and an understanding of the techniques I have out- studied with Gustav Leonhardt).

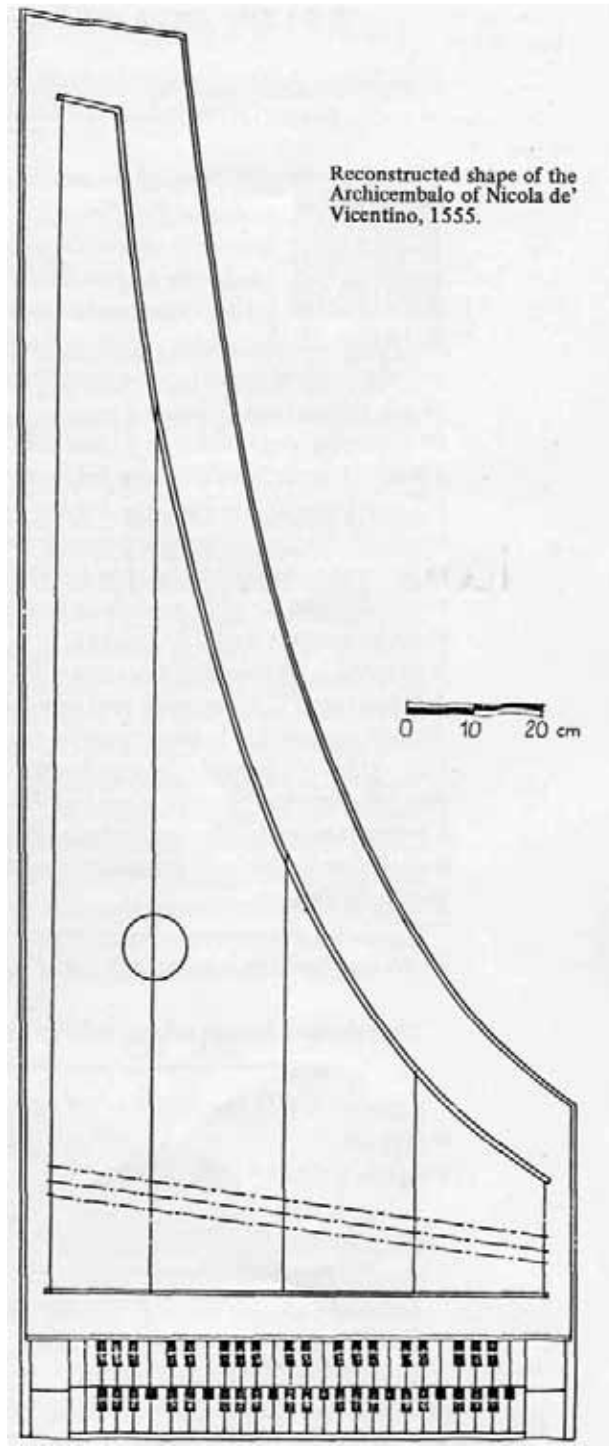
The Archicembalo of Nicola Vincentino

by Marco Tiella

Archicembalo after Vicentino. Designed by Marco Tiella and made by Luigi Tomasi and Didier Chanon at the workshop of Barthelemy Formentelli (organ and harpsichord maker of Pedemonte di Verona) who was responsible for the voicing.

In 1555 an important book was published in Rome: *L'antica musica ridotta alia moderna prattica ... ,* Nicola Vicentino's[1] *trattato,* which stated the level of research on the Greek *genera* according to the musicological views of the author, and proposed the practical use of these *genera* on a special instrument expressly designed for this purpose, the Archicembalo. This work caused extraordinarily intense polemics among musicologists from Vicentino's lifetime to the beginning of the eighteenth century[2]. All this proves how lively the interest was in some aspects of organology, although more recent musicologists have undervalued the role of theoretical interest in the musical reconstruction of Greek *genera* as well as the practical importance of an instrument belonging to the Archicembalo type[3]. Since some pieces of evidence show that the musicology and also the music of the Renaissance were based on the revival of Greek musical theories, it seemed necessary to me to experiment on an actual instrument if deeper and more precise knowledge about this kind of music was to be reached. Besides the necessary bibliographical researches, studies on Archicembalo-designed instruments were begun about 1968. First Vito de'

Trasuntini's *Clavemusicum Omnitonum* was examined in detail. As the instrument has been out of use, practice on an Archicembalo required the reconstruction of a proper instrument. From the various instruments for which details existed, Vicentino's Archicembalo was chosen as probably the first Archicembalo designed in Renaissance times. **Vicentino's description of the Archicembalo** In the fifth book of the *prattica musicale,* Vicentino gives a detailed description and some measurements for making the instrument. The original description can be summarized and literally translated as follows: *Chapter 1 - Preface to the fifth book of the musical practice of Don Nicola Vicentino, about the practice of the instrument which he named Archicembalo.* 'So that students of the *prattica musicale* may be attracted to studying, playing and learning to compose on the Archicembalo, the first and most perfect instrument, since it lacks no consonance, I made the new *prattica* of chromatic and enharmonic music with some examples ... and I made drawings to make the instrument, with measurements of lengths, heights and widths, giving a plan of all the keys in their six orders with the pattern of the upper part in which the holes for the jacks are seated, which pluck the strings with their quills. I also give their measurements, and the positioning of the iron pins round which the strings are rolled (wrest pins), and the bridge upon which the strings are laid, and with the measurements of the rose which has to be pierced through, and how far it must be from the keyboard which appears out of the instrument.' Vicentino keeps referring to some peculiarities of the sound of the instrument with regard to many kinds of intervals, notes, examples and consonances. 'And how the performer can pass from one order to another: and the defects in the scaling of lutes, viole d'arco and other instruments are discussed, mentioning the namings of every key, which, when referred to its orders, suffers from its great imperfection. Students must not spare efforts to obtain such a rare and marvellous musical experience, which will make them renowned ... as the usual art of playing at this time is almost the same for every performer, and all performers progress in the same way and on the same keys ... except for different speeds ... but nobody plays on keyboards which are different from each other. Then our keyboard without imperfections will give fame to the student ... who will be praised by everybody as *musico rarissimo et perfetto.' Chapter II - Description of the length, width, height and all the measurements, which are needed for making the Archicembalo, with drawings.* After saying that drawings and measurements are quite sufficient for a skilled craftsman to make the Archicembalo easily, Vicentino describes both keyboards as laid on a single frame and removable from the instrument. The upper keyboard would have some keys pierced through, to allow the..passage of



some long jacks. In the first (lower) keyboard there are 69 jacks, and 63 in the second (upper) one. Altogether the jacks, which have to serve all the keys are 132. 'Thus the student or the craftsman

Dimoſtratione della longhezza, & larghezza, & altezza di tutte le miſure che occorreno à formare l'Archicembalo, con il documento. Cap. II.

ANoſtra perpetua memoria, & acciò che reſti nel mondo un fermo Maeſtro à gli preſenti, & poſteri noſtri, hò deliberato di far ſtampare il diſegno della forma dell'Archicembalo, con le preſenti & ſotto ſcritte linee, che ſaranno le miſure che inſegneranno à ogni Prattico di fare ſtromente, formare il ſopra detto Archicembalo con facilità; & oltre le miſure delle linee, ſarà poſto il diſegno delle due taſtature, pigliate con le miſure giuſte, che non occorrerà all'operatore ſi non intagliar quelle ſopra il legno con poca fatica di miſurare, perche congiungerà inſieme i fogli della prima taſtatura, e formerà il primo telaro, il quale ſi potrà rimouere tutto in un pezzo; & il ſecondo telaro ſarà mobile, & ſi cauerà fuore & ſi rimetterà ſenza mouere li taſti, come il primo: & queſta ſeconda taſtatura ſarà bucarata, per cagione d'alcuni ſaltarelli longhi, che paſſano di ſotto in ſù, come ſi uedrà ne i loro luoghi in dette taſtature. & queſta ſeconda taſtatura ſarà in altri fogli, che congiunti inſieme formeranno la taſtatura à punto; & appreſſo ſaranno ſtampati altre fogli, che hauranno la diuiſione bucarata de i ſaltarelli del coperchio, miſurati con diligenza, & giuſti; perche la diuiſione del regiſtro è tutta l'importanza del ſtromento, per accommodare le corde & i ſaltarelli; & la prima taſtatura dè hauere 69. ſaltarelli, et la ſeconda 63. che hanno da ſeruire à tutti i taſti, i quali ſaranno tutti 132. ſaltarelli. Hora lo Studente ouer l'Operator, quando uorrà principiar à formare il predetto ſtromento, ſarà neceſſario che prima eleggi il legname impropoſito che ſia buono & ſecco, che ſia di molto tempo tagliato, et che poteſſe hauere & ſapere qual parte dell'arboro fuſſi ſtato poſto uerſo il ſole, quella parte ſarà migliore, & poi lo raſſettarà in modo che poſſi comporre eſſo ſtromento: & poi quello pigliarà la miſura della longhezza, che ſarà la ſotto ſcritta linea, la quale entrerà uenti uolte nella predetta longhezza del ſtromento, & anchora la medeſima entrerà otto uolte nella larghezza del ſtromento.

Lunghezza e larghezza della ſaumana.

& coſi dimoſtrarò tutte le miſure con le linee, con la dichiaratione ſopra di eſſe.

Linea che entra due uolte nella profondità, ouero altezza del ſtromento.

Linea dell'altezza delle ſuperfitie fin al coperchio, oue ſi ripoſano le chiaui, ouer i pironi di ferro che tengono le corde, & queſta medeſima ſerue dall'altezza della prima taſtatura, ouer primo telaro fin al piano baſſo del ſtromento.

Linea dell'altezza del morto del ſtromento, ouer di quella parte che è dalle ſponde de i taſti.

Linea dell'altezze delle due taſtature poſte una ſopra l'altra.

Linea che dimoſtra che l'intaglio della roſa dè eſſer lontano da ſaltarelli, tanto quanto è longa due uolte, e la medeſima longhezza sarà p una uolta appreſſo la longhezza dritta del ſtrom

Two pages from Vicentino's *trattato* (reduced – the lengths of the lines are given in the text)

Linea della longhezza che và dal riposo della corda fin al primo ſaltarello.

Linea della longhezza de i ſaltarelli longhi.

Linea della longhezza de i ſaltarelli corti.

Sono alcuni buchi oue uanno i ferri che s'apiccono le corde che ſi uedranno nel diſegno, & ſono lontani da quella tauola che giace ſopra i taſti, laquale ſerra che non ſi poſſono uedere i legni longhi della taſtatura, che entrano nel corpo del ſtromento, & i buchi ſono lontani dalla detta tauola, quanto è longa queſta piccola linea.

Nel primo ordine de ſaltarelli s'haurà i ſaltarelli longhi & corti: Nel ſecondo ordine de ſaltarelli quelli ſaranno tutti longhi in un modo. Il telaro ſarà bucarato diſotto, ſecondo che ſono bucarati i taſti; & tutti i ferri hanno del ſcamuſcio, ouero camoza bianca, eccetto quelli che ſono appreſſo il fine del taſto, quelli hanno del panno, acciò non faccino rumore: & ſotto tutti i ſaltarelli, è ſopra poſto al legno il ſcamuſcio. Et il Maeſtro che farà il ſopra detto ſtromento, dè auertire à far li taſti agili e preſti, e che non faccino rumore: & le penne che ſaranno poſte ne ſaltarelli debbino eſſere dolci & corte, per accommodare le corde; & ſopra ogni coſa ſi dè porre buone corde & perfette, perche le corde cattiue fanno parere cattiuo un buon ſtromento, e tanto debbono eſſere groſſe e ſottili quelle che ſeruiràno al primo telaro, come al ſecondo, perche corre poca altezza una dall'altra, come ſarà la metà del ſemitono minore piu alte. Et quando il Maeſtro uſarà diligenza con le miſure, & con i ricordi ſopra dati, farà un buon & perfetto Archicembalo: quando ſarà fatto un poco piu piccolo, acciò ſi poſſi cantare con eſſo, che con queſte miſure è un tono piu baſſo. Et il ſtromento ſarà buono & perfetto, quando le corde ſaranno molto bene tirate ſopra il detto ſtromento: & poi tutte queſte ante dette miſure, ſi rimettano al giuditio di quel piu & di quel manco che parerà al buon Prattico di far ſtromenti.

Delli ſei ordini dell'Archicembalo. Cap. III.

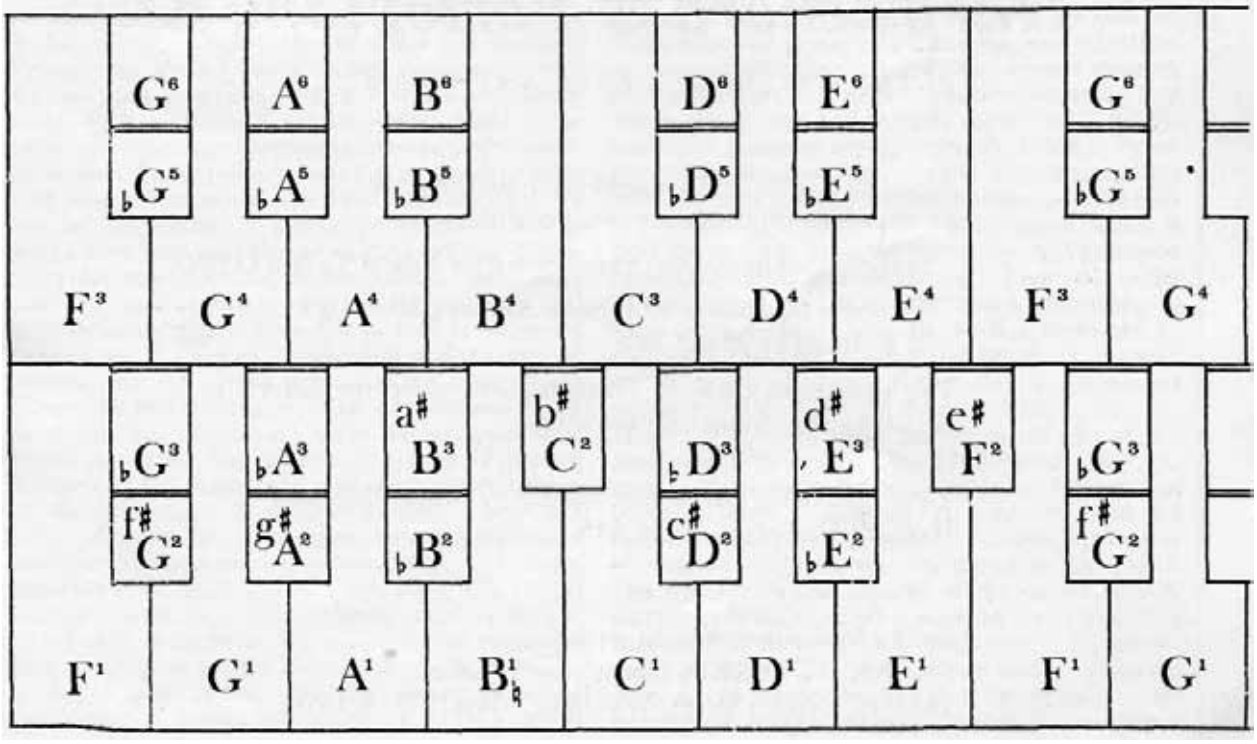
Fatto che habbiamo il noſtro ſtromento, ſarà neceſſario intendere li ſei ordini di quello: & acciò ch'il Prattico non ſi confondi con quello, darò regola ferma, che ogni uolta ch'io dirò il primo ordine & naturale, che ſarà quello che nelle taſtature de gl'Organi, ouer Monocordi, Arpicordi, et altri ſimili ſtromenti ſarà l'ordine delli taſti bianchi ſenza li neri, & poi alli taſti neri, dirò ſecondo ordine che ſaranno quelli taſti neri, che in tutti gli Organi & ſtromenti di taſtatura communamente s'uſano. Poi ſeguendo nel dire de gli ordini del noſtro ſtromento, domanderò terzo ordine, à quello che da l'operatore ſarà poſto nella taſtatura cõmuna, che ſarà in tutti i taſti ſcauezzi delli bianchi & delli neri, che ſaranno tutti i taſti poſti nel primo telaro. Poi ſeguendo ſi dirà quarto ordine à quelli taſti tutti bianchi, che ſaranno poſti ſopra queſto terzo: & alli

making the instrument needs to select the necessary wood as suitable and dry, cut sometime beforehand. He who can know what part of the tree was facing the sun, should choose it as the best...' The measure-

ments of the instrument are shown in lines, mostly fractions of the real lengths. Length, 20 x 9.8 cm (196 cm); width, 8 x 9.8 cm (78.4 cm); height, 2 x 10.8 cm (21.6 cm); height from the lower surfaces

to the cover where the keys or iron pegs holding the strings are fixed, and the same measurements serve to measure the distance from the first keyboard frame to the lower plane of the instrument (missing), height of the dead part of the instrument or of the part beside both the margins of keys, 6.9 cm; height of the two keyboards laid one on top of the other, 5.3 cm; distance of the sound hole from the jacks, 2 x 13.7 (27.4 cm); the same length will be taken once from the right side of the instrument to the sound-hole, 13.7 cm; diameter of the sound-hole, 8.9 cm; width of the space between the curved bridge and the bent side — it continues the same to the middle of the instrument and then it becomes gradually larger to the end of the instrument, 10.6 cm; length of the white keys of the first order, which appear out of the instrument, 6.9 cm; length of the black keys of the second order which appear out of the instrument, 3.9 cm; length of the black keys of the third order which appear out of the instrument, and these three orders are on the first frame, 2.1 cm; length of the white keys of the fourth order which appear out of the instrument, 6.2 cm; length of the black keys of the fifth order which appear out of the instrument 3.8 cm; length of the black keys of the sixth order which appear out of the instrument, and these three orders, i.e. the fourth, fifth and sixth ones are placed upon the second frame, which can be drawn out or put in easily as it is provided with two iron clasps fixed to the sides of the instrument with screws, 2.1 cm; height of the first black key laid on the first frame of the third order, these two orders of *semitonia* are assembled one on top of the other, when they come near together to simplify matters, 4.1 cm; widths of white and black keys are to be arranged according to the good judgement of the Master, and their lengths also, so that the player can run smoothly with his fingers over them all, and comfortably reach the most distant keys of both keyboards with one hand ... As regards all the measurements the skilled Master has to make the instrument well so that it can be played easily. The lengths of the entire keys need not be given, for they are shown exactly in the drawing of the keyboard. Little pieces of lead are to be placed at the ends of the longest keys so that they will come down faster, otherwise they will go slowly owing to their (greater) length. And a little piece of chamois leather has to be provided where the jacks hit the long part of the key, so that the jacks do not make a noise going down. And there are four holes near the centre of the frame, in which four iron rods are put to support the second frame, and every key has its own hole through which goes the iron peg (= balance pin) supporting it. The length of the first treble string which has to be twice as long, 2 x 15.8 cm (31.6 cm) length from the bridge to the first jack, 6.2 cm; distance of some holes for wrest-pins from the front wall (= name board) which hides the internal parts of the keys, to the instrument, 1.9 cm; length of the long jacks, 10.8 cm; length of short jacks, 7.2 cm; In the first order of jacks there are short and long jacks, the second order in the jacks will be of the same lengths. The frame will be pierced through, underneath the piercings in the keys. All the iron pegs will have some chamois leather (i.e. white female chamois) except those at the ends of the keys which have cloth (felt) so that they do not make a noise, and underneath all the jacks chamois leather is placed upon the wood. And the Master building the instrument will make the keys smooth and quick and noiseless, and the quills in the jacks will be soft and short to permit the placing of the strings; and above all good and perfect strings have to be fitted since bad strings make the instrument bad, and they have to be thin or thick for the first frame as much as for the second one, as there is little difference in pitch between the frames, i.e. half a minor semitone higher. The Master having followed these directions, the instrument will be a good and perfect Archicembalo. Made a little smaller, the Archicembalo will be suitable for singing, thus it is a tone lower if made with the given measurements. The instrument will be good and perfect when the strings are very well tightened on the instrument.' **Remarks about the reconstruction of Vicentino's Archicembalo and reliabUity of Vicentino's designs.** Some points in the foregoing instructions are not literally reliable, however Vicentino's descriptions must be considered sufficient in themselves for the maker to make the instrument. The most important objection which concerns the inconsistency between two measurements may be settled by comparisons between the shapes of various Italian harpsichords. In fact the length of the string for the highest note *c‴* and the inclusive length of the case seem to belong the former to a 16' Archicembalo and the latter to an 8' one. Omitting some details, existing Italian harpsichords demonstrate two main scales, for iron strings and for yellow strings respectively[4]. On the average, the yellow string scale was based on a c" length of about 25 cm. while the iron string scale on a *c″* length of 32 cm. The line on the page 100 of Vicentino's *trattato* measures about 15.8 cm. Multiplying this length by two gives approximately 31.6 cm. This length is in any case inconsistent with an 8' *c‴* one, but it would represent a 16' c""s. On the contrary, the inclusive length of the case, 196 cm. is clearly inconsistent with the shape of a 16' Italian harpsichord[5]. Statistically, the most probable exact interpretation points out that the line on page 100 would not have to be multiplied by two, but the actual length on the page is the real length of the highest string, so that the resulting scale of the instrument is of about 31.6 cm. for *c″*. Another point concerns the shape of the tail angle. As to this question, it is impossible to give one explanation more reliable than another, whether the angle was

square or pointed in accordance with the two main patterns of typical Italian harpsichords[6]. In the reconstruction the square tail angle was preferred, this form giving the possibility of a nearly just scale from *c'''* to G: *c'''*: 16.8 cm.: *c''*: 31.6 cm.: *c'*: 63.2 cm.: *c:* 126.4 cm.: G: 168.5 cm. The last point concerns the keyboard and frame which were to have been pierced through. Being a matter of technological importance, it was resolved to avoid the piercing through of keys and frame, since it is apparently impossible to establish criteria fit to distinguish the 'long' and 'short' jacks of the first jack order (note, the white keys of the lower keyboard). In fact, the question should be changed to another about the order of placement of the strings exactly according to the succession of the keys. Unfortunately, Vicentino's drawings do not coincide with each other, although they are reduced to the same scale. Rather, the shape of the tops of the upper frame keys would require quite a great number of borings in the keys. The seats of such borings seem really not to be rational in regard to the* process of sawing out the key tops fitted around adjacent key tops. Furthermore each practical solution to this question will be reflected on the succession of both strings and jacks. In the reconstruction certain inversions in the succession of the string were tolerated to avoid more uncertain processes in making the keys of the upper frame. It is possible to define other orders of strings and jacks starting from different presuppositions, as (1) keeping the string succession in rigid conformity with the succession of sounding frequencies (2) previous choosing of plucking timbre according to various possibilities of arranging the jacks in the three ranks apparent on the drawing. As regards the criteria carried out in the reconstruction about plucking timbres, the front rank contains the jacks of 4th and 6th orders of Vicentino's (all the white keys and half of black keys of the upper keyboard) the opposite rank the jacks of 1st and 2nd orders (all the white keys and the front black keys of the lower keyboard) the medium rank the remaining jacks of both keyboards. This choice is justified by the fact that the number of the jack mortises in the opposite rank coincides with the sum of the keys of Vicentino's 1st and 2nd orders, and lower frame keys being obviously longer than upper frame ones, the placing of the jacks of the 1st and 2nd orders does not allow any easier positioning. Besides the uncertainties stated above about keyboard designs there is the fact that Vicentino's keyboard drawings are not extended to the whole keyboard, Vicentino presumably thinking the jack mortises would be arranged symmetrically with reference to the middle of the keyboards. The designed cell of three jacks, which has to be tidily reproduced for the entire compass of the instrument, does not



The arrangement of Vicentino's keyboard. Note that C^2 and F^2 appear in the 3rd row, C^3 and F^3 in the 4th. Diagram based on Vicentino's plans of the upper and lower keyboards.

create a symmetrical form. In fact, working out Vicentino's drawings, rather more than 132 mortises would have to have been cut. All these exceptions maybe taken into a reasonable tolerance, as Vicentino himself concedes to the Master of Archicembalo, due to the fact that the drawings are presumably not the final ones. Case construction was carried out in accordance with old Italian making conceptions, using only cypress wood[7]. Quills were cut from Delrin. Their length is naturally short, for the little space provided for in the drawings, but not shorter than 2.5 mm. As regards diameters of strings there are no great problems, even if Vicentino did not specify how thick the strings should be. According to results of published specialized investigations and to results of research on some Italian harpsichords which have not yet been restored[8], it is possible to suggest a minimum diameter for iron string in the higher three octaves about 0.25 mm, increasing to 0.30 for c, to 0.40 for G.

Questions about tunings

It seemed that the most difficult obstacle to overcome would be Vicentino's tuning. In fact, some questions about old tunings systems appear really intricate and they involve necessary syntheses of many physical, technological and historical data often quite hard to reach even separately. In principle, today it is not generally understood why the old writers were so worried about tuning problems. It is almost impossible to speak about the philosophical grounds on which tuning systems were once based. It is scarcely necessary to remember that the richer the sounds are in partials, the simpler are the beats put forward. Pythagorean perfect ratios being inconsistent with the spectrum of natural partials, it was impossible to touch perfect fifths and natural perfect thirds at the same time on a single keyboard, even in single 'tones' or 'modes'. To the problem, whether an Archicembalo-type harpsichord would have been currently used as a musical instrument for normal performances or if it would have been regarded as an extraordinary instrument for special tuning demonstrations, there were manifest uncertainties among the old *trattatisti* and substantial indifference on the part of more recent musicologists[9]. The old mechanical tuning tester we possess, the tetrachord made for the Trasuntino's *Clavemusicum Omnitonum,* 1606, does not really help to clarify Vicentino's and other ancient musicians' tuning problems. The tetrachordum gives 31 unequal divisions of the octave, and even inconsistent division of the same notes in different octaves, based on a series of intervals: major tone, minor tone, minor semitone: minor tone, minor tone, major tone, major semitone (9/8, 10/9, 27/25; 10/9, 10/9, 9/8, 16/15) for the *c* scale, and other series of intervals not yet deciphered, presumably inconsistent with meantone tuning. Original bridges being lacking, the tetrachordum can scarcely be used for tuning an actual instrument[1]°. It goes without saying that it is almost impossible to tune such ill-defined intervals on an instrument by comparison with a tetrachordum. Possibly, the tetrachord is more useful only when all its series of intervals are indisputably defined as sums or differences between pefect (i.e. sounding without beats) fifths or thirds, so that identical intervals can be reconstructed directly on the instrument. On the contrary, the Archicembalo clearly has to have a quite different and more 'modern' meantone tuning, according to what its author wrote. In the 5th and 6th chapters Vicentino describes two processes of tuning, but without defining whether the second way is a single process or preferably a control of the first process [1]. Vicentino starts by tuning the lower keyboard like a normal harpsichord, in which the chromatic keys are interpreted as c sharp, e flat, f sharp, g sharp, b flat. These keys comprise Vicentino's first and second orders, thus the third order may serve for d flat, d sharp, e flat, g sharp, a flat and a sharp. All these keys are to be tuned with temperated fifths, apparently shortened as much as those used for meantone tuning of the first and second orders. In fact, all major thirds of the lower keyboard are perfect (natural) but the missing flats limit them to the following series:

— a flat; c; e; g sharp; b sharp;
— e flat; g; b; d sharp;
— g flat; b flat; d; f sharp; a sharp;
— d flat. f. a. c sharp, e sharp;

To pass onto the upper keyboard, Vicentino uses the tempered fifth g flat (already reached by tempered fifths) — *c flat**. There is no note corresponding in musical current practice to this *c flat* (about l/5th of an octave higher than 'a') the only musical meaning in a tuning system on an Archicembalo being that this *c flat* is one perfect fifth above the V of the meantone tempered lower keyboard, at which Vicentino is supposed to have aimed. But the resulting 'e' is too high if the meantone shortening of the fifth is a fourth of a comma[12]. But through this it is possible to trace back the real value of Vicentino's presumable meantone shortening. From this *c flat* to the 'e' of the lower keyboard (according to Vicentino's system: from B_4 to E_t) there are 11 shortened fifths by which c flat has to be reached: c flat-g flat-d flat-a flat-e flat-b flat-f-c-g —d-a-e (c flat-e: fifth in the ratio 2/3). Thus, 11 by the value (in cents) of Vicentino's shortened fifth makes 7 by 1200 cents - 701,955 cents. Vicentino's shortened fifth has the value of 699,822 cents (decimals of cent are used for mathematical purpose only). Possible tunings of Vicentino's Archicembalo are shown in the tables. The just theoretical division of the octave into 36 parts gives fifths of 700,000,cents, so that Vicentino's shortened fifths of 699,822 cents are a little shorter than the theoretical ones. Such little differences seem to be negligible, but it is impossible in the practice of tuning to pass them over for musical

reason. Nobody would compare Vicentino's shortened fifths and theoretical fifths tempered for a 36 degree-scale on an Archicembalo, if that had not a musical meaning. Furthermore, if thirds or other intervals (reconstructed with differently shortened fifths) are to be compared, there will be more noticeable differences[13] . Vicentino's great intuition was how practically to solve the already well-known inconsistence between natural thirds and fifths in an approximate way by means of two keyboards tuned by rneantone systems different in pitch between themselves as by much as the fifths were shortened. More generally, it is possible to define the tuning of the whole compass of the Archicembalo the more free the more numerous the divisions of the octave are[14]. In fact, Archicembalo tuning is based on sensibility as regards the consonance of the major third[1 s]. Vicentino explains his aims in a few passages (for example: p. 105r. 105v.) besides describing the procedure for choosing the consonances in chapter 6, p.!04v. 'without moving the external fingers set by the octave chord, the performer will touch with the other fingers (displacing them from the thirds and fifths of the same order) the perfect fifths and major thirds more perfectly tuned than those we use, so that we can obtain the fifths- and thirds used by the ancients'. All of *dichiarationi* of chapter 18 have to be considered in accordance with the basic tuning system practised but it would need too much space for this article. Too much space would also be needed for the following chapters in which successions of all the kinds of tones and semitones are described. These successions would permit the comparison of the two main tunings of chapters 5 and 6 with the lists of intervals formed on notes of all kind of *genera* (consonances) semitones or sharps in any order or transposed scales. Most evident examples are the units of measures inconsistent with each other used to form intervals or scales in some parts of the treatise. Very briefly listed in an example they are: four different tones i.e. *Tono accidentals* — about (sic) 8/7; *Tono naturale* — 9/8; *Tono (maggiore) naturale accidentale - 10/9; Tono minore accidentale* — 13/12; all of these being composed by an entire number of *dieses minori,* the *diesis minore* has the value from a minimum of 34.6 cents to a maximum of 45.6 cents[16] ; the approximation is much larger than the value of the presupposed interval between the shortened fifth and the fifth in the ratio 3/2, whichever is the way by which the syntonic comma is divided to obtain the meantone tuning. Similar remarks can be made as regards the semitones and dieses which in abstract could be added to or subtracted from the tones previously recognized as inconsistent with each other. Furthermore the names for semitones are rather obscure and perhaps contradictory: sometimes the minor enharmonic semitone coincides with the comma, sometimes it is the double of a comma. The debate of Vicentino's criteria in using special intervals (comma, minor diesis and subsequent multiples of them) is a matter of particular and very minute inquiry, whose interest depends on preordained principle point of view. Summarizing these possible inquiries there are certain paths in front of the musicologist (1) if all Vicentino's statements can be reassembled in an unique system, (2) whether Vicentino contradicts himself or (3) if Vicentino placed side by side the results of various experiences[1 7]. Beyond every answer there is the basic philosophical question of 'method' that can explain some apparent inconsistences in Vicentino's writings, Vicentino's behaviour being philosophically Aristotelian and scientific at the same time. He seems to be bound to the necessity of deriving his whole tuning system from classical operations on Pythagorean intervals without letting pass by his experimental confirmations.

But musical conclusions may be drawn from the reconstruction of Vicentino's Archicembalo:

(1) It is really possible to tune the instrument and keep it in tune.

(2) It is really possible to play on it at the normal rate if the performer touches only one keyboard, and at a reasonable rate if both keyboards are touched.

(3) The easiest way of tuning, no more difficult than tuning any keyboard in the meantone system, is to have natural perfect thirds in both keyboards and perfect fifths for the fifths whose notes are contemporaneously touched on both keyboards (the fundamental on the lower keyboard and the fifth on the upper keyboard).

(4) Start tuning by fixing a major third as 17th and proceed, dividing this interval into four shortened fifths. As major third, a third with minimal beats is intended. Successions of major thirds are ther constructed as previously described in the schedule and controlled by comparisons among resulting shortened fifths (2—3 per second beating fifths) To tune the upper keyboard, perfect fifths (i.e fifths without beats) are tuned between each note o the lower keyboard and the upper keyboard. On thi keyboard resulting major thirds and shortened fiftt are compared and all fourths of comma (syntoni comma obtained in every couple of the 'same' nots of both keyboards) controlled. In conformity with the fraction of syntonic comn which shortens the fifths, the difference in pitc between the two keyboards may change in co formity with the sensation of perfect thirds, who cycles may produce changings in the pitch differen between the two keyboards,

(5) There is not a single Archicembalo tuning ap; from these different possibilities of tuning whi may give emotionally different impressions *in tc* when playing on the instrument, however *ez* interval assumes little, negligible variations *ei* tuning.

From this Vicentino's convictions about liberty

expression allowed by the Archicembalo are really confirmed.[18]

NOTES

[1] Nicola de' Vicentini (Nicola Vicentino, b. Vicenza 1511, d. Milan c.1576) lived the first part of his life at Vicenza (Northern Italy) and attended the Trissino Academy. Very little is known about his musical formation, but that he declared himself pupil of A. Willaert. Contradictory sources indicate that he was connected with the Ferrarese court, however Vicentino affirms in his book that he was music teacher of several members of the family of Duke Ercole II. Vicentino was in Rome on a trip with the Cardinal Ippolito d'Este where he sustained in 1551 his theory in comparison with Vicente Lusitano. Vicentino having lost, 'decided to publish his theory in the aforementioned *trattato*. In 1552-54 Vicentino stayed in Siena, in 1555 again in Ferrara, in 1561 described in a publication the arciorgano, in 1563 assumed the post of Master of the Chapel at the Cathedral of Vicenza, in 1570 was *rector* of S. Tommaso in Milan where he possibly died in 1572 or 1576. Apart from the *trattato* only a small part of Vicentino's music is still preserved (See: H.W. Kaufmann: *The life and works of Nicola Vicentino,* American Institute of Musicology, 1966).

[2] Most musicologists of every age have written about Vicentino's theory, polemizing against most aspects of it. The ancients, (Zarlino, Artusi, Sigonion, Galilei, Doni), criticized the inconsistency between Vicentino's theory and Greek music. Since then Vicentino's designs have been quoted inaccurately(Rossi. Kircher). In the past century Vicentino's theory was completely distorted (Fetis), other musicologists made vague descriptions of the Archicembalo (Sachs, Light, Wright) and rather obscure summaries of the theory (Delia Corte, Malipiero). Besides Colonna's *Sambuca Lincea* (1567) design, there are some other schemes of possible *archicembali* from Zarlino to Nigetti (1670) and Bresciani (after 1711) made the last description of an archicembalo that we possess.

[3] A complete documentation about this practice is in course of publication. Notice that the Cantata *(Andate o miei sospiri (la stessa cantata fatta con idea inumana ma in regolato cromatico del Cav. Alessandro Scarlatti - non e per ogni professore)* c.1712 was apparently written for performance on an archicembalo.

[4] See: W.R. Thomas & J.J.K. Rhodes: *The String Scales of Italian Keyboard Instruments,* in *The Galpin Society Journal,* March 1967, XX, p.48-62.

[5] The only 16' Italian harpsichord, whose description we know, was presumably the *cimablo* of Girolamo Zenti (1658) with *due prinicpali unisoni et ottava bassa* in the inventory of Principe Ferdinando di Toscana (1700). See V. Gai: *// instrument! musicali della corte medicea* (..., LicosaJ Fkenze, 1969, p.6.) The instrument is described as about 3.30 m. long and about 87 cm. wide.

[6] See: F. Hubbard: *Three centuries of harpsichord making,* Harvard University Press, 1965, p.38. F. Colonna: *La Sambuca Lincea...,* Napoli, 1618, p.77.

[7] Besides F. Hubbard's plate II (op.cit.) and D. Shortridge's figure 9 (J.D. Shoitridge: Italian Harpsichord Building ..., in Smithsonian Institute Bulletin 225, 1960) which show schemes of frameworks, the internal structure of three original Italian harpsichords of unknown makers was taken into account.

[8] See: M. Thomas: *String Gauges of Old Italian Harpsichords,* in *The Galpin Society Journal,* July 1971, XXIV, p.69-77. Evidence of old stringing has been found on the instruments of note 7 and on other keyboard instruments which have not yet been restored, both spinette and cembali, in private ownership or in Ca'Rezzonico Museum at Venice (2 x 8' cambalo of an unknown maker). These cembali have the remains of thicker stringings than those described by Thomas. On the contrary, the spinette (in private ownership, of unknown makers and those in Museo del Conservatorio B. Marcello at Venice, of Franciscus Patavinus (?) 1552 and in Museo del Conservatorio Cherubini in Florence, of Benedetto Floriani 1568) have the remains of thinner stringings.

[9] See: note 2 and for example F. Hellwig: *The single-strung Italian harpsichord,* in Ripin: *Keyboard Instruments Studies ...* Edinburgh University Press F. Hellwig writes, referring to the Trasuntino's *Clavemusicum Omnitonum, '...* but also the problem of keeping even a single set of strings in tune must have bordered on the insuperable.'

Two copies of Trasuntino's *tetrachordum* were used to try the actual possibilities of tuning the Archicembalo by means of a comparison tester, but without satisfactory results, due to the large tolerance of such a method of comparative tuning.

Vicentino's tuning directions are discussed in: H.W. Kaufmann: *The Life and Works of Nicola Vicentino,* American Institute of Musicology, 1966 and in *More on the Tuning of the Archicembalo* in *Journal of the American Musicological Society* of the same author. But Kaufmann's conclusions do not seem to be definitive because he did not fully consider the really intricate implications in Vicentino's tuning process owing to fundamental meantone intervals on which both the processes are based. As to Lemme Rossi's ratios (see: Table II in the Kaufmann's article, op.cit.) defining archicembalo tuning by logarithms, it should be taken into consideration that such little intervals must be determined after more attentive examinations.

[1] This is the only way by which the two tuning processes can be unified. It seems impossible to establish whether Vicentino used *Vt* of syntonic comma shortened fifths or a very closed interval such as Zarlino's 2/7 of comma, or even 1/3 of comma. Barbour supposed this, thinking that the tuning of the lower keyboard had to be completed with a cycle of shortened fifths. In fact, this seems a problem near to the first one of Vicentino, but Vicentino certainly aimed to complete the cycle of fifths in his whole two-keyboard system. If Vicentino did not complete the description of the whole cycle and did not draw attention to the discrepancies in his 36-part subdivision of the octave, this was presumably caused by the excessive great tolerances in his means of inquiry, logarithmic procedures in mathematics not yet being invented. Modern means as to the reconstruction of the instrument and the possibility of easy ways of calculation allow experimental confirmations of the various hypotheses of Vicentino's possible goals. In any case Vicentino, having been a *pratico* (pragmatist), musical results have to be taken as standards of discrimination among various solutions, the one which may correspond to an actual meaning of *tastatura senza difetto et perfetta* (keyboard without defect and perfect) or *organo divino* (divine organ) even though the cycle of fifths can not be completed (chapter 5 and 6 of the 5th Book).

[13] Interesting questions arise from what Vicentino might have intended by 'major thirds, more pefectly tuned than the ones we use' (p.!04v. and 105r.) if not thirds in the ratios 4/5 and 5/6. And also why he did not use major and minor natural thirds as tuning means. Using only shortened fifths as the means of tuning for meantone systems may be inadequate. Substantially Vicentino assumes the various thirds as means of expression.

[14] See: S. Tanaka: *Studien int Gebiete der reinen Stimmung* in *Vierteljahrschrift fur Musikwissenschaft* VI, 1890, about the theoretical delimitation of a 'pure' tuning.

[1 s] This is the most general problem of every tuning system, but presumably the timbre of the sound of plucked keyboard instruments emphasized it from the origin of instrumental music. V. Galelei pointed out that the timbre of the sound makes imperfect intervals tolerable, referring to it in the

case of both lute and harpsichord and comparing the qualities of their timbres (in: *Discorso attorno alle opere dello Zarlino* ... p.127) Research on the influence of sound timbres on tuning systems is being carried out.

[16] Vicentino, op.cit., p.143-144.

[17] Comparisons between all these statements of Vicentino's are impossible in this article, although experiments have been tried on the reconstructed Aichicembalo. The level of minuteness which was reached in the music-ological research of the Renaissance period, makes it difficult for us to reconstruct views concerning the Archicembalo, so that it is difficult or even impossible to synthesize them briefly. Thus, in this article Vicentino's 'second' way of tuning (chapter 6) is discussed, referring to the 'first' (chapter 5), but with only desultory references as to Vicentino's more general theory declared in the 1st, 2nd, 3rd and 4th books of his *trattato.* Closer references to Vicentino's abstract theories as well as to his 'first' way of tuning would need more space and would overstep the limits of an article.

[18] **See: P. Righini,** // *pensiero Musicale di Nicola Vicentino e I'archicembalo,* in: *Strumenti* e *Musica,* anno XXVIII, n.ll, pg. 31.

TABLE 1: TUNING OF BOTH KEYBOARDS WITH A BASIC FIFTH OF 699,822 CENTS
(Decimals of cents are used for mathematical purpose only)

Upper Keyboard (the notes are named in accordance with corresponding names of the lower keyboard)	Lower Keyboard	Pitch in Cents
G 6 (g flat)		903,738
D 6 (d flat)		403,560
A 6 (a flat)		1103,382
E 5 (e flat)		603,204
B 5 (b flat		103,026
F 4 (f) (=F3 in 4)		802,848
C 4 (c) (=C3 in 4)		302,670
G 4 (g)		1002,492
D 4 (d)		502,314
A 4 (a)		2,136
E 4 (e)		701,958
B 4 (h)		201,780
	G 3 (g flat)	901,602
	D 3 (d flat)	401,424
	A 3 (a flat)	1101,246
	E 2 (e flat)	601,068
	B 2 (b)	100,890
	F 1 (f)	800,712
	C 1 (c)	300,534
	G 1 (g)	1000,356
	D 1 (d)	500,178
	A 1 (a)	0,000
	E 1 (e)	699,822
	B 1 (h)	199,644
	G 2 (f sharp)	899,466
	D 2 (c sharp)	399,288
	A 2 (g sharp)	1099,110
	E 3 (d sharp)	598,932
	B 3 (a sharp)	98,754
	F 2 in 3 = F 3 (e sharp)	798,576
	C 2 in 3 = C 3 (h sharp)	298,398
G 5 (f sharp)		998,220
D 5 (c sharp)		498,042
A 5 (g sharp)		1197,864
E 6 (d sharp)		697,686
B 6 (a sharp)		197,508

The lowest note of both keyboard was not named by Vicentino (C/E?)

TABLE 2: MEANTONE TUNING FOR BOTH KEYBOARDS (2ND TUNING – chapter 6)
(Decimals of cents are used for mathematical purpose only)

Upper Keyboard (the notes are named in accordance with corresponding names of the lower keyboard)	Lower Keyboard	Pitch in Cents
	A 1 (a)	0,000
A 4 (a)		5,376
	B 3 (a sharp)	76,050
B 6 (a sharp)		81,426
	B 2 (b)	117,105
B 5 (b)		122,481
	B 1 (h)	193,158
B 4 (h)		198,534
	C 2 in 3 = C 3 (h sharp)	269,211
	C 1 (c)	310,263
C 4 (c)		315,639
	D 2 (c sharp)	386,316
D 5 (c sharp)		391,692
	D 3 (d flat)	427,368
D 6 (d flat)		432,744
	D 1 (d)	503,421
D 4 (d)		508,797
	E 3 (d sharp)	579,474
E 6 (d sharp		584,850
	E 2 (e flat)	620,526
E 5 (e flat)		625,902
	E 1 (e)	696,579
E 4 (e)		701,955
	F 2 in 3 = F 3 (e sharp)	772,632
	F 1 (f)	813,684
F 4 (f)		819,060
	G 2 (f sharp)	889,737
G 5 (f sharp)		895,113
	G 3 (g flat)	930,789
G 6 (g flat)		936,165
	G 1 (g)	1006,841
G 4 (g)		1012,217
	A 2 (g sharp)	1082,89
A 5 (g sharp)		1088,27
	A 3 (a flat)	1123,94
A 6 (a flat)		1129,32