b e F^b, ogni nota diatonica era quindi dotata della sua versione diesata e bemollizzata. Nella Fig. 2b van der Elst aggiunge inoltre proprio i C^b e i F^b mancanti, portando l'ambito complessivo della catena di 5^e a F^b-B[#].²⁴

24 Van der Elst, *Notae Augustinianae*, fig. 53. La disposizione dei tasti di tale strumento presenta qualche analogia con quella della seconda versione del «Cembalo onnicordo» di Francesco Nigetti (c1644) e del «Cembalo pentarmonico» di Doni: Patrizio Barbieri, «Il Cembalo onnicordo di Francesco Nigetti in due memorie inedite di G. B. Doni (1647) e B. Bresciani (1719)», in: *Rivista italiana di musicologia* 22 (1987), pp. 34–113, pp. 59–63.

Fig. 2 b:

Joannes van der Elst (1657): «Claviarium IV» (ambito armonico F^b-B[#]).



2.2. Dal cimbalo cromatico all'archicembalo. Subito dopo aver presentato l'illustrazione di un cembalo dotato dello stesso ambito del cimbalo cromatico, nelle *Istituzioni armoniche* Zarlino prosegue dicendo che nel 1548 si era fatto costruire – da Domenico da Pesaro, che nelle *Dimostrazioni* verrà ricordato come suo «amico» – un cembalo ancora più complesso: infatti, secondo l'ed. 1558 delle *Istituzioni*, in esso erano suddivisi in due parti anche «tutti» i semitoni piccoli.²⁵ Martino Pesenti – che nel 1641, a Venezia, ebbe occasione di esaminare questo strumento – afferma che esso «fu il primo clavicembalo, che fosse mai fabricato col diatonico, cromatico, et henarmonico» (ignorando così il cimbalo cromatico, le cui origini sembrano invece essere anteriori). La puntuale descrizione fornitaci da Pesenti porta alla divisione di Tavola 7.²⁶

25 Zarlino, *Le istituzioni harmoniche*, p. 140; Zarlino, *Dimostrazioni harmoniche*, p. 235 (dove Adriano Willaert cita il cembalo del 1548, «che vi fece Maestro Domenico da Pesaro vostro amico»). Vedi anche i contributi di Rudolf Rasch, «Why were enharmonic keyboards built? – From Nicola Vicentino (1555) to Michael Bulyowsky (1699)», e di Denzil Wraight, «The cimbalo cromatico and other Italian string keyboard instruments with divided accidentals» (in questo volume).

26 Martino Pesenti, *Correnti, gagliarde, e balletti diatonici, trasportati parte cromatici, e parte henarmonici* [...], Venezia: Vincenti 1645, introduzione, pagine non numerate («A professori di musica, per maggior intelligenza»). Vedi anche Stembridge, «The Cimbalo cromatico», pp. 45–54 (con una traduzione in inglese dell'introduzione di Pesenti) e Rasch, «Why were enharmonic keyboards built?» (in questo volume). – Colgo l'occasione per ricordare che anche Pesenti possedeva uno strumento costruito dallo stesso cembalaro: *L'archivio IRE. Inventari dei fondi antichi degli ospedali e luoghi pii di Venezia*, a cura di Giuseppe Ellero, Venezia: IRE 1987, p. 174, anno 1645 («caso di testamento fatto da un cieco, Martino Pesenti qu. Giacomo [...] a don Gian Antonio Ferri il suo manacordi [sic] Domenico da Pesaro»).

Tabella 7 – Accordatura del cembalo enarmonico di Zarlino (Domenico da Pesaro, 1548)

				G $\sharp\sharp$	D $\sharp\sharp$	A $\sharp\sharp$	
			E $\sharp$	B $\sharp$	F $\sharp\sharp$	C $\sharp\sharp$	
		C $\sharp$		G $\sharp$	D $\sharp$	A $\sharp$	
	A		E	B	F $\sharp$		
F		C		G	D		
D $\flat$		A $\flat$	E $\flat$	B $\flat$			
			G $\flat$				

Riguardo a tale divisione, appare chiaro che Zarlino non suddivise «tutti» i semitoni piccoli, ma solo quelli relativi alle note bemollizzate del cimbalo cromatico, cioè D $\flat$ -D, E $\flat$ -E, G $\flat$ -G, A $\flat$ -A, B $\flat$ -B: in tal modo, «tutti i toni» furono suddivisi in quattro (e non più «tutti i semitoni minori» in due), come Zarlino stesso rettifica nell'edizione 1589 (sempre delle *Istituzioni*),²⁷ quando menziona il clavicembalo

ed. 1558, p. 140

il quale fece Maestro Dominico Pesarese fabricatore eccellente di simili istrumenti; nel quale non solamente li semituoni maggiori sono divisi in due parti, ma anche tutti li minori.

ed. 1589, p. 171

il quale fabricò Maestro Dominico Pesarese, raro et eccellente fabricatore di simili istrumenti; nel quale non solamente i semituoni maggiori sono divisi in due parti, ma anche i minori, di maniera ch'ogni tuono viene a essere diviso in quattro parti.

L'ultima menzione a noi nota di tale strumento ci è stata lasciata da Charles Burney, che ebbe occasione di esaminarlo nel settembre 1770, a Firenze.²⁸

At Florence, I found the harpsichord of Zarlino, which is mentioned in the second part of his Harmonical Instructions, p. 140. This instrument was invented by Zarlino, in order to give the temperament and modulation of the three genera, the diatonic, chromatic, and enharmonic; and was constructed, under his direction, in the year 1548, by Dominico Pesarese: it is now in the possession of Signora Moncini, widow of the late composer Piscetti. I copied Zarlino's instructions for tuning it, from his own hand-writing, on the back of the fore-board; but I shall reserve them, and the particular description of this curious instrument, for the History of Music, to which they more properly belong.

27 Apparsa in: Gioseffo Zarlino, *De tutte l'opere* [...], vol. I, Venezia: De' Franceschi 1589.

28 Charles Burney, *The present state of music in France and Italy* [...], London: Becket 1771, pp. 253-254.

Apprendiamo così che il cembalo di Zarlino era allora posseduto da Maria Rosa Mancini (e non «Moncini»), vedova del compositore Giovanni Battista Pescetti.²⁹ Si ricorda che Pescetti – figlio dell'organaro Giacinto – nei suoi ultimi anni ricoprì la carica di secondo organista della basilica di San Marco, a Venezia, la stessa in cui Zarlino era stato maestro di cappella.³⁰ Purtroppo Burney non mantenne la promessa di pubblicare nella sua *General history of music* le istruzioni per l'accordatura lasciateci da Zarlino: Pesenti colma comunque questa lacuna, sebbene continui a mancare la descrizione dell'effettiva disposizione dei tasti.

Nello stesso lavoro, Pesenti aggiunge che dal 1621 al 1634 – sempre quando era a Venezia – suonava e teneva accordato un cembalo costruito nel 1601 da Vito Trasuntino. Questo strumento era come quello di Zarlino, ma con ulteriori quattro 5^e inserite nella catena, due nell'estremità dei diesis (A $\sharp\sharp$ -E $\sharp\sharp$ -B $\sharp\sharp$) e due in quella dei bemolli (G $\flat$ -C $\flat$ -F $\flat$).³¹

A questo punto è bene fare alcune considerazioni.

1. Se Vito Trasuntino avesse aggiunto tre ulteriori 5^e all'estremità inferiore della catena, avrebbe ottenuto lo stesso ambito armonico dell'archicembalo di Vicentino (Tavola 8). Ciò sembra essere proprio quello che Vito fece nel suo «Clavemusicum omnitonum» del 1606, dotato di 31 tasti per ottava, la cui effettiva accordatura è però tuttora dubbia.³²

29 Mario Fabbri, «Giovanni Battista Pescetti e un concorso per maestro di cappella a Firenze», in: *Rivista italiana di musicologia* 1 (1966), pp. 120-126, p. 124.

30 Sandro Dalla Libera, «Cronologia musicale della Basilica di San Marco in Venezia – IV», in: *Musica Sacra*, serie II, 6 (1961), pp. 133-135.

31 Pesenti, *Correnti*, introduzione. Vedi anche Stembridge, «The Cimbalo cromatico», pp. 45-54, e Wraight, «The cimbalo cromatico», e Rasch, «Why were enharmonic keyboards built?» (in questo volume).

32 Indecifrabile è infatti l'accordatura del «Tetrachordum» (un monocordo dotato di quattro corde, nell'esemplare in questione contrassegnato «trecta cordo») allegato al «Clavemusicum»: Marco Tiella, «La ricostruzione dell'archicembalo di Nicola Vicentino (1555)», in: *Strumenti e musica*, 33/1 (1980), pp. 82-86, p. 84.

Vicentino.³⁵ Nelle *Istituzioni*, dopo avere menzionato il cembalo che Domenico da Pesaro gli aveva costruito, si limita a osservare – forse alludendo a Vicentino – che l'introduzione di ulteriori suddivisioni avrebbe portato a inutili complicazioni.³⁶ C'è inoltre da tenere presente che era in stretto contatto col noto organaro Vincenzo Colombo, operante a Venezia, il quale aveva realizzato monocordi per lo stesso Zarlino, nonché per Claudio Merulo e forse per Ettore Ausonio, un matematico di professione dell'area veneziana che si occupò anche di teoria musicale (Fig. 3):³⁷ poiché Colombo aveva costruito un «Arciorgano» per Vicentino, è probabile che Zarlino fosse al corrente sulla sua accordatura.³⁸

3. Tastiere enarmoniche sintoniche: Zarlino, Salinas e i seguaci franco-fiamminghi di quest'ultimo

Passiamo ora ai cembali basati sul sistema sintonico non temperato, una categoria di strumenti – se si eccettua quello di Joan Albert Ban – progettati unicamente a fini dimostrativi, e di conseguenza non destinati all'effettiva pratica.

3.1. *Zarlino e Salinas*. Gli scritti di Zarlino riportano che, prima del 1558, lui stesso aveva diretto la costruzione di uno «strumento» la cui tastiera –

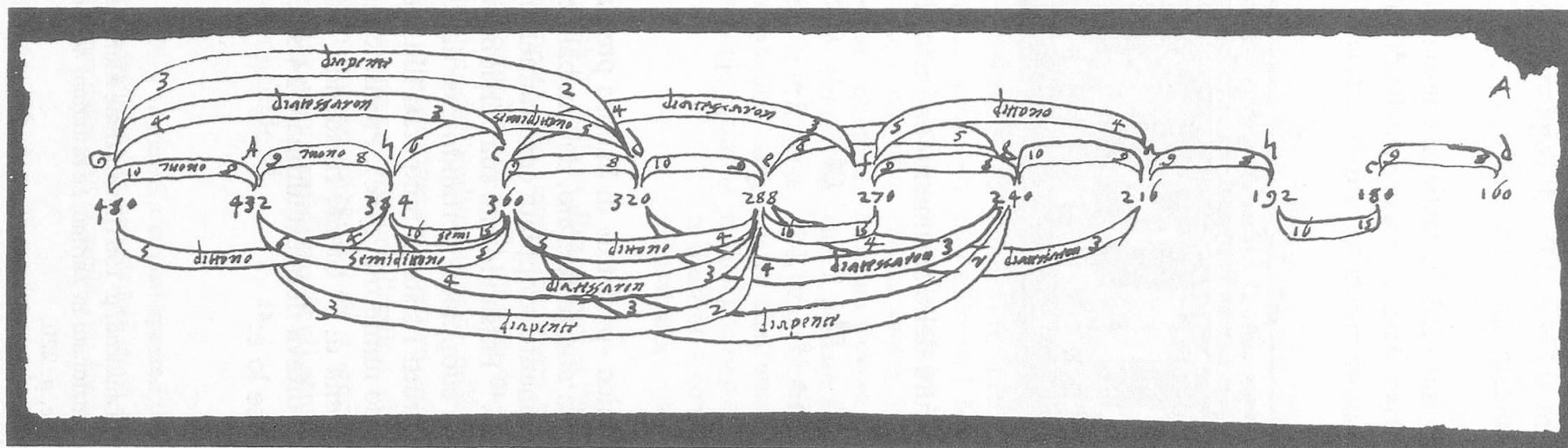
35 Zarlino, *Dimostrazioni harmoniche*, p. 221: «Et questo secondo temperamento [cioè il «quarto di comma»] è molto all'udito grato: né è anco molto difficile da fare: sì come sono gli due altri».

36 Zarlino, *Le institutioni harmoniche*, pp. 140–141. A p. 172 dell'ed. 1589, sempre delle *Istituzioni*, rafforza ulteriormente tali critiche (le frasi in corsivo non figurano nell'ed. 1558): «Dirò adunque per concludere, che questo è un'istrumento [cioè il cembalo di Domenico Pesarese], sopra il quale si potrà essercitare ogni ottimo sonatore, non solamente nell'harmonie diatoniche; ma etiandio nelle chromatiche, et nell'enharmoniche, quando potrà e saprà ridurle à i modi antichi, overamente quando à i nostri tempi potranno riuscir migliori, et più soavi di quello, che si odono in alcune sgarbate compositioni d'alcuni compositori moderni. Et dirò anco, che quando si volesse aggiungere al numero delle most-rate chorde alcun'altra chorda; perciocchè molte se ne possono aggiungere; senza dubbio sarebbe cosa vana e superflua [...]».

37 Zarlino, *Dimostrazioni harmoniche*, pp. 146 e 219. La Fig. 3 è stata tratta da: I-Ma Ms. G. 136. Inf.: Ausonius Hector, *Scholia ad musicam pertinentia*, ms. non datato, foglio volante in esso inserito (sul retro di detto foglio: «Charta datami da Maestro Vincenzo dall'Organi»).

38 Barbieri, «I temperamenti ciclici», pp. 160–161 e 195.

Fig. 3: Schema manoscritto di un sistema sintonico diatonico, inviato dall'organaro Vincenzo Colombo al matematico Ettore Ausonio (Venezia, metà Cinquecento): vedi nota 37. Esso illustra la scala C^0 - D^0 - E^1 - F^0 - G^0 - A^1 - B^1 - C^0 . Le lunghezze di corda vibrante segnate da Colombo risultano essere le stesse della *Musica theórica* di Fogliano (1529), alle quali è stato però tolto lo zero finale.



coprente l'usuale ambito $E\flat-G\sharp$ – è illustrata in Fig. 4 e nella Tavola 9.³⁹ Si può notare che, oltre al $B\flat^0$ e al D^{-1} di Fogliano, aggiunge un corretto $F\sharp^{-2}$, ma anche un armonicamente inutile $E\flat^0$.

Fig. 4: Gioseffo Zarlino (1558): tastiera a intonazione sintonica costruita secondo le sue direttive. Assieme forse a quello di Salinas, si tratta del primo strumento a intonazione giusta fornito di tasti sdoppiati commaticamente.

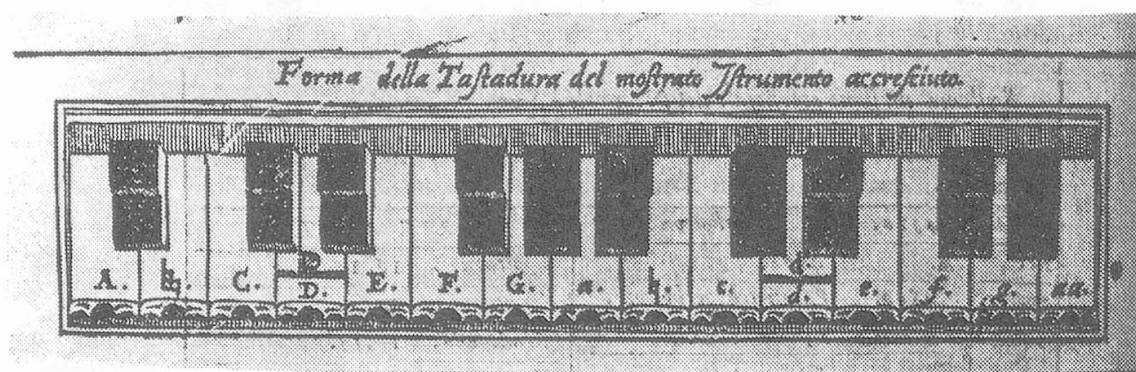


Tabella 9 – Accordatura dello strumento da tasto sintonico di Zarlino, illustrato in Fig. 4

		$F\sharp^{-2}$	$C\sharp^{-2}$	$G\sharp^{-2}$		
	D^{-1}	A^{-1}	E^{-1}	B^{-1}	$F\sharp^{-1}$	
$E\flat^0$	$B\flat^0$	F^0	C^0	G^0	D^0	
			$E\flat^{+1}$	$B\flat^{+1}$		

Il sistema sintonico «perfetto» di Salinas presenta invece (1) lo stesso ambito armonico, ma non temperato, del cimbalo cromatico ($G\flat^{+2}-B\sharp^{-3}$), e (2) note commaticamente sdoppiate correttamente estese al $G\flat$, $B\flat$, D , $F\sharp$, $A\sharp$ (vedi Tabella 10).⁴⁰ Passando alla sua versione mesotonica, Salinas unifica tali cinque note sdoppiate, portando così da 24 a 19 il numero totale di tasti per ottava (tutti i sistemi temperati illustrati nel suo trattato presentano questo stesso numero di note). Precisa che il genere enarmonico è contenuto nella catena di 5^e $G\flat-B\sharp$, ribadendo – nel capitolo XX – che il numero di tasti per ottava di quest'ultima è 24 se detto genere non è temperato e 19 se invece lo è.⁴¹

39 Zarlino, *Sopplimenti musicali*, p. 156 (illustrazione e lunghezze di monocordo). Tale strumento viene già menzionato in Zarlino, *Le istituzioni harmoniche*, p. 127, e in Id., *Demonstrationi harmoniche*, p. 220.

40 Salinas, *De musica*, p. 126.

41 Salinas, *De musica*, pp. 146-162 (capitolo XX a p. 151).

Quo pacto decem et sex soni generis Chromatici, et Enharmonij vigintiquinque instrumenti perfecti, ad tredecim, et viginti imperfecti per Participationem (quam vocant) reducuntur. Cap. XX.

In quale modo i 16 suoni del genere cromatico e i 25 di quello enarmonico, nello strumento perfetto, possono essere ridotti rispettivamente a 13 e a 20 in quello imperfetto, tramite il cosiddetto temperamento. Capitolo XX. [Salinas effettua le sue operazioni sull'ottava C-C, contando due volte il C].

Durante il suo soggiorno a Roma (c1538-58) si era anche fatto costruire uno strumento da tasto enarmonico. Infatti – alludendo all'organo di Santa Maria Novella, a Firenze, che era dotato di tasti spezzati solamente per il $G^\sharp/A^\flat$ e $E^\flat/D^\sharp$ – afferma:⁴²

Et plurima instrumenta Musica ex his, quae per alba, et nigra plectra pulsantur, secundum hoc genus disposita sunt (qualia memini me audire Florentiae) sed omnium perfectissimum est, quod ego Romae faciendum curavi et hinc habeo Salamanticae. In quo utrumque reperitur instrumentum, tam perfectum, quam id, quo utimur, imperfectum; et alterius ad alterum potest fieri collatio: et in utroque tria melodiarum genera maxima cura, atque diligentia perfectissime demonstrantur.

Molti strumenti musicali, fra quelli che si suonano premendo i tasti bianchi e neri, presentano questo genere [cioè l'enarmonico] (quali mi ricordo di avere ascoltato a Firenze). Ma il più perfetto di tutti è quello che ho fatto costruire a Roma e che ho qua a Salamanca. Nel quale si possono trovare entrambi gli strumenti, cioè il perfetto e quello che noi usiamo, cioè l'imperfetto; e ciascuno di essi può essere confrontato con l'altro, e in entrambi possono essere assai perfettamente illustrati – con la massima esattezza e accuratezza – i tre generi di melodie.

Come abbiamo visto nel §2.2, Salinas disapprovava l'Archicembalo di Vicentino (la cui costruzione aveva preso avvio, dice, meno di quarant'anni prima). Dichiarò di avere «tentato molte volte» di mettere in pratica tale sistema di accordatura, ma – al di fuori dell'ambito armonico $G^\flat-B^\sharp$ (lo stesso del cimbalo cromatico, potremmo aggiungere) – pervenendo a risultati negativi. Infatti i suoi problemi iniziano proprio «nell'ordine, che chiamano 4°», ribadendo che il genere enarmonico inizia nel $G^\flat$ e «termina» («terminatur») nel $B^\sharp$. Doveva certamente aver commesso degli errori nell'accordare il 4° e il 5° ordine, dato che conclude:⁴³

42 Salinas, *De musica*, p. 127; il riferimento ai tasti spezzati dell'organo di Santa Maria Novella è a p. 80. Sul suo soggiorno romano vedi José María Álvarez Pérez, «El organista Francisco de Salinas. Nuevos datos a su biografía», in: *Anuario musical* 18 (1963), pp. 21-44, p. 22.

43 Salinas, *De musica*, pp. 164-166. A p. 85 precisa che lo strumento che aveva fatto costruire a Roma presentava sia il tono grande che quello piccolo.

Quae quoniam plus nimio non meas solum, sed omnium etiam aures offende-
bat, cognovi, huiusmodi temperamentum
ab omni harmonica ratione, tam perfecti,
quam participati instrumenti prorsum
abhorre: et mutavi consilium. Nam in
tribus primis ordinibus accomodavi tem-
peramentum instrumenti participati, et
in tribus supremis perfecti; sonis C litera
signatis fixis manentibus, et ad uniso-
nantiam temperatis, quo ex utriusque
collatione posset (ut Ptolomaeus ait)
legitimum ab spurio, et imperfectum a
perfecto discerni.

Poiché offendeva grandemente non solo
le mie, ma anche le orecchie di tutti gli
altri, mi resi conto che tale accordatura
era assolutamente lontana da ogni rap-
porto armonico, sia dello strumento per-
fetto che dell'imperfetto: così imboccai
un'altra strada. Infatti nei primi tre ordini
sistemai l'accordatura dello strumento
temperato, mentre nei tre superiori quella
dello strumento perfetto. I suoni segnati
con la lettera C rimanevano fissi e accor-
dati all'unisono, di modo che confron-
tando le due [tastiere] si potesse rilevare
(come dice Tolomeo) la differenza tra il
giusto e il falso, e tra il perfetto e l'im-
perfetto.

Questo cembalo microtonale risultava quindi sempre dotato di due tastiere, ognuna delle quali con tre ordini di tasti, come nell'Archicembalo. Nella tastiera superiore presentava il summenzionato sistema «perfetto» sintonico (Salinas precisa che anche in questa i tasti erano disposti in «tre ordini», evidentemente non contando quello dei commi). I «tre ordini» di quella inferiore – come nello strumento di Vicentino – fornivano invece la sua versione temperata, cioè lo «strumento imperfetto» (accordato quindi come il cimbalo cromatico). Ricordando che – fra i tre temperamenti mesotonici citati nel §1 – Salinas riteneva il «quarto di comma» essere «assai meglio adatto agli strumenti da tasto», l'accordatura della sua versione dell'archicembalo può essere ricostruita come in Tabella 10.⁴⁴ Trovandosi all'unisono tutti i C delle due tastiere, poteva così effettuare il confronto tra gli intervalli del sistema enarmonico «perfetto» e quelli dell'«imperfetto». Nel 1618 Vicente Espinel riferisce di aver visto Salinas suonare tale strumento a Salamanca, «facendo miracoli con le mani».⁴⁵

44 Salinas, *De musica*, p. 154, titolo del capitolo XXII: «De tertio instrumentorum imperfectorum temperamento [cioè il «quarto di comma»], quod multo quam duo superiora [cioè il «due settimi» e il «terzo di comma»], et intellectu facilius, et instrumentis accommodatius esse videtur». E ancora, a p. 154: «Videtur, etiam ad instrumentis fabricandis accommodatius».

45 Vicente M. Espinel, *Vida de Marcos de Obregón*, a cura di Samuel Gili Gaya, Madrid: Espasa-Calpe 1940, II, p. 158: «Yo lo vi tañer el instrumento de tecla que dejò en Salamanca, en que hacía milagros con las manos; pero no le vi reducirlo a que voces humanas le ejecutasen, habiendo en el coro de Salamanca en aquel tiempo grandes cantores de voces y habilidad, y siendo maestro aquel grande compositor Juan Navarro».

Tabella 10 – Accordatura del cembalo a due tastiere di Salinas (c1538-58)

TASTIERA SUPERIORE, A 3 ORDINI:

«Instrumentum perfectum»

		A $\sharp$ ⁻³	E $\sharp$ ⁻³	B $\sharp$ ⁻³		
	F $\sharp$ ⁻²		C $\sharp$ ⁻²	G $\sharp$ ⁻²	D $\sharp$ ⁻²	A $\sharp$ ⁻²
D ⁻¹		A ⁻¹	E ⁻¹	B ⁻¹		F $\sharp$ ⁻¹
B $\flat$ ⁰	F ⁰		C ⁰	G ⁰	D ⁰	
G $\flat$ ⁺¹	D $\flat$ ⁺¹	A $\flat$ ⁺¹	E $\flat$ ⁺¹	B $\flat$ ⁺¹		
			G $\flat$ ⁺²			

TASTIERA INFERIORE, A 3 ORDINI:

«Instrumentum imperfectum» o «participatum»

		E $\sharp$ ^{-11/4}	B $\sharp$ ⁻³			
	C $\sharp$ ^{-7/4}		G $\sharp$ ⁻²	D $\sharp$ ^{-9/4}	A $\sharp$ ^{-10/4}	
A ^{-3/4}		E ⁻¹	B ^{-5/4}		F $\sharp$ ^{-6/4}	
F ^{+1/4}	C ⁰		G ^{-1/4}	D ^{-2/4}		
D $\flat$ ^{+5/4}	A $\flat$ ⁺¹	E $\flat$ ^{+3/4}	B $\flat$ ^{+2/4}			
			G $\flat$ ^{+6/4}			

3.2. *Galeazzo Sabbatini*. Sempre sulla scia dei «quinti di tono» di Vicentino, una ancor più complessa tastiera – in qualche modo basata sulla divisione non temperata dell'ottava fino al diesis enarmonico, e in alcuni punti anche oltre – è quella del cembalo di Galeazzo Sabbatini, dotata di 38 tasti per ottava. Le sue lunghezze di corda vibrante sono fornite dalla *Musurgia* di Kircher (1650). Queste non sono comunque totalmente affidabili, come indirettamente confermato dal fatto che, tre anni dopo, Sabbatini descrisse la sua accordatura in una tabella, ora persa, allegata a una lettera indirizzata allo stesso Kircher (1653). Anch'esso perso è un trattato manoscritto di Sabbatini – le *Scintille armoniche* –, che illustrava, oltre alla sua, altre tastiere enarmoniche, nonché la relativa pratica compositiva.⁴⁶

3.3. *Mersenne, Descartes, Ban e van der Elst*. Se si eccettuano alcuni esperimenti relativi agli ETS 19, 24 e 31,⁴⁷ in Francia le tastiere microtonali

46 Sull'argomento vedi Patrizio Barbieri, «Cembali enarmonici e organi negli scritti di Kircher. Con documenti inediti su Galeazzo Sabbatini», in: *Enciclopedia in Roma Barocca. Athanasius Kircher e il Museo del Collegio Romano tra Wunderkammer e museo scientifico*, a cura di Maristella Casciato, Maria Grazia Ianniello & Maria Vitale, Venezia: Marsilio 1986, pp. 111–128, pp. 118–125.

47 Barbieri, *I temperamenti ciclici*, pp. 149–50, 153, 156 e 173–175.

menzionate nel §2 non erano praticate. A partire da Mersenne (1636), si segnalano solo alcune modificazioni del sistema «perfetto» di Salinas, con l'aggiunta o la soppressione di alcune note.

Tabella 11 – Due proposte di ‘miglioramento’ del sistema di Salinas:

– tondo = Salinas (1577)

– tondo + grassetto = Mersenne (1636-7)

– tondo + grassetto + corsivo = Albertini (ante 1636)

				A ^{♯-3}	E ^{♯-3}	B ^{♯-3}		
A ⁻²	E ⁻²	B ⁻²	F ^{♯-2}	C ^{♯-2}	G ^{♯-2}	D ^{♯-2}	A ^{♯-2}	
F ⁻¹	–	G ⁻¹	D ⁻¹	A ⁻¹	E ⁻¹	B ⁻¹	F ^{♯-1}	
A ^{b0}	E ^{b0}	B ^{b0}	F ⁰	C ⁰	G ⁰	D ⁰		
		G ^{b+1}	D ^{b+1}	A ^{b+1}	E ^{b+1}	B ^{b+1}		
					G ^{b+2}			

Iniziamo con quelle che presentano alcune aggiunte (Tabella 11). Il «clavier parfait» di Mersenne (Fig. 5) non è altro che il sistema «perfetto» di Salinas allargato con l'aggiunta di due nuove note, entrambe armonicamente superflue (G⁻¹ e E^{b0}):⁴⁸ sebbene l'E^{b0} si riveli essere quello stesso già ideato da Zarlino (Tabella 9), la vera ragione di queste ulteriori sdoppiature commatiche sarà esaminata poco più avanti. *L'Harmonie universelle* riporta inoltre una versione del sistema di Salinas ulteriormente allargata, fino a 31 note per ottava, senza però alcun accenno al suo effettivo inventore.⁴⁹ Stando a un trattato manoscritto di Juan Carmuel Lobkowitz (1606–1682), esso è da identificarsi con tal «Albertinus nobilis italus» (a conferma, le sue lunghezze di corda vibrante sono state da lui denominate «Scala Musicae Panharmonicae ad mentem Albertini»).⁵⁰ Come si può vedere dalla Tabella 11, anche le cinque note aggiunte da Albertini sono inutili, così come lo erano quelle di Mersenne.

Di maggiore impiego pratico sembrano invece essere state le tastiere in cui alcune note del sistema perfetto di Salinas furono rimosse. Riducendolo a soli 18 tasti per ottava, otteniamo una tastiera illustrata dallo stesso Mer-

48 Marin Mersenne, *Harmonie universelle* [...], Paris 1636, Cramoisy, «Traité des instrumens à cordes», pp. 354–356. La Fig. 5 è stata tratta dall'ed. in facsimile della copia personale di Mersenne, che reca sue annotazioni autografe: Paris: C.N.R.S. 1965, III, tavola manoscritta.

49 Mersenne, *Harmonie universelle*, «Traité des instrumens à cordes», p. 357.

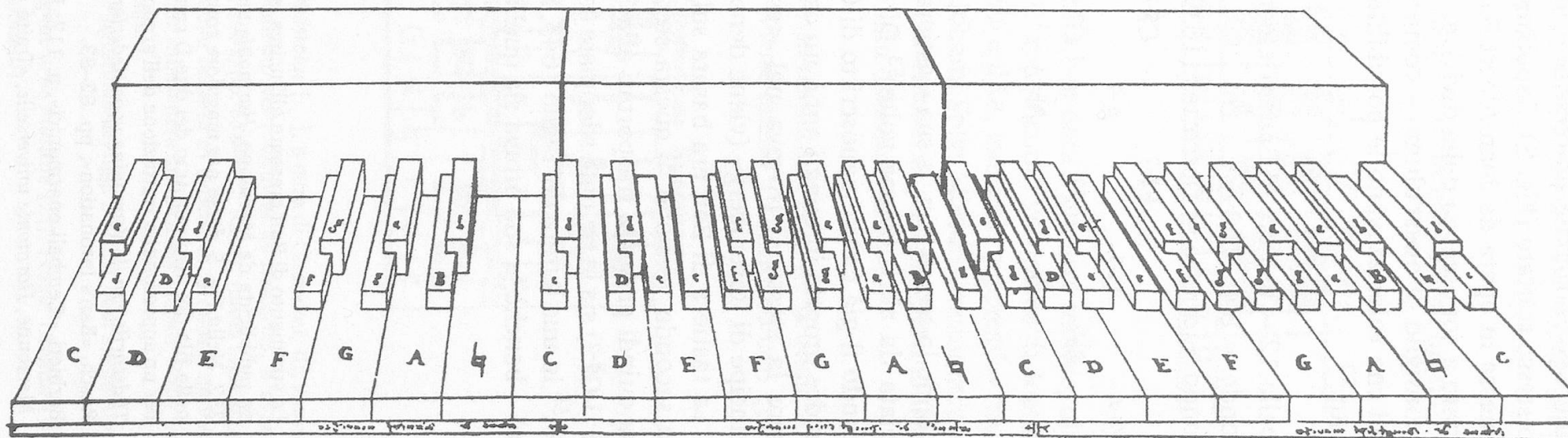
50 Barbieri, «Cembali enarmonici», p. 118; Id, «Juan Caramuel Lobkowitz (1606–1682): Über die musikalischen Logarithmen und das Problem der musikalischen Temperatur», in: *Musiktheorie* 2 (1987), pp. 145–168, p. 158.

Fig. 5: Marin Mersenne, disegno manoscritto non datato, allegato alla sua copia personale dell'*Harmonie universelle* (1636). Nel presente articolo questo schizzo viene riprodotto come verrebbe visto in trasparenza dopo averlo rovesciato, nell'originale di Mersenne essendo stato disegnato così come sarebbe stato tracciato da un incisore su di una lastra di rame. In esso vengono rappresentate tre differenti ottave (da C a C) in intonazione sintonica:

A sinistra: «octave de dix-neuf marches», cioè la stessa divisione messa in pratica da Joan Albert Ban (1639); nel suo cembalo, comunque, Ban adottò quasi esattamente la stessa disposizione dei tasti illustrata da Mersenne a p. 352 dell'*Harmonie universelle* («Traité des instrumens à cordes»). Non è altro che la divisione di Salinas nella quale sei tasti sono stati eliminati.

In centro: «octave de vingt-cinq marches», cioè lo stesso «instrumentum perfectum» progettato e fatto realizzare da Francisco Salinas.

A destra: «octave de vingt-sept marches», cioè il «clavier parfait» di Mersenne. Coincide con lo «strumento perfetto» di Salinas, cui sono state aggiunte due note, entrambe armonicamente inutili.



senne nell'*Harmonie universelle* e anche nelle sue aggiunte manoscritte allo stesso trattato (Fig. 5). Sappiamo che nell'ottobre 1639 tale divisione fu messa in opera da Joan Albert Ban, ad Haarlem (Tabella 12).⁵¹ Ban fu portato a conoscenza della divisione di Mersenne da Descartes e – sempre su consiglio di quest'ultimo – compose e pubblicò anche alcune composizioni che valorizzavano le possibilità di questa accordatura a intonazione giusta.⁵²

Tabella 12 – Tastiere di Ban e Descartes:

– tondo = Ban (1639)

– tondo + corsivo = Descartes (1639-46)

		F ^{♯-2}		C ^{♯-2}		G ^{♯-2}		D ^{♯-2}	
G ⁻¹		D ⁻¹		A ⁻¹		E ⁻¹		B ⁻¹	
	B ^{♭0}		F ⁰		C ⁰		G ⁰		D ⁰
		D ^{♭+1}		A ^{♭+1}		E ^{♭+1}		B ^{♭+1}	
									F ^{♯-1}

Secondo lo stesso Ban, la sua «tastiera perfetta» («volmaekte Klauwier») fu copiata da altri diverse volte.⁵³ Di una di tali copie si ha oggi notizia: secondo il già citato manoscritto di Caramuel, autore che soggiornò nelle Fiandre proprio in quegli anni, un cembalo con un'accordatura che risulta essere la stessa si trovava nel «tesoro» di un non meglio identificato «Principe di Rosenberg» (viene denominata «De Rosembergi Abaco»).⁵⁴

La tastiera di Ban era basata sull'ottava C-C. Mersenne riporta anche una seconda versione di questa stessa divisione, trasposta all'ottava F-F: essa quindi presenta trasportati alla 5^a inferiore sia il suo ambito armonico (G^{♭+1}-G^{♯-2}) sia le tre note sdoppiate commaticamente (E^{♭+1}/E^{♭0}, G⁰/G⁻¹, B⁻¹/B⁻²).⁵⁵ In una lettera del luglio 1643, Descartes riporta la tastiera di Ban, che però – benchè la sua ottava sia quella originaria (C-C) – viene inspiegabil-

51 Lo strumento di Ban presenta all'incirca la stessa disposizione di tasti della figura a stampa pubblicata da Mersenne, *Harmonie universelle*, «Traité des instrumens à cordes», p. 352. Nella Fig. 5, forse per maggiore comodità dell'esecutore, Mersenne ha fatto slittare nella fila dei tasti neri uno dei due D commaticamente sdoppiati.

52 Per un'approfondita trattazione dell'argomento vedi Rudolf Rasch, «Ban's intonation», in: *Tijdschrift van de Vereniging voor Nederlandse Muziekgeschiedenis*, 33 (1983), pp. 75-99.

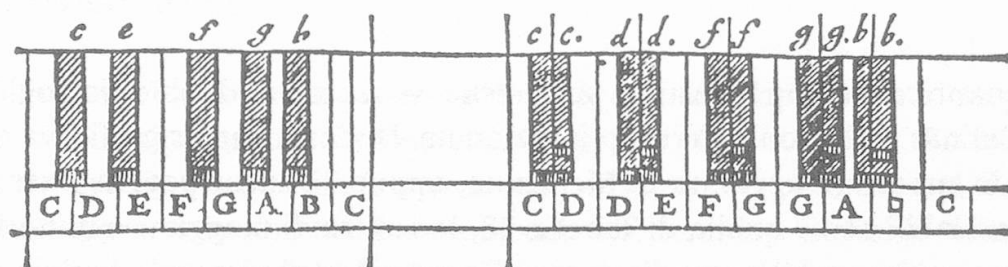
53 Rasch, «Ban's intonation», pp. 82-83.

54 Barbieri, «Cembali enarmonici», p. 117; Id., «Juan Caramuel Lobkowitz», p. 157.

55 Mersenne, *Harmonie universelle*, «Traité des instrumens à cordes», pp. 352-353.

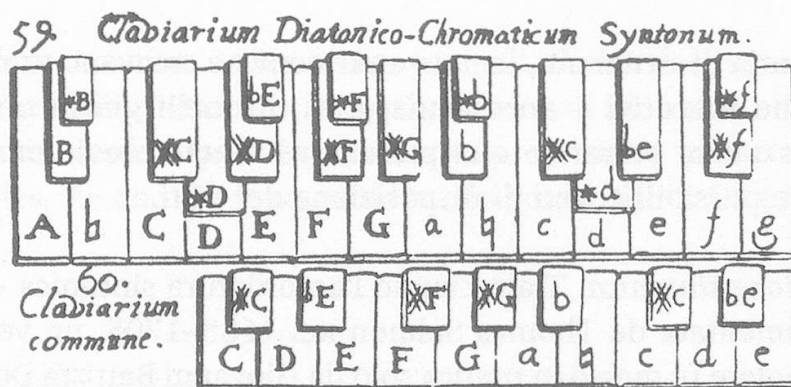
mente dotata non solo del D^{-1} , ma anche del G^{-1} (vedi la Fig. 6 e la Tabella 12, oltre alla Tabella 11 di Mersenne).⁵⁶

Fig. 6: René Descartes (1643): proposta di un (armonicamente inutile) G^{-1} da aggiungersi alla tastiera di Ban.



La tastiera di Ban sembra essere stata ben nota a un altro teorico, olandese: infatti il «Claviarium Diatonico-Chromaticum Syntonum» di Joannes van der Elst (1657) – se si escludono l' A^b e il D^b , entrambi soppressi – risulta avere identica accordatura (Fig. 7).⁵⁷ Johann Voigt Moritz – trattando della «Anatomia claviaturae chromaticae, et diatonicae, et partim enharmonicae» – nel 1719 aggiungerà invece un $A^{\#-2}$ alla divisione di Ban.⁵⁸

Fig. 7: Joannes van der Elst (1657): stessa tastiera di Ban, nella quale sono però stati soppressi sia l' A^b che il D^b (viene messa a confronto con quella comune, a 12 tasti per ottava).



56 La Fig. 6 è stata tratta da René Descartes, *Epistolae* [...], a cura di Clerselier, III, Amsterdam: Tip. Blaviana 1683, p. 387. Sull'argomento vedi: *Oeuvres de Descartes*, a cura di Charles Adam & Paul Tannery, IV, Paris: Cerf 1901, pp. 678–683; Rasch, «Ban's intonation», p. 92 (anche su di una versione allargata della tastiera di Descartes, proposta da Pieter Hellingwerf, Amsterdam 1718), e – specialmente sulla lettera di Descartes – Rasch, «Why were enharmonic keyboards built?» (in questo volume).

57 La Fig. 7 è stata tratta da van der Elst, *Notae Augustiniana*, figg. 59 e 60. Vedi anche Rasch, «Ban's intonation», p. 92.

58 Johann Voigt Moritz, *Conclave thesauri magnae artis musicae* [...], Praga: Labaun 1719, pp. 43–44 (dove però Ban non viene menzionato).

Tabella 13 – Tastiera attribuita a Giovanni Valentini (?)

		F $\sharp$ ⁻²		C $\sharp$ ⁻²		G $\sharp$ ⁻²		D $\sharp$ ⁻²
			A ⁻¹		E ⁻¹		B ⁻¹	
B $\flat$ ⁰	F ⁰		C ⁰		G ⁰		D ⁰	
G $\flat$ ⁺¹	D $\flat$ ⁺¹	A $\flat$ ⁺¹		E $\flat$ ⁺¹				

Per quanto concerne le tastiere sintoniche, senza alcun dubbio sia Fogliano che Salinas scelsero il criterio più razionale. Discostarsene significava ottenere le superflue aggiunte di Mersenne, oppure – ancor peggio – tastiere impraticabili come quella di Tabella 13, le cui triadi maggiori e minori sul D sono insopportabilmente dissonanti. Caramuel attribuisce tale tastiera a un «Valentinus Archimusicus Caesareus» (probabilmente Giovanni Valentini, maestro di cappella presso la corte viennese di Ferdinando III, imperatore che fu anche un prolifico compositore); aggiunge che essa fu anche adottata da tal «Cunradus organista apud Bavaros» (forse Caspar Conrad, organista a Öttingen, in Baviera). Si potrebbe però pensare a una svista dello stesso Carmuel nel riportare dette lunghezze di corda vibrante, essendo altamente improbabile che un musicista come Valentini si servisse di un cembalo che presentava accordi così dissonanti.⁵⁹

4. Il problema di liuti e viole

In tale categoria di strumenti, le note enarmoniche creavano problemi – sia costruttivi che esecutivi – ancora maggiori di quelli già incontrati negli strumenti da tasto. Verranno qua presentate alcune brevi considerazioni relative ai tre possibili criteri di disposizione dei tasti.

4.1. *Intonazione sintonica.* Tralasciando l'accordatura sintonica «a semitoni uguali» sperimentata da Thomas Salmon nel 1688–1705, un vero sistema sintonico regolare fu messo in pratica solo da Giovanni Battista Doni, nel suo

59 Barbieri, «Cembali enarmonici», p. 117; Id., «Juan Caramuel Lobkowitz», p. 157. Tanto più che Giovanni Valentini era autore di una *sonata a 5* «enarmonica»: Warren Kirkendale, Emilio de' Cavalieri «Gentilhomme romano». *His life and letters, his role as Superintendent of all the arts at the Medici Court, and his musical compositions. With addenda to «L'Aria di Fiorenza» and «The Court Musicians in Florence»*, Florenz: Olschki 2001 (= *Historiae Musicae Cultores* 86), p. 154.

concerto di viole «prepare» (1636–40).⁶⁰ Anche Joan Albert Ban sembra aver adattato un liuto (e forse anche una viola) disponendone i tasti in accordo col sistema già messo in pratica nel suo cembalo (§3.3).⁶¹ Si ricorda che, nel caso del liuto, lo spazio che separa due tasti a distanza di un comma sarebbe solo di alcuni millimetri, variando a seconda del livello in cui vengono ubicati.

4.2. *Tono medio*. Sappiamo che in tale categoria di temperamenti i semitoni sono di due tipi: grande (ad es. G-Ab) e piccolo (ad es. G-G#). Essendo la loro differenza pari al diesis enarmonico (G#-Ab, nel caso esemplificato), negli strumenti da manico mesotonicamente accordati il rischio di imbattersi in ottave affette da tale errore è effettivamente presente (Tabella 14).

Tabella 14 – Accordatura mesotonica di un liuto in D

corda	1°	2°	3°	4°	5°	6°	7°	8°	tasto
a vuoto									
Dacuto	E $\flat$	E	F	F $\sharp$	G	G $\sharp$	A	B $\flat$	
A	B $\flat$	B	C	C $\sharp$	D	D $\sharp$	E	F	
E	F	F $\sharp$	G	G $\sharp$	A	A $\sharp$	B	C	
C	D $\flat$	D	E $\flat$	E	F	F $\sharp$	G	A $\flat$	
G	A $\flat$	A	B $\flat$	B	C	C $\sharp$	D	E $\flat$	
Dgrave	E $\flat$	E	F	F $\sharp$	G	G $\sharp$	A	B $\flat$	

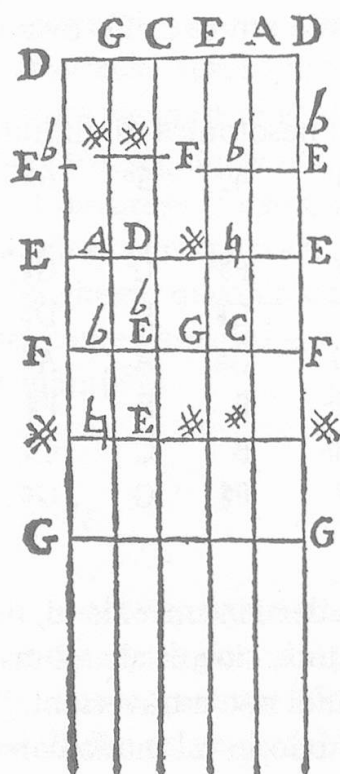
Al fine di non incorrere in detti inconvenienti, liuti e viole venivano talvolta dotati dei cosiddetti «tastini», cioè di alcuni tasti di avorio o di osso estesi solo ad alcune corde e quindi non attraversanti l'intero manico. Nella Fig. 8, di De Chales, A $\flat$ and D $\flat$ sono in tal modo convertiti in G $\sharp$ e C $\sharp$ (stando a

60 Su Salmon: Lindley, *Lutes*, pp. 68–69; Patrizio Barbieri, «Conflitti di intonazione tra cembalo, liuto e archi nel «concerto» italiano del Seicento», in: *Studi Corelliani IV*, a cura di Pierluigi Petrobelli & Gloria Staffieri, Firenze: Olschki 1990, pp. 123–153, pp. 132–134. Su Doni: Patrizio Barbieri, «Gli strumenti poliarmonici di G.B. Doni e il ripristino dell'antica musica greca (c.1630–1650)», in: *Analecta musicologica* 30 (1998), pp. 79–114, p. 84; Martin Kirnbauer, «Wherein the most compleat Harmony was heard: The Viola da Gamba in Chromatic and Enharmonic Music in Seventeenth-Century Rome», in: *The Italian Viola da Gamba. Proceedings of the International Symposium on the Italian Viola da Gamba, Magnano 29 April – 1 May 2000*, a cura di Susan Orlando, Solignac: Editions Ensemble Baroque de Limoges & Torino: Manzoni 2002, pp. 34–51; in questo volume vedi anche il contributo di Martin Kirnbauer.

61 Rasch, «Ban's intonation», pp. 82–83.

tale autore, questa era addirittura l'accordatura «comune»).⁶² Oltre a De Chales, anche Doni conferma che tali «tastini» erano per lo più posti in corrispondenza del primo tasto, al fine di restringere il semitono grande (a questo livello, su di una viola da gamba lo spazio corrispondente a un diesis enarmonico non è affatto trascurabile, aggirandosi intorno ai due centimetri).⁶³ Ad ogni modo, lo stesso Doni ricorda che la disuniformità delle corde di minugia e la loro inarmonicità era di grande ostacolo alla perfetta intonazione di tali note:⁶⁴

Fig. 8: Claude-François Milliet de Chales (1674): accordatura «comune» della viola da gamba, con un «tastino» all'altezza del primo semitono.



62 Claude-François Milliet de Chales, *Cursus seu mundus mathematicus*, III, Lyon 1674, pp. 37–38: «varie a variis ad concentum revocant chordae; commune tamen illius systema proferam divisionemque manubrij».

63 Doni, *Annotazioni*, p. 29: «Quelli che aggiungono un tastino alle viole, lo sogliono mettere immediatamente dopo il capotasto».

64 Giovanni Battista Doni, *Compendio del Trattato de' generi e de' modi della musica*, Roma: Fei 1635, pp. 45–46. Sul problema dell'inarmonicità degli strumenti da manico tastati vedi Patrizio Barbieri, «The inharmonicity of musical string instruments (1543–1993). With an unpublished memoir by J.-B. Mercadier (1784)», in: *Studi musicali* 27/2 (1998), pp. 383–419, pp. 407–412, anche in versione italiana: «L'inarmonicità degli strumenti musicali a corda (1543–1993). Con una memoria inedita di J.-B. Mercadier (1784)», in: *Strumenti, musica e ricerca. Atti del Convegno internazionale, Cremona 28–29 ottobre 1994*, a cura di Elena Ferrari Barassi, Marco Fracassi & Gianpaolo Gregori, Cremona: Ente Triennale Internazionale degli Strumenti ad Arco 2000, pp. 255–292, pp. 279–283.

per mezzo di questi strumenti [le «violetti diarmoniche» di Doni] si potranno far sentire cotale melodie nella loro perfezione; il che non riesce ne' comuni quando bene vi s'aggiunga qualche mezzo tasto che divida ogni semitono maggiore, sì perché in pochi luoghi servono, et gl'altri recano impedimento notabile al sonatore; sì anco perché calcandosi egualmente, et al medesimo segno le corde grosse, e le sottili, non egualmente alterano il suono; né anche sempre due d'una istessa grossezza tastate nel medesimo sito, parimente s'inacutiscono.

Se – al fine di scomporre tutti i semitoni grandi nel corrispondente semitono piccolo e relativo diesis enarmonico – in aggiunta a quelli ordinari fossero invece stati messi in opera ulteriori tasti di minugia attraversanti l'intero manico, l'esecutore avrebbe avuto a sua disposizione il ventaglio di note di Tabella 15: nessuna fonte storica accenna però a una simile divisione del manico, cioè a quello che potremmo chiamare un «liuto cromatico»! Solo il «violone panarmonico» di Doni e il «lirone enarmonico» di Pietro Salvetti's (c1668) erano dotati di alcuni tasti supplementari di questo tipo.⁶⁵

Tabella 15 – Accordatura di un ipotetico «Liuto cromatico»

corda	1°	2°	3°	4°	5°	6°	7°	tasto
a vuoto								
Dacuto	D $\sharp$	E $\flat$	E	E $\sharp$	F	F $\sharp$	G $\flat$	
A	A $\sharp$	B $\flat$	B	B $\sharp$	C	C $\sharp$	D $\flat$	
E	E $\sharp$	F	F $\sharp$	F $\sharp\sharp$	G	G $\sharp$	A $\flat$	
C	C $\sharp$	D $\flat$	D	D $\sharp$	E $\flat$	E	E $\sharp$	
G	G $\sharp$	A $\flat$	A	A $\sharp$	B $\flat$	B	B $\sharp$	
Dgrave	D $\sharp$	E $\flat$	E	E $\sharp$	F	F $\sharp$	G $\flat$	

Tabella 16 – Proposta di accordatura del liuto secondo l'ETS 31 (Vicentino, 1555)

corda	1°	2°	3°	4°	5°	6°	7°	8°	tasto
a vuoto									
Dacuto	E $\flat\flat$	D $\sharp$	E $\flat$	D $\sharp\sharp$	E	F $\flat$	E $\sharp$	F	
A	B $\flat\flat$	A $\sharp$	B $\flat$	A $\sharp\sharp$	B	C $\flat$	B $\sharp$	C	
E	F $\flat$	E $\sharp$	F	G $\flat\flat$	F $\sharp$	G $\flat$	F $\sharp\sharp$	G	
C	D $\flat\flat$	C $\sharp$	D $\flat$	C $\sharp\sharp$	D	E $\flat\flat$	D $\sharp$	E $\flat$	
G	A $\flat\flat$	G $\sharp$	A $\flat$	G $\sharp\sharp$	A	B $\flat\flat$	A $\sharp$	B $\flat$	
Dgrave	E $\flat\flat$	D $\sharp$	E $\flat$	D $\sharp\sharp$	E	F $\flat$	E $\sharp$	F	

65 Barbieri, «Gli strumenti poliarmonici», pp. 91, 102 e 110 (su Doni); Id., «L'accordatura strumentale», pp. 227–233 (su Salvetti).

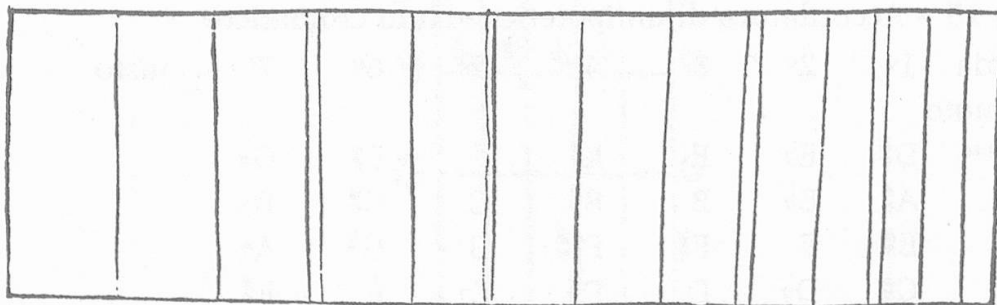
Fig. 9: Nicola Vicentino (1555): proposta di un liuto accordato secondo il suo ETS 31 (cioè ottava divisa in 31 «diesis» acusticamente uguali, cinque dei quali formano il tono e tre il semitono diatonico).

Dichiar. sopra li difetti del Liuto, e delle uiole d'arco, et altri stromenti cò simili diuisioni. C. LXVI.



All'inuentione delle uiole d'arco, et del liuto fin hora sempre s'ha sonato con la diuisione de i semitoni pari, et hoggi si suona in infinitissimi luoghi, oue che nascono due errori, uno che le consonanze delle terze, & in certi luoghi delle quinte non sono giuste; & l'altro errore è quando tali stromenti suonano con altri stromenti, che hanno la diuisione del tono partito in due semitoni, uno maggiore, et l'altro minore non s'incontrano, di modo che mai schiettamente s'accordano quando insieme suonano. Hora la diuisione del Liuto dè essere in questo modo diuisa, prima col semitono maggiore, & poi col minore; & così dè seguire per semitono maggiore et minore, & poi maggiore per finire essa quarta: & se si uorrà far la diuisione Enarmonica, se diuiderà il semitono maggiore in tre parti, & il minore in due, come tali diuisioni sono nel tono del nostro stromento, & la medesima diuisione occorrerà nelle uiole d'arco, et le uiole con tre corde senza tasti, che si suonano con l'arco saranno bonissime, che farà ogni diuisione, & per stromenti da fiato, i Tromboni saranno mirabili quando saranno con diligenza suonati. Hora qui sotto scriuo due linee lunghe, in modo d'un manico di liuto, & diuiderò quelle con i semitoni maggiori & minori, & le linee doppie saranno la diuisione ordinaria, e le linee semplici saranno l'aggiunte delli Diesis. che faranno li semitono mag. et min. quando si uorranno.

Diesis mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. Di.mi. di.m. di.mi. di.mi.



Longhezza di una Quarta diuisa in 13. Diesis Enarmonici tutti minori.
To no. To no. Semitono.

4.3. *Sistemi a divisione equabile (ETS)*. Nel 1555 Nicola Vicentino propose di estendere al liuto l'accordatura del suo Archicembalo (Fig. 9):⁶⁶ in tal modo tutti i semitoni piccoli di Tabella 15 sarebbero stati divisi in due, dando luogo a ottave composte da 31 quinti di tono fra loro uguali (Tabella 16). Come abbiamo visto nel §2.2, questa particolare specie di temperamento equabile (ETS 31) forniva terze maggiori praticamente pure (ad es. Ebb-Gb, D#-F##, D###-Abb=F####). Inoltre – contrariamente alle accordature delle

66 Vicentino, *L'antica musica*, fol. 146v. Riguardo ai «Diesis enarmonici minori» vedi la nota 33.

Tabelle 14 e 15, che non sono equabili – essa offriva all'esecutore la possibilità di trasporre un dato accordo semplicemente facendo scorrere la mano, senza variare la posizione relativa delle dita. Anche l'accordatura di Tabella 15, se realizzata con un mesotonico praticamente coincidente col «terzo di comma» ($1/2.98$ di comma), avrebbe dato luogo a una particolare specie di temperamento equabile: l'ETS 19, le cui ottave sono suddivise in 19 terzi di tono fra loro acusticamente uguali (con ciò si sarebbe inoltre trasformato in un comune $G\flat$ il solitario $F\sharp\sharp$ del quarto tasto).

Gli ETS 31 e 19 erano comunque dei sistemi complicati, mai messi in pratica negli strumenti da manico tastati. La soluzione più immediata era quella di far ricorso al ben noto temperamento equabile a 12 note per ottava (ETS 12), semplicemente eliminando il diesis enarmonico (cioè passando al secondo livello di temperamento, secondo la originale teorizzazione di Salinas vista nel §1.6).

4.4. *Il metodo di Salinas per dividere equabilmente il manico del liuto.* Nel tardo Cinquecento Vincenzo Galilei e Zarlino proposero alcuni metodi che permettessero di suddividere l'ottava in dodici medi geometrici.⁶⁷ Anche Salinas si cimentò in tale problema, pervenendo però a un'ingegnosa ma inutile soluzione, come fatto rilevare dallo stesso Zarlino (in una lettera a Bernardino Baldi, 1589) e, qualche decennio più tardi, anche da Claude Hardy (come riferito da Mersenne, 1636).⁶⁸ Riassumiamo in moderni termini matematici il suo tentativo.⁶⁹

67 Lindley, *Lutes*, pp. 21 e 24–26. A questo fine, sull'uso del mesolabio (così come suggerito da Zarlino) e del compasso di riduzione (secondo il rapporto 18:17 di Galilei), vedi Patrizio Barbieri, «Il mesolabio e il compasso di proporzione: le applicazioni musicali di due strumenti matematici (1558–1675)», in: *Musica, scienza e idee nella Serenissima durante il Seicento*, a cura di Francesco Passadore & Franco Rossi, Venezia: Fondazione Levi 1996, pp. 201–220, pp. 201–207 e 219–220.

68 Su Zarlino: Bernardino Baldi, *Vite inedite di matematici italiani* [...], a cura di Enrico Narducci, Roma: Tipografia delle scienze matematiche e fisiche 1887, p. 171 (*Bullettino di bibliografia e di storia delle scienze matematiche e fisiche*, XIX, luglio-novembre 1886, estratto). Su Hardy: Mersenne, *Harmonie universelle*, «Traité des intrumens à cordes», pp. 224–225. Claude Hardy, che gravitava nella cerchia di Mersenne, lasciò anche una traduzione in francese delle *Istituzioni harmoniche* di Zarlino, rimasta manoscritta: Marin Mersenne, *Correspondance* [...], a cura di Cornelis de Waard, I, Paris: Presses Universitaires de France 1945, pp. 187–188.

69 Salinas, *De musica*, p. 173.

Nella Fig 10, ab rappresenta la lunghezza della corda a vuoto del liuto, dal capotasto (b) al ponticello-cordiera (a). Essendo

$$ab = 2, bc = 1, dc = 1, ae = ad, ac = 5^{1/2},$$

Salinas ottiene correttamente

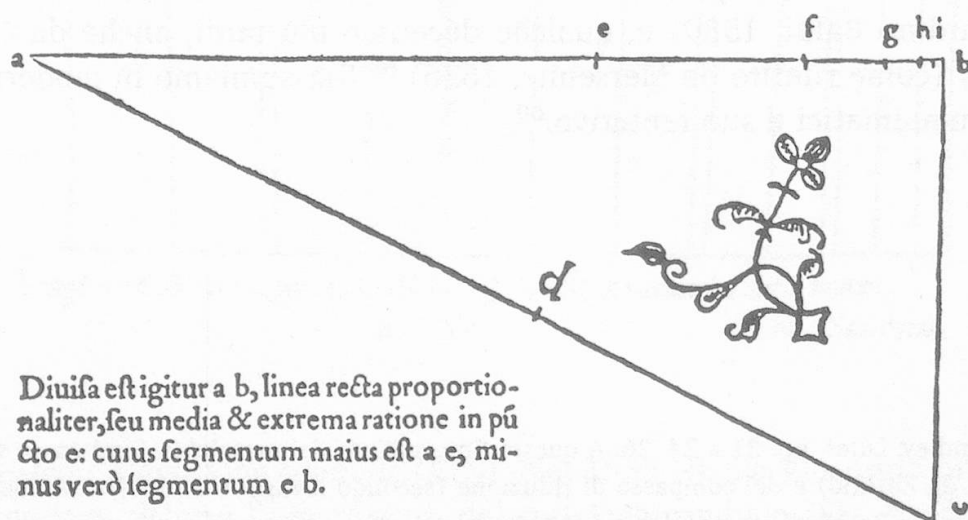
$$x = ae/ab = (5^{1/2} - 1)/2 = 0.618...,$$

cioè la sezione aurea («media et extrema ratio») di ab . Costruisce poi la sezione aurea ef di eb in questo modo:

$ef/eb = (ae - eb)/eb = (ae - eb)/(ab - ae) = x [1 - (eb/ae)]/(1 - x) = x$, essendo, ma solo per una sezione aurea, $ae/ab = eb/ae = x$. Salinas applica poi lo stesso criterio a fb , gb , hb , ecc.

Detta costruzione è quindi valida solo per la sezione aurea, e non per tutti gli altri possibili rapporti (come ad es. $1:2^{1/12}$, relativo all'ETS 12). Sebbene solo approssimato, un metodo per suddividere col temperamento equabile il manico del liuto – sempre basato sull'impiego della sezione aurea – fu esposto da William Brouncker nel 1653.⁷⁰

Fig. 10: Francisco Salinas (1577): proposta di suddivisione del manico del liuto secondo una progressione basata sulla sezione aurea.



70 Lindley, *Lutes*, pp. 33–36.

5. Il perché delle tastiere enarmoniche⁷¹

Almeno tre sono le ragioni a riguardo.

5.1. *La trasposizione dei modi ecclesiastici e il diffondersi della loro versione in «modo maggiore».* Ancora verso la fine del Quattrocento l'usuale ambito armonico poteva essere sia $E\flat-G\sharp$ che $A\flat-C\sharp$.⁷² Secondo Ramis de Pareja (1482) alcuni musicisti preferivano disporre del $G\sharp$ anche perché esso permetteva di eseguire cadenze («alla Landino») del tipo $B_2-G\sharp_3 \rightarrow A_2-A_3$.⁷³ Nel 1555 Juan Bermudo riferisce che «alcuni barbari esecutori» («algunos barbaros tañedores») solevano alterare la scala del 1° modo introducendo il cosiddetto «diatessaron intenso» ($D-E-F\sharp-G / A-B-C\sharp-D$); la stessa specie di 4ª era impiegata anche nel 4° modo ($E-F\sharp-G\sharp-A$). Essi si giustificavano dicendo che in tal modo entrambi i toni «facevano un migliore effetto»: ⁷⁴ chiaro segnale che il moderno «modo maggiore» iniziava già a estendere il suo predominio sui modi basati su tutte le note diatoniche dell'ottava, rafforzando così l'esigenza di disporre dei tre soprammenzionati diesis. Per quanto invece riguarda la nota posta all'estremità opposta della catena, cioè l' $E\flat$, possiamo osservare che (1) nei contrappunti fugati, il $B\flat$ (nota allora considerata «diatonica») necessitava della 5ª sotto e della 4ª sopra, e inoltre che (2) non essendoci alcun modo ecclesiastico sul B, il $D\sharp$ – secondo Pietro Aron (1529) – era dagli organisti «poco operato». ⁷⁵ Sebbene, potremmo aggiungere, esso sia in seguito stato aggiunto al fine di permettere le cadenze delle composizioni in E (e di dotare così della 3ª maggiore l'unica nota diatonica che ne era priva).

Riguardo poi all' $A\flat$, Bermudo ricorda che «una delle grandi necessità» degli organisti liturgici consisteva nel poter trasporre il 1° modo alla 3ª sopra, da D a F (per i comuni cantanti, in D sarebbe infatti risultato troppo grave, e in G troppo acuto); l' $A\flat$ era quindi necessario, al fine di disporre di una 3ª minore consonante sopra l'F (che, sia detto per inciso, rimaneva l'unica nota diatonica a esserne priva). Sempre secondo lo stesso autore, proprio a tale fine l'organo della cappella reale di Granada era stato dotato di uno speciale dispositivo: nel registro più usato – il *Flautado*, corrispondente al

71 Vedi anche Rasch, «Why were enharmonic keyboards built?» (in questo volume).

72 Su tale problema vedi: Lindley, «Fifteenth-Century Evidence», pp. 46–47; Wraight & Stembridge, «Italian Split-Keyed Instruments», pp. 163 e 171.

73 Lindley, «Fifteenth-Century Evidence», p. 47.

74 Bermudo, *Declaracion*, fol. 67r.

75 Pietro Aron, *Toscanello in musica* [...], Venezia 1529, De Vitali, cap. 40: il tasto nero tra il D e l'E è accordato come $E\flat$ invece che come $D\sharp$, «per cagione de gli organisti, gli quali più tosto vogliono accomodare il C fa ut de la terza minore, che il $\sharp$ mi de la maggiore: perché $\sharp$ mi da essi poco è operato».

Principale italiano o al *Diapason* inglese – mediante una particolare leva di ferro tutti i G $\sharp$ della tastiera potevano essere commutati nei corrispondenti A $\flat$, ciascuno di questi ultimi disponendo di una canna propria. Solo il *Flautado* era stato dotato di detto dispositivo, al fine di non sovraccaricare lo strumento. Anche in alcuni organi italiani – benchè, contrariamente a quello di Granada, dotati di tasti spezzati – le canne per i semitoni supplementari venivano aggiunte solo a uno o due registri.⁷⁶

È interessante ricordare che uno sviluppo della soluzione di Granada viene segnalata, verso la metà del Settecento, in alcuni strumenti inglesi. Essi erano infatti dotati di tastiere di tipo comune, ma con la possibilità di traslare l'ambito delle undici 5^e tramite opportuni registri azionati a mano: vedi, ad esempio, il cembalo costruito da Kirkman su progetto di Robert Smith; così come il famoso organo del Foundling Hospital di Londra (1768), anch'esso ispirato alle teorie di Smith, deceduto solo alcuni mesi prima. Su quest'ultimo strumento l'esecutore poteva di volta in volta optare per uno qualsiasi dei tre ambiti armonici E $\flat$ -G $\sharp$ (quello usuale), F-A $\sharp$, e D $\flat$ -F $\sharp$.⁷⁷ Alla fine del secolo la stessa idea fu estesa al pianoforte, adottando più comode leve a pedale e soluzioni tecniche simili a quelle impiegate nelle arpe di quello stesso periodo. A riguardo si segnalano in particolar modo:

- il «Royal Teliochordon» di Charles Clagget (1790–91), un dispositivo che poteva essere applicato anche agli strumenti a coda (con l'aggiunta di due soli pedali, rispetto a quelli soliti dei pianoforti, l'usuale ambito E $\flat$ -G $\sharp$ poteva venire esteso di cinque ulteriori note, o nei diesis oppure nei bemolli);⁷⁸
- il pianoforte di William Hawkes, del 1808 (temperamento del «sesto di comma» regolarmente esteso a 17 note per ottava, con la possibilità di commutare tutte le cinque note cromatiche della tastiera sia in diesis che in bemolli, mediante un solo pedale);

76 Bermudo, *Declaracion*, fol. 89v; Wraight & Stenbridge, «Italian Split-Keyed Instruments», pp. 170–171. Detta pratica è documentata in due organi italiani: (1) Mesagne (Brindisi), strumento costruito da Tommaso Mauro per la chiesa collegiata (1648): dieci registri, con «otto semitoni spezzati» (D/F $\sharp$, E/G $\sharp$, più sei altri enarmonici non specificati) solo per il *Principale* e il *Flauto in ottava fusulato*; vedi Luisa Così, «Organi e organari in terra d'Otranto nei secoli XVII e XVIII», in: *Musicisti nati in Puglia ed emigrazione musicale tra Seicento e Settecento*, Roma: Torre d'Orfeo 1988, pp. 117–138, p. 127. (2) Firenze, duomo (1649): «tasti rotti» solo per il *Principale*; vedi Barbieri, «Il Cembalo onnicordo», p. 67.

77 Alexander C.N. Mackenzie of Ord, *Keyboard temperament in England during the eighteenth and nineteenth centuries*, Unpublished Thesis, University of Bristol, settembre 1979, pp. 94–95.

78 Charles Clagget, *The Royal Teliochordon Stop*, London [1791].

- infine l'ancora più complesso pianoforte di David Loeschmann, del 1809 (temperamento del «quarto di comma» regolare, con 24 note per ottava, controllate da sei pedali).⁷⁹

5.2. *Il revival dell'antico genere enarmonico greco.* Già nel 1666 Lemme Rossi faceva notare che nel corso del rinascimento il revival del genere enarmonico greco era passato attraverso due distinte fasi:⁸⁰

1. Quella «antica», nella quale il semitono dei tre tetracordi B-C-D-E, E-F-G-A, A-B $\flat$ -C-D del Sistema Perfetto Greco veniva diviso aritmeticamente in due «diesis» (detto semitono diatonico era quello piccolo, essendo ancora riferito al sistema pitagorico). Dato che i quarti di tono B $\times$, E $\times$, A $\times$ in tal modo ottenuti non potevano dare origine ad alcun accordo consonante, probabilmente essi venivano impiegati solo melodicamente, come note ornamentali o per effetti di «portamento» (è proprio in tale maniera che essi furono trattati da Emilio de' Cavalieri e dai cantori papali romani nei primi decenni del Seicento).⁸¹
2. Quella «moderna», nella quale venivano impiegati in contrappunto consonante i «quinti di tono» enarmonici (come ad es. G $\sharp$ -A $\flat$) delle tastiere illustrate nei §§2-3.

Riguardo alla loro pratica, la più antica fonte pervenutaci è costituita da una *Epistola* non datata di John Hothby, il teorico musicale inglese che operò a lungo anche in Italia (morto nel 1487). Da essa apprendiamo che egli possedeva uno strumento dotato di tasti enarmonici:

E notate anchora bene che sopra li instrumenti che si fano ogidì il enharmonio non ce, ma cum la voce si fa al mancho uno de li semitonii minimi pur menti di meno. Io [ho] uno instrumento il quale lo ha interamenti, che altrimenti tal generatione sarebbe indarno trovata e anchora il nostro Boetio e li altri harebeno fallito.

79 Henry Liston, *An essay on perfect intonation*, Edinburgh 1812, pp. 141-142; Mackenzie of Ord, *Keyboard temperament in England*, pp. 180-181. È interessante ricordare che, sempre in Inghilterra, ancora nel 1885 la «concertina» veniva accordata col «quarto di comma» esteso a 14 note per ottava, dall'A $\flat$ al D $\sharp$: Helmholtz, *On the sensations of tone*, p. 434 (Addition di A.J. Ellis).

80 Rossi, *Sistema musico*, pp. 76-78.

81 Kirkendale, *Emilio de' Cavalieri*, p. 156; Patrizio Barbieri, «Violin intonation: a historical survey», in: *Early music* 19/1 (1991), pp. 69-88, p. 80. Questo tipo di impiego dell'enarmonico era ancora in uso alla fine del Settecento: Patrizio Barbieri, «G.B. Orazi's Enharmonic Flute and its Music (1797-1815)», in: *The Galpin Society Journal* 52 (1999), pp. 281-304, pp. 290-292.

Hothby precisa che – in aggiunta ai comuni tasti bianchi e neri – i B $\times$, E $\times$, e A $\times$ erano colorati in rosso e che tali note supplementari davano origine a «melodie» con intervalli così stretti da essere appena distinguibili dall'orecchio.⁸²

Un altro caso di un primo revival del cromatico e dell'enarmonico ci viene segnalato da Pietro Aron. Nel 1516 egli riferisce che il suo maestro – il bolognese Giovanni Spataro – aveva scritto una composizione in onore di papa Leone X, «il cui tenore conteneva i generi cromatico ed enarmonico». Questo pezzo – sebbene disapprovato da alcuni noti compositori italiani, a causa degli inusuali intervalli impiegati – fu cantato con piacere dallo stesso Aron e da altri amici di Spataro.⁸³ Collazionando le poche informazioni forniteci, possiamo solo inferire che tale composizione risale al 1513-16, ma non ci è dato sapere se essa era basata sulla divisione enarmonica di Hothby oppure sul trattamento in consonanza dei tasti spezzati già da tempo presenti in alcuni organi (come abbiamo visto nel §2.1, sebbene non ancora in quello della basilica di San Petronio, della quale nel 1512 Spataro era stato nominato maestro di cappella).⁸⁴

C'è inoltre da ricordare che – ancora verso il 1632-3 – Giovanni Battista Doni inserì nella «facies posterior» della sua *Lira Barberina* le stesse tre note enarmoniche citate da Hothby: infatti la seconda e ultima accordatura di tale strumento presentava i tasti disposti secondo un temperamento mesotonico, ma con i semitoni B-C, E-F e A-B $\flat$ suddivisi aritmeticamente in due parti uguali.⁸⁵ Doni ci ha lasciato anche un breve saggio dei generi diatonico, cromatico, ed enarmonico, audacemente sovrapponendo i loro tetracordi discendenti in un contrappunto a tre parti (Es. 3). Così come già per la sua *Lira Barberina*, anche qua Doni conferma che – al fine di ottenere i corretti microintervalli greci – i tre semitoni in oggetto dovevano

82 I-Fn Ms. Magl. XIX.36, ff. 74-78, pubblicato in *Johannis Octobi, Tres tractatuli contra Bartholomeum Ramum*, a cura di Albert Seay, Roma: American Institute of Musicology 1964 (= *Corpus Scriptorum de Musica* 10), pp. 79-92, pp. 85 e 91-92. E a p. 87: «le lor melodie sono tanto strete e serrate che l'orechio apena senti le loro differentie».

83 Pietro Aron, *Libri tres de institutione harmonica* [...], Bologna: in aedibus Benedicti Hectoris 1516, fol. 22v: «[Ioannes Spatarius Bononiensis] modulationem proxime in laudem Leonis decimi pontificis maximi edidit, quam ego et vidi, et libenter cecini. In cuius tenore chromaticum genus complexus est, et enarmonicum, licet a nonnullis non parvi nominis Italidis musicis explosa fuerit, quia inconsuetae atque reconditae modulationis rationem minime inveniebant, quam nos tamen amici eius invenimus, atque cecinimus».

84 Solo nel 1528 l'organo di Lorenzo da Prato, di cui la basilica era dotata, sembra sia stato dotato di tali tasti supplementari: Oscar Mischiati, «Documenti sull'organaria padana rinascimentale. I: Giovanni Battista Facchetti», *L'organo* 22 (1984), pp. 23-160, pp. 47 e 75-76.

85 Barbieri, «Gli strumenti poliarmonici», p. 85.

Es. 3: Giovanni Battista Doni (c1632–40): i tre antichi generi greci sovrapposti in contrappunto a tre parti.

Diagram illustrating the three ancient Greek genera (Diatonico, Cromatico, Enarmonico) overlaid in counterpoint on three parts.

The diagram shows three staves, each representing a different genus:

- Diatonico** (top staff): A sequence of notes in a diatonic scale.
- Cromatico** (middle staff): A sequence of notes in a chromatic scale.
- Enarmonico** (bottom staff): A sequence of notes in an enharmonic scale.

First system of musical notation (measures 1-3), showing the three genera overlaid in counterpoint on three parts.

Second system of musical notation (measures 4-6), showing the three genera overlaid in counterpoint on three parts.

Third system of musical notation (measures 7-9), showing the three genera overlaid in counterpoint on three parts.

Fourth system of musical notation (measures 10-12), showing the three genera overlaid in counterpoint on three parts.

venire suddivisi aritmeticamente in due parti uguali, e non accordati in consonanza come quelli delle tastiere illustrate nel §2 (cioè mediante 3^e maggiori del tipo C $\sharp$ -E $\sharp$): in tal modo si sarebbero dovute ottenere delle «terze mezzane», cioè delle (assai dissonanti) 3^e «neutrali» poste a metà strada tra le maggiori e le minori.⁸⁶

Ad ogni modo, già dal tardo Cinquecento fu Vicentino a essere riconosciuto come il restauratore degli antichi generi cromatico ed enarmonico. Il suo rimane il primo tentativo documentato riguardante la summenzionata «seconda fase», cioè il trattamento dei microintervalli enarmonici secondo le regole del contrappunto consonante. Vicentino non fu comunque strettamente rispettoso dell'originale struttura tetracordale dei generi greci, dato che essi spesso comparivano in forma ibrida, per cui le sue composizioni erano dette appartenere allo stile «misto» (quelle in stile rigoroso erano invece chiamate «semplici»).⁸⁷ Se si esclude l'erudito Doni, il primo – e anche l'ultimo – musicista ad averci lasciato qualche esempio di tali «composizioni semplici» cromatiche ed enarmoniche fu Ascanio Mayone (1618).⁸⁸

5.3. *Lo «Stylus metabolicus»*. Il termine «enarmonico» fu anche impiegato con un altro significato. Martino Pesenti – nell'opera già citata (1641) – pubblicò dei pezzi diatonici trasposti in tonalità aventi, in chiave, da tre a sette bemolli (da lui etichettati «cromatico») e da un diesis a due doppi diesis (da lui etichettati «enarmonico»).⁸⁹ Riferendosi a una scala discendente del tipo F-E $\flat$ -D $\flat$ -C $\flat$ -B $\flat$ -A $\flat$ -G $\flat$ -F, nel 1638 Domenico Mazzocchi fa rilevare che essa poteva ancora essere chiamata enarmonica, sebbene estranea alla struttura dei tetracordi appartenenti a quel genere.⁹⁰ Tale scala infatti non è altro che una sezione di quella in G maggiore, trasposta verso il grave di un semitono minore.

86 Giovanni Battista Doni, *Lyra Barberina*, I, Firenze: Tip. Caesarea 1763, pp. 406 e 410. Una esecuzione computerizzata di detta composizione è stata presentata in occasione della mia relazione al colloquio in Basilea.

87 Zarlino, *Dimostrazioni harmoniche*, pp. 213 («composizioni diatoniche, cromatiche o enarmoniche semplici», o «miste») e 276.

88 Barbieri, «La *Sambuca lincea*», pp. 190–193. Vedi anche van Asperen, «Consonant or dissonant?», e Rasch, «Why were enharmonic keyboards built?» (in questo volume).

89 Kirkendale, *Emilio de' Cavalieri*, p. 156. Vedi Rasch, «Why were enharmonic keyboards built?» (in questo volume).

90 Domenico Mazzocchi, *Dialoghi e sonetti*, Roma: Zannetti 1638, pp. 175 e 181 («nondimeno adoprandosi alcune parti di esso accomodate al Diatonico, pur tali composizioni si potranno chiamare enarmoniche»).

Secondo Athanasius Kircher, l'improvvisa introduzione di un gran numero di alterazioni in una composizione denota semplicemente una modulazione (o una trasposizione), e non l'impiego dell'enarmonico. Traendo chiaramente tale termine dai trattati di Doni (che chiamava «note metaboliche» quelle inserite al fine di introdurre una modulazione), afferma che tali composizioni dovrebbero essere considerate appartenenti a una categoria da denominarsi «*Stylus metabolicus*».⁹¹ Oltre a citare – in aggiunta a quelle dello stesso Doni – musiche di Pietro Heredia, Pietro Della Valle, Carlo Gesualdo da Venosa, Domenico Mazzocchi e Benedetto Narducci, Kircher riporta un esempio tratto da Giacomo Carissimi, nel quale – quando nelle parole del testo dalla gioia si passa alle lacrime – la «tonalità» passa rispettivamente da F maggiore a F minore e da B $\flat$ maggiore a B $\flat$ minore (Es. 4).

Es. 4: Giacomo Carissimi: esempio di «*stylus metabolicus*», secondo Athanasius Kircher (1650).

The musical score is presented in three systems, each with three staves (treble, alto, and bass). The key signature changes from F major (one flat) to F minor (two flats) and finally to B-flat minor (three flats). The lyrics are: "E' pur da pian - de - re", "ge - re, e' pur da ri - ge - re". The score includes figured bass notation below the bass staff of each system. The first system ends with a measure containing the figures 6, 4, 3, b, 8, 7. The second system ends with a measure containing the figures b, 4, 3. The third system ends with a measure containing the figures 43, b, 8, 7, b, 4, 3. The score is marked with measure numbers 8, 15, and 43.

91 Doni, *Compendio*, p. 62; Athanasius Kircher, *Musurgia universalis*, I, Roma: Corbelletti 1650, pp. 672–675 («De mutatione modi, sive toni, sive stylo metabolico»).

Verso la fine del secolo i tasti spezzati finirono per scomparire, dato che il nuovo sistema tonale richiedeva l'unificazione dei diesis con i bemolli enarmonicamente equivalenti. Nel §5.1 abbiamo visto che i tasti sdoppiati enarmonicamente erano sopravvissuti solo in Gran Bretagna, addirittura sui pianoforti, fino verso il 1810.⁹² In Italia, al contrario, gli ultimi strumenti dotati di detti tasti furono realizzati fino a circa il 1665-70.⁹³ Quelli costruiti da Nigetti risalgono al 1640-70, e ciò fece ritenere al suo concittadino Orazio Ricasoli Rucellai che forse in futuro la scala sarebbe stata suddivisa in microintervalli ancora più piccoli (c1665-73).⁹⁴ Invece si era giunti al termine di tali sperimentazioni: per quanto ne sappiamo, solo Giuseppe Sarti – nel 1779-84, quando era maestro di cappella del duomo di Milano – fece costruire un cembalo (dai fratelli Elli) e anche un organo (dal «celebre» Fontana) dotati di tasti spezzati.⁹⁵

5.4. *Tastiere traspositrici*. Limitatamente ai sistemi a divisione equabile (ETS), si deve ricordare che le divisioni enarmoniche erano state impiegate anche semplicemente per permettere alle usuali tastiere di effettuare delle trasposizioni microtonali, e ciò al fine di potersi adeguare al corista di un qualunque strumento: vedi ad es. il «Clavecymbalum universale» di Carl Luython e il cembalo traspositore di Iacopo Ramerino. Nella seconda metà del Seicento, unitamente alla possibilità di effettuare la «circolazione» dei toni, ciò costituì anche l'unica applicazione pratica dell'ETS 31 di Vicentino: vedi il «Cembalo onnicordo» di Francesco Nigetti (Firenze, 1640-70) e la tastiera traspositrice di Cristiaan Huygens (Parigi, c1669).⁹⁶

92 Di tale genere, ancora nel 1799 risultavano essere «the Temple [church] organ and one at Lord Uxbridges»: John Wall Callcott, *A critical examination of the musical theory of Kirnberger*, [London] Feb. 8, 1799 (GB-Lbl Ms. Add. 27648, p. 97).

93 Wraight & Stembridge, «Italian Split-Keyed Instruments», rispettivamente pp. 168 e 156. C'è inoltre da ricordare che, per la chiesa di Sant'Agnese in Agone, a Roma, nel 1667-68 Willem Hermans costruì un organo dotato di «tasti spezzati», sebbene dai documenti non sia chiaro se essi fossero relativi ai D/F# e E/G# dell'ottava corta, oppure alle spezzature enarmoniche: I-Rdp Mandati di pagamento 1671-V, n° 897 (settembre 1671): «E più per filo di ferro grosso e filo di otone per la redutione delli tasti spezzati, scudi 1.50».

94 Orazio Ricasoli Rucellai, *Segue il Timeo. Delle musiche proporzioni*, [Firenze] ms. non datato, ma c1665-73; I-Fn Ms. Cl. II. III. 269, fol. 157r: «e oggi si vede, che da musici di più alto sapere ogni dì si spezzano, e suddividono i tasti delli strumenti, e degli organi, e forse co' secoli avvenire s'andrà più ampliando la graduazione delle voci».

95 Patrizio Barbieri, «Giuseppe Sarti fisico acustico e teorico musicale», in: *Giuseppe Sarti musicista faentino*, a cura di Mario Baroni & Maria Gioia Tavoni, Modena: Mucchi 1986, pp. 221-240, p. 232.

96 Barbieri, «I temperamenti ciclici», pp. 153-155, 178, 184 e 203.

6. Conclusioni

6.1. Problemi di pratica esecutiva esigevano che il sistema sintonico dovesse venire temperato. La prima giustificazione quantitativa di tale genere di operazioni risale a Zarlino (1558–71), ma si deve a Salinas (1577) l'osservazione che, in ciascuno dei temperamenti regolari così ottenuti, tutti i toni risultavano avere la stessa ampiezza. Il termine «tono medio» verrà però introdotto solo in tempi relativamente recenti.

6.2. Le normali tastiere diatonico-cromatiche, accordate mesotonicamente, disponevano del solo semitono grande e piccolo. Il loro ampliamento verso l'enarmonico – genere praticato soprattutto in Italia – può essere inquadrato in quattro fasi: (1) la semplice divisione di alcuni semitoni grandi (da essa traggono origine tasti spezzati piuttosto diffusi in Italia, quali – ad entrambe le estremità della catena delle 5^e – G[♯]/A^b ed E^b/D[♯], il che fra l'altro permetteva di estendere a tutte le note diatoniche la disponibilità della 3^a maggiore e minore), (2) la divisione di *tutti* i semitoni grandi (cimbalo cromatico), (3) ulteriori divisioni, che iniziano a penetrare nel dominio dei semitoni piccoli (operazione cui dà il via Zarlino), (4) la divisione di *tutti* i semitoni piccoli (l'Archicembalo di Vicentino).

6.3. Le tastiere enarmoniche di tipo sintonico puro, al contrario, furono costruite quasi esclusivamente a scopo dimostrativo. Vedi ad esempio il cembalo di Salinas, la cui tastiera superiore era accordata secondo il suo sistema sintonico «perfetto» (a 24 tasti per ottava), mentre invece quella inferiore presentava lo stesso sistema, ma nella versione temperata (19 note per ottava, stessa accordatura del cimbalo cromatico). Dal sistema sintonico «perfetto» di Salinas hanno origine le proposte di Mersenne, Descartes e dei loro seguaci fiamminghi e olandesi: fra tutti questi autori, Joan Albert Ban è l'unico ad avere esteso alla pratica – anche compositiva – il tipo di accordatura sintonica da lui caldeggiata.

6.4. L'applicazione delle accordature mesotoniche agli strumenti da manico tastati consigliava il ricorso alla poco maneggevole pratica dei cosiddetti «tastini»: proprio per tale ragione il temperamento equabile venne generalmente preferito. A tale scopo differenti metodi furono suggeriti da Vincenzo Galilei e Zarlino; al contrario, la pur ingegnosa costruzione grafica di Salinas – basata sulla sezione aurea – si dimostrò inadatta a tale scopo.

6.5. L'introduzione dei tasti enarmonici fu dovuta a tre fattori: (1) la trasposizione dei modi ecclesiastici, al fine di agevolare i cantanti, (2) il revival dell'antico genere enarmonico greco, avvenuto in due successive fasi,

(3) il progressivo diffondersi delle trasposizioni e delle modulazioni in una singola composizione, stile che – ancora nel 1650 – Kircher classificava come «*Stylus metabolicus*».

Abstract

Only just intonation and meantone enharmonic systems are here taken into account: these are all open-chain, i.e., non-circulating. The circulating ones, i.e., those based on the many types of Equal Tempered Systems (ETS), have been examined in a previous article. The main subjects dealt with in the five sections of the article are the following:

1. Owing to practical performance problems, the just tuning system had to be tempered. The first quantitative exposition of such operations can be ascribed to Zarlino (1558–71), but it was Salinas (1577) who established that in each of the regular temperaments (later called «meantone») all tones had the same size.
2. Diatonic-chromatic, meantone-tuned keyboards normally provided only major and minor semitones. Their extension into the enharmonic – a genus used above all in Italy – can be divided into four progressive steps: (1) division of a few major semitones only (giving rise to widespread split keys like $G\sharp/A\flat$ and $E\flat/D\sharp$, at either end of the chain of 5ths, thus giving to all diatonic notes both the major and minor 3rd), (2) division of all the major semitones (*cimbalo cromatico*), (3) further divisions, beginning to penetrate into the minor semitones' domain (an enterprise started by Zarlino), (4) division of all the minor semitones (Vicentino's *Archicembalo*).
3. Just intonation enharmonic keyboards, on the other hand, were built almost exclusively for demonstration purposes. See Salinas' double harpsichord, providing his just intonation «perfect» system in the upper keyboard (24 keys per octave, in three rows) and the very same system, but tempered, in the lower one (19 keys per octave in three rows, which happens to be a *cimbalo cromatico*). From Salinas' just intonation «perfect» system stem the proposals by Mersenne, Descartes and their Flemish and Dutch followers (among them Joan Albert Ban is the only one to have put just intonation into practice, even compositionally).

4. The employment of meantone tuning to fretted instruments required the introduction of the awkward system of the so-called *tastini* and for this reason equal temperament was generally preferred. To this end different, yet correct methods were suggested by Vincenzo Galilei and Zarlino, but on the contrary, Salinas' ingenious construction – based on the golden section – has proved useless for this purpose.
5. The introduction of the above mentioned enharmonic keys was due to three factors: (1) the transposition of church modes, for the convenience of singers, (2) the revival of the ancient Greek enharmonic genus, put into practice in two stages, (3) the increasing spread of transpositions and modulations in a single composition, a style that – even in 1650 – Kircher classed as *Stylus metabolicus*.

Zusammenfassung

In dem Beitrag werden nur Systeme für reine und mitteltönige enharmonische Stimmung, d.h. für nicht-zirkuläre Stimmungssysteme, berücksichtigt. Diese zirkulären, die auf verschiedenen Systemen der Gleichschwebenden Stimmung basieren, waren Gegenstand eines anderen Artikels. Der Beitrag gliedert sich in fünf Abschnitte:

1. Aufgrund praktischer Aufführungsprobleme mußte die reine Stimmung temperiert werden. Die erste quantitativ gemessene Ausführung einer Temperatur kann Zarlino (1558–1571) zugeschrieben werden, aber erst Salinas (1577) erkannte, daß in jeder dieser später «mitteltönig» genannten Temperaturen alle Ganztöne dieselbe GröÙe aufweisen.
2. Normale, d.h. diatonisch-chromatische, mitteltönig gestimmte Klaviaturen bieten nur grosse und kleine Halbtöne. Ihre Erweiterung als enharmonische – als Genus vor allem in Italien verwendet – kann in vier aufeinander aufbauende Schritte unterteilt werden: (1) Unterteilung von nur wenigen grossen Halbtönen an den Enden der Quintenreihe (was zu den weitverbreiteten gebrochenen Obertasten wie $g\sharp/ab$ und $eb/d\sharp$ führte und so bei allen diatonischen Tönen eine grosse und eine kleine Terz ermöglichte); (2) Unterteilung von allen grossen Halbtönen (*Cimbalo cromatico*); (3) weitere Unterteilungen, beginnend mit dem Einbezug der kleinen Halbtöne (was von Zarlino zuerst unternommen wurde); (4) Unterteilung von allen kleinen Halbtönen (*Vicentinos Archicembalo*).
3. Enharmonische Tasteninstrumente mit reiner Stimmung wurden hingegen fast ausschliesslich zu Demonstrationszwecken gebaut. Z. B. Salinas doppeltes Cembalo, das sein «perfektes» System einer reinen Stimmung auf

dem oberen Manual (mit 24 Tasten pro Oktave, in drei Reihen angeordnet) präsentierte, und dasselbe System, nur temperiert, auf dem unteren Manual (mit 19 Tasten pro Oktave, in drei Reihen angeordnet, also wie bei einem *Cimbalo cromatico*). Von Salinas 'perfektem' System einer reinen Stimmung rühren die Vorschläge von Mersenne, Descartes und ihrer flämischen und holländischen Nachfolger her (darunter ist Joan Albert Ban der einzige, der reine Stimmung in die Praxis und sogar in Kompositionen umsetzte).

4. Die Verwendung von mitteltöniger Stimmung bei Bundinstrumenten erforderte die Einführung von unhandlichen sogenannten «tastini» (Bündchen), weswegen gleichschwebende Stimmung in der Regel bevorzugt wurde. Zu diesem Zweck wurden verschiedene, allesamt aber korrekte Verfahren von Vincenzo Galilei und Zarlino vorgeschlagen, hingegen erwies sich Salinas' geniale Konstruktion – basierend auf dem Goldenen Schnitt – als unbrauchbar.
5. Die Einführung der oben genannten enharmonischen Tasten beruhte auf drei Faktoren: (1) die Transposition von Kirchentönen zur Bequemlichkeit von Sängern; (2) die Wiederbelebung des antiken enharmonischen Genus, die in zwei Phasen umgesetzt wurde; (3) die wachsende Zahl von Transpositionen und Modulationen innerhalb einer einzigen Komposition, ein Stil, den Kircher 1650 als *Stylus metabolicus* bezeichnete.

«Si possono suonare i Madrigali del Principe» – Die Gamben G. B. Donis und chromatisch-enharmonische Musik in Rom im 17. Jahrhundert

Martin Kirnbauer

Im Rahmen des Symposiums kam dem folgenden, abschliessenden Beitrag die Aufgabe zu, den Bogen von den «vieltönigen» Instrumenten, der Theorie sowie der Rezeption antiker Musik zur musikalischen Praxis zu schlagen. Der Vortrag wurde ergänzt durch ein Konzert «Zu Gast bei Francesco Barberini» des Gambenensembles THE EARLE HIS VIOLS (Irene Klein, Jessica Marshall, Brigitte Gasser, Randall Cook) mit Evelyn Tubb (Gesang) und Marie Nishiyama (Harfe), das in Programm und Aufführungspraxis explizit auf das Referat bezogen war.

Der Beitrag steht im Kontext eines grösseren Forschungsprojektes zu chromatischer und enharmonischer Musik im 16. und 17. Jahrhundert an der Universität Basel. In Hinblick auf die Publikation der Ergebnisse wurde die lockere Form des mündlichen Vortrags auch in der schriftlichen Fassung weitgehend beibehalten und nur durch Anmerkungen ergänzt.

Athanasius Kircher (1602–1680), der berühmt-berüchtigte jesuitische Universalgelehrte und Professor am *Collegio Romanum*, veröffentlichte 1656 in Rom eine Schrift mit dem sprechenden Titel *Iter exstaticum coeleste* – eine ekstatische Reise in den Himmel.¹ Darin geht es – gekleidet in die klassische Form eines Traumberichts – um astronomisch-philosophisch-kosmologische Gedankengänge, um Fragen des Himmels und der Natur der Gestirne, die verschiedenen Weltsysteme und weiteres. Zu Beginn seiner Schrift schildert Kircher, wie der weitsichtige Traum zustande kam. Er war etwa 1652 auf Einladung dreier Musiker einziger Gast einer intimen musikalischen Akademie, bei der ihm aussergewöhnliche Dinge vorgeführt werden sollten. Bereits die Umstände dieses Konzertes wiesen alle Anzeichen eines geradezu konspirativen Treffens auf, da ein geeigneter Ort gefunden und die richtige Zeit abgewartet werden musste, bis das Treffen schliesslich stattfinden konnte. Dort begannen dann die Musiker auf zwei Violinen und einer Theorbe mit

1 Bei der ersten Publikation im Jahre 1656 lautete der Titel *Iternarium exstaticum coeleste*; die im folgenden benutzten, von Gaspar Schott kommentierten Ausgaben verwenden schliesslich den griffigeren Titel *Iter* ... (Herbipoli [=Würzburg] 1660 und 1671). Vgl. auch Ingrid D. Rowland (Hg.), *The Ecstatic Journey. Athanasius Kircher in Baroque Rome*, (Ausstellungskatalog University of Chicago 1. Februar–7. April 2000), Chicago 2000, S. 20–22 und S. 75–77.

ihrem Spiel, «und zwar in einem solchen Zusammenklang der Harmonie und in einer so ungewöhnlichen Unterscheidung ungebräuchlicher Tonschritte», wie er sie nie zuvor gehört hatte. «Sie vermischten nämlich diatonische mit chromatischen und diese wiederum mit enharmonischen flirrenden Tonfolgen, und es ist kaum auszudrücken, wie sehr die ungewöhnliche Mischung dieser Genera die Empfindungen des Gemüts bewegte.»² In der darauf folgenden Nacht hatte Kircher dann seinen unglaublichen Traum.

Die an diesem Abend gespielte *symphonia diatonico-chromatico-enharmonica* hat sich leider nicht erhalten, aber eine Reihe vergleichbarer Kompositionen, die nicht zuletzt zeigen, in welchem Ausmass praktische Experimente mit chromatischen und enharmonischen Genera in Rom in der Mitte des 17. Jahrhunderts von Interesse waren. Ziel des folgenden Beitrags ist es, einige dieser Versuche vorzustellen und vor allem auch nach den konkreten Aufführungspraktiken dieser Musik und möglichen Konsequenzen für die zeitgenössische Musik zu fragen.

Mehr als ein Jahrzehnt vor Kirchers chromatisch-enharmonischen Erlebnissen berichtet der französische Gambist André Maugars (um 1580–ca.1654) über Musik und Spielpraktiken in den antiken Genera, wie er sie 1639 während eines gut einjährigen Aufenthaltes in Rom kennengelernt hatte. So beschreibt er etwa Cembali mit mehrfachen Tastaturen und gebrochenen Obertasten, auf denen Kompositionen im chromatischen und enharmonischen Genus auszuführen sind.³ Tatsächlich sind solche Instrumente in den Inventaren

2 Kircher, *Iter*, S. 72 («tantâ harmoniæ concordîâ, tam inusitatis insolitorum intervallorum discriminibus, ut tametsi nonnihil eximium in Musica explorasse me fateri possim, simile tamen quid me percepisse non meminerim. Dum enim diatonica chromaticis, haec enarmonicis modulorum teretismatis [meint eigentlich das Gezwitscher und Geschnatter von Vögeln] miscent; dici vix potest, quantum insolita horum generum miscella animi affectus commoverit. Jam enim per diapason descensum ex sono acuto in gravem paulatim languescens desinebant, ac languore quodam animum auditoris afficiebant;»). Für die Übersetzung danke ich Felix Heinzer, Stuttgart, sehr herzlich. – Auf diesen Bericht wurde schon öfters hingewiesen, zuerst bei Helene Wessely-Kropik, *Lelio Colista. Ein römischer Meister vor Corelli, Leben und Umwelt*, Wien 1961 (= Österreichische Akademie der Wissenschaften, Philosophisch-historische Klasse, Sitzungsberichte, 237. Band, 4. Abhandlung), S. 35–42.

3 André Maugars, *Response fait à un Curieux, svr le Sentiment de la Musique d'Italie*, o. O. und o. J. (1639 ?), S. 16: «l'ay veu quelques curieux [Espinettes] qui en ont fait faire à deux clauiers; l'un propre pour sonner le mode Dorien, & l'autre le Phrygien, diuisans le ton en quatre chordes, pour tascher à sonner purement les genres Chromatique & Enharmonique, & pour destourner facilement d'un demy ton en l'autre. Je vous asseure que cela produit un bel effet: [...]». – Zu solchen Instrumenten speziell aus Rom vgl. Denzil Wraight, «The *cimbalo cromatico* and other Italian string keyboard instruments with divided accidentals» (in diesem Band).

römischer Paläste jener Zeit in vergleichsweise grosser Zahl belegt⁴ – und sie wurden auch gespielt. Maugars Erfahrungen könnten ganz konkret mit zwei Publikationen zusammenhängen, die 1638 in Rom erschienen. Beide enthalten sie Musik von Domenico Mazzocchi (1592–1665), Komponist und hoher Beamter in Diensten von Kardinal Ippolito Aldobrandini: *Dialoghi, e Sonetti* ist der eine betitelt, *Madrigali a cinque voci* der andere.⁵

Die *Dialoghi* enthalten Vertonungen von Texten und Gedichten des Barberini-Papstes Urban VIII., Torquato Tasso und weiteren zeitgenössischen Autoren, aber auch zwei Kompositionen über Texte aus Vergils *Aeneis*.⁶ In dem im Stile römischer Oratorien gehaltenen Dialogus «Nisus et Euryalus»⁷ wird der Tod der beiden Freunde Nisus und Euryalis geschildert, die aus dem eingeschlossenen Lager der Trojaner ausbrechen konnten, aber von den Feinden entdeckt und getötet wurden. Am Ende folgt ein «Lamentum Matris Euryali», also die Klage der Mutter von Euryalus über den Tod ihres Sohnes für Sopran mit beziffertem B.C. (vgl. Abb. 1). Der unzweideutige Vermerk «Cantatur, vt scribitur, rigorosè.» verweist auf die strikte Einhaltung der in diesem Gesang geforderten enharmonischen Intervalle und harmonischen Herausforderungen – dieses *Lamentum* solle lieber gar nicht, als nicht korrekt aufgeführt werden.⁸

Gleich zu Beginn fallen einige dieser Besonderheiten auf, etwa in der Gesangsstimme im 4. und 5. Takt zu «aspicio». Die Zeichen «v» (zwischen den Tonschritten *cis1-d1* und *d1-dis1*) und «x» (vor dem *e1*) werden von Mazzocchi im Nachwort des Druckes näher erläutert. Das «v» bezeichnet ein kon-

4 Vgl. etwa Frederick Hammond, *Music & Spectacle in Baroque Rome. Barberini Patronage under Urban VIII*, New Haven & London 1994, S. 89–98.

5 *Dialoghi, e Sonetti posti in mvica da Domenico Mazzocchi*, Rom 1638; *Madrigali a cinque voci, e d'altri varij Concerti*, Rom 1638. – Vgl. allgemein zu Mazzocchi und diesen beiden Drucken Wolfgang Witzemann, *Domenico Mazzocchi 1592–1665. Dokumente und Interpretationen*, Köln & Wien 1970 (= AnMc 8), und Richard Eric Englehart, *Domenico Mazzocchi's «Dialoghi e Sonetti» and «Madrigali a cinque voci» (1638): A modern edition with biographical commentary and new archival documents*, Ph.D. Diss. Kent State University 1987.

6 Vgl. William Oliver Strunk, «Vergil in Music», in: *MQ* 16 (1930), S. 482–497, und Helmuth Osthoff, «Domenico Mazzochis Vergil-Kompositionen», in: Heinrich Hüsch (Hg.), *Festschrift Karl Gustav Fellerer zum Sechzigsten Geburtstag am 7. Juli 1962*, Regensburg 1962, S. 407–416.

7 Mazzocchi, *Dialoghi*, S. 113–156, das «Lamentum» auf den S. 153–156.

8 Solche Vermerke sind offensichtlich ein Kennzeichen von «vieltöniger» Musik, erscheinen sie beispielsweise auch bei Crescenzo Salzilli, *Libro Primo de Madrigali a cinque voci*, Neapel 1607 und *Del secondo libro de madrigali a cinque voci*, Neapel 1611, wie auch bei Scipione Stella, *Hymnorum Ecclesiasticorum*, Neapel 1610, und den Madrigalen von Michelangelo Rossi (s.u.).

Abb. 1: Domenico Mazzocchi, *Dialoghi, e Sonetti*, Rom 1638, S. 153

MATER EVRYALI.

Cantatur, vt scribitur, rigorosè.

Vnc ego te Eu-rya-le a-spi- cio? tu ne illa fenest

3 5 4 3 4 4 3 4 6

V

Abb. 2: Domenico Mazzocchi, *Dialoghi, e Sonetti*, Rom 1638, S. 155
(T. 28–30 «aut vulnera laui Veste tegens»)

oculos, aut vul-nera la- ui Ve- ste tegens: tit

2 6 4 3 3 4 5 3 4

trolliertes «messa di voce», also ein allmähliches Anschwellen der Stimme, das aber verbunden ist mit einer Tonhöhensteigerung exakt um einen «kleinen» Viertelton, d.h. um die Hälfte der mit einem «x» bezeichneten «Diesis Enarmonico».⁹ Dieses Intervall ergibt sich «logisch» aus der zugrundeliegenden mitteltönigen Stimmung, wenn sie um zusätzliche reine Terzen erweitert wird; die Tonstufe steht als «semituono minime», als Kleinstintervall, unter seinem modernen enharmonischen Äquivalent. Es handelt sich hierbei um reale und damit gegenüber der herkömmlichen zwölfstufigen Skala um zusätzliche Tonstufen, was nicht zuletzt daraus deutlich wird, dass diese Differenzierung auch in der Continuo-Stimme und seiner Bezifferung erscheint (vgl. Abb. 2). Ganz eindeutig bezieht sich Mazzocchi hier auf ein Instrument, das diese besonderen Tonstufen realisieren kann, etwa ein Tasteninstrument mit zusätzlichen gebrochenen Obertasten, wie er es auch in seinem Nachwort mit dem Hinweis «come si vede nell'Instrumenti hodierni perfettamente spezzati»¹⁰, also Instrumente mit mehreren geteilten Obertasten, erwähnt.

In Verbindung zu einem antiken Sujet wie dieser Vergilvertonung liegt die Verwendung entsprechender musikalischer Mittel nahe und hat auch eine lange Tradition. Der antikisierende Ansatz ist aber nur ein Aspekt, viel wichtiger aber war die durch Chromatik und Enharmonik mögliche unerhörte Steigerung der Affekte in ihrer Darstellung und damit in der Wirkung bei den Zuhörern – «che all'hora farà mirabilissimi effetti» heisst es bei Mazzocchi.¹¹ So verlangt Mazzocchi denn auch in den *Madrigali*, dem zweiten genannten Druck von 1638, mit den gleichen Symbolen die feine Unterscheidung von Tonstufen. Dort findet sich als letztes Stück einer Gruppe von acht Madrigalen mit Generalbassbegleitung «Pian piano, aure tranquille».¹² Gemäss der Forderung Mazzocchis, dieses wirkungsmächtige Stilmittel nur an besonderen «pathetischen» und durch den Text legitimierten Passagen anzuwenden,¹³ kommt die Enharmonik zum Schluss des Madrigals als Höhepunkt und letzte Steigerung zum Einsatz, um die «beltà crudel», die «grausame Schöne», auszudrücken, die im grössten Gegensatz zu dem «sachten Wehen» der Winde zu Beginn des Textes steht.

9 Mazzocchi, *Dialoghi*, S. 179–182, S. 180: «che è l'andar crescendo à poco à poco la voce di fiato insieme, e di tuono, & è specie della metà del sopradetto x, come si pratica ne gli Enarmonici». – Ein *messa di voce* ohne Tonhöhenveränderung bezeichnet Mazzocchi mit «C», das er aus dem anschaulichen Vergleich mit «cauato da vna Cisterna» ableitet.

10 Mazzocchi, *Dialoghi*, S. 181.

11 Mazzocchi, *Dialoghi*, S. 181.

12 Mazzocchi, *Madrigali*, Madrigal VIII in jedem Stimmbuch.

13 Mazzocchi, *Dialoghi*, S. 182: «hò inteso di fare solo per alcuni luoghi patetici, e doue dall' oratione istessa son stato tirato».

Bsp. 1: Domenico Mazzocchi, *Madrigali*, «Pian piano» (T. 57–62)

57 V 60

Bel-tà cru-del, Bel-tà cru-del, che m'è nel pet-to a-sco-sa,
 Bel-tà cru-del, Bel-tà cru-del, che m'è nel petto a sco-sa,
 Bel-tà cru-del, Bel-tà cru-del, che m'è nel pet-to a-sco-sa,
 Bel-tà cru-del, Bel-tà cru-del, che m'è nel pet-to a sco-sa,
 Bel-tà cru-del, Bel-tà cru-del, che m'è nel pet-to a-sco-sa,
 Bel-tà cru-del, Bel-tà cru-del, che m'è nel pet-to a-sco-sa,
 # 6 #6 # #5 # 4 3 x # 6 b5 5 7 #6 4 3 #

Die Cantus-Melodie steigt von *d*2 über *dis*2 *e*2 <*eis*>2 (dies ist die «diesis enarmonico», also keineswegs mit einer modernen enharmonischen Verwechslung als *f* zu interpretieren) zum *fis*2, dann absteigend über *dis*2 <*eis*>2 *cis*2 *h*1 etc. bis zum *ais*1 über den (modern gesprochen) Fis-Dur-Klang. Wie auf den ersten Blick zu erkennen, erreicht der Satz hier sehr rasch sehr ferne tonale Regionen. Die Pointe allerdings besteht darin, dass zwar die Tonstufen der Stimmen ungewohnt sind, die Akkorde dabei aber jeweils in sich rein sind (so gewährleistet das <*eis*> hier eine reine Terz zu *cis*). Dissonanzen ergeben sich – kontrapunktisch ganz traditionell – durch Sekunden zwischen den Oberstimmen, durch Vorhalte etc.¹⁴ Diese weit vom üblichen entfernten, dabei aber vertikal reinen Klänge in einer gleichsam mitteltönig gestimmten Welt sind das besondere dieses Satzes und bewirken Affekte auf einer ganz unerhörten klanglichen und tonalen Ebene.

Das oft geäußerte Argument, die «crudeltà» solle gerade durch verstimmte, sozusagen «buchstäblich knirschende» Klänge ausgedrückt werden,¹⁵ greift hier sicher nicht, denn wiederum finden sich in der Continuo-Stimme

14 Etwa T. 61 zu «(che) m'è» oder «(nel) pet(to)» oder «(as)co(sa)».

15 Vgl. Silke Leopold, «Die Vanitas-Idee in der Musik», in: *Zeitsprünge – Forschungen zur Frühen Neuzeit* 1 (1997), S. 645–669, S. 652 (bezogen auf Mazzocchis Klage der Magdalena, «Lagrima amare», das am Ende der *Dialoghi* steht).

die Zeichen für Töne mit der «diesis enarmonico» (siehe T. 59, T. 60 oder T. 61) und zu Beginn wiederum die strenge Vorschrift «Questo Madrigale si canta come è scritto, à rigore : però non si faccia alteratione alcuna se non doue si trouerà segnata.»¹⁶

An diesen Beispielen ist die Frage nach der Aufführungsart eindeutig zu beantworten, nämlich vokal unter Verwendung der differenzierten kleinsten Intervallstufen, jeweils aber mit der Unterstützung etwa eines entsprechenden Tasteninstrumentes mit hier mindestens 16 Tasten pro Oktave, eben «perfettamente spezzati».¹⁷ Zudem liess Mazzocchi seine *Madrigali* 1638 in zwei parallelen Ausgaben erscheinen, nicht nur wie üblich in Stimmbüchern, sondern zusätzlich auch «in partitura», um sie bequemer auch instrumental aufführen bzw. begleiten zu können, womit Mazzocchi ausdrücklich rechnet.¹⁸ In seiner Widmung an Kardinal Francesco Barberini (1597–1679), dem Neffen des Papstes, weist Mazzocchi zudem auf den Ort dieser Musik hin: Madrigale würden ja leider nur noch wenige komponiert und noch seltener aufgeführt, ausser im Rahmen der Akademien des Kardinals. Dieser aber würde ihnen gleichsam ein sicheres Asyl gewähren und, um seine Seele von der Bürde öffentlicher Angelegenheiten zu erleichtern, liesse er Madrigale «sopra il Conserto delle sue Viole» singen.¹⁹ In Mazzocchis Madrigalsammlung selbst ist nur eine einzige Komposition explicit «per le Viole» bezeichnet²⁰ – diese Gamben spielten aber eine viel grössere Rolle in den Akademien des Kardinals und darüber hinaus.

So finden sich in den Ausgabenbüchern des Kardinals vielfache Hinweise auf dieses Gambenensemble: Bereits 1634 ist der Kauf einer «muta di violoni» – eines Satzes von insgesamt sechs Gamben – und von 23 Madrigaldrucken in Venedig belegt. Zwei Jahre später wurden abermals 21 Musikbücher angeschafft, ausdrücklich als «mute de libri da sonare di viola» genannt. In den Dokumenten erscheint dieses Gambenensemble als «viole dell'accademia»

16 In dem parallelen Partiturdruk der *Madrigali* (s. u.) findet sich im Vorwort «A gli amici lettori» abschliessend die listige Bemerkung «[die Sänger] chè sara, quando con qualche poco di diligenza, & osseruatione fatta alli ritrouati segni (prima di farli sentire in publico) siano premediamente concertati.» (S. 5).

17 Neben *eb/dis* und *gis/ab* werden noch *ex* und *hx* verlangt.

18 Domenico Mazzocchi, *Partitvra de' Madrigali a cinque voci, e d'altri varij Concerti*, Rom 1638, S. 4: «hò stimato bene per maggior commodità di chi se n'hà da seruire il mandarli fuori insieme con la Partitura, sì perche con questa potranno più francamente cantarsi, come ancora, perche se tal'vno hauesse gusto (essendo questo à tutti differente) di accompagnar parimente coll'Istrumento quei, che non si deono, lo possa fare senza sua fatica.»

19 Mazzocchi, *Partitvra*, S. 3. – Zu den vergleichsweise seltenen Madrigal-Kompositionen dieser Zeit vgl. Gloria Rose, «Polyphonic Italian Madrigals of the Seventeenth Century», in: *Music & Letters* 47 (1966), S. 153–159.

20 «Chiudesti i lumi Armida» (Mazzocchi, *Partitvra*, S. 166–172, Nr. XX).

oder sogar als «l'accademia delle viole», womit die Instrumente zugleich diesen Veranstaltungen des Kardinals den Namen gaben. Hierzu haben vor allem Frederick Hammond und Wolfgang Witzmann einiges Material zusammengetragen.²¹ In diesem Zusammenhang aber sei eine ganz konkrete Frage gestellt: Wie ist sich die Aufführung eines Madrigals wie «Pian piano» und ähnlicher Kompositionen, die «vieltönige» Skalen verwenden, mit einem Gambenkonsort vorzustellen, wie dies offensichtlich in den römischen Akademien Francesco Barberinis vorgesehen war? Um diese Frage zu beantworten, ist ein weiteres römisches Gambenensemble aus derselben Zeit heranzuziehen, die «präparierten» Gamben von Giovanni Battista Doni (1594/5–1647).

Doni diente nach klassischen und juristischen Studien den Barberinis, die ab 1623 den Papst stellten, und wurde 1629 zum Sekretär des Kardinalskollegiums ernannt.²² Etwa gleichzeitig widmete er seine Studien fast ausschliesslich der antiken Musik und ihrer Wiedernutzbarmachung für die zeitgenössische Musik. Doni war fest davon überzeugt, dass allein durch die Wiedereinführung der antiken Genera und Modi die wunderbaren Effekte der Musik zu erzielen seien, wie sie bei den antiken Autoren zu lesen waren und wie sie die zeitgenössische Musik in dem Ausmass vermissen liess. Aufgrund seiner hervorragenden Kenntnisse der griechischen Sprache war er in der Lage, die bis dahin bekannt gewordenen antiken Traktate im Original zu studieren und sie neu zu interpretieren. Für das Folgende genügt es, die

21 Die Quellen bezüglich der Viole Barberinis finden sich in folgenden Studien: Frederick Hammond, «Girolamo Frescobaldi and a Decade of Music in Casa Barberini», in: *Analecta musicologica* 19 (1979), S. 94–124; Wolfgang Witzmann, «Beiträge der Brüder Mazzocchi zu den musikalischen Akademien Kardinal Francesco Barberinis», in: *Akademie und Musik. Erscheinungsweisen und Wirkungen des Akademiegedankens in Kultur- und Musikgeschichte: Institutionen, Veranstaltungen, Schriften (Festschrift für Werner Braun zum 65. Geburtstag)*, hg. von Wolf Frobenius, Nicole Schwindt-Gross & Thomas Sick, Saarbrücken 1993, S. 181–214 (= Saarbrücker Studien zur Musikwissenschaft, Neue Folge 7); Hammond, *Music & Spectacle*, S. 105–106. – Vgl. auch Martin Kirnbauer, «Wherein the most complete Harmony was heard» – The Viola da Gamba in Chromatic and Enharmonic Music in Seventeenth-Century Rome», in: *The Italian Viola da Gamba. Proceedings of the International Symposium on the Italian Viola da Gamba, Magnano 29 April–1 May 2000*, hg. von Susan Orlando, Solignac & Turin 2002, S. 34–51.

22 Zu Doni und seinen musiktheoretischen Arbeiten vgl. vor allem Claude V. Palisca, «G.B. Doni, Musicological Activist, and his «Lyra Barberina»», in: *Modern Musical Scholarship*, hg. von Edward Oleson, Stockfield 1980, S. 180–205; Claude V. Palisca, «Giovanni Battista Doni's Interpretation of the Greek Modal System», in: *Journal of Musicology* 15/1 (1997), S. 3–18; Patrizio Barbieri, «Gli strumenti poliarmonici di G. B. Doni e il ripristino dell'antica musica greca (c. 1630–1650)», in: *Analecta Musicologica* 30/I (1998), S. 79–114.

Umriss seines Systems zu beschreiben. Doni glaubte, dass die bei Ptolomaïos beschriebene Praxis der griechischen Musik, die verschiedenen Tonskalen (Modi) auf unterschiedliche Tonstufen oder -höhen (Tonoi) zu transponieren, wichtiger als ihre Veränderungen in den verschiedenen Genera waren. Zudem war er der Ansicht, dass nicht nur der dorische Modus transponiert wurde, sondern alle sieben Modi (siehe Bsp. 2).²³ So konnte ein Modus entweder in der gleichen Lage, aber mit der charakteristischen Intervallstruktur eines anderen Modus dargestellt werden, oder umgekehrt konnte nur die Tonlage bei gleichbleibender Intervall-Struktur des Modus gewechselt werden. Dies führte, nicht zuletzt wegen der zugrundeliegenden ungleichschwebenden Stimmung der Skalen, zu einer Vielzahl von Tonstufen.

Bsp. 2: Skalen nach Doni

I

a) Tuono, e Modo Dorio b) Tuono Dorio, Modo Frigio c) Modo Dorio, Tuono Frigio

d) Tuono, e Modo Frigio *notiert:* e) Tuono, e Modo Hypolidio

II

Dorio diatonico Dorio cromatico Dorio enarmonico

Der dorische Modus – hier in Bsp. Ia auf der richtigen Tonhöhe (*tuono*) und in seiner eigentlichen charakteristischen Intervallfolge (*modo*) – lässt sich auf derselben Tonhöhe mit der Intervallstruktur des Phrygischen darstellen (vgl. Bsp. Id – projiziert auf die Tonhöhe des Dorischen Bsp. Ib). Umgekehrt kann die Skala des Dorischen auch auf die Tonhöhe des Phrygischen gebracht werden (Bsp. Ic). Darüber hinaus konnten diese Skalen in den verschiedenen Genera, also auch chromatisch und enharmonisch, verwendet werden (Bsp. II).

23 Claude V. Palisca, *Humanism in Italian Renaissance Musical Thought*, New Haven & London 1985, S. 330–332. Zum heutigen, abweichenden Verständnis der Theorie von Ptolemaïos vgl. Thomas Mathiesen, *Apollo's Lyre. Greek Music and Music Theory in antiquity and the Middle Ages*, Lincoln, Neb. 2000 (= Publications of the Center for the History of Music Theory and Literature 2), S. 429–495, bes. S. 459ff.

Musik, die mit derartig «vieltönigen» Skalen arbeitet, konnte natürlich nur durch entsprechend eingerichtete Instrumente gespielt oder begleitet werden. In seinem *Compendio del trattato de' generi e de' modi della mvsica* (Rom 1635) beginnt Doni denn auch mit einer Diskussion von «i Clauicembali diuisi, come diccono, Cromaticamente, o Enarmonicamente», das sind wiederum Cembali mit geteilten Obertasten bzw. auch zusätzlichen Tastaturreihen.²⁴ Dann stellt er aber fest, dass Gamben viel besser geeignet seien, «far sentire la diuersità de'Generi, e de'Modi», weil es auf Gamben bedeutend leichter sei, die richtigen Intervalle zu finden («perche meglio si possono trouare del' interualli giusti, e rationali nelle Viole, [...] che in questi Clauicembali»). Zudem würden sich Gamben besser mit Gesangsstimmen mischen und sie daher auch besser führen können, worin laut Doni auch die eigentliche Absicht der instrumentalen *colla-parte*-Begleitung von Vokalmusik liegt.²⁵ Und nicht zuletzt seien Gamben einfacher zu spielen und zu stimmen als die Tasteninstrumente mit ihren komplizierten Tastaturen wie es dabei für den Spieler auch einfacher wäre, jeweils nur einer Stimme in einer polyphonen Komposition zu folgen als die ganze komplexe Struktur im Auge – und in den Fingern – zu behalten. Um die Gamben entsprechend auszurüsten, liess sich Doni einen Satz alter Instrumente umbauen. Trocken berichtet Doni, dass er ihnen die ursprünglichen Hälse absägen und durch neue ersetzen liess, die breiter und länger waren, um zwei Saitengruppen anzubringen (siehe Abb. 3).²⁶

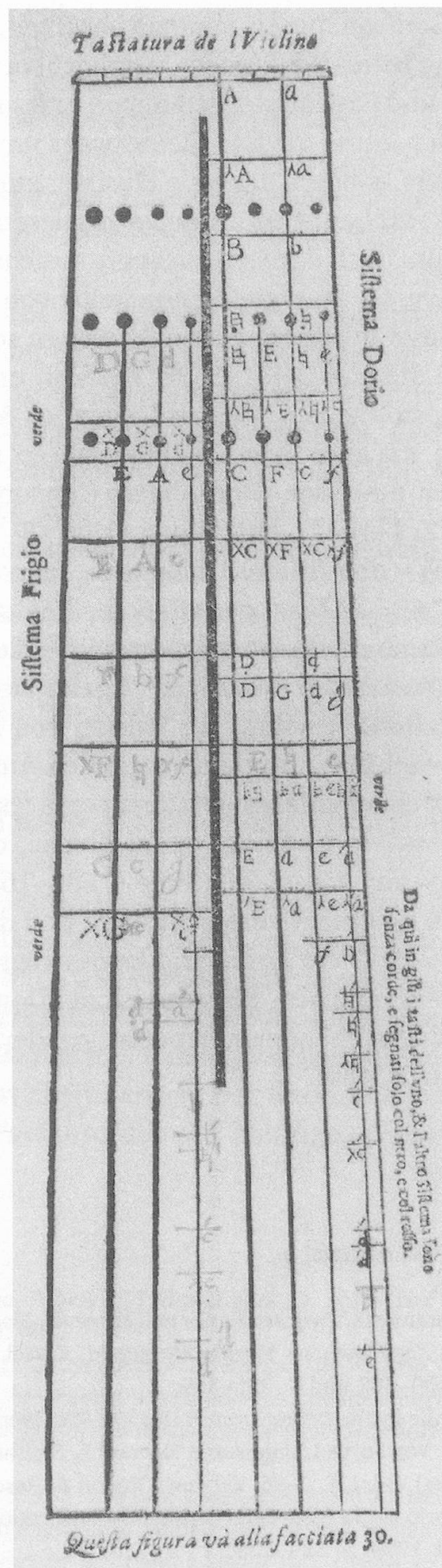
In diesem Beispiel gibt es eine Gruppe mit drei und eine mit vier Saiten, die jeweils in Quarten und Quinte gestimmt waren: Die Vierergruppe diente hier für den dorischen Modus, die drei Saiten für das «Sistema Frigio». Durch das Griffbrett und den Hals gebohrte Löcher ermöglichten es, unterschiedlich lange Saiten für unterschiedliche Modi anzubringen. Durch einen langen Schlitz längs im Hals konnten Bündel nur für einzelne Saitengruppen adjustiert werden. Zusätzlich erwähnt Doni «un tastino incolato», also ein aufgeklebtes «Bündchen» für einzelne Saiten.²⁷ Wie zu erkennen, stehen so eine Vielzahl von Abstufungen für den Ganztonschritt zur Verfügung.

24 Doni, *Compendio*, S. 17; die beiden folgenden Zitate auf S. 19.

25 Doni, *Compendio*, S. 20: «[...] possono molto meglio seruir per guida delle voci humane: quale deue essere il vero scopo di questi instrumenti, e non di multiplicare le consonanze ne'concenti, o sinfonie [...]».

26 Doni, *Compendio*, eingelegtes Blatt zwischen S. 30–31 (sowie nochmals am Ende des Traktats). Vgl. hierzu auch Kirnbauer, «The Viola da Gamba».

27 Giovanni Battista Doni, *Lyra Barberina amphichordos*, hg. von Antonio Francesco Gori & Giovanni Battista Passeri, Florenz 1763, Bd. I, S. 379 (im «Discorso quarto della disposizione, e facilità delle viole diarmoniche»).

Abb. 3: Gambenhals nach Doni, *Compendio* (1635), nach S. 30

Ohne hier auf die Feinheiten – und Schwierigkeiten – von Donis System und seiner Gamben einzugehen, lässt sich folgendes festhalten: Doni beschreibt ein Verfahren, wie auf Gamben mittels zusätzlicher Bünde eine Vielzahl von Intervallstufen realisiert werden können – vergleichbar den gebrochenen Obertasten bei Cembali und Orgeln «perfettamente spezzati». Dabei ist wichtig, dass es sich bei seiner «muta di viole» keineswegs um ein unpraktisches Phantasieprodukt handelte, sondern um reale Musikinstrumente, deren Funktionsfähigkeit in musikalischen Aufführungen erwiesenermaßen erprobt wurde.²⁸ Zudem gibt Doni auch darüber Auskunft, welche Musik auf diesen Instrumenten gespielt wurde. So regte er eine Reihe von Komponisten, darunter namhafte, an, Musik in seinem neuen System zu schreiben. Zu ihnen gehörten beispielsweise Stefano Landi (1586/7–1639) und Domenico Mazzocchi, denen er Kompositionen «in Genere Cromatico & Enarmonico [...] non solo nelle mie Viole, ma anco in vn Clauicembalo co' tasti spezzati» vorführte.²⁹ Weitere Namen umfassen Gino Angelo Capponi (1607/8–1688), Ottaviano Castelli (1602/3–1642), Luigi Rossi (1597/8–1653) und Virgilio Mazzocchi (1597–1646) – den Bruder Domenicos, *maestro di cappella* der *Cappella Giulia* und ab 1636 de facto der «Hofkapellmeister» der Barberinis und zuständig für das Gambenkonsort des Kardinals.³⁰ Leider scheinen sich die meisten dieser Kompositionen (Madrigale, Rezitative, eine «Commedia in musica», eine musikalische Fassung der *Troades* von Seneca etc.) nicht erhalten zu haben, obwohl ihre aufsehererregenden Aufführungen belegt sind. Um so wertvoller ist ein erhaltenes «Oratorio per la festa della Santissima Purificazione [...] con varietà di cinque tuoni diversi, cioè Dorio, Frigio, Eolio, Lidio, et Hipolidio» von Pietro della Valle (1586–1652), ein römischer Patrizier, der viele Jahre im Orient verbracht hatte und der mehrere Oratorien in Donis Stil schrieb.³¹ Diese kurze und keineswegs vollständige Auflistung soll vor allem verdeutlichen, dass es sich bei Donis Ideen nicht um ein isoliertes und marginales Phänomen handelte, sondern um eine hörbare Musikpraxis im Rom jener Jahre.

28 Siehe Kirnbauer, «The Viola da Gamba».

29 Doni, *Compendio*, S. 135.

30 Vgl. zuletzt Bernhard Schrammek, *Zwischen Kirche und Karneval. Biographie, soziales Umfeld und Werk des römischen Kapellmeisters Virgilio Mazzocchi*, Kassel etc. & Lucca 2001 (= Musiksoziologie 9), S. 200–202 und S. 355–359.

31 In I-Rn Mus. 123; Faksimile in *The Italian Oratorio 1650–1800. Works in a Central Baroque and Classic Tradition*, hg. von Joyce L. Johnson & Howard E. Smither, New York & London 1986 (= A Garland Series), Bd. I, S. 3–36. Vgl. auch Rudolf A. Rasch, «The Greek tones in Pietro della Valle's «Oratorio per la Festa della Santissima Purificazione» 1640», in: *Stichting Huygens-Fokker Jaarboek* 1994, S. 124–138.

Ausdrücklich für Donis präparierte Gamben bestimmt ist eine vierstimmige Komposition Pietro Heredias (ca. 1575–1648), «vn saggio di melodia vocale modulata in due Tuoni, per maggior espressione d'affetto» (siehe Bsp. 3).³² Sie beruht auf einem Sonett Papst Urbans VIII. (alias Maffeo Barberini, 1568–1644), «Passa la vita all'abbasar d'un ciglio», wobei allein die oberste Stimme textiert ist, die – unisono mit einer Gambe – vokal auszuführen ist. Der spezielle Effekt besteht in einem Wechsel zwischen dem Dorischen und Phrygischen Modus, notationsmässig durch einen Schlüsselwechsel dargestellt. Tatsächlich handelt es sich bei der Schlussnote des einen Abschnittes und der Anfangsnote des nächsten um den gleichen Ton, die übrigen Töne der Skalen differieren allerdings. Diese von Doni propagierte Vereinfachung in der Schreibweise, die etwa der modernen Praxis bei transponierenden Instrumenten entspricht, findet sich weitergetrieben in dem genannten Oratorium von Della Valle. Dort ist nur noch angegeben, auf welcher der insgesamt drei unterschiedlich gestimmten Tastaturen eines eigens konstruierten «Cimbalo à tre ordine» jeweils zu spielen ist.

Das Notenbeispiel entstammt nicht dem ursprünglichen Satz Heredias, mit dem Doni nicht unbedingt zufrieden war – «è poca cosa, & assai sforzato» urteilte er später in einem Brief.³³ Die modifizierte oder vielleicht sogar neu komponierte Fassung (von Doni?) integriert chromatische und enharmonische Elemente.

Bedeutsamer noch als diese neuen Kompositionen ist aber, dass Doni auch vorsah, Madrigale, die in einer vergleichsweise traditionellen Manier komponiert waren, mit seinen speziellen Gamben aufzuführen. Als Beispiel druckt er am Ende seines bereits erwähnten *Compendio* den Beginn eines Madrigals von Carlo Gesualdo (ca. 1561–1613) aus dem V. Buch fünfstimmiger Madrigale ab: «Tu m'uccidi crudele» – in traditioneller Partitur («con la Intauolatura ordinaria») und zusätzlich in einer speziellen Tabulatur, die Doni eigens für seine Gamben entwickelt hatte.³⁴ Der Notentext bei Doni entspricht dabei weitgehend dem Partiturdruk der Madrigale Gesualdos von 1613,³⁵ und

32 In Doni, *Compendio*, S. 163–171; das Zitat auf S. 162. – Das Beispiel hier nach Doni, *Lyra Barberina*, Bd. I, S. 409.

33 Io. Baptistae Doni [...] *Commercium litterarium*, hg. von Antonio Francesco Gori, Florenz 1754, Sp. 225; zit. bei Angelo Solerti, «Lettere inedite sulla musica di Pietro della Valle a G. B. Doni ed una Veglia drammatica-musicale del medesimo», in: *RMI* 12 (1905), S. 271–338, S. 278.

34 Doni, *Compendio*, S. 153–160 (die Tabulatur-Version auf den S. 157–160, die aber in der falschen Reihenfolge gedruckt wurden). Vgl. hierzu Kirnbauer, «The Viola da Gamba».

35 *Partitvra delli sei libri de' madrigali a cinque voci*, Genua 1613, fol. 172v–174v.

Bsp. 3: Heredia/Doni «Passa la vita»

Dorio.

On - de si can - gia in a - tra not -

(not.x)

5

Frigio.

te il gior - no ch'a noi ri - de - va

(not.a)

(klingend:)

2

1 Dorio.

74

E la cu - na ta - lor' fu - ne - bra

This system contains the first four staves of a musical score. The first staff is a vocal line with lyrics. The second staff is a piano accompaniment. The third and fourth staves are empty. The key signature has one sharp (F#) and the time signature is 7/4.

5

Frigio.

ba - - ra Ter - re - na pom - pa

This system contains the next four staves of the musical score. The first staff continues the vocal line with lyrics. The second staff continues the piano accompaniment. The third and fourth staves are empty. The key signature changes to two flats (Bb, Eb) and the time signature is 3/2.

(klingend:)

This system contains the final four staves of the musical score. The first staff continues the vocal line. The second staff continues the piano accompaniment. The third and fourth staves are empty. The key signature remains two flats (Bb, Eb) and the time signature is 3/2.

weicht vor allem nur durch zusätzliche kleine Punkte zu einigen Noten ab, mit denen Doni die «Tuoni minori» bezeichnet, die um ein Komma tiefer klingen und die notwendig sind, «per fare le consonanze giuste». Resultat sind gleichsam rein ausgestimmte Akkorde bei dieser melodisch wie harmonisch kühnen Musik, was den Effekt der im Satz angelegten Dissonanzen verstärkt und deutlicher zur Geltung bringt.

Donis eigenwillige Gamben stellen sicher einen Sonderfall dar und sind nicht mit den Instrumenten der Akademie Barberinis zu verwechseln. Aber im Rahmen der Beschreibung seiner Gamben erwähnt Doni auch «le Viole comuni più perfette», die – vergleichbar den *Cembali spezzati* – kleine zusätzliche Bündel zu haben pflegen, um etwa *dis* und *eb* und sogar eine weitere «diesis enarmonico» spielen zu können – «andernfalls könne man darauf die Madrigali des Principe oder ähnliche weit modulierende³⁶ Musik nur schlecht spielen, wie einem jeden Verständigen solcher Instrumente bekannt ist» («[...] le Viole comuni più perfette, anch'esse sogliono avere un tastino, che fa l'istesso effetto, ed altrimenti malamente vi si possono suonare i Madrigali del Principe, e simili cantilene Metaboliche, come ad ogni perito di tali instrumenti è noto.»).³⁷ Beiläufig erwähnt Doni hier «gewöhnliche» Gamben, allerdings der besseren Art, die mit zusätzlichen Bündeln für die Darstellung «vieltöniger» Skalen ausgestattet sind und die die stimmungsmässigen Aufführungsprobleme hochchromatischer Madrigale etwa eines Gesualdo lösen. Anders gesagt: Die Beachtung der subtilen Differenzen in nicht-gleichschwebender Stimmung stellen eine praktizierte Aufführungsweise dieser Musik dar, und zwar nicht nur mit *Cembali spezzati*, sondern eben auch mit Gamben. Eine andere Aufführungsweise wäre – und ist es in aller Regel auch heute noch – ein mehr oder weniger weitgehendes Negieren dieser subtilen Unterschiede, indem etwa eine gleichschwebende Stimmung verwendet oder irgendwie «gebastelt» wird. Die Position von Doni und dem Umkreis in der Akademie Barberinis zu diesen Alternativen ist eindeutig. Sehr deutlich wird sie etwa von Pietro della Valle formuliert, der 1640 in einem Disput über die damals neu aufkommende gleichschwebende Stimmung auf die

36 Zur Kategorie des «Stylus Metabolicus» vgl. auch Athanasius Kircher, *Mvsurgia vniversalis*, Rom 1650, Bd. I, S. 672–675. Siehe auch Patrizio Barbieri, «The evolution of open-chain enharmonic keyboards c1480–1650», § 5.3. (in diesem Band).

37 Doni, *Lyra Barberina*, Bd. I, S. 389; vgl. zum Kontext auch Patrizio Barbieri, «Il Temperamento equabile nel periodo Frescobaldiano», in: *Girolamo Frescobaldi nel IV Centenario della Nascita. Atti del convegno internazionale di studi (Ferrara, 9–14 settembre 1983)*, hg. von Sergio Durante und Dinko Fabris, Florenz 1986, S. 387–423 (= Quaderni della Rivista Italiana di Musicologia 10).

besondere Qualität von reinen Akkorden hinweist, die bei mitteltöniger Stimmung mit Hilfe gebrochener Obertasten von einem «buon sonatore» leicht zu spielen wäre.³⁸ Dagegen seien die scheinbaren Vorteile der gleichschwebenden Stimmung Bagatellen, zudem weise diese «grandissime imperfettioni» auf. Gerade die musikalisch so wichtigen Terzen und Sexten seien «tutte false, che non si possono sentire», die unterschiedlichen «diesi» und «bemolli» in Mitteltönigkeit hingegen «servono meravigliosamente alla espressione de gli affetti». Und bei dieser Gelegenheit weist Della Valle auch das unhaltbare Argument zurück, Instrumente mit Bündlen würden stets eine gleichschwebende Stimmung verwenden: «non ne parlo, e me ne rido; perche questo è tanto falso [...] quanto è falso il fondamento». Dies könne man beispielsweise deutlich an den Gamben «in Casa del Mazzocchi» sehen, die eine eben nicht gleichschwebende Stimmung und Bundverteilung aufwiesen.

Die Gamben «in Casa del Mazzocchi» sind aber nichts anderes als das oben erwähnte «Conserto delle sue Viole» von Kardinal Francesco Barberini, die von Virgilio Mazzocchi betreut wurden – «sue Viole più perfette» könnte man nun mit Doni ergänzen. Hier findet nicht nur der Madrigaldruck Mazzochis seinen angemessenen Kontext, sondern es ist wohl auch kein Zufall, dass die für dieses Gambenensemble 1634 angeschafften Drucke ein Repertoire umfassen, das weitgehend identisch ist sowohl mit der von Doni im Zusammenhang mit seinen Gamben als auch mit der von Mazzocchi als Vorbild genannten Musik.³⁹ Gekauft wurden Musikdrucke von Giovanni Maria Nanino, Pomponio Nenna, Gesualdo, Sigismondo d'India, Claudio Monteverdi u.a.,⁴⁰ also zu dieser Zeit teilweise bereits gut dreissig bis vierzig Jahre alte Musik, bekanntlich oftmals hochchromatisch.

Vor diesem Hintergrund erscheinen nicht nur Mazzochis *Madrigali* von 1638, sondern auch vergleichbare Werke anderer Komponisten dieser Zeit in einem neuen Licht – und in einem neuen Klang. Es lässt sich vermuten, dass vor allem der scheinbar einen Endpunkt darstellende und kaum überbietbare Madrigalstil eines Gesualdo durch die Beschäftigung mit diesem Repertoire und den entsprechenden Instrumenten – *Cembali cromatici* sowie Gamben unter Berücksichtigung einer gleichsam «erweiterten Mitteltönig-

«...e di questa maniera si può dire che il cromatismo è stato il primo passo verso l'armonia moderna» (Della Valle, *op. cit.*, S. 119).

38 Agostino Ziino, ««Contese letterarie» tra Pietro della Valle e Nicolò Farfaro sulla musica antica e moderna», in: *Nuova rivista musicale italiana* 3 (1969), S. 101–120, S. 119–120 (hier auch die folgenden Zitate).

39 Mazzocchi, *Dialoghi*, S. 179 («il Marenzo, il Macque, il Nenna, il Pecci, il Luzzasco, il Principe di Venosa & ogn'altro buono Autore»).

40 Zu den genauen Identifizierungen siehe Witzenmann, «Beiträge», S. 205–206.

keit durch zusätzliche Tasten bzw. Bünde – zu ähnlichen Kompositionen führte. Noch nicht lange bekannt ist eine handschriftliche Sammlung von fünfstimmigen Madrigalen des vor allem in Rom tätigen Komponisten Michelangelo Rossi (1601/2–1656), dort gleichfalls im Barberini-Zirkel zu finden.⁴¹ Diese Madrigale haben zwar keine eigene Basso Continuo-Stimme, liegen aber – bezeichnenderweise wie die Madrigale Domenico Mazzocchis – sowohl in Stimmbüchern als auch in Partitur vor und weisen wiederum den vergleichbar strengen Hinweis auf, die Vorzeichen immer nur dort zu beachten, wo sie auch notiert wurden («I ♯ et i: b: non si cantano se non dove sono segnati»)⁴². Der Hinweis ist auch notwendig, verwendet Rossi die Akzidentien doch geradezu verschwenderisch. In «Prodighi di fiamme» z.B. werden *cis*, *fis*, *gis*, *dis*, *ais*, *eis* und *his* verlangt – neben *b*, *eb* und *ab*. In einer bemerkenswerten Passage kommt sogar – modern gesprochen – ein in der Musik der Zeit aussergewöhnliches «*cisis*» vor (siehe Bsp. 4)⁴³.

Zu der Passage «e voi scarsi men siete» (und ihr missgönnt mir euren Blick) moduliert der Satz von – wiederum in moderner Terminologie – H-Dur über Gis-Dur, Cis-Dur, Ais-Dur (mit dem doppelten Kreuz vor *c1* in T. 31), dis-moll nach Ais-Dur, weiter über ais-moll, fis-moll, h-moll, wieder fis-moll und G-Dur nach D-Dur. Die Kompositionen Rossis sind vermutlich zur gleichen Zeit oder sogar etwas später wie die Madrigale Mazzocchis entstanden,⁴⁴ aber es gibt noch weitere Madrigale aus dieser und späterer Zeit, die ganz ähnlich funktionieren (etwa von dem päpstlichen Kastraten Domenico Dal Pane und sogar noch von Alessandro Scarlatti) und die einen eigenen Typus zu bilden scheinen, bezeichnet als «Madrigali al Tavolino».

41 Erstmals genannt bei Alexander Silbiger, «Michelangelo Rossi and His Toccate e Correnti», in: *JAMS* 36 (1983), S. 18–38, S. 30–31; siehe auch Catherine Moore, *The Composer Michelangelo Rossi: A «Diligant Fantasy Maker» in Seventeenth-Century Rome*, New York & London 1993 (= Outstanding Dissertations in Music from British Universities).

42 Die Partitur wird heute in USA-BEm MS 176 aufbewahrt, die Stimmbücher in CDN-Mc Inv.-Nr. 12160 (wo nur das zweite Buch des Cantus fehlt, das aber auf einem Mikrofilm in USA-NYp *ZBT 215 dokumentiert ist); zur Quellenlage vgl. Moore, *The Composer*, S. 50–51.

43 In der Edition von Moore, *The Composer*, S. 197–202, S. 200, ist dieses doppelte Kreuz unterschlagen, sowohl in der Partitur wie in dem betreffenden Stimmbuch aber eindeutig vorgezeichnet. – In diesem Zusammenhang ist es von Bedeutung, dass in dieser Zeit Doppelkreuze – soweit ich sehe – stets im Kontext von *Cimbali cromatici* vorkommen (vgl. etwa Giovanni Maria Trabaci, *Il Secondo Libro de Ricercare, & altri varij Capricci*, Neapel 1615, oder Martino Pesenti, *Correnti, Gagliarde, e Balletti Diatonici. Trasportati Parte Cromatici e Parte Henarmonici ... Libro Quarto. Opera Decimaquinta*, Venedig 1645).

44 Die bei Moore, *The Composer*, S. 22, vermutete frühere Datierung ist nicht zuletzt wegen des geschilderten Kontextes eines besonderen Interesses des Barberini-Zirkels an Madrigalen zu relativieren.

Bsp. 4: M. Rossi «O prodighi» T. 30–36

30

è uoi scar -
e uoi scar - si men sie - te (e voi scar -
e uoi scar - si men sie - te (e uoi scar -
e uoi scar - si men sie - te (e voi
e uoi scar - si men sie - te

34

- si men sie - te spie-ta-tis - si - mi ra - i
si men sie - te) men sie - te spie-ta-tis - si - mi ra - i
si scar - si) men sie - te spie-ta-tis - si - mi ra - i
scar - si men sie - te) spie-ta-tis - si - mi ra - i
spie-ta-tis - si - mi ra - i

Hier schliesst sich ein Kreis, denn einer der drei Musiker in dem eingangs geschilderten phantastischen Traumbericht von Athanasius Kircher war jener Michelangelo Rossi.⁴⁵ Wenn auch die Frage nach der Aufführungsart der Madrigale Rossis nicht so eindeutig zu beantworten ist wie im Falle Mazzocchis und Gesualdos (zumindest in seiner römischen Rezeption im Umfeld der Barberini), so lässt sich hier in jedem Fall eines belegen: Ein direkter Einfluss auf die zeitgenössische Musikproduktion, der sich aus der Beschäftigung mit den antiken Genera und entsprechend eingerichteten Musikinstrumenten ergab, und der zu einer ungeahnten Expansion des musikalischen Tonraums führte – der schliesslich auch ohne solche Instrumente zu begehen war.

45 Neben Lelio Colista und Salvatore Mazzela; vgl. Wessely-Kropik, *Lelio Colista*, S. 35–42.

Zusammenfassung

Berichte aus der Mitte des 17. Jahrhunderts von André Maugars oder Athanasius Kircher belegen ein besonderes Interesse an chromatisch-enharmonischer Musik in römischen Akademien. Die Erfahrungen Maugars können sogar direkt auf zwei Publikationen von Domenico Mazzocchi zurückgeführt werden, die 1638 erschienen: *Dialoghi, e Sonetti* und *Madrigali a cinque voci*. Darin werden u.a. enharmonische Tonschritte verlangt, die auch vom Basso continuo auszuführen sind. Mazzocchi verweist in diesem Zusammenhang auf «Instrumenti hodierni perfettamente spezzati», also Tasteninstrumente mit mehrfachen gebrochenen Obertasten, aber auch auf ein «Conserto delle Viole» von Kardinal Francesco Barberini. Im Rahmen der Akademien des Kardinals wurde besonders alte und neue Madrigalkunst gepflegt, die mittels eines solchen Gambenkonsorts begleitet wurde. Im Vergleich mit Gamben von Giovanni Battista Doni, der seine Instrumente speziell präparierte, um die von ihm rekonstruierten griechischen Skalen zu spielen, lassen sich bemerkenswerte Parallelen ziehen: Neben Neukompositionen (etwa von Pietro Eredia, Luigi Rossi oder Pietro della Valle) liess Doni auf seinen Gamben auch ältere Madrigale, beispielsweise von Carlo Gesualdo aufführen. Diese hochchromatische und die Grenzen eines mitteltönig gestimmten Tonsystems überschreitende Musik konnten mittels seiner Gamben adaequat dargestellt werden. Aber Doni kannte auch «Viole comune più perfette», also Gamben herkömmlicher Bauart, die mittels zusätzlichen aufgeklebten kleinen Bündeln – wie die Cembali spezzati mit mehrfachen gebrochenen Obertasten – vieltönige Skalen spielen konnten. Es kann gezeigt werden, dass genau solche Gamben in den Akademien von Kardinal Francesco Barberini gespielt wurden und dass Domenico Mazzocchi seine Musik für diese Instrumente schrieb. Vor diesem Hintergrund erscheinen weitere Kompositionen aus römischen Akademien in neuem Licht und Klang. So lassen sich vielfache Bezüge zu den erst unlängst bekannt gewordenen Madrigalen von Michelangelo Rossi herstellen. Solche «Madrigali al Tavolino», die es noch von anderen Komponisten wie Domenico Dal Pane oder Alessandro Scarlatti gibt, stellen ein besonderes musikalisches Repertoire dar, dass durch die Experimente und Erfahrungen mit antiken Tonsystemen und entsprechend eingerichteten Instrumenten angeregt wurde. Es lässt sich der Schluss ziehen, dass diese Beschäftigung zu einer ungeahnten Expansion des musikalischen Tonraums führte, der schliesslich auch ohne diesen Hintergrund zu begehen war.

Abstract

Reports from c.1650 by André Maugars or Athansius Kircher indicate a particular interest in chromatic-enharmonic music in the Roman academies. Maugars' testimony can be traced back to two publications by Domenico Mazzocchi that appeared in 1638: *Dialoghi, e Sonetti* and *Madrigali a cinque voci*. Among other things, these contain enharmonic sequences, which are also to be played by the basso continuo. Mazzocchi refers in this connection to «Instrumenti hodierni perfettamente spezzati», i.e., keyboard instruments with multiply-split accidentals, but also to a «Concerto delle Viole» of Cardinal Francesco Barberini. Within the academies of the Cardinal it was particularly the Old and new Art of the Madrigal that was cultivated using such a viol consort as the means of accompaniment. Some remarkable parallels can be drawn with the viols of Giovanni Battista Doni, whose instruments were specially adapted in order to permit performance of the Greek tunings he had reconstructed, since alongside new compositions, such as those by Pietro Eredia, Luigi Rossi, or Pietro della Valle, Doni also arranged for older madrigals by Carlo Gesualdo to be performed. This highly chromatic music, which exceeded the normal boundaries of a meantone tuning could be satisfactorily demonstrated using his viols. Doni also knew of «Viole commune più perfette», that is, ordinary viols which by means of additional, small, glued-on frets permitted multi-toned scales to be played, similar to harpsichords with multiply-split sharps. It can be shown that exactly such viols were played in the academies of Cardinal Francesco Barberini and that Domenico Mazzocchi wrote music for these instruments. Against this background other compositions of Roman academies appear in a new light and with a different tonal nuance. Several links can be formed to the madrigals by Michelangelo Rossi that have only recently become known. Such «Madrigali al Tavolino», which are known from composers such as Domenico Dal Pane or Alessandro Scarlatti, represent a particular musical repertory that was stimulated by experiments with the tuning systems of antiquity and instruments specially constructed for them. It can be concluded that this activity of the Roman academies led to an unexpected expansion of musical space, which in the last analysis could have been produced even without this background.