THE ENGLISH VIRGINAL

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Declaration

I declare that this thesis is entirely my own work.

Darryl Martin

ABSTRACT

This thesis examines the English virginal – a rectangular plucked keyboard instrument – of which there are twenty-two surviving examples ranging in date from c. 1580 – 1684. It also examines other English plucked keyboard instruments from documentary and iconographical sources where there are no known surviving examples (particularly relevant to the period from 1500 to the late sixteenth century), plus the two surviving harpsichords of the period (by Lodewyk Theewes, dated 1579, and Johannes Hasard, dated 1622), and the early spinets which became increasingly popular following the Restoration, eventually replacing the virginal as the major domestic plucked keyboard instrument by 1688. The research concentrates on the design concepts, construction and decoration of the English virginal, based wherever possible on the evidence from the surviving examples. The thesis also considers the virginals in relation to England as a whole in the period from 1500 – 1688, discusses various performance considerations that are applicable specifically to the English virginal, and examines the reasons why the virginal was replaced by the spinet. A comprehensive Catalogue gives measurements of all the surviving instruments, and each entry has a commentary section in which arguments pertaining to individual instruments or specific related groups of instruments are presented. There are also commentary sections at the end of specific groups of instruments by the same maker or workshop tradition.

A slack strynge in a virgynall soundeth not aright

It dothe abyde no wrastynge it is so louse and light

The sounde borde crasede forsith the instrumente

Throw mysgovernannce to make notis was not his intent

Leckingfield Proverb, c. 1518-23

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For help with illustrations I must firstly offer blanket thanks to the various owners and museums for allowing images of their instruments to have been included. Generally the photographs were taken by the author, but there are several notable exceptions. The photographs of the 1638 TW were taken by Miles Hellon during an examination he made of the instrument. The 1641 GT photographs were mostly taken by Anne Meurant of the Musical Instrument Museum, Brussels. Several photographs of the 1679 CR were taken by Peter Barnes. The photographs of the c. 1675 Stephen Keene spinet have been reproduced by the kind permission of the Royal College of Music, London, and the photographs of the 1687 Charles Haward spinet by the kind

permission of the Musical Instrument Museum, University of Leipzig. Photographs from the Raymond Russell archive, by Andrew Garrett, and by Raymond Parks have also been included in the thesis. All photographs taken by the above-mentioned people are acknowledged in the text.

Any omissions in the above lists are accidental, and I must apologise to anyone whose contribution has not been given the credit it deserves.

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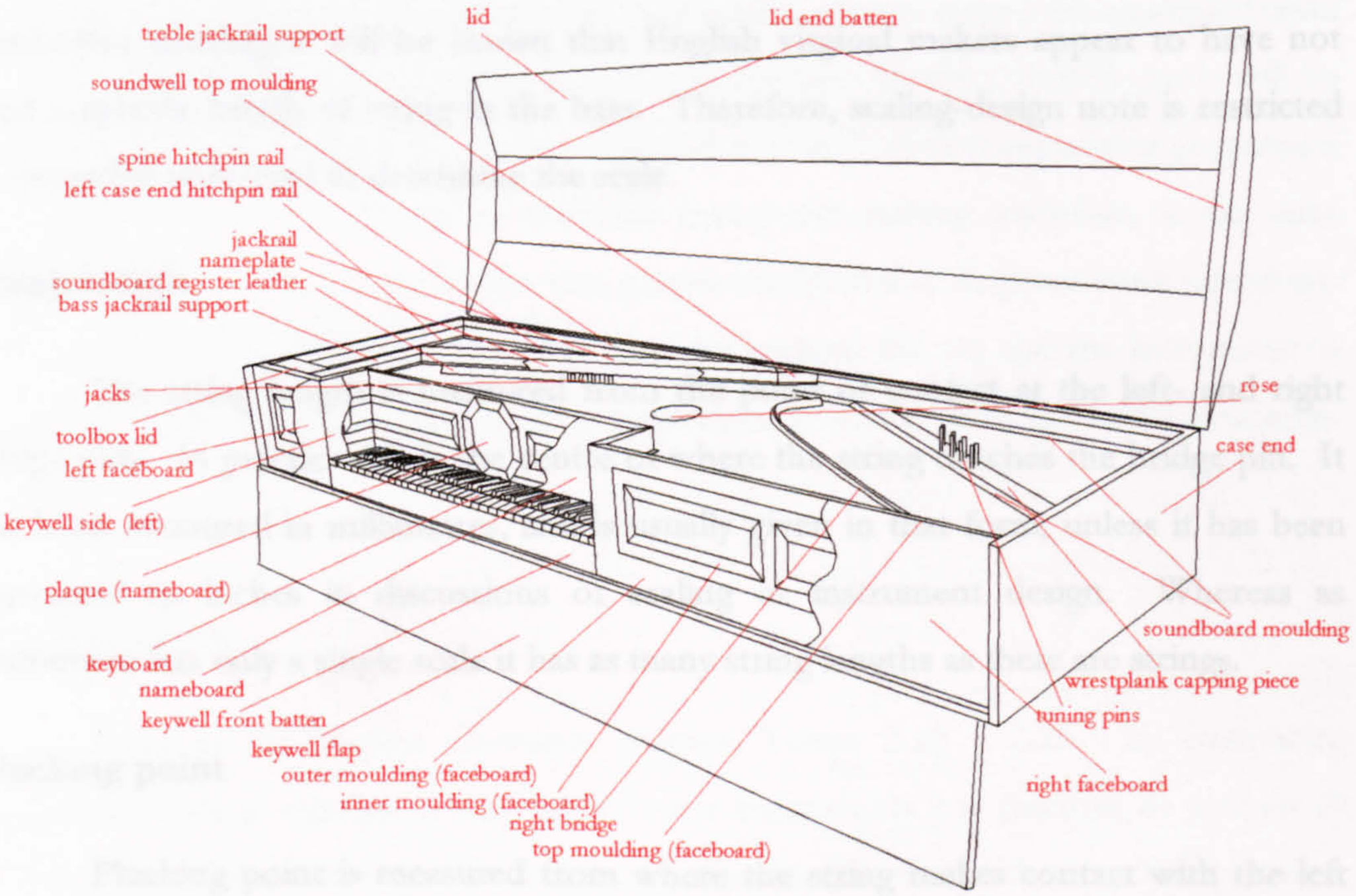
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TERMINOLOGY AND CONVENTIONS

THE PARTS OF AN ENGLISH VIRGINAL



DEFINITION OF SPECIAL TERMS

Scale

Scale is often considered to be synonymous with string length. In this thesis it is, at its simplest, defined as the length of the string which was used as the basis of the design. It is also used in a wider sense to compare instruments with each other, or an individual string in an instrument with a given reference. An instrument which has strings doubling or halving in length each octave in referred to as Pythagorean scaled. In all instruments discussed the scale is not Pythagorean since, mostly due to size constraints, the string lengths get proportionally shorter (the scale reduces) towards the bass. This is referred to as "foreshortening".

Scaling-design note

The scaling-design note is the particular note that the maker used to determine his scale length when designing his instrument. It can be argued that the maker may have had several notes which were used in the design of the instrument (for example a note in the treble to determine the scale, and one in the bass to determine the overall case dimensions). Although this is possible (probable in some schools of keyboard instrument making) it will be shown that English virginal makers appear to have not used a specific length of string in the bass. Therefore, scaling-design note is restricted to the treble note used to determine the scale.

String length

The string length is measured from the point of contact at the left- and right bridge pins. In practice this is the centre of where the string touches the bridge pin. It has been measured in millimetres, and is usually given in that form, unless it has been converted to inches in discussions of scaling or instrument design. Whereas as instrument has only a single scale it has as many string lengths as there are strings.

Plucking point

Plucking point is measured from where the string makes contact with the left bridge to the centre of the plectrum where it is in contact with the string. It should be pointed out that it is not necessarily the side that is closest to a bridge. Some examples may have a plucking point which is more than 50% of the sounding string length.

V

V has been introduced to allow scaling comparisons to be made between different English virginals. An instrument with a scaling at V has a scaling-design note of c^3 6" long or f^3 4½" long. This is used in the manner of a reference, similar to "R" as adopted by O'Brien (1990). As it will be shown that virginal makers built instruments with scalings separated by semitones (rather than at differences of a tone, fourth or fifth). Therefore, virginals have different scalings referred to by adding or subtracting the number of semitones. An instrument seven semitones above V is referred to as "V + 7s", and an instrument 2 semitones below V is referred to as "V – 2s". As it will

shown that scale is directly related to pitch it also allows a direct comparison of pitch levels to be made.

c^2 equivalent

When measuring individual string lengths on an instrument and converting them to a particular scale the length of c^2 has traditionally been used. It is becoming known that in many instruments c^2 was not the actual scaling-design note – for example Italian instruments were often designed using the *f* notes (see Wraight (1997)), an it will be shown that English virginals used (as a rule) either c^3 or f^3. For comparative purposes it is essential to present scalings of different instrument-making traditions at the same note, and c^2 is used in this thesis (for that purpose only) due to its precedence elsewhere. When the likely scaling-design note has been determined for any specific instrument its string length has been converted to its c^2 equivalent, generally without further comment.

12" comparison

Used in the Design Concepts chapter, Tables 2.20 – 2.23. In comparing frequency levels in relation to scale of different instruments it is essential to convert all of the scalings to a single specific length. In this thesis twelve inches has been chosen, as it is twice the length found in instruments with a c^3 scaling-design note at V, and not too far from most quoted scalings which normally use c^2. The inch measurement has been taken from the Yardstick dated 1659 which is considered (see Chapter Two, page 38) to be the most reliable primary source for English length measurement. One inch = 25.378 mm, one foot = 304.536 mm.

CONVENTIONS

Dates

In the period covered by this thesis the year designation changed at Lady Day, rather than our present New Year's Day. So, the year 1660 ran from what we think of as March 25, 1660 – March 24, 1661. In order to avoid confusion for the period

between January 1 and March 24 those dates are written 1660/1, where the first part of the date signifies what it was considered then, with the modern year following.

Names

All names are given as they appear (with the same spelling) in documents of the period. The only exception to this is the first names of English virginal makers who Latinised their names when signing instruments. In these examples they are given in modern English form (eg. James for Iacobus, and John for Iohannes). Rather than use any different spellings that may be found for particular names, those found on instruments is given preference.

Instrument designation shorthand

Throughout the text a shorthand notation has been used to refer to the various English virginals. This method uses the date of the instrument's manufacture, followed (after a space) by the maker's initials. Therefore, the instrument made by James White in 1656 is always referred to as the 1656 JW. Two makers — Thomas Body and Thomas Bolton — share the same initials, the Body virginal dated 1662 (1662 TB), and the Bolton 1684 (1684 TB). The big difference in date makes the risk of confusion minimal. The only exceptions are the two unsigned instruments in Edinburgh. These instruments are referred to as "Mar", denoting the instrument owned by the National Museums of Scotland and housed at the Museum of Scotland, which was believed to have belonged to Lady Marie Stewart, Countess of Mar; and "AH", referring to another instrument belonging to the National Museums of Scotland, now housed at the Russell Collection, Edinburgh, which has the initials AH painted on the lid. When discussing instruments that are not English virginals, the maker's name and the date are usually given in full. If there is any possible confusion the number given in the third edition of Boalch (1995) is used. When referring to instruments made by the Ruckers family in Antwerp the shorthand notation employed by O'Brien (1990) has been adopted, and when discussing Italian instruments the numbering system of Wraight (1997) is used.

Quotations

All quotations are given exactly as they appear in the original text, without any attempt to change spelling or syntax, or note errors found in the quoted passage. Most quotations have been separated from the text are printed in a smaller font size, indented at the left and right sides.

Pitch and note designation

Pitch designation is given in normal type using the Oxford University Press system, as found in Boalch (1995).

CC, FF, C, F, c, f, c^1, f^1, c^2, f^2, c^3, f^3.

In this designation c^1 indicates middle c. The octave change occurs at *b/c*. Unless specifically noted the pitch is that found on the keyboard, not that of any produced sound. When a note is mentioned without concern for which octave (or octaves) the note is given in an *italicised* form.

Short octave instruments are indicated either C/E or GG/BB. As explained in the main reference works a short octave omits various accidentals, so that, for instance, in a C/E short octave instrument the lowest note is an apparent E but produces a C, the F and G play their usual notes, but the $F^{\#}$ and $G^{\#}$ play D and E respectively. The instrument is then chromatic from A. In a GG/BB short octave the apparent BB produces a GG, the C and D play their usual notes, and the $C^{\#}$ produces an AA. On instruments made on the continent the E^{b} usually plays a BB or BB^{b}, but in England the E^{b} usually played its own note. An instrument may be designated as having a broken octave in which one or both of the accidentals is divided into front and back sections, the front playing the note as it appears in the short octave, and the rear playing the accidental note. When notes are missing from the compass a comma is used, eg. FF,GG indicating there is no $FF^{\#}$.

Interval sizes

Interval sizes are sometimes given in cents. One cent is one hundredth of a semitone (or 1/1200 of an octave). Cents have been calculated by taking the logarithm

of a ratio multiplied by 3986.3137. Therefore, instruments with c^3 scalings of 153 mm and 173 mm can be calculated as log (153/173) x 3986.3137 = 213 cents difference. As 100 cents equals a semitone it can be easily seen that the difference between the two scalings amounts to a little bit more than 2 semitones.

Wood identifications

Unless explicitly stated, all wood identifications are by the author and have been made only on the basis of visual examination. The term "deal" has been used for wood that could be pine, fir, larch or wide-grained spruce. In several instances soundboard wood has been identified microscopically. In all other examples the term "conifer" or "conifer wood" is used to identify what could be wood of the *picea*, *abies*, or *pinus* families. The term "fruitwood" appears in addition to the term "pear". It is very possible that the fruitwood in question is, in fact, pear. Often woods are discoloured and/or could only be observed in less-than-ideal conditions with low lighting. Therefore some identifications are less reliable and are followed by a question mark (?) in the case of quite doubtful identifications.

Bibliographic references

The "Author-Date System, Style B", as recommended by *The Chicago Manual of Style* is employed for all bibliographic references. Using this system the Author is named, followed by the date of publication in brackets. If the page number is included as well, a colon and then the page number follow the date. The bibliography lists all of the works mentioned in this thesis according to the Oxford University Press format. Thus, for example, O'Brien (1990:233) refers to page 233 of the book listed in the bibliography as:

O'Brien, G., 1990, *Ruckers: a harpsichord and virginal building tradition* (Cambridge, 1990).

A shorthand notation hereafter refers to two indispensable Reference collections, published in various editions over the years. The various editions of the *Grove's Dictionary of Music and Musicians* are labelled GD*x*, with the most recent editions — *The New Grove Dictionary of Music and Musicians* (edited by Stanley Sadie, published 1980) referred to as GDN, and the second edition (edited by Stanley Sadie, published 2001) referred to as GDN2 — and Donald Boalch's *Makers of the Harpsichord and Clavichord*

1440 - 1840 as B*x*. The particular edition number replaces the *x* in the text, so that, for example Boalch (1995) is commonly written as B3.

Italics

Italics serve several purposes in this thesis. They are used for:-

- Indicating note names where no particular octave need be designated (see above).
- Titles of books or journals.
- Foreign words.
- Words or phrases that require special emphasis in the text.

Font and size

The thesis has been printed using the Garamond typeface with a 12-point font size. Quotations and footnotes are in Garamond 10-point. Occasionally an altered font size is used in tables in order to retain clarity of the table and its information.

LIST OF ABBREVIATIONS

B	back or bottom [measurement] (only used in tables – the context is made clear in the notes at the end of the table)
c.	circa
C	century (eg. C16 for sixteenth century).
diff.	difference [measurement] (only used in tables)
ed.	edition (in Bibliography)
eg.	for example
F	front [measurement] (only used in tables)
Hz	Hertz (preceded by the number and then a space). This may be used in the sense of absolute frequency, or (in relation to pitch) converted to the frequency of the note a^1.

ie.	as in the case of
kg	kilograms
L	left [measurement] (only used in tables)
M	middle [measurement] (only used in tables)
mm	millimetres (preceded by the number of millimetres and then a space)
n.a.	not available / not applicable
n.o.	not original
PC	Private communication
R	right [measurement] (only used in tables)
R/	reprinted (in Bibliography)
s	semitone (preceded immediately by a number)
T	top [measurement] (only used in tables)
V	pitch V (defined on page xiii)
1st	first (preceding ed. in Bibliography)
2nd	second (preceding ed. in Bibliography)
3rd	third (preceding ed. in Bibliography)
’	foot / feet
”	inch / inches
%	percent
@	at
+	plus
-	minus
±	plus or minus

↔ consistent over the span of the piece being measured, used in the Catalogue when only a single measurement is given, to differentiate from single measurements given when only one measurement was possible.

↕ approximately (used in the Catalogue for pieces of wood that vary in thickness for no apparent reason)

‡ estimate (used in the Catalogue for pieces which could not be measured other than by a visual estimation)

INTRODUCTION

In 1965, Frank Hubbard wrote:

> The sudden appearance of the oblong English virginals in the seventeenth century is a little puzzling. Like a marching platoon of soldiers they burst into view in 1641. Seventeen dated examples are found in the thirty-eight years between that date and 1679. There are no stragglers, no prototypes, and few variants. The ranges begin long by Flemish standards (C – e‴) and ended longer (GG/BB – f‴), but this is about the only evidence of evolution to be detected.[1]

Despite being written nearly 40 years ago, this description of English virginals is still the most thorough found in any of the major books on early keyboard instruments,[2] and this opinion, with slight factual corrections,[3] is still held to be correct my most organologists and players.

This present thesis re-evaluates the English virginal from design, construction and decoration viewpoints. The research has been carried out, as far as possible, from the instruments themselves, and has been approached from a position of neutrality rather than with any pre-conceived thesis.

The English virginals form a small but visually distinctive group of instruments. Although the term "virginal" [4] was used generically in England and Scotland in the sixteenth and (most of) the seventeenth century to mean any stringed keyboard instrument which has a plucking mechanism, by the 1690s the modern nomenclature was fully established in England.[5] In this modern form, a virginal can be defined as a plucked keyboard instrument, usually rectangular, in which the strings are parallel, or

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[1] Hubbard (1965:151).

[2] Various recent editions of the New Grove Dictionary of Music have fuller descriptions, but are reference works rather than general books.

[3] The earliest dated example listed in the most recent version of Boalch (1995) is 1638, with a C – c^3 compass. The latest dated instrument is 1684. There are now known to be 20 signed and dated virginals.

[4] With variants in spelling, for example, virginall or virgynall. It is also found with an *s* on the end (virginals, virgynalles), and sometimes referred to as a "pair of virginals", again with various spellings. From the contexts it is clear that all of the above terms can be used to refer to a single instrument.

[5] This distinction has been blurred by modern writers, for example Hodsdon and Clutton (1947). The nomenclature of instruments from different traditions (for example Italy) has further confused the issue in modern times. The nomenclature used in England by the time of Talbot has been re-established in the GDN.

nearly so, to the front of the keyboard, with the bass strings towards the player at the front, and the treble strings at the rear.

Of the other instruments that may have been meant when the generic term was used, a "harpsichord" has strings which are perpendicular to the keyboard, i.e. they run from a solid block of wood just behind (and at a higher level than) the keyboard directly away from the player to be hitched next to the inside edge of the case. A "spinet" has strings which are at an angle, usually about 40°, to the keyboard, with the bass strings towards the rear of the instrument. A final type of instrument is the "clavicytherium", which is an upright harpsichord, usually having the same general soundboard shape as a harpsichord, with the bass strings to the left, but the strings are vertical rather than horizontal.[6]

In this thesis the modern nomenclature is adopted, with the definitions given above when discussing specific types of instrument. The terms "plucked keyboard instrument" and "stringed keyboard instrument" are both cumbersome, and I have therefore resorted to early usage and use the term "virginall" (with the double "l" at the end) to refer to plucked or stringed keyboard instruments.[7]

The thesis concerns the surviving English virginals, of which there are twenty-two examples dating from c. 1580 – 1684. There are two English harpsichords[8] built in the same tradition that have also been included, although various construction techniques specific to the harpsichord have not been discussed.

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[6] There is no evidence that clavicytheria were made in England, although a reference in the inventory of Henry VIII (see page 284) mentions an instrument described as being made "harp fashion" which may be an upright harpsichord. There is nothing to suggest that it was English.

[7] The spelling is close to the modern term, differentiated only by the additional "l" at the end, however, there is no confusion once the system is used in practice and the reader becomes familiar with it. The term virginall should be considered as being synonymous with the term *clavicimbel*, as used by O'Brien in his work on the Ruckers family.

[8] These two instruments are the 1579 Theewes harpsichord, now in the Victoria and Albert Museum, London, and the 1622 Hasard harpsichord at Knole Park, Sevenoaks, Kent. Two other instruments which may be considered as being relevant have not been included. They are the "Jessus Cassus" harpsichord (Collection of Robert Johnson, California) and the 1683 Charles Haward harpsichord at Hovingham Hall, Yorkshire. I have been unable to examine the "Jessus Cassus" instrument personally, but other authors have been sceptical that is was built in England, although it was certainly altered there. The Haward instrument has been designed from the basis of the spinet rather than the virginal, and has not been included here for that reason. A final instrument with a date of 1623, formerly belonging to Michael Thomas and now in the Cobbe Collection, Hatchlands Park, Surrey, has not been included here as it appears to be an early eighteenth-century harpsichord, built in a pseudo-Flemish tradition.

The period of the virginall can loosely be said to span from 1500 – 1688. It is about 1500 that evidence concerning the manufacture and use of the instruments starts to be found in some quantity. Although keyboard instruments were made and used in England before that date, the references are not detailed enough to allow any firm conclusions to be made. The year 1688 is an acceptable termination date for various reasons. In that year William and Mary were invited to become joint rulers on the British throne, thus providing a suitable political reason for ending at that date. Unlike other political changes in England it influenced, to a greater-or-lesser extent, a change in taste that had commenced a decade or so previously. The rectangular virginals became unfashionable and were superseded by the smaller, more elegant bentside spinets with walnut (rather than oak) casework and marquetry decoration in place of paint and gold.[9]

Although virginall makers probably made all types of keyboard instruments,[10] it is only the rectangular virginal that survives in large enough numbers to allow generalisations to be made. The few harpsichords are best discussed on an individual basis, and the early spinets are dealt with by considering the early instruments of the three major makers — Stephen Keene, John Player, and Charles Haward.

The geographic area covered by this thesis is Great Britain. However, although two Scottish virginal makers are listed in the seventeenth century as working in Edinburgh,[11] it is likely that all of the surviving instruments were built in England. With the exception of three virginals – those built by John Loosemore (1655) and Charles Rewallin (1675 and 1679) who both worked in Exeter – all of the instruments with a place of manufucture written on the nameplate on the jackrail were built in London. Three instruments, the 1684 Thomas Bolton and two unsigned instruments[12] give no

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[9] The latest dated virginal is 1684. The earliest dated extant spinet is 1680, although they were certainly being made as early as 1668, when Pepys records seeing (and later buying) one from Charles Haward. An unambiguous earlier reference by Pepys (dated July 1, 1664) also concerns a spinet (and an octave spinet or virginal).

[10] Stephen Keene and John Player have surviving virginals and spinets, and both are known to have made harpsichords. It can similarly be shown that other makers definitely made keyboard instruments other than virginals.

[11] One of these makers, John Davidson, appears to have later moved to Aberdeen. See Farmer (1947).

[12] Referred to in the thesis as AH and Mar. The AH instrument is named because those initials appear in the lid, probably noting the original owner. The Mar instrument is named as a result of its provenance. The AH and Mar virginals share a common workshop tradition and were possibly built by the same maker.

indication about where they were built.[13] One of the unsigned instruments has been in Scotland since the late sixteenth or early seventeenth century, but that does not imply the instrument was Scottish-built.

Previous major studies in keyboard organology have generally been concerned with a single maker or workshop, for example the work on Kirckman,[14] Delin,[15] Ruckers,[16] Blanchet,[17] Dulcken,[18] Cristofori,[19] and Hass.[20] Other major studies exist which concentrate on a particular aspect of keyboard research such as string metallurgy,[21] instrument identification,[22] and Italian stringing practice.[23]

This study is the first to consider a school of instrument building as a whole in a detailed manner.[24] Rather than a single workshop tradition, as dealt with by the authors of the studies on the above-listed instrument makers, the twenty-two extant English virginals represent the work of thirteen or fourteen different builders, representing at least four (and perhaps as many as eight) different workshop traditions.

Although the essential purpose of a musical instrument is as a tool for musicians to play music, and despite the well-known and extremely fine repertoire for the English virginall, this thesis is not concerned with the repertoire at all. Various design or constructional aspects that have a bearing on the performer are discussed, but the compositions and performance-practice are major subjects in their own right.

As the surviving instruments provide the main focus of the study, little attempt has been made to carry out any archival research. Therefore the thesis contains limited

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13 Although the instrument does not have a singed indication of a place of manufacture, the style of workmanship shows that Thomas Bolton was either an apprentice of, or worked as a journeyman with, Stephen Keene in London. Similarly it can be shown that the AH and Mar virginals were also most likely built in London.
14 Mould (1976).
15 Tournay (1980).
16 O'Brien (1983) and O'Brien (1990).
17 Dowd (1984).
18 Tournay (1987).
19 Henkel (1992).
20 Whitehead (1994).
21 Goodway and Odell (1987).
22 Wraight (1992).
23 Wraight (1997).
24 John Koster is writing monographs on the sixteenth-century Neapolitan school and (separately) the sixteenth-century Flemish school. These have not been published at the time of the presentation of this thesis.

new information of a biographical nature, and no new research concerning inventory listings of virginals.

Despite their well-known and characteristic appearance, there have been few previous studies that have concentrated on the English virginal. The following are works, which have sections devoted to either the instruments or music contemporary with the instruments:-

Rimbault (1860), Engel (1874), Brinsmead (1889), Bie (1894), Fuller Maitland & Barclay Squire (1899), Naylor (1905), Galpin (1910), Dale (1913), Hipkins (1929), Glyn (1934), Geiringer (1943), Closson (1947), Farmer (1947), Russell (1959), Gillespie (1965), Hubbard (1965), Kirby (1966), Sumner (1966), Caldwell (1973), Luckett (1973), Hollis (1975), Whitehead (1988), Harley (1994).

Other works dealing specifically with particular surviving instruments are mentioned in the relevant Catalogue entries.

None of the above studies concentrates on the English virginal from a design or construction viewpoint, and the decoration of the instruments is normally described in only the broadest terms. Most of the above-mentioned publications concentrate on the music of the "English virginalist" school, often with short sections discussing the instruments of the period.

The author has previously presented the following studies specifically concerning aspects of the English virginall relevant to this thesis.

"The Spanish Influence on the English Virginal", published in the *Early Keyboard Journal* (Volume 14) 1996.

"Two Elizabethan Virginals?", published in the *Galpin Society Journal*, LIII, 2000.

"The Robert Hatley Virginal and Common Measure", published in the *Early Keyboard Journal* (Volume 18) 2000.

"Addenda to the Article "Two Elizabethan Virginals?"", published in the *Galpin Society Journal*, LIV, 2001.

These studies have all been fully revised since publication for this thesis. New material resulting from these revisions has been presented in this thesis without mention of the prior work. Rather than repeat some arguments presented in detail in the articles, aspects have been footnoted, referring the reader to the original text.

The thesis concentrates on the virginal in all aspects, with the exception of the music that was played upon them. It has been divided into various chapters as follows:

Chapter One provides an historical background to the period of the English virginal. It considers England during the period 1500 – 1688, discussing the political situation, general population and society issues, and the position of the virginall maker in society, including his working conditions and practices. It also provides information concerning English keyboard instruments built prior to the earliest surviving virginalls, and discusses pitch nomenclature as used during the period.

Chapters Two to Four form the main argument of the thesis. Chapter Two discusses the various design concepts concerning English virginals. This includes general virginal layout geometry, and discussions on the English length measurement, design scalings, stringing evidence, pitch groupings and standards, and string gauges and tensions. Chapter Three considers the construction of English virginals. This chapter traces the various construction methods and techniques used in the building of the instruments. The chapter attempts to follow, where they can be determined, the different work processes in the order they were carried out on the instrument. Chapter Four concentrates on the decoration of the instruments. English virginal decoration is very distinctive and, though fairly elaborate, was standardised to a great extent. Although the work was not necessarily carried out by the makers themselves, there must have been a close relationship between the makers and decorators, and sometimes the decorative work can shed further light on the construction practices of the makers.

Chapter Five considers the English virginal as an instrument to be played. Although the surviving music itself is not considered, the effect the instruments had on the performance of the music is examined, highlighting details such as the pitch levels, compass, the keyboard and action, the double stringing in the bass of some instruments, and tuning.

Chapter Six concentrates on the decline of the rectangular virginal. Early spinets of Keene, Haward and Player are examined showing both the characteristics inherited from the virginal and departures to the previous designs. The terminology of the various instruments, which took its modern form at this period, is considered.

Following those chapters a Summary covers each of the chapters in turn, highlighting the major points, and providing an overview of the thesis. Although no new arguments will be presented, the methods used to determine the results will be briefly restated.

A series of Tables is included to allow the reader quick access to many details of the virginals at a glance. These tables contain raw data taken directly from examinations of the instruments and do not include any attempt at analysis or interpretation with the exception of mathematical conversions when required.

Several short Appendices follow, and a bibliography closes the thesis.

The "Catalogue of Instruments" forms a separate volume. This Catalogue provides the raw material from which the thesis has been drawn. It is presented in the form of measurements followed by a short commentary of each instrument. When makers have more than a single surviving example of their work additional "Further Commentary" sections have been included following the individual instrument entries on that maker. For reasons of clarity it has often been essential to present essential arguments of the thesis in the "Catalogue" sections. This argument is contained in the "Commentary" section at the end of each entry, or in the "Further Commentary" sections as mentioned above.

BACKGROUND PERSPECTIVES

ENGLAND 1500 – 1688

The period from 1500 – 1688 covered enormous political and social change in England. Politically, England in 1500 was in the final stages of recovering from the War of the Roses with Henry VII trying to establish a firm Tudor dynasty on the English throne. The civil strife known as the War of the Roses ended at Bosworth Field in 1485 with the defeat and death of Richard III. England's political power system at that time was centred on the Monarch and his personally chosen favourites in much the same way as it had been for centuries previous. The dynasty founded by Henry VII was continued by his son Henry VIII, and then his grandchildren Edward VI, Mary (Tudor) and Elizabeth I, ending with her death in 1603. Elizabeth remained unmarried and childless, and following her death the throne passed to James VI of Scotland, who became James I of England, commencing the Stuart dynasty in England. James was succeeded by his son Charles I, who was beheaded in 1649, concluding the English Civil War. A period of Interregnum, when the country was ruled by Oliver Cromwell as Lord Protector and by Parliament followed, before Charles II (the son of Charles I) was invited back as Monarch. He died in 1685, to be followed by his brother James VII & II, who was forced into exile in 1688, when the throne was offered to William of Orange and his wife Mary in what is known as the "Glorious Revolution".

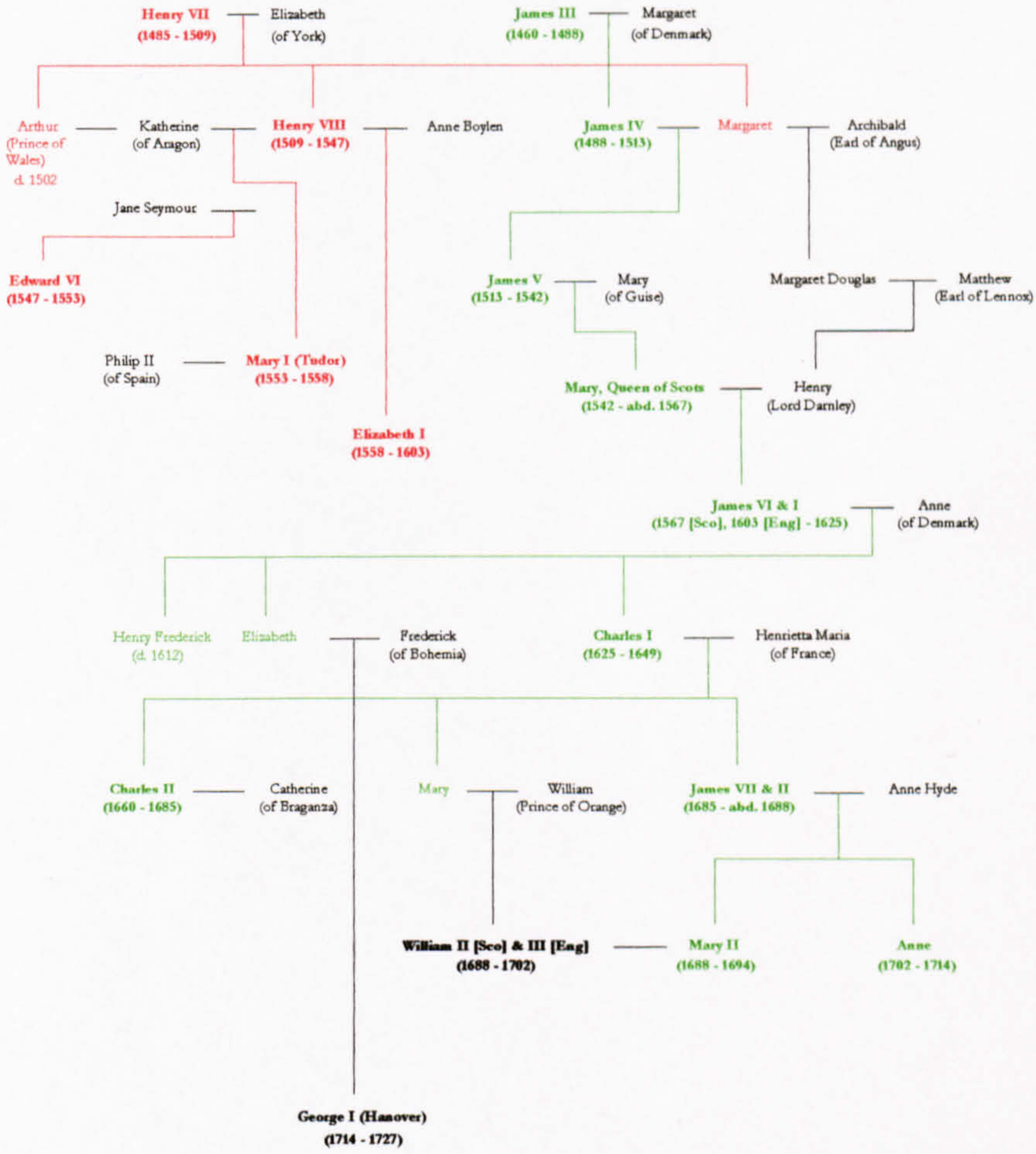
The change of political power from the Monarch to Parliament can be seen to have developed during the seventeenth century, possibly fortuitously (from a Parliamentary perspective) due to the need for increasing amounts of money requested by James I and Charles I.[1] This reversal of power was partially responsible for, and completed as a result of, the English Civil War. Although the Interregnum showed that Parliament ultimately preferred the country to have a Head of State, Parliament had

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[1] Such a situation was less of a problem for the Tudor rulers for various reasons. Elizabeth (who reigned from 1558 to 1603) only had her own Household to finance, rather than several Households as were required for James and his family. The Tudor family directly held property in England which directly raised money for them or (in the first half of the sixteenth century) took control of property by

gained the power to invite Charles II back as King, and later effectively elect the Monarch in extreme circumstances, rather than be fully subservient to the Monarch.[2]

Figure 1.1 – Family tree of the Tudor and Stuart Dynasties.



Notes on the illustration :
Red text indicates members of the Tudor Dynasty, green text indicates members of the Stuart Dynasty. All other individuals have been named in black.
Only directly relevant individuals have been mentioned.
Dates given are those of reigns, or death dates of non-succeeding heirs.
Names in bold indicate ruling Monarchs.

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forfeit which was sold to others. The Stuart dynasty had no significant property that could be converted to cash and thus relied on taxes agreed by Parliament for much of its financial subsistence.

[2] It must be emphasised that this is a simplification. The Monarch still retained much power and in practice still ruled the country. That James II was forced into exile was the result of extreme circumstances and not the result of any simple whim of the parliament. A modern equivalent of the relationship between the Monarch and Parliament in the second half of the seventeenth century can be found in the present United States with the President and Congress.

Despite the political upheavals during the sixteenth and seventeenth centuries, it must be emphasised that most people had uneventful lives. Even the major political events of the sixteenth and seventeenth centuries – the Reformation towards the end of Henry VIII's reign, and the English Civil War – did not have a constant lasting effect on most people.[3] The great majority of individuals who adapted themselves to whatever instructions were commanded generally avoided the religious strife of the mid-sixteenth century. A late sixteenth-century example of this pragmatism is perhaps found in the case of William Byrd – a noted recusant who rose in his profession. The Civil War generally consisted of a series of short local battles or sieges, rather than continuous widespread fighting as found in modern warfare. During the Interregnum and subsequent Restoration most people again followed the given leadership. It is possible that secular music in fact flourished during the Reformation and again during the Civil War – times when religious music, including the use of organs, was at a low point.

Population numbers and demographics during the Tudor and Stuart periods are uncertain, and at best approximations rather than firm facts. Although there are various occurrences, such as muster certificates and subsidy returns in the 1520s, and hearth tax records from 1662, there is no census or other comparable listing to give a wholly accurate detail of population numbers. Despite the uncertainties accepted estimates have been given covering the period from 1450 – 1750.[4] From a high of 6 million people in 1300, English population figures reduced to a low of 1.5 million in 1450.[5] Based on the Muster certificates of 1522 and subsidy returns of 1524 and 1525, the English population has been calculated as about 2.3 million by the mid-1520s, and is believed to have reached 3.02 million in 1541, then 3.16 million in 1556, before dropping back to 2.96 million in 1561. From that time onwards population numbers increased again, to reach 4.11 million in 1600 and then 5.28 million in 1656, before numbers fell back to about 4.87 million in 1684. By 1710 the population reached 5.1 million, and had further increased to 5.5 million in 1730.

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[3] This is not to say that people were not affected by the Civil War, which resulted in the greatest loss of life prior to the World Wars in the twentieth century. Much of the Civil War was a time of stalemate rather than active fighting between opposing forces.

[4] The figures quoted here have been taken from Heard (1992) and Heard (1995).

[5] This reduction is due to harvest failures in the early part of the fourteenth century, the Black Death in 1349, and later similar epidemics. See Heard (1992:6).

Unlike the population of England as a whole, London saw constantly increasing numbers throughout the sixteenth and seventeenth centuries. In 1500 the London population was approximately 50,000, which increased to about 190,000 by 1600, then 575,000 by 1700, and 675,000 in 1750. Although London was by far the biggest urban centre, other towns also showed population increases as people increasingly left the countryside to work in urban areas. The second largest town in England, Norwich, had a population of about 12,000 in 1500, 15,000 in 1600, and 30,000 in 1700. The population in Bristol increased from 12,000 – 21,000 from 1600 – 1700. In terms of percentage of total population, it is believed that in 1600 5.8% of people lived in towns with 10,000 or more inhabitants, and by 1700 this had increased to 13.3%. In 1700 11.5% of England's population lived in London. This increase can be seen in maps of London, where the town was more-or-less contained within the city walls as shown in a map by Braun & Hofenberg in 1572, but had vastly increased in the 1660s by the time of the Great Fire of London.

Plate 1.1 – Section of a map of London by Wenceslaus Hollar, made in 1666 following the Great Fire, with (marked in red) the extents of the city as shown in the 1572 Braun & Hofenberg map.



As the population increased, the demographics within society changed. As early as the 1560s Sir Thomas Smith, writing in *The Commonwealth of England*, divided society into four "sorts", defined as gentlemen, citizens, yeoman artificers and labourers. These groupings were based more on power and influence rather than financial considerations, as merchants, craftsmen and smaller husbandsmen were included in the "labourers" category.[6] Other writers in the sixteenth century used the same groups. These attitudes had changed a century later when Gregory King wrote his *Estimate of the Comparative Strength of Great Britain* (1696). Due to primogeniture the younger sons of the landed elite were forced to the cities to enter trade or the professions. His reclassification considered craftsmen and merchants as part of what has been described (Heard 1995:96) as the "lesser middle orders", what today we might call "lower middle class". King puts numbers on the various social groups, suggesting that 3% of the population were members of the "landed elite", and 7% were of the "pseudo-gentry". These figures have been accepted as reliable by modern historians (Heard 1995:95). In the lesser middle orders King places some 39% of the population.[7] Virginall makers would be considered within this social grouping.

Along with an increase in population numbers in the upper groups (including the lesser middle orders) was an increase in their prosperity and in their leisured time. Thus, compared to the sixteenth- and early-seventeenth century, there was an increase in cultural activities by the Restoration, including the learning of music (as well as other activities). An example - probably not uncommon - of this can be seen in the diaries of Samuel Pepys, who writes on May 1, 1663:

> "...went to hear Mrs. Turner's daughter (at whose house Sir J. Mennes lies) play on the Harpsicon; but; Lord, it was enough to make any man sick to hear her; yet I was forced to commend her highly...Ashwell playing upon the Tryangle[8] very well before I went to bed..."[9]

The position of a virginall maker in society was like that of many allied trades. The rules governing craftsmen (including virginall makers) and their apprentices were

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[6] See Heard (1992:82).

[7] King estimated that the total population was 5 500 520 in 1688. Using the accepted modern figures of approximately 4.91 million people in 1688, King's social-grouping estimates place 147 000 people (including dependents as well as heads-of-household) as members of the landed elite, 344 000 as part of the pseudo gentry, and 1.91 million amongst the lesser middle orders.

[8] This instrument was almost certainly an octave spinet, see page 225.

[9] Robert Latham and William Matthews, and published in Latham, R., and Matthews, W., (eds.)*The Diary of Samuel Pepys*, (London, 1970 - 1983).

set in the Statute of Artificers, passed in 1563. This law was introduced in an attempt to protect the craftsmen from untrained people setting up in business, as well as to curb the urban unemployment and population problems which affected cities such as London. The Statute ensured that all craftsmen had to serve a seven-year apprenticeship, commencing around the age of fourteen. During this time the apprentice lived with his master and was, to all intents and purposes, treated as one of the family. The Statute also insisted that no Freeman could set up his own business before the age of 24.[10] In practice this meant that any Freeman, having just finished his apprenticeship, had to work as a journeyman for three years before he could work under his own name.[11] Once established as a Master in his own right, a virginall maker had the right to employ journeymen and take apprentices himself. Often the only way to have one's own business was to inherit it or else marry a maker's widow, since the finance required was usually prohibitive.[12] Working hours were included in the Statute, ensuring that from the middle of March to the middle of September working hours were from 5am to 8pm, and for the remainder of the year people were expected to work during the daylight hours. There were 2½ hours during the day to be set aside for eating and drinking.[13]

The workshop itself was in one or more rooms in the maker's house. In addition to the maker himself, there could be up to two apprentices and one or more journeyman.[14] There is no evidence concerning the number of instruments produced by any workshop, but assuming a total workforce of four it is reasonable to expect an annual minimum production of perhaps twelve to fifteen instruments a year. The variety of compasses and pitch levels suggests that virginals were generally built on a

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10 See Heard (1992:19). The age limit was introduced to stop apprentices marrying young and setting up their business without sufficient financial security.

11 An example of this can be seen in the case of Philip Jones. Jones was apprenticed to John Haward in July 1658, and became a freeman of the Joiners' Company in August 1667 (the reasons for a nine year apprenticeship are unknown). His surviving virginal is dated 1671, and is clearly related to the instruments of Stephen Keene. Jones must have worked as a journeyman for Keene following his apprenticeship before commencing on his own.

12 The oft-told story of Jacob Kirckman marrying Tabel's widow and thus gaining the business is probably only a colourful version of what was a fairly common occurrence.

13 If this part of the Statute were followed, each person would spend approximately 3100 hours a year working. This compares with a present-day average of 1700 hours a year.

14 Usually the two apprentices overlapped, so that one was halfway through his apprenticeship when the other started. This ensured that there was never a sudden loss of skills due to both apprentices leaving at the same time.

custom basis. A different, more speculative, approach is found with the appearance of the bentside spinet, as shown by the writings of Samuel Pepys:

> 4 April, 1668 — "Up betimes, and by coach towards Whitehall; and took Aldersgate-street in my way and there called upon one Hayward that makes virginalls, and did there like of a little Espinettes, and will have him finish them for me; for I had a mind to a small Harpsicon, but this takes up less room and will do my business as to finding out of Chords - and I am very well pleased that I have found it..."
>
> 10 July, 1668 — "...So home to dinner; thence to Hawards to look upon an Espinettes, and I did come near the buying one, but broke off. I have a mind to have one..."
>
> 13 July, 1668 — "...I to buy my Espinette which I now did agree for; and did at Hawards meet with Mr. Thacker and heard him play on the Harpsicon, so as I never heard man before, I think..."
>
> 15 July, 1668 — "...At noon home to dinner, where is brought home the Espinette I bought the other day of Haward; cost me £5..."

It is clear from this passage that Haward was building at least some of his instruments speculatively. It is impossible to determine if this is because the spinet was not well known and Haward felt it was the only way to sell them, or if this was a more common practice – at least with some makers.[15] It is possible that Pepys actually ordered an instrument in April, and then had a choice of several instruments when they were completed in July, but more likely the spinets were finished before Pepys committed himself to purchase.

EARLY ENGLISH INSTRUMENTS

Although it is often considered that the English virginal developed from the Flemish virginals by members of the Ruckers family[16], it is likely that the native instrument was fully developed by 1570-80. The Mar and AH virginals, the Theewes harpsichord, and a painting of a group of children around a virginal, attributed to the Master of the Countess of Warwick (dated 1560-70)[17] show visual similarities. Therefore it is essential to look earlier to find the origins of the English virginal.

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[15] As will be seen below (Chapter Six), there is more standardization with surviving spinets. This suggests that by the last third of the seventeenth century that makers tended to build instruments according to particular models rather than on a more individual basis.

[16] See O'Brien (1990:206).

[17] The painting is privately owned, and was exhibited at the Grosvenor House Fair, a major antiques fair put on by the British Antique Dealers' Association in London in 1989. It is illustrated in the exhibition

The earliest references to stringed keyboard instruments in England concern the *chekker*, an instrument (or name given to various types of instruments) found as early as the fourteenth century. It is possible that the *chekker* was first developed in England, and the earliest references certainly point to it being an English instrument. The first mention of the instrument appears in 1360:

> *Jehan Perrot qui apporta au Roy 1 instrument appelle leschequier quil avoit fait le Roy dangleterre avoit donne au Roy et li envoioit par le dit Jehan pour don a li fait a la relation M. J. le Royer xx nobles.*[18]
>
> [To] Jehan Perrot who brought to the [French] King 1 instrument called the eschequier, which he had made. The King of England had given [it] to the King and consigned through the named Jehan to give to him paid through the agency of M[onsieur] J. le Royer 20 nobles.[19]

The next reference occurs in a poem by the composer Guillame de Machaut, referring to a reception he organised in 1364 for Peter I, the King of Cyprus:

> *... Cornemuses & Chalemelles,*
> *Muses d'Aussay, riches & belles,*
> *Et les fretiaus, & monocorde,*
> *Qui à tous instrumens s'acorde,*
> *Muse de blé, qu'on prent en terre,*
> *Trepié l'eschequier d'Entleterre ...*[20]

Although it is uncertain exactly what type of keyboard instrument the *chekker* was,[21] it is clear that both clavichords and harpsichords were known in England in the first half of the fifteenth century. There is a carving of an angel playing a clavichord in Saint Mary's Church, Shrewsbury, dated c. 1440, and stained-glass window of angels playing the clavichord in Saint Mary's Church, Warwick. This is known to be the work of John Prudd, dated 1439 – 47. An even earlier illustration, probably of a clavichord with a lid, can be dated as c. 1400, as is found in a Breviary and Antiphonary (Sarum Use) at Ranworth Parish Church, Norfolk. Also by John Prudd in Saint Mary's

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catalogue titled "England at the tyme of the Armada". I would like to thank Maria Boxall for bringing the painting to my attention, showing me the illustration of the painting and giving me the details concerning its authorship. I have been unable to make contact with the owner.

[18] Accounts of King John the Good in England, Paris, Bibliotehèque Nationale, ms, fr. 11205, fol. 915v. See Ripin (1975:15) for a facsimile reproduction of the document.

[19] Translation by this author.

[20] Described in a narrative poem *La Pris d'Alexandrie*, cited in Bowles (1966:153).

[21] The most recent publication concerning the *chekker* is Kinsela (1998). He lists all of the previous research on the instrument including the opinions of previous authors concerning the *chekker's* likely identity.

Church, Warwick, is another stained-glass window showing musician-angels playing an instrument, which is considered to be a harpsichord.[22]

By the reign of Henry VII the clavichord was well established at the English Court, as found in the Court records:

1501/2. (Jan)	To one that sett the Kinge's Clevecordes	xiii s. iv d.
1504. (March)	For a paire of clavycords	xx s.[23]

Other references to the clavichord (often referred to as a monochord) can be found as early as c. 1407, and then throughout the fifteenth and early-sixteenth centuries.[24] The clavichord was still known at the English court as late as 1547, when two references are found in the Inventory taken at the death of Henry VIII.

The virginall was known at the English court as early as 1515, when a letter dated May 3 includes the following passages:

> "... [The King is] an excellent musician [who] plays well upon the harpsichord."
>
> "... After dinner [the Ambassadors] were taken into rooms containing a number of organs, harpsichords [*clavicimbani*], flutes and other musical instruments. ..."[25]

As early as the mid 1520s there are records of payments made to John Heywood as a "player of the virginals", following earlier appearances of him in the court records as a "synger".[26] In April 1530 there is a number of payments made to William Lewes for delivering (and probably making) virginals:

> Itm the 6 daye paied to Willm lewes for 2 payer of virginalles
> in one coffer w[t] 4 stoppes brought to Greenwich, £3;
> And for 2 payre of virginalls in one coffer brought to the More other £3;
> And for a little payer of virginalls brought to the more: 20s.:
> £7. 0s. 0d.[27]

The first item in the above list has been the cause of some controversy, with suggestions that it could refer to a double manual harpsichord[28] or a claviorgan.[29]

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[22] There is no jackrail which makes identification a little uncertain. It is possible the jackrail was simply omitted, that it had an action in which the jacks were attached to the keys, or that it may be a harpsichord-shaped clavichord. A slightly later image – a carved musician-angel playing what is almost certainly a harpsichord – can be found in Manchester Cathedral. See Bowles (1971) for illustrations of all of these instruments.

[23] See Russell (1959:66).

[24] See Boxall (1999:15). It should be pointed out that Boxall is mistaken in considering that the earliest reference to a clavichord (with that name, or a similar spelling) is a payment made at Fountains Abbey in 1547/8, as shown by the references above.

[25] Quoted in Ashbee (1993:46).

[26] See Ashbee & Lasocki (1998:568).

[27] Ashbee (1993:363).

Given the almost identical wording with the item below, it is possible that the coffer (what may be described as an outer case) contained two separate instruments, with a total of four registers. Alternatively, it could be an early "transposing" double-manual harpsichord, with the two keyboards at "quire" and "organ" pitch,[30] and only two sets of strings, similar to the double-manual instruments by the Ruckers family.[31]

It is almost certain that, even in the first half of the sixteenth century, the majority of keyboard instruments found in England were likely to be made by native craftsmen.[32] Foreign instruments were no doubt found as well, with evidence to suggest that examples from Spain, Flanders, Italy and Germany could be found.

It is probable that Spain and Flanders provided the majority of foreign keyboard instruments found in England in the period up to 1560.[33] The connection between England and Spain was particularly strong in the early part of the sixteenth century. This is mostly due to Katherine of Aragon, the youngest child of Ferdinand of Aragon and Isabella of Castile. Katherine was betrothed at a young age to Henry VII's eldest son Arthur, Prince of Wales, and arrived in England with a retinue of over 50, (including her duenna, ladies-in-waiting, priests, chapel musicians and lesser minstrels). The marriage took place in November 1501, soon after her arrival in England, and the couple moved to Ludlow Castle, where Arthur died on April 2, 1502. For political reasons both Henry VII and Katherine's parents were still keen for a match, and plans were soon under way for a marriage between her and Henry VII's surviving son Henry, Duke of York. In the normal course of events the influence of the Spanish musicians would have been limited as the musicians would have either returned to Spain or become assimilated with their English counterparts, and the ladies-in-waiting would have been married. However, during the protracted negotiations (which lasted until after Henry became King in 1509 – a period of seven years) the retinue stayed together, and interacted with the English musicians when the political conditions were

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[28] Russell (1959:67).
[29] Barry (1982).
[30] See below, page 27 for the meaning of these terms.
[31] See O'Brien (1990:42) for an illustration of a Ruckers instrument of this type.
[32] See Koster (1980) who has presented a good argument for the number of English instruments that were likely to have been made during the sixteenth century.
[33] See Martin (1996) for full details of the connection between England and Spain. It is probable that the opinions in that article were expressed too strongly, suggesting Spanish instruments were found to the almost complete exclusion of other types.

favourable.[34] The relations between England and Spain remained particularly strong until the failure of Katherine to produce a male heir resulted in Henry's attempts (and final success) in divorcing her.[35] Although it can be shown that Katherine and her musicians were in a good position to influence English tastes, it does not necessarily follow that the Spanish influenced the types of instruments used in England. The frequent trade between England, Spain and the Low Countries[36] would almost certainly have meant that keyboard instruments from Spain and her Italian towns (including chiefly Naples, which had been under Spanish rule since 1502) would have arrived in England and the Low Countries.

The earliest surviving keyboard instruments that may be compared with descriptions of instruments found in England are those of the "Naples school", comprising perhaps eight to ten extant instruments, including clavichords, harpsichords and virginals. This school of instruments has characteristics described by Koster (1992), Wraight (1992) and Steiner (1994). The most obvious features include maple case sides, dovetailed corners, often a raised baseboard, and distinctive panelled endblocks. The earliest surviving instruments built in Antwerp, virginals by Ioes Karest dated 1548 and 1550, have many similar characteristics including the maple cases and dovetailed corners. Similarities are also found in Flemish paintings, notably a series of about a half-dozen paintings of musicians or girls playing the clavichord dating from c. 1510 – c. 1530, and slightly later paintings including virginals dating from 1548 – 1564.[37] The Inventory taken at the death of Henry VIII,[38] contains descriptions of instruments

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[34] See Mattingly (1990).

[35] Despite the often-bitter situation between herself and Henry, Katherine remained at Court until 1530. It should also be emphasized that the relationship between Henry and Katherine was particularly strong until it became apparent that Katherine could have no more children.

[36] The Low Countries, including Antwerp, were under Spanish control during much of this period. Katherine's father Ferdinand died in 1516, and Maximilian of Austria (who ruled the Low Countries) died in 1519, leaving both crowns to Charles V, the son of Philip ("the Handsome", son of Maximilian and Mary of Burgundy) and Joanna ("the Mad", daughter of Ferdinand and Isabella, Katherine's elder sister).

[37] The clavichord paintings have been discussed in Martin (1998), and illustrations of them can be found in Brauchli (1994) and Brauchli (1998). The paintings of the virginals are discussed and illustrated in Ripin (1977). The possibility that the "maple school" characteristics originated in Flanders has been discussed at length in Martin (1996) and Martin (1998). Briefly, it is possible that this was the case, although on the balance of evidence it is probable that the characteristics were first used in Spain or Naples. It is unlikely that both places developed such similar styles totally independently.

[38] See Appendix One, p. 284.

which may be ascribed a Spanish, Neapolitan or Flemish origin,[39] for example those which probably imply maple as a case wood:

> Item. Another newe paire of double Virgynalles vernisshed yellowe and painted all ouer with redde rabesque work the lid beinge lined with purple serrconet and havinge the Kinges armes painted and guilte in the middes of hit.[40]

In addition to instruments whose description shows similar characteristics to the "Naples school" keyboard instruments, other possibilities in the Inventory that would suggest Spanish influence might include leather-covered surfaces, a common feature of Spanish furniture and decorations of the time.[41] Arabesque decorative work might also imply a Spanish influence, which originated with the Moors.[42]

Other instruments that mention Spain would provide clear evidence of influence. Listed amongst the "Instruments of Soundrie Kinds" is some definite proof of Spanish instruments:

> Item. Foure Gitterons with iiii cases to them : they are caulled Spanishe Vialles

That the instruments are plucked rather than bowed can be determined by their being described as Gitterons (guitars), and the Spanish provenance clearly shows them to be Vihuelas (Viola da mano).[43] Further down in the same list is another possible mention of a vihuela:

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[39] It should be pointed out that the instruments listed in the inventory are those of Henry VIII's household. For inventory purposes Katherine (and Henry's other wives) had her own household, and her belongings were not absorbed into Henry's at her divorce or death.

[40] For the wood to be varnished yellow it would have to be a light colour, and it almost certainly was not cypress since that wood is mentioned by name elsewhere in the Inventory.

[41] A particularly good example of this can be found at Levens Hall, Cumbria, England, where the dining room walls are covered in sixteenth-century Spanish leather, brought to Levens at a later period. An example of leather wall coverings (from the seventeenth century) can also be seen at the Isabella Stewart Gardner Museum, Boston, Mass., described as Spanish (and some Venetian), the leather being tooled, gilded and painted. I would like to thank Melissa Kuronen for giving me the detailed information concerning the Gardner Museum wall coverings.
John Koster (PC, 2003) points out that other countries also made use of leather coverings on surfaces, and therefore it is not necessarily the case that any leather-covered instrument must have been influenced by Spain. This author accepts Koster's point, which corrects the views expressed in Martin (1996).

[42] This decorative work is also found in early Flemish instruments, both on an extant 1550 virginal by Ioes Karest and in paintings of clavichords and virginals. To my knowledge, there is no evidence of Flemish builders covering their instruments with leather.

[43] The vihuela is a Spanish instrument, similarly shaped to a guitar but with six unison-strung courses (pairs of strings) tuned as a lute. The decoration is distinctive, having inlaid ornaments on the soundboard.

> Item. A Gitteron and a Lute beinge in a Case Cheste fashion of Timbre couered with leather.

The direct influence of the Low Countries can be seen with many of the craftsmen working in England during the sixteenth century. Up until 1550 about 80% of England's exports went to Antwerp.[44] By the middle of the sixteenth century several Flemish makers had moved to England. The earliest recorded foreign keyboard instrument maker in England was William Treasourer,[45] who was listed in a certificate dated 1571 as "came into the realme with S[r] John Walloppe about 50 yeares past", and Miguel Marcator, who is first listed in Court records in 1527. Both of these makers were originally German, or possibly from the Low Countries. On the basis of his name, it is possible that Gregory Estamproy was also from the continent.[46] In the second half of the sixteenth century Jaspar Blanckart, Lodewyk Theewes and Paul Defield came from Flanders, all settling in England in the 1560s. Theewes made the earliest extant dated virginall, the harpsichord of 1579. This instrument shows elements that may display his Flemish learning, such as the corner joints that are similar to those found on instruments by the Ruckers family.[47]

John Koster (PC, 2003) mentions that export records in Antwerp (examined by Jeannine Lambrechts-Douillez) include a reference to an instrument by Ioes Karest which was sent to England. Given the amount of trade between England and Antwerp it must be presumed that more Flemish instruments also came to England, either as direct commissions or to be sold speculatively.

Although the overall concept of the English virginal had its origins in the first half of the sixteenth century at the latest, it is probable that this generation of Flemish makers had considerable influence over a number of subtle aspects of virginal design, in particular soundboard barring. An examination of barring found in Flemish virginals of the last third of the sixteenth century shows similarities with the soundbar layout found

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[44] This is perhaps a little misleading of the true trade market. Almost all of the trade with Antwerp was the export of woollen cloth. England traded other commodities with Spain, France, Germany, Ireland, Sweden and the Baltic region. Until the death of Mary Tudor in 1558 the majority of trade (excluding wool) was with Spain and the Habsburg controlled regions (the Low Countries and parts of Germany).
[45] Biographical information about Treasourer and other makers comes from Ashbee & Lasocki (1998) and B3.
[46] See Ashbee & Lasocki (1998) and Appendix Five for details on Estamproy.
[47] See the Catalogue, page 324, for full details of the Theewes instrument.

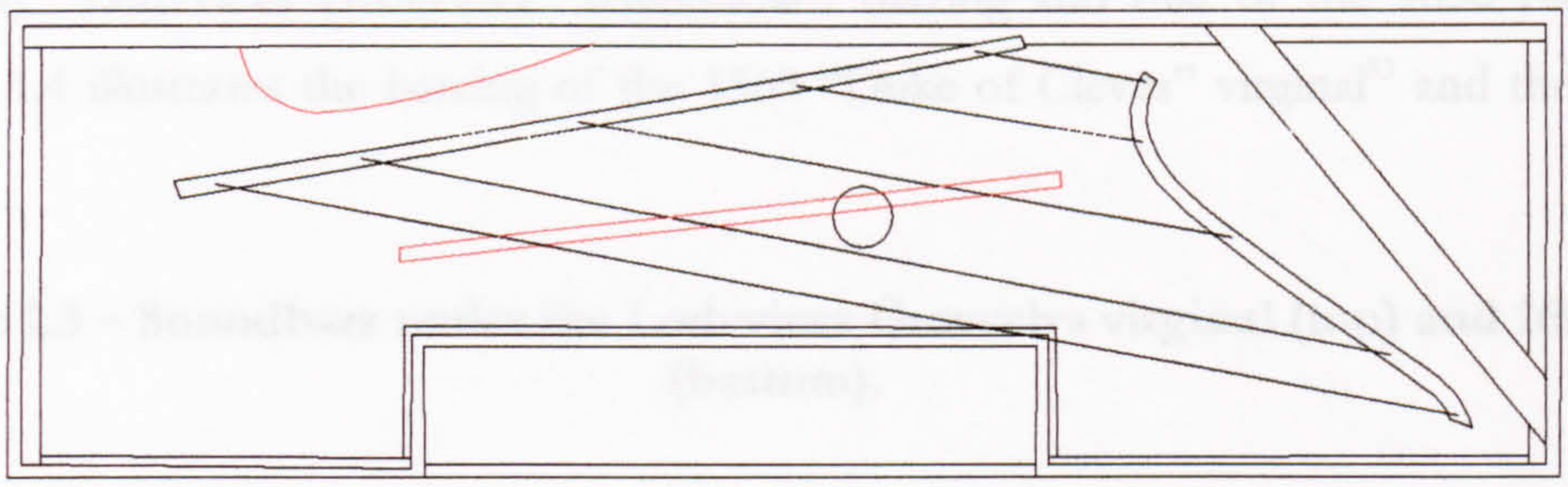
in England.[48] The Johannes Grouwels virginal of c. 1580[49] has essentially the same soundboard barring as found in the contemporary AH instrument. This can be seen below in Figure 1.2, where the soundbars of the Grouwels, AH, and Mar virginals are illustrated.[50]

[48] I would like to thank John Koster for making available to me his drawings of the soundbars found in sixteenth century Flemish virginals.

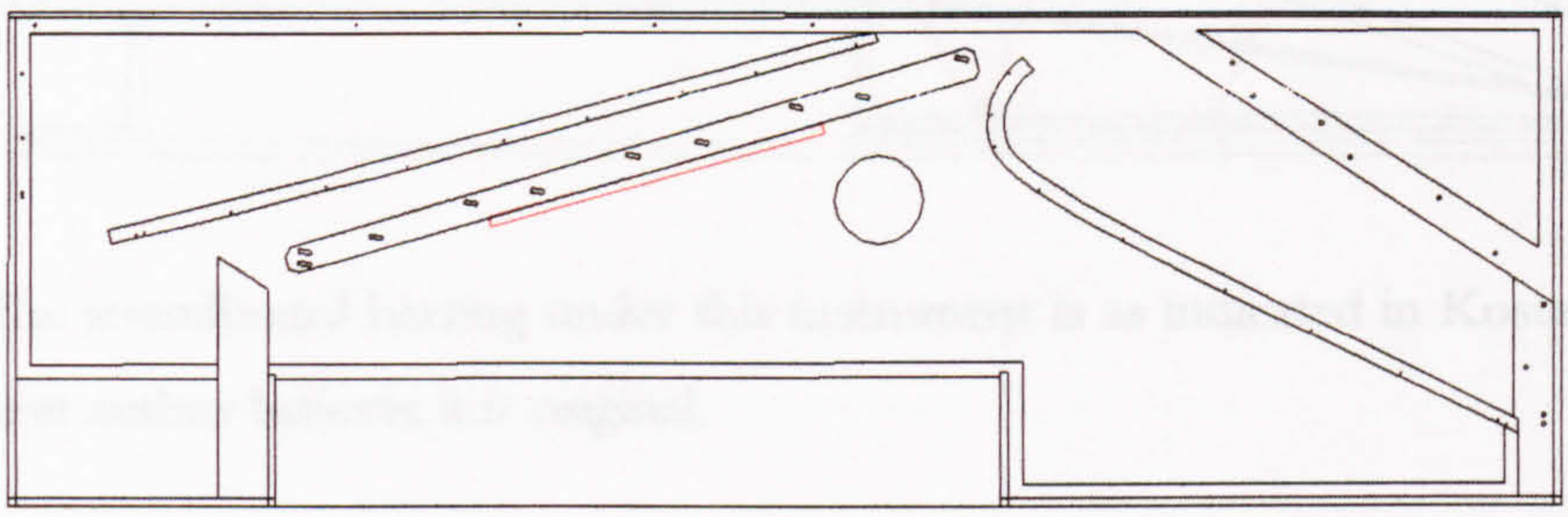
[49] Musical Instrument Museum, Brussels, No. 2929.

[50] The attribution of the AH and Mar virginals to the Theewes workshop tradition (See the Catalogue, page 46) is strengthened by the soundbar similarities. This was not mentioned in Martin (2000/1) or Martin (2001).

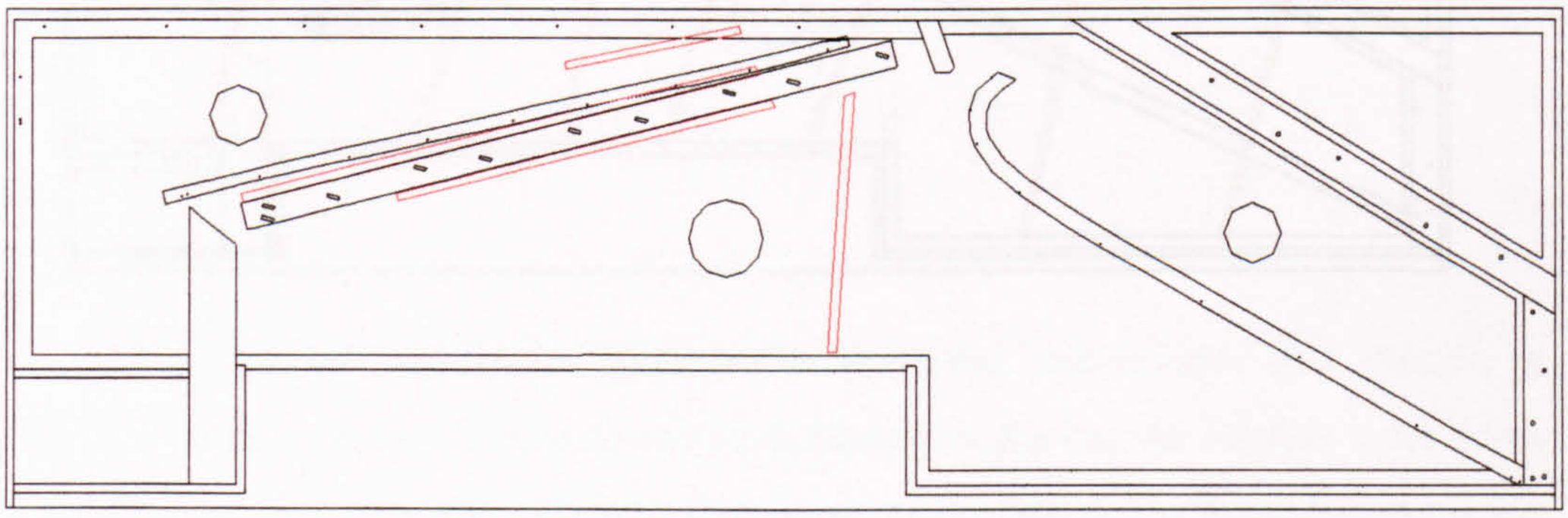
Figure 1.2 – Soundboard barring of the Johannes Grouwels (top), AH (middle), and Mar (bottom) virginals.



There is a full-depth cut-off bar in front of the register. The bar indicated behind the left bridge is only 4 mm thick.



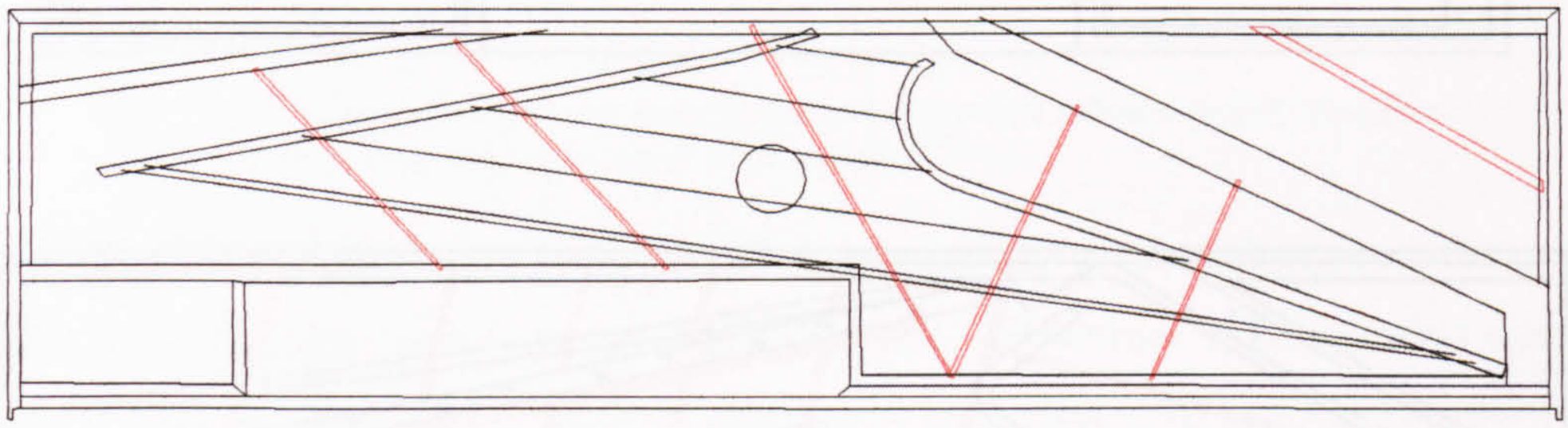
The only soundbar is a full-depth cut-off bar.



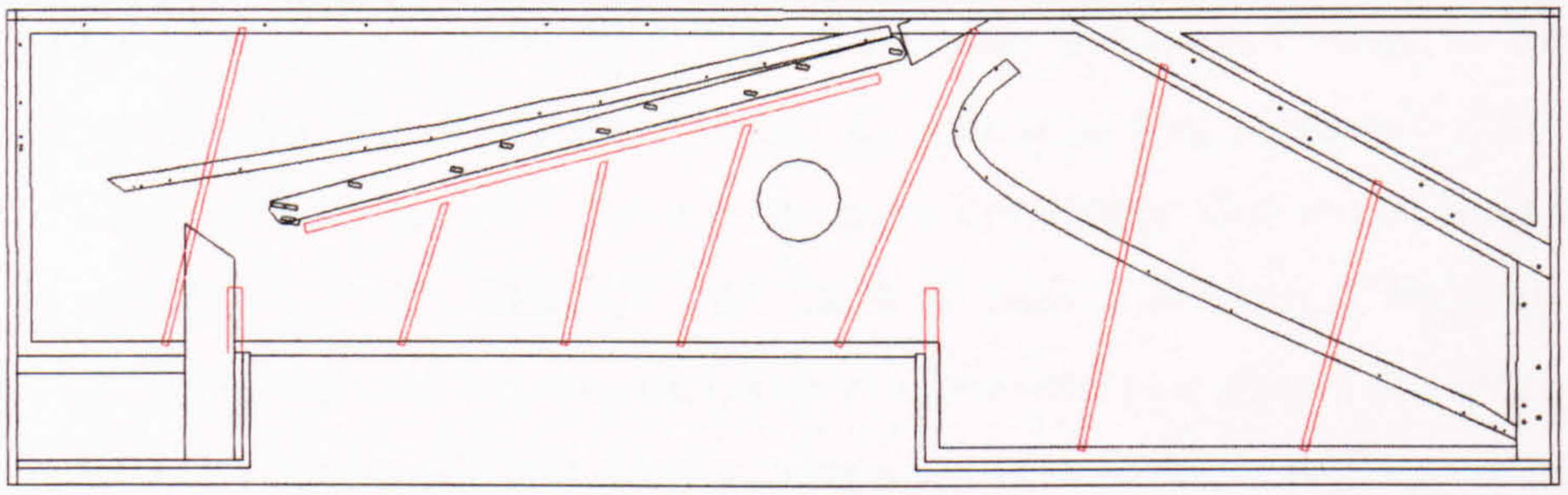
There is a cut-off bar in front of the register. All other soundbars are of typical dimensions.

Two other Flemish instruments can also be shown to have soundboard barring which is similar to that found in later English virginals. Figure 1.3 shows the (probably original)[51] Lodvvicvs Grovvelvs[52] soundboard barring and that of the 1656 JW; and Figure 1.4 illustrates the barring of the 1568 "Duke of Cleves" virginal[53] and the 1666 AL.[54]

Figure 1.3 – Soundbars under the Lodvvicvs Grovvelvs virginal (top) and 1656 JW (bottom).



The soundboard barring under this instrument is as indicated in Koster (1977). The present author believes it is original.



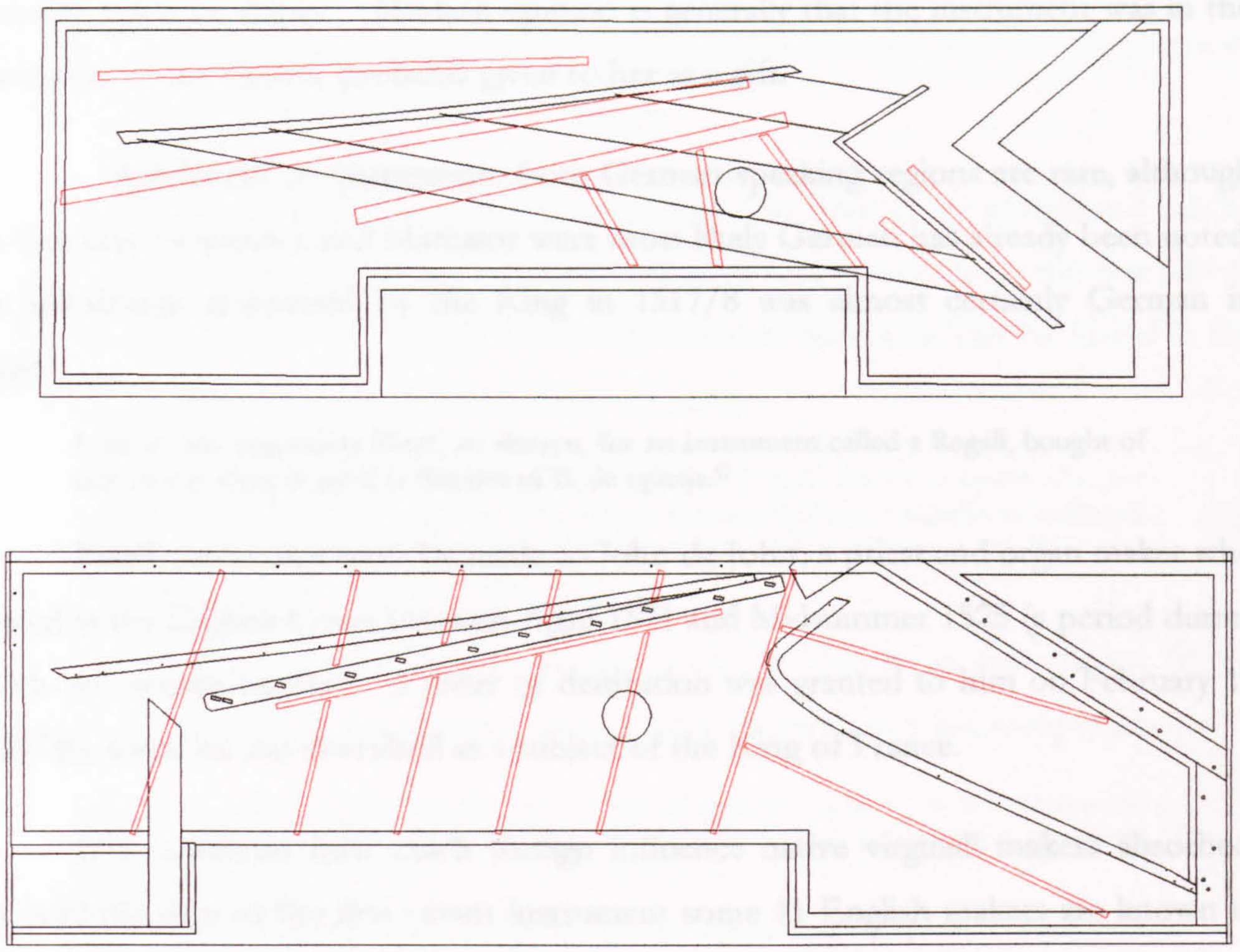
[51] There are several later added soundbars under this instrument (see Koster (1977)), which have not been included in Figure 1.3. There is some debate over whether any of the soundbars are original (see Pollens (1998:167)), however, the method of attaching the soundbars into the liners is found in various English virginals, and I believe it is the original maker's work, or representative of it. The drawing of the soundbars found under the Grovvelvs instrument is based on that shown in Koster.

[52] Metropolitan Museum of Art, New York, No. 89.4.1196.

[53] Victoria and Albert Museum, see Schott (1985), No. 5.

[54] The soundbars found under the right bridges of the 1656 JW and 1666 AL instruments is typical of most of the extant English virginals. See below in Chapter Three, page 118.

Figure 1:4 – Soundbars under the Anonymous "Duke of Cleves" virginal (top) and 1666 AL (bottom).



The influence of Italian, particularly Venetian, instruments and makers is uncertain. Many Italian musicians are listed as having worked at the English court from the first half of the sixteenth century. There are also references to instruments in the Inventory that are possibly of Italian origin:

> Item. A paire of double Virgynalles of Cipres in a case of wainscot.
>
> Item. Twoo faire paire of newe longe Virginalles made harpe fashion of Cipres with keies of Iuorie havinge the Kinges armes crowned and supported by his graces beastes within a gartier guilte standinge ouer the said keies with twoo cases to them couered with blacke leather the inner parts of the liddes to the saide caeses beinge of walnuttre with sondrie antickes of white wood wroughte in the same.

Although neither of those examples can be shown to be definitely Italian,[55] a later instrument, known as "Queen Elizabeth's Virginal" is certainly of Venetian origin, probably made by Baffo.[56] Modern opinion is generally that the instrument was in the possession of the Queen, probably given to her as a gift.

References to instruments from German-speaking regions are rare, although the fact that Treasourer and Marcator were most likely German has already been noted. An instrument, purchased by the King in 1517/8 was almost certainly German in origin:

> Item to one Sygemond Skeyf, an almayn, for an Instrument called a Regall, bought of him by the King & payd to thandes of B. de opicijs.[57]

Finally, reference must be made to John de John, a priest and organ maker who arrived at the English Court between April 1521 and Midsummer 1525 (a period during which no records survive). A letter of denization was granted to him on February 12 1539/40, when he was described as a subject of the King of France.

It is uncertain how much foreign influence native virginall makers absorbed. Up until the date of the first extant instrument some 11 English makers are known to have worked to England.[58] They are J. Ede, T. Browne, W. Lewes, Cowtes, W Betton, W. Buck, R. Gundet, W. Goodman, J. James, E. Schetts and A. Marsam.[59] The wide places of origin of these makers – Browne was from Cambridge, Betton and Buck from Norfolk, Goodman from Chester,[60] and Marsam from Leicester – suggests that instrument making had not become centralised in London, as it was to do later. It is certainly clear that keyboard instrument making was well established in England by the time of the first surviving examples, and that earlier instruments would have been predominantly English in origin.

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[55] O'Brien has shown that instruments made in Naples (and thus considered Spanish) were sometimes made of cypress, and the soundboard of the 1622 Hasard harpsichord is almost certainly cypress. Writing as late as c. 1690, James Talbot mentions in his manuscript (Christ Church, Oxford, Mus. MS 1187, see Martin (1995)) cypress as a possible soundboard material.

[56] Wraight (1997), his number W299. The attribution is discussed in his catalogue section, page 50.

[57] See Ashbee (1993:234). Benedict de Opicijs was a Flemish organist, listed in the English Court records from 1516.

[58] This list does not include others mentioned above who may have also been English.

[59] See B3 and Appendix Five for details of these makers.

[60] See Boston (1954).

PITCH NOMENCLATURE

In Chapter Two the relative pitch standards of the English virginals shall be considered. It is important to understand how virginall makers and the musicians of the period broadly interpreted these pitch levels

The major elements of pitch nomenclature that need to be considered can be seen when examining documents relating to keyboard instruments from the first half of the sixteenth century. An example which illustrate the problems can be found in the "Duddyngton contract" (1519), which reads (in part):

> "...to make an Instrument: that ys to say a payer of Organs for the foreseid Churche of Dowble Cefaut: that ys to say xxvij playne kayes and the pryncipalle to conteyne the length of v foote so following Wythe Bassys called Diapason to the same ẹonteynyng length of x foot or more..."[61]

Another of the nomenclature problems can be seen in an examination of the Inventory of instruments belonging to Henry VIII, including the following examples:[62]

> Item oone pair of single Regalles with 7 half stoppes of pipes, of wodde vernisshed yellowe and painted with blac Rabaske woorke with a fote of waynscott unpainted wherein lyeth the Bellowis.
>
> Item oone Instrument with a doble Regall and a doble Virgenall with 3 stoppes of pipes of wodde painted with grene Rabaske woorke with a fote of waynscott And the Bellowis lying in the same.
>
> Item oone peir of doble Virgenalles coverid with blac Lether ptely Silverid the lyd lined with grene bridges Satten.
>
> Item oone peir of single Virgenalles with pipes underneath in a case of tymber coverid with blac Lether.

The two different sources must be considered together in order to enable of full understanding of the nomenclature issue. The passages from the Inventory mention both single and double instruments – both virginals and regals.[63] Barry (1982) has shown that a "double" instrument went down to "dowble Cefaut" (to quote from the Duddyngton contract), which can be written according to organ builders as CC. Barry also says that a "single" instrument only went down to C. The implications of

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[61] Quoted in Bicknell (1996:28).
[62] There are other instruments listed in between the various entries quoted here, but these have not been included as they replicate the various terminology issues.
[63] The terminology of a regal is not strictly applicable to this thesis but can be briefly considered. An instrument in the Inventory was called a "regal" if it contained a set of regal pipes, regardless of any other registers also available. If the instrument had only flue pipes it was classed as an "organ". In instruments with more than one register – for example, the two quoted instruments – other registers would almost certainly be flue pipes. Other entries in the Inventory make this explicit.

this are important, although Barry (1982:37) is incorrect with his definition as described. It is almost certain that for musical reasons both the "double" and "single" instruments described in the Inventory would have similar compasses, either C-a^2 or C-c^3, using modern terminology.[64] It is therefore wrong to regard to keyboard compass as the element that defined pitch nomenclature. Barry points out that a "double C" refers to an 8' pipe, and a "single C" is a 4' pipe. It is this definition that is used for the pitch nomenclature of the period.[65] This nomenclature had its origins in the writings of Guido d'Arezzo, writing c. 1026 [66], who devised a hexachord system with the notes *ut, re, mi, fa, sol, la,* beginning on any of three notes – *g, c,* or *f,* the lowest possible note being the *gamma ut*, G. Using Guido's nomenclature, as above, the octave designation changes at $f^{\#}/g$, rather than at b/c which is used now. Notes below the *gamma ut*, when they were later introduced were referred to as "double"; hence "dowble Cefaut" means that the note is "double C", *fa* in the hexachord starting on GG, and *ut* in the hexachord starting on CC.[67]

The second important element of the pitch nomenclature that must be considered is how the above nomenclature relates to pitch standards. As has been stated, the terms "single" and "double" do not refer to apparent keyboard compass, but to pitch. The dividing line between "single" and "double" must therefore be determined.

It has been established by Gwynn (1985) and others that English organs pipes were defined as 10 or 5 foot, rather than the 8 or 4 foot terminology used today. That organs were usually "transposing" instruments has also been established.[68] If an organ had its C pipe referred to as either 10 or 5 foot it was at organ pitch, and it was at quire pitch if the F pipe was designated as 5 or 10 foot long. Common quire pitch has been

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64 There are some exceptions to this. The soundboard of the "Wingfield" organ, c. 1525 (rediscovered by Dominic Gwynn in 1995) shows the compass was 41 notes, probably F – a^2.

65 It should be emphasized that present-day organ makers and researchers refer to compass according to this nomenclature, considering each respective octave to commence at CC, C, c^1, c^2, and c^3; rather than C, c, c^1, c^2, c^3, that is used by stringed keyboard instrument researchers.

66 Found in *Micrologus*, written no earlier than 1026 and dedicated to Bishop Theoaldus of Arezzo, and in a letter, the *Epistola se ignoto cante.*

67 This can be confirmed by original sources from throughout the period of this study. Organ contracts from the first half of the sixteenth century make clear this arrangement, as does the organ sections found in the Talbot Manuscript of c. 1700 (Christ Church, Oxford, Mus, MS 1187). Finally, note names on some instruments also provide evidence to support this.

68 See Gwynn (1985), and Bicknell (1985).

established (see Gwynn (1985)) at approximately 474 Hz, so organ pitch is therefore a fourth higher – approximately 633 Hz.

Figure 1.5 – Transcription (bars 1 – 6) of "How Long Shall Mine Enemies" by William Byrd. SAATB and organ. The transcription uses the original clefs. Vocal Parts from Christ Church Library, Oxford (MSS 984 – 988); dated 1581 – 1588, organ part from Durham Cathedral Library (MS A1), dated c. 1635. This is the earliest surviving organ part (of three known examples) for this piece.



The frequency of the note F, assuming quire pitch at a level of 474 Hz is 94.1 Hz. A 5 foot pipe at organ pitch can also be calculated as c. 94 Hz, assuming the same quire pitch standard. Therefore the 5 foot register should be considered the unison register on an instrument at organ pitch. The 10 foot register should be considered as a sub-bass stop, in the same sense as the 16 foot stop is used today.[69] As the 5 foot C register (at "organ" pitch) is considered the principal or unison, the pitch produced by the lowest note must be the level defined by the term double C. The note produced – when referred to in the quire pitch system is F, below the *gamut* G. It is therefore most likely that quire pitch was the level used to define the octave nomenclature.[70]

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[69] See Bicknell (1996:79) who comes to the same conclusion, albeit by different methods.
[70] An instrument pitched a tone higher, so that the lowest pipe was G (in the quire pitch system) would be considered a "single" organ, as the lowest note is contained within the Guidonion hexachord system.

DESIGN CONCEPTS

Design concepts may be defined as pre-determined parameters that are incorporated into the design of an instrument in order to achieve a specific desired result. When discussing the design concepts used by a maker, it is important to ascertain what parts of the instrument the maker specifically used as part of his design, rather than the result of his construction process.

This chapter is divided into various sections as follows:-

- Virginal layout geometry, which considers the effect that the various parameters have on each other, and the result of altering specific features such as the plucking points.

- The English inch, discussing various methods to determine its length and its importance to the work of the virginal makers.

- The determination of design scalings, considering how the makers decided the string lengths of their instruments.

- The stringing of English virginals, presenting and evaluating all of the evidence of the strings that were used on English virginals.

- The determination of pitch groupings, in which the scales of the surviving English virginals will be examined as a group, and the resulting differences used as a basis for defining the different pitch levels found in English virginals.

- Historical pitch evidence, examining the relationship between string length, material and pitch of early keyboard instruments as a whole and then relating them to English virginals in particular

- String details and tensions, where the evidence of original English virginal stringing is combined with the determined pitch levels.

A maker must consider all of the above-mentioned details before commencing work on an instrument to ensure that his intentions can be realised as the work progresses.

VIRGINAL GEOMETRY

The string lengths, materials and plucking points may be considered to be the central design features that a maker must manipulate to obtain a desired pitch and tone. Historically the common stringing materials in the treble section of plucked keyboard instruments are iron or brass.[1] Physically, a brass string will break at a lower pitch than an iron string of the same length and diameter. This difference is generally in the region of three to five semitones. The factors which virginal makers used to determine the string lengths for a particular pitch level are discussed below. Geometrically, there are no particular difficulties using either brass or iron, unless a particularly high octave pitch is desired. A string must pass over the left and right bridges with enough space in between for the jacks, and there must be enough free soundboard wood around at least one of the bridges to vibrate and to ensure an acceptable sound. This places a practical limit on how short a string can be in the treble. The bass strings cannot proportionally exceed those of the treble without causing the overall pitch to be lowered, and are almost always foreshortened. The amount of foreshortening is, ultimately, a personal choice of the maker. He must make a compromise between having strings which are long enough to produce a sound that is considered adequate without making the physical size of the instrument unacceptably large. In a very high pitched instrument (for example, the (c. 1610)a AR virginal at a pitch of R + 9) it may be necessary to reduce the width between the jack slots to obtain short enough bass strings.[2]

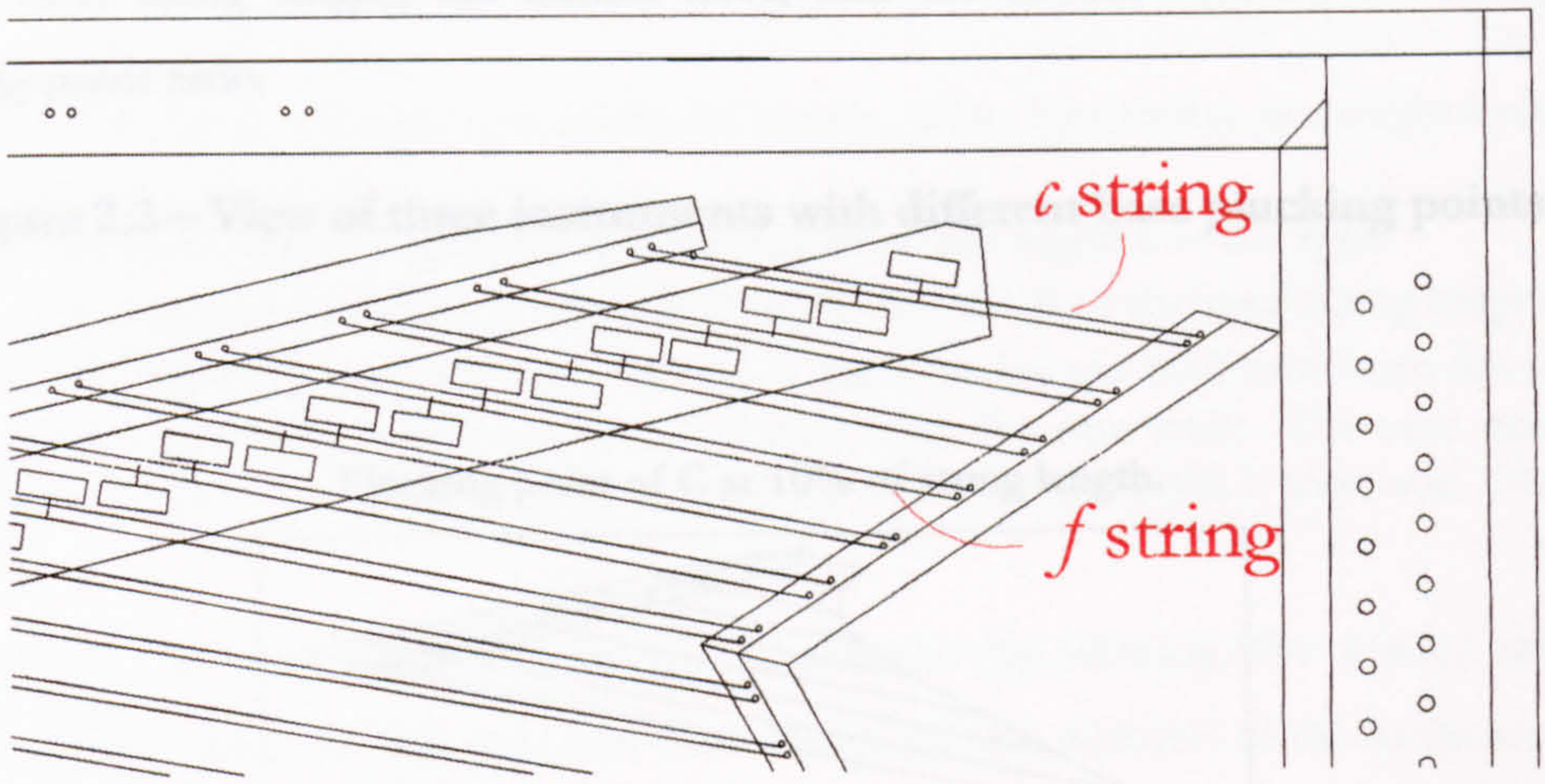
English virginals, like almost all other virginals and spinets, have the jacks placed in pairs between the strings, requiring the strings to be moved apart to give enough room for the jack and quill (see Figure 2.1). Therefore all of the strings on the player's side of their respective jacks are slightly longer, and the strings behind their jacks slightly shorter, than their theoretical lengths were they to be spaced evenly along the bridges.

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[1] This has been discussed at length in various reference books, for example Russell (1959) and Hubbard (1965). More recently specific research has been carried out on individual schools of instrument making (for example O'Brien (1990) and Wraight (1997)) in which the use of different string materials are examined with reference to specific makers. Although gut-strung harpsichords are mentioned in historical documents, and there are occasional references to other string materials (for example silver), the vast majority of surviving instruments were designed to be strung with either iron or brass treble strings

[2] O'Brien (1990:288).

Figure 2.1 - View of the treble section of the 1638 TW, showing the strings grouped into pairs and separated by jacks.



Once the basic string lengths have been decided there are a number of separate features that must be considered in order to design the instrument around these lengths. The plucking points, the angle of the strings to the spine, and the free space around the bridges are all important considerations which are part of the design of the instrument; the first two having geometric implications.

Although it is possible to design and construct an instrument with strings parallel to the front of the keyboard (as found, for example, in Italian virginals by Antegnati and Rossi),[3] the great majority of virginals have their strings at an angle to the keyboard. The advantages of this angling are that the keylengths and balance points can be longer in the bass allowing a more consistent balance ratio and even touch,[4] and that the strings can be longer within a case of the same dimensions, improving the sound of the bass register. Typically, English virginal strings are at an angle of between 10° and 15° to the spine.

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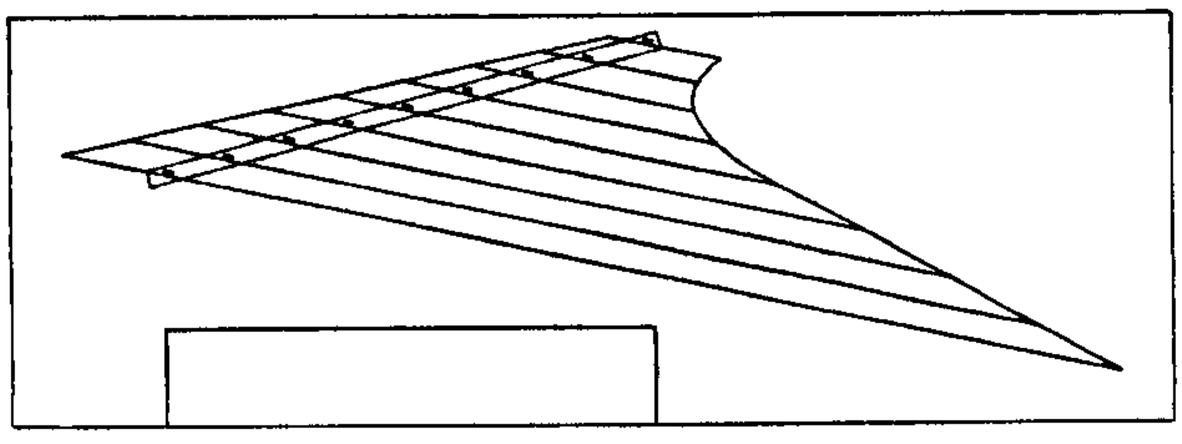
[3] Illustrations of instruments by both makers can be found in Schott (1985).

[4] Consistent balance ratios are not necessarily indicative of an even touch. The distance between the front of the key (strictly speaking – where the key is pressed by the player's finger) and the balance point is of greater importance. The closer the balance point is to the front of the key the harder it is to control.

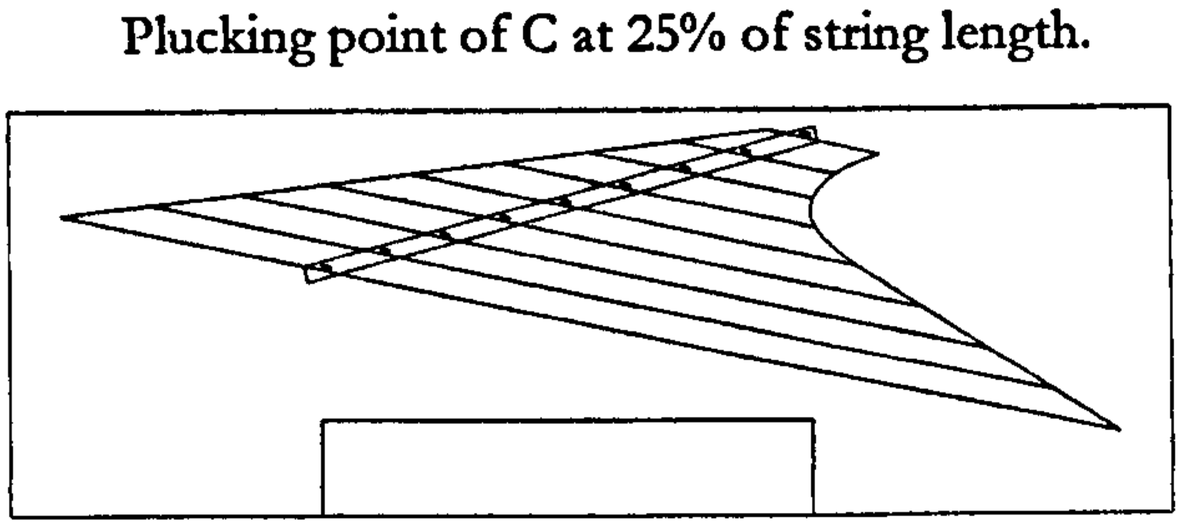
The effect that different plucking points can have on the overall design can be seen in Figure 2.2. The highest diagram has the bottom-string's plucking point at 10% of the total string length, the middle 25%, and the lowest illustration has a 40% plucking-point ratio.

Figure 2.2 – View of three instruments with different bass plucking points.

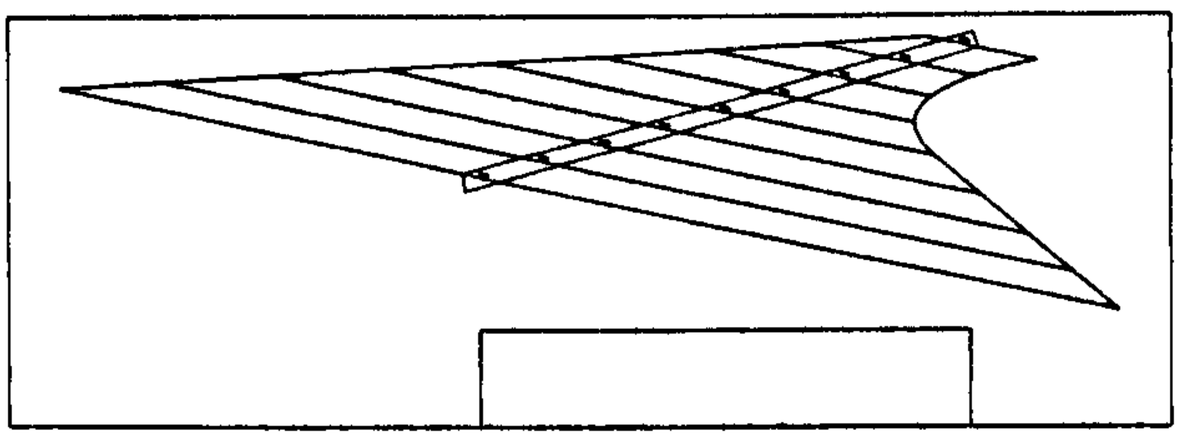
Plucking point of C at 10% of string length.



Plucking point of C at 25% of string length.



Plucking point of C at 40% of string length.



The following features have been used as standard in all three illustrations :—

- A compass of C - c^3 has been used. The drawn strings represent those of the *c* and *f*# notes. The *f*#strings have been used so that every third "long string" is illustrated.

- The string lengths are Pythagorean between c^1 and c^3. The following string lengths were used – C 1440 mm, c 1020 mm, c^1 600 mm, c^2 300 mm, c^3 150 mm.
- The strings are parallel and equidistant to each other, at an angle of 12° to the front of the keyboard. The perpendicular string-to-string distance between two strings an octave apart is 76.3 mm.
- The left bridge is straight throughout its length. The right bridge is straight between C and c^1.
- The horizontal (left-to-right) three-octave span of the register is 480 mm.
- The plucking point of the top string is 50 mm, one-third of the total string length.
- The c^3 left bridge pin is 28.8 mm, and the c^3 right bridge pin 60.0 mm from the spine. The C left- and right bridge pins are 70.0 mm from the case ends. The case sizes are identical, 1548.5 x 551.3 mm. The keywell space is identical, 651.7 wide and 130 mm deep.

None of the above constraints is affected by altering the lowest string's plucking-point position. The features that change are the position of the keyboard, the plucking points of all but the top string, and the bridge positions.

The following table gives the relative plucking points (expressed as a percentage of total string length) in each example.

Table 2.1 – Plucking point percentages for instruments having different plucking points for C.

Note	String length	C at 10%	C at 25%	C at 40%
c^3	150 mm	33.3	33.3	33.3
$f^{\#2}$	212 mm	29.1	41.9	54.6
c^2	300 mm	24.5	42.5	60.5
$f^{\#1}$	424 mm	20.1	39.2	58.3
c^1	600 mm	16.2	34.2	52.2
$f^{\#}$	810 mm	13.4	30.1	46.8
c	1020 mm	11.8	27.7	43.6
$F^{\#}$	1230 mm	10.8	26.1	41.5
C	1440 mm	10.0	25.0	40.0

If the maker wishes to alter the plucking points in the middle of the compass he could curve the left bridge. This would cause the strings to change in length (curving the left bridge so that the plucking points are reduced will result in a shorter string length). Should he wish to retain Pythagorean scalings, the shape of the right bridge would also need to be altered. If a maker wishes to alter the plucking ratios and string lengths and not use Pythagorean scaling, he can alter the shape of either or both of the

bridges. In such a manner a maker can control all aspects of string length and plucking points within practical limits.

As can be observed in Figure 2.2, changing the position of the bridges results in all of the bridge pins (with the exception of c^3, which was defined as part of the original design) being closer to the spine as the bass plucking point increases. The following tables give the distance of each *c* perpendicular to the spine, and the difference between that *c* and the *c* above it.

Table 2.2 - Instrument with 10% lowest plucking point

Note	left distance	difference	right distance	difference
c^3	28.8	—	60.0	—
c^2	67.9	39.1	130.3	70.3
c^1	107.0	39.1	231.8	101.5
c	146.1	39.1	358.2	126.4
C	185.2	39.1	484.6	126.4

Table 2.3 - Instrument with 25% lowest plucking point

Note	left distance	difference	right distance	difference
c^3	28.8	—	60.0	—
c^2	56.7	27.9	119.0	59.0
c^1	84.6	27.9	209.3	90.3
c	112.4	27.8[5]	323.6	114.3
C	140.3	27.9	437.9	114.3

Table 2.4 - Instrument with 40% lowest plucking point

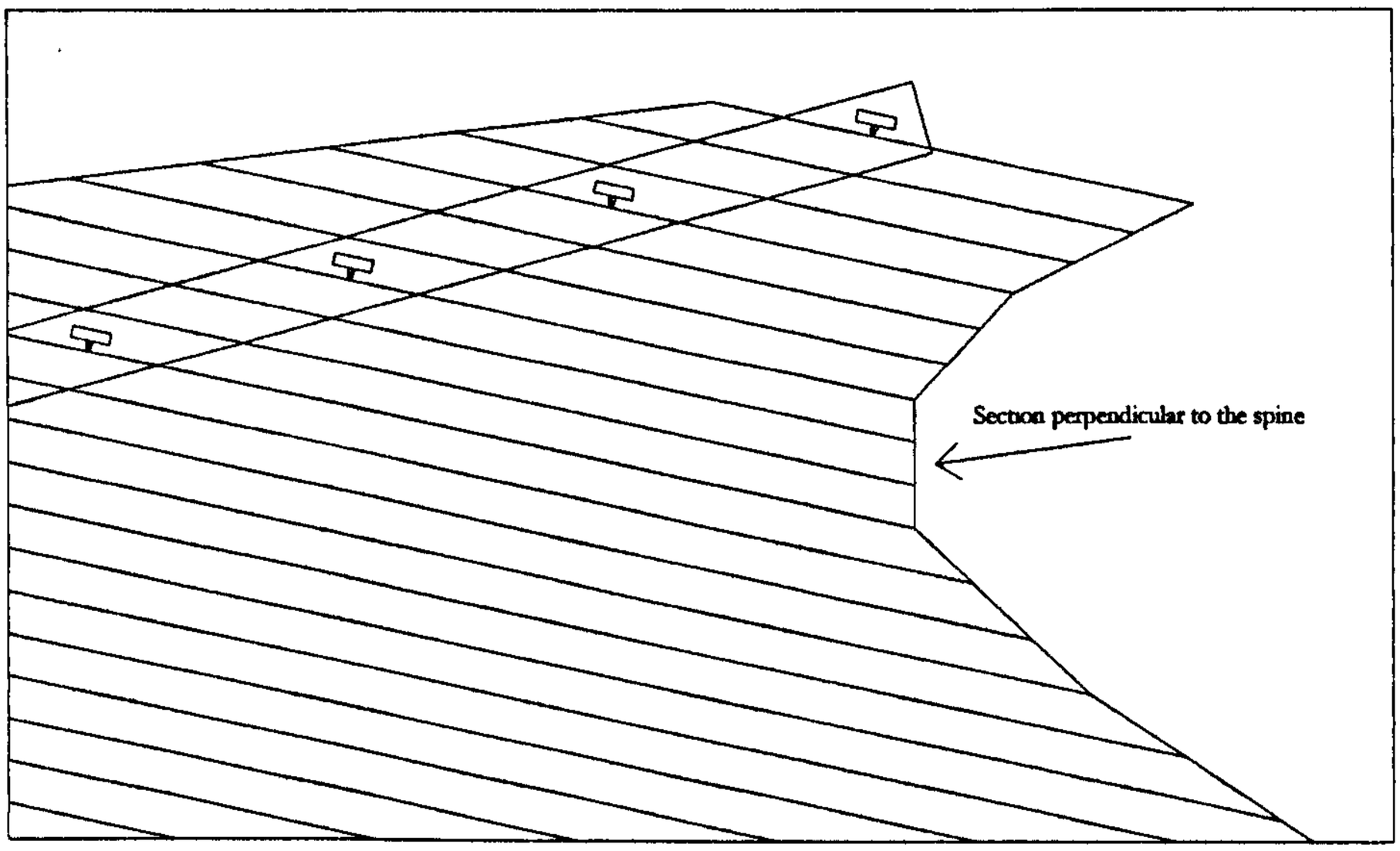
Note	left distance	difference	right distance	difference
c^3	28.8	—	60.0	—
c^2	45.5	16.7	107.8	47.8
c^1	62.1	16.6	186.9	79.1
c	78.8	16.7	290.8	103.9
C	95.4	16.6	394.8	104.0

[5] These differences are all the same in practice. Quoted figures which are 0.1 mm different (in Tables 2.3 and 2.4) are a result of quoting to only one decimal place.

As will be shown below (Chapter Three), English virginal makers used a marking-out stick held against a virtual spine to obtain the position of the right bridge pins. As can be clearly seen in the above tables, the spacing of the bridge pins in relation to the spine is not entirely consistent. On the left bridges, which are straight throughout their lengths, the difference between the various octaves is the same, and this also occurs in the straight section of the right bridges (between notes C and c^1). The treble curved section of the right bridges, however, produces measurements which are dependent on the shape and curvature of this bridge.

One of the original design constraints in Figure 2.2 is that the strings are parallel to each other and evenly spaced. Therefore it is not correct that the smaller differences measured in the treble section of the right bridges indicate the strings are closer to one-another, but in fact that the measurements are determined by the angle of the bridge to the spine. This can be shown more clearly by an examination of Figure 2.3 and Table 2.5.

Figure 2.3 – Enlarged view of Figure 2.2 with straight segments for the right bridge.



In this illustration every second "long" string has been illustrated, with the right bridge divided into straight sections at each *c* and *f*#. The section between $f^{\#1}$ and c^2 is

perpendicular to the spine. Table 2.5 shows the distance of the bridge pins to the spine, and the difference between adjacent bridge pins.

Table 2.5 – Distance of the right bridge pins to the spine, and the distance between adjacent bridge pins.

Note	Distance	Difference	Note	Distance	Difference
c^3	60.00	—			
b^{b2}	69.11	9.11	b^{b1}	132.90	13.00
$g^{\#2}$	78.22	9.11	$g^{\#1}$	145.90	13.00
$f^{\#2}$	87.33	9.11	$f^{\#1}$	158.90	13.00
e^2	98.19	10.86	e^1	175.70	16.80
d^2	109.04	10.85[6]	d^1	192.51	16.81
c^2	119.90	10.86	c^1	209.32	16.81

It can be seen that if the bridge pins are to the right of their neighbour, sloping from bottom-left to top-right (as occurs between c^2 and c^3), then the more acute an angle between the bridge and the spine is, the closer the spacing must be between any graduations on a marking-out stick. If the bridge pins are placed to the right of their neighbour, sloping from top-left to bottom-right, (as between c^1 and $f^{\#1}$), the graduations are further apart when the angle of the bridge to the spine is more acute.

In all of the above, it has been assumed that the strings are parallel to each other. In surviving English virginals, however, the angle of the strings to the spine is not constant. This has implications for understanding how the instrument was marked out which shall be discussed below in Chapter Three.

THE ENGLISH INCH

A number of recent organological publications[7] have shown that many instrument makers used their local unit of measurement when designing and constructing their instruments.[8] In order to attempt to see if this was done in English virginals it is necessary to determine the size of the English foot and inch as accurately

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[6] In practice these measurements are the same, the quoted figures representing an accuracy of only two decimal places.

[7] For example Henkel (1981), (1990), and (1994); Heyde (1986); O'Brien (1990), (1997), (1999), and (2000); and Steiner (1994).

[8] There are dangers in this type of research which have been well described by Wraight (1992).

as possible. There are a number of different methods that can be used to determine the English foot and inch – each approach having advantages and drawbacks.

A first method is to look at primary sources. In the case of the English inch there was an Act of Parliament in 1558 which defined the "Queen Elizabeth Yard". This Act remained in force until 1824, therefore covering the period of the surviving English virginalls. There are also surviving length-standard rulers from the period which can be examined and measured. Second, written documentary evidence can be used. Usually this takes the form of tables comparing the length measurements of various European cities. Finally, the surviving instruments can be measured and these figures analysed to attempt to determine the sizes of the inch and foot used by the maker.

The "Queen Elizabeth Yard" replaced the measure introduced by Henry VII in 1497. The original 1497 Standard Yard ruler that defined this earlier length was made of bronze, and is now in the Science Museum, London.[9] It was an outside measure (meaning that the correct length is defined as the longest distance from end to end), and has been measured at 0.037 (modern) inches shorter than the Imperial Standard Yard.[10] One foot is therefore equal to 304.49 mm.[11] The official 1558 Yardstick that was used to determine the Queen Elizabeth Yard is also in the collection of the Science Museum.[12] This ruler is of brass, and has been measured as 0.01 modern inches shorter that the Imperial Standard Yard – one foot therefore equal to 304.71 mm. The yardstick is badly bent, and has at some stage been broken and repaired; therefore the present measurement is unlikely to represent the original figure accurately.

Another official Yardstick representing the Queen Elizabeth Yard (originally housed at the Tower of London) survives, also at the Science Museum.[13] This yardstick was made and inscribed in 1659. It is of brass, and measures 35.972 modern Imperial

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[9] Accession number 1931-984.

[10] The modern Imperial Standard Yard is 914.4 mm, based on one inch = 25.40 mm exactly. The measurements of all the rules have been taken by the Science Museum and quoted in the form given in the text. The lengths are mentioned on the display captions with the rulers, and are also quoted in Skinner (1967). I would like to thank the museum staff for confirming these measurements.

[11] Strictly, the measurement cannot be given with the accuracy I have quoted. I shall give the measurements to two decimal places with an understanding that they are no more accurate than ±0.013 mm.

[12] Accession number 1931-985.

[13] Accession number 1932-313.

Standard Inches, one foot is therefore equal to 304.56 mm. Given the damage to the 1558 Yardstick, this stick is probably the best primary source for evidence of the official length standard in use from 1558 to 1824.[14]

The earliest evidence from a written documentary source that I am aware of is the *Lexicon Technicum*, compiled by John Harris and printed in London in 1704. In his entry on *Measures*, he compares a list of foreign foot-lengths with that of England. Unfortunately, his methodology is not explained, although it is clear the measurements come from a number of sources. The lengths used in different geographical areas and cities have been quoted in two forms, the first in proportion to one English foot divided into 1000 parts, and the second compared to one English foot expressed in feet, inches, and tenths of inches. The first measurement is the more mathematically accurate. In practice, the rulers used (assuming they were specially made for the purpose) could be divided into no more than 500 marked parts, due to the coarseness of the lines, and therefore the person taking the measurements must decide whether it is closer to a division line or the centre of the space in order to achieve greater accuracy.

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[14] I use this measurement (to three decimal places, ie. 304.563 mm) when making any calculations that involve a theoretical foot or inch measurement throughout this thesis.

Plate 2.1 – First page of the table of measurements published in *Lexicon Technicum* by John Harris, London, 1704

MEA MEA

A TABLE of the *Foreign Meaſures*, Carefully Compared with the *Engliſh*.

	Suppoſe an *Engliſh* Foot divided into 1000 Equal Parts, thoſe here mentioned are in Proportion to it, as follows.	The *Engliſh* Foot divided into Inches and Decimal Parts of an Inch.
London —— Foot	1000	0.12.0
Paris, —— the Royal Foot	1.068	1.00.8
Amſterdam —— Foot	.942	0.11.3
Brill —— Foot	1.103	1.01.2
Antwerp —— Foot	.946	0.11.3
Dort —— Foot	1.184	1.02.2
Rynland or *Leyden* —— Foot	1.033	1.00.4
Lorain —— Foot	.958	0 11.4
Mechalin —— Foot	.919	0.11.0
Middleburg —— Foot	.991	0 11.9
Strasbourg —— Foot	.920	0.11.0
Bremen —— Foot	.964	0.11 6
Cologn —— Foot	.954	0.11.4
Frankford admanam —— Foot	.948	0.11.4
Spaniſh —— Foot	1.001	1.00 0
Toledo —— Foot	.899	0.10.7
Roman —— Foot	.967	0.11.6
On the Monument of *Ceſtucius* / *Statilius* ——	.972	0.11.7
Bononia —— Foot	1.204	1.02.4
Mantua —— Foot	1.569	1.06 8
Venice —— Foot	1.162	1.01 9
Dantzick —— Foot	.944	0.11.3
Copenhagen —— Foot	.965	0.11.6
Prague —— Foot	1.026	1.00.3
Riga —— Foot	1.831	1.09.9
Turin —— Foot	1.062	1.00.7
The *Greek* —— Foot	1.007	1.00.1
Paris Foot, according to Dr. *Bernard* ——	1.066	
Univerſal —— Foot	1.089	
Old *Roman* —— Foot	.970	
Bononian Foot of M. *Auzout* ——	1.140	
Lyon —— Ell	3 976	3.11.7
Bologn —— Ell	2.076	2.00.8
Amſterdam —— Ell	2.269	2.03.2
Antwerp —— Ell	2.273	2.03.2
Rynland or *Leyden* —— Ell	2.260	2.03.1
Frankford —— Ell	1.826	1.09.9
Hambonrgh —— Ell	1.905	1.10.8
Leiping —— Ell	2.260	2.03.1
Lubick —— Ell	1.908	1.09.8
Noremburg —— Ell	2.227	2.03.3
Bavuria —— Ell	.954	0.11.4
Vienna —— Ell	1.053	1 00.6

Plate 2.2 – Second page of the table of measurements published in *Lexicon Technicum* by John Harris, London, 1704.

M E A M E A

The Table Continued.

Bononia	——	—Ell	2.147	2.01.7
Dantzick	——	—Ell	1.903	1.10.8
Florence	——	—Brace or Ell	1.913	1.11.0
Spaniſh or *Caſtile*	—	—Palm	0.751	0.09.0
Spaniſh Vare or Rod, wich is Four Palms			3.001	1.00.0
Lisbon	——	—Vare	2 750	2.09.0
Gibralter	——	—Vare	2.760	2.09.1
Toledo	——	—Vare	2 685	2.08.2
Naples	——	Palm	0.861	0.09.6
		Brace	2.100	2.01.2
		Canna	6.880	6.10.5
Genua	——	—Palm	0 830	0.09.6
Milan	——	—Calamus	6.544	6.06.5
Parma	——	—Cubit	1.866	1.10.4
China	——	—Cubit	1.016	1.00.2
Cairo	——	—Cubit	1.824	1.09.9
Old *Babilonian*	——	—Cubit		1. 6.$\frac{1}{100}$
Old *Greek*	——	—Cubit		1. 6.$\frac{11}{100}$
Old *Roman*	——	—Cubit		1. 5.$\frac{424}{1000}$
Turkiſh	——	—Pike	2.200	2.02.4
Perſian	——	—Araſh	3.197	3.02.3

The *Hebrew* or *Jewiſh Long-Meaſures.*

	Feet	*Inches*	*Parts*
Cubit —— ——	1	09	888
Span, or Half Cubit —— ——	0	10	944
Palm —— ——	0	03	648
Digit —— ——	0	00	912
Fathom, 4 Cubits, or —— ——	7	03	552
Ezekiel's Reed, 6 Cubits, or —— ——	10	11	328
Pole or *Canna*, 8 Cubits, or —— ——	14	7	104
Schænus, Chain or Line, —— ——	145	1$\frac{82}{100}$	

Sabbath-Day's Journey, 2000 Cubits, or 3648 Feet.
Eaſtern-Mile, 4000 Cubits, or 7296 Feet.
Paraſang, 12000 Cubits, or 24888 Feet, or 4$\frac{1414}{1000}$ Miles.
Stadium, $\frac{1}{30}$ of a *Paraſang*, or 400 Cubits.
A *Day's Journey*, 8 *Paraſangs*, or 96000 Cubits, or 33,16 Miles.

The

Comparing all of Harris' figures with those from other sources suggests that his table is not very accurate.[15] However, he quotes two measurements for the Parisian foot which are very close to each other. Two other sources give information about the Parisian foot and they agree with each other to within one hundredth of a millimetre.[16] The two measurements given by Harris, 1.066 and 1.068 feet probably reflect the practical problems of taking the measurements as outlined above. Using the lengths quoted by Harris, and comparing them with the two other measurements for the Parisian foot, results in an English foot measure between 304.156 mm (one inch = 25.346 mm) and 304.736 mm (one inch = 25.395 mm). Later measurements give very similar results. Johann Heinrich Zedler, in his *Universal-Lexicon*, published in Halle in 1737[17] gives the length of the English foot as 304.5375 mm, almost halfway between the extremes calculated from Harris. Another measurement, given in Cotty (1819) gives an English foot of 304.7625 mm.

All of the above measurements are similar though not close enough to consider any particular measurement as representative. The maximum difference using the above sources is nearly two millimetres over one yard (about three and a half millimetres over the length of a virginal).[18]

The final method of finding the foot measurement should, in theory, be the most relevant. Rulers (and other tools) were often made by the craftsmen themselves by copying existing rulers, and therefore, in practice, each ruler will be a little different from the others. Therefore, the actual foot measurement used by different makers will differ slightly, and may be reflected in their instruments.

The use of this method relies on several assumptions. There must be enough measurements available so that the slight errors caused in transferring the measurement to the work can be averaged out statistically; the workmanship of the original maker must be good enough to reflect accurately his intentions; and the measurements used

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15 The measurements by Harris were compared to the different sources quoted in Heyde (1986).
16 Vega (1803), quoted in Heyde (1986), and Cotty (1819).
17 Quoted in Heyde (1986).
18 This figure can be expressed as an extreme difference of 0.2%.

must be from specifically designed parts of the instrument, rather than the result of chance.

One instrument that shows a large number of measurements – all plausibly part of the design process – giving units of the English inch is the 1664 RH. These have been tabulated below.

Table 2.6 - Robert Hatley inch measurements

	Actual mm	nominal inches	average
Overall length	1674	66	25.364
Left case end	521	20½	25.415
Right case end	519	20½	25.317
Left faceboard	152	6	25.333
Right faceboard	685	27	25.370
Case height	220½	8¾	25.200
Faceboard height	210	8¼	25.454
Keywell ft to nameboard ft	103	4	25.750
Top of baseboard to liner	157	6¼	25.120
Bass capping length	221	8¾	25.257
Treble capping to spine	518	20½	25.268
Apex hole to R inside	684½	27	25.352
Apex hole to spine	127	5	25.400
Lowest pos. hole to R inside	101	4	25.250
Lowest pos. hole to spine	404	16	25.250
spine to c^3 position	63½	2½	25.400
spine to c^2 position mark	127	5	25.400
spine to c^1 position mark	204½	8	25.563
spine to c position mark	290	11½	25.217
spine to FF position	419½	16½	25.424
template hole to L inside	151½	6	25.250
template hole to spine	281½	11	25.591
c^3 string length	153	6	25.500
c^2 string length	266	10½	25.333
c^1 string length	518	20½	25.268
FF string length	1525	60	25.417
Rose 1 to R inside	938	37	25.351
Rose 1 to spine	216	8½	25.412
Rose 1 diameter	81.8	3¼	25.169
Rose 2 to R inside	291	11½	25.304
Rose 2 to spine	211	8¼	25.576
Rose 2 diameter	65.2	2½	26.080
Total [32 measurements]	12099½	477	
		average inch	25.366
		average foot	304.390

On the basis of the above measurements, the foot length of Hatley's ruler was 304.3899 mm. This figure is within the extremes found in documentary sources. The 1664 RH appears to have been built (perhaps as a prototype due to its compass) using the English foot for all aspects of the design and construction, whereas other instruments do not have the same frequent use of the inch. Using only Hatley's major case dimensions and the scaling-design note results in an inch measurement of 25.360 mm (one foot equals 304.323 mm). Therefore, it can be shown that the number of available measurements can affect the accuracy of the result.

Using the case dimensions and the scaling-design note, an analysis of other makers' foot measurements can be attempted. The following tables compare instruments by Stephen Keene (Table 2.7) and Charles Rewallin (Table 2.8).

Table 2.7 - Measurements of 1668 SK and 1675 SK

	1668 SK measurements	nominal inches	1675 SK measurements	nominal inches
Overall Length	1821	72	1772	69¾
Left case end	551½	21¾	514	20¼
Right case end	552	21¾	516	20¼
Left faceboard	211	8¼	228	9
Right faceboard	767½	30¼	723	28½
Overall height	248	9¾	224	8¾
design-scale note	151½	6	120½	4¾
Total	4302½	169¾	4097½	161¼
Average inch	25.346		25.411	
Average foot	304.153		304.930	

Table 2.8 - Measurements of 1675 CR and 1679 CR

	1675 CR measurements	nominal inches	1679 CR measurements	nominal inches
Overall Length	1626	64	1656	65¼
Left case end	528	20¾	529	20¾
Right case end	526	20¾	528	20¾
Left faceboard	224	8¾	237	9¼
Right faceboard	636	25	661	26
Overall height	216	8½	218	8½
design-scale note	159½	6¼	n.a.[19]	n.a.
Total	3915½	154	3829	150½
Average inch	25.425		25.442	
Average foot	305.104		305.302	

Both Keene and Rewallin show enough consistency of results to suggest that some idea of the workshop ruler length could be determined, particularly Rewallin where the difference in the calculated foot measurement of the two insruments is only 0.2 mm. However, using the same method with the instruments of Adam Leuersidge shows the problems associated with this approach.

Table 2.9 - Measurements of 1666 AL and 1670 AL

	1666 AL measurements	nominal inches	1670 AL measurements	nominal inches
Overall Length	1692	66½	1704	67
Left case end	516	20¼	541	21¼
Right case end	515	20¼	544	21½
Left faceboard	254	10	264	10½
Right faceboard	605	23¾	594	23½
Overall height	223	8¾	222	8¾
design-scale note	n.a.	n.a.	112½	4½
Total	3805	149½	3981½	157
Average inch	25.452		25.360	
Average foot	305.418		304.318	

[19] The bridge has lifted and therefore it is impossible to determine the exact measurement of the design note scale.

The problems with using this method of foot determination for Leuersidge are that the resulting foot measurement is 1.1 mm different between the two instruments, and that the method involved an analysis of the 1670 AL in which different lengths were assumed for the left and right case ends, something the maker surely didn't intend.[20] In all of the above analysis the measurements are taken at the baseboard level. The measurements of the case ends at the top on the 1670 AL are both 547 mm. The right case end is therefore 6 mm wider at the top than the bottom, reflecting either poor workmanship or a result of working practices, and therefore rendering any results highly dubious in this example.[21] Such inconsistent workmanship is not uncommon on English virginals.

It is possible to collate all of the scaling-design notes, as determined on page 49, as another method of calculating the English unit of measure.

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[20] Using the foot measurement found in the 1659 Standard Yardstick, the left case end equals 21.32 inches, and the right case end equals 21.43 mm. On that basis it is not possible to argue which one is more likely to represent the maker's intentions.

[21] It is possible that the case lengths were marked out from the top. On that basis, both ends are 547 mm, being 21½ nominal inches. The 1670 AL average inch would then be 25.377 mm, the foot 304.521 mm.

Table 2.10 - Design-scale note lengths

Instrument[22]	Scaling-design note string length	nominal inches	average inch
Mar	176½	7	25.214
1641 GT	172½	6¾	25.555
1642 TW	151	6	25.167
1644 TW	126	5	25.200
1651 TW	153½	6	25.583
1653 TW	152	6	25.333
1655 JL	172½	6¾	25.555
1656 JW	145	5¾	25.217
1661 JW	122	4¾	25.684
1662 TB	125½	5	25.100
1664 RH	153	6	25.500
1668 SK	151½	6	25.250
1670 AL	112½	4½	25.000
1671 PJ	133	5¼	25.333
1675 SK	120½	4¾	25.368
1675 CR	159½	6¼	25.520
1684 TB	112	4½	24.889
Total	2438½	96¼	
		average inch	25.335
		average foot	304.021

The resulting foot measurements from this table are close to the figures determined using the primary source material, and within the limits found using the supporting written evidence.

DETERMINATION OF DESIGN SCALINGS

A significant problem encountered by organologists is determining how the original makers chose their design scalings. Modern researchers commonly quote the c^2 string length as the scale, but there is little evidence to suggest that this note was commonly used in various schools of plucked keyboard instrument making.[23] It must be considered whether English virginal makers used the c^2 string length as their scaling-

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[22] The instruments which show evidence of bridge movement or repinning have not been included in this table to avoid the risk of figure distortion.

[23] Although, for example, some Italian instruments have a c^2 string length either one foot, or an integral number of inches, using the local unit of measurement, Wraight (1997) has shown that many sixteenth-century Italian instruments were laid out with reference to the *f* strings. The fact that c^2 may work out as a simple integral on the inch may be simply the result of chance.

design note before any conclusions concerning stringing materials and pitch standards can be reached.

It has been shown that instruments from many different schools have scalings, amongst other measurements, which are based on the local unit of measurement, and one would expect English virginals to follow the same principle. Table 4.11 lists all of the surviving virginals with the string lengths of c^2, f^2, c^3, and the top note if higher than c^3. If c^2 is the design-scale note, almost all of the string lengths for that note might be expected to be inches or simple fractions of the inch.

Table 2.11 - Treble string lengths of surviving English virginals

Instrument	c^2	f^2	c^3	top note	foreshortening	long string
AH [a]	n.a.	n.a.	n.a.	n.a.	n.a.	*c*
Mar	**324½**	238	**176½**	n.a.	109% / n.a.	*c*
1638 TW [b]	186	144	**103**	n.a.	111% / n.a.	*c*
1641 GT	**328½**	246	**172½**	137 (e^3)	105% / 104%	*c*
1642 TW	**297**	**216**	**151**	n.a.	102% / n.a.	*c*
1644 TW	302	250	168½	**126** (f^3)	112% / 111%	*f*
1651 TW	300½	**223**	**153½**	n.a.	102% / n.a.	*c*
1653 TW	**303**	**227**	**152**	n.a.	100% / n.a.	*c*
1655 JL	**304½**	231½	**172½**	155 (d^3)	113% / 115%	*c*
1656 JW	**274**	220	**145**	n.a.	106% / n.a.	*f*†
1661 JW	**284½**	218½	150	**122** (f^3)	106% / 114%	*f*
1662 TB	319½	244½	161½	**125½** (f^3)	101% / 102%	*f*
1664 JP [c]	295	231	**151½**	131 (d^3)	103% / 100%	*f*†
1664 RH	**266**	**208**	**153**	n.a.	115% / n.a.	*c*
1666 AL [d]	290	**233½**	**150½**	**115½** (f^3)	104% / 106%	*f*
1668 SK	**287**	**215½**	**151½**	131½ (d^3)	106% / 103%	*c*
1670 AL	290	231½	**153**	**112½** (f^3)	106% / 103%	*f*
1671 PJ	**328**	**253**	**158**	**133** (f^3)	96% / 108%	*f*
1675 SK	308	225	**158**	**120½** f^3)	103% / 104%	*c*†
1675 CR	295	219½	**159½**	**141** (d^3)	108% / 108%	*c*
1679 CR [e]	**304**	**217**	143	130 (d^3)	94% / 96%	*c*
1684 TB	290	**226½**	143½	**112** (f^3)	99% / 103%	*f*

Notes on the above table:

All measurements are in millimetres. The measurements quoted in bold indicate that the string length divides into quarter-units of the inch (± 7%, approximately 1½ mm). The top note of the compass (if higher than c^3) is indicated in brackets.

Two foreshortening figures have been quoted showing the relationship between c^3 and c^2 (first figure); and the top note and c^2. To determine the relationship of the top note to c^2 the top note was converted to c^3 by multiplying the top note by the 12^{th} root of 2 (1.059463094) the

required number of times (once for each semitone), and then multiplying that figure by two. This figure is then divided by the actual c^2 string length.

The "long string" is defined on page 32. Generally the long string is the highest pitched string on an English virginal. The exceptions have been indicated in the table by a dagger (†).

[a] The bridges and register of this instrument are not original. Therefore it is impossible to estimate the string lengths with any sufficient degree of accuracy.

[b] The string lengths have been estimated because the treble section of the right bridge has been moved and repinned. The measurements have been taken from a computer reconstruction of the original state.

[c] The string lengths have been estimated because the right bridge and register leather are not original.

[d] The string lengths have been estimated because the left bridge has lifted from the soundboard at the front. The measurements have been taken from a computer reconstruction of the original state.

[e] The string lengths have been estimated because the left bridge has lifted in the treble section at the front. The measurements have been taken from a computer reconstruction of the original state.

Only eleven (i.e. half) of the English virginals have c^2 string lengths which can be expressed in quarter-units of the inch. This suggests that, unlike the instruments of some other schools, the English virginal makers may have used another method in determining the treble design scale.

As the geometry of a virginal dictates that the jacks are placed in pairs between the strings, the strings are alternately longer and shorter than they would be if evenly spaced with a jack in between each pair of strings always plucking in the same direction. Nineteen of the twenty two surviving examples have the top string, regardless of what note it is, to the player's side of the jack.[24] Of the three exceptions, one shows a number of signs of having been altered during construction with an extra note added in the treble, and another instrument has 56 notes rather than the (by that time) usual 55 notes. Therefore there appears to be a general design-concept rule that *the top string is always on the player's side of its jack.*

One consequence of this is that instruments with compasses ending on c^3, d^3, or e^3 in the treble usually have *c* as a "long" string, and the virginals which ascend to f^3 have

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[24] There is an acoustical reason why this may have been done – putting the string further away from the spine increases the amount of soundboard wood that is able to vibrate.

c as a "short" string.[25] When making comparisons between instruments this must be taken into account.

An examination of Table 2.11 shows that the string lengths in the treble can be expressed as quarter-units of the English inch (as shown in bold type).[26] On all but one of the instruments that ascend to c^3, d^3, or e^3, the string length for c^3 can be divided into quarter inches, and in about half of the examples the string length is 6 inches. The only exception is the 1679 CR virginal, where the treble strings are proportionally shorter than c^2. In this example the c^2 string length was originally approximately 304 mm (almost exactly one foot), and this string was probably used as the design note, as is often found in contemporary spinets.

In the instruments that have f^3 as the top note, four of the eight examples have a c^3 string length that can be expressed as quarter units of the inch. However, in all eight examples the f^3 string lengths are definable as quarter units of the inch.

It appears that the virginal makers took the relative lengthening and shortening of the string lengths into consideration when designing instruments for a particular scale, and had a general rule that *c^3 is used for the scaling-design note, unless the compass extends to f^3, in which case that note is used.*

One remarkable feature about English virginals is the lack of scaling standardisation in the treble part of the compass. Although some of the virginals have treble string lengths which are close to being Pythagorean in scaling – for example the 1642 TW, 1651 TW, 1653 TW and 1684 TB virginals – other instruments have treble scales which foreshorten by up to 15% between the design-scale note and c^2 – for example the 1655 JL, 1661 JW, and 1664 RH. Sometimes examples by the same maker can show this effect. Three instruments by Thomas White, mentioned above, are nearly Pythagorean in scaling, but the others show a noticeable amount of foreshortening. In the 1638 child virginal there is no choice, as the right bridge is composed of two straight

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[25] When the top note is a *c*, and it is on the player's side of the jack, the notes *c*, *d*, *e*, $f^\#$, $g^\#$, and $b^\flat$ are longer than theoretical, and notes $c^\#$, $e^\flat$, *f*, *g*, *a*, and *b* are shorter than theoretical.

[26] The common joiner's ruler of the period generally used quarter inches as the finest marked subdivision.

segments, but the 1644 virginal, now in Cardiff, foreshortens by over 11% between the top note and c^2.[27]

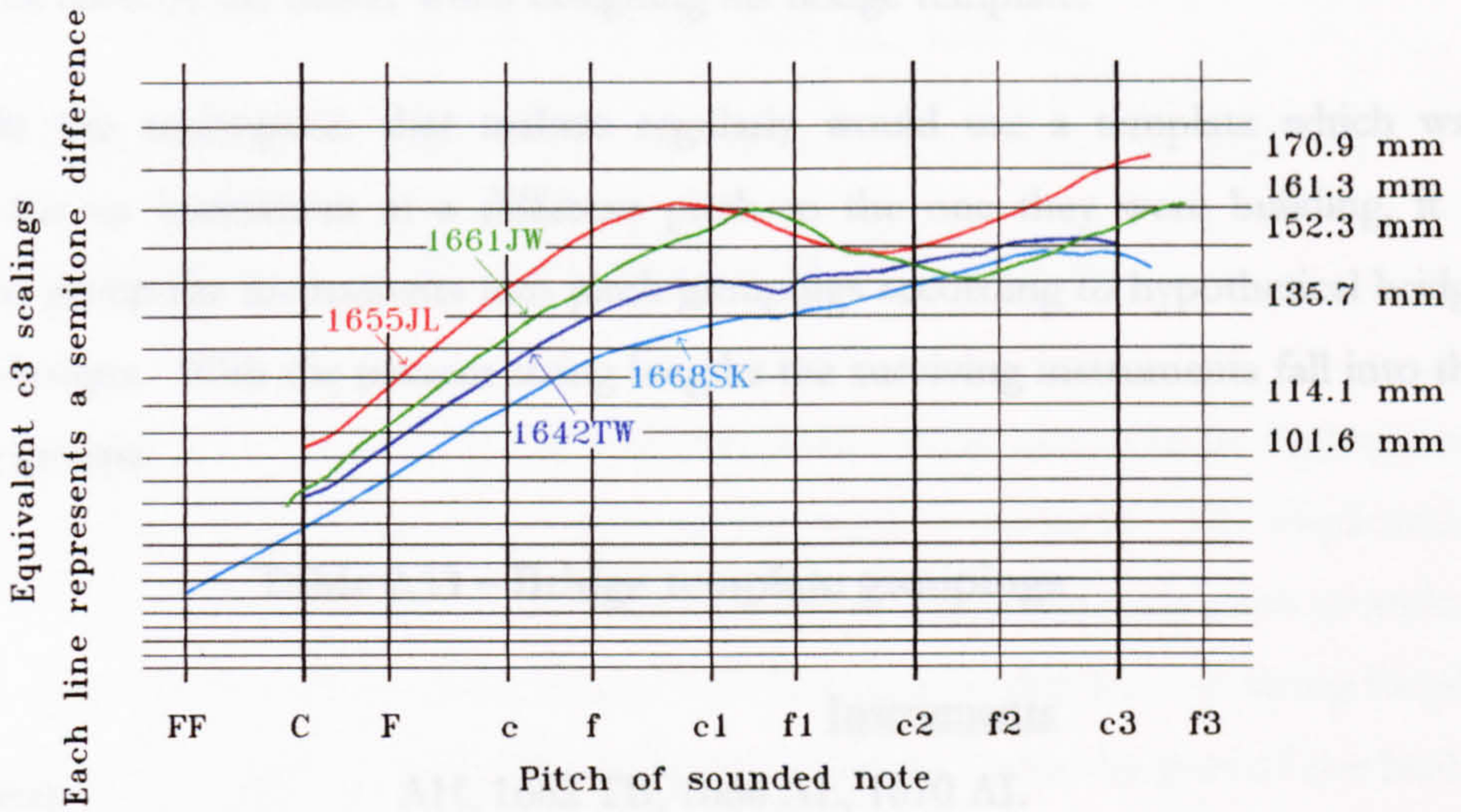
It cannot be discounted that some makers exploited the fact that thinner wire is usually stronger than thicker wire due to the drawing process, and chose to use thinner than normal gauges in the extreme treble. Goodway and Odell (1987) suggest that the scale-length increase available by using thinner wire is approximately 2-6% per gauge reduction.[28] On the instruments which foreshorten by up to 15% this would imply the need of at least three changes of gauge between the top of the compass and c^2, and several instruments with this foreshortening have scales increasing again towards c^1, an octave lower, which suggests the strings would need to get thinner again. I am unaware of any evidence to suggest any stringing practices of that nature were used by makers in the historical era.

This scale foreshortening and lengthening can be illustrated by drawing a graph which shows each of the string lengths converted to its equivalent c^2 scaling.[29] The horizontal lines on the graphs represent semitone reductions in pitch. Were an instrument to be Pythagorean throughout its whole compass it would be graphed as a straight horizontal line. Graph 2.4 shows the equivalent lengths for four different instruments - the 1642 TW, which is fairly close to Pythagorean in the treble, the 1668 SK, which shows a slight constant foreshortening throughout the compass, the 1655 JL which foreshortens by about 2½ semitones between the top of the compass and c^2, then increases to within a semitone of the treble scale just below c^1, and the 1661 JW, which foreshortens by about two semitones in the top octave, then increases to nearly reach the equivalent of the treble scales at e^{b1}.

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[27] This could be explained by the fact that the top note is an *f*, which is comparatively longer than the *c*s. However, c^3 is 12% longer than c^2, showing an even greater foreshortening than between f^3 and c^2.
[28] I know of no evidence to suggest tensile increase greater than 6% per gauge reduction.
[29] As the strings are alternately "long" and "short" throughout the compass, the curves on the graph follow the arithmetic mean of the two closely spaced strings.

Graph 2.1 – Graph showing all of the string lengths of four English virginals converted to their c^3 equivalent lengths.



In a number of instances the foreshortening around c^2 can be shown to be a result of workshop practice rather than a specific design element. As shall be discussed below in Chapter Three, the makers used a template to mark-out the shape of the right bridge. It is clear that instruments at different pitch levels did not necessarily need to use different templates.[30] This can be tested in the following table which shows the c^3, c^2, and c^1 string lengths for the Mar virginal, together with the c^3 equivalent scale. The last two columns show the instrument with the c^3 string length reduced to 6 inches and the other notes reduced by the same linear proportion.

Table 2.12 – Mar string lengths with present and hypothetical 6" scale

	Actual string lengths	Equivalent c^3 scaling	Hypothetical string lengths	Equivalent c^3 scaling
c^3	176½	176½	152¼	152¼
c^2	324½	162¼	300¼	150
c^1	633½	158½	609¼	152¼

[30] I would like to thank Grant O'Brien who first suggested this possibility to me.

As can clearly be seen, if the Mar had a 6 inch c^3 scale, the top half of the compass would be Pythagorean. It is therefore reasonable to conclude that this scale was the one used by the maker when designing his bridge template.

On the assumption that makers regularly would use a template which was designed for an instrument at a different pitch to the one they were building, it is possible to group the instruments into pitch groupings according to hypothetical bridge template designs. With the present string lengths the surviving instruments fall into the following groups.

Table 2.13 – Bridge template groupings

	Instruments
Pythagorean	AH, 1662 TB, 1666 AL, 1670 AL
constant foreshortening	Mar, 1642 TW, 1644 TW, 1651 TW, 1653 TW, 1656 JW, 1641 GT, 1664 JP, 1668 SK, 1675 SK, 1671 PJ, 1675 CR, 1664 RH, 1684 TB
c^3 and c^1 near Pythagorean	1638 TW, 1661 JW, 1655 JL
c^2 longer than c^3	1679 CR

As can be seen, only four of the 22 surviving instruments have scalings which are Pythagorean in the treble. Three instruments have c^1 string lengths which are close to Pythagorean when compared to c^3, and the majority of instruments show a foreshortening throughout the compass.

When using the same technique as applied to the Mar above, it is possible to re-order the groupings to take account of the original bridge template design intentions as follows.

Table 2.14 – Hypothetical bridge template groupings

	Instruments[31]
Already Pythagorean	AH (?), 1662 TB, 1666 AL, 1670 AL
Pythagorean	Mar, 1641 GT, 1671 PJ, 1675 CR, 1679 CR
constant foreshortening	1642 TW, 1644 TW, 1651 TW, 1653 TW, 1668 SK, 1684 TB
c^3 and c^1 Pythagorean	1638 TW, 1655 JL, 1661 JW, 1664 RH

As can be seen, an additional five instruments can be shown to be Pythagorean scaled when a different scaling-design note string length is assumed. The implications of this will be considered in relation to the hypothetical bridge template pitch groupings below on page 64. The above table shows four instruments that have c^2 string lengths shorter than both c^3 and c^1. This foreshortening around c^2 must be part of the bridge template design in these examples.

ENGLISH VIRGINAL STRINGING EVIDENCE

There are only two instruments that retain any evidence of possible historical stringing practices. The 1671 PJ has remains of strings coiled around the original tuning pins (now kept separately from the instrument following its restoration in the 1970s). These string remains fall into two groups; most are clearly 19th-century strings added for cosmetic reasons and are of iron material. However, nine string remains are neat, soft, and slightly oval, and are almost certainly original or early replacements. These strings have been independently measured by Andrew Garrett, when he and Richard Clayson restored the instrument[32]; and by the author, during an examination of the instrument.[33] Our measurements agree with each other, and Garrett also considers the strings to be either original or very early. Two of the nine strings are of a copper alloy, the remainder are iron, the lowest surviving iron string being at c.

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[31] The 1656 JW, 1664 JP, and 1675 SK instruments have not been included as their scaling-design note is "short". These instruments must be considered on an individual basis.

[32] Rose and Law (1991:99) give full details of Garrett's measurements. The tension graph at the bottom of the page is the work of the book's authors.

[33] The measurements taken by the author were taken several times, and the quoted measurements listed in Table 2.15 are median figures. The examination preceded publication of Rose and Law (1991).

Table 2.15 - Old strings found coiled around the tuning pins of the 1671 PJ virginal

Note	String Diameter	String Material
f^3	.23	iron
f^2	.23	iron
$c^{\#1}$	.27	iron
b	.30	iron
$f^{\#}$	.37	iron
e	.37	iron
c	.42	iron
F	.43	yellow brass
C	.49	yellow brass

The second instrument that contains evidence of historical stringing is the 1641 GT virginal at the Musical Instrument Museum in Brussels. No original strings remain, but the wrestplank has gauge numbers written in a hand which matches the writing found on some of the instrument's replacement jacks which originated in an English eighteenth-century double-manual harpsichord.

Table 2.16 – Gauge numbers on the wrestplank of the 1641 GT virginal

Gauge Number	Notes	Material
4	$g^2 – e^3$	
5	$e^{b2} – f^{\#2}$	
6	b^1 - d^2	
7	g^1 - b^{b1}	
8	$e^{b1} – f^{\#1}$	
8 [in pencil over 6]	$b – d^1$	
9	g - b^b	
9	$e^b – f^{\#}$	
10	B – d	Coper (sic.)
11	G - B^b	
12	E^b - $F^{\#}$	
13	Extra C – D	brass

The gauges suggest tensions that are considerably higher than those found in eighteenth-century English harpsichords and spinets,[34] and possibly represents an

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[34] Based on the evidence presented by O'Brien (1981). Pitch levels of (a^1 =) 425 Hz (iron treble stringing) and 346 Hz (brass treble stringing) were assumed in calculating the string tensions. The figures presented by O'Brien assumed a pitch level of 415 Hz. His results were mathematically adjusted by the author before making any tension comparisons.

attempt to replicate the original diameters, rather than following eighteenth-century stringing practices.

A complication exists in regard to the string materials. The word "brass" is beside gauge 13 at the bottom of the compass, and next to gauge 10 (at note B) is the word "Coper" (sic). This is almost certainly a mistake. Copper (more correctly red brass, a copper alloy consisting of approximately 90% copper and 10% zinc) breaks at a lower pitch (given the same diameter) than yellow brass (approximately 70% copper and 30% zinc), and it is common historical stringing practice to use red brass for the notes lower in pitch than yellow brass.[35]

The most likely cause of the complication is that the words were transposed, which suggests that the lowest octave should be strung in red brass and the remainder in yellow brass. Another possibility is that iron stringing was intended for the treble, and copper (probably meaning yellow brass) was used for the lowest octave between the two written indications.

Both the 1671 PJ and the 1641 GT have similar c^2 string lengths,[36] so the ambiguity of the 1641 GT stringing is important when trying to determine the stringing and pitch of the English virginals. Assuming the gauge numbers found on the 1641 GT represent the original stringing practice, and yellow brass was the intended treble stringing material, the evidence would show that stringing material doesn't correlate to string length, but was decided according to the desired pitch, allowing a range of pitches potentially about a major or minor third larger than if a single type of treble stringing material was used. If iron were the intended material it would help to confirm the stringing found on the 1671 PJ virginal.

Given the uncertainty concerning the stringing of the 1641 GT, it can be shown that there is evidence to support the use of iron treble stringing on English virginals, and that there is later (questionable) evidence to suggest that brass may have been used as the treble stringing material.

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[35] O'Brien (1981) discusses the historical evidence of stringing practice, and explains the reasons why different stringing materials were used. He shows that historical makers strung their instruments so that the equivalent c^2 scale of the highest red brass string is on average approximately 78% of the length of the highest yellow brass equivalent c^2 scale.

[36] The 1671 PJ has a c^2 string length of 328 mm, and the c^2 string length of the 1641 GT is 328½ mm.

DETERMINATION OF PITCH GROUPINGS

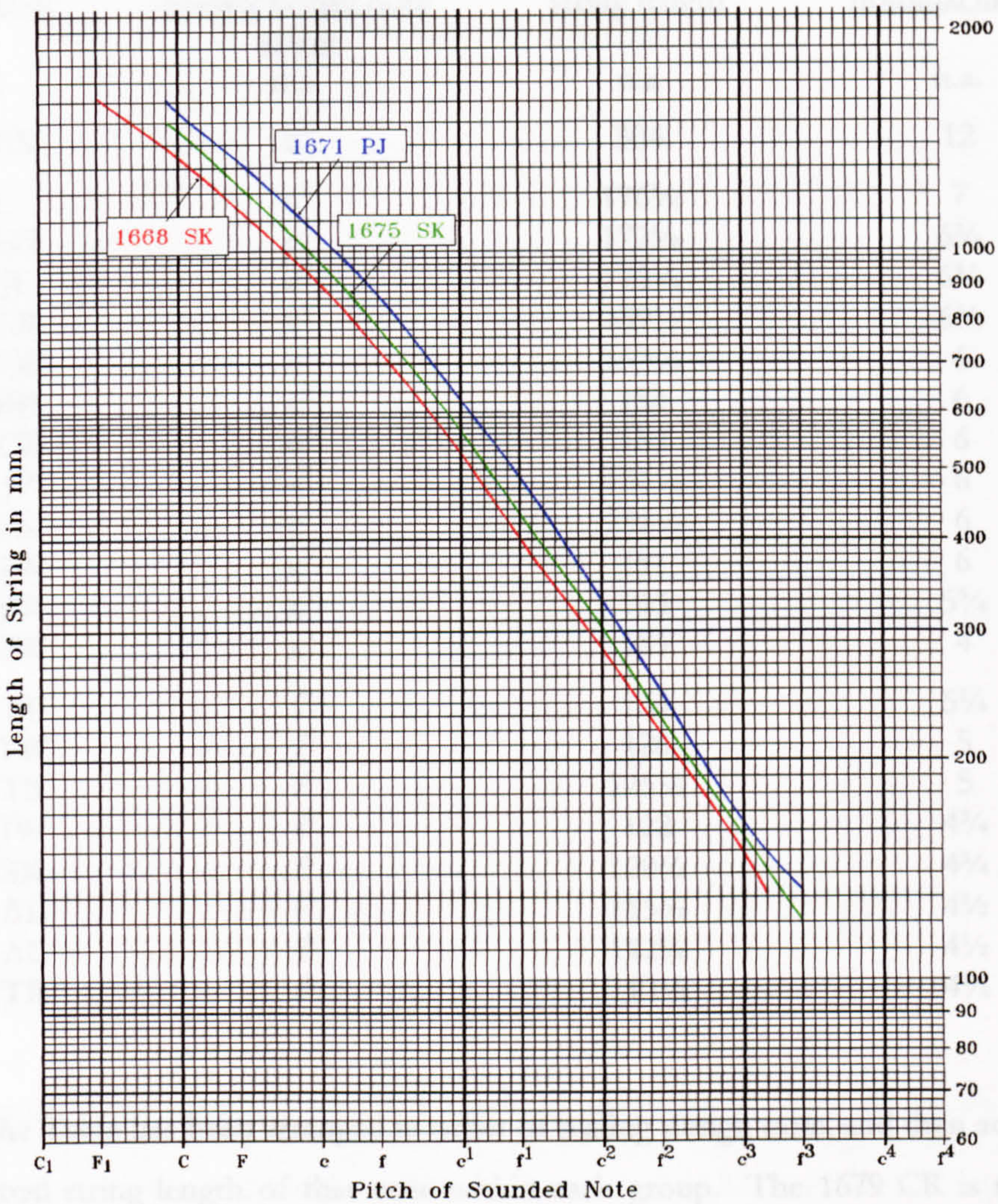
It has been shown by Gwynn (1985) and Haynes (1995) that a number of different pitch standards were in use in seventeenth century England. Similar evidence can be found for plucked-keyboard instruments of other schools, for example instruments by the Ruckers family[37] and various Italian instrument-making schools.[38] It is therefore possible that English virginal makers designed their instruments to be played at different pitches.

Evidence to support that idea can be found when comparing the string lengths of instruments in the same workshop tradition. Graph 2.2 plots the string lengths of the 1668 SK, 1675 SK, and 1671 PJ virginals[39] on semi-logarithmic paper. O'Brien (1981) has shown that instruments (from the same workshop tradition) designed for different pitches should have both the treble and bass string lengths in proportion to each other, which results in offset lines when graphed on semi-logarithmic paper. This condition is clearly seen on Graph 2.2.

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[37] O'Brien (1990).
[38] Wraight (1997).
[39] The 1671 PJ is very closely related in design layout and overall appearance to the instruments by Keene, particularly the 1675 instrument. In fact, the 1671 PJ and 1675 SK virginals are closer in design to each other than the two Keene instruments. It is not clear what the common workshop tradition between the two makers is, as Jones was apprenticed to John Haward, becoming a Freeman in 1667. It is possible that Jones worked as a journeyman in Keene's workshop before setting up his own shop.

Graph 2.2 - Semi-logarithmic graph of string lengths of the 1668 SK, 1675 SK, and 1671 PJ virginals



The correlation between treble scaling-design note string length and the length of the bass strings is found in all of the English virginals.[40] Therefore it is probable that the scaling-design note lengths can be used to determine the relative pitch of the different instruments. Table 2.17 shows the design-scale note lengths in millimetres, and the conversion of those lengths to nominal inch measurements.

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[40] The maximum difference in bass string length of the surviving virginals is 361 cents at C. This has been calculated by comparing the length of the C string converted to its equivalent scaling-design note length and then converting the ratio into cents as described in footnote 42. 361 cents is approximately 3½ semitones, so it would be possible to argue that this was due to different treble stringing materials. However, the maximum difference between virginals with a 6" c^3 / 4½" f^3 scale is 239 cents, which strongly indicates that the differences are due to reasons other than treble stringing material.

Table 2.17 – Surviving virginals grouped according to their nominal scaling-design note string lengths

Instrument	Scaling-design note string	string length	nominal inches
AH	n.a.	n.a	n.a.
1679 CR	c^2	304	12
Mar	c^3	176½	7
1641 GT	c^3	172½	6¾
1655 JL	c^3	172½	6¾
1675 CR	c^3	159½	6¼
1651 TW	c^3	153½	6
1664 RH	c^3	153	6
1653 TW	c^3	152	6
1664 JP	c^3	151½	6
1668 SK	c^3	151½	6
1642 TW	c^3	151	6
1656 JW	c^3	145	5¾
1638 TW	c^3	103	4
1671 PJ	f^3	133	5¼
1644 TW	f^3	126	5
1662 TB	f^3	125½	5
1661 JW	f^3	122	4¾
1675 SK	f^3	120½	4¾
1666 AL	f^3	115½	4½
1670 AL	f^3	112½	4½
1684 TB	f^3	112½	4½

The Table has been arranged in order of scaling-design note, and then according to the actual string length of that note within each group. The 1679 CR is the only instrument that appears to use c^2 as the scaling-design note. Twelve instruments have c^3 as the scaling-design note, with string lengths from 4 - 7 inches, and eight instruments use f^3 as the scaling-design note, with string lengths from 4½ - 5¼ inches.

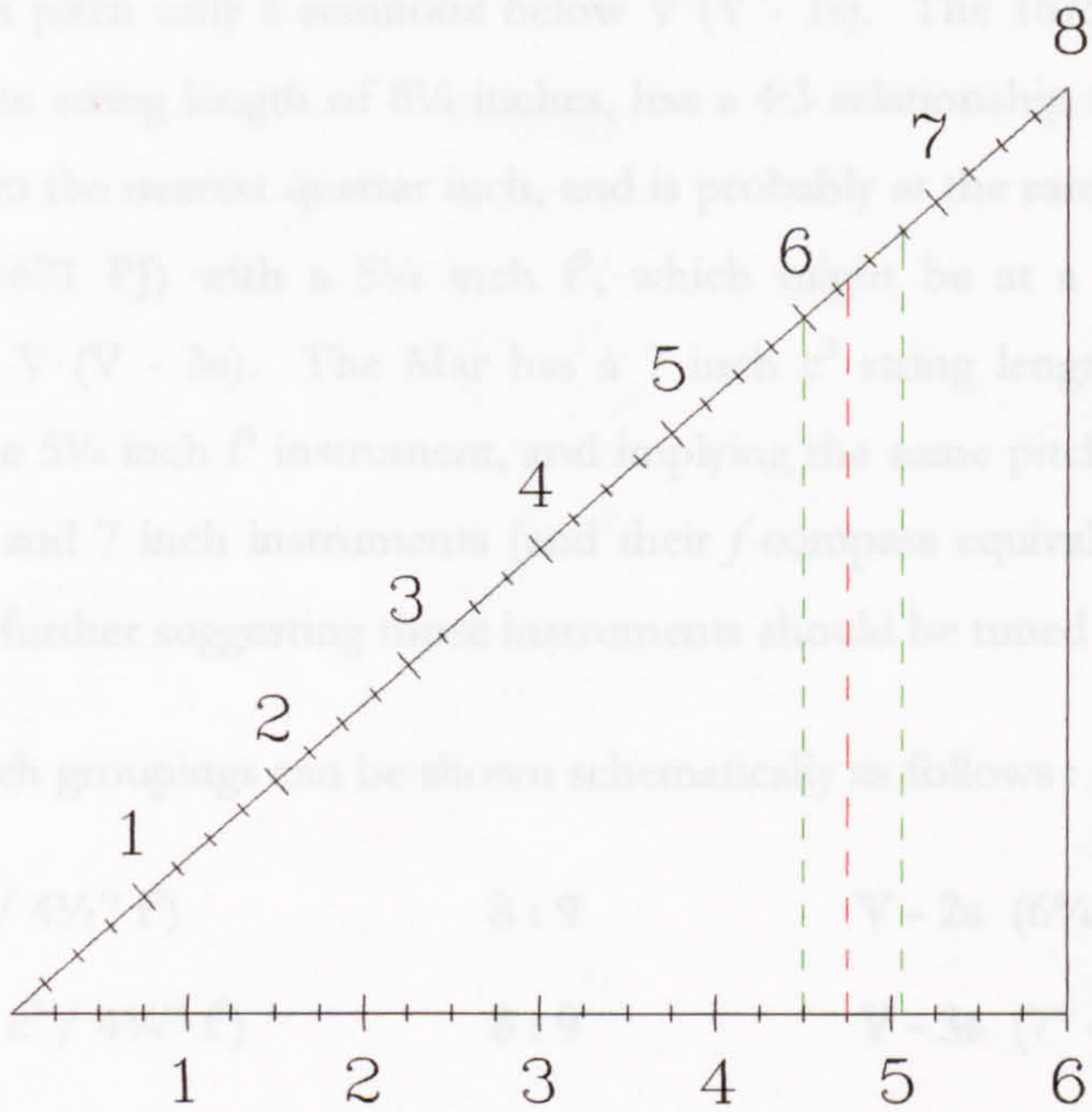
On the basis of the surviving instruments, it appears that a c^3 string length of 6 inches may have been considered by the makers to be something of a reference pitch, which shall be referred to as "V". In determining the c^3 string length of virginals at different pitches, mathematical ratios might have been used, as found in instruments by the Ruckers family.[41] In practice the makers may have initially used a right-angle triangle, with the hypotenuse and one other side having lengths of the desired ratio.

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41 O'Brien (1990).

The desired string length (using the nearest quarter inch) could be easily found by marking across the triangle as shown in figure 2.4.

Figure 2.4 - 4:3 Triangle



The diagram shows a triangle with a 4:3 ratio, the base set to show six inches and the hypotenuse 8 inches, which would give the relationship between instruments designed using c^3 and f^3 scaling-design notes. The two green dashed lines show the f^3 equivalents of a 6 inch c^3 (4½ inches) and 6¾ inch c^3 (close to 5 inches). The red dashed line shows the nearest c^3 quarter inch equivalent (6¼ inches) of a 4¾ inch f^3.

The earliest dated English virginal is the 1638 TW child virginal with a c^3 string length of 4 inches, which is in a 2:3 ratio to the virginals at V, implying a pitch a perfect fifth above V (V + 7s). The mother of this instrument would have been tuned an octave below, a perfect fourth below V. Another early instrument is the 1641 GT with a c^3 string length of 6¾ inches. This again can be expressed as a simple ratio to 6 inches — 9:8 — suggesting a pitch a tone below V (V - 2s).

When instruments that ascended to f^3 began to be built, and the f^3 rather than the c^3 was used as the scaling-design note, it would have been necessary to use a 3:4 ratio to determine the equivalent string lengths. For instruments at V, the f^3 string should be 4½ inches long, and virginals a tone below V, the f^3 string should be 5 inches long (to the nearest quarter-inch). There are three virginals with a 4¾ inch f^3 string length, implying a pitch only a semitone below V (V - 1s). The 1675 CR, having a c^3 scaling-design note string length of 6¼ inches, has a 4:3 relationship to these virginals, when converted to the nearest quarter inch, and is probably at the same pitch. There is also a virginal (1671 PJ) with a 5¼ inch f^3, which might be at a pitch level three semitones below V (V - 3s). The Mar has a 7 inch c^3 string length, showing a 4:3 relationship to the 5¼ inch f^3 instrument, and implying the same pitch level. The ratio between the 6¼ and 7 inch instruments (and their *f* compass equivalents) can also be expressed as 9:8, further suggesting those instruments should be tuned a tone apart.

These pitch groupings can be shown schematically as follows :

V (6" c^3 / 4½" f^3) **8 : 9** **V - 2s** (6¾" c^3 / 5" f^3)

V - 1s (6¼" c^3 / 4¾" f^3) **8 : 9** **V - 3s** (7" c^3 / 5¼" f^3)

The only instrument that does not fit in the above groupings is the 1656 JW, which has a c^3 string length of 5¾. The ratio of 5¾:6 can be expressed as 74 cents[42], making it possible that the instrument played at a pitch of V + 1s. However, this instrument shows evidence of having been altered during construction, with an extra note added in the treble.[43] Therefore, the string length was probably an attempt by the maker to rectify the fact that the *c* strings were comparatively "short", and that a pitch of V was desired.

It is theoretically possible that rather than four different pitch levels there were only two – V and V – 2s – with the instruments that have slightly longer string lengths (the assumed V - 1s and V - 3s groups) representing a personal choice by the makers

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[42] The interval relationship between two string lengths can be expressed in cents by multiplying the logarithm of the ratio by 3986.3137. This method was first brought to my attention by Wraight (1997:11).

[43] See the Catalogue description on page 244 for details. The instrument appears to have been altered from a C - c^3 to GG/BB - c^3 compass at a stage of construction where the only possibility was to move the treble keywell side and frame to the right to gain enough room for the extra note.

about how close to breaking-point the strings were tuned. This cannot be discounted, although the nominal-inch string lengths for the f^3 design-scale instruments - 4½", 4¾", 5", and 5¼" - show logical quarter inch increments per semitone, suggesting that the four pitch levels are more likely.

Table 2.18 - Virginals arranged according to pitch groupings

Pitch level	c^3 designs	f^3 designs
V + 7s	1638 TW	
V	1642 TW	
	1651 TW	1666AL
	1653 TW	1670 AL
	1656 JW	1684 TB
	1664 JP	
	1664 RH	
	1668 SK	
	(1679 CR)[44]	
V - 1s	1675 CR	1661 JW
		1675 SK
V-2s	1641 GT	1644 TW
	1655 JL	1662 TB
V - 3s	Mar	1671 PJ

Note : The "AH" virginal does not retain enough information to accurately determine its original string lengths. I estimate that the c^3 string length was approximately 151 mm.

As discussed above, the bridge templates were not necessarily intended for the scalings that are found in the surviving instruments. By calculating the string lengths that give scalings which are as close to Pythagorean as possible, a Table can be compiled to show hypothetical pitch groupings *according to the bridge templates.*

Table 2.19 – Hypothetical pitch groupings according to bridge templates

Pitch	Instruments
V	AH, Mar, 1642 TW, 1651 TW, 1653 TW, 1668 SK, [1656 JW, 1664 JP]
V – 1s	1641 GT, 1655 JL, 1661 JW, 1664 RH, 1666 AL, 1670 AL, 1671 PJ, 1679 CR, 1684 TB, [1675 SK]
V – 2s	1644 TW, 1662 TB, 1675 CR

[44] As mentioned in the text, the 1679 CR uses a 12" c^2 design scale rather than a 6" c^3 scale. The pitch level is the same, hence its inclusion in this table.

There are a number of points that need to be explained about the Table. The instruments have been fitted in to the table in their best position, but some instruments could be intended for a different pitch grouping. Three examples of this are the 1666 AL, 1670 AL and 1684 TB instruments, all of which may have been intended to have a bridge template designed for V. All three of the instruments have been included in Table 2.18 as playing at V on the basis of their f^3 string lengths. The f^2 scales are longer than the f^3 string lengths, but not by enough to suggest a different pitch was intended. It is possible that inaccuracy in either making the bridge or marking the bridge pin positions could have caused this anomaly.

Two instruments — the 1664 RH and the 1675 CR — have bridge templates which place them in the above pitch groupings when a top note of f^3 is assumed. It is reasonable to assume both makers regularly made instruments that extended to f^3 at the time these instruments were built. As the 1656 JW, 1664 JP, and 1675 SK virginals have a design scaling note which is short rather than long it is not possible to determine the hypothetical bridge template scale. They have been included in Table 2.19 at their present pitch levels. The 1638 TW instrument has a right bridge made of two straight sections rather than a curve. It is unlikely that a bridge template was used. The instrument has not been included in the above Table 2.19.

EVIDENCE OF PITCH LEVELS IN THE HISTORICAL PERIOD

The evidence from the surviving English virginals does not allow an unambiguous conclusion to be drawn concerning treble stringing material and pitch. However, it has been shown above (page 62) that it is most likely there were four pitch levels, each a semitone apart, in addition to a child virginal pitched a perfect fifth above the highest of the four levels. To make further conclusions about the stringing material and pitch levels, the virginals must be compared with instruments of different types.

The evidence presented by O'Brien (1981) shows that iron treble scales should be about 20 - 25% longer than brass scales for instruments at the same pitch level. He has argued that different schools of instrument making probably used strings similarly close to their breaking point. Examining all of the reliable evidence can test this. For

the evidence to be of use the scale and pitch level of an instrument must be known. There are few instruments that satisfactorily fit this criteria.

There is reliable evidence about historical pitch levels and corresponding string lengths from eighteenth-century England, where the average scalings for harpsichords by Kirckman and Shudi have been concluded, and there is much evidence of the general pitch level (concluded from organs, tuning forks, and pitch pipes). There are also Continental claviorgans in which the string length and pitch can be accurately determined.[45] A similar approach can be used to calculate the *Cammerton* pitch level in Hamburg, where a set of Gedackt pipes survive in the organ at the Jacobikircke[46] which probably reflects the pitch of Hass and Fleischer instruments.[47] The (independent) work of Wraight (1997) on Italian plucked keyboard instrument stringing and Haynes (1995) on baroque pitch standards gives a suitable amount of material to conclude the pitch levels and string lengths in sixteenth century Venice. On the basis of the documentary evidence of Praetorius (1618), John Koster (1999) has concluded the likely pitch level in late sixteenth century Flanders (particularly in relation to Hans Bos).

The following Tables give the scalings of the instruments (column two), the pitch at which the instrument played in column three, and information about what source has been used to determine the pitch level in column four. The pitch level quoted in column five (the 12" comparison) has been calculated by dividing the scale (column two) by one English foot (= 12 inches, 304.563 mm), and multiplying the result by the pitch level given in column three. This enables a direct comparison to be made for the different instruments for a given length. The conversion of the scalings to twelve inches has been used because twelve inches is twice the length of the c^3 string found in English virginals which play at V.

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[45] Information on the continental claviorgans was provided by Alfons Huber (PC).
[46] The organ was built by Arp Schnitger in 1689.
[47] Haynes (PC) disagrees that this evidence can be considered reliable, pointing out that there were several different Cammerton levels in Hamburg at this period. However, the other levels are at a higher pitch which would result in string breakages.

Table 2.20 - Reliable string length / pitch evidence

Instrument	Scale	Pitch	How concluded	12" comparison
Kirckman	343 mm	425 Hz	forks, pitch pipes, claviorgan	479 Hz
Rorif (1565-9)	324 mm	c. 415 Hz	claviorgan	441 Hz
Pock (1591)	306 mm	465 Hz	claviorgan	467 Hz
Zeiss (1639)	315 mm	460 Hz	claviorgan	476 Hz
Zeiss (1646)	300 mm	460 Hz	claviorgan	453Hz
Hass / Fleisher	362½ mm	408 Hz	Cammerton stop	485 Hz
Venice (high)[48]	313½ mm	470 Hz	cornett pitch	484 Hz
Bos	386 mm	392 Hz	Praetorius	497 Hz

Several pieces of other evidence exist which are less reliable, but may also provide a clue about the string length - pitch relationship. A number of long-scaled seventeenth century French harpsichords survives, and Haynes (1995) has shown their likely pitch was c. 395 Hz. There is a tuning fork associated with a clavichord built by Pehr Lindholm in Sweden that produces a pitch of 458 Hz.[49] Finally, the harpsichord owned by Christiaan Huygens – presumably the Couchet that had belonged to his father – had its pitch measured as 409 Hz.

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[48] There are two common sixteenth-century scale lengths found in Venetian plucked keyboard instruments strongly implying pitches a tone apart. Wraight (1997) shows that the makers designed their instruments using the *f* strings, rather than the *c* strings, and gives the f^2 string lengths as 235 and 265 mm. The shorter of these string lengths has been mathematically converted to its c^2 equivalent in the Table. The pitch standards come from Haynes (1995:70), following his examination of the evidence from the surviving Venetian instruments from that period.

[49] The clavichord with which the tuning fork is associated does not have reliable information concerning its string lengths. The figure given in column two is an estimate based on other Lindholm clavichords.

Table 2.21 - Less reliable string length / pitch evidence

Instrument	Scale	Pitch	How concluded	12" comparison
Richard	387½ mm	395 Hz	see Haynes.	503 Hz
Lindholm	≈320 mm	458 Hz	tuning fork	481 Hz
Couchet	356 mm	409 Hz	scientific measurement	478 Hz

There is a surviving tuning fork which is known to have belonged to the Parisian harpsichord maker Pascal Taskin. It has been accurately measured at 409 Hz. However, this fork is unlikely to represent Taskin's usual pitch, and Haynes (1995) has shown that this pitch was uncommon in France.[50] A table can be shown using the scalings of Taskin and Blanchet[51] and the possible pitch levels as found by Haynes to provide further comparisons.

Table 2.22 - 12" comparison with Taskin and Blanchet

Maker	Scale	12" comparison @ 395 Hz	12" comparison @ 403 Hz
Taskin	364 mm	472 Hz	483 Hz
Blanchet	357 mm	463 Hz	472 Hz

Finally, Koster has persuasively argued that Ruckers reference pitch may have been at the same level as Bos' pitch,[52] as suggested by the documentary evidence in

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50 This fork survives at the Academy of Applied Sciences, Paris, and was tuned to the hautboy of Antoine Sallatin, the first oboist at the *Opéra* (see Haynes (1995:137)). There is no evidence to link the tuning fork to the *Opéra* itself, and as Sallatin used an instrument with multiple joints, Haynes suggested the fork was made to the pitch of one of the shorter joints. If the pitch was usual to Taskin it is unlikely he would have needed a specially made fork.

51 Quoted in O'Brien (1981).

52 This disagrees with the frequency measurement made by Christiaan Huygens of his harpsichord. There are several possibilities which could explain the anomaly. The most likely simple explanation is that the harpsichord of Christiaan Huygens was not his father's Couchet, thus making the evidence presented in Table 2.20 invalid. Another possible reason is that the instrument was the Couchet but it had been tuned to a different pitch, possibly with different stringing. Huygens lived in Amsterdam rather than Antwerp (where Couchet worked) and may well have had local reasons for a higher pitch, despite Couchet's firm advice to Constantijn Huygens to keep the instrument at its intended pitch.

Praetorius.[53] Ruckers instruments have shorter scales than the virginal by Bos, and this may be due to the heavier stringing used by Ruckers.[54] Table 2.23 gives a 12" comparison assuming Bos' pitch (above), and the pitch level of Huygens' instrument (below).

Table 2.23 - 12" comparison with Ruckers

Instrument type	average scaling[55]	pitch level	12" comparison
Harpsichord	356.6 mm	392 Hz	459 Hz
Virginal	364.8 mm	392 Hz	469 Hz

Instrument type	average scaling	pitch level	12" comparison
Harpsichord	356.6 mm	409 Hz	479 Hz
Virginal	364.8 mm	409 Hz	490 Hz

Accepting all of the above evidence with equal weighting, it suggests that the extreme difference of pitch of a given string length found in historical instruments amounts to about 228 cents. This compares favourably with research on individual makers, such as the Ruckers family, whose work in the treble of the compass is accurate to no closer than plus-or-minus one semitone.[56] Bruce Haynes (1995:24) claims that it is not possible to generalise pitch standards to an accuracy finer than 21-22 cents.

Unfortunately, all of the evidence refers to instruments which have iron treble stringing material, with only the information from Hamburg giving direct assistance in determining brass treble string lengths. The changeover point from iron treble string to brass stringing in the bass is known for many instruments (see below), and therefore evidence of likely brass scales for given pitch levels can still be obtained.

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[53] The relevant passage in Praetorius has been translated by Koster, with a confirmation reading by Herbert Heyde as follows :-

> In England formerly and in the Netherlands still up until now they voiced and tuned most of their wind instruments a minor third lower than our present chamber pitch [*Cammerton*] such that their F is our chamber pitch D and their G is our E. Likewise, the excellent instrument maker in Antwerp, Johannes Bossus, voices and tunes to the same pitch most of his Clavicymbeln [harpsichords] and Symphonien [virginals] and also the organs built into them [claviorgans].

[54] O'Brien (1990:62).

[55] The average scaling has been determined by converting the c^2 string lengths of the harpsichords and virginals used by O'Brien (1990) in his catalogue.

[56] O'Brien (1990:79).

On the assumption that the strings in English virginals were equally close to their breaking points,[57] some comparisons can be made with the above-mentioned instruments. If iron was used as the treble stringing material of English virginals, the instruments at V, with a c^3 string length of 6 inches, should have a pitch of between 441 and 503 Hz – the extreme limits found in Tables 2.20 – 2.23. Most of the evidence suggests a pitch level between about 467 and 485 Hz. This level is one to two semitones above modern pitch. The virginals at lower pitch levels would produce pitches a semitone, a tone, or three semitones below that, approximately 450, 425, and 403 Hz respectively.[58] Were English virginals to use brass treble strings, the four pitch standards would be approximately 389, 367, 346, and 327 Hz.[59]

It is also possible to make direct comparisons between English virginals and instruments from other schools. Comparing English virginals with virginals of the Ruckers family show that both the treble and bass string lengths are consistent with the same treble stringing material, as can be seen when graphed on semi-logarithmic paper (see Graph 2.3). All the evidence suggests that the Ruckers family used iron for the treble stringing of their instruments, and the offset lines on the graph support the use of iron treble stringing on English virginals.

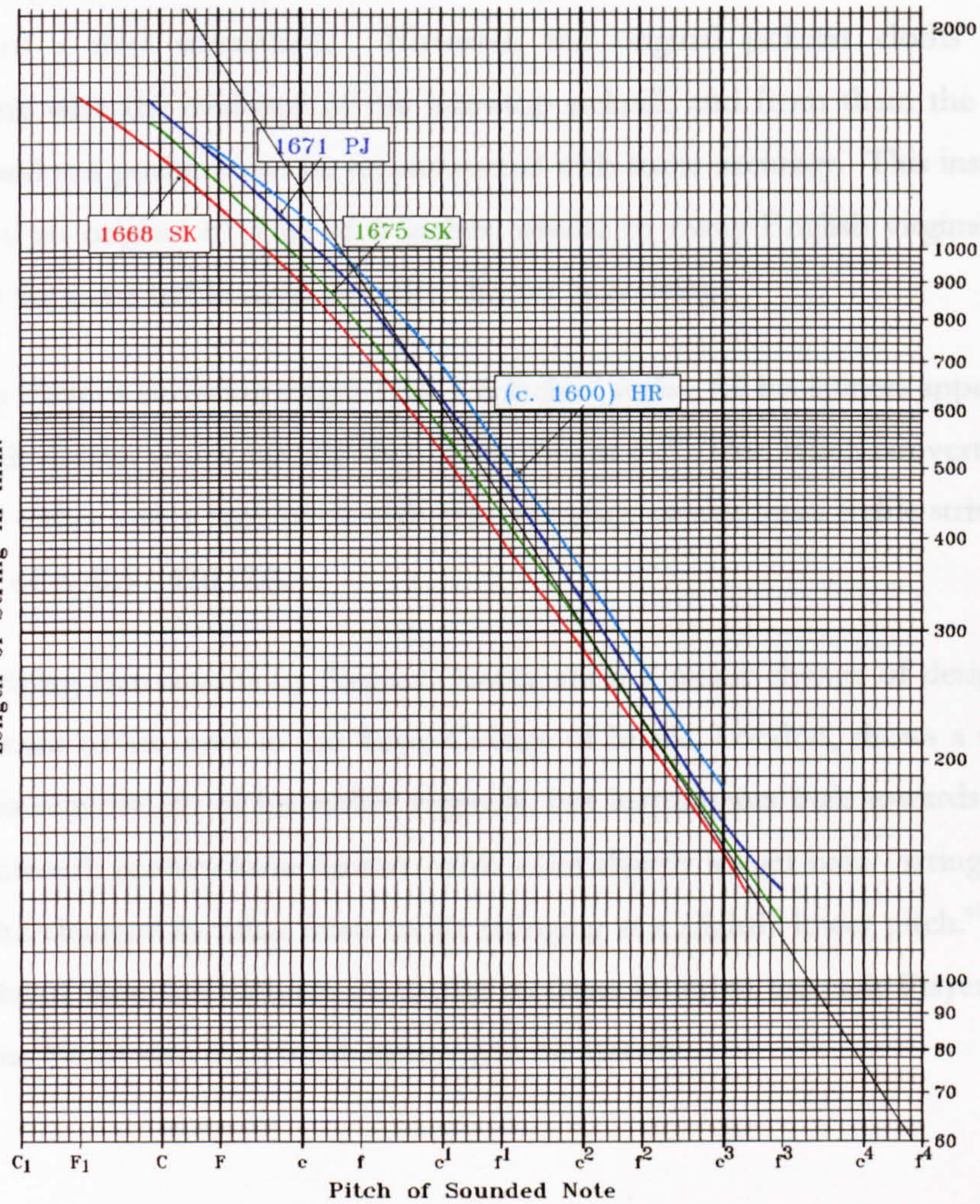
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[57] As there is a large foreshortening in the treble section of a number of surviving English virginals it appears that the scaling-design note string must have been tuned fairly close to its breaking point for the less stressed strings to sound at all well.

[58] The frequencies given are those used by Haynes (1995) as his interpretation of the English quire pitch grid system. V would be 474 Hz.

[59] The brass pitch standards have been calculated at 350 cents below the corresponding iron levels. The evidence shown in Table 2.25 would suggest the pitch levels should perhaps be even lower.

Graph 2.3 – Graph showing virginals from the "Keene workshop tradition" compared to a Ruckers virginal which plays at R.



An examination of the scalings of early English bentside spinets also provides evidence for iron treble stringing. The spinet began to supplant the virginal in popularity around 1675, and the earliest surviving examples were probably built around 1680. Most of the makers of the early spinets were also makers of virginals, and according to written sources, harpsichords. In terms of numbers of surviving instruments three makers stand out, namely Charles Haward, Stephen Keene and John Player.

There are no surviving Haward virginals (unlike Player and Keene), but fortunately, enough spinets survive by these three makers to gain an idea of any

stringing and pitch changes compared to the earlier virginals. All of Haward's surviving instruments date from the 1680s. There is a harpsichord at Hovingham Hall, as well as a number of spinets. The harpsichord has undergone considerable alteration, including the fitting of a new wrestplank. However, the original jackrest cloths survive, corresponding with the evidence of the lute-stop jackrail, and from them the original wrestplank and nut position can be reconstructed with some accuracy. This instrument probably had an original c^3 scale of 6 inches, similar to many English virginals. The spinets have the same treble scale, but with shorter bass strings.

John Player's surviving virginal has a 6 inch c^3 scale. All his spinets appear to be designed with shorter scales, usually about 10 inches at c^2.[60] This, when converted to c^3, would imply either a very high pitch with iron stringing, or else brass treble stringing (at a pitch level of c. 425 - 450 Hz).

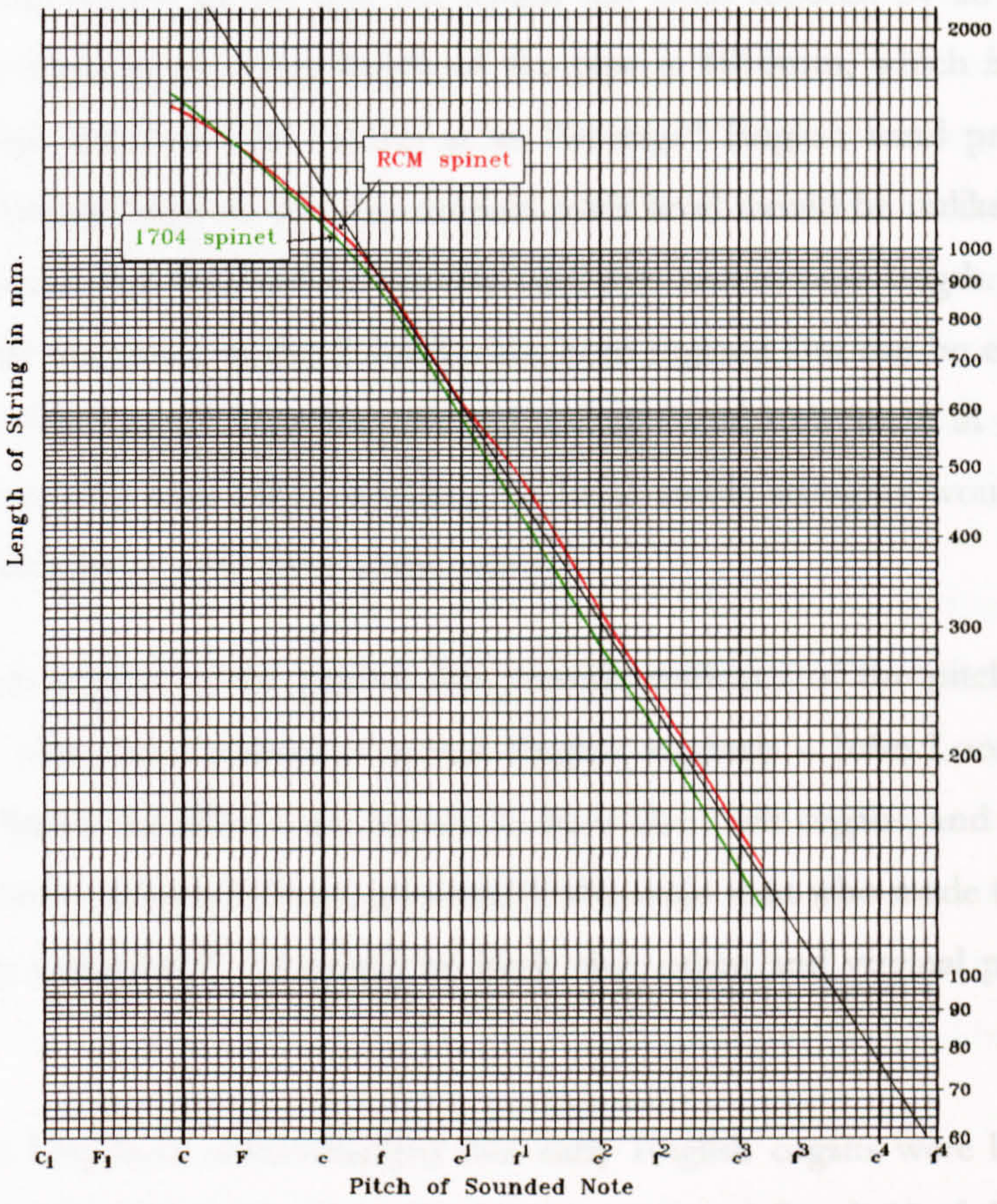
Surviving instruments by Stephen Keene show a major change of design. An early instrument of his, now in the Royal College of Music, London, shows a stringing layout that is reminiscent of his earlier virginals, but instruments built towards the end of the seventeenth century have shorter treble - but slightly longer bass - string lengths, suggesting he changed to using brass treble stringing at a slightly lower pitch.[61] As the string lengths of these instruments are similar to those found in the early Player spinets, it implies that Player also used brass stringing in his spinets.

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[60] English bentside spinets probably used c^2 rather than c^3 as their design-scale note. This is discussed further in Chapter Six.

[61] The changes that have taken place to the Hovingham Hall harpsichord built by Haward follow the same pattern, the original six inch c^3 design scaling being altered to a 10¼ inch c^2 scaling, also probably reflecting a change to brass stringing at a lower pitch.

Graph 2.4 - Semi-logarithmic graph plotting the string lengths of undated (RCM) and 1704 Keene Spinets[62]



A final piece of evidence to support the use of iron treble stringing can be found when examining the earliest surviving English plucked keyboard instrument - the Lodewyk Theewes claviorgan, dated 1579, now in the collection of the Victoria and Albert Museum, London.[63] This instrument appears to have built originally as a harpsichord, but converted soon after completion to a claviorgan by the addition of an organ underneath.[64] Although little of the instrument's action remains, it is possible to determine that the instrument originally had a C - c^3 chromatic compass. A single organ pipe survives which John Koster has identified from its note marking as being for the bass E^b. Koster made a reproduction of this pipe based on the measurements he was

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[62] RCM179, and Private Ownership, Ayr, B3 number KEENE, S. 1704.
[63] Museum No. 125-1890.
[64] For a full discussion on this instrument see the Catalogue, p. 337.

able to obtain during his examination, and from this reproduction has concluded that the pitch was between 1½ and 2 semitones below modern pitch.[65] An examination of the pipe by this author shows that the length has been reduced by an indeterminate amount. The present sounding length of the pipe is 1010mm, which is too short to sound the pitch concluded by Koster at an "average" English wind pressure.[66] The narrow pipe scaling suggests that the original pitch level would be unlikely to be more than a tone lower than the level obtainable with the current pipe length. The c^3 string length is a little uncertain, as the 8' bridge has been reglued, but can be estimated to be very close to 171½ mm.[67] This harpsichord scaling could only work in relation to the organ pipe assuming iron treble stringing, as brass treble stringing would be likely to cause the organ pipe to over-blow at the octave.

English organs of the period also provide evidence of the pitch levels of the virginals. At least three makers of extant English virginals – John Loosemore, James White, and Charles Rewallin – are known to have also built organs, and Thomas Body was apprenticed to a Joseph Body, presumably the same man who made the 1661 organ at Canterbury Cathedral.[68] It would be likely that organ and virginal pitches were at similar levels.

It has long been acknowledged that early English organs were built at pitches very different from those of today. In the sixteenth and first half of the seventeenth centuries organists usually had to transpose when they accompanied choirs. Early written records survive which show that the bass pipe was frequently 5 or 10 foot long, and the lowest note on the keyboard was C. Pipes of these dimensions suggests that the actual note produced by the played note C would be somewhere between modern G and $G^{\#}$. From an examination of surviving music it is clear that written organ parts were pitched a fifth below the vocal parts,[69] suggesting that the standard quire pitch in the sixteenth and seventeenth centuries was between two and three semitones above modern pitch (V + 1s).

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[65] The information on Koster's methodology comes from a PC, 2003. Koster measured the pipe as an open rather than stopped pipe. Barry (1990) has shown that the pipe was most likely a stopped 4', and therefore the true pitch should be a little higher than concluded by Koster.

[66] The pipe, with its present sounding length, would sound at a pitch of approximately 425 Hz.

[67] This measurement is based on a drawn reconstruction following a close examination of the original instrument.

[68] Jeffrey (1998).

[69] This is proven when looking at performance manuscripts where both the vocal and organ parts survive.

Both Haynes (1995) and Segerman[70] have used surviving contracts between organ-makers and churches as evidence to support this pitch standard. That Haynes should do this is interesting in view of remarks earlier in his thesis. In a section specifically dealing with the relationship between length and pitch standards,[71] Haynes quotes Adlung (1758) as warning against the expectation that organ pipes were necessarily the specifically quoted length, and then produces his own — separate — evidence citing Nuremburg-made woodwind instruments, suggesting there is no proof that instruments were built to specific lengths. More recently Haynes (PC, 2001) has informed me that he now accepts the views expressed by Gwynn (see below).

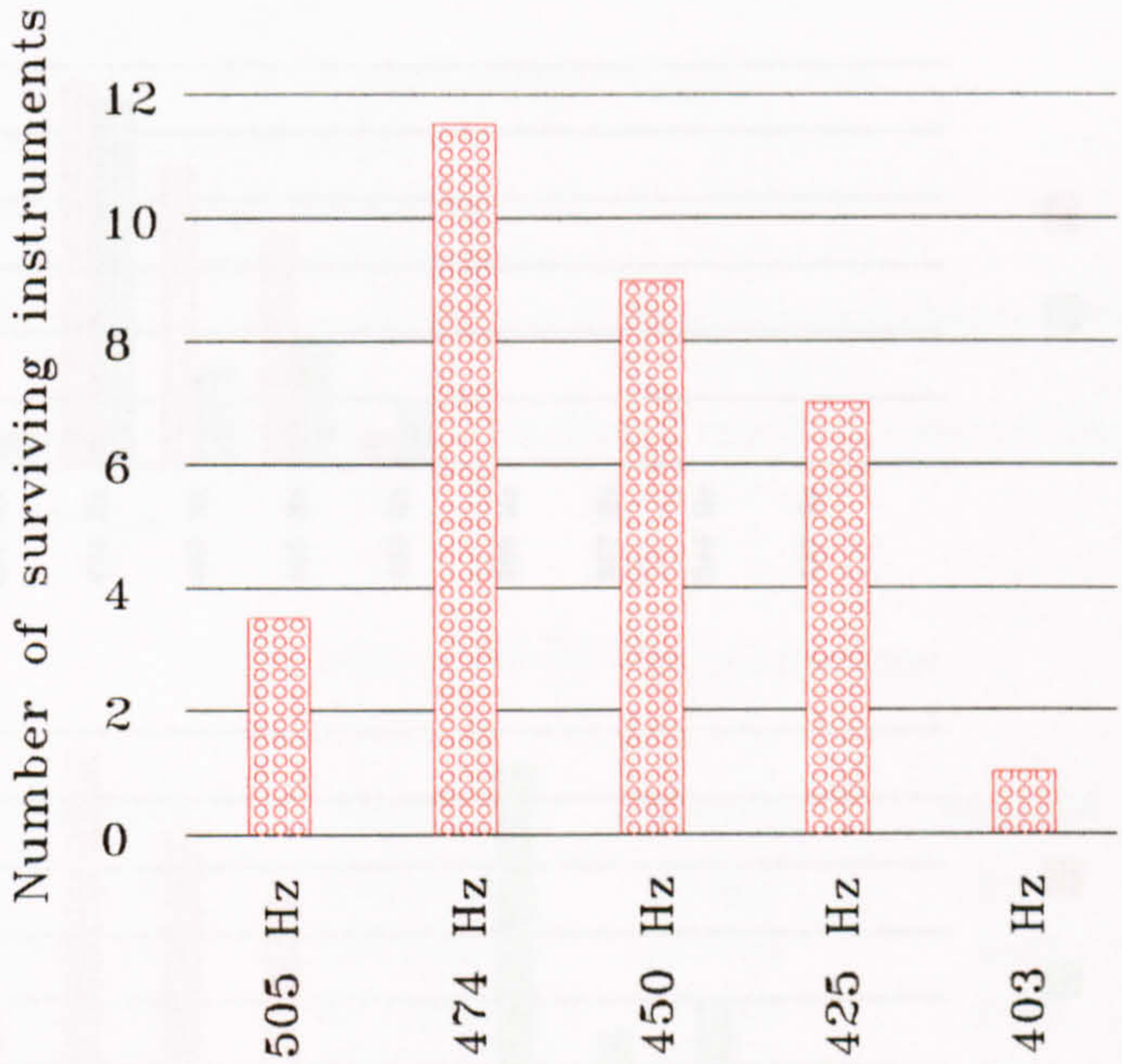
The evidence from contemporary documents is often not as clear as those supporting the 10 foot (exact) pipe length argue. Perhaps the best known document which may provide evidence to support the V + 1s pitch standard - the so-called "Duddyngton Contract" - is ambiguous in its wording, actually stating that "the pryncipalle to conteyne the length of v foote so following Wythe Bassys called Diapason to the same conteynyng length of x foot or more...".[72] This use of the terms "five and ten foot" appears to parallel the modern convention of defining organ registers in terms of 4, 8, or 16 foot length. The use of this present system can be dated back in England at least as far as the Talbot Manuscript, compiled around 1697.[73]

The most thorough examination of the surviving early English organs has been carried out by Gwynn (1985). Much of his information came from the instruments themselves, though often via altered pipe markings showing changes in pitch standards, and his work also quotes Ellis, who made a number of measurements in the nineteenth century using tuning forks. Haynes (1995) has used Gwynn's figures and added other instruments whose pitch has been determined since the publication of Gwynn's work. I have graphed these results, dividing any instrument outside the quire pitch system evenly between the upper and lower semitone groupings.

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[70] Segerman is a prolific writer, and has contributed a number of papers on the subject of English organ pitch. These need to be read along side the alternate opinions he disagrees with. On the subject of the English organ see his articles in FoMRHI (1991), (1992/1), (1992/2), and (1994).
[71] Haynes (1995:39).
[72] Quoted in Bicknell (1996:28).
[73] Dominic Gwynn (PC) informs me that the references to 8' pitch schemes in the Talbot Manuscript does not necessarily imply that such a pitch scheme was in use in England, as it refers to stop lists copied by Talbot from Mersenne.

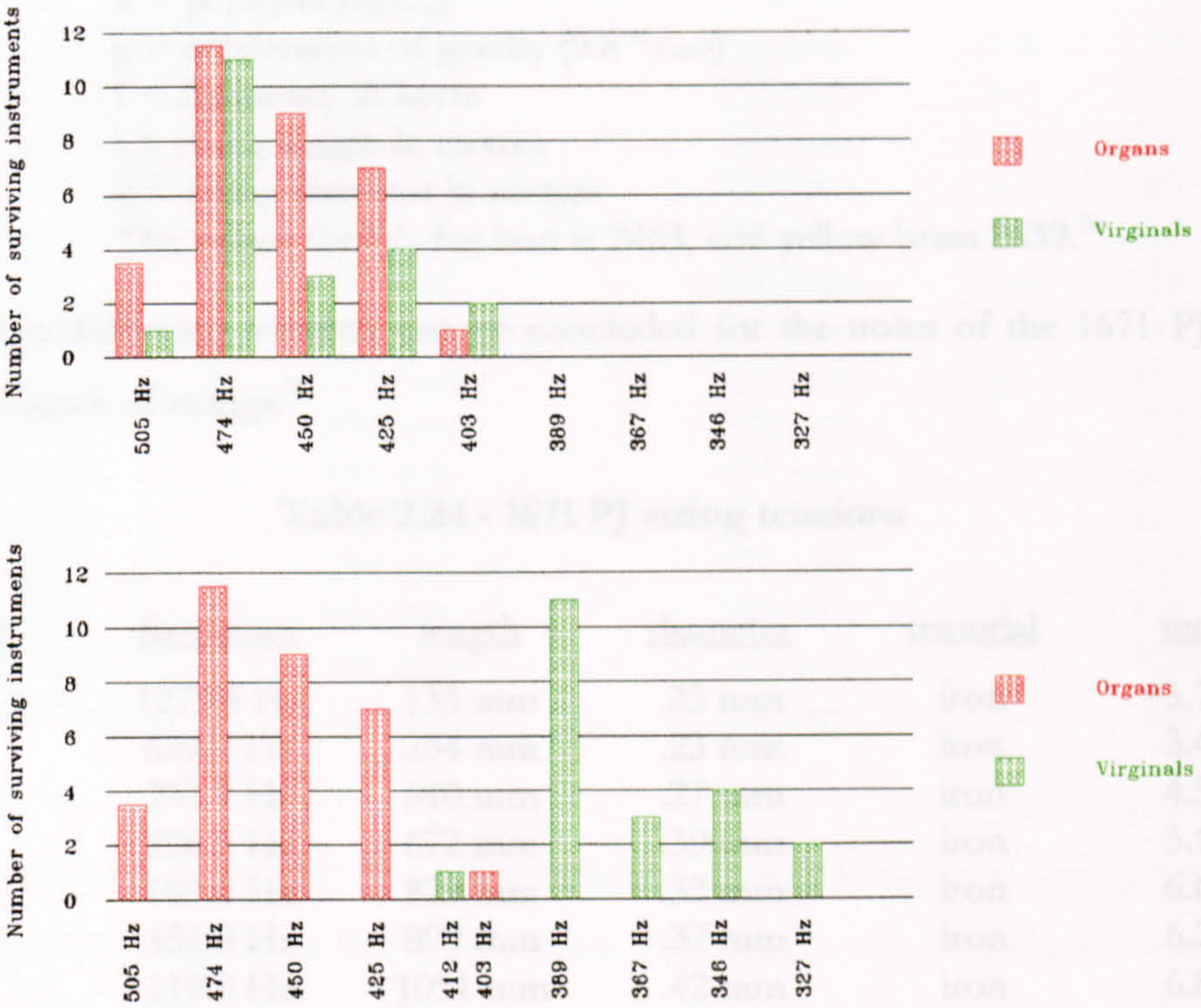
Graph 2.5 – The numbers of English organs which played at different pitch levels.



Although there is a number of instruments which support the evidence that 10' pipes were built to that specific length, sounding at a pitch level of approximately 505 Hz (two to three semitones above modern pitch), considerably more organs are at a pitch a semitone below that, at approximately 474 Hz. On the basis of the large amount of surviving primary evidence, Gwynn considers this was the common seventeenth-century quire pitch. It is notable that this pitch – one to two semitones above modern pitch – has been calculated as the likely pitch of English virginals which play at V, assuming iron wire in the treble.

Comparing all of the surviving English virginals with the evidence from organs, it can be seen that the virginals and organs have a similar relationship of surviving instruments at each of the four different pitch standards assuming iron wire, as can be seen in the top graph on Graph 2.6, but are all lower in pitch than the organs were they to be strung in brass, as seen in the lower graph. This would appear to confirm the use of iron wire as the virginal treble stringing material.

Graph 2.6 – A comparison of the surviving English virginals (in their proposed pitch groups)[74] to the organs, assuming iron stringing in the treble (top graph) and brass treble stringing (lower graph).



It seems most probable that V, the highest found in surviving English virginals,[75] is therefore at the same level as Gwynn's quire pitch, that is, between one and two semitones above modern pitch, and that all of the virginals were strung with iron treble stringing.

STRING DETAILS AND TENSIONS

As has been shown above (page 54), there is only one English virginal (1671 PJ) retaining strings that are from the historical period. The other information in this chapter has shown that iron treble stringing was used; given a likely indication of the pitch levels in use; and how the makers designed their scales for the different pitch levels. It is therefore possible to give information on string tension for this instrument.

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[74] Two virginals – the AH and the 1656 JW – are divided evenly between the two highest pitch-groupings.
[75] Not including the 1638 TW, which is a child virginal whose mother instrument is missing.

The formula for determining string tension is $T = {}^{p\pi}/_{g} \cdot (fld)^2$, where

T = string tension in kilograms
p = string material density
π = pi (3.1415927...)
g = acceleration of gravity (9.8 $^{m}/_{sec^2}$)
f = frequency in hertz
l = string length in metres
d = string diameter in metres
The values for ${}^{p\pi}/_{g}$ for iron is 2463, and yellow brass 2639.[76]

The following tensions can be concluded for the notes of the 1671 PJ which retain evidence of strings.[77]

Table 2.24 - 1671 PJ string tensions

Note	frequency	length	diameter	material	tension
f^3	1279.4 Hz	133 mm	.23 mm	iron	3.77 kg
f^2	639.7 Hz	254 mm	.23 mm	iron	3.44 kg
$c^{\#1}$	253.9 Hz	610 mm	.27 mm	iron	4.31 kg
b	226.2 Hz	672 mm	.30 mm	iron	5.12 kg
$f^{\#}$	169.4 Hz	829 mm	.37 mm	iron	6.65 kg
e	151.0 Hz	899 mm	.37 mm	iron	6.21 kg
c	119.8 Hz	1051 mm	.42 mm	iron	6.89 kg
F	79.97 Hz	1353 mm	.43 mm	brass	5.71 kg
C	59.91 Hz	1546 mm	.49 mm	brass	5.44 kg

The brass/iron transition is uncertain, but was probably between B and c. This can be compared to the transition scalings found in instruments from other schools.[78]

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[76] O'Brien (1981:167).
[77] A pitch level of 403 Hz has been assumed.
[78] The scalings for the instruments by Ruckers, Willbrook, Shudi, Kirckman, Blanchet and Taskin are from O'Brien (1981:163). The Donzelague information is from Rose and Law (1991:10). The Antegnati and Jadra measurements are from Wraight (1997). The design scale (f^2) has been converted to its c^2 equivalent scale. The (Couchet)-Taskin measurements are from Koster (1994). The measurements of the Bertolotti, Pisaurensis, Jones and the (Goermans)-Taskin are by the author.

Table 2.25 - Transition scalings in instruments from different schools

Maker	iron scaling (c^2)	brass scaling (c^2)	cents difference
Antegnati (W533)	340 mm	278 mm	338
Jadra (W168)	353 mm	242 mm	654
Bertolotti (W41)	351 mm	268 mm	467
Pisaurensis (W387)	333 mm	238 mm	581
Ruckers	356 mm	290 mm	355
1671 PJ	**355 mm**[79]	**263 mm**	**519**
Donzelague	365 mm	275 mm	490
Willbrook	357 mm	264 mm	522
Shudi	346 mm	279 mm	373
Kirckman	345 mm	275 mm	393
Hamburg	362½ mm	285½ mm	413
Blanchet	357 mm	278 mm	433
Taskin	364 mm	293 mm	376
(Couchet) Taskin	344 mm	270 mm	419
(Goermans) Taskin	365 mm	296 mm	363

Although the 1671 PJ has a low transition scaling, it is almost identical to that of the English harpsichord by Willbrook, dated 1730, and is also very close to the French harpsichord by Donzelague (1711). It is possible that low transition scalings were normal on earlier instruments.[80]

It is also possible to calculate tensions for the stringing used on the 1641 GT following the work carried out on it in the eighteenth century, as it may reflect the original stringing found on the instrument. On the basis of the pitch evidence presented above, it must be concluded that brass stringing was used between the two written indications, and iron stringing was used in the treble.

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[79] The string length for c^2 has been calculated by taking the scaling-design note (f^3) and multiplying by 4/3 (to convert to c^3) and then by 2.

[80] This would seem to agree with the evidence found on the Jadra virginal (dated 1552). Wraight was inclined not to believe the string information on the instrument, but primarily due only to the low transition scaling.

Table 2.26 - 1641 GT string tensions

Note	frequency	length	gauge	diameter[81]	material	tension
e^3	1273.6 Hz	137 mm	4	.229 mm	iron	3.93 kg
c^3	1010.8 Hz	172½ mm	4	.229 mm	iron	3.93 kg
f^2	674.6 Hz	246 mm	5	.256 mm	iron	4.45 kg
c^2	505.4 Hz	328½ mm	6	.286 mm	iron	5.55 kg
f^1	337.3 Hz	473½ mm	8	.359 mm	iron	8.10 kg
c^1	252.7 Hz	643½ mm	8	.359 mm	iron	8.39 kg
f	168.7 Hz	865 mm	9	.401 mm	iron	8.43 kg
c	126.4 Hz	1055½ mm	10	.449 mm	iron	8.84 kg
F	84.33 Hz	1295 mm	12	.562 mm	brass	9.94 kg
C	63.18 Hz	1500 mm	13	.629 mm	brass	9.38 kg

Several other instruments from the period to 1710 have gauge numbers as well. The 1668 SK has gauge numbers which are almost certainly nineteenth-century and refer to Birmingham Wire Gauge.[82] Spinets by Charles Haward (c. 1685)[83] and Stephen Keene (1704),[84] and a harpsichord by Thomas Barton (1709)[85] all have gauge numbers, and the Talbot Manuscript (c. 1685)[86] lists gauge numbers along with measurements of a single-manual harpsichord.

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[81] The diameters used in this table are from O'Brien (1981:166).
[82] I would like to thank Grant O'Brien who provided me with a reasonable explanation of the gauge's meaning.
[83] B3 number HAWARD, C. 1685(A). Information kindly provided by John Watson.
[84] B3 number KEENE, S. 1704. on loan to the Russell Collection.
[85] B3 number BARTON, T. 1709. Collection of Dr Rodger Mirrey, London. Information kindly provided by Grant O'Brien.
[86] Och Mus. MS 1187.

Table 2.27 - Stringing of instruments before 1710

	1641 GT	1668 SK	1671 PJ	Haward	Talbot	Keene	Barton
f^3	4	-	.23 mm	-	-	-	-
e^3	4	-	(.23 mm)	-	-	-	-
e^{b3}	4	-	(.23 mm)	-	-	-	-
d^3	4	1	(.23 mm)	4	1	4	1
$c^{\#3}$	4	1	(.23 mm)	4	1	4	1
c^3	4	1	(.23 mm)	4	1	4	1
b^2	4	1	(.23 mm)	4	1	4	1
b^{b2}	4	1	(.23 mm)	4	1	4	1
a^2	4	1	(.23 mm)	4	2	5	1
$g^{\#2}$	4	1	(.23 mm)	4	2	5	2
g^2	4	1	(.23 mm)	4	2	5	2
$f^{\#2}$	5	1	(.23 mm)	4	2	5	2
f^2	5	1	.23 mm	4	2	5	2
e^2	5	1		4	2	5	2
e^{b2}	5	1		4	2	5	2
d^2	6	1		4	2	5	2
$c^{\#2}$	6	1		4	3	6	3
c^2	6	1		5	3	6	3
b^1	6	1		5	3	6	3
b^{b1}	7	1		5	3	6	3
a^1	7	1		5	3	6	3
$g^{\#1}$	7	1		5	3	6	4
g^1	7	1		5	3	6	4
$f^{\#1}$	8	2		5	3	6	4
f^1	8	2		5	3	6	4
e^1	8	2		6	3	6	4
e^{b1}	8	2		6	3	6	4
d^1	8	2		6	3	6	5
$c^{\#1}$	8	2	.27 mm	6	3	6	5
c^1	8	2		6	4	6	5
b	8	2	.30 mm	6	4	7	5
b^b	9	2		6	4	7	5
a	9	2		6	4	7	5
$g^{\#}$	9	3		6	4	7	5
g	9	3		6	4	7	5
$f^{\#}$	9	3	.37 mm	7	4	7	6
f	9	3	(.37 mm)	7	4	8	6
e	9	3	.37 mm	7	4	8	6
e^b	9	3		7	4	8	6
d	10	3		7	4	8	6
$c^{\#}$	10	3		7	4	8	6
c	10	4	.42 mm	7	4/5	8	7
B	10	4		7	5	9	7
B^b	11	4		8	5	9	7
A	11	4		8	5	9	

G#	11	4		8	5/6	9	
G	11	5/6		8	5/6	9	
F#	12	5/6		8	5/6	10	
F	12	6	.43 mm	9	5/6	10	
E	12	6		9	6/7	10	
Eb	12			9	7	10	
D	13			9	8	11	
C#	13		-	-	-	11	
C	13		.49 mm	9	8/9	11	
BB	-		-	-	-	10	
BBb	-		-	-	-	-	-
AA	-			9	9/10	11	
GG#	-	-		-	-	-	-
GG	-			9	11	11	
FF	-	-		-	-	-	-

Notes on the above table :

A line in a column indicates a change of stringing material.

A dash (-) indicates that the particular note does not exist on the instrument in question. A blank space indicates that the gauge number is unknown. Two listed gauges (eg. 9/10) indicates the correct gauge is one or the other of those two gauges.

It should be pointed out that the use of gauge 1 in the treble of the Talbot and Barton instruments probably does not indicate lighter stringing, but instead that there was a change of gauge system at some time around 1700.[87] The tensions, when calculated for all of the instruments suggest that gauge 1 on those instruments was the same as gauge 4 on the 1641 GT, Keene and Haward instruments.

[87] If we assume the same gauge system was in use on instruments which went to gauge 1 in the treble, the calculated string tensions are much lower than those of any historical school.

ENGLISH VIRGINAL CONSTRUCTION

THE ORDER OF CONSTRUCTION

In many instances the order of construction used in the manufacture of an English virginal can be deduced, as later parts have to fit pre-existing pieces. Fitting these later parts can often obscure the various working methods used for the earlier processes. For example, applying mouldings to the front of the faceboards hides the type of joint used between the case ends and faceboards. It should be emphasised that there is no reason to believe that all makers used the same order of construction. In fact, as shall be shown below, individual makers sometimes changed working methods from instrument to instrument. In order not to overcomplicate this chapter, reference is made to various Catalogue entries that will discuss some practices specific to individual makers or instruments in more detail.

The order of construction used for some of the major parts can be impossible to determine, as the end result would be visually identical. This is particularly relevant when considering if an instrument was built from the "outside-in" – where the case is designed and made first, and the soundboard and action then fitted inside; or built "inside-out" – commencing with the baseboard or soundboard layout, and once completed then building the case around it. The first method was characteristically used in "Northern" traditions, as found in instruments by the Ruckers family and their followers; whereas the "inside-out" method is commonly found in Italian instruments, in which the design can sometimes be found drawn on the baseboard of an instrument. Although most English virginals have construction lines on top of the baseboard, often indicating the position of the frames and faceboards, there is no example of an English virginal in which the full design has been marked-out on the baseboard. This does not preclude the possibility that the "inside-out" method was used, but with the instrument's construction built around the soundboard rather than the baseboard.

In attempting to determine the order of construction, it is best to give a brief examination of the parameters a maker needed to incorporate into his design, or, in other words, his design concepts. He had a desired pitch level with a corresponding

scaling-design note string length (and, by extension, a limit on the string lengths lower in the compass, which cannot proportionally exceed the scaling-design note string length). He had a selected keyboard width for his desired compass.[1] He had geometry constraints and preferences, which placed practical limits on the instrument's length and width, and the left-to-right position of the keywell within the case structure; and he had to ensure an acceptable perpendicular distance between the strings, and to avoid basic errors such as the right keywell side interfering with the lowest strings.

The simplest way to attempt to determine if an instrument was built from the "outside-in", or "inside-out", is to examine the external and internal case dimensions converted into units of the English inch.[2] This can most easily be seen in the "Case Details" Comparative Table, page 261, in which all of the major case parts have their external and internal dimensions expressed in inches. As an examination of that Table shows, neither the external or internal measurements have a consistency that suggests a regular use of simple inches as the basis for a construction "recipe".[3] Two possible alternatives are that makers were not concerned with specific dimensions for the casework, or that another design method was used. Design methods that have been proposed by other authors (albeit for other types of instrument) include constructive geometry,[4] the use of modules,[5] and the use of different "*schuchs*".[6] An exhaustive test using the measurements of surviving English virginals shows that none of these methods produces results which support any of these design methods.[7]

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[1] Birkett and Jurgenson (2001) have argued that the keyboard width was not specifically designed in some instruments, but the result of chance based on geometric design originating elsewhere.

[2] The use of Antwerp *duimen* in "outside in" construction is described by O'Brien (1990). The use of *oncia* in Italian instruments conforming to an "inside out" construction can be found in O'Brien (1999).

[3] The 1664 RH is an individual exception, where the use of the inch is so consistent that he clearly was basing the instrument on it. See Martin (2000/2) for a full discussion on that instrument. The use of the inch in that example may be as a result of Hatley designing the instrument to take an unusual (FF,GG-c^3) compass into account.

[4] This is best described as designing an instrument using a compass and straightedge. This method has been proposed by Birkett and Jurgenson (2001), and Speerstra (2000).

[5] See Gug (1990).

[6] See Koster (1998/1) and (2000/2). This method involves building one part in ratio to the previous part, so that an existing part becomes a "*neue schuch*" which is divided and then a number of those units becomes the length of the next piece.

[7] Koster (1998/1:22) proposes three "rules" to be followed when accepting the possibility of any analysis of an instrument. They are (using his words): 1) The analysis should be based on lines or points actually on the instrument, 2) the geometry, arithmetic, or mensuration should accord with theories, practices, or standards that were prevalent in the maker's own culture, and 3) the analysis should be repeatable, for example, on several instruments of the same model or on several instruments of different models by the

The various methods proposed by O'Brien, Birkett and Jurgenson, Speerstra, Gug, and Koster make the assumption that the makers were concerned with achieving practical results that were very close to their design layouts.[8] However, two historical sources imply that exact measurement of case dimensions should not necessarily be expected. In 1699, Class Douwes[9] gives directions for a clavichord which is "four feet or somewhat longer",[10] and in the 1780's David Tannenberg wrote:-

> Zuerst wird das Gehäuse A gemacht, nämlich 4 Fuss oder auch etliche Zoll länger [je] nachdem man es haben will.
>
> First the case A must be made, namely 4 feet or also a few inches longer, according to the way one wants to have it.[11]

These vague measurements (both given in treatises that were specifically written to assist in the construction of real keyboard instruments) suggest that preciseness of case measurement may have been of minimal importance to some makers.[12]

As none of the possible analysis methods has produced an indication of any commonly used design approach, it is probable that the makers of English virginals were not concerned with achieving precise dimensional results, and, as an extension of this (although the sample is very small) it is unlikely that virginal makers regularly made any standard "models",[13] such as those of the Ruckers workshop or found in late-seventeenth- and eighteenth-century English spinets and harpsichords. This is perhaps surprising, but is probably a natural consequence of having to make instruments at a variety of pitch levels and compasses. In such circumstances the makers may have

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same builder. Using the last rule is difficult with the English virginal school, as only 5 makers have more than a single surviving instrument, but given the close workshop traditions of other makers, the last rule can be logically extended to cover different makers. Even instruments such as the 1664 RH technically violate the last of Koster's criteria. Perhaps a fourth criteria should be established to cover situations where there is only a single example of a maker's work - that there should be an internal consistency (ie. the method can be applied to the case and the soundboard, for example), *and* a large sample number of figures from which the theory has been based. This must be associated closely with Koster's first rule.

[8] Koster (2001) presents good reasons for why a practical craftsman would not necessarily be so exact in his workmanship whilst still adhering to an intended construction method. Although he used six-plank chests as the basis of his examples, the same methods could apply to instrument makers.

[9] Douwes (1699).

[10] The quoted section has been translated by Barnes (1994:75).

[11] See McGeary (1982). The quoted translation is McGeary's.

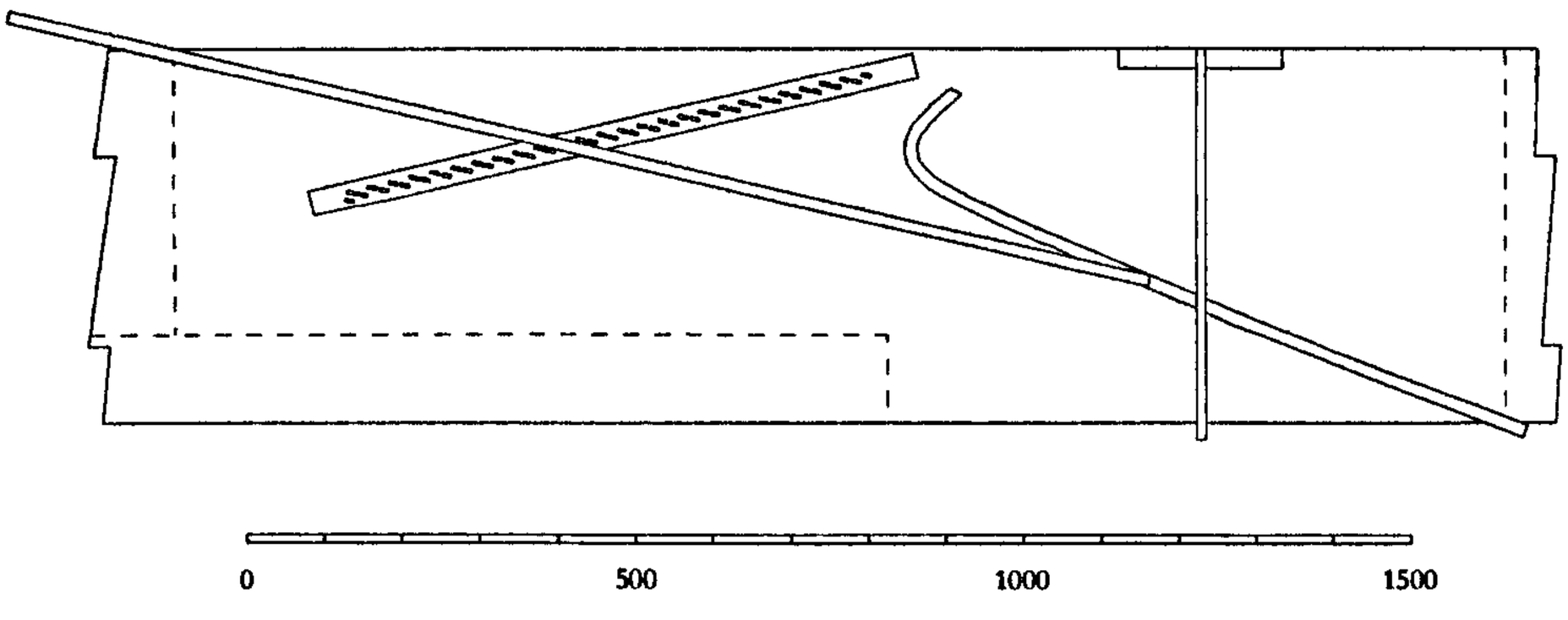
[12] The word "some" is not used in any pejorative sense. The makers may have been in the majority.

[13] It is possible that instruments were occasionally made in small "batches". Both the Mar and the 1655 JL have figures on them that *may* indicate batch production. The numbers may, alternatively, represent a sequence of instruments constructed using different designs.

thought it easier to layout each instrument individually. A similar situation appears to be found in Italian instruments of the sixteenth and seventeenth centuries.[14]

The lack of an identifiable method of design makes it difficult to establish the order of construction in English virginals. It does suggest, however, that the maker himself had control over the laying-out of the instrument, rather than being able to give a "recipe" for others in the workshop to follow. As the workshop would probably have been very busy – occupying the time of the master, one or more journeymen, and one or two apprentices – it would have been essential that the process of transferring the design parameters to the instrument be achieved quickly. Here it is essential to anticipate information which will be discussed later – makers used templates or marking-out sticks for the register, right bridge, and for marking the right bridge-pin positions onto the bridge. As the scaling-design note string length and the keyboard width[15] have been determined as design parameters, it is possible to use the templates and sticks and layout the instrument's design directly onto the soundboard. Only the position of the left bridge remains to be determined, and this was probably done using a long scaling stick with several of the *c* and / or *f* notes marked on it.

Figure 3.1 – Schematic diagram showing an overlong soundboard with the various templates used to layout the instrument's design.



[14] The surviving Italian pentagonal spinets seem to be made to different designs, and are also often found at different pitch levels (or, at the least, different scalings). It should be pointed out that, in the case of Italian instruments the lack of identifiable "models" does not in any way contradict the conclusions of O'Brien (1999) about the layout of those instruments.

[15] But *not* the keywell width. Instruments by the same maker using the same compass have different keywell widths, showing they didn't have a pre-determined marking-out stick or standard marking method for this process.

It would be possible to do a similar process on the baseboard and then build the case first, but this involves an extra process, and can probably be discounted (by an application of Occam's Razor,[16] and supported by the lack of direct evidence on the baseboard itself).

It is possible that the soundboard was used to mark-out the instrument, but was left over-long until the case was built, so that when it was glued in place it ensured a close fit between the edge of the soundboard and the case sides. It is also possible that some makers used the soundboard to mark out the instrument, and that other makers built the case first. Regardless of whether the soundboard or casework was used for the initial layout of the instrument, it was essential that the casework be completed before the soundboard can be installed. For that reason this chapter follows the order in which parts are likely to have been applied to pre-existing parts in the final assembly.

THE REDUCTION OF TIMBER

It is likely that timber in plank form was available in a much greater variety of sizes than obtainable today. It is possible that the wood was specially cut according to the virginal maker's instructions, but more likely it was purchased ready cut from a sawyer or importer.

The cutting of wood into planks is a laborious job. It required two workers – a sawyer, the more senior of the two, working from on top of the log, and the pitman working underneath the log. Together they operated a large handsaw, set to cut the seasoned wood to a pre-determined thickness. Once sawed into planks the wood was available for sale, and it is in this form that it would have been purchased by the virginal maker.

In England the cutting of wood was almost always done using the above method, with the work generally being done in a sawpit, a large oblong hole in the ground about six foot deep, three to four feet wide, and fourteen feet long.[17] Elsewhere in Europe (with the exception of Denmark, which also used sawpits), the logs were placed on high trestles and the lower worker at ground level. A water-powered sawmill

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[16] Occam's Razor (named after William of Occam) states that if any process can be shown to be superfluous then it reasonably certainly wasn't originally used.
[17] See Salaman (1974:442).

was set up near London in 1663 but soon closed due to the hostility of the sawyers,[18] though elsewhere in Europe powered sawmills had been in operation since before 1600. As England was not self-sufficient in wood from the sixteenth-century onwards, it is likely that some of the wood used by the virginal makers was cut in this manner.

Generally, only two woods were used for the construction of the corpus of an English virginal. Deal, probably pine, was used for the baseboard, spine, frames and faceboards, and oak was used for the case sides, keywell sides, lid and keywell flap. Usually, though not exclusively, the corpus wood is quarter-sawn, giving dimensional stability over the width of the planks, and reducing the risk of the wood warping due to changes of humidity.

The reduction of the timber from sawn-plank form to its finished state took place in the workshop, and was almost certainly the task of the apprentices. All of the corpus parts needed to be planed on both sides to obtain smooth finished surfaces. Although apprentices represented a very cheap source of labour, it is uneconomical to hand plane more wood than is absolutely necessary. The raw planks were selected so that an acceptable finished thickness could be obtained with a minimum of work.

The planks were probably purchased in large sizes, and would have been reduced to the approximate finished length and width before being planed. Once roughly dimensioned, one side of the plank would be smoothed to a finished state, and then the wood would be turned over and the other side finished. Parts which required edge gluing to obtain enough width (for example the baseboard, and occasionally the case sides) were probably glued after the first side was smoothed, and any unevenness in the glued planks cleaned up before commencing on the unfinished side.

Two factors can result in uneven finished plank thicknesses. As the planks were initially often sawed by hand they can often vary slightly in thickness. The wood may also warp slightly after being sawed. As it is essential to have the finished planks flat across their width, it is often necessary to plane more off one end than the other. The variation in finished thickness can be seen in the following tables.

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[18] See Hubbard (1965:200).

Table 3.1 - Thicknesses of the baseboard and spine

Instrument	Baseboard				Spine			
	L	M	R	diff.	L	M	R	diff.
1644 TW	12.9	12.3	12.4	**0.6**	13.2	13.0	11.2	**2.0**
1656 JW	9.0	9.1	10.6	**1.6**	10.0	-	9.0	**1.0**
1662 TB	11.0	11.4	12.9	**1.9**	9.4	11.0	12.0	**2.6**
1664 RH		n.o.		**n.o.**	10.1	9.9	10.1	**0.2**
1668 SK	12.8	16.9	13.6	**4.1**		n.o.		**n.o.**
1670 AL	10.8	12.8	11.8	**2.0**	12.9	13.2	13.4	**0.5**
1655 JL	13.0	13.6	13.8	**0.8**	8.8	9.8	7.8	**2.0**
1679 CR	13.8	14.8	13.6	**1.2**	9.8	10.6	9.2	**1.4**

Table 3.2 - Thicknesses of the case ends

Instrument	Left case end				Right case end			
	F	M	B	diff.	F	M	B	diff.
1644 TW	9.1	8.0	8.1	**1.1**	8.3	7.6	8.6	**1.0**
1656 JW	9.7	10.0	9.5	**0.5**	8.9	9.4	9.4	**0.5**
1662 TB	9.6	10.0	10.0	**0.4**	8.9	9.0	9.2	**0.3**
1664 RH	9.7	9.0	7.9	**1.8**	9.4	9.8	10.5	**1.1**
1668 SK	8.5	9.4	9.0	**0.9**	8.8	8.2	8.1	**0.7**
1670 AL	9.9	10.1	10.5	**0.6**	8.6	10.1	10.0	**0.5**
1655 JL	8.1	7.7	7.6	**0.5**	8.1	8.2	8.3	**0.2**
1679 CR	10.4	11.2	10.6	**0.8**	10.0	9.9	9.9	**0.1**

Table 3.3 - Thicknesses of the lid and keywell flap

Instrument	Lid				Keywell flap			
	L	M	R	diff.	L	M	R	diff.
1644 TW	7.8	8.3	8.4	**0.6**	9.3	9.9	9.2	**0.7**
1656 JW	8.1	8.1	8.5	**0.4**	9.9	8.8	9.5	**1.1**
1662 TB	10.8	10.5	10.9	**0.4**	11.2	10.8	11.7	**0.9**
1664 RH	8.6	8.6	8.3	**0.3**	10.0	8.7	9.4	**1.3**
1668 SK	8.4	9.1	8.1	**1.0**	6.9	8.8	8.3	**1.9**
1670 AL	8.3	8.3	8.8	**0.5**	8.6	9.4	9.8	**1.2**
1655 JL	6.6	6.5	6.4	**0.2**	7.2	6.8	7.0	**0.4**
1679 CR	6.0	7.2	7.5	**1.5**	12.0	11.0	10.1	**1.9**

Notes on the above tables :
The case parts were measured with a metal dial calliper to the nearest tenth of a millimetre. The measurements on the baseboard and lid were taken at the front, and those on the spine and keywell flap were taken at the top. The measurements were taken at the left and right ends (L and R) and at the midpoint (M). The measurements

of the left and right case ends were taken at the top at the front (F), midpoint (M), and back (B).

The figures in bold give the maximum difference (diff.) between the measurements.

Every effort was made to take the measurements at a part of the case where there was no damage that would give misleading figures. The various instruments listed have been chosen to give only a single example of any maker's work, and in the case of makers who have more than one surviving instrument, to be representative.

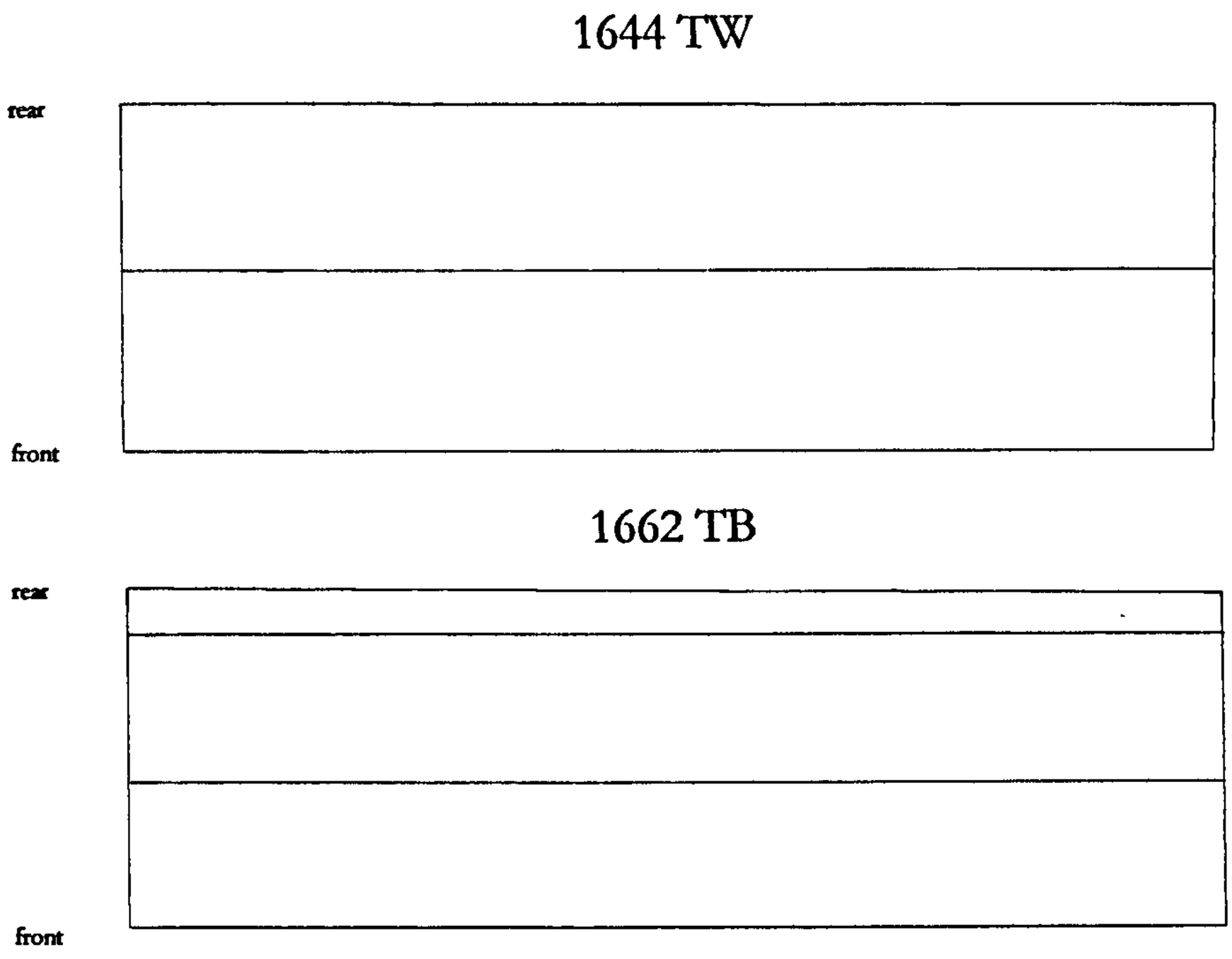
A small dash (-) indicates that no measurement was taken at that position. The letters n.o. mean that either the whole part, or the section used for measurement is not original

THE BASEBOARD

The baseboard is always of deal, probably pine (*pinus sp.*).[19] It is usually made from two wide planks jointed edge to edge, although three planks are occasionally found. When a third plank is used to make up the required width there is no attempt to make the three planks the same width, the extra plank is often only one to three inches, rather than the ten to twelve inches used for the other baseboard planks.

[19] Without scientific examination it is often impossible to determine whether conifer wood is pine, spruce or fir. Any unidentified wood shall be referred to as deal unless the exact species is known.

Figure 3.2 – Plan view drawing of the 1644 TW (top) and the 1662 TB (bottom) baseboards showing the planks cut to final dimensions.



The boards were glued – as were all of the other joints in an English virginal – with animal glue. Animal glue is made from various gelatine substances of an animal – the hooves, hide, and bones. The glue is dissolved in warm water and must be kept at a warm temperature (typically about 70° Celsius) to avoid setting before being applied to the wood. The parts to be glued should be heated to lengthen the working time before the glue gels. Once the glue cools and gels it is possible to remove any clamps and proceed with the next operation, although the glue does not obtain full strength until it has completely hardened, a process which usually takes about 24 hours.

Although the majority of the instruments have baseboards that vary in thickness by less than one millimetre over the front edge, others can vary by up to two or so millimetres. Usually the overall thickness is between ten and thirteen millimetres. Only one instrument – the 1638 TW child virginal – has a baseboard which is consistently

thinner than ten millimetres, and five instruments exceed thirteen millimetres, including all three of the Exeter-made instruments.

The thicknesses of the extant baseboards suggest that a finished thickness of a nominal half-inch was desired. The planks were probably about five-eighths or three-quarters of an inch thick in their rough sawn states.

CASEWORK

The main constructional strength of an English virginal is provided by the spine, case ends, faceboards, keywell sides, keywell liner and the baseboard, which combine to form an open-topped box. With the soundboard glued to the top of the keywell liner and the other case liners (effectively closing the box) the resulting structure is very strong.

There is little variation in the materials that were used for the various case members. The spine is almost always of deal, only the non-original 1641 GT (lime) and (also non-original) AH (oak) instruments being different.[20] The case ends are oak with the exceptions of the 1641 GT (walnut), 1679 CR (deal), and 1638 TW (deal).[21] The faceboards are almost always deal, covered by mouldings and pressed papers, the only exception being the left faceboard of the 1671 PJ (lime). The keywell sides are generally oak, although walnut is used on the 1664 JP and 1668 SK instruments, and deal has been used on the 1662 TB, 1670 AL, and 1679 CR virginals.

The following tables show the spine length, total front length, and case end lengths for various English virginals.

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[20] The spine of the 1664 JP is also not original, though is deal.
[21] The 1638 TW is a child virginal, and has the case ends decorated with mouldings and embossed papers identical to those on the faceboards and keywell. The deal is not visible except from underneath.

Table 3.4 - Lengths of the spine and total front

Instrument	Spine			Total front			diff.
	T	B	diff.	T	B	diff.	
1641 GT		n.o.		1752	1745	7	**n.a.**
1644 TW	1694	1693	1	1686	1687	1	**8 / 6**
1656 JW	1672	1671	1	1669	1669	0	**3 / 2**
1662 TB	1699	1699	0	1702	1701½	½	**3 / 2½**
1664 RH	1673	1674	1	1678	1674	4	**5 / 0**
1668 SK	1821	1821	0	1824	1820	4	**3 / 1**
1670 AL	1705	1704	1	1698½	1701	2½	**6½ / 3**
1655 JL	1733	-	-	1731	1732	1	**2 / -**
1679 CR	1656	1656	0	1660	1658	2	**4 / 2**

Table 3.5 - Lengths of the case ends

Instrument	Left case end			Right case end			diff.
	T	B	diff.	T	B	diff.	
1641 GT	542½	540	2½	541½	542	½	**1 / 2**
1644 TW	548½	548½	0	548	549	1	**½ / ½**
1656 JW	517	517	0	517	516	1	**0 / 1**
1662 TB	531½	532	½	528	528	0	**3½ / 4**
1664 RH	522	521	1	519	519	0	**3 / 2**
1668 SK	547	551½	4½	551	552	1	**4 / ½**
1670 AL	547	541	6	547	544	3	**0 / 3**
1655 JL	517	521	4	514	520	6	**3 / 1**
1679 CR	528	529	1	528	528	0	**0 / 1**

Notes on the above tables:
The measurements were taken with a metal retractable rule, and were taken to the closest half millimetre.

The tables list the lengths at the top (T) and bottom (B) of the various parts. The diff. measurements for each case part indicate the difference in length between the top and the bottom for that part. The **diff.** distances in bold in the right column indicate the difference in the measurements at the top (first figure) and bottom (second figure) of the spine to total front (in Table 3.4), and left and right case ends (Table 3.5).

Every effort was made to take the measurements at a part of the case where there was no damage that would give misleading figures. The various instruments listed have been chosen to give only a single example of any maker's work, and in the case of makers who have more than one surviving instrument, to be representative.

A small dash (-) indicates that no measurement was taken at that position.

As can be seen from the above tables, a number of the case parts show differences between the top and bottom lengths exceeding two millimetres, and likewise, there are equally large differences between the spine and total front lengths, and between the left- and right- case end lengths on various instruments. Any postulated case construction method must take these differences into account.[22]

The differences in length of the various case parts from top to bottom makes it difficult to determine how the actual lengths of the pieces of wood were decided. O'Brien (1990:69) has shown that Ruckers virginals had case lengths and widths which work out accurately as integral or half-integral units of the Flemish *duim*, and it seems reasonable that the English virginal makers would also use easily memorised measurements for their instruments.[23]

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[22] It should be noted that the differences in length at the top and bottom of the total front might be explained by the fact that there are various separate pieces that make up the total front length. Small inaccuracies in any of these parts can cause larger dimensional differences at the top of the case.

[23] O'Brien (1990:69) gives figures with variations of up to 9% of an inch as an acceptable working error in his Table 5.1. An examination of his Catalogue measurements (pages 236 - 276) show that a larger variation existed in Ruckers instruments. Using 6-*voet* muselar virginals as an example; the 1620 IR has a width of 19.13 *duimen*, and the 1622 IR a width of 18.86 *duimen*. These variations (chosen at random) amount to about ±3.75 mm from the intended measurement. Two 4-*voet* virginals built by the same maker in the same year (1613a AR, and 1613b AR) shows a 4 mm difference in widths (17.16 and 17.00 *duimen* respectively). A full analysis of the measurements provided in the catalogue shows that although a large number of instruments do work out accurately as units of the *duim*, other instruments can be a quarter-*duim* away from O'Brien's figures in his Table 3.1.

The following table lists the actual case lengths followed by the inch measurements for the spine and case ends of the extant English virginals.

Table 3.6 – Case measurements and inch equivalents (arranged according to identifiable workshop tradition, and then by date).

Instrument	Spine metric	Spine inches	L. case end metric	L. case end inches	R. case end metric	R case end inches
Mar	1652	65.09	505	19.90	505	19.90
1638 TW	914	36.01	448	17.65	448	17.65
1642 TW	1647	64.89	521	20.52	521	20.52
1644 TW	1693	66.71	548½	21.61	549	21.63
1651 TW	1657	65.29	517	20.37	519	20.45
1656 JW	1671	65.84	517	20.37	516	20.33
1661 JW	1697	66.86	533	21.00	533	21.00
1641 GT	n.o.	n.o.	540	21.28	542	21.36
1668 SK	1821	71.75	551½	21.73	552	21.75
1675 SK	1773	69.86	515	20.29	517	20.37
1671 PJ	1744	68.71	558	21.99	560	22.06
1684 TB	1775	69.94	552	21.75	548	21.59
1666 AL	1692	66.67	516	20.33	515	20.29
1670 AL	1704	67.14	541	21.32	544	21.43
1655 JL	1733	68.28	521	20.53	520	20.49
1675 CR	1626	64.07	528	20.80	526	20.72
1679 CR	1656	65.25	529	20.84	528	20.80
1662 TB	1699	66.94	532	20.96	528	20.80
1664 RH	1674	65.96	521	20.53	519	20.45

Notes on the above table:
The measurements were taken with a metal retractable rule, and were taken to the closest half millimetre.

Every effort was made to take the measurements at a part of the case where there was no damage that would give misleading figures.

Only the measurements from the bottom of the case parts have been quoted.

The above table illustrates the problems associated with trying to determine the method that the maker actually used in constructing his instrument. Statistically the measurements, when converted into inches, show fairly random results, with about 30% of the figures being able to be expressed as whole- or half-inches, and another 35% being expressed as one-quarter or three-quarters of an inch, giving a total of about 65% of the measurements falling into quarter-unit divisions. By choosing to express the

results in quarter-inch units one would then be forced to explain why a maker would deliberately choose to make an instrument (for example) 71¾ inches long instead of 72 inches.[24] As only 30% of the measurements can be expressed as whole- or half-inches it is must be concluded that makers either used a different method of obtaining the case dimensions, used a different unit of measurement,[25] or were not especially concerned with precise case dimensions.

If (as suggested above) the soundboard was used to layout the instrument's design before the case was built, it would be the resulting internal dimensions that would be expected to be an integral number of inches. The possibility that the inside case dimensions rather than the outside measurements were used by the maker can be discounted by compiling a table similar to 3.6. Only one maker, James White, has instruments which work out as simpler fractions of the inch when the inside measurements are used. The only other likely scenario, that the maker's rulers were of slightly different lengths, is reasonable,[26] but taking large numbers of measurements from the various instruments has not proved conclusive, as shown in Chapter Two.

An examination of the nominal inch measurements shown in Table 3.6, along with the inaccuracies found in the case lengths (Tables 3.3 and 3.4), suggests that precise accuracy was not of prime importance to most makers. Few spine lengths can be best defined as a half-inch rather than a whole inch, so it is likely that the maker wanted the case length to be 66 inches, he would have been willing to accept deviations of plus-or-minus a half-inch. That neither the external nor internal case dimensions can be commonly expressed as units of the inch suggests that – as shown to happen with six-plank chests[27] – the dimensions of the case probably reflect inaccuracies in the construction process. Cutting the wood to length is a job to be entrusted to apprentices, and this probably explains the discrepancies found in the top and bottom

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[24] As found in the 1668 SK.
[25] The possibility that makers used their own "workshop ruler", which bore no resemblance to the local unit of measurement has been discussed by Birkett and Jurgenson (2002). An application of their proposed methods suggest that the practice was not used on English virginals.
[26] This is discussed in Chapter Two, page 42. The rulers were probably made by the makers themselves copying existing rulers. That they would be slightly different from each other is almost inevitable.
[27] See Koster (2001:9).

lengths of some pieces, as shown in Tables 3.4 and 3.5. The case ends were probably considered in terms of the nearest half-inch.[28]

The case height of English virginals is usually between 8½ and 9 inches. The only instrument that has a height exceeding 9 inches is the 1668 SK, which has a maximum height of 249 mm (9¾ inches). The 1638 TW child virginal is shallow due to it having had to fit below the soundboard of its (now missing) mother. The AH and Mar virginals are both also shallow, the AH being a maximum of 191 mm (7½ inches), and the Mar 184 mm (7¼ inches). The only other virginal which measures less than 8½ inches is the 1656 JW, which is 212 mm high (just over 8¼ inches). Differences in case height of 2 - 3 mm are not uncommon in an instrument, suggesting that the planks were purchased, or cut to, a nominal 9 inch width, then edged once the boards were thicknessed. A final cleaning up would have been carried out once the case was assembled.

It is likely that the construction of the case itself commenced with planing the case members to the appropriate width, and then marking the outside ends of the spine and cutting it to length. The spine was probably measured using a yardstick commencing at one of the edges. Repositioning the yardstick to obtain the full length of the spine may partially explain some of the case length inaccuracies.[29] Once the length had been marked, a line would be scribed from one edge to the other, acting as a guide when sawing and planing the spine to length.

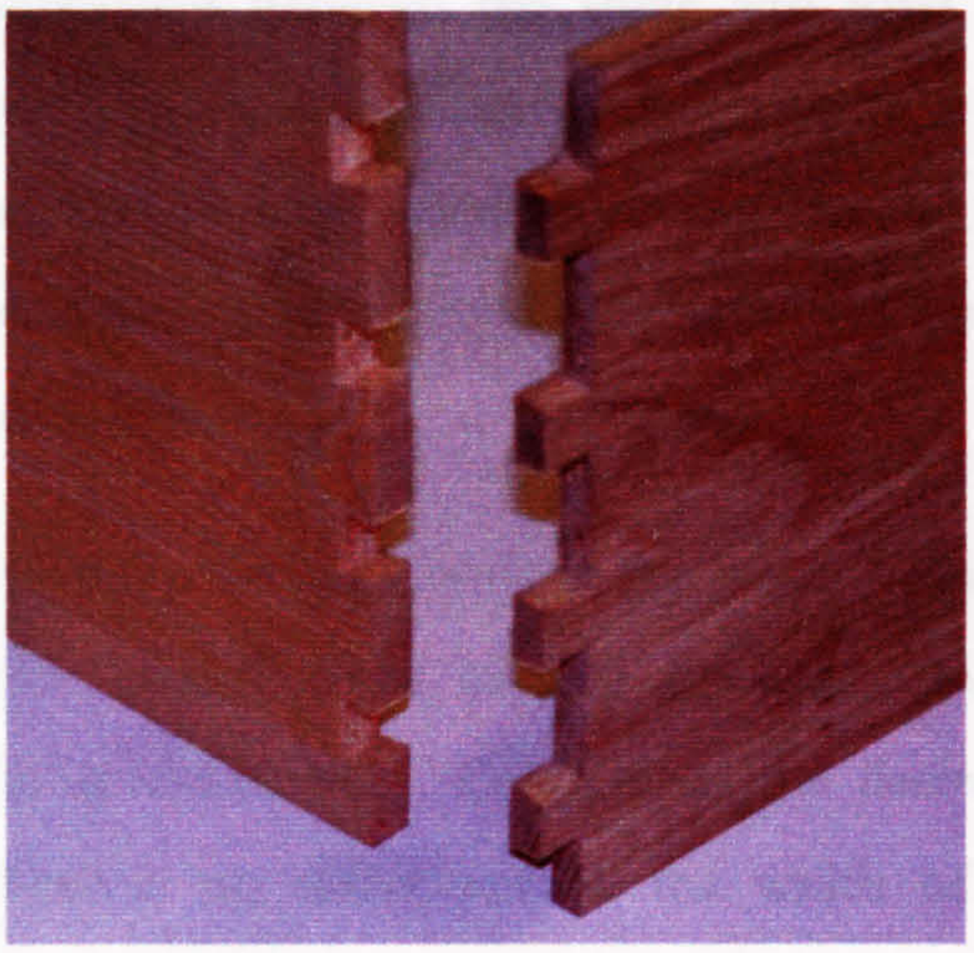
The joint between the spine and the case ends is almost always a dovetail, cut so that the decorative "tails" are visible on the spine.[30] To make the dovetail joint the maker would have rested the spine flat on the workbench, and positioned the rear-end of the case end on top, with its outside edge aligning with the end of the spine, and a line would be scribed on the spine along the inside edge of the case end. The same method would be used to mark the spine thickness onto the case end. Once the guide

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[28] The case ends are more critical for the practical layout of the instrument since the string band, the angle of the strings, and the distance of the bridges to the case members must all be taken into consideration.
[29] A yardstick is, of course, only 36" long. The maker would have needed to mark the end of the yardstick, and then reposition it so that the "zero point" was at this mark to obtain the full spine length.
[30] The exceptions include the 1671 PJ which has a butt joint, and the 1684 TB which is lap-jointed. The AH virginal has the case ends butted to the (non-original) spine, and there is no evidence to determine the type of the original joint. The types of join between the case parts of the 1638 TW are not observable due to the decoration around the instrument and a thin veneer of cedar on the spine.

lines were marked on both pieces, a template or jig[31] would have been used to mark the dovetail pin angles on the case ends. Once marked, the dovetails on the case ends were cut and cleaned up to a finished state. The finished case end was then placed on the spine and the position of the tails marked directly from the case end onto the spine. Once the tails were cut and cleaned up the joint is ready to be glued.

Plate 3.1 – Exploded (above) and closed (below) views of dovetail joint between the spine and left hand case end



[31] The jig need be no more than an adjustable bevel set to an appropriate angle.

When the spine and case ends were assembled the baseboard was probably cut to size. The spine and case ends almost always overlap the baseboard in surviving English virginals, although the spine sits on the baseboard in the 1656 JW, 1664 RH and 1668 SK instruments.[32] Once the back edge of the baseboard was planed straight, the assembled case members would be placed on the (over-length) baseboard with the inside of the spine aligning with the planed back edge of the baseboard. The baseboard would then have been scribed along the inside edges of the case ends. There is a difference of several millimetres between the spine and total front length of most English virginals, suggesting this method was used, as opposed to marking the inside edge at the back and then using a large set-square to ensure the ends of the baseboard were perpendicular to the spine. Once scribed, the baseboard would have been cut and planed to its finished dimensions.

The distance in between the case ends at the front is taken up by the left- and right faceboards, and the keywell. The keywell distance consists of space for the keyboard, and endblocks at either end. Other than the desire to ensure a visually satisfying appearance, there is no restriction on the width of the endblocks. The following table gives the length of the left and right faceboards, and the total keywell width for the extant English virginals.

[32] The bottom of the spine of the 1668 SK is not original, but the baseboard is original, showing that the baseboard must have always overlapped the spine.

Table 3.7 - faceboard and keywell measurements

Instrument	L. faceboard metric	L. faceboard inches	keywell metric	keywell inches	R. faceboard metric	R. faceboard inches
AH	258½	10.18	701	27.62	542	21.36
Mar	246	9.69	702	27.66	689	27.15
1638 TW	118	4.65	709	27.94	87	3.43
1642 TW	289	11.39	706½	27.84	632½	24.92
1644 TW	265	10.44	791½	31.19	613	24.15
1651 TW	266	10.48	755½	29.77	619	24.39
1656 JW	251	9.89	718	28.29	682	26.87
1661 JW	253	9.97	803	31.64	620	24.43
1641 GT	240	9.46	770	30.34	720	28.37
1664 JP	238	9.38	808	31.84	711	28.01
1668 SK	211	8.31	825	32.51	767½	30.24
1675 SK	229	9.02	803	31.64	725	28.57
1671 PJ	160½	6.32	802	31.60	757	29.83
1684 TB	213½	8.41	822	32.39	718	28.29
1666 AL	254	10.00	818	32.23	605	23.84
1670 AL	264	10.40	821	32.35	594	23.40
1655 JL	210	8.27	697	27.46	807½	31.82
1675 CR	224	8.83	748	29.47	636	25.06
1679 CR	237	9.34	739	29.12	661	26.04
1662 TB	253	9.97	819½	32.29	612	24.11
1664 RH	152	5.99	819	32.27	685	26.99

Note on the above table:
The measurements were taken with a metal retractable rule, and were taken to the closest half millimetre.

The faceboard measurements have been taken from the inside of the case end to the faceboard / keywell side corner.

It is clear from the working methods that have been postulated above that the total width inside the case ends is the result of chance, and therefore it is not to be expected that all three measurements work out as integral units (or simple fractions) of the inch by design. However, the possible lack of concern with achieving precise case dimensions does not necessarily imply that makers did generally use specific dimensions for either the faceboards or the keywell. Most English virginals have scribed lines on the baseboards along the inside edge of the keywell sides (which is also the end of the faceboards), and it might be expected that these positions were marked to be a specific measured distance from the ends of the baseboard. It is clear from Table 3.7 that there

is no consistency amongst the surviving virginals as an entire group, although an analysis of individual makers instruments may suggest practices that were specific to themselves. For example, the virginals by Adam Leuersidge have left faceboards which are both simple fractions on the English inch (the left faceboard of the 1666 AL can be expressed as 10", and the 1670 AL 10½" long), and the keywell widths are very similar in both instruments. However, examining the instruments by other makers who have more than a single surviving example of the work shows that there is nothing to support the view that any of these dimensions were deliberately intended to be simple units of the English inch.

The faceboards and keywell sides sit on, and are glued to, the top of the baseboard. The front of the faceboards is generally about 15 - 17 mm behind the front edge of the case ends. Two different methods of joining the faceboards to the case ends can be determined. The simplest, though structurally weaker, method was a simple butt joint, with the faceboard butting up to the case end. To provide some added strength makers used four or five evenly spaced oak dowels, usually about 8 mm diameter through the case ends into the end of the faceboards. This type of joint was used by the White family and Adam Leuersidge. The other type of joint that is found is an elongated mortice-and-tenon. A mortice, usually about a quarter of an inch wide, was cut into the case end, and the end of the faceboard was reduced in width and is let into the case end, providing a very secure joint. All other makers used this type of joint.[33]

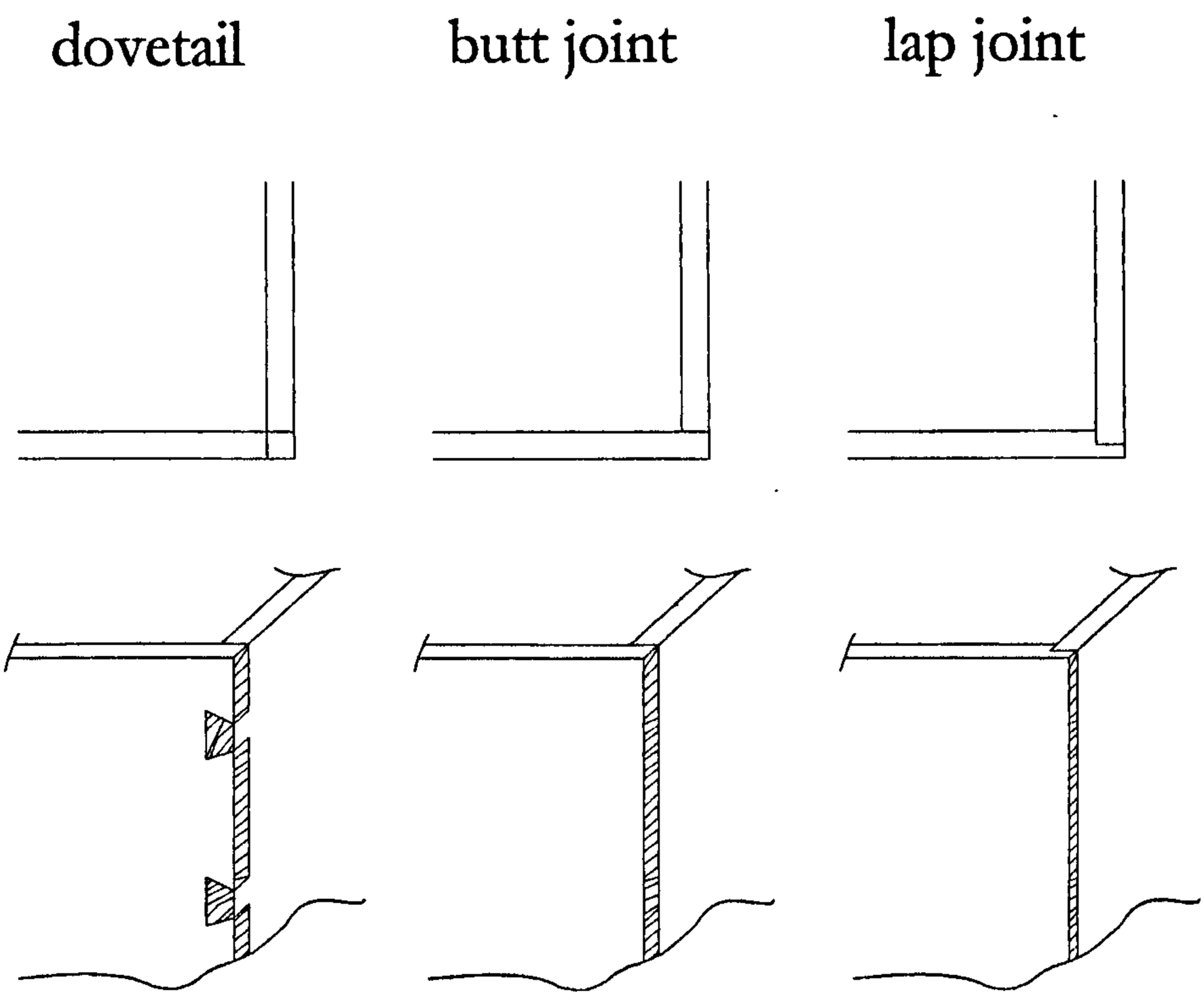
[33] The AH is another exception owing to its very different style. The maker of this instrument used a dovetail joint on the corners.

Plate 3.2 - Exploded view of the mortice-and-tenon joint used between the case ends and faceboard



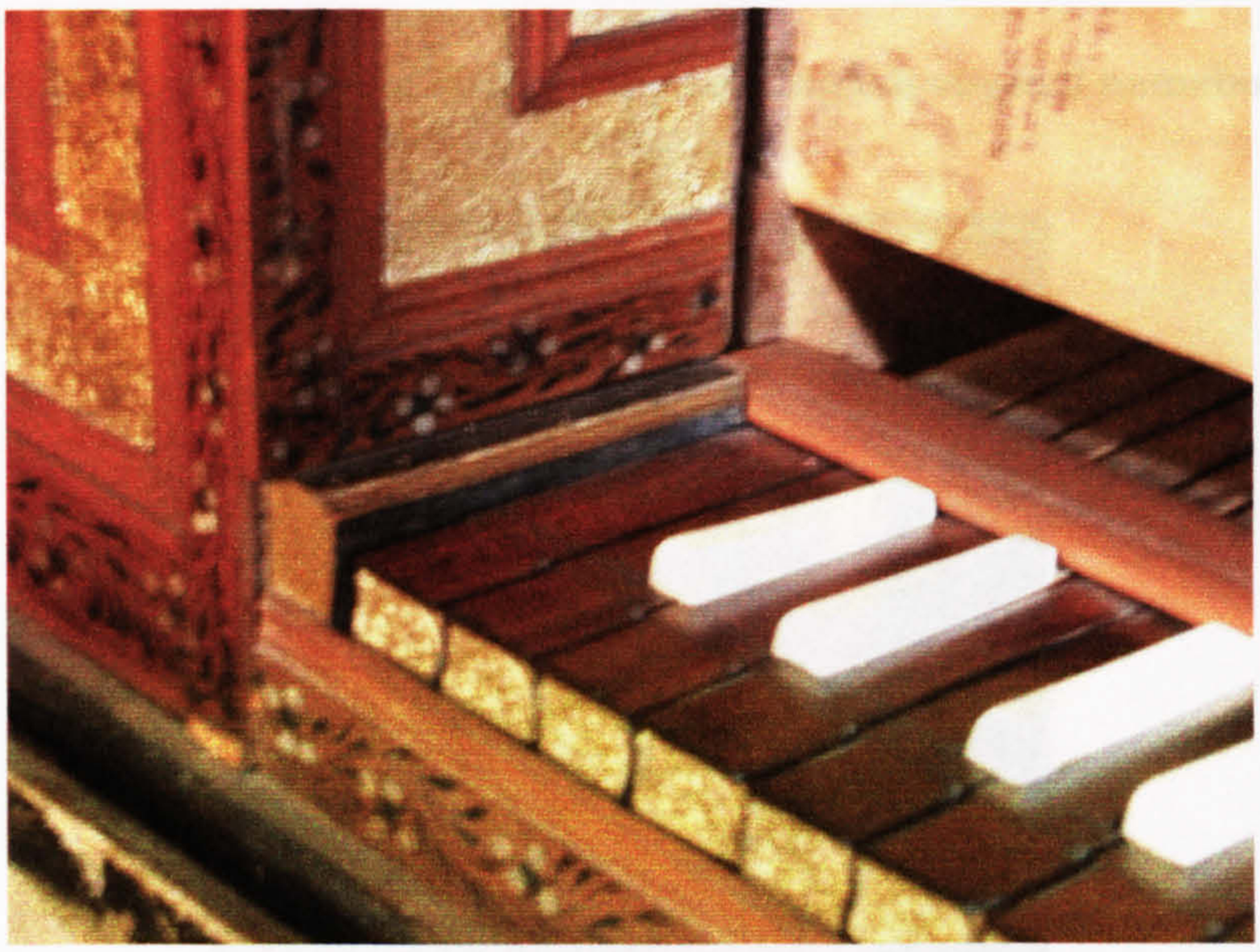
In most of the surviving English virginals there is a dovetail joint between the faceboards and keywell sides, with the decorative tails on the faceboard. In the 1664 JP and 1655 JL instruments a simple butt joint was used, with the faceboards overlapping the keywell sides, and in the two instruments by Rewallin a lap joint was used, again with the faceboards overlapping. Because of the faceboard decoration it is impossible to know if the joints on these four instruments are also doweled.

Figure 3.3 – Top- and perspective views of the various types of joint between the faceboard and keywell sides.



The keywell sides are typically between 4½ and 5 inches long, measuring from the front edge of the faceboard (not including the decoration). A vertical slot was cut near the distal end of the keywell sides to position the nameboard and allow it to slide in and out. This slot is usually about one-quarter of an inch wide and deep. For ease of construction the slots were cut before the keywell sides were glued to the faceboards. After the keywell sides and faceboards were assembled the faceboard would be attached to the case ends.

Plate 3.3 – View of a slot for the nameboard, just in front of the keywell liner (1668 SK).



The nameboard is always of deal. The top of the nameboard is the same height as the top of the keywell sides and faceboards. The depth of the nameboard depends on the total case height, and the distance between the top of the baseboard and the top of the keyboard. Normally it is around 150 mm (6"), with the bottom edge no more than 2 mm above the top of the natural touchplates at the back.[34] Nameboards typically taper in thickness from top to bottom, normally being around 10 mm at the top and 8 mm at the bottom. The back of the nameboard is reduced in thickness at the ends to fit into the keywell side slots, and the length also tapers slightly from top to bottom.

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[34] Several instruments have a "dustcatcher" in between the top of the keys and the nameboard. An example (albeit of a replacement) can be seen in Plate 3.3.

Figure 3.4 – Drawing of a typical nameboard (applied mouldings are not shown).

top view

front view

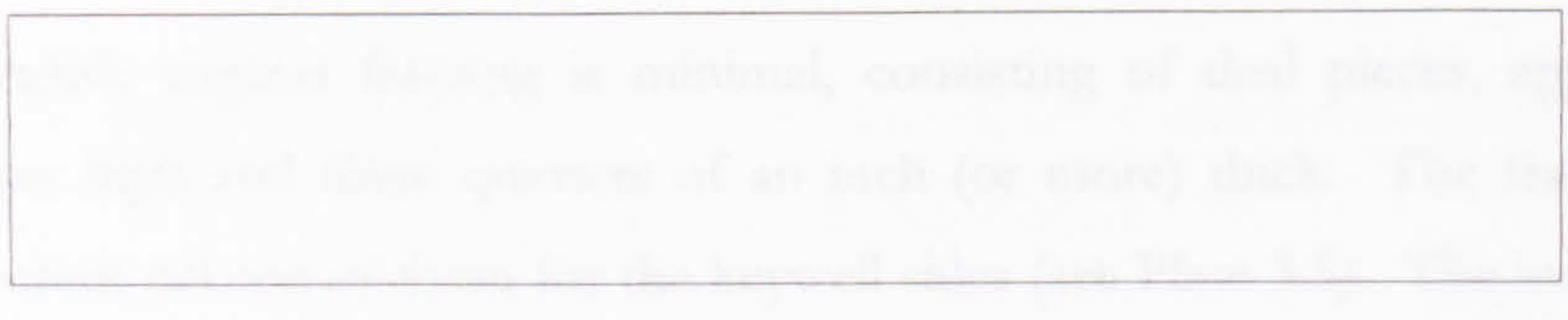
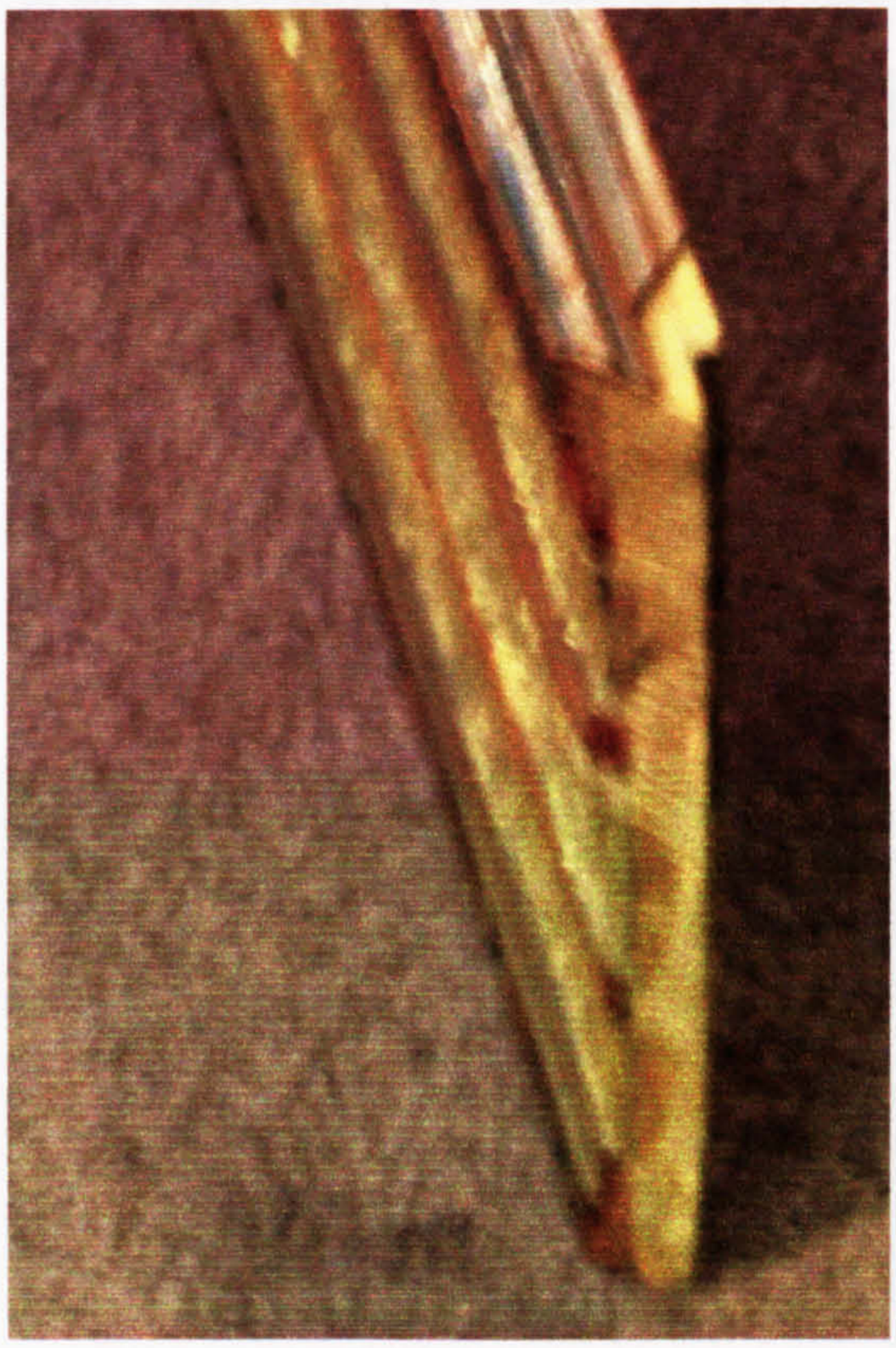


Plate 3.4 – Photograph of the end of a typical English virginal nameboard (1668 SK).



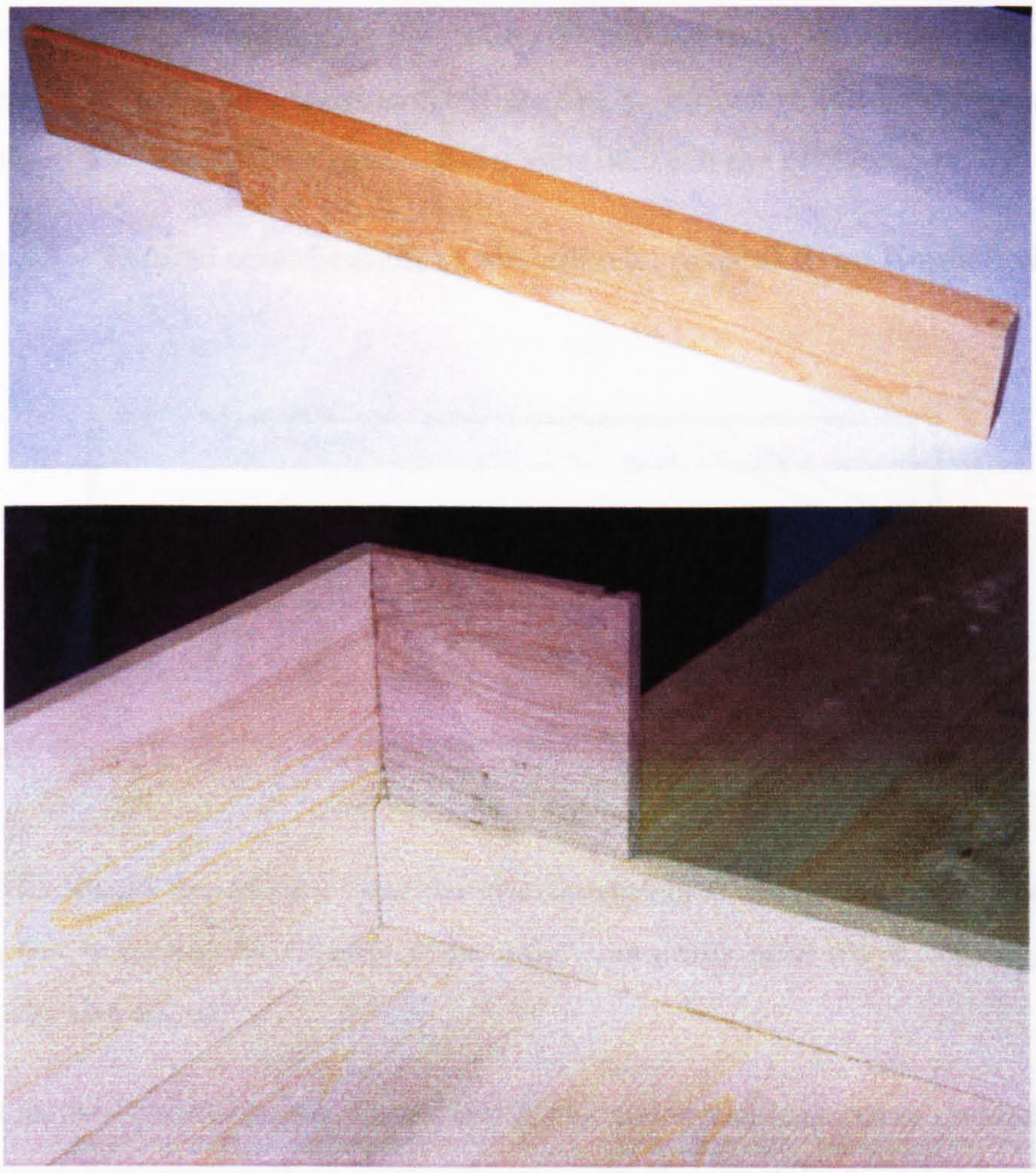
It is impossible to know at what stage the baseboard was actually glued to the case members. Although it must have been in position when the faceboards were joined to the case ends to ensure the placement at the correct height, it need not

necessarily have been glued until the late stages of construction. There are no dowels from the case ends into the edge of the baseboard, although nails can occasionally be seen. The nails might have been used as an aid to clamping the case ends to the baseboard when they were glued together.

INTERNAL FRAMING

English virginal framing is minimal, consisting of deal pieces, approximately three inches high and three quarters of an inch (or more) thick. The frames have a rebated section cut out of them for the keywell sides (see Plate 3.5). The inside edge of the frames are in the same front-to-back line as the inside edge of the keywell sides.

Plate 3.5 – View of a typical frame showing the rebated section (above), and attached to the baseboard, spine and keywell side (below).



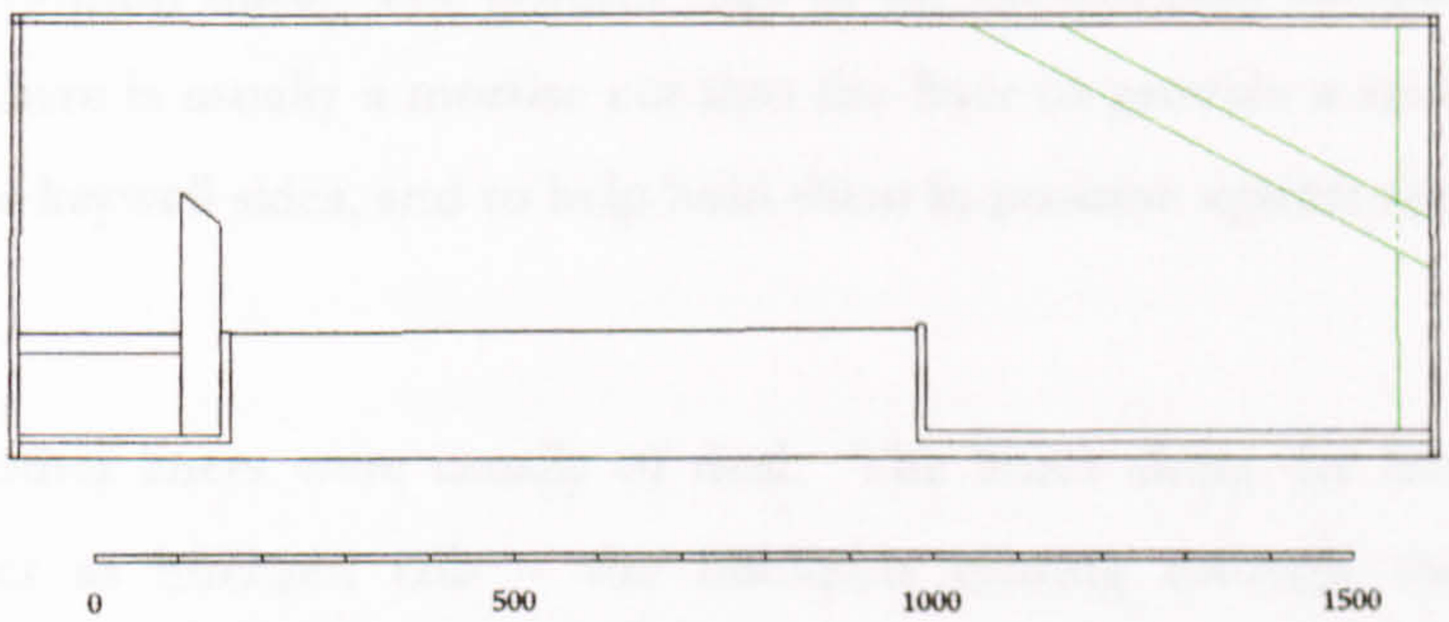
The frames normally span the whole width of the instrument, butting up to the faceboards and the spine. Occasionally there are large nails from the spine into the frames. Without removing a baseboard it is impossible to determine if the spine was morticed to receive the frames.

There is always a scribed line on top of the baseboard to mark the inside (and, where it can be determined, the outside) position of the frames. These lines, along with scribed lines parallel to the front of the baseboard, are construction guide-lines which were used to position the case members on the baseboard.

WRESTPLANK AND LINERS

With the exception of the virginals by Keene and Jones, all of the English virginals have wrestplanks on the right side. The wrestplanks are divided so that the bass wrestplank is glued along the right case end, and the treble wrestplank is at an angle to the case end and spine, approximately parallel to the tenor and bass regions of the right bridge. The wrestplanks have half-lap joins between the two sections.

Figure 3.5 – Typical arrangement of wrestplanks (green) in an English virginal.

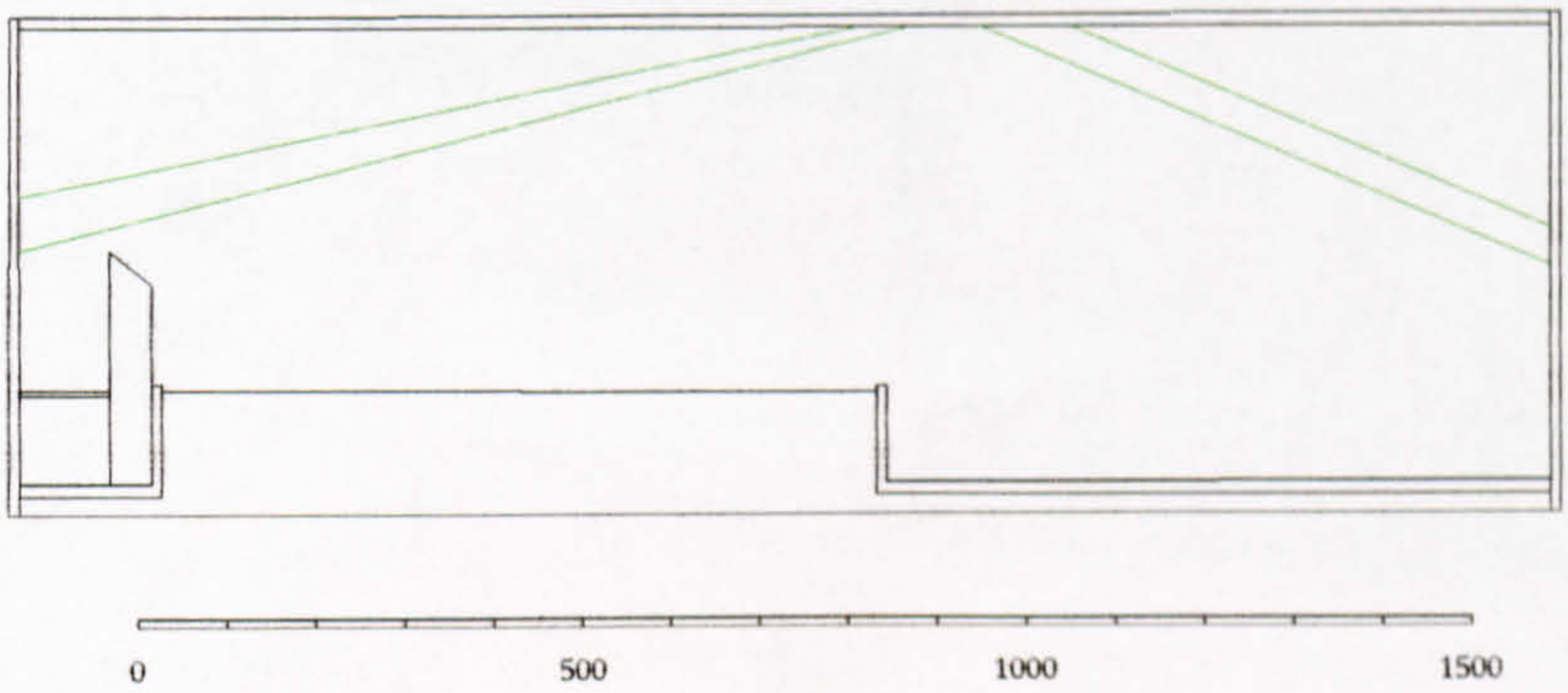


Hardwood was always used for the wrestplanks. Identification is sometimes difficult, but it appears that beech is the most commonly used wood, although oak is occasionally also found.

On the instruments by Keene and Jones, the wrestplanks were divided so that treble tuning pins were in their usual position, with the wrestplank angled between the spine and right case end. The bass tuning pins were positioned on the left side and rear

of the instrument, into a separate wrestplank which was angled between the left case end and the spine. This arrangement is similar to that found in the spinett-type virginals built by members of the Ruckers family, where the hitchpins are placed into a wide solid piece which extends under the left bridge.[35]

Figure 3.6 – Wrestplank arrangement (green) found in 1668 SK, 1675 SK and 1671 PJ virginals.



The keywell liner has an important structural role, providing the strength at the front of the case between the keywell sides. It is usually made of quarter-sawn deal, generally about three inches (75 mm) deep and between one-half and three-quarter inches (13 – 19 mm) thick. The bottom edge of the keywell liner sits on the top of the frames, and there is usually a mortise cut into the liner to provide a stronger joint with the rear of the keywell sides, and to help hold them in position against the tension of the strings.

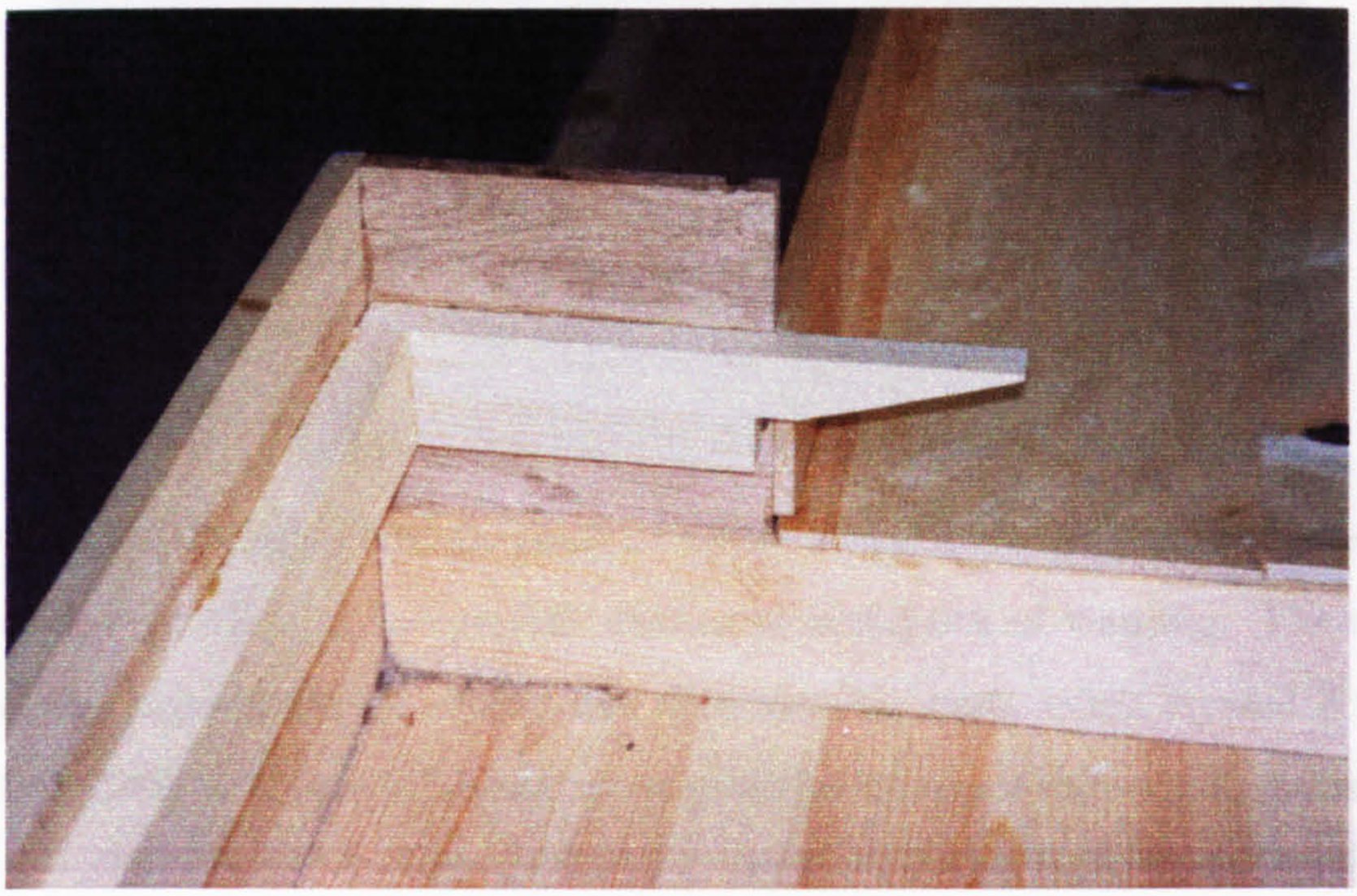
The other liners were usually of deal. The liners along the left case end and spine also act as hitchpin rails – the hitchpins passing through thin soundboard mouldings and the soundboard itself before going into the liners. These, and the other liners, were normally about one-and-a-half inches deep and three-quarters of an inch thick. In some instruments the bottom corner of the liners were chamfered, as found in Ruckers instruments. The liners were glued into the case with it in an upright position (i.e. on its baseboard), as shown by glue-runs on the interior of the case sides and spine. The keywell-side liners need specific discussion. Usually these liners extend past the keywell liner for a distance of two and a half to three inches (63 – 75 mm), tapering in

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[35] See O'Brien (1990:75).

depth towards the ends. This was probably done to reduce the risk of the soundboard cracking just behind the keywell liner as a result of structural movement. As they extend into the free soundboard area they might have been considered to have a beneficial acoustical effect.

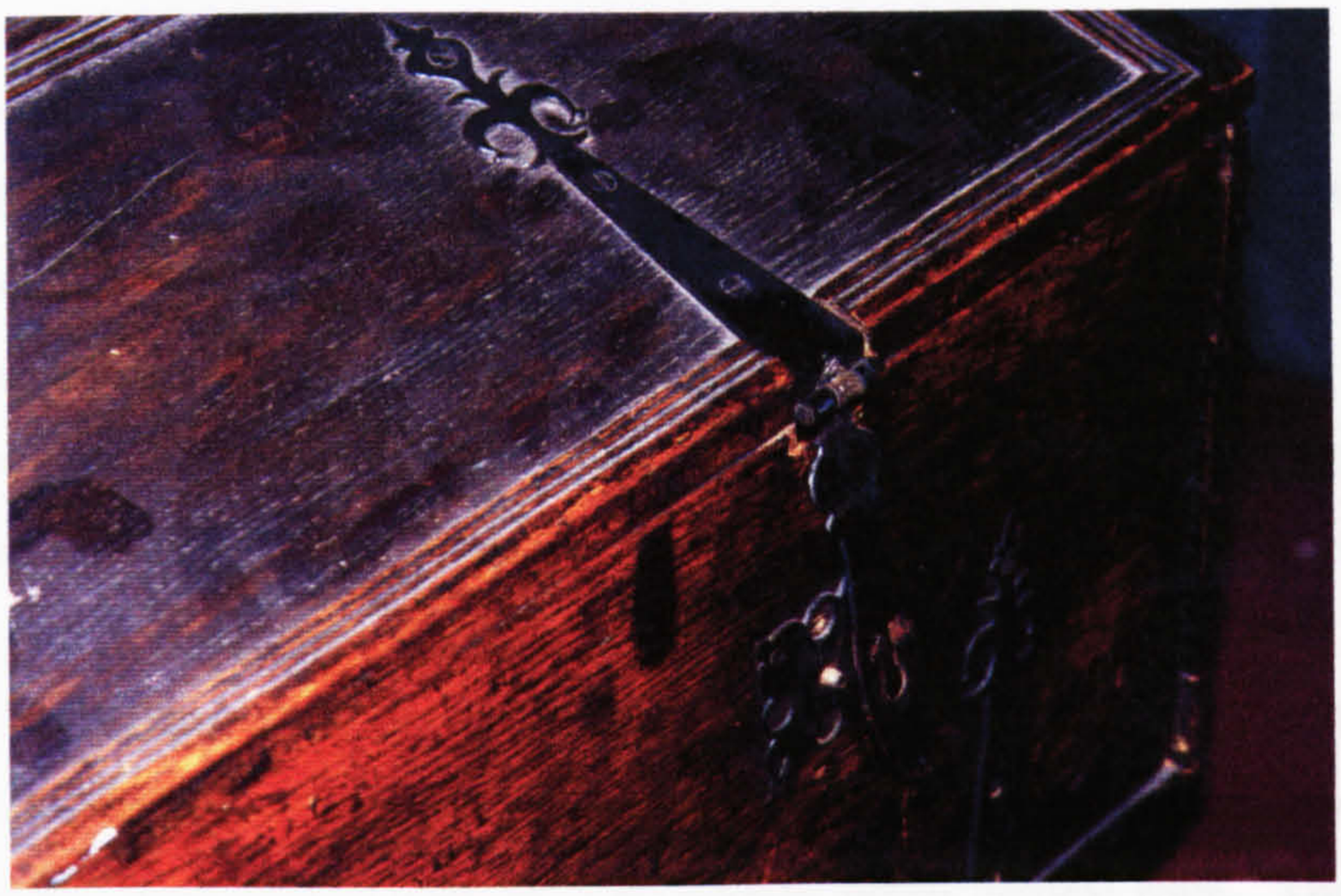
Plate 3.6 – The keywell and keywell-side liners. A full-width lower-guide board can be seen glued to the top of the frame and under the keywell liner.



THE LID AND KEYWELL FLAP

The lid and keywell flap were always made out of the same type of wood as the case ends. The lids were always originally coffered from three pieces, supported at each end by battens. The centre of the batten is usually 45 – 62 mm (1¾ - 2½") high. There are applied mouldings on top of the lid – always made of the same wood as the lid, rather than cedar or coniferous wood as often found on interior mouldings – which are often less delicate in design than the interior mouldings. The mouldings were usually applied on top of the four edges of the lid, and along the joins. Several virginals have short sections of mouldings which divide the long lid pieces into three sections.

Plate 3.7 – Photograph of part of the top of the 1684 TB lid, showing the applied mouldings.



The keywell flap is a single piece of wood, without any supporting battens at the end. The wood needed to be carefully chosen to avoid risk of warping. The thickness of the lid and keywell flap is usually less than the case ends, often around 8 mm, but sometimes as little as 6 mm. This was done partially to reduce the weight, particularly of the lid.

THE SOUNDBOARD

The soundboards of English virginals are of conifer wood, probably most often spruce (probably *picea abies*).[36] At least one instrument – the 1664 JP – has a soundboard made from pine (*pinus strobus*).[37] The use of this pine (commonly known as American white pine, which grows in the south-east of the United States) suggests that makers were not necessarily purchasing wood from specific tonewood importers, but instead buying suitable wood from any available source – American white pine was probably imported as ballast with the intention of it being converted to ship masts. The use of

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[36] This wood was identified by John Koster as the material of the 1656 JW soundboard from a sample provided by the author (with permission from the museum). The same type of wood appears to have been used in most virginals on the basis of a visual examination of defects in the material, usually in the form of small knots, the centres of which have fallen out of the wood, which has then been plugged.

[37] Wood identification by John Koster, from a sample provided by the author following the restoration of the instrument.

wood from different sources appears to mirror the situation found in violins from the same period.[38]

The soundboard wood itself varies greatly in quality. Most instruments have soundboards which are of good quarter-sawn wood, although some have planks which are slab-sawn.[39] The occasional use of (and reference to), cypress as a soundboard wood in English instruments may explain the willingness of English virginal makers to use slab sawn wood.[40] The wood occasionally had knot defects, as discussed in footnote 36. This inconsistent quality of soundboard wood further suggests that makers were not buying wood from established suppliers who specialised in tonewoods. There was no attempt by makers to ensure consistent grain across an instrument, or even across the width of a single board. Generally a soundboard was be made from three or four planks, typically between 120 and 180 mm (five to seven inches) wide.. There was no attempt to make boards an integral or half-integral number of inches wide.

English virginal soundboards are thick in comparison to the virginals of the Ruckers family, typically about 3.5 – 4.0 mm over large areas of the board. One instrument, the 1664 JP has a soundboard which is thinner than usual (similar in thickness to the 1668 SK virginal, discussed below), despite not being of particularly close-grained wood. This might reflect the use of American white pine which could be stiffer than the wood Player typically used.[41] The AH virginal, probably because of its minimal barring, has a soundboard which is varies from 4.5 – 5.1 mm thick behind the keywell.[42] The 1641 GT has a soundboard thickness that varies between 3.3 and 4.0

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[38] John Topham (PC) informs me (from the basis of his dendrochronological examination of violin soundboards) that the wood found in seventeenth-century violins comes from a variety of sources, whereas eighteenth-century makers were able to purchase wood from specific suppliers.

[39] The 1642 TW is a notable example of an instrument having quarter-sawn wood for the front planks and slab-sawn wood on the rear plank.

[40] The 1622 John Hasard harpsichord at Knole has a soundboard which is almost certainly of cypress, and a reference to cypress as a soundboard wood can be found in the Talbot Manuscript. Several instruments in the inventories of Henry VIII (see Appendix One) have cypress mentioned as a soundboard wood, although these are probably imported Italian instruments.

[41] This is not to imply that white pine is stiffer than spruce, but simply that the wood in the 1664 JP is stiffer than Player's normal wood, be it pine or spruce. There has been no attempt to judge the stiffness of various English virginal soundboards, nor has there been an attempt to consider the relationship between soundboard thickness and barring. These subjects are worthy of consideration, but are outside the scope of this study. The 1664 JP has a tonal quality equal to, if not better than, that of most other playable examples.

[42] Measured by the author with a magnetic thickness gauge. There are non-original pieces of pine (approximately 20 mm wide and 30 mm deep) which have replaced the keywell-side liners and extend to the spine liner. It is therefore impossible to measure the remainder of the soundboard.

mm behind the keywell.[43] Two instruments – the 1642 TW and 1668 SK – have had published drawings made of them which included soundboard thicknesses.[44] A brief description of each of them follows:-

1642 TW

The soundboard is thinnest in front of the register, and in the alto part of the left bridge, where it measures 3.1 mm. The thickest parts of the soundboard are near the bass ends of the bridges, typically 4.1 (left bridge) – 4.3 (right bridge) thick. The majority of the soundboard is typically about 3.3 – 3.5 mm thick, getting slightly thicker towards the edges, where the soundboard is generally 3.7 – 3.8 mm thick.

1668 SK

The soundboard is thinnest behind the tenor region of the right bridge where it measures 1.7 mm. The thickest area (3.3 mm) is behind the left wrestplank. The area in front of the register is about 3.15 mm, and it gets thinner towards the right bridge, being 2.7 – 2.8 mm thick under the top two octaves, decreasing to about 2.2 mm (on average) in the tenor region. It is 2.7 mm thick near the bass end of the bridge.

THE BRIDGES

The majority of English virginal bridges appear to have been made of close-grained fruitwood, probably pear. Beech is occasionally found (Mar, 1661 JW, and the left bridge of the 1671 PJ), the 1666 AL appears to have bridges of walnut, and the 1684 TB has bridges of oak. The right bridges were always sawn to shape with the grain in the direction of the long straight section in the tenor and bass,[45] but it is difficult to determine if the left bridges were bent or sawn, as they deviate only slightly from straight.

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[43] Measured by the author.
[44] The 1642 TW drawing is by William Debenham, and is available from the Victoria and Albert Museum. The 1668 SK drawing is by Edward Turner and is available from the Friends of St Cecilia's Hall.
[45] Several instruments have scarf-jointed sections for the top pairs of strings (up to an octave in some examples) with the added section having the grain along its length. This avoids any short-grain on the bridge.

Usually the bridge sections take the form of a triangle with the top edge planed off (see Figure 3.7). The facing side is always vertical, with the angle of the back slope varying over the length of the bridge, depending on the width of the bass. A variation on this bridge is found in several instruments from the Keene workshop tradition, in which there is a flat-topped part in between the two chamfered sections (illustrated in Figure 3.11, bridge "b"). Occasionally (both bridges on the 1668 SK, the left bridge of the 1671 PJ, and the right bridge of the 1638 TW) there is a small ogee moulding instead of a slope on the top surface (Figure 3.8). On the left bridge of both Rewallin virginals there is also a moulding at the top of the front face, and the rear of the bridge is parallel to the front face for approximately half of the height before being rounded over to the top of the moulding (Figure 3.9).

Figure 3.7 – Usual English virginal bridge section.

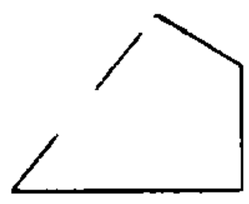


Figure 3.8 – Bridge with moulding on the top front corner.



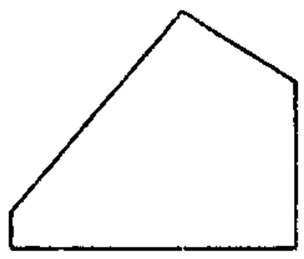
Figure 3.9 – Bridge with moulding and rounded top back corner.



Rather than having the rear slope ending in a sharp corner where the bridge is glued to the soundboard, there was often a perpendicular step below the slope (see Figure 3.10). This may have been a deliberate part of the construction process where

the rear slope was not taken to a sharp point, or else a separate process carried out later. The perpendicular step gives the advantage of providing a precise surface to ensure accurate alignment of the bridge during gluing.

Figure 3.10 – Bridge with perpendicular step on rear slope.



The following tables list the bridge dimensions of various English virginals. Following the listing of the instrument is a figure in brackets, which indicates the bridge shape using Figures 3.7 – 3.9 above. Figure 3.11 shows the positions from where the measurements were taken:

Figure 3.11 – Bridge positions for measurements.

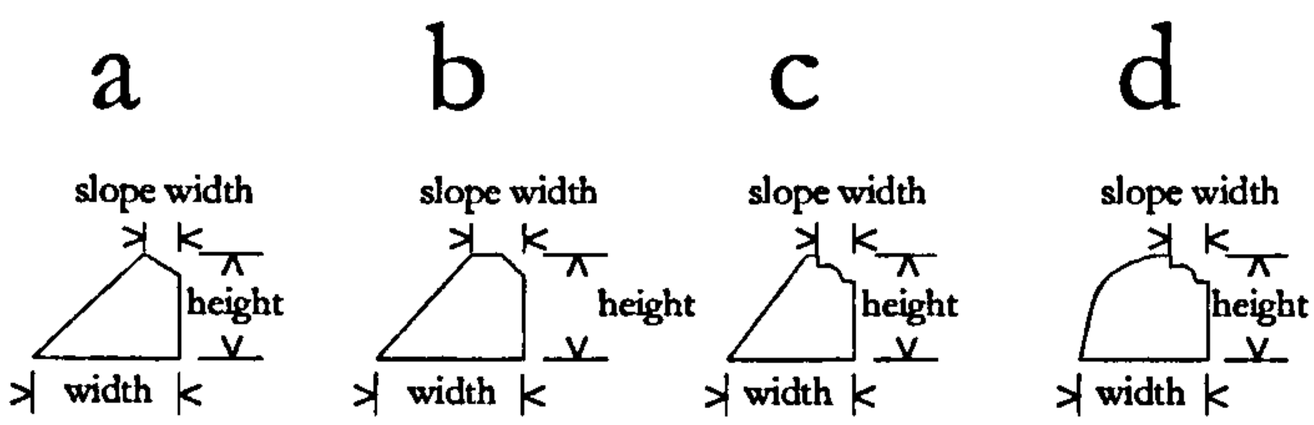


Table 3.8 – Left bridge dimensions for various instruments.

1641 GT [a]	C	c	c^1	c^2	c^3
Height	12.2	10.9	10.3	9.9	9.9
Width	18.8	16.3	16.3	15.8	15.9
slope width	5.8	5.9	5.4	5.4	5.8

1644 TW [a]	C	c	c^1	c^2	c^3
Height	10.6	11.1	11.0	10.8	9.9
Width	15.9	16.2	16.2	16.2	16.1
slope width	4.3	5.1	4.7	5.3	4.6

1656 JW [a]	C	c	c^1	c^2	c^3
Height	17.7	17.7	17.6	17.2	16.0
Width	16.1	16.2	15.2	15.7	11.4
slope width	4.5	4.4	4.0	4.1	4.0

1662 TB [a]	C	c	c^1	c^2	c^3
Height	9.7	9.6	9.6	9.3	9.8
Width	15.2	15.6	15.2	15.8	16.5
slope width	4.9	4.6	4.5	4.5	4.6

1664 RH [a]	C	c	c^1	c^2	c^3
Height	10.3	-	9.0	-	9.9
Width	16.0	-	16.1	-	14.6
slope width	4.9	-	4.6	-	4.4

1668 SK [c]	C	c	c^1	c^2	c^3
Height	10.0	9.7	9.5	9.3	9.4
Width	15.6	15.8	16.0	16.4	15.9
slope width	5.1	5.4	5.5	5.2	5.0

1670 AL [a]	C	c	c^1	c^2	c^3
Height	9.1	9.0	8.8	9.0	8.8
Width	17.7	17.8	17.6	17.4	15.5
slope width	3.6	3.5	3.7	3.7	3.9

1655 JL [a]	C	c	c^1	c^2	c^3
Height	9.6	9.6	9.4	9.5	10.4
Width	13.6	13.6	13.6	13.6	13.4
slope width	5.3	5.0	4.8	5.0	5.0

1679 CR [c]	C	c	c^1	c^2	c^3
Height	11.2	11.5	11.4	11.3	10.8
Width	10.0	11.3	11.9	11.2	10.9
slope width	4.2	4.6	4.1	3.7	3.7

Table 3.9 – Right bridge dimensions for various instruments.

1641 GT [a]	C	c	c^1	c^2	c^3
Height	10.4	10.8	10.6	10.1	10.7
Width	11.8	14.4	16.1	17.2	17.2
slope width	6.0	4.7	5.2	4.8	5.4

1644 TW [a]	C	c	c^1	c^2	c^3
Height	10.4	9.8	8.6	9.4	8.9
Width	17.6	18.7	18.5	18.1	17.6
slope width	5.3	4.8	4.6	5.6	5.1

1656 JW [a]	C	c	c^1	c^2	c^3
Height	17.2	16.7	17.0	17.0	17.0
Width	19.6	21.0	19.6	19.1	20.9
slope width	6.1	6.1	4.7	6.9	5.4

1662 TB [a]	C	c	c^1	c^2	c^3
Height	9.3	8.3	8.6	8.4	8.0
Width	16.2	17.2	17.4	18.6	19.1
slope width	4.9	4.9	5.0	4.4	4.4

1664 RH [a]	C	c	c^1	c^2	c^3
Height	9.7	-	9.5	-	9.8
Width	16.4	-	15.9	-	16.9
slope width	4.8	-	4.2	-	5.2

1668 SK [c]	C	c	c^1	c^2	c^3
Height	9.7	9.9	8.8	8.9	8.2
Width	16.7	17.0	16.7	16.6	16.7
slope width	6.1	5.6	6.2	5.7	6.3

1670 AL [a]	C	c	c^1	c^2	c^3
Height	8.7	9.0	8.6	8.8	8.8
Width	18.7	17.1	16.5	18.8	17.3
slope width	5.6	6.0	6.0	5.4	5.3

1655 JL [a]	C	c	c^1	c^2	c^3
Height	8.8	9.2	9.9	10.3	8.6
Width	16.5	16.2	15.8	16.4	16.3
slope width	4.6	4.3	3.9	3.7	4.3

1679 CR [a]	C	c	c^1	c^2	c^3
Height	10.1	9.9	10.4	10.5	10.4
width	12.5	12.0	12.8	12.3	12.8
slope width	3.9	4.2	3.6	3.9	4.1

The treble of the left bridge and the bass of the right bridge are often tapered in width over the last 40 – 50 mm (1½ - 2"). On the left bridge this gives more clearance near the spine liner, and increases the soundboard flexibility in areas where the bridges are close to case members.

Several instruments have deep scribed lines at the crest of one or both of the bridges. This is found on both bridges of the 1671 PJ, the left bridge of the 1668 SK, and the right bridges of the 1664 RH and 1679 CR. A similar feature is found on some early English spinets, and it has been suggested that a brass wire was inlaid into the groove to allow the strings to pass over the bridge with less friction.[46] Close examinations of the above-mentioned virginals has not revealed any evidence to support the hypothesis. It is perhaps more likely that the lines were marked to indicate the highest part of the bridge during construction, and were not removed in subsequent operations.[47]

The bridges were probably planed to approximate height before being shaped. The right bridge was sawn to shape, probably using a heavy-duty coping saw. Once roughly shaped, the front surface would have been cleaned up with a small plane, spokeshave or drawknife to match the front of the bridge template. The back surface was probably cut to width and then angled with a spokeshave or drawknife. The chamfer on the top of the bridge may have been planed after the bridge was glued to the soundboard to allow go-bars to be used without risk of damage to the crest of the bridge. Although most instruments have bridge-positioning holes, they are often only on one side of the bridge and are randomly placed. Occasionally damage marks from the bridge-positioning pins can be seen on the front surface of the bridges. It is likely that other positioning methods were also used, such as using blocks of wood held in positions by go-bars.

The position of the bridge pins in relation to the spine is discussed below in the section on Soundboard Marking-Out Methods. There is usually a scribed line,

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[46] See, for example, Wells (2000:42) where the possible use of a brass crest-wire is discussed in relation to the spinet by Stephen Keene, c. 1685.

[47] The likelihood that the scribed lines being construction lines rather than intended as grooves to receive a brass wire is increased by the fact that the lines are not found on both bridges of some of the instruments or on other instruments by Keene and Rewallin.

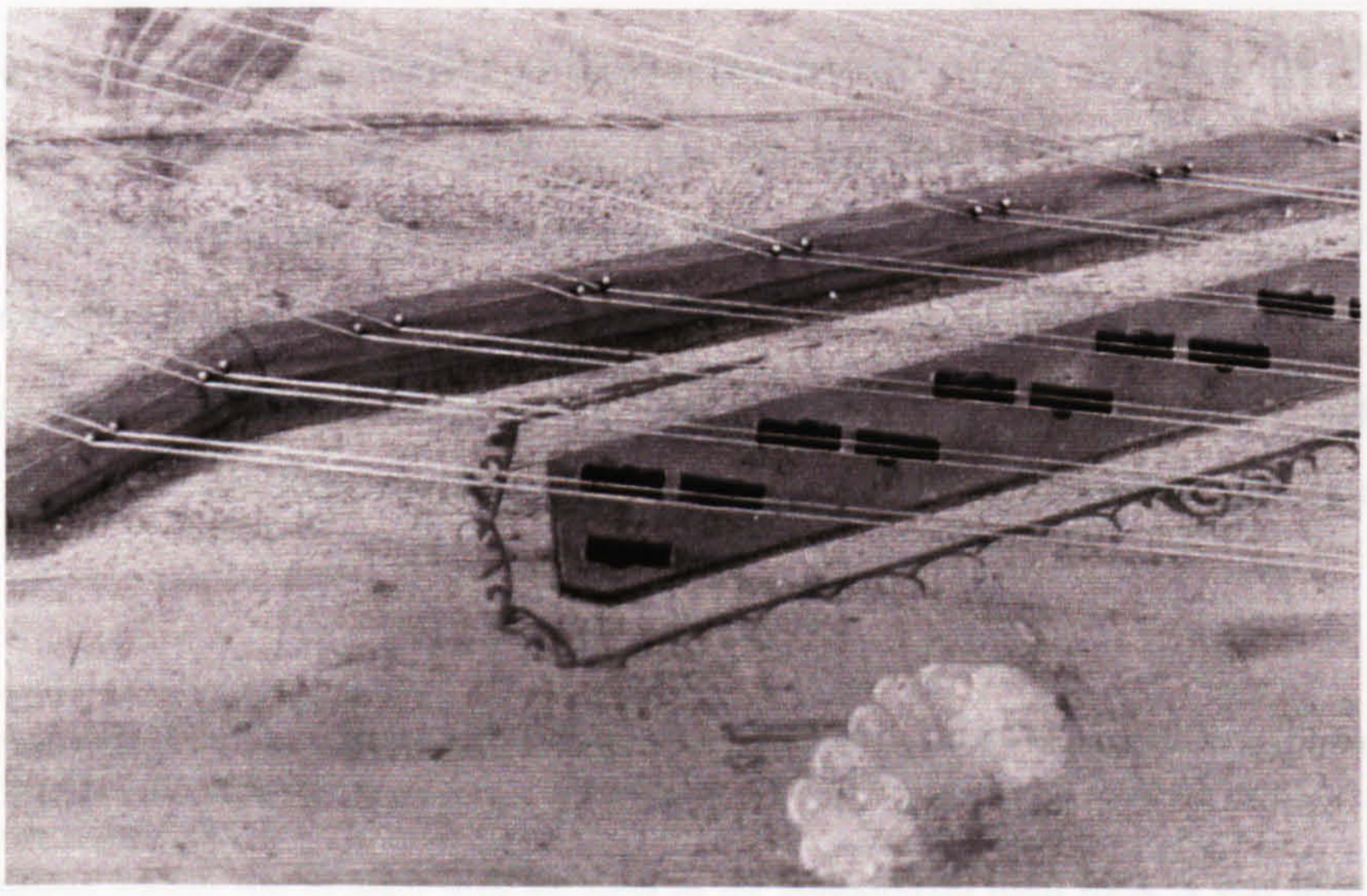
approximately 2 mm in front of the crest of the bridge, which acts as a guide for positioning the pins in relation to the crest. This was often made with a double-pointed scriber, with the second point scribing a parallel line on the back surface, to help ensure an accurately placed line. On instruments with moulded sections the bridge pins are usually placed in the depression just in front of the step to the crest of the bridge.

SOUNDBOARD REGISTER

The soundboard register is a strip of leather, glued to the top of the soundboard, with pierced holes through which the jacks pass. The soundboard wood underneath the register leather is cut slightly larger than the jack slots, and has a single hole for both jacks. This ensures that the jacks touch only the softer leather, reducing the background noise caused by friction as the jacks rise and fall.

The thickness of the leather varies from instrument to instrument, the extremes ranging from 0.6 mm to 2.0 mm. The width is usually around 27 mm, occasionally tapering in width (possibly not intentionally) from bass to treble. The leather appears to have been treated during production to reduce the stretch when glued in place, and to stiffen it so that it does not tear in the weak section between the two jacks. The rough side of the leather is always glued to the soundboard.

Plate 3.8 – Soundboard register leather.



Photograph by Miles Hellon.

The jackslots in the leather were probably cut with a chisel before the leather was glued to the soundboard.[48] As discussed below, the maker probably used a template for the jackslots, and would have been likely to cut the leather directly through the holes in the template. Although most of the jackslots have sides which are parallel to each other, occasional examples where the sides taper along their length are seen, showing that a double-sided chisel was not used. It appears that the makers used chisels which were ground to the required width, cutting through the leather with a single stroke. As pointed out by O'Brien (1990:114), chisels were probably ground to an acute angle to allow a cleaner cut through the leather.

It is not certain how the leather was actually glued to the soundboard. The risk of the leather expanding creates problems when applying glue directly to the leather, and the same problem exists if the maker applies glue to the soundboard.[49]. An alternative possibility is to apply glue to the soundboard where the register leather will be positioned and let it gel. Once it has hardened the leather can be placed on top and then a heat source (a hot iron bar, for example) can be applied to it, causing the glue to become partially liquid and creating a permanent bond between the leather and the soundboard. This method would also have the effect of ensuring that no glue-runs foul the jackslot holes and interfere with the jacks, and that the sides of the register leather do not get glue on them which might cause the jacks to stick in humid weather.

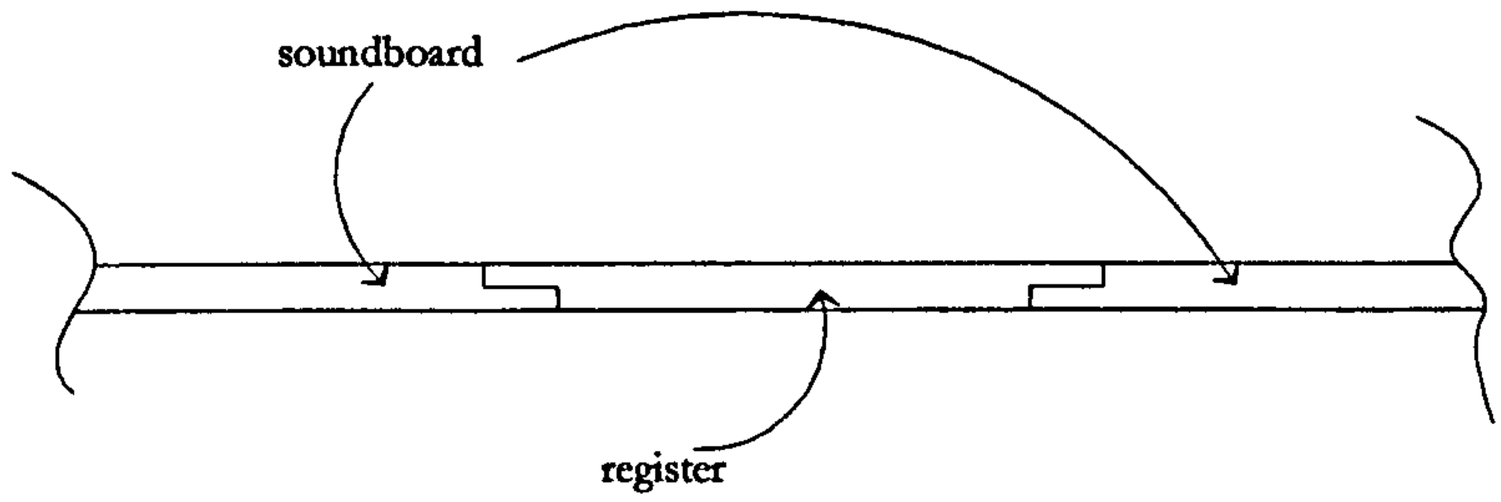
One instrument – the Mar – has a wooden register which is set into the soundboard so that its top surface is flush with the top of the soundboard. There are ink numbers (in an old-style hand) behind the jackslots for jacks 30 and 40 when counting from the treble. These numbers face the back of the instrument and could only have been written when the register was made. The handwriting of the numbers closely matches that found on the jacks, suggesting both are original. The register hole in the soundboard has a lip, creating a larger gluing area than using a simple butt join.

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[48] If the jackslots were cut *in situ* from underneath (as might be expected) the leather would be raised at the edge of the jackslots (based on personal experience). As the leather is not raised it must be assumed that it was cut from above.

[49] As the register leather has to align with the slots in the soundboard itself there is very little leeway for expansion. Personal experience shows that even leather that has been treated to reduce stretch expands by more than the excess distance between the intended end of the leather jackslots and the slots in the soundboard wood.

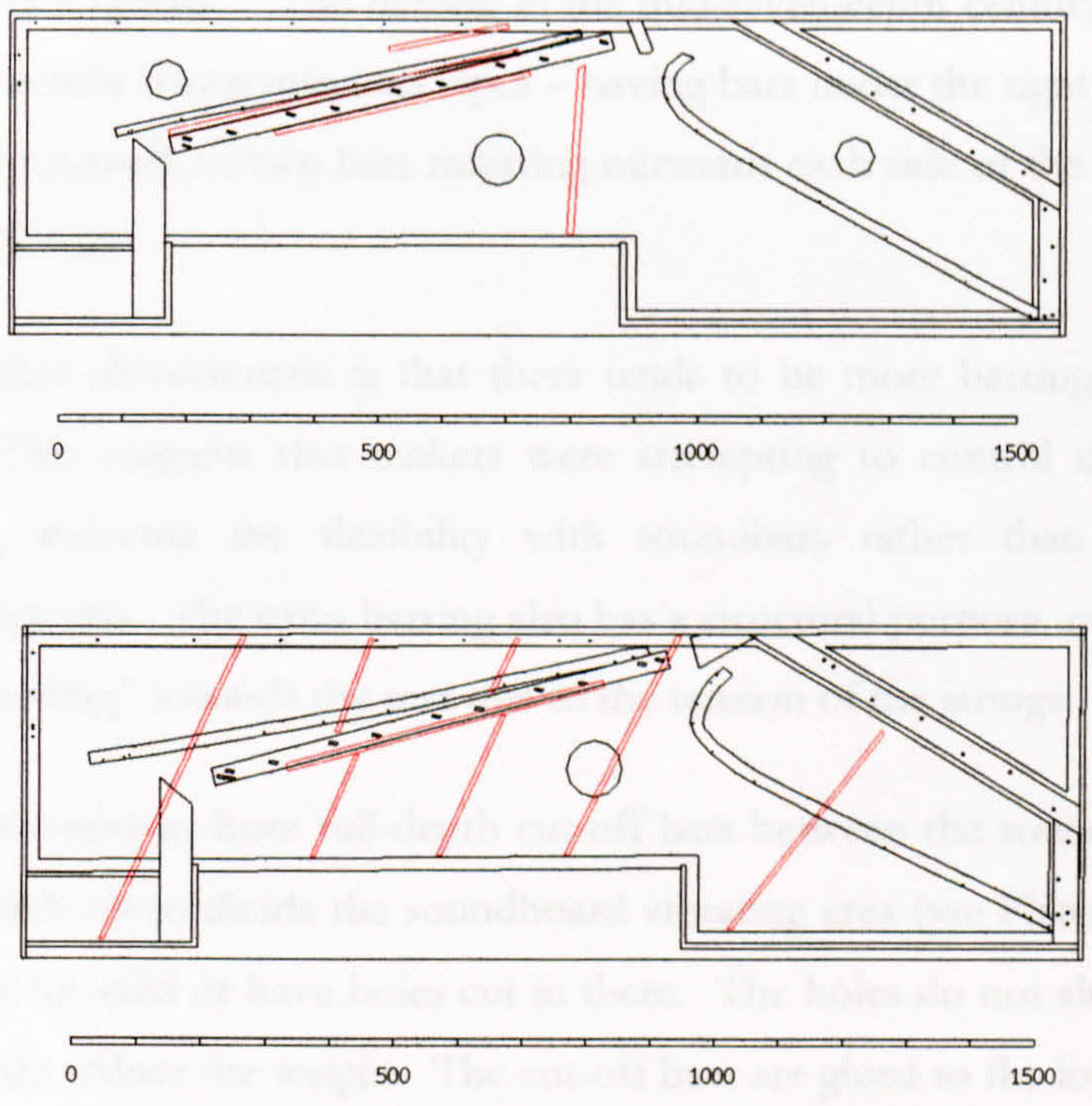
Figure 3.12 – Cross-section drawing showing the joint between the soundboard and the register of the Mar virginal.



SOUNDBOARD BARRING

English virginals have a variety of different styles of soundboard barring, as might be expected from instruments by different makers spanning a period of approximately 100 years. The illustrations below show some typical soundboard barring layouts.

Figure 3.13 – Soundboard barring (in red) for the (from top to bottom) Mar, 1651 TW, 1670 AL, and 1684 TB virginals.

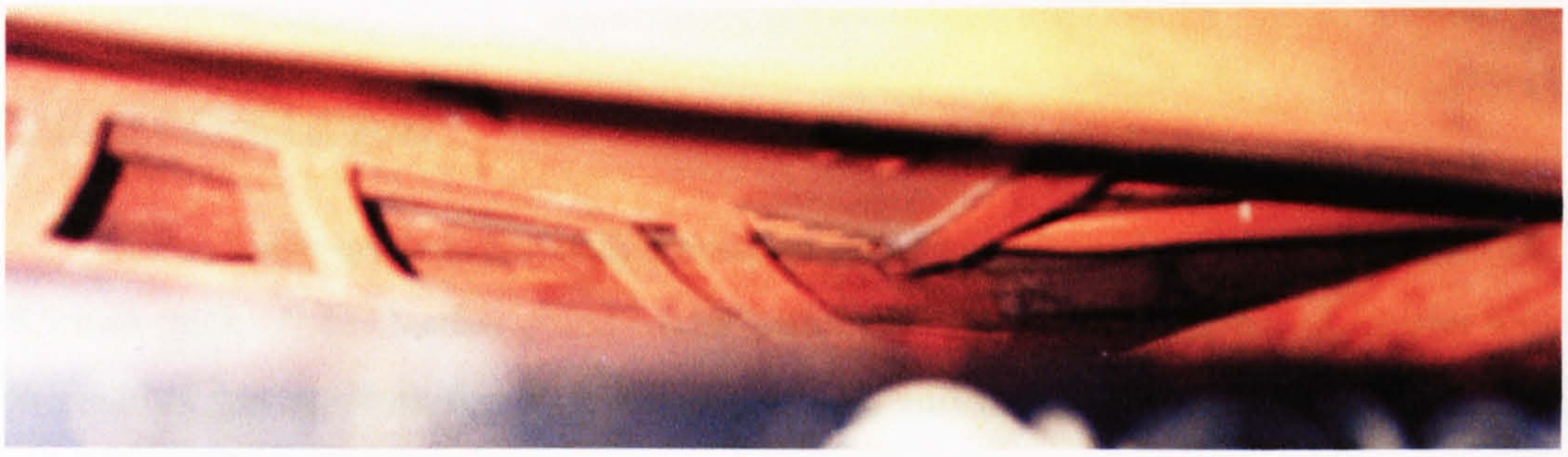


Although there is variation in the surviving instruments, some broad generalisations can be made. The earliest instruments have minimal barring, as seen in the Mar and AH virginals.[49] The barring in the mid-seventeenth century instruments is heavier, and generally forms into two types – having bars under the right bridge (as seen in the 1684 TB virginal), or two bars radiating outwards each side of the right bridge (as seen in the 1670 AL).

One other characteristic is that there tends to be more barring found in later instruments. This suggests that makers were attempting to control the soundboard vibrating area, reducing the flexibility with soundbars rather than by increasing soundboard thickness. The extra barring also has a structural purpose, reducing the risk of the bridge "rolling" towards the rear due to the tension of the strings.

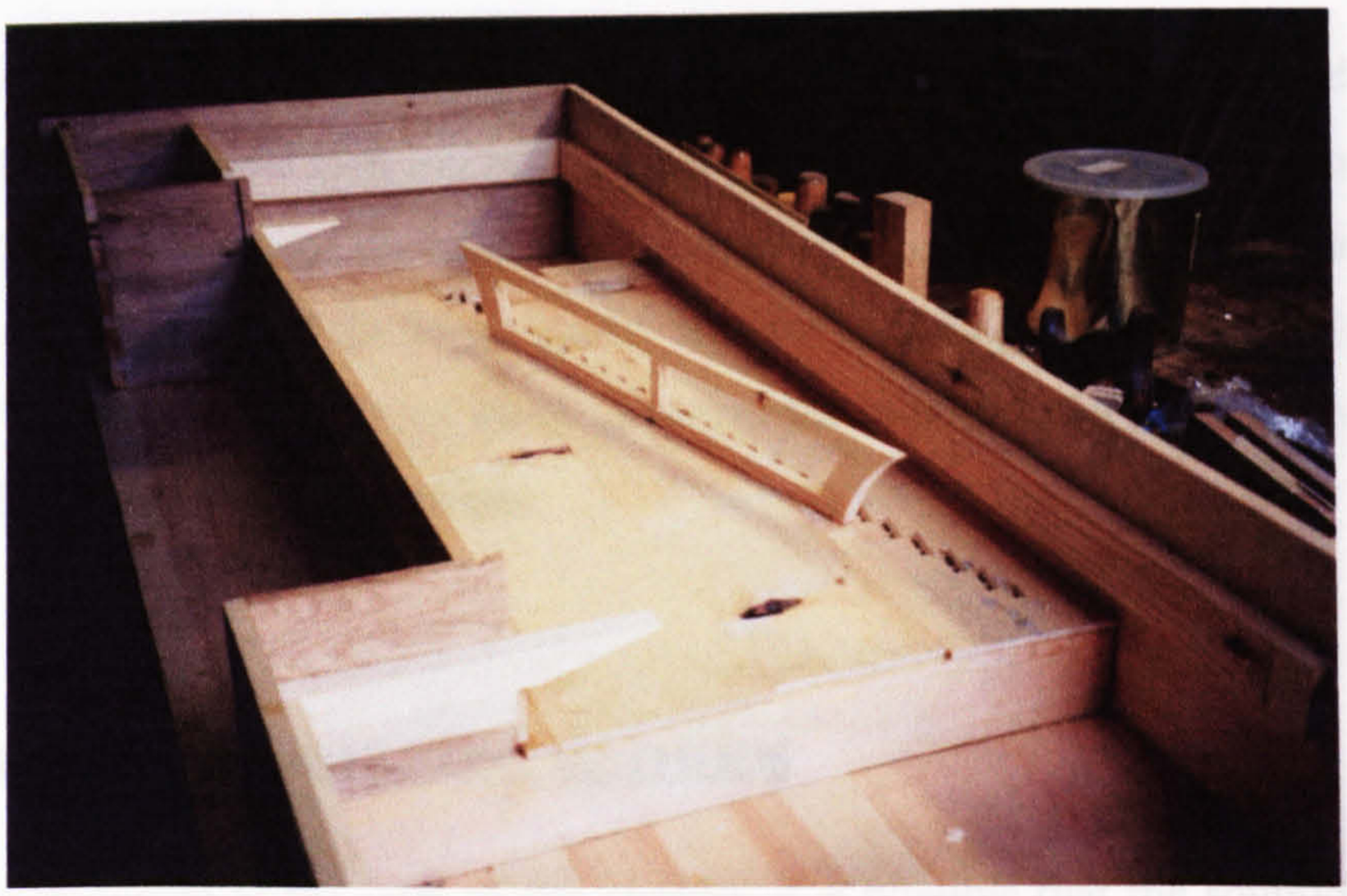
Most instruments have full-depth cut-off bars between the soundboard and the lower guide which act to divide the soundboard vibrating area (see Plates 3.9 and 3.10). These bars may be solid or have holes cut in them. The holes do not alter the stiffness of the bar, but do reduce the weight. The cut-off bars are glued to the lower guide prior to gluing the soundboard in the instrument.

Plate 3.9 – Photograph of the 1675 CR showing the cut-off bar.



[49] All of the instruments have their soundboard barring shown in the Catalogue entries.

Plate 3.10 – Photograph of a reproduction of the Mar virginal (made by the author), showing the full-width lower guide and the cut-off bar glued in position. The lower guide wood is typical of the quality found in original English virginals.



The soundbars are of coniferwood, often of a quality similar to that of the soundboard. Their width typically tapers from the soundboard to the bottom, and the height reduces from the centre to the edges. Typical soundbar shapes can be seen to the right of the cut-off bar in Plate 3.9.

THE LOWER GUIDE

The lower guide is normally a scrap piece of soundboard wood, between 3.5 and 5.5 mm thick. It has leather glued to the under surface, as the soundboard register with the leather having slots for each individual jack, and the wood itself cut for a pair of slots with clearance so that the jacks touch only the leather. The lower guide is normally about 80 – 100 mm (3¼ - 4") wide, and long enough to pass over the frames. In most instruments it is glued to the top of the frames, occasionally with nails passing through the guide into the frames as well. This shows that the lower guide had to be permanently positioned in the instrument before the soundboard was glued in. The earliest instruments (AH, Mar and 1638 TW) have full-width lower guide boards, spanning the entire area between the frames. These boards are glued to the lower edge of the keywell liner and to the top of the frames, showing that – in these instruments at

least – the board must have been glued into the instrument before the keywell back liner. A similar type of full-width lower guide board can be found in the Hasard harpsichord (see the Catalogue, page 349).

There are one or more bars glued to the top surface of the lower guide, which act to stiffen it. In some instruments the bars are full depth between the bottom of the soundboard and the top of the lower guide (see above), serving a structural purpose for both the soundboard and the lower guide. Smaller stiffening bars are typically around 25 mm (1") high, and taper from about 18 mm at the bottom to 10 mm at the top. The ends are frequently reduced in height.

SOUNDBOARD MARKING-OUT METHODS

As discussed at the start of this chapter, it is possible that the soundboard and its marking-out were used to layout the design of the entire instrument. It is certain that the main design concepts are put into practice on the soundboard, rather than elsewhere on the instrument.

The first aspect of the soundboard marking-out is the positioning of the register. The register must be placed behind the intended position of the keyboard, so that the backs of the keys align (from left to right) behind their heads. The keyboard itself (discussed below) has endblocks at either end, usually about ¾" (19 mm) wide, which limits any possible splaying or angling of the keys at each side.[50] Generally, the left-to-right spacing of the register closely matches the width of the keyboard itself, the total width of the register slots usually being within a quarter- to half-inch of the keyboard width at the front.[51] If the case was constructed first the maker had only a little leeway in positioning the register, as the instrument's overall length and the length of the faceboards and keywell had already been determined. If the soundboard is made first it was possible to commence with overlong boards without a precise cut-out for the keywell.

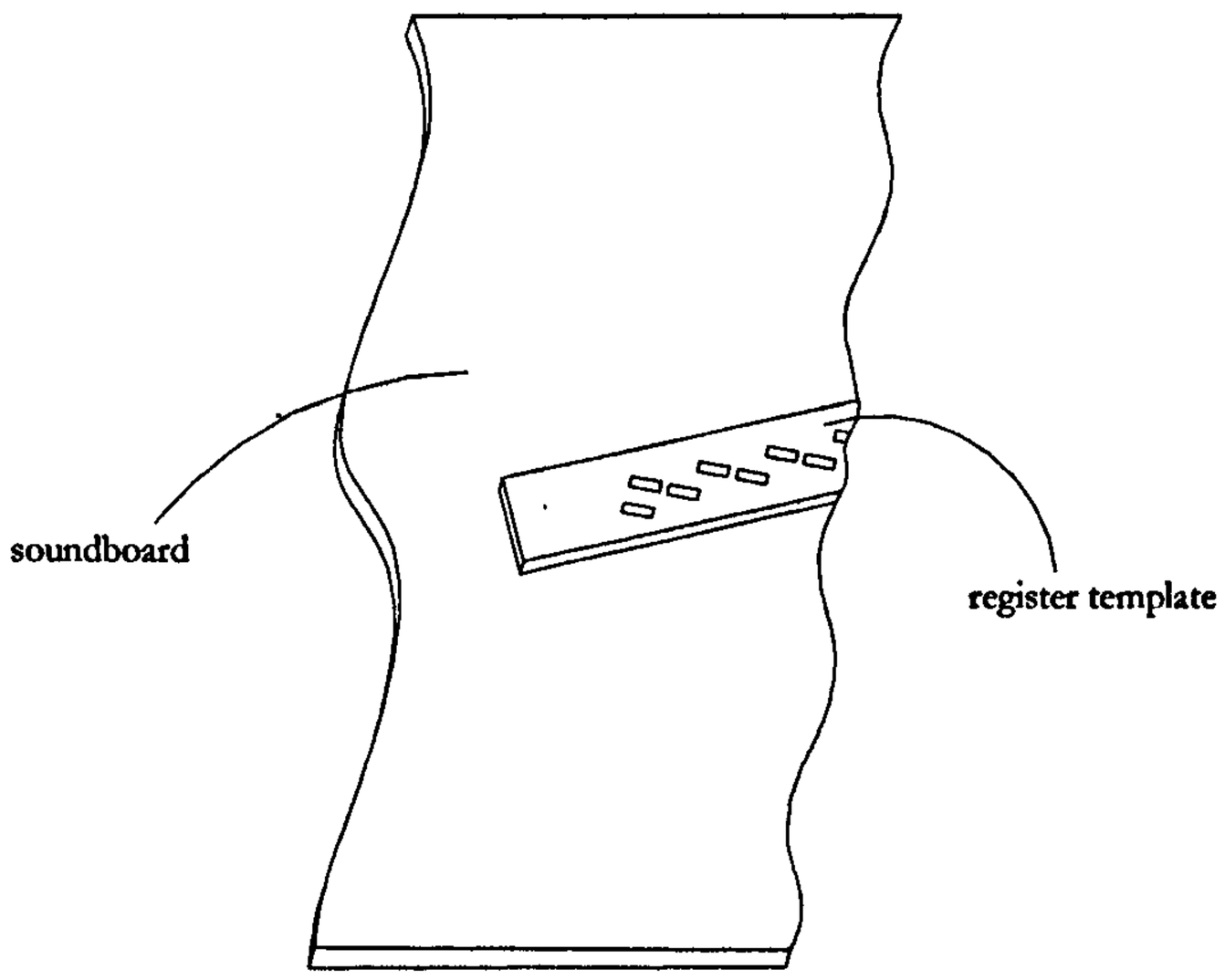
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[50] This space is further limited by the keyboard hold-down blocks – normally spare soundboard bars about ¼" (6 mm) wide – which are glued to the frames behind the endblocks.

[51] The register is measured from the left back corner of the lowest note to the right front corner of the highest note. The number of surviving instruments in which the keyboard is wider than the register, is very similar to the number of instruments in which the register is wider than the keyboard.

As the register marking-out process is carried out four times on each instrument, and must be identical on each occasion, some form of template would have been used. On several instruments (the 1641 GT and 1664 RH, for example) a template-positioning hole can be seen on the soundboard. This template was probably a thin piece of wood (or perhaps hard leather) with register slots pierced through it. Once positioned on the soundboard, the maker marked one or more points for each jackslot – possibly with an awl, or even perhaps using paint – and then removed the template. Although the leather register is cut so that each jack has its own slot, the soundboard wood is pierced so that the slot is a slightly oversized hole without any division between the two aligned jacks.

Figure 3.14 – Diagram showing the method of marking-out the register leather and the soundboard slots.



The same template would then be used to mark out the register leather, although it is possible that a chisel or knife was used to cut the register slots with the template *in situ*, rather than having the dual processes of separately marking and then cutting the slots.

The lower guide would have been made at the same time, and in the same manner. The only difference between the process carried out on the soundboard and

the lower guide is that the leather was glued to the underside of the lower guide rather than the top, as occurs on the soundboard.

It is not certain how the register template was positioned to ensure an acceptable slope.[52] A number of instruments have register template holes, but they can't be shown to always be placed an integral (or half-integral) number of inches from the front or back of the soundboard. All of the instruments can have their slopes defined as small whole-number ratios, varying between 1:5 and 3:10. However, with the exception of instruments by members of the White family, where the "normal" virginals[53] have very similar slopes,[54] instruments by the same builder have different slopes, even in the examples where the compass is the same. The instruments by Leuersidge have slopes of 1:5 (1666 AL) and 2:9 (1670 AL); those by Rewallin 2:7 (1675 CR) and 3:10 (1679 CR). The slope in instruments which belong to what may be defined as the "Keene workshop tradition" also vary, the instruments by Keene having slopes of 3:10 (1668 SK) and 1:4 (1675 SK), whereas the 1671 PJ and the 1684 TB both have 3:11 slopes. It is unlikely that the different slopes can be attributed to different keyboard widths, as this can be shown not to apply in the examples by Keene, Rewallin and Leuersidge. Similarly, the difference is not attributable to an attempt to ensure the same left-to-right distance between jackslots, as that doesn't apply in the instruments made by the White family.

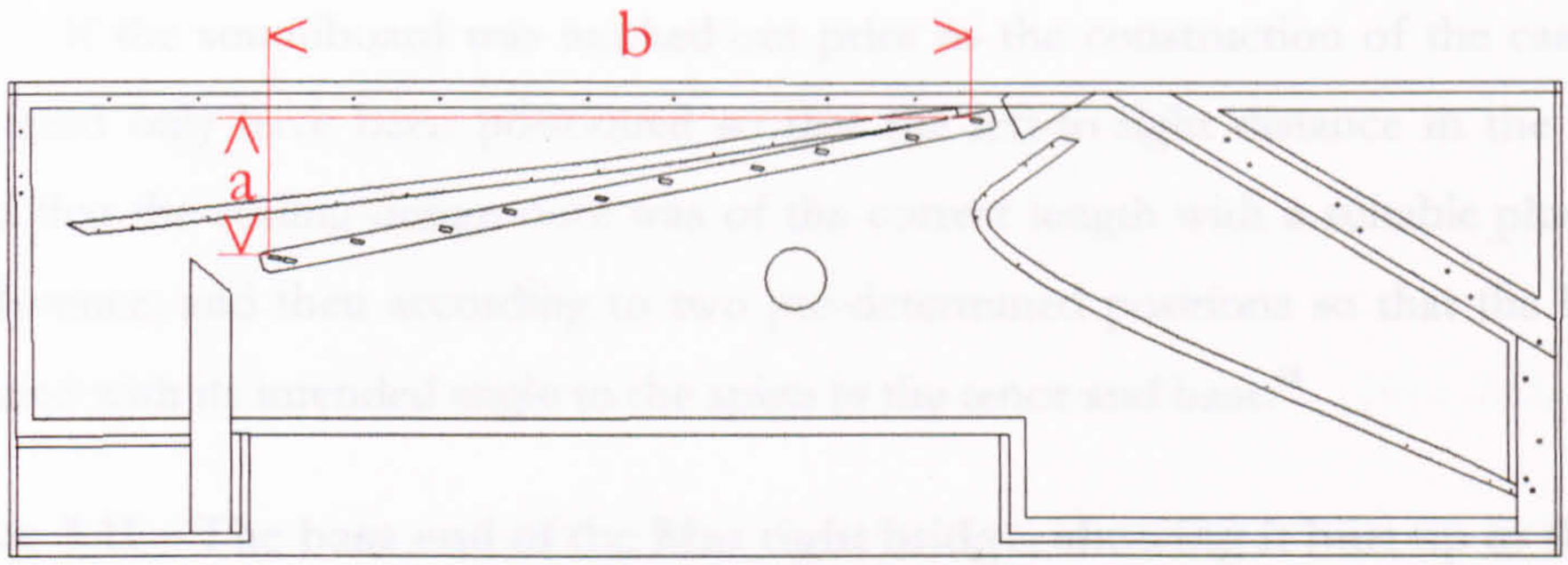
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[52] The slope can be defined as the angle of the register to the spine, and can be defined as a ratio of the difference between the distance from the back of the register to the spine at each end : left – right distance.

[53] Excluding the 1638 TW, which is the child of a mother-and-child double virginal, and the 1644 TW, which has double-stringing in the bass, and, as a result, two different register slopes.

[54] The slopes do vary slightly, but the actual angle differs by less than one-half of a degree, which may well be attributable to inaccuracy of measurement, a result of humidity changes, or a result of fitting the soundboard into the case.

Figure 3.15 – Illustration of the method used to determine the slope.



It is possible that the different slopes are the result of refinements that were introduced by makers having had the experience of building previous instruments. Similarly, it is not reasonable to expect that the register templates themselves would not be changed through the years, particularly as wear occurred to the template in the process of marking-out the instruments. It should be emphasised that the actual slope – within the variations found in surviving English virginals – makes little practical difference to the length of the quill, but has geometric implications for the plucking point and the corresponding overall length of the instrument.

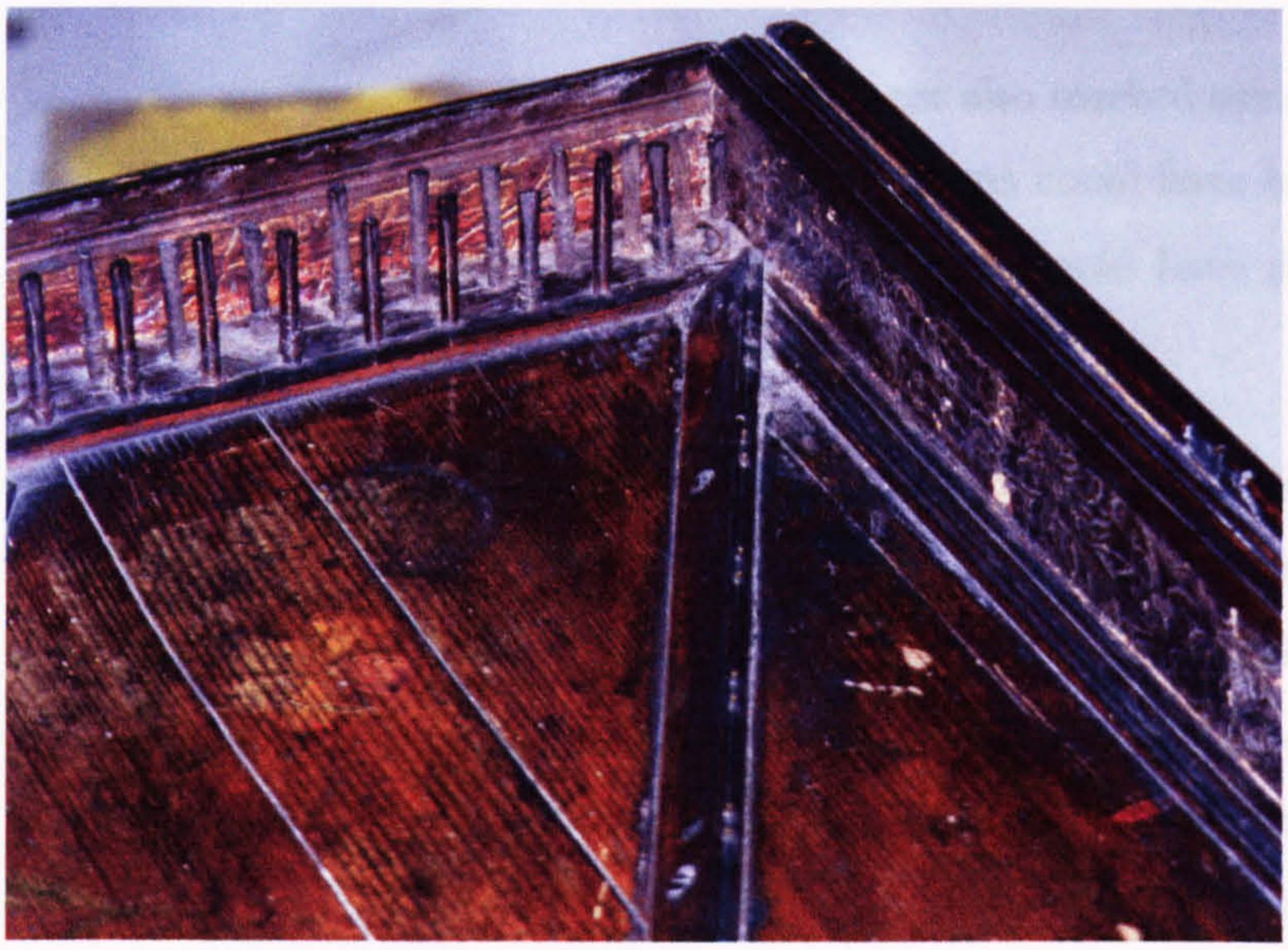
Once the register leather had been glued to the soundboard the right bridge could be positioned. As discussed above, the right bridge was sawn to a pre-determined shape using a template. The bridge position on the soundboard was determined by the need to ensure the correct scale and an acceptable plucking-point distance in the treble, and so that all of the bridge pins would fit onto the bridge.[55] In most English virginals the bass end of the right bridge butts against the bass wrestplank capping-piece (see Plate 3.11). If the case was made prior to marking-out the soundboard the position of the wrestplank capping-piece is already determined by the inside of the case and the width of the wrestplank, in which event the bridge must be angled to ensure that the bass end is low enough to have room for all of the bridge pins. The other possibility is that, as the same bridge template can be (and was) used for instruments with different

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[55] See Appendix Eight for a discussion on how a maker might design his bridge template to ensure Pythagorean scalings.

scalings,[56] the right faceboard distance was lengthened by a pre-determined amount, equal to the increase in scale length between the template-design and the actual scale length.[57] If the soundboard was marked-out prior to the construction of the case, the bridge need only have been positioned so that the left-to-right distance in the treble ensured that the scaling-design note was of the correct length with a suitable plucking-point distance, and then according to two pre-determined positions so that the bridge was placed with its intended angle to the spine in the tenor and bass.[58]

Plate 3.11 – The bass end of the Mar right bridge, showing it butt up to the wrestplank.



There are at least four different variations on a single method used to position the bridge pins. Three of these variations involve the obvious use of a marking-out stick. In some examples it is clear that a single maker has used more than a one method

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[56] See Chapter Two, page 62.

[57] This can be considered unlikely as it involves several calculations which are otherwise unnecessary. It would require a pre-determined right faceboard length, to which the increase in scale length must be added, plus any other alterations such as compass additions must be included. It can be further discounted by the fact that instruments which use templates designed for their particular scale would be expected to have right faceboards which are an integral number of inches.

[58] The fact that many scalings are either Pythagorean, or have c^3 and c^1 Pythagorean (with a short c^2 string length) suggests that there was a deliberate intention to ensure the angle of the bridge in the bass and tenor was kept constant from instrument to instrument.

in different instruments.[59] The variations used can be summarised as follows, according to the evidence found on the bridges:

- Scribed lines parallel to the spine of the virginal. (Mar, 1638 TW, 1644 TW, 1656 JW, 1666 AL, 1668 SK, 1675 SK)
- Scribed lines essentially parallel to the strings. (1641 GT, 1642 TW, 1651 TW, 1662 TB)
- Spiked marks between the close pairs of bridge pins. (1664 RH, 1684 TB)
- No marks on the bridge at all. (1655 JL, 1661 JW, 1670 AL, 1671 PJ, 1675 CR, 1679 CR[60])

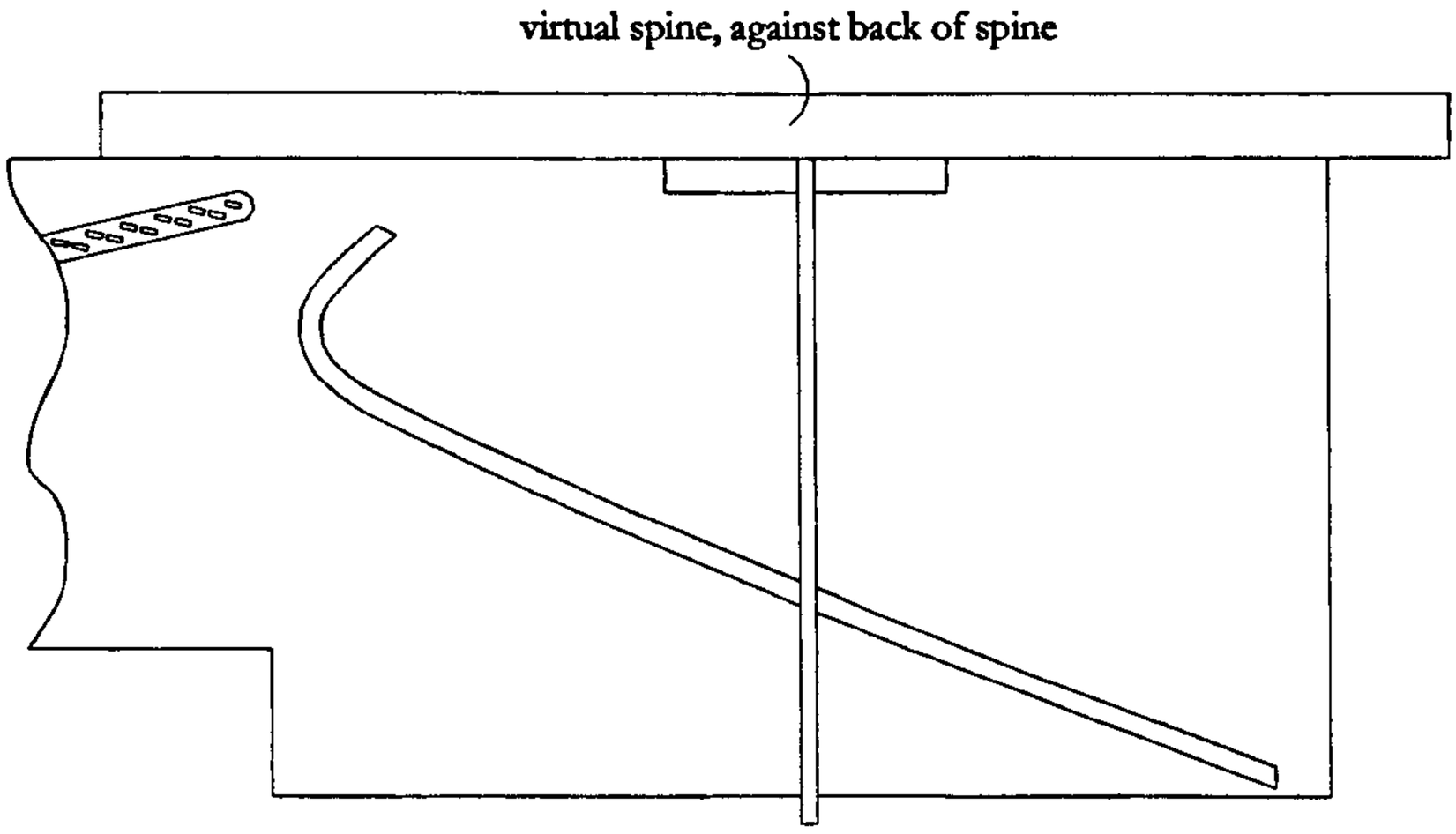
It is possible that the last group of instruments were also marked using marking-out stick as in the other variations, since the marked positions could have been spiked marks in the position of the bridge pins themselves, which would have disappeared when the bridge pins were fitted into the bridge.

The first of the variations makes use of a marking-out stick which is held perpendicular to the spine (or, more correctly, a virtual spine, probably a long piece of straight wood against which the back edge of the soundboard was held). The marking out stick could have either slots cut into it, into which a knife fitted; or else simple marks on it, from which the maker marked the bridge by eye. The third method probably also used a marking-out stick held perpendicular to the spine, the maker using a pointed object to mark the bridge.

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[59] For example Thomas White.
[60] There are possible marks on the treble section of the bridge.

Figure 3.16 – Drawing showing a marking-out stick perpendicular to the spine.



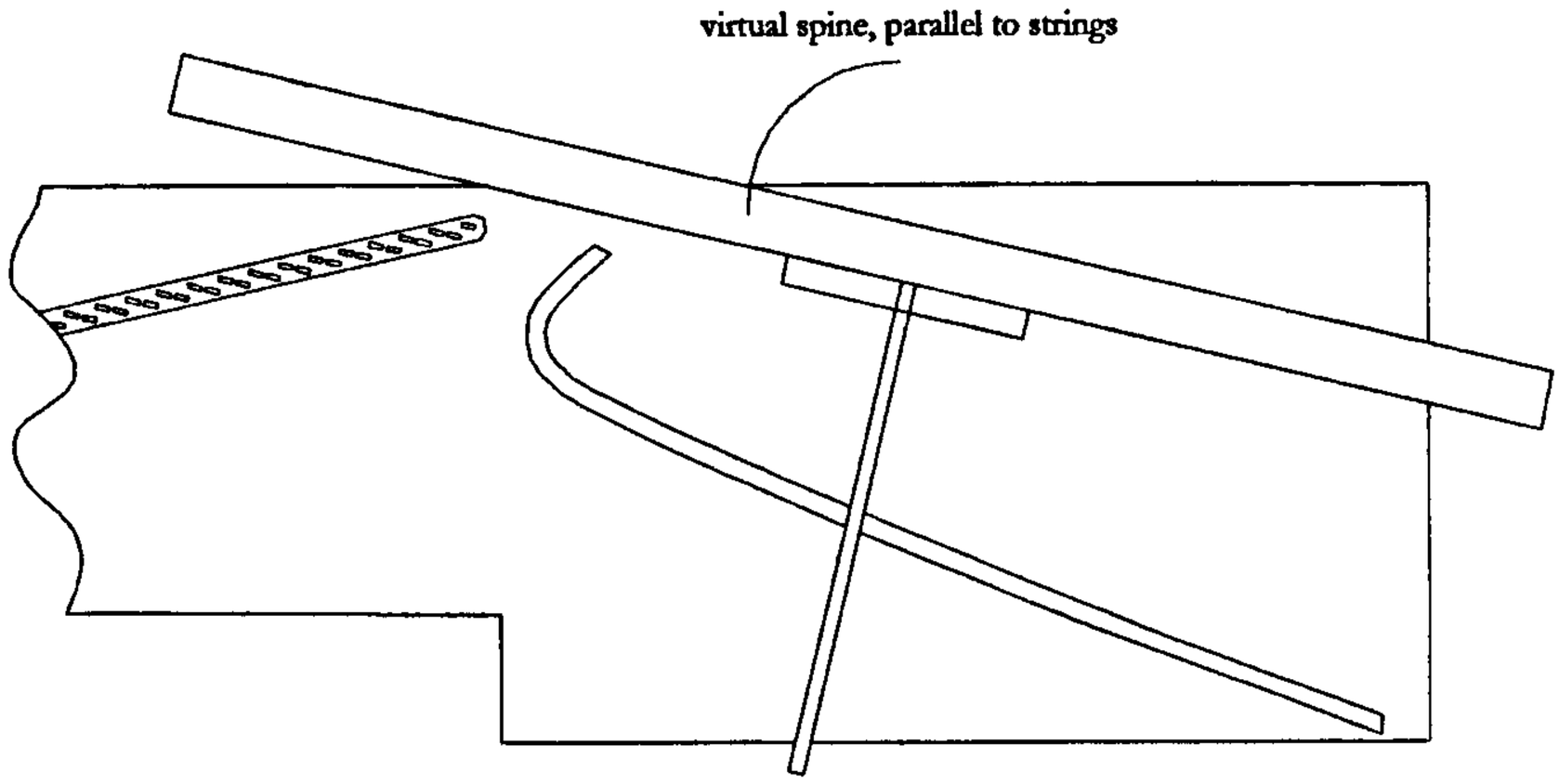
The second group causes some problems of interpretation. If the marking-out stick was perpendicular to the spine the maker would need to have a specific point on the bridge to which he aligned the stick each time, for example the front edge or the crest of the bridge. He would also need slots in the marking-out stick which were cut at an angle to the stick itself. An alternative would have been to use a stick which was parallel to the strings, a method which is complicated by the fact that the strings themselves are not parallel to each other. In almost all instruments the angle of the strings to the spine is more acute towards the bass, though this decrease is generally small in the bass and tenor regions. It would have been possible to use a virtual spine which is set at an angle to the back of the soundboard which is parallel to the general string direction in the tenor or bass[61], and a pre-determined distance from the scaling-design note.

[61] The marks on the right bridge of the 1641 GT are at an angle to the spine, and appear to align with the strings in the bass.

Table 3.10 – Angle of the strings to the spine.

Instrument	C	c	c^1	c^2	c^3
1641 GT	9.9	10.0	10.3	11.0	11.5
1644 TW[62]	10.4 / 10.4	10.8	11.3	12.0	12.0
1656 JW	10.3	10.8	11.4	12.4	13.2
1662 TB	10.2	10.5	11.0	11.7	12.9
1664 RH	6.7	7.5	9.1	10.3	10.9
1668 SK	6.9	6.8	7.7	7.8	7.8
1670 AL	10.8	11.6	12.1	13.0	13.6
1655 JL	11.0	12.1	15.3	13.0	12.9
1679 CR	9.4 / 9.4	9.7	10.1	11.0	13.0

Figure 3.17 – Drawing showing a possible arrangement of a marking-out method using a virtual spine parallel to the strings.



Since the right bridge is positioned according to a template, and the right bridge pins are placed by means of a marking out stick held against a virtual spine, it is possible that the intended bridge pin positions may not be achieved. The implications of such inaccuracies need to be taken into account, when considering how the maker located the left bridge to ensure acceptable string lengths. In addition, the right bridge may not

[62] The 1644 TW is double-strung in the bass from GG/BB – A, and the 1679 CR is double-strung from GG/BB - D. The two figures are for the longer and shorter of the strings respectively.

accurately replicate the shape of the template, particularly in the treble region where the curve is great; or the pin positions may not be in the correct front-to-back position.[63]

As shown in Chapter Two (page 47), English virginal makers used c^3 (or f^3, if the instrument went that high) as their scaling-design note, and its length determined the intended pitch of the instrument. It is, therefore, of importance that the maker be able to accurately position his left bridge in order to achieve the correct string length. How the remainder of the bridge is positioned is uncertain, and may have varied from maker to maker.

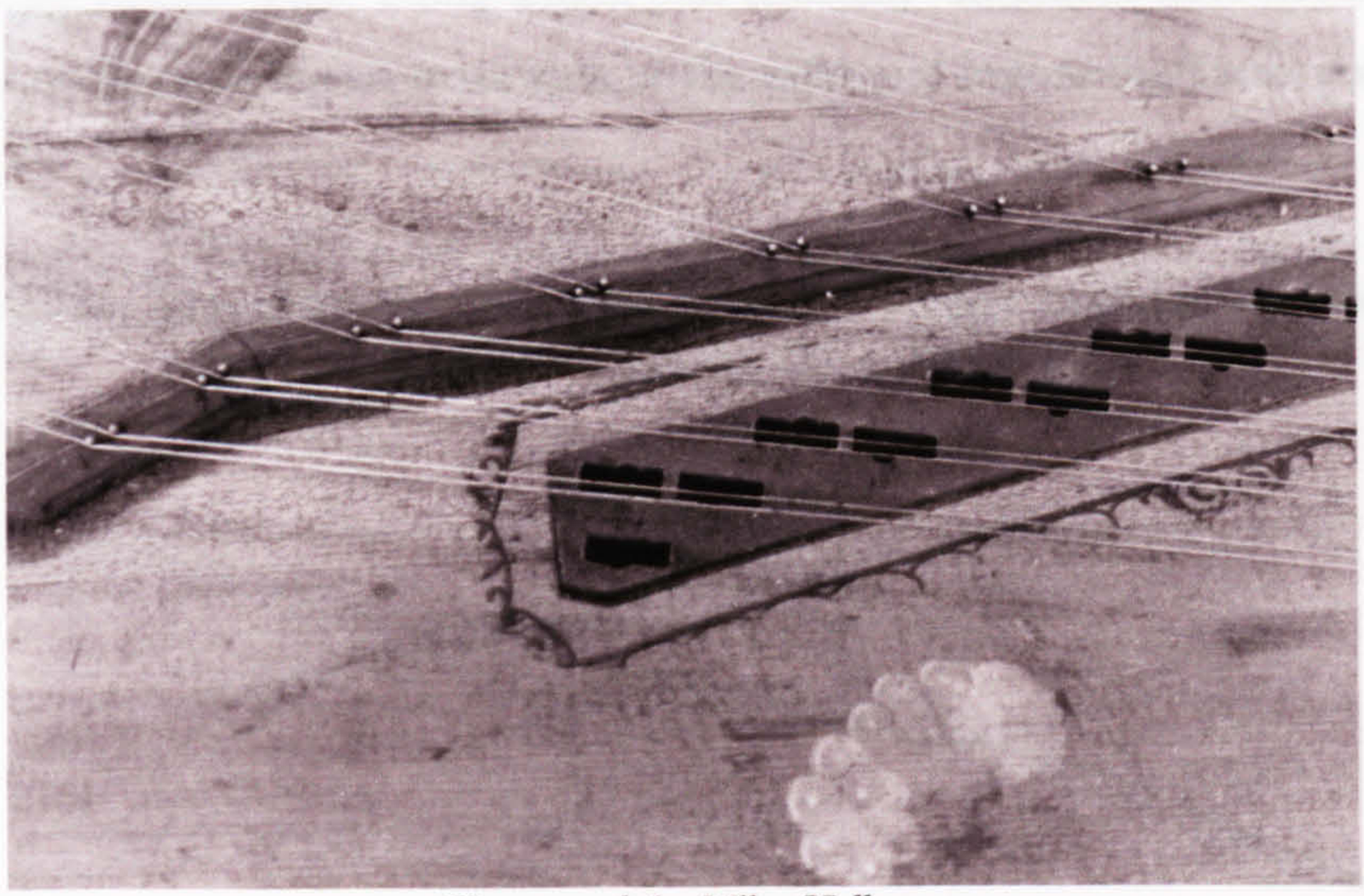
There are usually marks on the register leather, positioned centrally between the wide pair of jackslots which held pins to act as a guide for dummy strings which were used to mark the left bridge pin positions (see Plate 3.12).[64] It is probable that these pins were nailed into the register leather and soundboard before positioning the left bridge, as it would allow the maker to position the bridge more accurately.

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[63] There is invariably only one bridge positioning mark for each pair of strings, meaning the maker must judge (by eye) the correct position of at least one of the bridge pins in each pair.

[64] On the occasion of restoring the 1664 JP the author had occasion to remove a non-original register-leather. Pin marks could be clearly seen in the soundboard wood underneath the leather. These marks were clearly deep, and would have securely held pins for the purpose of marking-out the left bridge. The non-original leather had no marks on it, showing that the soundboard marks were the result of earlier work.

Plate 3.12 – Register-leather spike marks, indicating where upright pins were placed to guide dummy strings used when positioning and marking-out the left bridge.



Photograph by Miles Hellon.

The scaling-design note string length determines the treble position of the left bridge, but there is not always an obvious method of placement for the remainder of the bridge. Four instruments (the AH[65], 1662 TB, 1666 AL and 1670 AL) have Pythagorean scalings down to c^1, and the left bridge was obviously placed to ensure the scalings were correct to c^1, and then letting the bridge follow a natural curve down to the bass. Other instruments show a variety of scaling methods, from a constant (although not necessarily consistent) foreshortening throughout the compass, to having the scaling-design note and c^1 Pythagorean, but with reduced scalings in between. On these latter instruments the bridge was probably positioned using the scaling-design note and c^1 as pre-determined lengths and allowing the bridge to follow a natural curve in the bass.

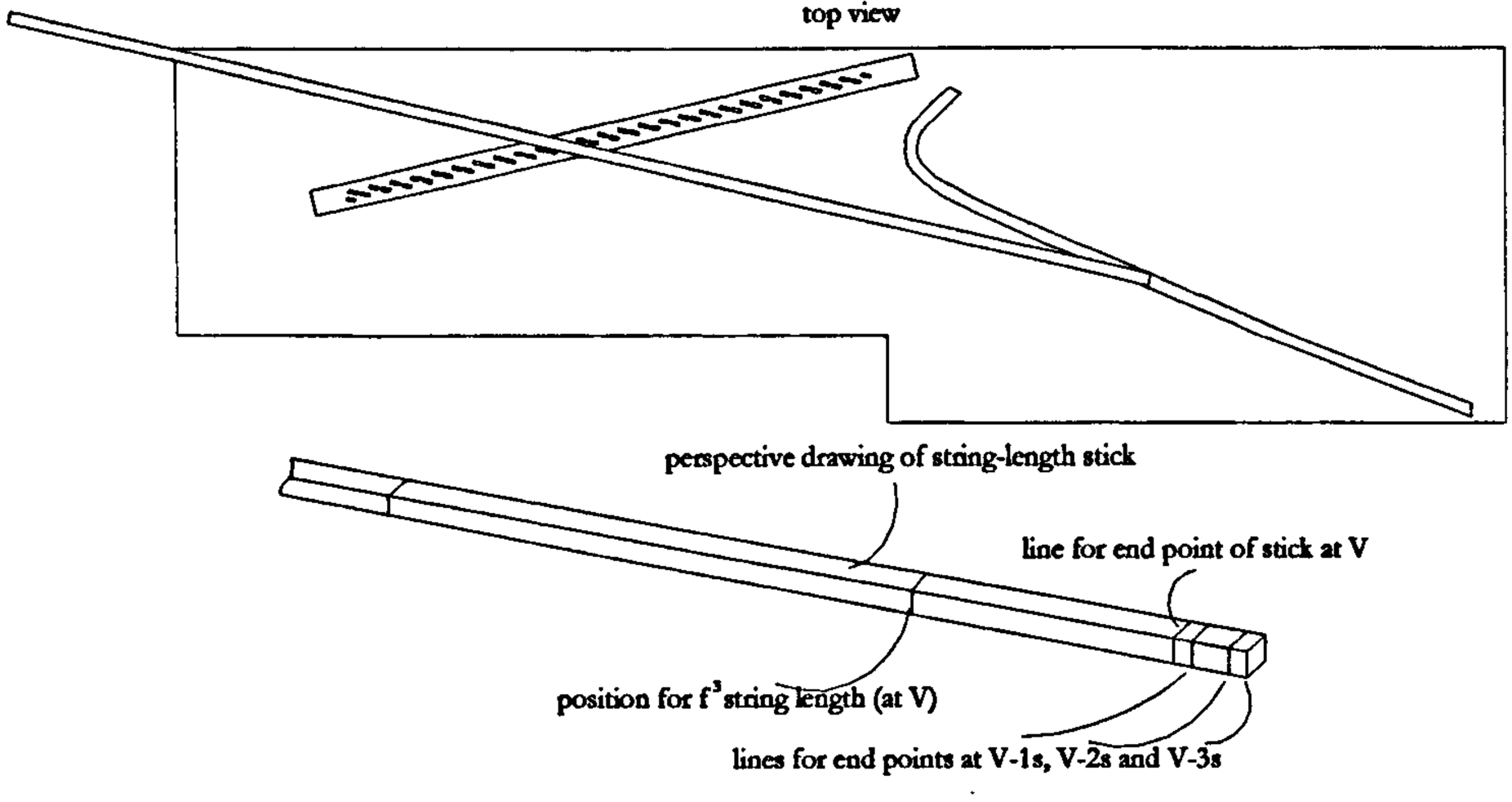
The instruments in which there is a constant foreshortening throughout the compass are more difficult to analyse, something further complicated by the fact that five instruments (the Mar, 1641 GT, 1671 PJ, 1675 CR and 1679 CR) have scalings which would be Pythagorean if a shorter scaling-design note length was used, as discussed in Chapter 2 (page 52). If, as seems likely, these five instruments show the deliberate intention of the makers, then it must be assumed that the left bridge was placed according to a template or in relation to specific points on the instrument (eg.

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[65] This occurs regardless of the actual scaling-design note string length (within reasonable limits of the bridge positions).

consistent plucking points regardless of string length). Alternatively the left bridge was positioned using an extension at the right end of the scaling-stick corresponding to the increased scale-length. This "string-length plus constant" extension does not need to be anything more than having an extra inch at the right end before the "zero point" scale mark.

Figure 3.18 – Drawings showing a possible left bridge marking-out method assuming an extension on the scaling-stick.



It is not possible to draw firm conclusions about how the left bridge is positioned in those virginals which have a constant foreshortening. It is possible that the two instruments by Stephen Keene have been designed so that there is a drop of a semitone over each of the top two octaves (or two semitones over two octaves); and the 1664 JP, 1638 TW, 1642 TW, 1651 TW, 1653 TW and 1656 JW (all of the instruments by the White family except the 1644 TW which is double-strung in the bass, and the 1661 JW) could all have been designed to have scalings which reduce by one semitone over two octaves. The 1684 TB may also have been designed to have scales which reduce by a semitone over two octaves, although the top octave is Pythagorean,[66] and the left bridge could have equally well been placed with that specific intention.

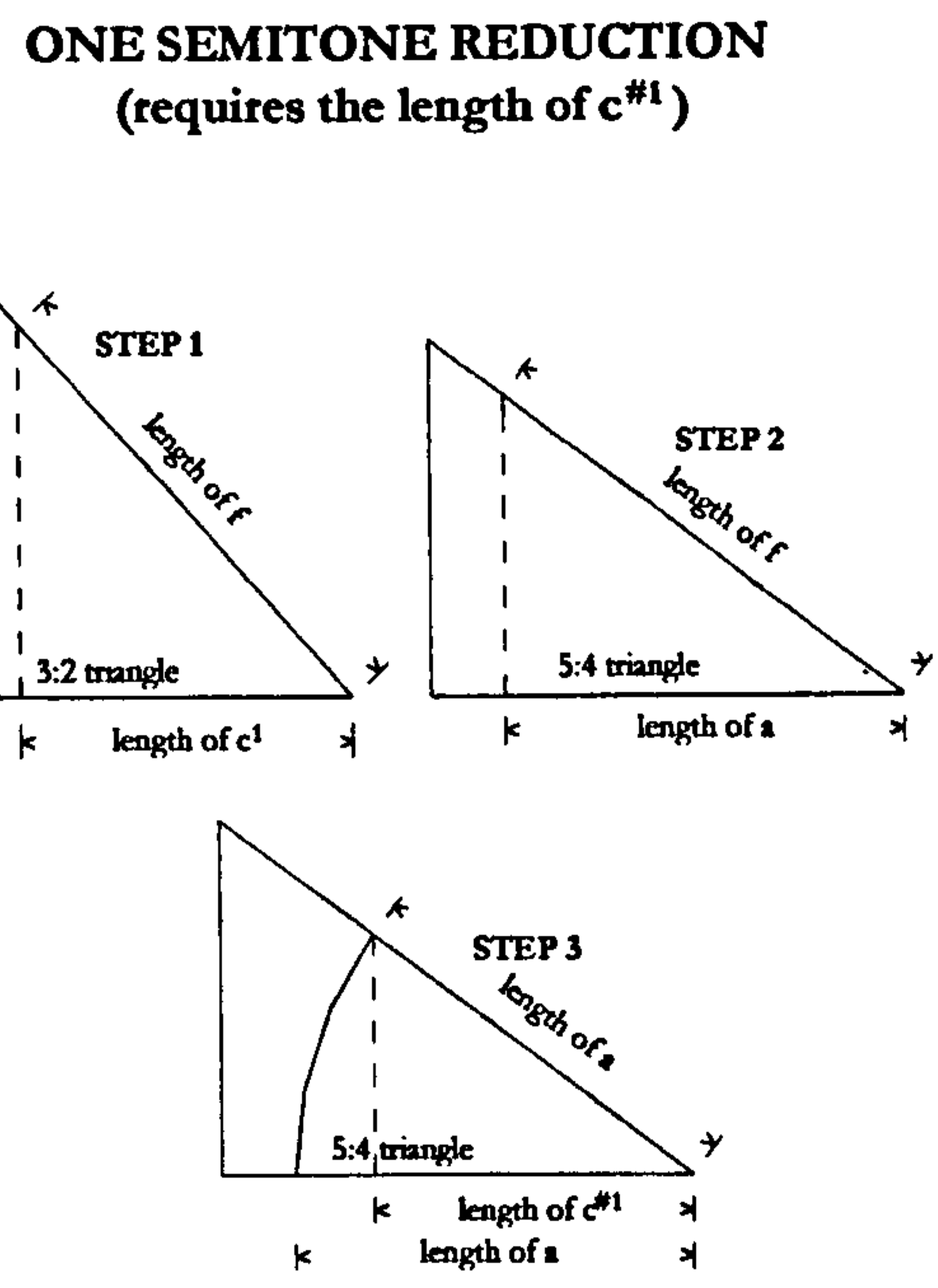
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[66] It is possible that the scaling-design note (f^3) and the note two octaves below (f^1) were specifically measured and that all the intermediate notes are the result of chance, including the Pythagorean scaling over the top octave.

The actual method of calculating the string length for the reduced scalings probably used one or more triangles. A triangle with its base set to two units and the hypotenuse set to three units would give a ratio allowing the calculation of perfect fifths, and another triangle with sides set to four and five gives a ratio to measure major thirds. These would be all that are required (to a high enough level of accuracy).[67] The following Figure shows how the maker could determine the lengths for the reduced scalings using the two triangles. In both examples the maker starts with the length of c^1 assuming Pythagorean scaling.

[67] A full possible method of using triangles for calculating string lengths for quarter-comma meantone-tuned triple-fretted clavichords is discussed and illustrated in Martin (2000/3), and a method using the geometric mean is shown in Koster (1998/1).

Figure 3.19 – Method for calculating the required string length for an instrument whose scale reduces by one semitone over two octaves (above), and two semitones over two octaves (below).



An alternate method of obtaining a reduction of two semitones would have been to use a 9:8 triangle, with the length of c^1 set on the hypotenuse (9). The length of d^1 is found by drawing a line which was at a right angle to the base (8) through the c^1

mark. The distance on the base from where the line intersected to the point where the base meets the hypotenuse gives an acceptably correct string length for d^1.

As these reductions appear to represent standard design practices by the makers (in the case of Keene and the White family), these calculations need only be determined once (or once for each scaling-design note length), and then could be scribed on a permanent marking-out stick for future use.

The bass end of the left bridge was probably positioned without any specific length in mind.[68] An examination of the bass string lengths shows that, although most instruments have one or more potentially significant bass note (C or the lowest note) which are integral or half-integral units of the English inch, this is not consistent from maker to maker, or even in examples by the same builder. Likewise, there is no consistency found in the plucking point lengths. Instead, rather than position the left bridge to give a particular string length, it is likely that the left bridge was positioned so that the string lengths were accurate in the top octaves, and the bridge was able to follow its natural curve to the bass.

If the soundboard was marked out prior to the case being built it would have been possible to add an appropriate distance at the outside edges of the bridges for clearance, and then to have cut the soundboard to length. The bass end of the right bridge usually butts against the wrestplank capping-piece (minus its applied moulding), and therefore the space required at the right is simply the desired width of this piece. The bass end of the left bridge is on free soundboard, so an appropriate – arbitrary – amount needs to be added before that edge can be finished to size. As discussed at the start of this chapter, it would also be possible for the maker to take these measurements from the soundboard and then build his case, fitting the soundboard once the case structure was complete.

THE SOUNDBOARD MOULDINGS AND WRESTPLANK CAPPING-PIECES

The soundboard mouldings serve several purposes. The left case end and left spine mouldings serve as hitchpin rails, through which the hitchpins were driven. These, and the other mouldings, act as frames for the soundboard decoration and the

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[68] One exception to this is the 1664 RH, discussed fully in Martin (2000/2) and in the Catalogue, page 89.

soundwell papers, disguising any space between the edge of the soundboard and the case members; and protect the soundboard from any damage at the edges (particularly the section behind the nameboard). The wrestplank capping-pieces provide a hardwood surface through which the tuning pins were drilled, whilst also giving visual contrast with the soundboard itself.

The soundboard mouldings are made of oak, Virginian cedar or conifer wood, depending on the instrument, and (to an extent) when it was made. The earlier instruments tend to be of oak, with Virginian cedar appearing from the earliest surviving instruments by the White family. Some later instruments use conifer wood for the soundboard mouldings. Most of the instruments with Virginian cedar or conifer wood mouldings use oak for the spine and left case-end mouldings - the two sections which act as hitchpin rails. These mouldings are the same height as the other pieces, typically 3.5 – 4.0 mm, but are usually several millimetres wider; 16 – 17 mm, rather than the 14 – 15 mm of the other soundboard mouldings.

The hitchpins are usually made of iron, cut from long lengths of stock,[69] and are typically about 1.4 – 2.0 mm diameter. They are normally set in a single line, into a little hollow in the hitchpin rail moulding, approximately 5 mm from the inside of the spine and left case end. They are hammered in to the rails vertically and then bent afterwards, several instruments having notably curved, rather than kinked, protruding shapes. Normally the pins protrude a total of about 6 mm from the hitchpin rail, and are bent to an angle of around 45°. There are usually about 16 pins in the left case-end hitchpin rail, with the remainder on the spine hitchpin rail. The pins are in pairs, as found with the bridge pins, and positioned so that the strings are deflected by an angle of about 10° from their sounding-portion line. This angle is not consistent (see Table 3.11, below), implying that they were not positioned with any type of jig.

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[69] The top surfaces of the pins are typically jagged, as left when a cutter is used to cut the stock into individual pins.

Table 3.11 – Divergent angle (in degrees) of the strings between the sounding length and the portion between the hitchpins and the bridge.

Instrument	C	c	c^1	c^2	c^3
1641 GT	6	8	10	8	11
1644 TW[70]	7 / 7	8¾	8	88	8½
1656 JW	9½	9	9	9	9
1662 TB	6	7	7	7	9
1664 RH	7	11	11	11	14
1668 SK	6	5	11	12	21
1670 AL	11	8	9	9	14
1655 JL	12	8	8	12	16
1679 CR	4 / 6	10	8½	9	1

The mouldings are held in place by glue, without any additional pegs or nails. The corners are mitred. The moulding behind the nameboard extends to the left case end in a single straight piece, with the rear wall of the toolbox being in line with the nameboard. The mouldings that are at the edge the wrestplank capping-pieces are reduced in width, so that only the moulded part remains, generally having a width of 7 – 8 mm. There are mouldings at both sides of the treble wrestplank capping-piece, and on the left side of the bass capping-piece. The right side of the bass capping-piece butts against the inside of the right case end.

Treble and bass wrestplank capping-pieces are found on almost all surviving virginals. The 1668 SK, 1671 PJ and 1675 SK instruments have only a treble wrestplank capping-piece – the bass tuning pins go directly into the soundboard wood – and the 1638 TW has a single capping-piece, next to the right case end, into which all of the tuning pins are positioned. The capping-pieces are almost invariably of oak,[71] typically about 35 – 45 mm wide, not including any applied mouldings. They are glued to the top of the soundboard, usually without any other method of attachment,[72] and – in examples where it can be accurately determined – closely match the width of the wrestplanks themselves. They are always the same height as the flat sections of the

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[70] The 1644 TW is double-strung in the bass from GG/BB – A, and the 1679 CR is double-strung from GG/BB - D. The two figures are for the longer and shorter of the strings respectively.
[71] The only exception is the 1641 GT, in which the case and wrestplank capping-pieces are of walnut.
[72] Some instruments have unplugged holes which may have originally had nails in them. These nails would be used for clamping purposes only, and there is no evidence that they were placed there permanently. It is possible that nails were used to clamp the capping-pieces in place on other instruments, with the holes later obliterated when the tuning pin holes were drilled.

soundboard mouldings, creating a smooth visual transition from the soundboard mouldings to the capping-pieces.[73]

Plate 3.13 – Photograph showing the top of the treble wrestplank capping-piece and the soundwell mouldings (1668 SK).



The tuning pins are in two rows on the wrestplank capping-pieces. There are scribed lines on the capping-pieces, usually set approximately 20 mm (¾") apart to position the pins. As with the hitchpins, the sidedraft angle is not consistent, suggesting that the pins were positioned from front to back without the aid of a jig. On a number of instruments it appears that the maker decided to position the pins a certain distance above the bridge pins, possibly using the same marking-out stick. This naturally results in a different sidedraft angle depending on the distance between the bridge pins and tuning pins.

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[73] The one exception is the AH virginal, where the (non-original) capping-pieces are approximately twice the height of the mouldings.

Table 3.12 - Divergent angle of the strings between the sounding length and the portion between the tuning pins and the bridge.

Instrument	C	c	c^1	c^2	c^3
1641 GT	19	11	11	11	14
1644 TW[74]	12 / 12	9	10	12	16
1656 JW	35 / 35	12½	14	14	19
1662 TB	9	12	11	10	11
1664 RH	11	13	12	11	14
1668 SK	9	8	10	10	9
1670 AL	28½	17	12½	10½	14
1655 JL	21½	13	14	13½	14
1679 CR	11½ / 10½	8	8	8	13

The tuning pins are made of iron. They are normally around 3.5 – 4.0 mm diameter, with the top 12 – 15 mm flattened on opposite sides to allow accurate fitting of the tuning hammer. There is a taper at the bottom of the pins. No pins have any evidence of threads on them, or holes for the wire to pass through. Only one instrument, the 1671 PJ has strings which are probably original, and the surviving coils are neat, the tops set about 15 mm from the top of the pin, and the coils themselves about 7 mm deep. The length of the tuning pins can vary from instrument to instrument,[75] as does the amount the pins protrude from the hole, although a height of around 25 mm (1") is not uncommon. The holes for the tuning pin were drilled using a brace-and-bit, and occasionally damage from the drill bit can be seen around the hole.

THE TOOLBOX

The toolbox is situated to the left of the keyboard, at the front of the case between the left case end and the bass jackrail support. The "dead" part of the soundboard (to the left of the keywell) acts as the bottom of the toolbox. The rear of the toolbox consists of a piece of wood, usually deal about 8 mm thick, which is glued

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[74] The 1644 TW is double-strung in the bass from GG/BB – A, and the 1679 CR is double-strung from GG/BB - D. The two figures are for the longer and shorter of the strings respectively.

[75] The full height of the tuning pins could only be measured in examples where one or more pins was removed from the instrument. In no example did I remove a pin for the purposes of measuring its length.

to the top of the soundboard.[76] The top edge of this piece is normally about 13 mm (½") below the top of the case top, and the bottom of the rear side is glued against the soundboard moulding, in line with the back of the keywell.[77]

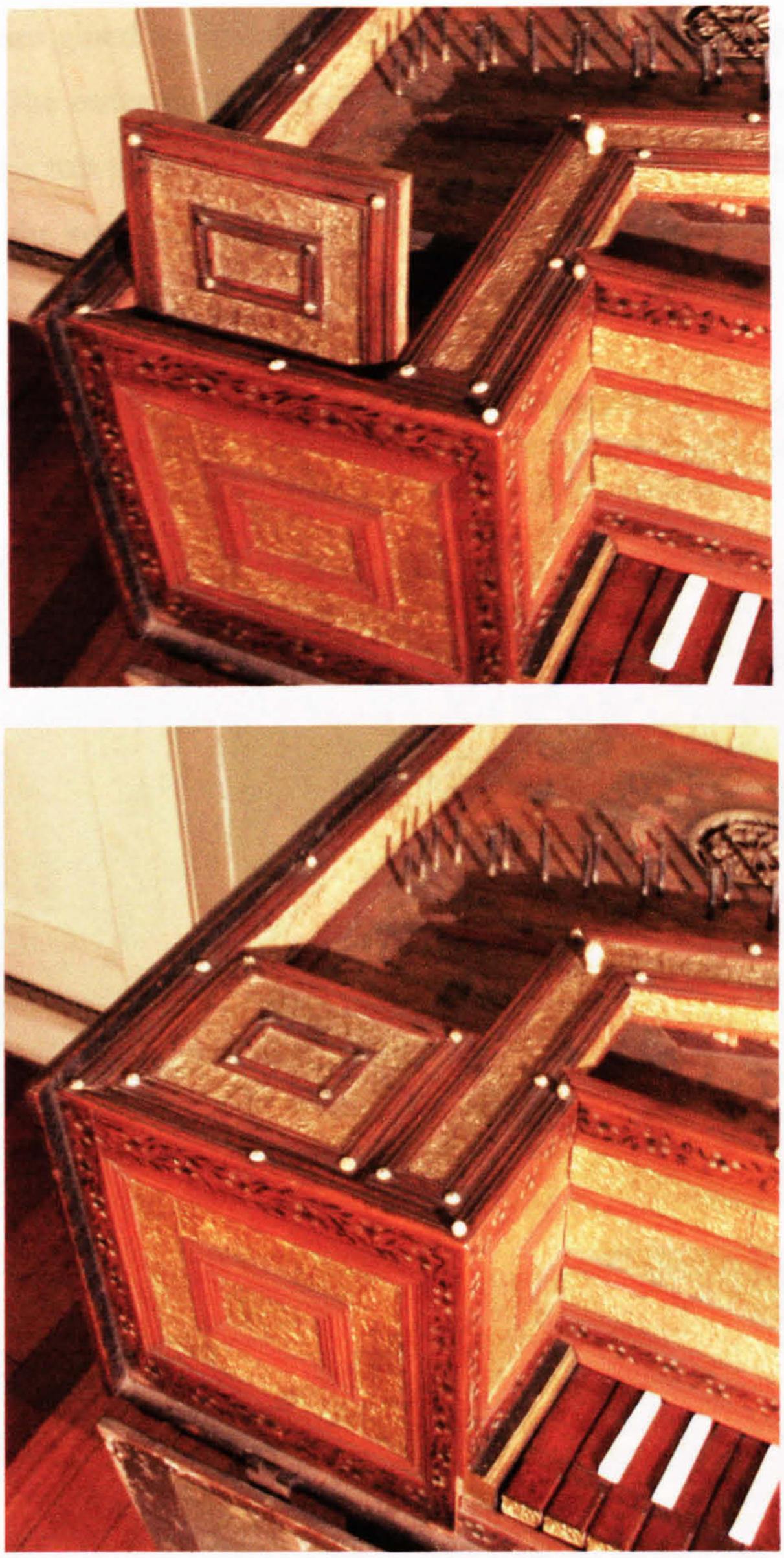
Surviving toolbox lids were made in a variety of woods – oak, pine, lime, Virginian cedar and pear are all found in surviving instruments. They were usually decorated in a manner similar to the case or soundboard, often having arabesques on the top surface. Typically the left- and right-edges of the toolbox lid have decorative scallops gouged out at regular intervals. Depending on the toolbox lid material, it can be either painted or varnished as the rest of the case. The toolbox lid hinges by means of pins which protrude from the left case end and the bass jackrail support, normally about 10 mm from the back surface of the faceboard. The soundwell top moulding on the left case end is cut so that the front end is just behind the toolbox lid when it is in a closed position. The rear part of the toolbox lid rests on the back piece. There is no lock or hook to keep it securely closed, so that, if the instrument is transported on its spine, there is no way of stopping the toolbox lid opening, and the contents spilling into the soundboard area.

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[76] The one exception to this is the Mar virginal, in which there is a full depth vertical piece which originally extended to the baseboard. This piece has subsequently been broken.

[77] The instruments by Charles Rewallin are slightly different, having a toolbox which does not go as far back as the back of the keywell. See the Catalogue, pages 187 and 201.

Plate 3.14 – Typical English virginal toolbox lid shown open (above) and closed (below).



THE JACKRAIL AND SUPPORT PIECES

The jackrail is always made of deal, usually rectangular in section, approximately 50 mm (2") wide and 20 mm (¾") thick. With the exception of the 1644 TW and 1679 CR virginals (which both have more than one note with double stringing) the jackrails are straight. The bass end of the jackrail has a tenon at its end which slides into a

mortice at the end of the bass jackrail support piece. This bass support piece is also of deal, the same width and thickness as the jackrail. It is set perpendicular to the front of the case, with its end glued against the left faceboard and the front portion of its right edge glued against the outer (left) keywell side. Normally the top surface is flush with, or slightly below, the top edge of the keywell side, so that the rear section of the support piece floats above the soundboard, leaving a space in between which is normally about 20mm (¾") deep.

Plate 3.15 – The joint between the bass jackrail support piece and the jackrail fully assembled, showing the mitred join appearance (top), and separated, showing the mortice-and-tenon joint (bottom).

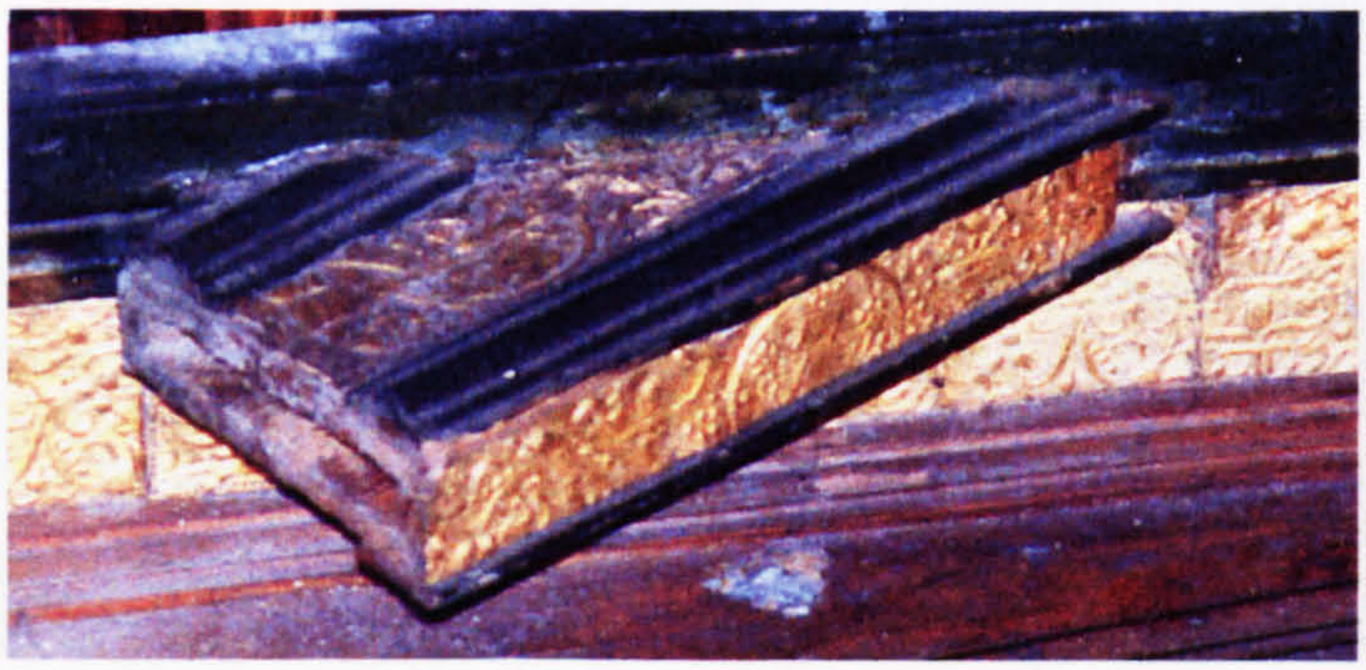


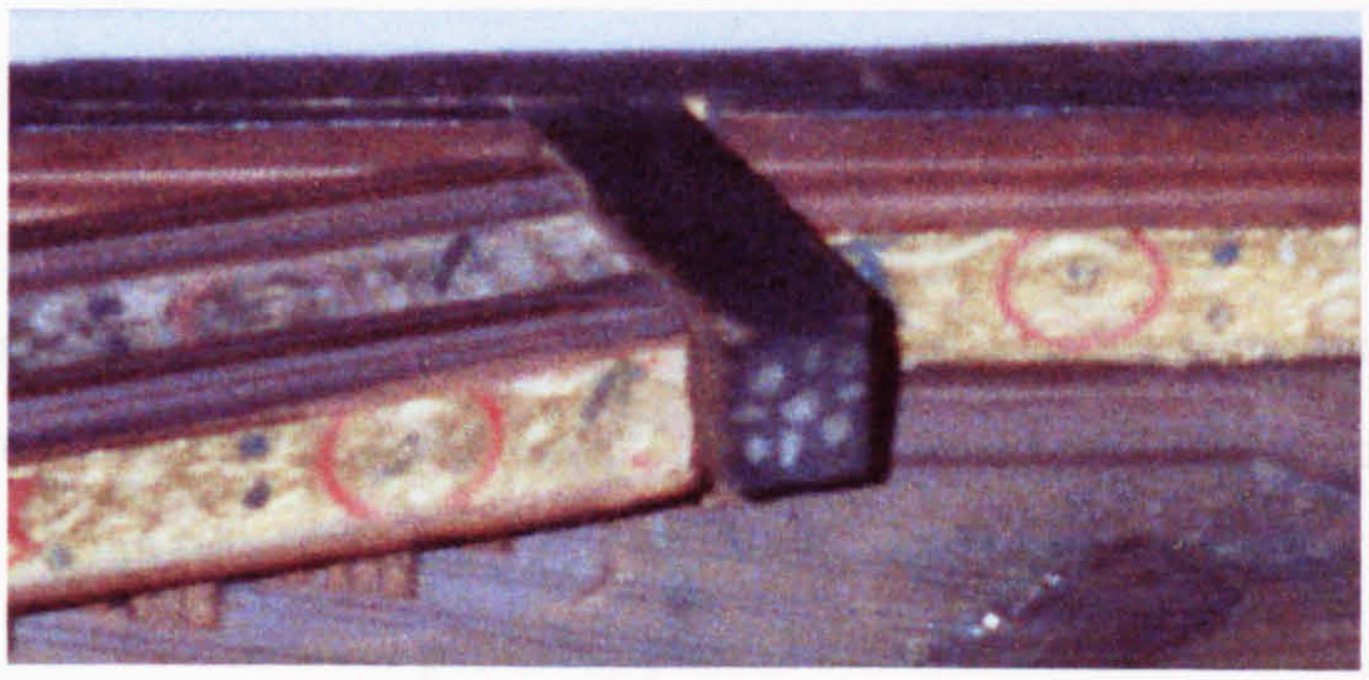


The treble jackrail support piece can be made in either of two forms. The most common style is in the shape of a triangle with three unequal sides. This style is always made of deal, probably an offcut from the jackrail piece. The short side has a mortice in it, which receives a tenon from the jackrail. One of the long sides is glued to the spine, having the spine soundwell top moulding recessed so that the jackrail support is glued along the entire rear surface. The facing side is normally at an angle to the front surface of the jackrail, typically by ten or fifteen degrees. This ensures that there is no chance of its bottom edge interfering with the right bridge or bridge pins.

The second type of treble support piece is usually made of hardwood. The piece has parallel sides, the front of which has a mortice to receive the jackrail tenon. The width is usually about 25 mm (1"), and the overall length typically about 62 – 85 mm (2½ - 3½"). The long sides are perpendicular to the jackrail, at an angle to the spine. The end which is glued to the spine is normally full-depth, from the top of the soundboard to the top of the soundwell. About 20 – 25 mm (¾ - 1") from the spine the bottom part is cut away so that the strings are not obstructed.

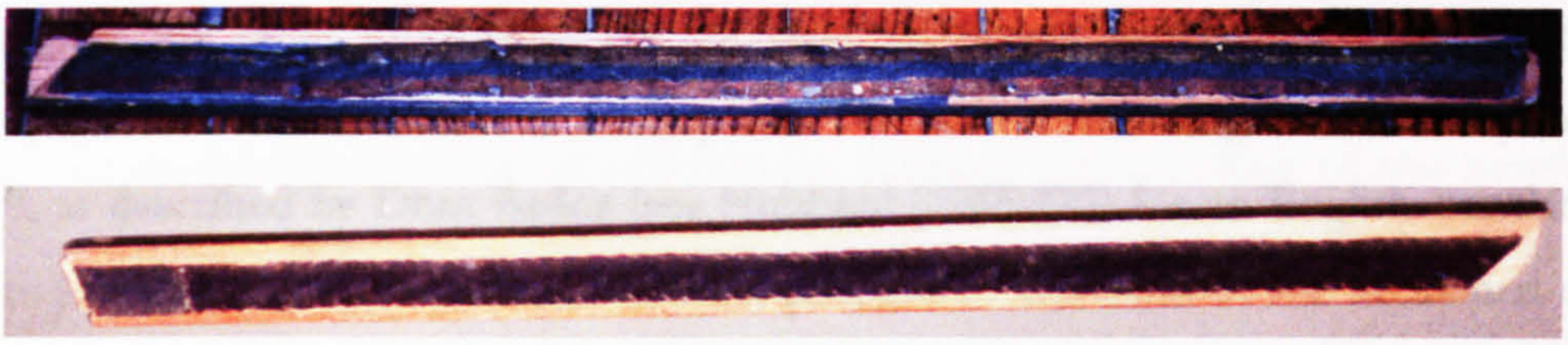
Plate 3.16 – Treble jackrail support pieces, showing the triangular shape (above), and the parallel type (below).





The top of the jackrail and of the bass jackrail support piece have mouldings glued at the front and back, with gilt papers glued in between. At the front bottom edge of the jackrail there is a long strip of the same type as wood as the mouldings, normally about 10 mm wide, 3 mm thick, and protruding about 3 mm in front the bottom edge of the jackrail and bass support piece. This serves as a border for the gilt papers on the front of the jackrail and bass support piece, as the lower part of the nameplate, and to hide the jackrail cloth from view. Original jackrail cloths are usually a single piece of coarsely woven wool, with an uncompressed thickness of approximately 3 mm.

Plate 3.17 – Original jackrail cloths on the 1675 SK (above) and 1675 CR (below).



The nameplate is always of the same wood as the jackrail mouldings. The front jackrail moulding, and the jackrail bottom strip protrude past the front edge of the jackrail, effectively creating a wider area for the maker's name (see Plate 3.18). Each end of the nameplate comes to a decorative point.

Plate 3.18 – Close view showing a typical nameplate.



THE KEYBOARD

The keylevers are made of softwood, usually deal, although lime and poplar are occasionally found (1641 GT, 1666 AL and most of the instruments by the White family). Before being cut into individual levers, the wood was joined together in wide boards, usually about 100 – 150 mm (4 – 6") wide, made up to span the entire width of the keyboard. The boards were probably planed smooth on one surface, then had their edges planed at right angles to that surface, before being glued.

Once the full keyplank has been glued together both surfaces were planed flat. Once that has been done the maker would cut the front edge of the keyplank perpendicular to the joints and then plane it straight, probably cutting the rear edge of the keyplank to approximate size at the same time. The keyplank can then be finished to its final thickness. The keyplanks taper in thickness from front to back, typically being about 14 mm at the front, reducing to approximately 9 mm at the rear.[78]

The top of the keyplank could be marked out once it had been thicknessed. The exact order of marking out varied from maker to maker, and possibly even instrument to instrument. For example, the touchplates for the *d* notes between the accidentals are wider than the other touchplates on the 1668 SK, but a similar width to the other touchplates in the 1675 SK. It is likely that the makers used a graduated "keyboard ruler", as described by Dom Bedos (see Hubbard (1965:222) for an English translation of the passage). The sides of the naturals, position of the front of the accidental cut-outs and the back of the touchplates and the balance pin lines would probably be marked in the first stage. Often the scribed lines for the sides of the naturals extend past the back of the touchplates, and they sometimes have diagonal lines across the marks for *c*/*d*, *d*/*e*, *f*/*g*, *g*/*a* and a/*b* so that they were not accidentally cut too far back. The lines for the sides of the accidentals can then be scribed on, usually only as far as the line for the back of the touchplates, although occasionally a little further.

The next process requires the keyframe (see below) to have been made. As can be seen from an examination of the Keyboard Details table, instruments by the same maker often have three-octave spans which are slightly different from each other (for example 471 and 473½ mm in the instruments by Rewallin, 498 and 496 mm in the Leuersidge virginals, and 481, 482, 483 and 483½ in those of Thomas White). These different lengths can be explained by a change in humidity between when the front of the keyboard was marked-out (as described above), and the next stage of construction in which the keyboard was temporarily pinned to the keyframe. The method used by the makers to determine the width of the keyboard cannot be determined. The total keyboard width is not usually an integral number of inches, but it is possible that the maker divided a particular number of naturals into a number of inches. For example,

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[78] Full details of the keyboard dimensions are given in the Keyboard Details table.

instruments with a c. 483 mm three-octave span may have had keyboards designed so that there are 21 natural touchplates divided into 19 inches.

Once pinned, the keyboard is placed in its correct position in the instrument.[79] The positions of the jacks on the back of the keyboard were then marked, often using a dummy jack which may have a sharp point, an inked lower surface, or a V-shaped base.[80] The dummy jack was hammered down, leaving a mark on the keyplank. The keyboard was then removed from the instrument and lines from the rear of the natural and accidental edge positions to the back of the keyplank were scribed, positioned in between the dummy jack marks. In this manner it was ensured that the jacks would rest centrally on the back of the keylevers.

Once the edges of the keylevers were scribed, the rear edge of the keyplank could be cut and planed to its final width, and the positions of the balance pins could be marked with an awl. The keyplank and balance rail were then drilled, using a drill with a diameter that would produce a tight fit for the balance pins into the balance rail. The keyboard was then removed from the keyframe, and the balance pin holes were drilled with a slightly larger drill to give a clearance for the balance pins and then morticed so that the levers can rock forwards and backwards on the pin.

The final process is marking the position for the keyback guide pins. These were usually marked with a knife, making a V-slot at the top back of the key. The rack had to be offered to the back of the keyboard, and then the position of the rackslots transferred by placing a knife in the V-slot and pushing, which made a small mark on the rack. The rack was then removed and the edges of the slots marked with a knife as discussed below.

Once all of the lines were marked on the keyplank the natural touchplate pieces could be glued on.[81] In all English virginals the natural touchplate material is glued on

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[79] The endblocks are not on the keyframe at this stage - the keyboard sitting loosely in the virginal.

[80] Some instruments have a small hollow underneath the keyback cloth on top of the keylever where the "dummy jack" has left an impression.

[81] It is possible, as suggested in Barnes (1985:17) that the touchplate material was glued as the second process, following the scribing of the natural edge lines. This would avoid having to re-scribe the lines for the front and sides of the accidentals. Although this is possible, the position for the front of the accidentals has to be re-scribed when the other decorative scribed lines are marked, and personal experience shows that it takes little extra time to re-scribe the lines at the sides of the accidentals.

in wide pieces spanning several (usually three or four) naturals and is contiguous, rather than having separate pieces for the front and rear portions.[82] Occasionally with later instruments which have snakewood naturals the pieces were butt-jointed in the middle of a keylever to ensure the most economic use of the wood. All of the earlier virginals have boxwood natural touchplates, whereas the 1668 SK, 1671 PJ and 1675 SK virginals have naturals of snakewood, and the 1684 TB uses ebony. The keyboard of the 1664 RH is a replacement, but uses the original (solid bone) accidental touchplates, and an old photograph[83] shows that the previous keyboard had dark natural touchplates, which may have been snakewood or ebony.[84] Once the natural touchplates had been glued on, the front edges of the touchplates were planed so they overhung the keyplank by a consistent amount, ranging from 2.0 to 3.7 mm, and the top surface of the touchplate material was planed and scraped smooth. All English virginal touchplates are thicker at the front than the rear, typically 2.5 – 3.0 mm thick at the front and 1.0 – 2.0 thick at the rear. The finished plates were then ready to have the lines for the front of the accidental cut-out and the parallel decorative lines, plus those for the sides of the accidentals, scribed.

Once the decorative lines have been scribed the keyplank is ready to be cut into individual keylevers. For convenience this was probably done in several steps, the first of which was to cut the keyplank into groups of five and seven keys, making a full cut between the *b* and *c*, and the *e* and *f* keys. Once completed, these more manageable sections could be cut, probably commencing with the small sections at the front of the keyboard to separate the naturals, and then from the rear edge to the scribed line at the front of the accidentals. These long cuts must have been made with a deep-throat coping saw, but a dovetail saw may have been used to separate the naturals at the front. Once all of the saw-cuts were made the individual keylevers could be separated, using either the fretsaw or a chisel. Most instruments have a gap of between three and five millimetres between the front part of the touchplates and the accidental keylevers, and some instruments show compression of the wood at the front of the accidental

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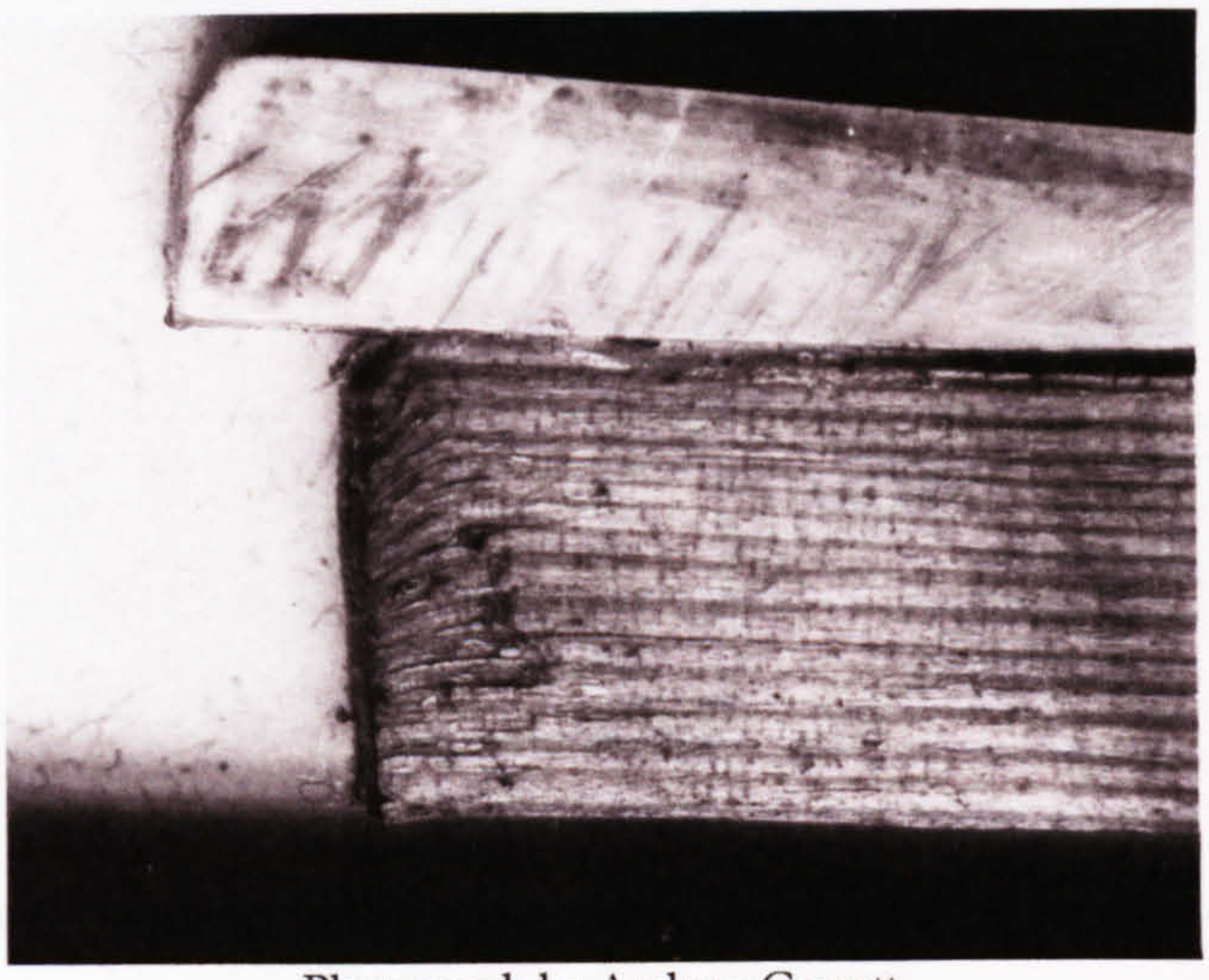
[82] The touchplates of the instruments by Rewallin are different, having a snakewood strip in front of the accidentals rather than decorative scribed lines. On these virginals a different method must have been used, probably glued the snakewood strip first, and then the pieces in front and behind for the remainder of the touchplates.

[83] In the possession of Derek Jackson, former curator of Fenton House. A copy of this photograph is in the instrument's file at Fenton House and has been seen by the author.

[84] The present keyboard has ebony touchplates, but this does not necessarily reflect the original.

touchplates from a chisel. It is not possible to determine if this has been done as the keylevers were separated or in the subsequent cleaning-up operation.

Plate 3.19 – Wood compression (caused by a chisel) at the front of an accidental keylever (1671 PJ).



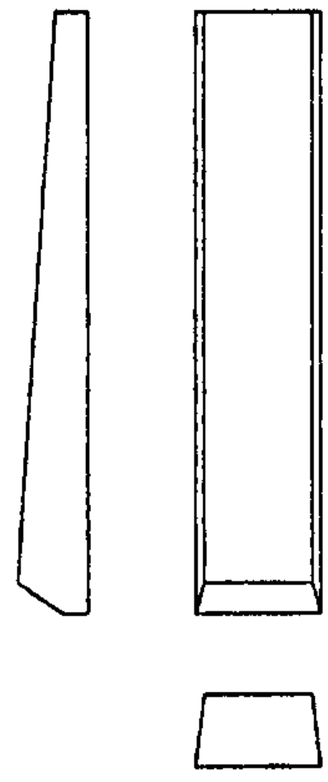
Photograph by Andrew Garrett.

The cleaning-up process included planing the edges of the keylevers, cutting angles on the natural keylevers to ensure that the accidental touchplates did not foul them when depressed, and ensuring that the edges of the natural touchplates were straight and parallel. This last process requires the balance pins and the rack to be on the keyframe, and for the backguide slips to be inserted into the keylevers. The backguide slips are pieces of wood – often beech or deal – one end of which are glued into holes that has been drilled into the rear end of the keylevers. The slips usually protrude about 12 mm (½"), and have a diameter of 3.0 – 3.5 mm where they are glued into the keylever, and taper in width to fit the rackslots with a minimum of excess play. Once the individual keylevers were able to move freely at the balance pin and rack, the maker could ensure that the sides of the natural touchplates were consistently spaced and parallel. The final finishing step on the natural touchplates – prior to oiling them – was to round the edges of the keys. This process may have been done with a profiled scraper, or by using chisels and files. The rounding was usually taken up to the first decorative scribed line and ends abruptly.

The accidental touchplates are made of a variety of materials – deal, pear, walnut, oak and snakewood are found on instruments with boxwood naturals; and solid

bone and ivory found on those with dark naturals. The solid bone and ivory accidental touchplates were made individually and taper in width from top to bottom and front to back.

Figure 3.20 – Drawing of the 1675 SK accidental touchplates.



Wooden accidental touchplates were often made in strips, smoothing the base first and then cutting to the correct height. Once the height had been established the sides were planed, so they were wider at the bottom than the top. The strips were then cut into individual touchplates of the correct length. Occasionally the height tapers from front to back, a process that was carried out after the touchplates have been cut into individual pieces. On some virginals (Mar, AH, 1638 TW, 1653 TW and 1656 JW) the tops of the accidental touchplates have inlaid decoration. This was made by routing out part of the top of the touchplate and then inlaying the design, rather than applying a thin decorative slip over the entire accidental.

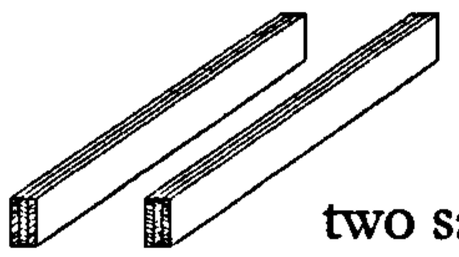
Plate 3.20 – Close-up photograph of the Mar keyboard, showing inlaid accidentals.



The inlay usually consists of small sections of boxwood, ebony, bone or sycamore laid in between long strips. Using the Mar as an example, the process probably commenced with cutting long strips which were glued together in two sandwiches – one ebony/sycamore/ebony, and the other sycamore/ebony/sycamore. These sandwiches were then cut into sections of consistent length, approximately 2.2 mm, which were then glued together in alternate pieces giving the chequered effect. The long side strips were then glued on, providing strength to the structure. If the initial chequered sandwiches were thick enough it would be possible to take slices down the length, leaving strips of the required width and approximately 2 mm thick. The accidental blanks could then be routed using a chisel, and the strips inserted. When the glue had dried the top of the inlaid piece could be planed flush with the top of the accidental blanks. Once the edges were rounded over to remove sharp corners the finished accidental touchplate could be oiled. These processes can be illustrated as follows:-

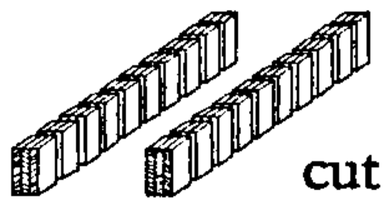
Figure 3.21a – Illustration of the various steps in making an inlaid accidental touchplate (steps 1 – 5).

1



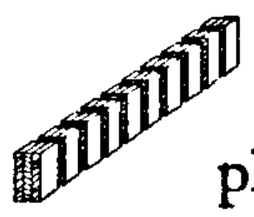
two sandwiched strips
ebony / sycamore / ebony
sycamore / ebony / sycamore

2



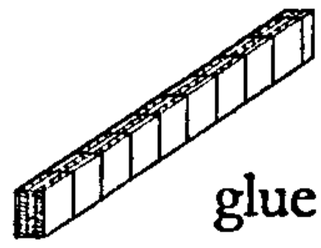
cut up the strips into small rectangles

3



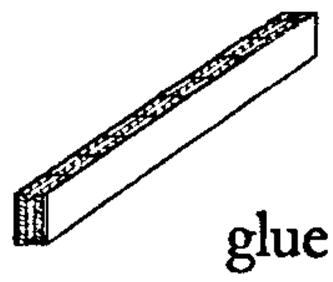
place the rectangles into a chequered pattern

4



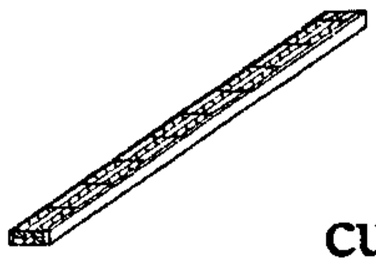
glue the alternate rectangles against a sycamore side strip

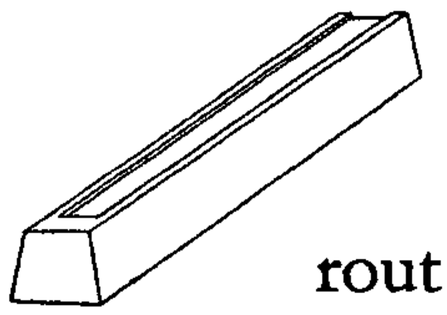
5

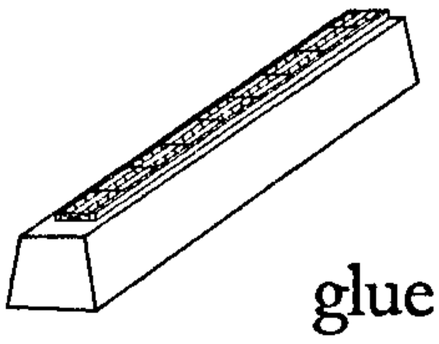


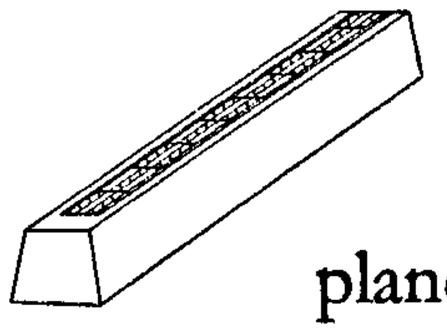
glue sycamore strip on other side

Figure 3.21b – Illustration of the various steps in making an inlaid accidental touchplate (steps 6 – 9).

6  cut sandwich block into strips

7  rout slot in top of jack

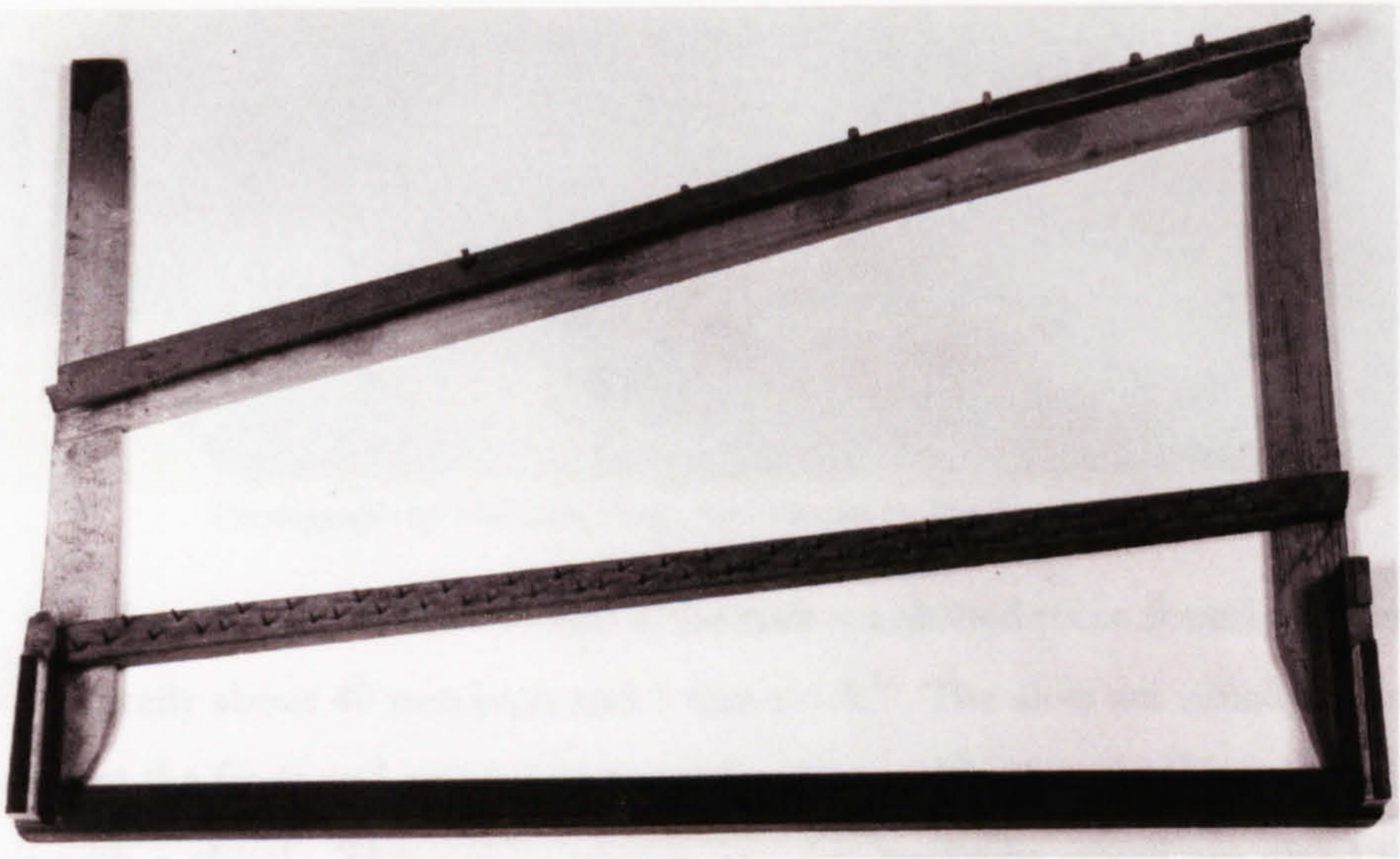
8  glue strip into top of jack

9  plane top surface smooth

VIRGINAL KEYFRAME AND KEYPLANK

The keyframes of English virginals are usually of deal, with hardwood used for the balance rail. The keyframe consists of the balance rail, usually beech, normally about 30 mm wide and 25 mm high, with slightly chamfered corners; and the siderails, backrail and frontrail of deal (the sides usually around 10 mm high, the backrail about 15 mm high, and the frontrail is normally about 6 mm thick).

Plate 3.21 – Top view of a typical keyframe (1668 SK).



Photograph by courtesy of the late John Barnes.

The siderails often taper in width, being reduced in width at the front to stop any risk of interfering with the depressed natural keylevers. There is a half-lap joint between the balance rail and the siderails. The backrail and front rail are joined to the siderails with a similar joint. The balance rail and backrail are angled to take account of the shorter keys in the bass.

Two instruments – the AH virginal and the Theewes harpsichord – have recesses cut into the top of the balance rail so that the front edge of balance rail is higher than the rear for the natural keys, and the rear edge higher for the accidental keys (see Plate 3.21). On the Theewes balance rail the recesses are cut at an angle, suggesting that he made balance rails in batches. As the keys of that instrument are not angled (and that the joint with the (now missing) siderails is cut perpendicular to the front of the case), it would imply that the recesses were cut either before the balance rail was drilled to determine the balance pin positions, or after it was drilled but before keyframe was glued together.[85] The Theewes balance rail is also unusual in being made in two sections, with an oak capping over a softwood lower piece.

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[85] It should be pointed out that the angling of the recesses in the Theewes (between 4° and 9°) is not enough to cause any interference with adjacent keys, and therefore it causes no practical problems.

Plate 3.21 – Balance rail with recessed cutouts (Theewes harpsichord).



Photograph by Malcolm Rose, reproduced by kind permission.

Glued to the top of the backrail is the rack – a slotted piece found in a variety of woods – typically about 40 mm high and 5 mm thick.[86] The slots are usually about 2½ - 3 mm wide at the front and expanding towards a rear width of approximately 5 mm, and were cut with a chisel. These slots receive wooden backpins which are glued into the rear ends of the keys. The slots are not evenly spaced, showing that the position of the slots was determined from the backs of the keys after they were marked out. There are usually scribed lines on the front (and occasionally the back) of the rack, parallel to the backrail to mark the top and bottom of the rack slots. The edges of the rackslots appear to have been cut individually, rather than with parallel blades, judging from the inconsistent width of the rackslots and uneven marks seen where the knife has overrun.

The keyboard endblocks (a good example of can be seen in Plate 3.20) are glued to the top of the siderails at the front. They are usually of deal, and taper in height from front to back. The endblocks fit underneath the keywell side mouldings to hold the keyboard down at the front, and there are other pieces – usually spare soundbars – which are glued to the inside of the frames, holding the keyframe down at the back.[87]

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[86] In the instruments by Rewallin the rack is glued to the rear of the backrail.

[87] The Theewes keyboard was held down by turnbuckles at the front of the balnce rails and small blocks glued to the lower belly rail.

Table 3.13 – Endblock width and height in typical instruments.

Instrument	Bass endblock width	Treble endblock width	Bass endblock height	Treble endblock height
1641 GT	26.0	28.5	34.3 – 32.2	36.3 – 34.3
1644 TW	13.6	16.0	47.6 – 38.0	48.4 – 39.0
1656 JW	12.6	11.8	58.1 – 48.0	57.0 – 50.0
1662 TB	26.0	25.9	40.8 – 38.0	42.2 – 40.2
1664 RH	33.0	33.5	47.9 – 45.8	48.3 – 46.5
1668 SK	17.4	16.1	44.0 – 40.5	44.0 – 42.5
1670 AL	16.7	16.8	46.5 – 43.5	50.8 – 46.4
1655 JL	7.5	10.2	49.0 – 39.3	47.0 – 40.0
1679 CR	21.0	21.9	47.2 – 42.9	47.7 – 44.5

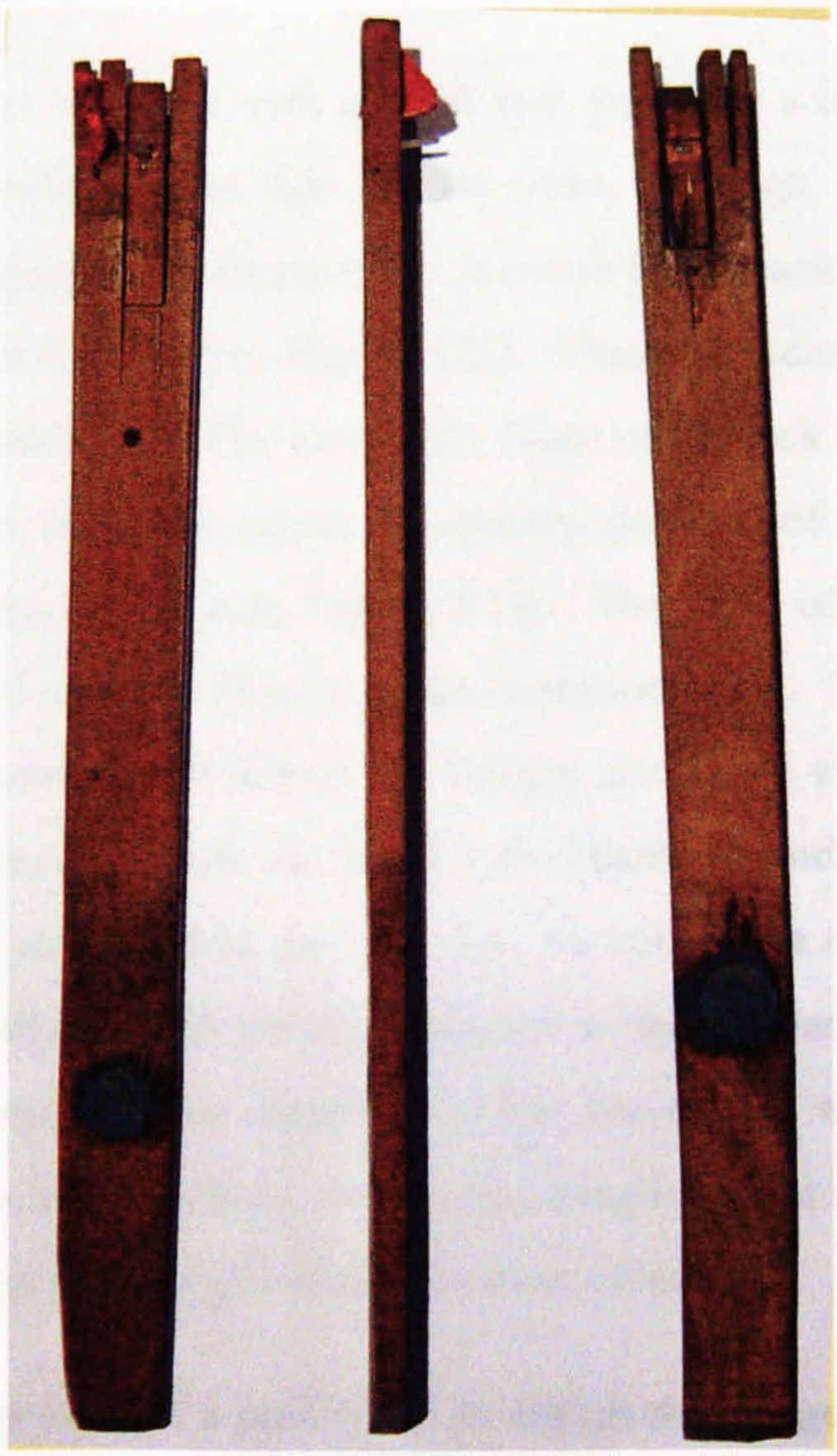
There is a front batten glued to the front of the endblocks and frontrail. This batten is the same thickness as the faceboard mouldings, has a moulding on the top surface, is made of the same material and is decorated in the same manner as the other case mouldings. The keyframe was designed so that the rear of the backrail touches the inside of the spine, limiting the possible front-to-back movement, and ensuring that the keyboard is in the correct position when the front of the keyframe front batten is flush with the faceboard mouldings.

ENGLISH VIRGINAL JACKS

English virginal jacks are usually made of pearwood with boxwood or holly tongues, or else beech for both the body and the tongue. Only one instrument, the 1675 CR is noticeably different, using lacewood for the jack body.[88] The jacks are made and fitted by hand, and show a variety of scribed lines used in the construction process.

[88] Lacewood is not a species of wood, although it is commonly considered so and sold as such. The wood itself is London plane (*platanus sp.*), cut in a way that the grain gives a "lace-like" effect.

Plate 3.22 – Photograph of front, side and rear view of a typical English virginal jack (1641 GT).



Photograph by Anne Meurant, reproduced by the kind permission of the Musical Instrument Museum, Brussels.

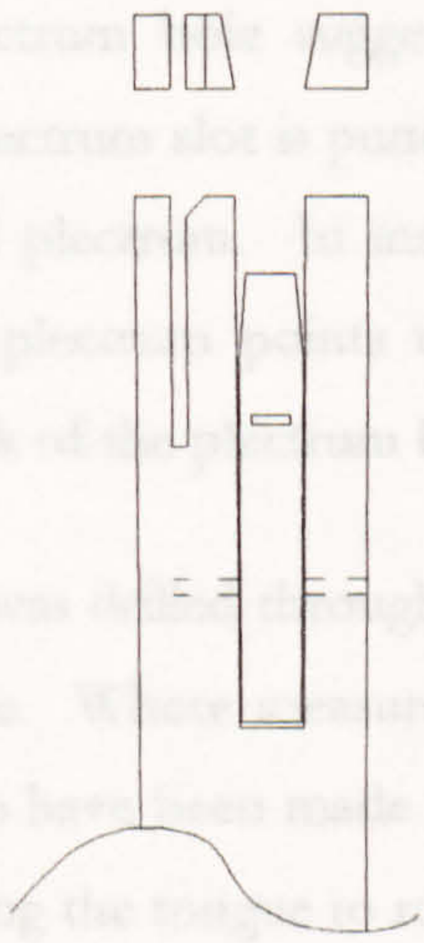
Once the wood for the jack bodies had been cut into over-length blanks matching the desired maximum width and thickness of the jack, the jacks were individually fitted into slots. To do this the blank was first tapered in width, and then in thickness, being wider and thicker at the top. Whereas the width can be consistent from jack to jack, the thickness will vary slightly according to the actual dimensions of the soundboard register and lower-guide slots. A jig with one end slightly higher than the other can be used to ensure a consistent taper from jack to jack, using slips of paper or card in order to alter the overall thickness along the length of the jack.

Once all of the jacks have been tapered and fitted to their slots, they are scribed for the tongue and damper slots, as can be seen in Plate 3.22. There are usually vertical

scribed lines for the sides of the jackslots and horizontal lines for the plectrum, axle, and the bottom of the tongue slot.

The tongue slots were cut with a small saw, probably a dovetail saw. Most of the slots were cut parallel to the side of the jacks, although some taper outwards towards the rear, giving a greater clearance at the rear of the jack and reducing the risk of the tongue sticking in the slot (see Figure 3.22). Once the sides of the slots had been cut, the bottom is chiselled out. The slot at the front of the jack is usually about 5 mm below the rear, and was angled to ensure the correct position of the tongue (illustrated in the side view drawing of the jack, Figure 3.25). The sides of the tongue slot were cleaned up with a chisel or small files to ensure a smooth edge. There is usually only a single flag damper, placed to the left of the tongue slot when viewed from the front. The damper slot is often cut below the line for the plectrum, and is often deeper at the rear. One instrument, the Mar has damper slots on either side of the tongue, and the Theewes has a jack with a closed slot that requires a "mouse-ear" damper.[89] The Mar virginal may retain some original dampers. They are of red woollen cloth, and are angled at the top and bottom corners, so that the damper makes contact with the string at an angle and dampens the string's vibrations more effectively.

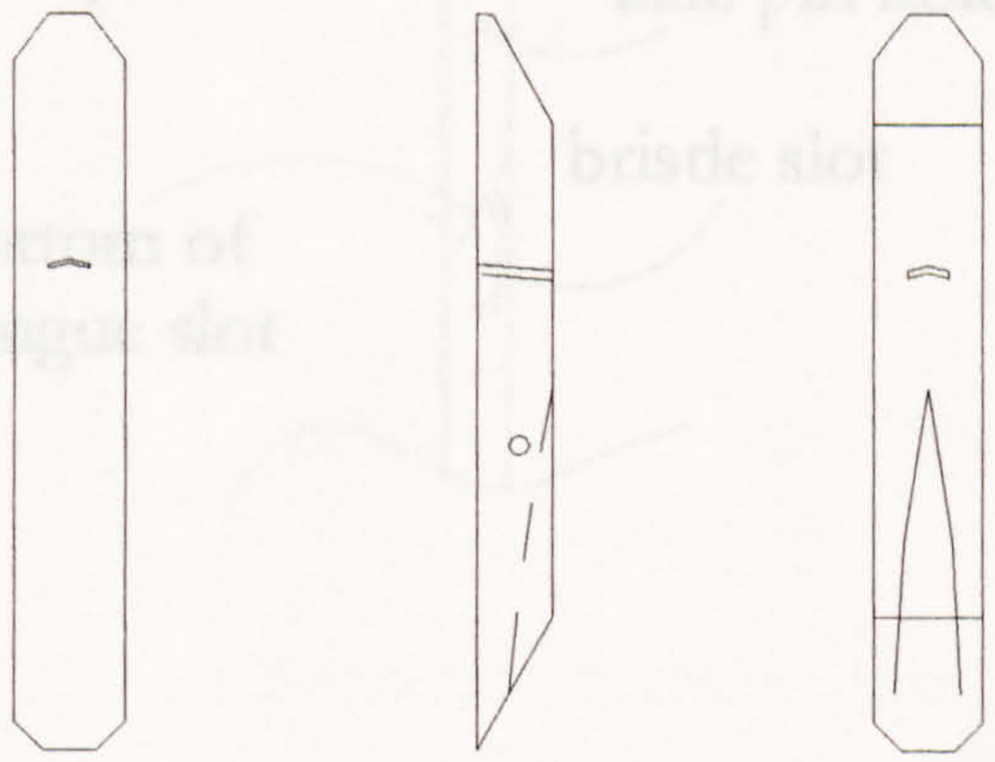
Figure 3.22 – Top view of a jack body in which the tongue slot tapers out towards the rear.



[89] See Rose (2002:292) or the Catalogue entry, page 334, for an illustration of the surviving jacks in the Theewes, and O'Brien (1990:123) for a description and illustration of how a "mouse-ear" damper is made and functions.

The tongues are rectangular in front view, occasionally having slight chamfers on the top and bottom corners to reduce the risk of catching the side of the tongue slot. They were made from wide strips of wood, planed to the correct maximum thickness (typically 2.5 – 3.0 mm), and cut to the required height. The bottom rear edge of these tongue blanks was chamfered to a sharp point at an angle that is more acute than that at the bottom of the tongue slot, and the top of the blank is chamfered, usually leaving a thickness of about 1.0 mm at the top.

Figure 3.23 – Front, side and rear views of a typical tongue.



front view side view rear view

The accuracy of the plectrum hole suggests that it was punched after the tongues were sliced apart. The plectrum slot is punched from behind, and often curves slightly to accommodate the quill plectrum. In instruments which show little tongue damage it can be seen that the plectrum points upwards at a slight angle, typically between 5 and 8°, reducing the risk of the plectrum hanging on the string on its return.

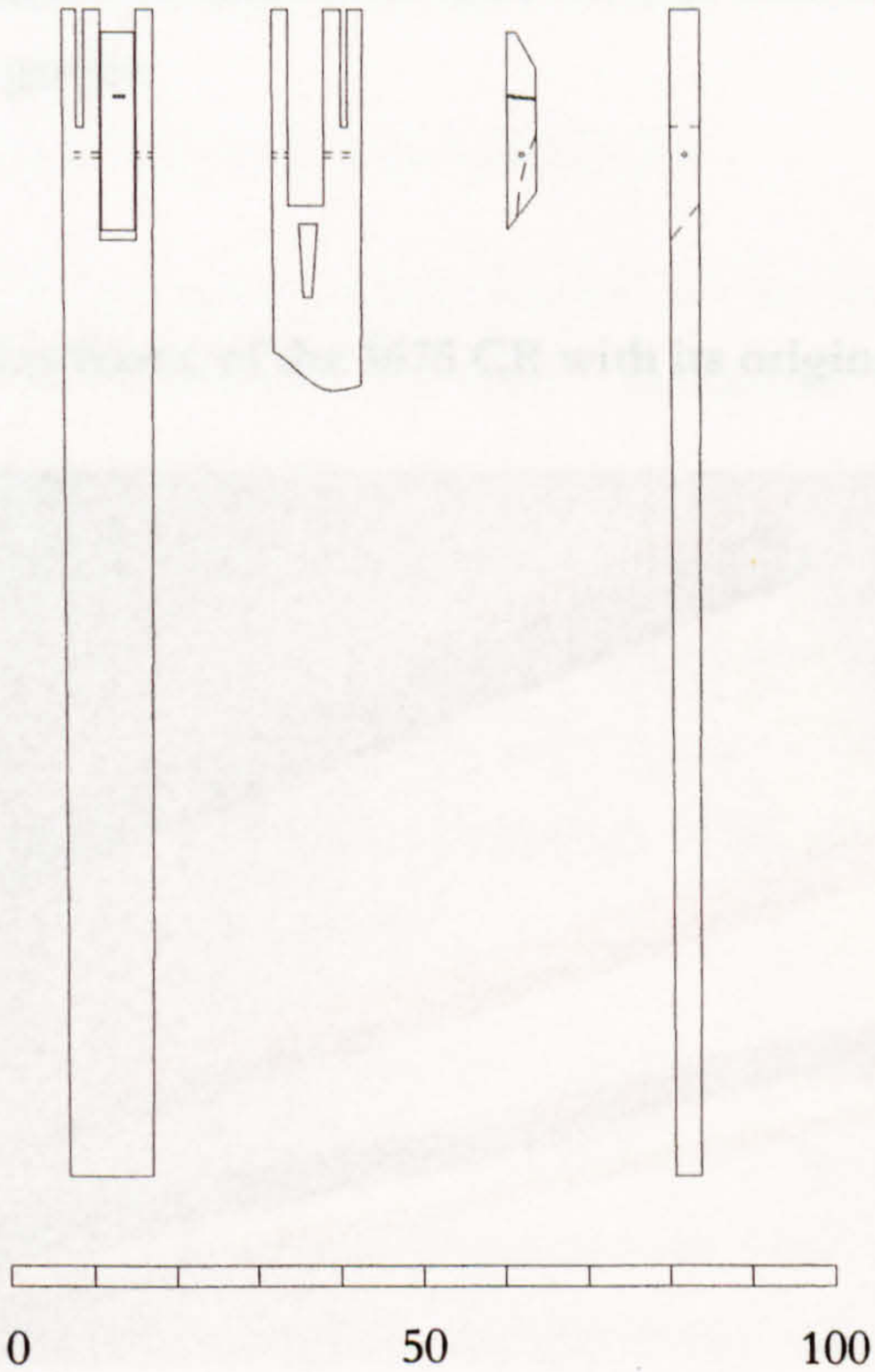
The hole for the axle pin was drilled through the right side of the jack and does not protrude through the left side. Where measurable the axle pin is typically 0.60 – 0.65 mm diameter, and appears to have been made from brass wire. The hole through the tongue is slightly larger, allowing the tongue to rotate freely without any excess play.

The bristle spring is hinged from the jack body and rests in a deeply cut V-slot on the back of the tongue. The bristle goes through a hole that was drilled into the

angled section at the bottom of the tongue slot, then being angled towards the rear and then into the jack body (see Figure 3.24). The bristle slot was cut with a chisel, often so deep that the axle pin can be seen protruding through the sides of the V. Occasionally the V-slot cut goes through the bottom of the tongue.

Figure 3.24 – Side view section through the upper part of the jack body.

Figure 3.25 – Front, side and rear views of a typical jack.



ACTION CLOTHS

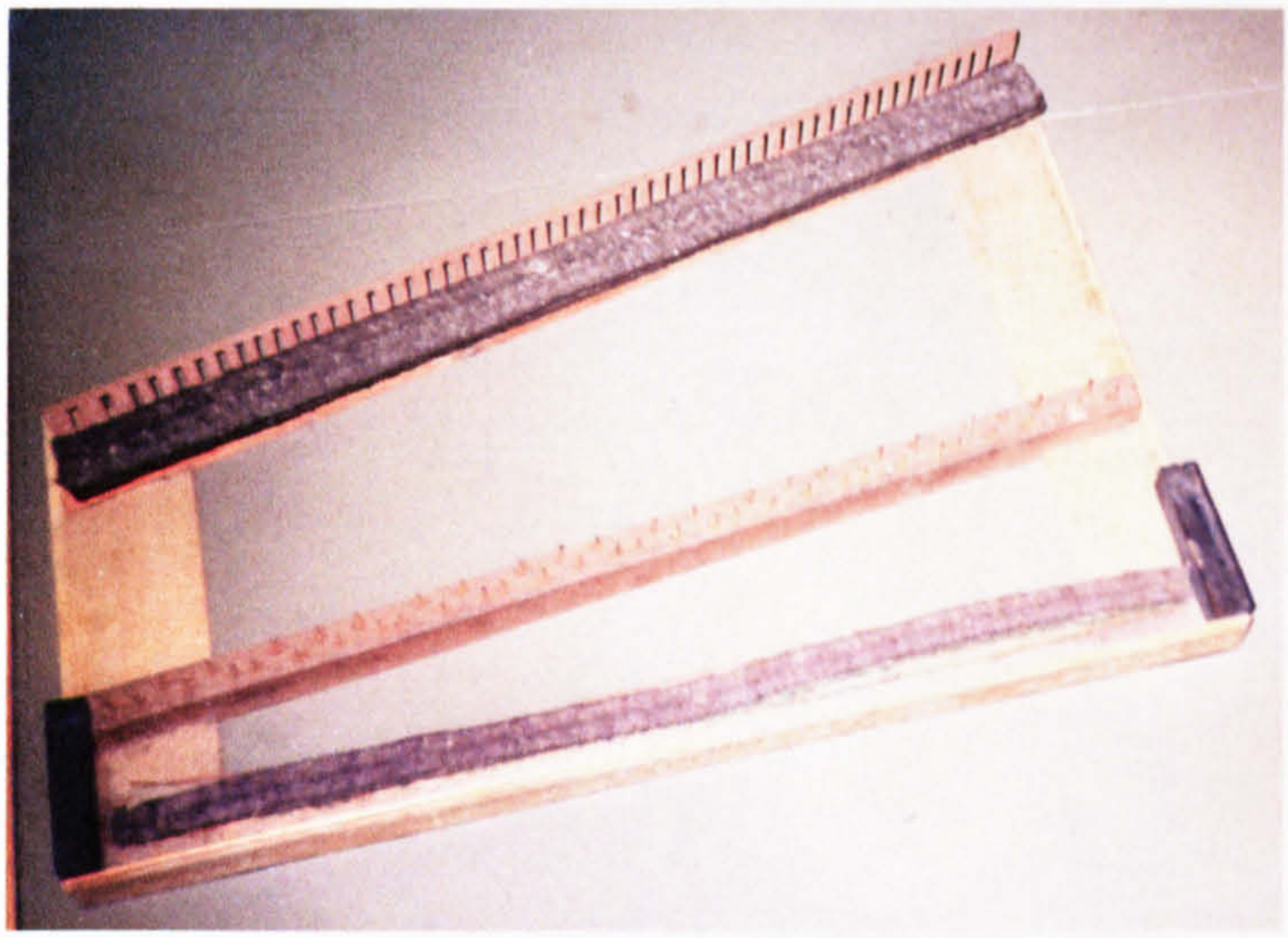
Only one instrument (1675 CR) retains all of its original action cloths, although various other instruments retain some cloths. All of the cloths found in English virginals are of woven wool, varying in thickness according to their purpose.[90] The cloths are generally quite coarse in texture with a limited reduction in thickness under high compression. Although this may partially be the result of age, it is likely that this was a characteristic of the original action. Occasionally original felted[91] action cloths are found, particularly used for the jackrest cloths on top of the keys at the rear. Leather is also occasionally found in surviving instruments, but in no example can this be shown to be certainly original.

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[90] The action cloths are discussed in detail in the Catalogue entry for each instrument.
[91] Felted by mechanical means. The cloths are not "felt" in the modern sense.

Original jackrail cloths (and the key-rest cloths on the keyframe) are always attached by small tacks. The cloths on the back of the keys for the jacks to rest on are glued over the entire length. Balance cloths have holes in their centres are held in place by the balance pins and gravity.

Plate 3.23 – The keyframe of the 1675 CR with its original action cloths.



THE DECORATION OF ENGLISH VIRGINALS

THE STANDARDISATION OF THE DECORATION

The most immediately recognisable feature of an English virginal is its decoration. The same type of elaborate – if naïve – decoration is found on all of the seventeenth-century virginals,[1] and all of the major characteristics are found in the surviving instruments from the sixteenth century. Although the case exteriors are plain, decorated only by iron hardware, the interiors have lid and keywell flap paintings, painted flowers and birds on the soundboard, gilt roses, and finely cut mouldings on the faceboards, keywell, and soundwell, contrasting with gilt papers. Often the keyboard itself has decorative features of note.

The application of this type of decoration appears to have became standard in between about 1550 and 1580. The instruments listed in the Inventories of Henry VIII (1543 and 1547)[2] contain few descriptions of instruments which match the decoration found in surviving examples.[3] However, the decorative similarities found in the Theewes harpsichord (1579) and the Mar and AH virginals, and seen in a painting attributed to the Master of the Countess of Warwick (dated 1560 – 70)[4] show a tradition in the process of establishment and standardisation. Although the Theewes, Mar and AH instruments were built in the same workshop tradition, and possibly decorated in the same workshop, they have few decorative variations. The painting the Master of the Countess of Warwick shows gilt decoration and mouldings around the soundwell. A comparison between the Mar and Theewes instruments, and the virginals of the seventeenth century shows that the only major difference is the paintings on the lid and keywell flap, which are small strapwork panels inside strapwork

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[1] The 1622 Hasard harpsichord at Knole Park is decorated in a different manner, and described in detail in the Catalogue, page 345.

[2] See Appendix One, for a full transcription of the keyboard instrument entries.

[3] There are various references in the inventories to instruments with oak cases, and to instruments which have been covered in leather – a type of decoration found on the Theewes harpsichord. There are also Court records of iron hinges and lockplates being supplied for musical instruments. There is no mention of soundboard decorations or lid paintings in either of the inventories of Henry VIII.

[4] It has not proven possible to trace the owner of this painting. It was displayed at the British Antique Dealers Association exhibition in Grosvenor House, 1989, and is illustrated in the catalogue "England at the tyme of the Armada".

borders on the Mar and the Theewes, rather than covering the full lid interior (with the exception of a small border) on the later instruments. The earlier instruments all lack border patterns on the soundboard,[5] although they have arabesque decoration at the corners; and the decorative work on the lids of the earlier instruments is similar to the soundboard border-patterns found on the seventeenth-century virginals. The AH virginal is probably in an earlier decorative style, having arabesque work, Latin mottos and (on the lid) small diamond panels with birds and flowers inside, rather than painted scenes.[6]

The Hasard harpsichord of 1622 is decorated in a much simpler style than the other instruments. Although much is missing, it is clear that there were probably no gilt papers, the instrument having a Latin inscription in orpiment over lamp black around the soundwell, and the maker's name painted in the same manner on the nameboard.[7] All of the soundboard, apart from a small section about 20mm wide in the treble, is missing, but it is unlikely that there was painted decoration on it, judging from the surviving wrestplank veneer and the small piece of the soundboard that remains. In any case, the soundboard is almost certainly cypress rather than a conifer wood.[8]

There is very little variation in the later instruments, despite the decorative work being carried out by a number of different workshops. There is also no documentary evidence to suggest that other types of decoration were used.

THE DEMARCATION BETWEEN MAKER AND DECORATOR

It is clear that the decoration was not carried out by a member of the maker's workshop. The same decorator is responsible for the early instruments of Thomas White as well as the 1641 GT, and a different artist decorated the instruments by both Keene and Jones. That artist may have been responsible for other instruments as well, possibly the Leuersidge virginals and the 1684 TB. Alternatively, the decoration on the

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[5] The Theewes harpsichord has white lines either side of the bridges and the edge of the soundboard, but there are no decorative scallops as found on later virginals.

[6] It is possible that this instrument is earlier in date than the Theewes harpsichord and Mar virginal, possibly even from the late 1560s. If this is correct it may show a decorative link from the instruments listed in Henry VIII's Inventories to the Theewes and Mar. For a full discussion about the dating of this virginal see the Catalogue, page 20.

[7] See MacTaggart (1978).

Leuersidge and Bolton instruments may represent a "workshop tradition", where different artisans use a style which is very similar to each other. This can be seen in the decoration found on the Theewes, Mar and AH instruments, where all are similarly decorated.

Despite it being clear that the decorators were not actually part of a maker's workshop, it is equally certain that there was a close link between the builder and the decorator. All of the interior of an English virginal is decorated in some manner, and this must have involved some degree of collaboration. The similarity between lid, keywell flap and soundboard decoration suggests that the same hand carried out all those tasks. Other decorative features, such as the mouldings, any stamped decoration on the keyboards and the gilt papers were the responsibility of the maker. The hardware was purchased from an independent supplier, and it is reasonable to assume it was the maker who attached it to the case, as several pieces – for example the lockplate and hasps – involve some modification to the woodwork to be carried out when they are applied. The stand is simple woodwork, but was probably also purchased from a separate supplier. Although Livery Company rules were not enforced as strictly as on the Continent, they would have prevented members of the Joiner's Company from carrying out any turning work.[9] Rather than only the legs, the matching wood suggests that a woodturner is responsible for the entire stand.

The close relationship between the maker and decorator can be seen when examining the soundboard decoration on some instruments – most notably those of Keene and Jones. One feature of this decorator's work is his use of scribed circles around the roses, and, more significantly, scribed lines around the wreath and arabesque decoration that surrounds the roses. It can be seen that the scribed circles would, if continued around a full 360°, go under the bridges and soundboard register. The bridges and register must have been in place (or, at least, their positions determined) prior to the circles being scribed, and – as the centres of the scribed circles are also the rose centres – the rose positions must have been determined at that time.[10]

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[8] See Koster (1980). My own examination of the instrument concurs with this view.

[9] To carry out woodturning on a scale required to make the legs for a stand would involve the use of a pole lathe. This would be too large to attempt to disguise in any way.

[10] As the scribed circles occur on instruments of both Keene and Jones they must be the work of the decorator rather than the maker.

MOULDINGS

English virginals have applied mouldings around the top of the soundwell, the edges of the soundboard, and on the faceboards, the keywell, the jackrail and jackrail supports, the keywell front batten, and often the top of the lid. Various woods are used for the mouldings including poplar, oak, cedar and conifer wood.

The mouldings are cut either with a pair of moulding planes – two mirror-image planes cut with the negative shape of the finished moulding, or else a scratchstock – a metal scraper shaped to the reverse image of the moulding and held in an L-shaped wooden block.[11] Both can achieve excellent results, and it can be impossible to tell them apart unless any distinctive faults occur. When using moulding planes, a pair is required to allow the grain to be cut from both directions, thus avoiding "tear-out" which occurs when planes are used against grain rising towards the plane. The faults, which may be expected when using moulding planes, are some tear-out, particularly in wood with an inconsistent grain, or slight overlap from the blades not being an exact image of each other. A scratchstock can be used in both directions on a piece of wood,[12] but it can produce a wavy surface as a result of the moulding having been cut to an inconsistent depth. There are also advantages with using either method which are distinctive in the wood prior to any finishing that is applied. A moulding plane produces a clean cut with a smooth open-pored surface, whereas a scratchstock tends to polish the surface. Examining the mouldings themselves has not revealed any firm evidence about how the mouldings were cut, and it is probable that both methods were used, albeit in different workshops. The lack of tear-out, particularly in mouldings made of oak, and the lack of any overlap, suggests that a scratchstock is more likely to have been used in the majority of circumstances.

The most commonly used material for the mouldings is Virginian Cedar (*Juniperus virginiana*). This wood is native to the south-east area of the United States, as suggested by its name. This wood (also known as pencil cedar) is relatively soft, fine

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[11] Wraight (1997) gives a long discussion on the methods used to make mouldings and the results that are likely to be achieved with each method. The conclusions presented are based on personal experience.

[12] Personal experience shows that using the scratchstock in the direction of the rising grain works much better than against the grain. By putting a "burr" on both sides of the blade it can be used in either direction as required.

grained, and finishes well. It is a medium to dark red/brown colour, creating a little contrast to the oak of the casework, and a greater contrast to the gilt papers. The wood was first imported into Britain at the end of the sixteenth or early-seventeenth century, probably being used as ballast for ships returning from the American colonies. Oak is also found on a number of virginals, particularly those of an earlier date. Oak is harder to cut cleanly on account of its inconsistent grain and its hardness. When oak is used it is finished in the same manner as the casework, which provides a great contrast with the gilt papers. Lid top mouldings are always of oak, even if another wood is used for the soundwell, faceboards and keywell mouldings.[13] Poplar is found on a single instrument, the Theewes harpsichord. In this example it has been left a light colour, providing a minimal contrast with the gilt papers. The final wood found is conifer, usually appearing to be off-cuts of the soundboard wood. This is found in the AH virginal, where it has been stained and darkened to a warm brown colour (not dissimilar to Virginian cedar), and again in later instruments – the 1664 JP, 1671 PJ, 1675 SK, 1675 CR and 1679 CR. The first three listed instruments have had the mouldings stained or painted a green colour, often obscuring the grain, and likewise the 1679 CR has maroon-coloured painted mouldings. Only the 1675 CR has natural colour mouldings, which give little contrast to the gilt papers.

The following illustration shows typical designs of mouldings as found on the 1565 JW virginal.

[13] The 1641 GT and 1679 CR virginals are exceptions. Both have lid top mouldings made out of the same wood as the lid and case ends – walnut for the 1641 GT, and deal for the 1679 CR.

Figure 4.1 – Mouldings found on the 1656 JW virginal.



Case and nameboard - top moulding



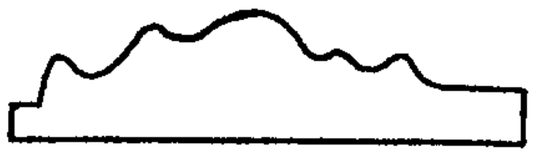
Jackrail Moulding



Inner case-top moulding



Soundboard moulding



Inner panel moulding on case front



Outer panel moulding on case front

DECORATIVE PAPERS

There are gilt decorative papers around the soundwell, and on the keywell, faceboards, jackrail, jackrail supports, and on the keyfronts. Although commonly called "embossed" papers, the papers found on English virginals can more correctly be described as being pressed. This can be seen on occasional examples when the back of the papers behind the design is visible, and show that there is no reverse impression as deep as that found on the front.[14] It is probable that the raw material used for making the decorative papers was purchased as new sheets of paper. No instrument appears to have decorative papers with any evidence of writing on them. Although new paper was comparatively expensive, the use of paper with a consistent quality outweighed the cost factor.

A large variety of different designs is found on surviving English virginals, and even designs which are superficially similar can be shown to have come from different moulds.[15] None of the actual moulds that were used to press the papers is known to survive, and the material used to make the moulds is uncertain. To make the pressed papers, several layers of paper are glued together into a laminate, and pressed into a negative mould on the front surface. It appears that four or five layers, interspersed with normal-strength animal glue were usually used.[16] The degradation of the animal glue was probably responsible for the brown colour found in the surviving papers. With several layers of padding at the back, pressure would have been applied to the mould allowing the still-damp paper laminate to take on the design it is pressed into.[17] The lack of any physical damage to the front of the papers shows that a non-porous mould material was used. As the designs are often detailed it is likely that the mould

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[14] I would like to thank Chris Nobbs, who had occasion to remove a paper during the restoration of the 1662 TB, and informed me that the back was essentially flat rather than embossed.

[15] This has not been tested rigorously and it is possible that some of the simpler designs are in fact identical. The one example where the same papers have certainly been used is in the instruments by Charles Rewallin. These papers have been discussed separately.

[16] It is not uncommon to find the laminates separating at the edges, revealing the different layers. Where they can be measured it can be seen that the thickness of each layer of paper is typically 0.10 – 0.15 mm thick.

[17] Personal experience has shown that the most successful results have come from using papers which were glued together under pressure for about an hour.

itself was cast, probably from pewter or (possibly) lead.[18] The initial design was probably made in plaster, probably as a positive design,[19] which is then used to cast the actual mould.

The one exception to the above method is found in the instruments by Charles Rewallin. In his two surviving instruments the paper that was used is still white, rather than having turned a brown colour. In addition, the rear of the papers has a different – less smooth – surface. A close examination suggests that these papers have been made using a form of papier maché, rather than laminated layers of paper. Although it is possible that pulp was purchased directly from a paper mill, it is more likely that sheets of blotting paper were obtained, or else writing paper was soaked in boiling water, breaking down the size and returning the paper to its pulp form. The pulp was then placed in the mould with some type of size, and placed under pressure. With this process it is even more important that the mould is non-porous.

The papers were always gilded. Close examination suggests that sheet gold was usually used. Personal experience suggests that it is possible to apply the gold before or after the papers have been pressed. As a size is required in between the paper and the gold, a more detailed finish would be obtained applying the gold to the papers before they were pressed. Generally the gold would not be sealed, although microscopic analysis of the 1671 PJ papers show a layer of varnish was applied over the gold.[20] Occasionally powder (probably bronze powder) was used rather than gold, notably on the arcades of the 1664 JP virginal. When bronze powder is used it is essential to seal the surface after the powders have been applied to avoid tarnishing.

One characteristic found on the surviving virginals is the common use of more than a single design of papers on an individual instrument. Often this is due to the different widths that the papers need to occupy. It is rare to find any evidence of papers being reduced in width to fit a particular space.

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[18] Clay is another possibility, but it would require firing with a non-porous glaze before it would be usable. The variety of designs makes it unlikely that they were carved into endgrain boxwood or something similar, and, again, wood needs to be sealed to ensure the paper would easily release once it was stamped.
[19] Some geometrically-based designs are far easier made as a negative, with another positive casting as an intermediate step. The precision found in most of the designs suggests that were few different stages.
[20] This examination was carried out by Ann and Peter MacTaggart during their restoration of the decorative work on the instrument. I would like to thank Ann MacTaggart for communicating the results of the examination.

Although the papers seem to come from different moulds, a number of common designs appear. The following is a catalogue of the major designs found on the surviving English virginals.[21]

Keyfront papers:

1) "trefoil" [AH]



2) "sunflower" [1664 JP, 1668 SK]



3) "moorish" [1656 JW]



4) "floral" [1655 JL, 1675 CR, 1679 CR]



[21] All of the "names" given to the designs reflect the patterns and have been named by the author.

Other papers:

1) "Elizabeth shield" [1641 GT, 1656 JW, 1662 TB]



2) "Carolus shield" [1668 SK, 1675 SK]



3) "bird and heads" [AH]



4) "strapwork heads" [Theewes]



5) "vinework" [1655 JL, 1671 PJ]



6) "moresque" [1642 TW, 1644 TW, 1651 TW]



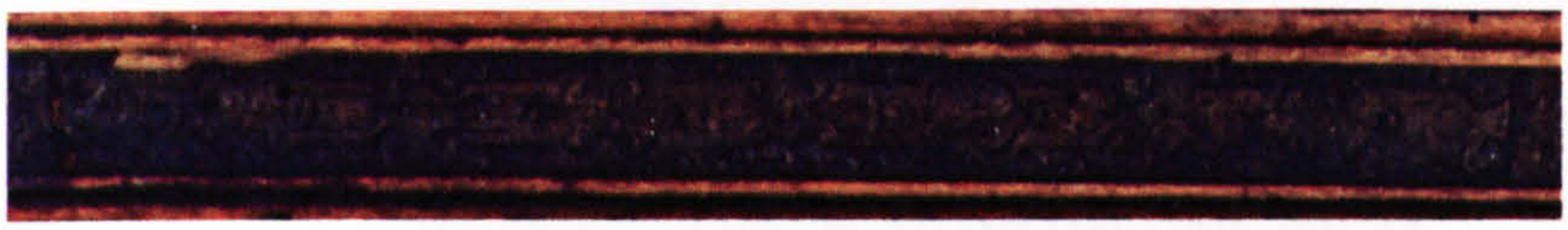
7) "monkey" [1638 TW, 1644 TW, 1668 SK]



8) "circles" [Theewes]



9) "geometric" [Theewes]



SOUNDBOARD ROSES

All extant English virginals have roses recessed into the soundboard. Although the majority of instruments have only one rose, other instruments may have two, three or four roses. Some makers with more than a single surviving instrument have different numbers of roses in their instrument – for example the virginals by Stephen Keene have three (1675) and four (1668),[22] and both James and Thomas White have surviving instruments with one (1656 JW, 1638 TW, 1642 TW, 1651 TW), and two roses (1661 JW, 1644 TW).

The roses are almost always made of wood glued on top of parchment. Only the surviving rose in the Mar is different, being made from several layers of medium-thickness card. The roses are always geometric in design, with the lower parchment layer more intricate than the upper layer. The roses are very similar in design to those

[22] The 1671 PJ, which is the work of the same decorator, has three roses.

found in some Flemish virginals (for example the 1581 HR)[23], but are simpler in design than those found in many Venetian instruments.[24] Once completed the roses are gilded on the top surface.

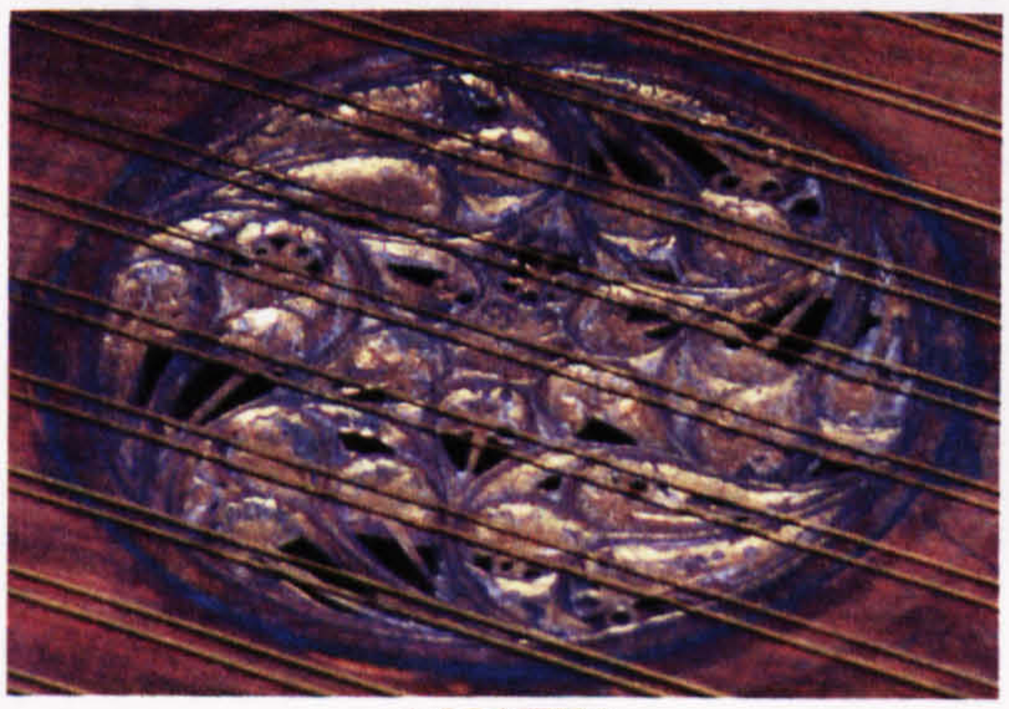
Plate 4.1 – Various surviving roses from English virginals.



Mar



1641 GT



1651TW

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[23] See O'Brien (1990:36).

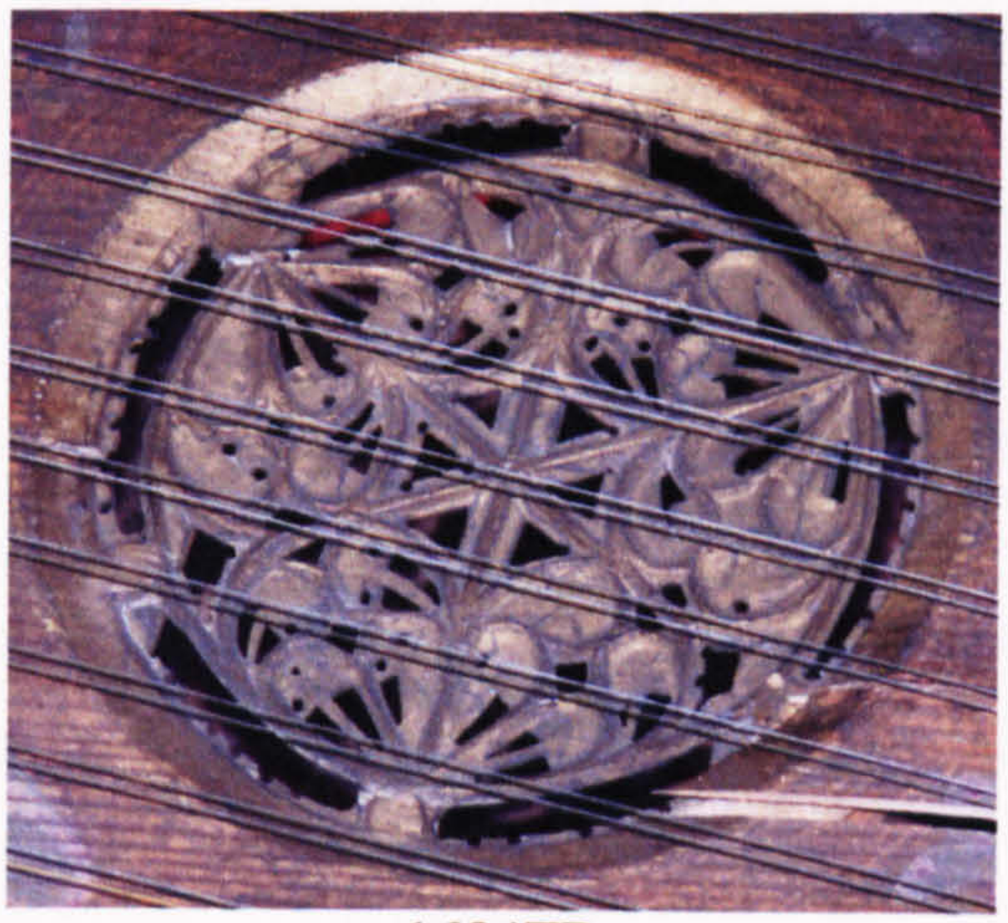
[24] For example the rose found in the 1574 Baffo harpsichord in the Victoria and Albert Museum, pictured in Schott (1985:35).



1668 SK



1668 SK

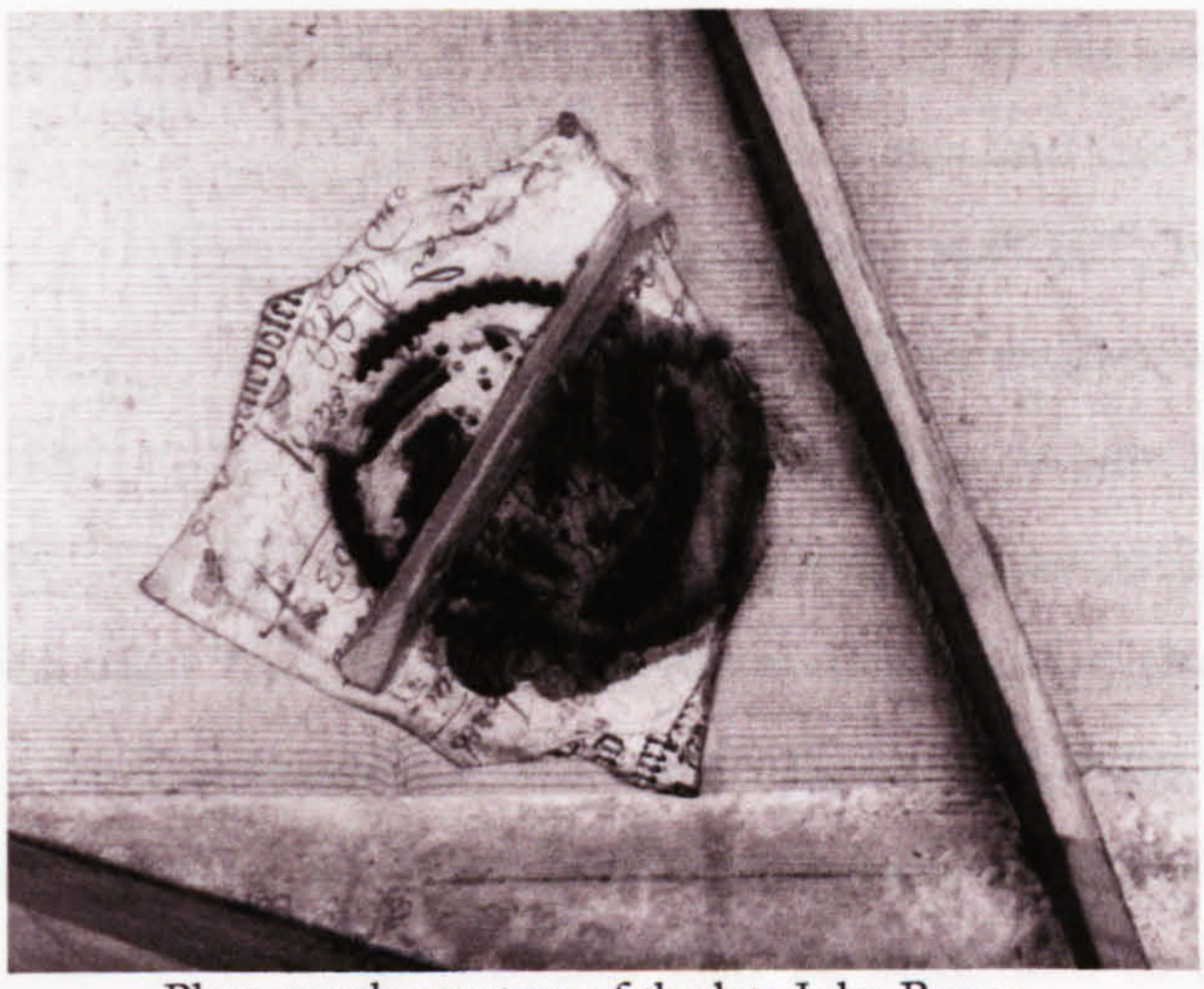


1684TB

The designs have been cut with punches (on the parchment layer) and knives. On some later roses a scraper was used to achieve concave sections. It is possible that a scraper was used on the convex sections of all of the roses, although a small, fine file might have been preferred, which would allow finer control, particularly in the corners. There are no noticeable flat facets which would suggest this rounding was done with a knife or chisel.

On most instruments the roses are placed in the soundboard so that their top surface is flush with the top of the soundboard. There are three methods used to attach the roses positioned flush. The first method is to glue small bars underneath the roses which hold it in place. The second method is to have a half-thickness protruding edge of soundboard wood, approximately 3 mm wide, that the rose sits on. The final method is a variation of the second, cutting all of the rose area to half thickness, and then cutting pieces out of it so that the rose sits on three or four strips of soundboard wood. This method provided the greatest strength for the soundboard as well as the largest gluing area for the underside of the rose.

Plate 4.2 – Methods of gluing roses to the soundboard, using small bars glued underneath (1668 SK) (above), and leaving half-thickness strips of wood underneath (1641 GT) (below).



Photograph courtesy of the late John Barnes.



On instruments that have the rose glued to the underside of the soundboard there is a small bevel – usually about 6 – 7 mm (¼") wide – from the top of the soundboard down to the edge of the rose. On these instruments the rose diameter is wider than the rosehole, with the extra area at the top of the rose glued to the underside of the soundboard.

SOUNDBOARD PAINTINGS

The paintings on the soundboard and lid interiors are naïve in execution, but distinctive in style. It is likely that a single artist did all of the painted work on an instrument. Several artists have particularly obvious styles and can be shown to have worked for more than a single maker. For example, the 1641 GT, 1638 TW, 1642 TW and 1644 TW are all the work of a single artist, and another painter was responsible for the 1668 SK, 1675 SK and 1671 PJ virginals. Although less certain, it appears the 1651 TW, 1656 JW, 1661 JW and 1662 TB also have the same artist. The Theewes harpsichord, and the Mar and AH virginals have many similar characteristics in the painted work, but nothing particularly close to make an attribution to the same artist. Instead, artists from the same workshop tradition probably painted them. Instruments other than those mentioned could probably also be attributed to some of the same artists or workshop traditions, but the styles are not distinctive enough for the author to make these attributions.

The soundboards are decorated with flowers, birds, and fruit, and are usually surrounded with border patterns, and arabesques in the corners. Only one instrument, the 1671 PJ has had its pigments analysed.[25] A limited range of pigments was found, and, with the exception of the border patterns, there was little mixing of pigments.

The pigments used on the 1671 PJ include the following:

> Lead white, chalk, indigo, smalt, greenish verditer, yellow ochre, yellow lake, vermilion, pink lake, red iron oxide, lamp black.

A full range of pigments that might be used would include the following:[26]

> Lead white, Ivory black, bone black, lampblack, various umbers, ochres and siennas, iron oxide reds, madder lake, vermilion, realgar, massicot, orpiment, Naples yellow, malachite, terre verte, verdigris, ultramarine, blue verditer, smalt and indigo.

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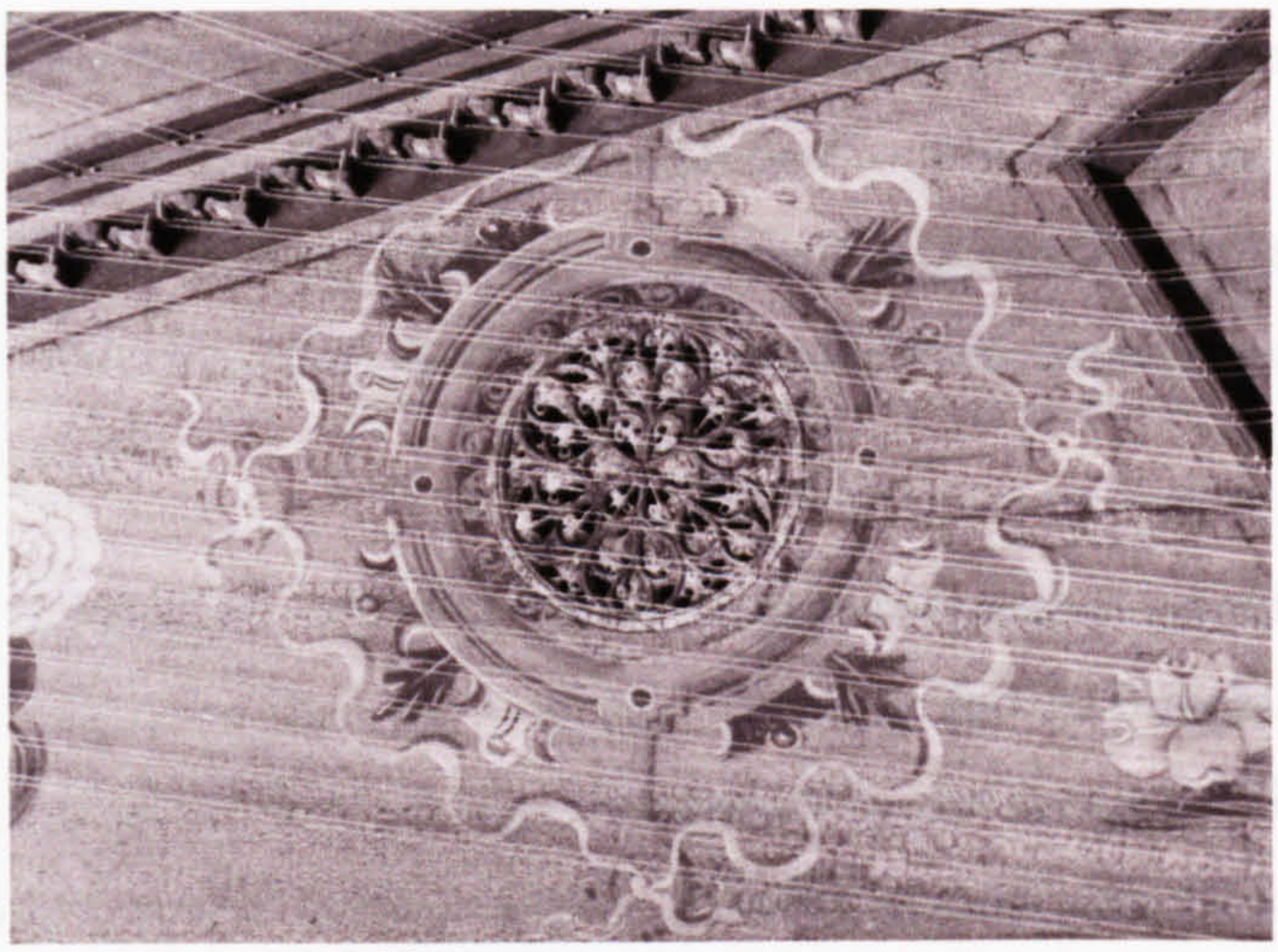
[25] Analysis carried out by Ann and Peter MacTaggart. The list of pigments was passed on to the author (PC) in 1991.

[26] This list is very similar to the one given by O'Brien (1990:158) which arranges the pigments into basic colour groups. As many of the colours are obtainable from specific locations only, it is clear that there was an organized trade in artist supplies, and that the range available would be similar throughout Europe.

It is certain that the pigments were mixed in a water-soluble medium, probably gum Arabic. A number of instruments show evidence of water damage to the paintings on both the lids and soundboard. In addition, Simon Egan (PC, 2002) states that, during his restoration of the decoration of the 1641 GT, he found that the paintings were very water soluble, but were not affected by various solvents used to remove over-painting.

The motifs used for the soundboard painting probably came from pattern books. The use of pattern books and prints is discussed in detail below. Wreaths surround the roses, usually consisting of scrollwork and arabesques plus flowers. The wreath is often the most distinctively individual aspect of the soundboard decoration and serves as the easiest way of identifying the soundboard decorator.

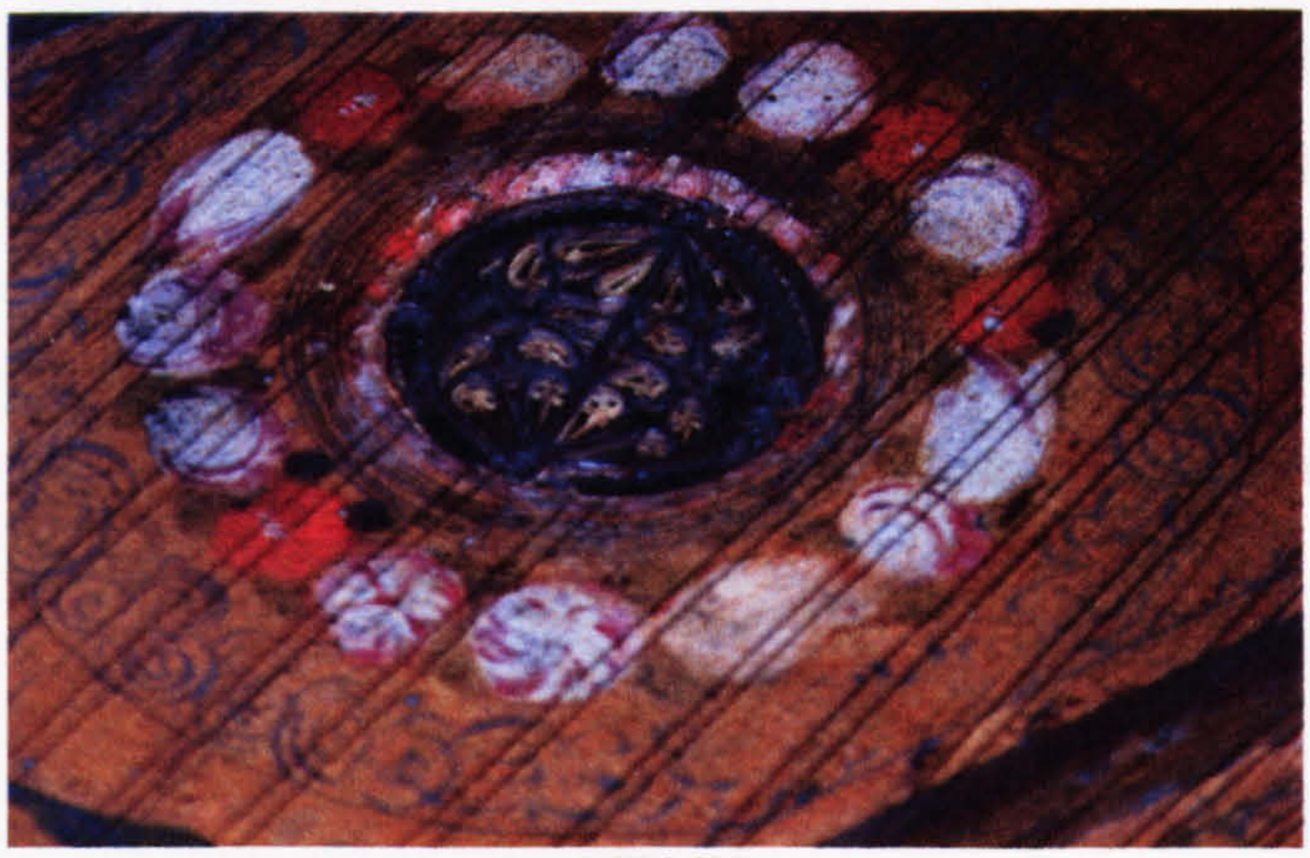
Plate 4.3 – Soundboard roses and wreaths showing various characteristics of the soundboard decorators.



1638 TW Photograph by Miles Hellon



1656 JW



1671 PJ

The flowers on the soundboard are all commonly found in Northern Europe. Those identified on the Theewes include roses, borage, carnation, lily of the valley, dianthus, lesser spearwort, cornflower, pansy, columbine, stock, periwinkle, wallflower, fleabane, marigold, geum, anemone and cherries.[27] The birds are also common, including robins and thrushes. The style of painting is generally simple, without much overshading. In this it is reminiscent of the soundboard decoration found in early Flemish instruments.[28]

The border patterns are always blue, occasionally with a greenish tinge. They usually take the form of a line and scallops. The Mar and AH virginals do not have border patterns, although they do have arabesques in the corners. The Theewes has white lines as borders, but no arabesques. English virginal arabesques are always of different designs (even in the same instrument), no doubt improvised to fit the available space. They are usually restricted to the corners, without any additional arabesques placed evenly along straight edges as found with instruments by members of the Ruckers family.

LID PAINTINGS

The lid and keywell flap paintings use the same pigments and medium as the soundboard. Rather than isolated motifs, the paintings cover the full span of the lid and keywell flap (with the exception of narrow borders).[29] The subject matter falls into several groups. The most common lid paintings are pastoral landscape scenes, often referred to in modern writings (without foundation) as "St James' Park". The scenes are generic, featuring a landscape, often with background buildings, and human figures promenading. Paintings illustrating the mythical story of Orpheus taming the Beasts are found in a number of virginals, from the earliest examples (Mar and Theewes) to post-Restoration examples (1661 JW). Biblical paintings are also found in some examples. The narrower height of the keywell flap restricts compositional possibilities, and therefore landscape or biblical scenes are used.

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[27] Flowers identified by Janeve Bainbridge and Malcolm Rose, and quoted in Rose (2002:305).
[28] See O'Brien (1991) for examples of early Ruckers decoration.
[29] The Theewes harpsichord, and the Mar and AH virginals are exceptions which are discussed indivually.

The paintings are either carried out on the wood (probably with a coat of thin size to seal the grain), or over a gessoed background. Those paintings over gesso are invariably brighter and smoother, whereas those painted directly on the wood have been dulled and frequently have turned slightly transparent, revealing the underlying wood grain, obscuring many of the painted details.

The paintings themselves are generally of poor quality in a technical sense, and consist of broad brush stokes. It is probable that this is the result of the artist's specific training (which would be in decorative rather than fine art painting). There is no evidence to suggest that well-established fine art painters ever decorated English virginals.

It is likely that, like the soundboard decoration, the images came from prints. Only one image found on a virginal has a known corresponding print source. The central picture on the lid of the Mar, showing Orpheus taming the Beasts, is based on an image found as the frontspiece of a collection of prints called *A Book of Beasts* by Thomas Johnson[30]. This plate is dated 1630, but the panel in which the date has been written, and a panel with English writing to the right of it are clearly in a different hand to the left panel with writing in Latin. It is almost certain that a previous impression of the plate, probably originating in France or Flanders, c. 1570, was used as the source for Johnson's print and the lid of the Mar virginal.[31] Another painted panel, originally at Knole Park, Sevenoaks, Kent comes from the original continental print source, and may be the work of the same artist or workshop as the Mar picture.

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[30] Housed in the British Library, London, No. 562b/18(1). I would like to thank Paula Woods who provided me with details of the full contents of the publication.

[31] The right panel of the print probably had a translation of the Latin text into the vernacular language of the original engraver, with a title in the centre panel. The writing in the panel attributing the work to Johnson is poorly spaced and executed.

Plate 4.4 – The engraved print (above), and centre panel of the Mar lid (below), both showing Orpheus taming the Beasts which was taken from the same source.





The use of prints as source material has been well documented. Wells-Cole (1998:x) points out that there were hundreds of thousands, if not millions of different prints, and the comparatively small fraction that still survive present an impossibly large task to catalogue. All of the images of Orpheus found on surviving English virginals appear to have come from different print sources. Any search for other sources would be a massive, and probably fruitless task.

The Mar, Theewes and AH lids are decorated differently from all of the seventeenth century virginals. The Mar and Theewes lids have painted panels surrounded by strapwork decoration.[32] The lid of the AH has six small diamonds – each with a painting of a bird inside – surrounding arabesque work and a Latin motto. An almost identical arrangement, using a diamond at each end of a Latin motto, is used on the (now concealed) keywell flap of the Mar virginal.[33]

OTHER PAINTED DECORATION

In addition to the soundboard, lid and keywell flap, there is usually additional painted work on the flat bands of the faceboard mouldings and keywell front batten. This work usually takes the form of geometric designs or vinework in one or two colours.

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[32] The strapwork is in different styles, that on the Mar being in the form of a flat border, whereas the strapwork on the Theewes is in a grotesque style. This is very similar to the strapwork surrounding the ex-Knole picture of Orpheus. This strapwork is dicussed in detail in Thornton (1998).

[33] See the Catalogue, page 37. The author has previously suggested that the diamonds on this instrument may have contained the coat-of-arms of the Countess of Mar. See Martin (2001).

Plate 4.5 – Examples of geometric (above) and vinework (below) designs on the faceboards on English virginals.



A variation of this decoration is found inside the inner mouldings on the faceboards and keywells of some virginals. This painted work is sometimes used rather than gilded papers. Invariably this painting is a white or off-white colour in a vinework design painted over a black background.

Plate 4.6 – Example of white-on-black vinework decoration on some virginals.



Similar work is also occasionally found on the lid and keywell flap borders. This border work always takes a geometrical form, usually a series of crosses with alternate overpainted circles.

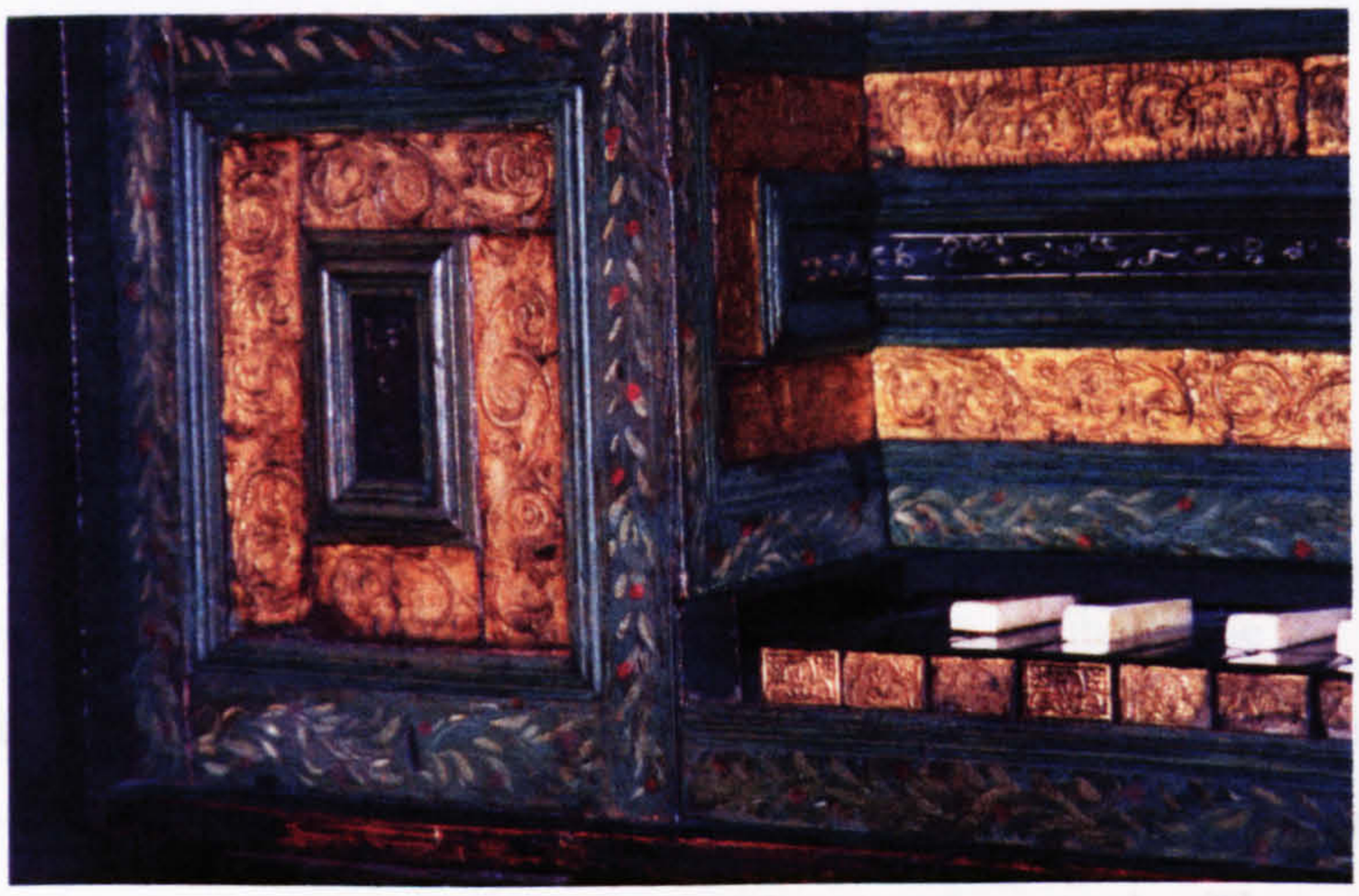
Plate 4.7 – Example of lid border decoration.

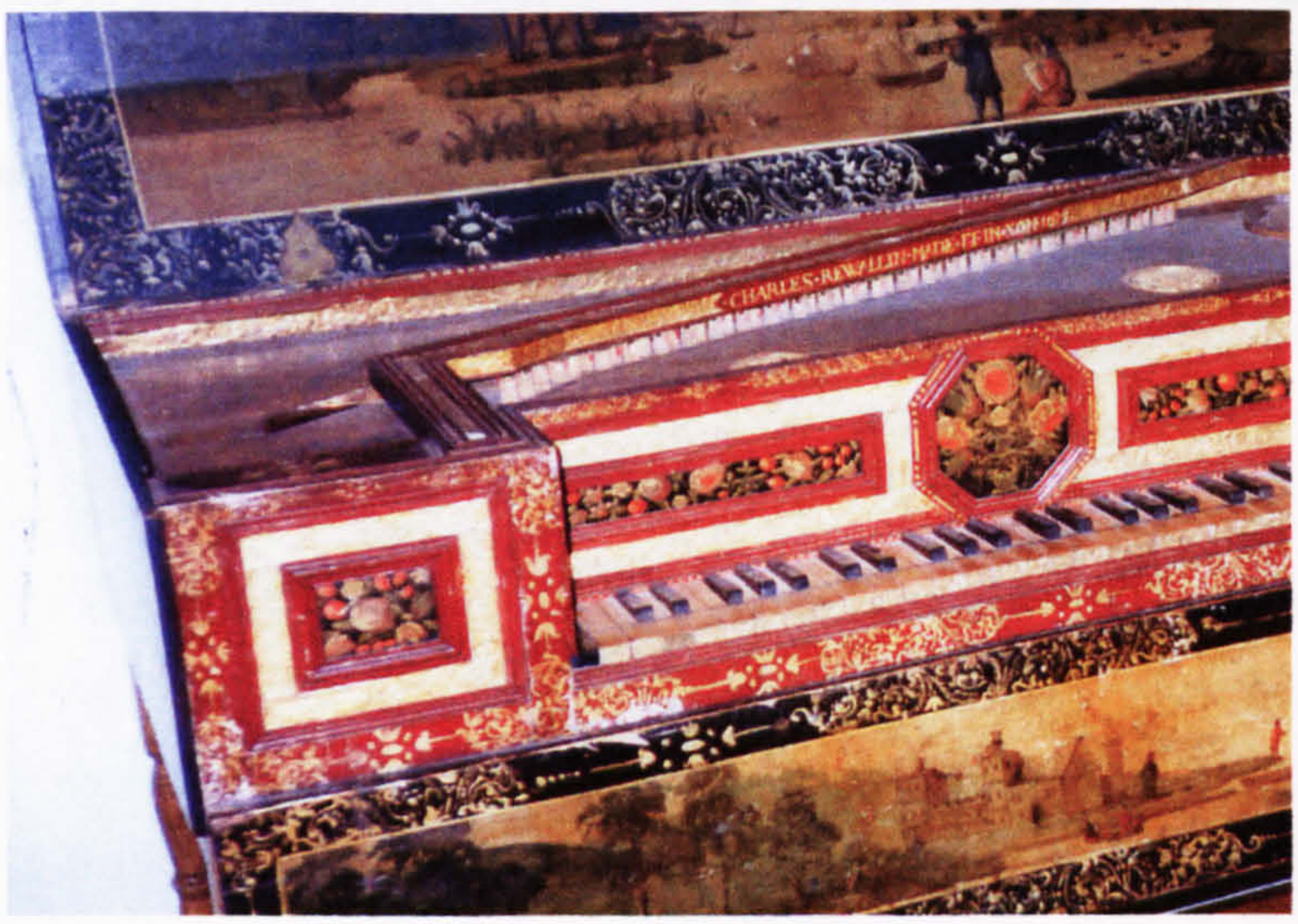


On some instruments the mouldings themselves are painted rather than left natural. On the 1664 JP, 1671 PJ and 1675 SK virginals the mouldings are painted a green colour,

and on the 1679 CR the mouldings are a maroon colour. This block colour forms the background to geometric or vinework which is applied on the top of it.

Plate 4.8 – Painted mouldings on the 1671 PJ (above) and 1679 CR (below) virginals.





The final type of additional painted decoration is plaques, found on some nameboards and right faceboards. Plaques are octagonal in shape, with a painted or gilded background and polychrome paintings on top. The paintings are usually of flowers, although the 1656 JW has a painted figure of a female lutenist. The quality and style of the painted work clearly shows that the artist responsible for the soundboard and lid paintings also painted the plaques. One instrument, the 1655 JL, has a rectangular piece

of mirror glass in the centre of the nameboard instead of a painted panel. It cannot be determined if the mirror glass is original, or, if not original, what may have been in that place originally.[34]

KEYBOARD DECORATION

Although keyboards are primarily intended to be functional, they were occasionally given specific decorative features. These include scribed lines separating the front and rear portions of the natural touchplates, stamp impressions and inlaid work on the accidentals.

The natural touchplates are usually of boxwood which has been oiled. The plates are contiguous from front to back, and have a scribed line to indicate the position of the front of the accidental touchplate cut-outs. Another scribed line marks the rearmost position of the rounding of the touchplates. Other lines, usually one or two, are scribed in between those lines at closely spaced intervals. The only exception to the use of scribed lines is the work of Charles Rewallin who separated the front and rear natural touchplates by a thin strip of snakewood.

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[34] It should be emphasized that there is no reason *per se* to doubt the originality of the piece of mirror glass.

Plate 4.9 – Natural touchplates of the Mar (above) and 1675 CR (below) virginals.



In addition to the scribed lines some early instruments have stamped decoration in between the central scribed lines. This work is particularly associated with the instruments of the White family, and in all examples the same designs are used. These two designs are clearly made with a metal stamp with the design raised on the surface. On a single instrument, the 1661 JW, additional wedge shaped marks are found, of a lesser quality than the normal designs. These marks have been made with either a knife or a chisel, and may have been added after the instrument was manufactured.

Plate 4.10 – Stamped decoration found on some instruments of the White family.



Several instruments – the 1668 SK, 1671 PJ and 1675 SK – have natural touchplates of snakewood rather than boxwood, and have bone or ivory accidentals, giving a reverse keyboard effect. Another instrument, the 1684 TB, has a similar effect

using ebony naturals with solid ivory accidentals. A final instrument – the 1664 RH – has a replacement keyboard, but still retains the original bone accidental touchplates suggesting that dark accidentals were used.

Plate 4.11 – Keyboards of the 1679 CR (above) and 1675 SK (below) instruments showing the effect of the standard and "reverse" designs.





Several instruments have inlaid decorative accidental touchplates. Rather than a separate plate on top of an accidental blank, English virginal makers cut a slot in the top and inlaid the decoration into the slot. The inlaid decoration is generally in the form of a chequered design, often with long strips at the sides. Decoration is found in the earliest surviving virginals, though appears less regularly in the later instruments. Although the keyboard is missing, an accidental touchplate believed to have come from the Theewes survived until the middle of the twentieth century. It has been described differently by various authors. Koster (1980:52) quoting Hugh Gough describes the missing accidental as "made of about ten alternate layers of ebony and boxwood", while Russell (1959) says it was "topped with small squares of ebony and boxwood, alternately placed". Although these two descriptions appear contradictory it is possible that Gough

intended to convey that the alternate layers went from front to back. Usually only two woods are used in the inlay, but occasionally more are used, for example the 1656 JW.

Plate 4.12 – Inlaid touchplates of the 1656 JW and Mar virginals.



THE CASE EXTERIOR

The exterior of an English virginal is usually natural wood. Only one instrument, the 1675 CR, has a painted finish, which is probably intended to imitate graining.[35] Oak is the usual case wood, although the 1641 GT appears to be of walnut, and the 1679 CR is of deal.

[35] This finish is almost certainly not original. It is discussed and illustrated in the Catalogue, page 196.

It is almost impossible to determine if any finish now found on an English virginal is original.[36] The finish found on most of the surviving virginals is similar from instrument to instrument, which may imply that the finish on these instruments might be indicative of the original. On these instruments the finish has not been thickly applied, the open grain of the wood not being filled in any way. On some instruments the exterior surface appears to have been "rushed" – a process in which coarse rushes are beaten over the surface – creating an effect where the softer wood is in low relief.

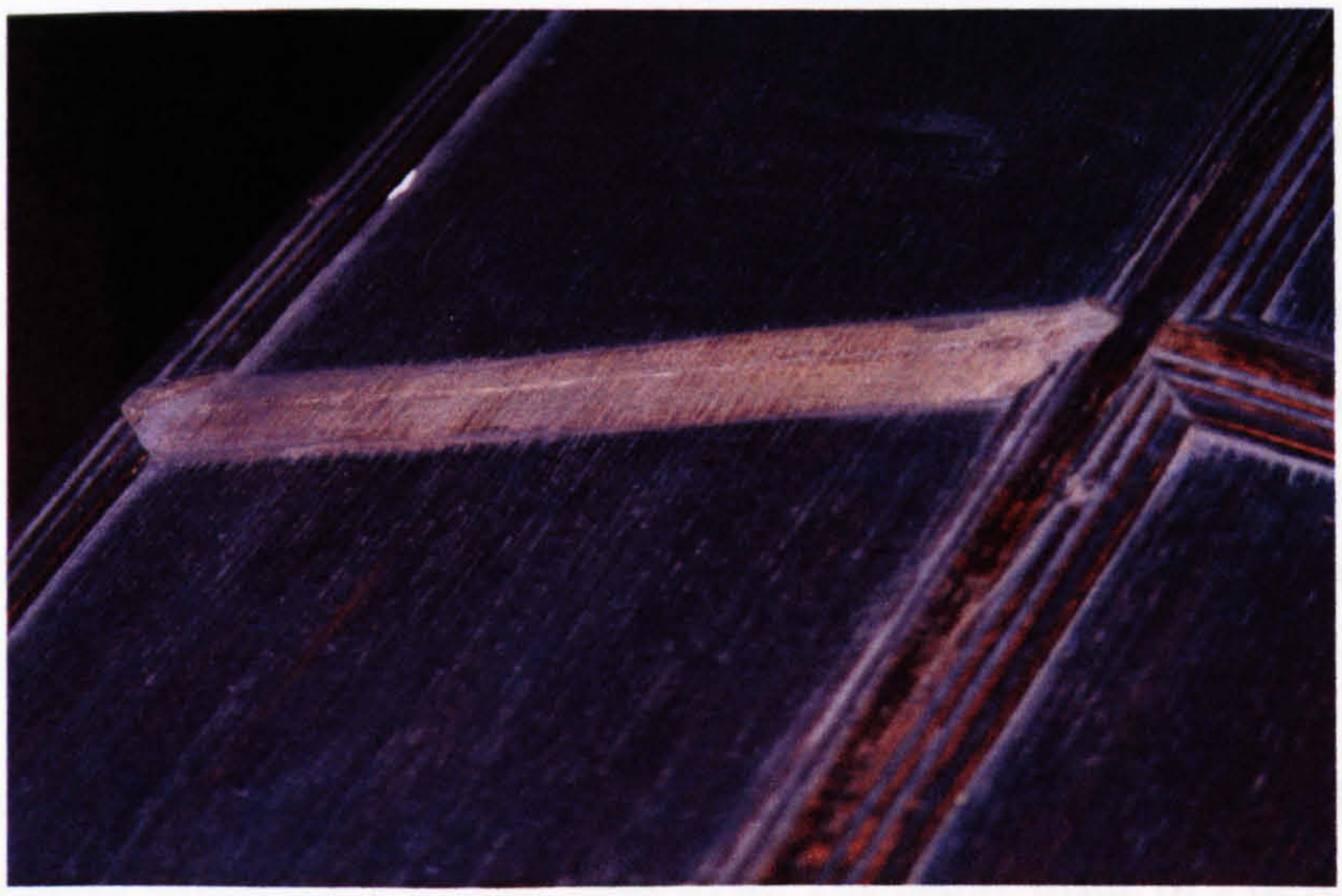
The case exterior appears to have been deliberately coloured – either stained or by the use of coloured varnish. The case exterior is dark, in contrast to the bare oak seen on the interior surfaces. On the interior surfaces the finished colour is a warm brown, probably a natural finish which has darkened over the period of several centuries. The dark finish found on the exterior of English virginals (and other pieces of English furniture) should not be considered as a natural consequence of the ageing effect upon the varnish. An examination of oak furniture found in other countries shows it is often a much lighter colour, despite also having a similar sheen and patina. A well-known example of this can be found at Fredericksborg Castle, Copenhagen, where the furniture – much of it dating from the seventeenth century – is a mid-brown colour. An example of an English instrument in which the oak has not been deliberately darkened is the Hasard harpsichord at Knole, which is a mid-brown colour.

Further evidence of the deliberate darkening of English virginal case exteriors can be seen in examples where damage has occurred to surviving instruments. Several instruments – for example the 1641 GT – show damage to the varnish where it has chipped off in places. The surface, where visible under the damage, is of a colour similar to that found on the interior of the instrument. A particularly obvious example of deliberate colouring can be seen on the 1684 TB, where one of the lid moulding battens is missing, revealing the bare wood underneath. Seepage, either from a stain or varnish can be seen at the edges of the bare wood.

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[36] A similar point, discussing old English furniture in general is made by Chinnery (1979:217).

Plate 4.13 – The lid exterior of the 1684 TB, showing the missing lid moulding batten, and the effect of the finish upon the bare wood.



The actual type of varnish used cannot be determined. Varnished finishes are known on English keyboard instruments from at least the mid-sixteenth century where references are found in the inventories associated with Henry VIII.[37] Some examples include the following:-

> Item oone peir of single Regalles with 2 stoppes of pipes of wode vernisshed yellowe and painted with blac Rabaskewoorke standinge upon a fote of wainscott with the Bellowis lyeng in the same.
>
> Item oone peir of dobre Regalles with 3 stoppes of pipes, of wodde vernysshed yellowe and paintid with Antigue worke having the Kinges Armes and Quene Janes Armes, with two playinge upon a harpe and a lute and two singing paintid upon the same standing upon a fote of waynscott paintid yellowe with Antigue woorkes wherein lyethe the Bellowis.
>
> Item. Another newe paire of double Virginalles vernisshed yellowe and painted all ouer with redde rabeske woorke the lidde beinge lined with purple serrconet and havinge the Kinges armes painted and guilte in the middes of hit.

At this date the varnish used would certainly have been oil based – mixing a resinous gum such as copal into an oil-based solvent (probably linseed oil). Many varnish recipes are known, usually from Continental Europe. English writers mentioned varnishes in the seventeenth century, and they are discussed in detail in Stalker and Parker (1688). This work concentrates on imitating oriental furniture, and is an early source for the use of spirit-based varnish. These varnishes were made by dissolving materials such as shellac in alcohol. Spirit-based varnishes are often

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[37] See Appendix One for a complete transcription of the relevant entries.

considered to be more brittle than oil varnishes,[38] and the damage found on instruments such as the 1641 GT – where the varnish has cleanly separated in a small area – may be indicative of a spirit-based finish. It is most likely that oil-based varnishes were used generally, probably with a colouring agent included in the varnish itself, rather than being applied directly on the wood. This is consistent with the damage evidence as seen on the 1684 TB. It is possible that the case exteriors were given a coat of linseed oil, or another similar friction oil, and then waxed. John Watson[39] carried out a microscopic examination of wood underneath a previously unremoved lid hinge of a 1762 Kirckman harpsichord and found traces of wax, but no varnish film (for example shellac).

Occasionally a finish other than the usual dark oak survives. The 1644 TW has a varnished finish which has a reddish tinge to it. The stand, made of a different wood (either lime or cedar), has a similar colour and patina, suggesting both were finished at the same time. The finish has been very well applied, and there is no evidence of any build-up of varnish by the hardware as might be expected if it was carried out later. The 1679 CR has a case of deal and has been varnished to a mid-brown colour. Although this may be the result of applying the same amount of varnish as normal with the resulting lighter colour being a consequence of the lighter-coloured natural wood, it is more likely that the finish was specifically applied.

HARDWARE

The external hardware on all English virginals is made of iron, usually wrought, although cast hinges are occasionally found. Generally an instrument will have hinges (either strap or wire) between the spine and the lid and between the baseboard and the keywell flap, strap locks between the lid and the keywell flap, a lockplate in the centre of the keywell flap, and lock hasps either side on the keywell flap.

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[38] The evidence to support this is limited. An examination of various woodworking magazines tends to support the view amongst finishing "experts".
[39] PC 2001, expanding upon comments made in a paper given at the Meeting of the Galpin Society, Edinburgh, August 1997.

The hinges between the spine and the lid were originally usually wire hinges. Wire hinges consist of two crossing pieces of wire – each forming a small circle through which the other piece passes. The ends of the wire pass through a hole in the lid or spine, and are then spread when they protrude before being hammered back into the wood or held in place by mouldings. The wire is usually 1.5 – 2.0 mm diameter. There are usually four wire hinges, placed more-or-less equidistant with the outside hinges between 85 and 150 mm (3½ - 6") from the edges of the spine. Strap hinges are occasionally found, and when used are in a group of three. The design on the lid matches the hinges between the baseboard and the keywell flap. The hinges between the baseboard and spine are always strap hinges. There are invariably three hinges – one at each end and one in the middle.[40] The section of the hinges on the spine or baseboard are plain rather than decorated in any way, and are usually about half the length of the sections on the lid and keywell flap. The section that attaches to the baseboard is bent at the front so that there is not a large gap between the baseboard and the keywell flap when the instrument is opened. The strap hinges are attached by hand-forged nails which pass through holes in the hinge and into the wood. The sharp ends of the nails often pass through the wood and are cut off flush. The paintwork on the lid and keywell flap often shows damage where the paint has not stuck to the metalwork.

There are three strap hasps from the lid to the keywell flap. The hinge section on the lid is the same design as that used for the decorative part of the strap hinges at the rear of the lid and on the keywell flap to baseboard. The front portions of the hinge sections are usually of a slightly different shape. The end hinges have holes cut into them (in the shape of an inverted keyhole), through which pass turnbuckles which are attached in the centre of the outer lock hasps. The centre hinge front section has a riveted piece through which the locking mechanism of the central lockplate passes.

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[40] The AH is an exception as the keywell flap only extends the width of the keywell. There are two strap hinges from the baseboard to the keywell flap, and the keywell flap is held closed by small lid hooks attached to the keywell sides.

The outer lock hasps are always based on the same design, of an undulating diamond shape with holes (normally about 15 mm diameter) inside the corners. In the centre of the lock hasp is a piece of cast iron which can rotate through 360°. This piece is L-shaped, with a circular centre part and a rotating arm. When the instrument is closed up this piece (with the "arm" facing upwards) passes through the keyhole-shaped hole in the floating front portion of the lid hinge, and can then be rotated, firmly securing the instrument.

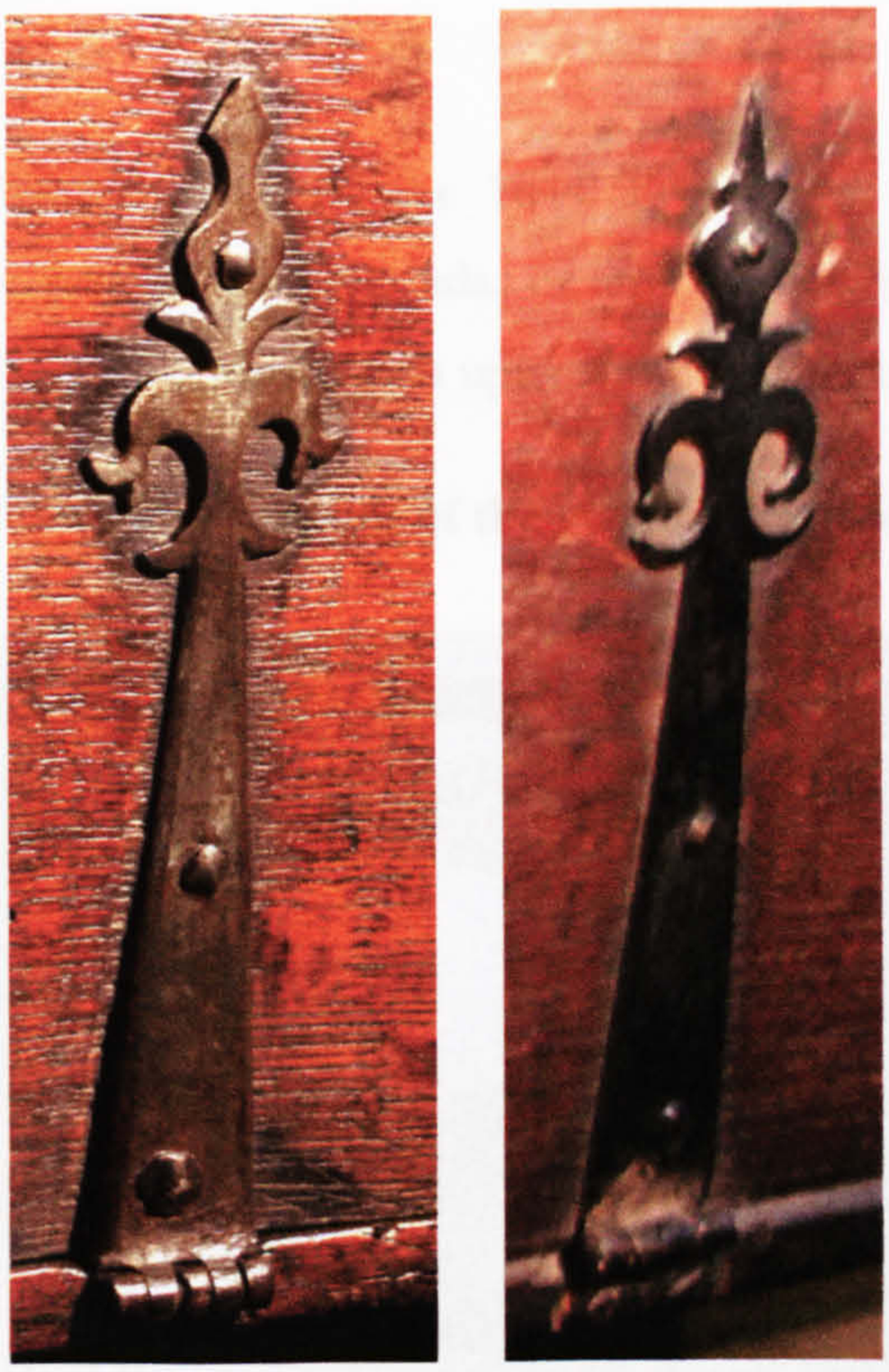
The central lockplate is normally of an ornate shape. Although variation is found all extant lockplates follow generally similar patterns, differing only in the finer details. At the back of these lockplates is a standard locking mechanism which is operated by a key. The riveted piece on the front portion of the centre hinge fits into a slot on the lockplate, and the key is then turned to cause a latch to pass through the riveted section, locking the instrument. Only one virginal – the 1644 TW – retains an original key for locking the instrument.[41]

Plate 4.14 – Typical English virginal hardware.



Lockplates from the AH (left) and 1668 SK (right) virginals.

[41] The key for the 1644 TW was found during an examination of the instrument by the author. It had been trapped in the toolbox underneath the bass jackrail support.



Baseboard to Keywell flap hinges of the AH (left) and 1668 SK (right) virginals.



Centre lid hasp and lockplate of the 1684 TB virginal.

All of the hardware found on English virginals is of a type common to other furniture of the period, rather than being specially designed. It is likely that it was purchased from specialist ironmongers or blacksmiths.

STANDS

Only one rectangular virginal, the 1644 TW, has a stand which is almost certainly original. The stand is made of cedar or lime, and consists of four turned legs with an H-stretcher near the bottom and an upper frame at the top.

Plate 4.15 – Photograph of the stand of the 1644 TW.



The front of the upper frame consists of two pieces of wood, glued lengthways, with the top part divided into 5 panels made up of applied mouldings, and with a lower part featuring a shaped piece with a stamped decoration applied over the front surface. The side panels are made of two pieces, glued lengthways, with a deep arch cut through all of the lower, and part of the upper, piece. The back piece is undecorated. The H-stretcher has mouldings on the upper edge. The stand is held together by wooden pegs. The edges of the instrument overlap the stand by approximately 50 mm on each side. The final feature of the stand is its height, designed so that the top of the keyboard is 928 mm from the floor. A technical drawing of the stand is shown in the Catalogue, page 299.

The stand under the 1671 PJ appears contemporary with the instrument, and is possibly original to it. The instrument has always been in the same location, and it is unlikely that, barring accident, any other original stand would be disposed of whilst keeping the instrument. The stand can be described correctly as a cup-board,[42]

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[42] See Chinnery (1979) for definitions and illustrations of all types of seventeenth-century furniture. His terminology has general acceptance in Great Britain.

consisting of framed upper- and lower-boards with turned legs at the front corners and rectangular legs at the rear corners. The upper-board is totally covered by the instrument. The front panel has fine relief carving of foliage, and there are moulding designs on the side frames. There is a brass lockplate in the front frame, situated centrally from left to right, near the top. The lower-panel is of oak. The frames have mouldings applied to the bottom edge.

Plate 4.16 – The closed 1671 PJ on its stand.



A final virginal that may have an original stand is the 1661 JW. Unlike the stands under the 1644 TW and 1671 PJ which feature turned legs, the four legs of the 1661 JW stand are rectangular, with bevels between the upper and lower frames. There is a lower H-stretcher, set approximately five inches above the floor, and a rectangular upper frame. There are X-section frames at the ends and along the length of the stand. Except where they cross, the edges of the X-sections and the lower H-stretcher are bevelled. The stand is made to fit the virginal fairly closely, suggesting it may be original (or, at least, built especially for it), and the stand has worm damage which matches similar damage found on the virginal itself. The stand is glued entirely, rather than making use of pegs as found in the 1644 TW and 1671 PJ stands, which may suggest it was built later, although built specially for the virginal.

Plate 4.17 – The stand of the 1661 JW.



The stand underneath the Hasard harpsichord has always been considered to be original. It consists of ten fluted legs, each separated by arches, with carved arabesque decoration in low relief. The lower stretcher is rectangular, with an applied moulding on the outside edge, and the upper stretcher has cut mouldings on the outside surface. The height of the stand is 820 mm, meaning that the player must be seated at a high stool to play the instrument. It is possible that the height of the stand was determined in order to provide attractive visual proportions to the instrument.

Plate 4.18 – The Hasard harpsichord on top of its stand.



The final instrument which has a contemporary stand – in the broadest sense of the word – is the Theewes harpsichord. Although probably not intended as a claviorgan,[43] the instrument was certainly converted soon after (or possibly during) construction. The organ part of the instrument serves as the stand of the harpsichord. It is housed in a large rectangular box, 1030 mm high, divided into two sections with an applied moulding approximately two-thirds of the way up.

[43] See the Catalogue, page 337, for a discussion of the Theewes.

PERFORMANCE CONSIDERATIONS

Although this thesis is not concerned with the music played on English virginalls, there are several aspects of the instruments themselves which have a direct bearing on the performance of music, either from the performer's or the listener's point of view. This chapter considers these features, commencing with the pitch levels in use, and how they relate to those found in other instruments in sixteenth- and seventeenth-century England (including a discussion of the few "transposing" instruments which survive. The keyboard compasses found in the surviving instruments and in documentary evidence are discussed next, followed by a section on the keyboard and the action, specifically looking at the mechanics and their effect on the performer. One peculiar feature of English virginals is the regular use of the "extra C" – an additional jack and string which are operated by the C key – and that is discussed along with three virginals which are double-strung in the bass for more than one note. Finally, tuning will be briefly mentioned.

PITCH LEVELS

It has been established in Chapter Two (pages 57 - 63) that English virginals were built at a variety of different pitch levels. Instruments were built to sound at four different levels separated by semitone intervals (V, V - 1s, V - 2s and V - 3s), as well as another instrument which was at a pitch a fifth above V (V + 7s), survive. These results can be summarised as follows :-

Table 5.1 – Pitch levels of the surviving English virginals.

Pitch	Instruments	Number
V + 7s	1638 TW	1
V	AH[1], 1642 TW, 1651 TW, 1653 TW, 1656 JW[2], 1664 JP, 1664 RH, 1666 AL, 1668 SK, 1670 AL, 1679 CR, 1684 TB	12
V - 1s	1661 JW, 1675 CR, 1675 SK,	3
V - 2s	1641 GT, 1644 TW, 1655 JL, 1662 TB	4
V - 3s	Mar, 1671 PJ	2

In addition to the virginals listed in the table, the harpsichords can also be shown to fall into the above pitch groupings. The Theewes has been shown (page 71) to be at a pitch of V - 2s. Although less certain, the Hasard probably should be grouped with the 1638 TW in the above table, playing at a pitch of V - 5s / V + 7s assuming a GG,AA - c^3 compass.

Gwynn (1985) and Haynes (1995) have established the existence of five semitone-apart pitch levels in English organs. The implications of these different levels – for both performers and makers – should be considered.

On the basis of documentary written evidence, Haynes (1995) concluded that "quire pitch" was between two and three semitones above modem pitch (V + 1s). He did not offer a name for the pitch a semitone below that, despite his evidence of the large number of organs built to that level. Gwynn (1985) considers this level (V) to be quire pitch, arguing that the evidence from the surviving organs is more reliable than written documents. The much higher incidence of organs at V, rather than V + 1s, is a good argument that the lower pitch was the *common* quire pitch standard, especially as many of the organs were in major cathedrals and chapels, and would obviously have been used to accompany singing. It is probable that two different quire pitch standards,

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[1] This instrument has not been included in any of the tables in Chapter 2, due to the missing bridges and soundboard register. A computer reconstruction of the instrument, using the present bridge positions (which must be essentially identical to the original placements), and the lower guide, which is original, suggests that it had a c^3 string length of about 151mm (6 inches), which implies it played at V. See the Catalogue, page 20 for full details.

[2] This instrument was possibly intended to play at V + 1s. See Catalogue entry, page 245.

a semitone apart, existed in the sixteenth century, that at the V + 1s level perhaps proving too high for the comfort of the singers and gradually dropped from use.[3]

The use of three pitch standards below quire pitch also has performance implications. It has already been illustrated that the pitch levels generally fall into two groups, a tone apart.[4] By the end of the seventeenth century the group playing at V - 1s and V - 3s were used in the majority of secular music.[5] The other group, at V and V - 2s, are more closely associated with church music, V being the common quire pitch standard, and V - 2s used as the pitch level in the organs of Renatus Harris, and eventually becoming the usual keyboard pitch level in the eighteenth century.

In order to understand the reasons for the different pitch levels found in the surviving virginalls, it is essential to consider other instruments used in seventeenth-century England.

The instruments that provide the most reliable information on pitch standards are wind instruments. Few wind instruments survive from before the last quarter of the seventeenth century. Two cornetts remain at Christ Church, Oxford that sound at a pitch of about 490 Hz (two semitones above modern pitch). These instruments were unusual in falling outside the quire pitch grid system,[6] and were probably made to match the pitch of the organ at Christ Church, which also fell outside the common system.[7] Renaissance flutes survive in reasonable numbers, generally playing at pitches of 455 Hz or 483 Hz, essentially V - 1s and V.[8] Although flutes were certainly used in England as part of the broken consort, no surviving instrument can be reliably shown to have been used in England.

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[3] Given the alterations to the surviving instruments, as well as the destruction of so many examples, this argument is a little uncertain. It does appear that evidence of instruments at a pitch of V + 1s mostly comes from early in the sixteenth century.

[4] Chapter Two, page 61.

[5] This is examined fully below. Briefly, viol consorts, recorders, trumpets and many chamber organs all appear to have been based in the V – 1s / V – 3s groups.

[6] For a full discussion on the quire pitch grid system, and on general English pitch standards, see Haynes (1995).

[7] Haynes (1995:332).

[8] Haynes (1995) considers Renaissance flutes as being pitched a tone lower, ie. in *d* at 405 Hz and 430 Hz. However, Philip Pickett (PC) says that the instruments were played in the key of *c*, and therefore, they should be considered at the pitch levels I have indicated. As this Chapter is considering Performance, rather than just pitch, I have chosen to accept Pickett's argument when giving the quoted pitch levels.

In the last quarter of the seventeenth century French-designed woodwind instruments were becoming increasingly popular, and London became the home of Peter Bressan, who was born and learnt his trade in France.[9] There are a fairly large number of Bressan recorders still surviving, and the general consensus is that these instruments now play at a pitch of around 408 Hz. When shrinkage is taken into account the original pitch was likely to have been around 403 Hz.[10] This pitch is the likely common standard for V - 3s.

Brass instruments provide further pitch examples, and show evidence of what was probably a practical approach to the problem of transposition by their use of crooks. It is very difficult to determine if a natural trumpet has been shortened in order to raise its pitch, but the instruments which appear to still be their original size are considered, with the instrument tightly assembled, to play in D at 440 Hz (modern pitch).[11] Assuming the instrument was made at a slightly high pitch to allow fine tuning with small shanks and adjustment of the yards, it is likely that the most common type of surviving Stuart trumpet, for example those of William Bull and Augustine Dudley[12] can be considered to play in *D* at V - 2s.[13] Several of the surviving trumpets have accompanying tone crooks which, when inserted, allow them to play in *C* at V - 2s. Without the crook the instrument can also be considered at playing in *C* at V. Trumpet music was traditionally written in the key of *C*, requiring any other players to transpose as required.

Surviving string instruments are less reliable indicators of pitch, but may be examined with the knowledge that the pitches can in no way be considered absolute. The higher limit for pitch may be estimated in the same manner as was used for virginals in Chapter Two. Perhaps the most reliable indicator for the working pitch of gut strings is the modern classical guitar, which used gut prior to the Second World War. The pitch level was essentially at 440 Hz, with a standard vibrating string length of

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[9] Byrne (1983).
[10] Haynes (1995) quotes a commonly accepted formula for determining the alteration of a woodwind bore due to shrinkage.
[11] My thanks to Crispian Steele-Perkins (PC, 2002) for this information, based on his own playing experience.
[12] Halfpenny (1962) and (1963) discusses these instruments in considerable detail. Two of the Bull trumpets are now in the collection of the Museum of London, the other is in the Ashmolean Museum, Oxford. The Dudley instruments are in the Museum of London and the Burrell Collection, Glasgow.
[13] It is a brasswind convention to consider these instruments as playing in the key of D as standard.

650 mm producing a top string note of e^1. This pitch was maintained even when gut was scarce during the earlier years of the War.[14] On this basis it is possible to determine the longest string lengths that can be used to play at the different known pitch levels.[15]

Table 5.2 – The maximum possible string lengths for known seventeenth-century English pitch standards.

Instrument	Top string pitch	Pitch level	Frequency	Maximum String length
Violin	e^2	V	474 Hz	300
Violin	e^2	V - 1s	450 Hz	318
Violin	e^2	V - 2s	425 Hz	336
Viol	d^1	V	474 Hz	677
Viol	d^1	V - 1s	450 Hz	713
Viol	d^1	V - 2s	425 Hz	755
Viol	d^1	V - 3s	403 Hz	797

Unfortunately, there are few performing scores from the period available to consider how various instruments coped with the V - 1s / V - 3s standards. Holman (1993:214) mentions the purchase in January 1637/8 of a "Cremonia vyolin to play to the Organ", which clearly implies that smaller instruments played at the organ's pitch standard. However, by the time of Purcell, it appears that most standard size violins were generally tuned to the same pitch as the recorders. Talbot measured a violin and quotes a string length of 13 inches, identical with that used today.[16] Although it is possible to tune violins with that string length to a pitch around 450 Hz (V – 1s),[17] the lower pitch is likely. Further evidence to support this can be found in the cellos of the period. Although most contemporary sources, such as Talbot, quote the tuning of the

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[14] There are various reported stories of Andres Segovia trying to obtain gut strings and the difficulties he encountered. There are no reports to suggest he lowered the pitch of his instrument in order to lengthen the lifespan of the strings. It must therefore be assumed that this provided a reasonable safety-factor against string breakage.

[15] These string lengths are the *longest* at which the quoted pitch level can be reached, assuming the same safety margin as used on the early twentieth-century classical guitar. I am unaware of any evidence that can be used to determine more firmly the safety margins used in seventeenth-century gut-strung instruments.

[16] It should be pointed out that Talbot's method of measuring is ambiguous, and it is possible that the 13 inch string length includes the thickness of the nut. The inch used is the same as that found in Chapter Two.

[17] That pitch standard was commonly exceeded in the nineteenth century when orchestral pitch was c. 455 Hz. The violins were still using gut strings. This would have required a smaller safety margin than I have assumed in Table 5.2.

open strings as B^b, F, C, and G, most of the surviving music requires the standard modern tuning of C, G, D, and A.[18] The two tunings might be explained conveniently as a result of the pitch levels. The surviving cellos of the period, for example that by William Baker dated 1672, are generally of small dimensions.[19] The players would have considered them as instruments playing in *C* when they were at c. 403 Hz, and in *B^b* when they played at the higher organ pitch of c. 450 Hz.[20] Bass Viols also appear to have been built at the two different pitch standards, the larger instruments playing at V - 3s, and the smaller instruments such as the so-called "Division Viols" by Barak Norman at V-1s.[21]

Although there is no surviving English-built lute, or lute which can be shown to have been used in England at a particular pitch standard, English craftsmen are known to have made metal-strung plucked fingerboard instruments. Both a bandora by John Rose[22] and an orpharion by Francis Palmer[23] survive. The bandora has all of its strings the same length (610 mm), and the orpharion has an angled bridge and nut, with strings ranging from 522 mm in the treble to 603 mm in the bass.[24] Both require the top string to be tuned to near breaking point to allow the lowest string to sound and play.

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[18] I would like to thank Brenda Neece for bringing this to my attention.

[19] See Trevelyan (1996).

[20] This is based on the string length of the surviving instruments, and using the modern classical guitar as the standard to judge the likely breaking level of the gut, as done in Table 5.2.

[21] Most modern players and makers of the viol would disagree with this view. However, their experience of pitch levels is invariably based on modern viol stringing practices, which use overwound strings for the fourth, fifth and sixth strings. Overwound strings are not mentioned by Talbot, despite his list of sources including the leading performers in London during the last decade of the seventeenth century, and it can be argued that the strings were not commonly used before the start of the eighteenth century, despite being known in England as least as early as 1658, where they are mentioned in Playford's *Musick's Handmaid.*

Using plain strings, the lowest note that can be obtained with an acceptable sound is two octaves and a fifth below the top string, and therefore, a six-string viol has a possible range of a fourth over which it could be tuned. On this basis Division viols of the size built by Norman could acceptably play at V – 3s. However, seven string viols must be tuned to the highest safe pitch for the low string to sound acceptable. The earliest seven-string English viol the author is aware of is dated 1677. It would be odd if an invention had taken place without prior experiment, or that instruments with identical string lengths were tuned to different pitches simply on the basis of the number of strings. It is unlikely that seven-string instruments were built because of the use of overwound strings, since they, as already shown, were not common, even in professional circles. Likewise, music for Lyra viol is written in scordatura, requiring the player to re-tune his instrument for various pieces. Pieces which use an open six-string range of two octaves and a fourth (AA – d^1) are known (information from Dr Christopher Field (PC)).

[22] Now in the possession of Lord Tollemache, Helmingham Hall.

[23] Now at the Musikhistorisk Museum, Copenhagen. Measurements of this instrument have been taken by the author. The bridge is probably not original, and the quoted string length is taken by multiplying the nut-fret 12 distance by two.

[24] The orpharion measured by Talbot has string lengths very close to the Palmer instrument, suggesting they were both played at the same pitch level.

Assuming the safety margin of these instruments to be the same as concluded in Chapter Two for English virginals, the absolute frequency for the top string of the bandora is 237 Hz, and the orpharion approximately a tone higher (277 Hz). Assuming the top note of both instruments was d^1, the bandora would have played at V - 2s, and the orpharion at V. Most references to the tuning of the orpharion refer to the highest string tuned to g^1 or a^1, as found in the lute. This discrepancy can probably be explained by considering the Palmer orpharion, and the instrument measured by Talbot, as bass instruments.[25]

It is likely that the different pitch levels in England prior to 1700 were the result of changes due to the development of new instruments, combined with the unwillingness to disregard earlier music and pitch standards. Organ pitch generally remained at higher levels, partly due to the reluctance of makers to build new instruments at lower pitches for economic reasons, and also because the sacred music sung to the organ needed to be performed at higher pitches to remain within the voice ranges of the singers. As new instruments were developed, or other instruments began to be used with organs, it became essential to compromise, sometimes using transposition between instruments.

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[25] It has been suggested by Abbott and Segerman (1974) (later refined in various articles by Segerman) that a "super-strong" steel wire existed and was used on orpharions and citterns. This wire was supposedly produced by Jobst Mueler in Nuremburg until he was forced to stop producing it around 1620. This wire would have a tensile strength allowing the orpharion illustrated by Praetorius (treble string length of 591 mm) to reach g^1 at Praetorius' pitch standard (Segerman believes the pitch level to be c. 435Hz, most other commentators believe it to be a semitone higher at c. 460 Hz.). Although a full analysis of the argument cannot be presented here, I believe that there is no evidence to support the existence, let alone the use, of strong steel wire. The main instruments used to support the argument are Praetorius' *Klein Englisch Zitterlein* and the orpharion – both which have problems when examined. Using the string length of the *Zitterlein* as 330 mm, it would be impossible to get the third course (of brass, tuned to a^1 or b^{b1}) to pitch without breaking, even assuming Segerman's 435 Hz standard. Segerman has argued that strong steel wire had to be used on orpharions before the development of overwound bass strings in order for the bass strings to work at all. However, personal experience in making braided strings has shown that they can work effectively with the string lengths and pitch levels as suggested above.

Table 5.3 - Pitch levels and transpositions.

Approx. frequency	V pitch scheme	Nominal pitch name	Instruments using pitch level	Possible transposition combinations
505 Hz	V + 1s	[high] quire pitch	organs, virginals [?], voices	
474 Hz	V	quire pitch	organs, virginals, voices, (small) violins [?], trumpets (in C)	
450 Hz	V - 1s	church pitch in f (Gerard Smith)	organs, virginals, voices, C16 wind, division viols, cellos (in B^{b})	
425 Hz	V - 2s	chappell pitch (James Talbot)	organs, virginals, voices, violins, trumpets (in D, or crooked into C)	
403 Hz	V - 3s	consort pitch (Thomas Mace)	organs, virginals, "French" winds, opera pitch voices, large violins, large viols, cellos (in C), trumpets (in E^{b}, as indicated by Talbot)	

It is clear from the above table that no pitch can claim priority over others in the seventeenth century. Organs were built at all five pitch levels, and, as virginall makers were often associated with organs,[26] they are unlikely to have considered the demand for instruments at different pitch levels to be unusual.

It is probable that the pitch used in a virginal was selected as the customer's request, probably to suit other instruments or voices if required. Comparing the pitch levels of the instruments by makers who have more than a single example of their work surviving, it is clear that different pitches are normally found.

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[26] John Loosemore made several surviving organs, including the instruments at Exeter Cathedral in 1665. James White became a partner of the organ maker Ralph Dallam, Thomas Body commenced his apprenticeship as an organ builder, and the Inventory taken at the death of Charles Rewallin see Appendix Six) included organ pipes, suggesting he was also a builder.

Table 5.4 – Pitch levels of instruments by makers with more than a single extant virginal.

Maker	Different pitch levels
Thomas White	**V - 2s** (1644 TW), **V** (1642 TW, 1651 TW, 1653 TW), **V + 7s** (1638 TW)
James White	**V - 1s** (1661 JW), **V** (1656 JW)
Stephen Keene	**V - 1s** (1675 SK), **V** (1668 SK)
Adam Leuersidge	**V** (1666 AL, 1670 AL)
Charles Rewallin	**V - 1s** (1675 CR), **V** (1679 CR)

Further evidence to show that it was the customers who chose the pitch level for the instruments can be seen when considering the 1671 PJ and 1675 SK virginals. These two instruments are situated close to each other in Cheshire, and are believed to have always been there since new. The 1671 PJ is at a pitch of V - 3s, and the 1675 SK at V - 1s. It is inconceivable that the original owners did not know each other socially, given the very close geographical proximity of these two instruments. It is likely that the different pitches were chosen according to the individual requirements of the particular customers.[27]

Although specific customer requirement can explain the use of the different standard pitch-levels found in majority of the instruments, there are two instruments that do not fit into any of the above groups. The 1638 TW plays at a pitch of V + 7s, and a similar pitch has been surmised for the Hasard harpsichord. Instruments at this pitch level must have transposed if they were to play with other instruments. The relationship between these instruments and those at the most frequently found pitch level, V, is of a fifth higher (or fourth lower), which echoes that found in the double-manual harpsichords of the Ruckers family.[28]

O'Brien (1990) has argued that the instruments at his R - 4 pitch were used to aid transposition for inexperienced organ players when rehearsing choirs. Although no

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[27] An inventory of Tabley House shows that a chest of viols was included amongst the other instruments at a time contemporary with the arrival of the 1671 PJ. This probably explains its use at V – 3s.
[28] See O'Brien (1990).

better solution for their use has been found, the evidence of English transposing organs is not consistent with this theory.[29]

A letter from Nathaniel Tomkins to John Sayer, written in May, 1665, makes clear the relationship between quire and organ pitch.

> "The great Organ w^ch^ was built at Worc^r^ consisted of 2 open diapasons of pure and massy mettall double F fa ut (of the quire pitch & according to Guido Aretines scale (or as some term it double C fa ut according to th^e^ keys & musiks) an open pipe of ten foot long. th^e^ diameter 7 inches & an half. (at St. Pauls Lond. th^e^ diameter was 8 inches)."

This makes clear that when a *c* key was pressed, the sounding note was an *f* according to quire pitch. Therefore the organ was at a pitch level of [quire pitch =] V + 5s, a fourth *higher* than the quire. This level is a tone below that found on the 1638 TW and Hasard instruments.

Bunker Clark (1974) shows that many organ accompaniments were *written out* a fifth higher or fourth lower than the quire parts;[30] so that, if the organist played a written *c*, the quire sang an *f*. When using an instrument at organ pitch (V + 5s) the resulting pitch level would be at quire pitch (V). Bunker Clark is incorrect in his statement (1974:43) that the transposing instruments built by the Ruckers family would be ideal rehearsal instruments,[31] and by extension the V + 7s / V - 5s English instruments were not designed to be used in this manner. If the keyboard player pressed a *c* key on the 1638 TW the resulting note would be at (quire pitch) *g*, not *f*.

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[29] This is not to say that the system did not apply to Antwerp, where the Ruckers instruments were made. Like England, The Netherlandish organs are found at two pitches and can be defined as "*C*" or "*F*" organs. If the vocal ranges of the period imply that something close to modern pitch was used, the "*F*" organs would be transposing, just as occurs in the double-manual harpsichords. Since clef substitution was a standard practice during the seventeenth century it is very likely the Ruckers double-manual harpsichords developed as instruments which had both organ pitch-levels available to the player. Any transposition neccessary was not carried out by going from one keyboard to another, but by clef substitution on the *appropriate* keyboard.

[30] An example of this is given in the Pitch Nomenclature section, Chapter One, page 28.

[31] It should be pointed out that the pitch level of Ruckers transposing doubles would make the lower manual (at R-4) produce a pitch close to the English organ-pitch standard.

As these instruments do not have an obvious use as substitute organs for rehearsals (unlike those of the Ruckers family in Antwerp), another solution for their use must be found. The only possibility that presents itself when considering the use of these virginalls with other types of instrument is that they accompanied large viols which were nominally tuned a fourth below the standard consort (ie. a bass viol pitched at AA). Praetorius is unique in mentioning such a tuning, and there is no evidence to suggest that such tuning was common (although there are some viol consort pieces which require a double-bass viol with its bottom string tuned to AA, or that instruments were built of a size that required them to be tuned a tone below the standard consort instruments which played at V - 3s. It appears likely that English instruments at a pitch of V – 5s / V + 7s were rare in comparison to the Ruckers workshop where all (except one) of the surviving double-manual harpsichords had one keyboard pitched a fourth below the other.[32] It is more likely they were built in numbers proportionate to the *quarto alla bassa* harpsichords made in Venice during the sixteenth- and early-seventeenth centuries.[33]

ENGLISH VIRGINAL COMPASS

English keyboard instruments are unique in their standard use of a chromatic compass from C in the bass. Only one English-made keyboard instrument, the 1623 chamber organ at Knole Park, Kent, has evidence of a compass that may have originally been a C/E short octave. The compass in this instrument is now chromatic from C.

The use of the chromatic C compass can be traced to the earliest records of keyboard instrument making in Tudor England, the Duddyngton organ contract at All Hallows Barking (1519):

> "to make an Instrument, that i^{s} to say a payer of organs for the foresed church, of dowble Ce-fa-ut that i^{s} to say, xxvij. playne keyes..."

The contract of between Holy Trinity Church, Coventry, and the organ builders John Howe and John Claymore, dated December 1526, further provides evidence, stating that:-

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[32] The 1612a HR in the possession of Her Majesty the Queen, and housed at Fenton House, London, was originally built with two manuals a tone apart, at R – 4 and R – 5. See O'Brien (1990:178).
[33] See Wraight (1997:235).

> "A peir of organs w^t^ vii stopps, ov'r and besides the two Towers of cases, of the pitches of doble Eff, and w^t^ xxvii pleyn keyes, xix musiks..."

Both contracts specify 27 natural keys, which could be C/E - c^3, C - a^2, or possibly F - d^3. The Coventry contract also specifies 19 accidental keys, ruling out the short octave compass. The Duddyngton contract is specific in asking for the lowest note to be a C. The Coventry contract is less specific in regard to keyboard range, but given the consistent use of transposing organ parts a fully-chromatic C - a^2 compass is most likely.[34] This compass has all the notes required when the organist has his part a fourth lower than written, the bass C of the organ producing the low F required by the bass vocal parts.

Early solo organ music by composers such as John Redford (*fl.* c. 1530) show that the C - a^2 compass was required, with a number of pieces requiring the low notes below F.[35] The music is often written out an octave higher, but exceeds the top note of the organ's compass unless transposed down an octave.[36]

The main reason for such a compass, and the necessity for transposition when accompanying choral works, was probably monetary. If composers were writing solo organ music that descended to C, but choirs only went as low as F, it was financially beneficial to have the keyboard compass suitable for the organ music, but with shorter (and thus cheaper) pipes that only went down to the lowest note of the vocal range. This had the drawback of forcing the organist to transpose choral accompaniments.[37]

There is no reason why virginalls would have had a compass different from that of the organ, although the instruments were usually (at least in the surviving examples) built at pitches that did not require transposition. Therefore, the earliest instruments probably had the same C - a^2 compass as the organs, which was extended to c^3 by at least 1579, when the Theewes harpsichord was built. Although the Theewes has lost

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[34] The wording "of the pitches of doble Eff" should not be taken to imply that was the lowest keyboard note, as other contracts make clear.

[35] It is probable that some organs were made which had a compass that only went as low as F. The soundboard of an organ which was formerly in Wingfield, Suffolk survives which probably had only 41 notes, most likely F – a^2. The soundboard dimensions suggest the instrument was at quire, rather than organ, pitch. See Bicknell (1996:32) for full details of this and other instruments which may have had the same compass.

[36] I would like to thank Maria Boxall (PC) who first pointed out both of these features to me.

[37] Although there is no documentary evidence to support this argument in the first half of the sixteenth century, it is clear from later records that English organs regularly suffered from financial constraints. The use of clef substitution generally made any required transpositions fairly straightforward.

its keyboard, the balance rail is almost certainly original, despite having angled bevels which would imply it was reused from a virginal.[38] The only other compass that would fit its 49 notes is AA - a^2. This compass is otherwise unknown.

The C - c^3 compass remained in use until at least 1653.[39] In addition to being found in the majority of surviving instruments built up to that date, it is mentioned as the usual virginal compass by Charles Butler (1636)[40] who describes the organ compass as C - d^3, one note more than the C - c^3 found in contemporary virginals.

Other compasses are occasionally found in early virginalls. The 1641 GT has a compass from C - e^3, and the 1655 JL goes from C - d^3. This instrument is the last surviving example that has a compass descending to C in the bass. Thomas White has surviving instruments that use a GG/BB short octave, the 1644 TW extending to f^3 in the treble, and the 1651 TW having a GG/BB - d^3 range. The 1656 JW shows evidence of having originally been intended to go to C, but was altered during construction to GG/BB - c^3.

The GG/BB bass compass became standard after 1660. With the exception of three long-bass instruments (1664 RH, 1664 JP and 1668 SK), all of the surviving virginals built after the Restoration have this bass compass. The treble note was usually f^3, although Charles Rewallin made instruments that only ascended to d^3.

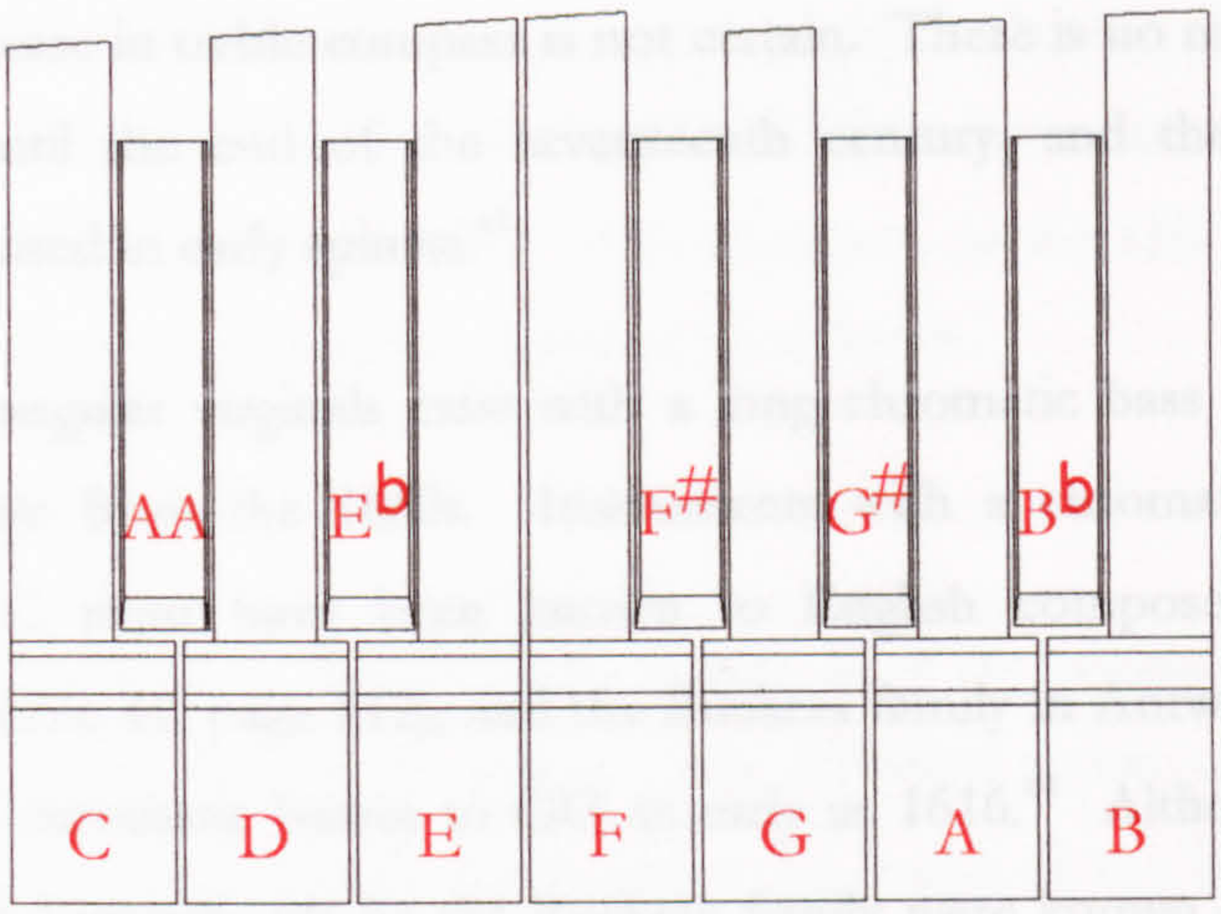
Musically and historically, the GG/BB compass in England should perhaps be seen as a GG/BB key added to the pre-existing C compass, rather than a change from a chromatic to a short octave bass system. The organ section of the Theewes instrument had only 48 notes, rather than the 49 of the harpsichord. This suggests that the missing note was the $C^{\#}$, which was usable on the harpsichord section as an AA. This latter note occurs frequently in music from the late sixteenth-century onwards, only rarely found in the same piece as the $C^{\#}$.[41] By contrast, the note is regularly found in pieces

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[38] Illustrated in the Catalogue, page 333.
[39] It is found in the 1653 TW virginal, and was probably the intended compass of the 1656 JW, before it was altered during construction.
[40] See Bunker Clark (1974:26) for a quotation of the complete passage.
[41] The only instances I am aware of where the two notes appear in the same piece are a *Galiarda* (XVII) and a *Praeludium* (CXV) by John Bull and a *Pavana* (CXXIII) by Thomas Tomkins. The numbers in parenthesis following each of the titles indicates their numbers in the Fitzwilliam Virginal Book. The Tomkins piece has a fast running bass passage which includes both notes (and a BB) at the end, and

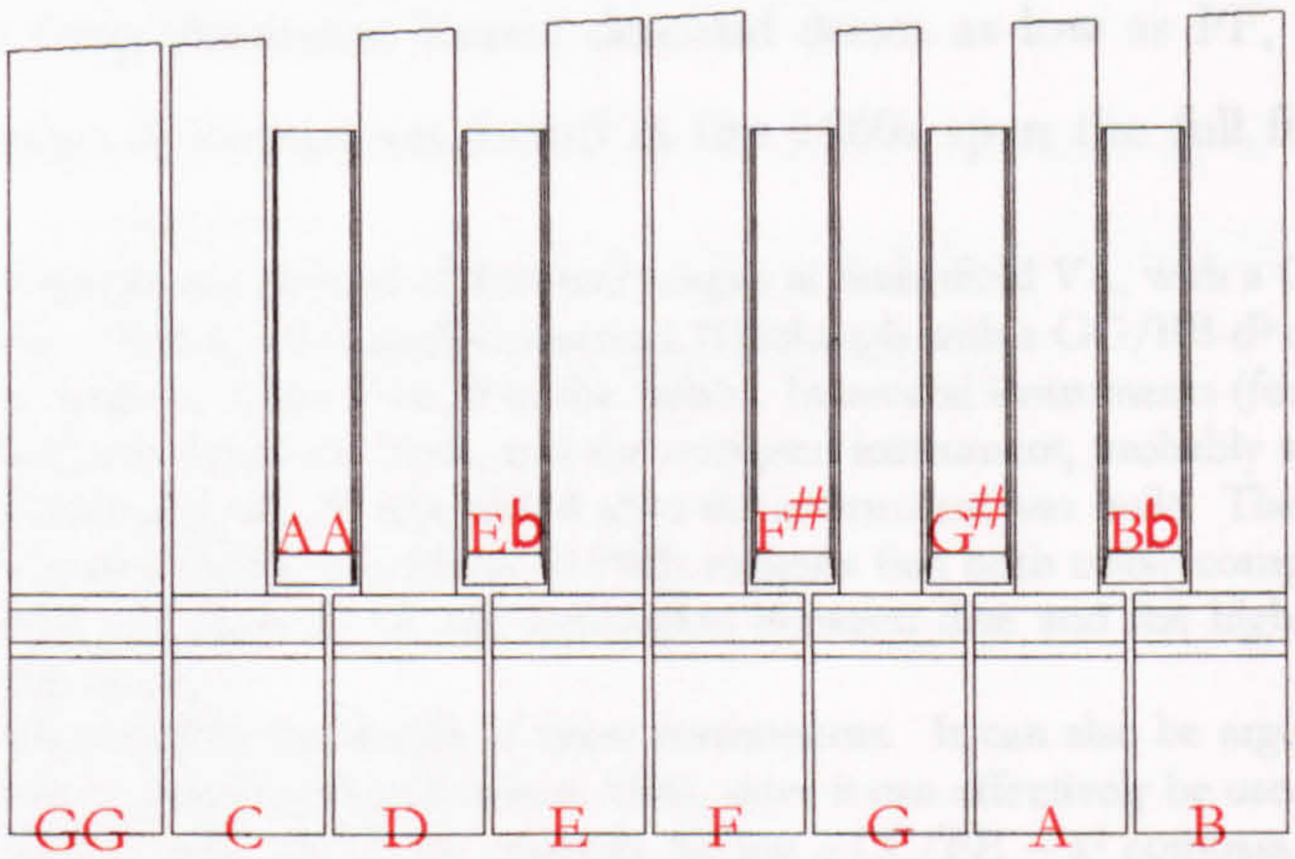
that also have a C. This suggests that the $C^{\#}$ was commonly tuned to AA, giving the bass compass with the following arrangement.

Figure 5.2 - Standard bass tuning with compass descending to C.



The addition of the GG/BB key was done without any other alteration to the bass-note arrangement, the E^{b} key remaining as that note, rather than being tuned to a BB, as required in French instruments of the period. Therefore, the following arrangement was found :-

Figure 5.3 - Standard bass tuning with compass descending to GG/BB.



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ergonomically is most satisfactory on a chromatic instrument, rather than one with a short or broken octave.

This arrangement of bass notes is often found in contemporary organs that descend to C or GG/BB.[42]

The increase of the treble compass mirrors that of the bass. The 1644 TW, the first instrument to descend to GG/BB in the bass also rises to f^3 in the treble. The reason for the increase in treble compass is not certain. There is no music that requires notes above d^3 until the end of the seventeenth century, and the treble compass extension was not used in early spinets.[43]

Three rectangular virginals exist with a long chromatic bass below C. These instruments all date from the 1660s. Instruments with a chromatic bass compass extending below C must have been known to English composers (for example, Tomkins, see footnote 41, page 212), and the Ruckers family in Antwerp were building harpsichords with chromatic basses to GG as early as 1616.[44] Although chromatic-C bass single manual harpsichords by the Ruckers family were known as being built "*op sijn engels*"[45], there is no contemporary documentary evidence explaining why the chromatic-GG bass double manual instruments were built, and they could also have been predominantly for the English market.[46]

As shown in the Catalogue, page 349, the Hasard harpsichord of 1622 was probably built with a GG,AA - c^3 compass. It is likely, therefore, that the long chromatic-bass compass was known in England, if uncommon, for some fifty years before the instruments built in the first decade after the Restoration. Two of the three instruments with long chromatic basses descend down as low as FF, lacking the $FF^{\#}$. Therefore, the range of compasses found in the 1660s span the full five octaves from

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42 For example the Anonymous (School of Dallam?) organ at Smithfield VA, with a C-d^3 compass, or the Anonymous organ of c. 1700 in the Russell Collection, Edinburgh with a GG/BB-d^3 compass.

43 The earliest spinets went to either c^3 or d^3 in the treble. In several instruments (for example the spinet by John Player in the Castle Museum, York, and the unsigned instrument, probably also by Player, in the Russell Collection, Edinburgh, the d^3 was added after the instrument was built. The stringing list of the harpsichord listed by James Talbot (see Martin (1995)) suggests that both treble compasses were in use in the 1690s. There does not seem to be any correlation between date and the highest note in a spinet during the seventeenth century.

44 1616 IR. See O'Brien (1990) for details of these instruments. It can also be argued that a chromatic compass from GG can be found in Flanders in c. 1580, since it can effectively be used on an Anonymous double-manual instrument with one of the manuals having a CC/EE – a^2 compass. The instrument is now in the Musical Instrument Museum, Brussels (see Koster (1982)).

45 "In the English style". See O'Brien (1990:43).

46 O'Brien refers to these instruments as being "French" doubles, as the surviving examples all appear to have been in that country since the historical era. However, the surviving music suggests that the GG/BB bass compass was standard.

FF - f^3. The widest compass found in any surviving virginal is FF,GG - d^3, used in the 1668 SK.

As with the compass reaching f^3 in the treble, it is uncertain why a compass with notes below GG should be used. All of the instruments with the long bass are pitched at V, and it is possible that the extra notes were required to allow transpositions down a second, minor third or fourth when playing with other instruments. A similar reason cannot explain the use of the extended treble compass, as the GG/BB - f^3 range is found in instruments at all of the main standard pitch levels.

THE KEYBOARD AND ACTION

Only one instrument, the 1675 CR, retains all of its original action cloths. A number of other instruments have one or more different action cloths, usually that under the jackrail, and occasionally those under the backs of the keys, or the cloths attached to the top of the keys at the rear. Therefore, although almost all of the instruments have their original keyboards,[47] it is difficult to come to any firm conclusions about important elements such as the depth of touch.

Generally the keyboard natural headlength falls into two groups: the most common length being about 35 mm, with another group having headlengths of around 32 mm. The headlength is generally a characteristic of a particular maker — of the five makers with more than one extant instrument only Stephen Keene has keyboard natural headlengths which differ by more than one millimetre.

These headlengths are relatively short, as can be seen by a comparison with instruments from eighteenth-century schools of instrument making, but are comparable with other sixteenth- and seventeenth-century instruments.

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[47] The only instrument with a replaced keyboard is the 1664 RH. A number of keys of the AH and 1684 TB instruments are replacements. The keyboards of the Theewes and Hasard harpsichords are entirely missing.

Table 5.5 - Natural headlengths found in instruments from different schools.

Maker or school[48]	Natural headlength
English virginal	32 or 35 mm
Kirckman / Shudi	39½ - 41 mm
Seventeenth-Century France[49]	28 - 31 mm
Eighteenth-Century France	35 - 36½ mm
Hass	41 - 42 mm
Ruckers	32 - 34 mm
Dulcken[50]	35 mm
Venice	33½ mm

The octave span of the virginals is also generally of small dimensions. Unlike the natural headlength, there do not appear to be any groupings into which the octave spans could be fitted. This may partially be the result of workshop conditions. In workshops without a controlled environment the humidity can fluctuate enough to easily cause differences of up to 4 mm, despite the use of the same marking-out stick.[51] Stephen Keene, James White and Charles Rewallin have keyboards which differ by more than that amount. This implies that the octave span may also have been a requirement that was specified by the customer.

Despite the variations found, there are several consistencies. The Exeter built instruments have the smallest three-octave spans, ranging from 459½ to 474 mm. The two earliest instruments, the AH and Mar virginals have three-octave spans of about 476 and 478 mm respectively, similar to the 1641 GT. The majority of the instruments have three-octave spans between 480 and 486 mm. Only four instruments have larger spans – the 1662 TB is 488½ mm, the 1684 TB is 491 mm, and the two instruments by Adam Leuersidge are 496 and 498 mm. These three-octave spans can also be compared to instruments from other schools.

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[48] All information in this and the following table based on instruments in the Russell Collection and measured by the author unless otherwise indicated.

[49] The figures for seventeenth-century French instruments have been taken from a list compiled by Jack Peters, and are quoted with his permission.

[50] Barnes Collection, measured by the author.

[51] Personal experience of the author. This is based on the experience of making two keyboards from the same timber stock which were glued up at the same time. The difference in the final width can therefore be concluded to be exclusively the result of different humidity at the time the keyboards were pinned and cut.

Table 5.6 – Three-octave spans of various instruments.

Instrument or school	Three-octave span
English virginals	459½ - 498 mm
Kirckman / Shudi	486 mm
Seventeenth-Century France	465 - 475 mm
Eighteenth-Century France	475 - 480 mm
Hass	491½ mm
Ruckers[52]	500 mm
Dulcken	490 mm
Venice[53]	497 or 507 mm

The natural headlengths and the octave span are not alone in determining the perception of a keyboard's size from the perspective of a player. The rounding at the edges of the keys, although less easy to quantifiably measure, has a pronounced effect for the player. In English virginals the rounding usually commences 2½ to 3 mm from the edge of the key, and tends to be fairly abrupt. This gives a small flat surface for the players fingers, requiring a more accurate finger placement. This, combined with the octave span itself, and the relatively small natural headlength, gives an impression to the player of a small keyboard, needing a precise technique.

Figure 5.4 - Typical rounding at the edge of the keys.



The accidental touchplates and the spacing of the back of the natural touchplates also have a bearing on the impression the keyboard gives the player.

English virginal keyboards are generally quite forward-balanced compared with eighteenth-century instruments. There is no consistency in the balance ratios[54] found in

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[52] See O'Brien (1990).

[53] See O'Brien (1999).

[54] The balance ratio is defined in the same manner as used by O'Brien (1990:118). It is the ratio of the distance from the front end of the natural touchplate to the balance point divided by the distance from the balance point to the rear of the keylever. Therefore, if the total keylength is 450 mm and the distance from the front of the natural touchplate to the balance point is 175 mm the ratio is 175:275 (400 - 175) = 0.64.

the surviving English virginals. Thomas White always has a balance ratio which is typically about 0.59 in the bass reducing to about 0.53 in the treble, whereas the instruments by James White are more evenly balanced across the compass from 0.53 or 0.54 in the bass to 0.52 in the treble. Several makers do the opposite, increasing the balance ratio from bass to treble.[55] Of particular note are the three long bass instruments (the 1664 JP, 1664 RH and 1668 SK), all of which have balance ratios in excess of 0.60.

The following table lists the balance ratios of various English virginals along with instruments from other schools:-

Table 5.7 – Balance ratios of various English virginals and instruments from other schools.

Instrument	Balance Ratio
AH	0.54 – 0.57
Mar	0.58 – 0.58
1642 TW	0.59 – 0.52
1655 JL	0.50 – 0.52
1656 JW	0.54 – 0.52
1662 TB	0.59 – 0.55
1666 AL	0.53 – 0.52
1675 SK	0.61 – 0.62
1679 CR	0.53 – 0.57
Pisaurensis virginal[56]	0.54 – 0.51
Bertolotti virginal	0.55 – 0.54
Ruckers virginals[57]	0.53 – 0.56
1764 Hass single manual harpsichord	0.71 – 0.75
Ruckers double-manual harpsichords	0.55 (lower manual) 0.60 (upper manual)
Dulcken double-manual harpsichords	0.70 (lower manual) 0.70 (upper manual)
Taskin double-manual harpsichords	0.80 (lower manual) 0.79 (upper manual)
Kirckman double-manual harpsichords	0.87 (lower manual) 0.85 (upper manual)

From the above table it can be seen that the English virginals have balance ratios comparable to the sixteenth- and seventeenth-century instruments by Pisaurensis, Bertolotti and Ruckers, but are notably more forward-balanced than the later

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[55] For example, the AH has a ratio of 0.54 in the bass to 0.57 in the treble.

[56] The Pisaurensis, Bertolotti and Hass instruments are all housed at the Russell Collection and were measured by the author.

[57] The figures for the instruments by Ruckers, Dulcken, Taskin and Kirckman and all measured by Grant O'Brien, quoted in O'Brien (1990:221).

instruments by Hass, Taskin, Dulcken and Kirckman. This, and the generally short keylengths found in the earlier instruments are indicative of a different keyboard technique.

Only one virginal, the 1675 CR retains all of its original action cloths. These are fully described in the Catalogue, page 194. The depth of touch can be determined as the distance the key travels before reaching the cloth underneath the front of the keys, and varies between 5.5 and 6.5 mm except where the cloth is nailed to the keyframe.[58] It appears that Rewallin intended the jacks to come in contact with the jackrail cloth at the same time the key reached the frontrail cloth. This depth of touch is similar to what is found in other sixteenth- and seventeenth-century instruments, but shallower than what is typically found on later instruments.[59]

Most English virginals do not have frontrail cloths, the depth of touch being controlled exclusively by the top of the jacks hitting the jackrail cloth. A number of instruments retain some original action cloths and, assuming the missing cloths to be similar to those found in other surviving instruments, would give similar touch depths to that found on the 1675 CR.[60]

THE EXTRA C AND DOUBLE STRINGING IN SOME VIRGINALS

One feature found in most of the surviving English virginals is the facility of an extra string and jack operated by the C keylever (referred to as the extra C). In addition to those instruments,[61] three virginals – the 1644 TW, 1675 CR and 1679 CR – have additional jacks and strings for other keys. The 1675 CR has an extra jack and string for the GG/BB in addition to the C, the 1679 CR has two strings and jacks for four notes from GG/BB to D, and the 1644 TW has extra jacks and strings from GG/BB – A (11 notes). It is probable that these additional strings and jacks are related to the use of the extra C.

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[58] The complete figures are given in the Catalogue, page 194.
[59] Personal observation, and also confirmed in discussion with other restorers and curators.
[60] Koster (1994) lists the "effective depth of the sharps" which, as he points out, provides the maximum depth of touch on a keyboard. On English virginals the effective depth of the sharps is typically 7.0 – 7.5 mm.
[61] The instruments with the extra C are the AH, Mar, 1638 TW, 1641 GT, 1642 TW, 1651 TW, 1653 TW, 1655 JL, 1656 JW, 1661 JW, 1675 SK.

It has been suggested[62] that the extra C is to allow one of the strings to be tuned to AA and substituted in pieces which require that note. However, an examination of music from the period, for example the Fitzwilliam Virginal Book[63] shows that pieces which require the AA almost invariably also require C.[64] The suggestion does not take into consideration the fact that English organs of the period had the C# tuned to AA (see above), which shows that another solution must be found.

If the use of the double stringing on the 1644 TW, 1675 CR and 1679 CR instruments is related to the use of the extra C there are only a few possibilities which are – from a musical view – likely to exist. It is certain that the extra strings being used as an alternative tuning facility can be ignored since there is no musical requirement for it.[65] The four remaining possibilities are that the extra strings are tuned in unison, an octave higher, an octave lower, or a fifth higher than the standard note.. Each of these possibilities can be tested.

Table 5.8 – The string lengths and Equivalent percentage of the design-scale note of the highest and lowest doubled strings for the 1644 TW, 1675 CR and 1679 CR virginals.

	Highest Note string lengths	Equivalent Percentage of design-scale note	Lowest Note string lengths	Equivalent Percentage of design-scale note
1644 TW	975, 986 (A)	60.9, 61.6	1507, 1521	42.0, 42.4
1675 CR	1330, 1356½ (C)	52.1, 53.2	1406½, 1433	41.3, 42.1
1679 CR	1296½, 1308 (D)	59.7, 60.3	1435, 1449	44.2, 44.6

The first possibility – having both strings tuned in unison – is obviously acceptable under any conditions, and need not be tested further here. Tuning the strings to the higher octave requires one of the doubled strings to have equivalent percentages of the scaling-design note below 50%. In none of the examples is that condition met, and therefore that possibility can be excluded. It is more difficult to

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[62] See, for example, Schott (1985:59).

[63] Fuller Maitland and Barclay Squire (1899).

[64] It could be argued that this could be accommodated by retuning the C# down to C when the AA is in use. Aside from any other argument it can be pointed out that C# is rarely required in music of the period.

[65] The occasional piece which requires notes outside of the usual English bass tuning system, with the C# tuned to AA (as cited in footnote 41, page 212) are more suited to a GG chromatic bass rather than any other short octave or altered bass octave tuning)

determine the lowest pitch a string can sound and which would result in an acceptable note. This makes testing the argument for sub-octave bass strings uncertain. Assuming that the lowest string of the orpharion (see above, page 206) to actually be the lowest equivalent percentage of the scaling-design note it can be concluded that the required figure is 19.3%.[66] This figure is comparable to the equivalent percentage of scaling-design note, which would be 21.05% for the 1675 CR. Therefore it would be possible (just) for the extra string to be tuned an octave lower. For that to be practical the sub-octave strings would all be braided, with the GG/BB sub-octave string using red brass at the tightest twist level. A precedence for using braided strings in plucked keyboard instruments can be seen in the 1581 HR.[67] If the extra strings were at a pitch a fifth higher it would require the highest of the extra strings to have an equivalent design-scale note percentage not exceeding 67%.[68] All of the instruments meet this condition.

As a result of this test it can be shown that the extra strings could be at the same pitch, a fifth higher, or an octave lower. There is no evidence on the instruments themselves that can provide any further answer to the question. This is probably significant when considering the sub-octave strings as a possibility. Musically they can be shown to have precedence in the "bassys" found in a number of organs,[69] however there is no indication of braided strings on any surviving English virginal. As some indication would be expected this possibility can probably be discounted.[70] The possible use for strings tuned in fifths would be specifically for drone effects. This would be reasonable for the instruments with just an extra C, and even the two Rewallin instruments where the fifths would be above GG and C in the 1675 instrument and GG, AA, C and D on the 1679 virginal. However, its use on the 1644 TW would be somewhat unattractive and unnecessary. This can also be rejected, leaving the extra strings most likely to have been tuned in unison. Although this may appear somewhat

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[66] This is calculated as follows. The lowest string of the Palmer orpharion is 603 mm long, and the top string is 522 mm long. Assuming the highest string to be tuned to d^1, the lowest string produces a pitch of AA, two octaves and a fourth lower than the top string. As the lowest string is 603 mm long the figure is 603 x (2/3) / 4 [=113] / 522 = 19.3%. Personal experience suggests that this is very near the lowest limit for producing an acceptable sound.

[67] See Pollens (1998) for details of these strings.

[68] As the note of the extra string is tuned a fifth (3/2) higher the equivalent percentage must be the inverse (2/3).

[69] For example the "Duddyngton" instrument (see Chapter Two, page 73), the Wetheringsett organ (see Bicknell (1996:30)), and the organ by John Loosemore at Exeter Cathedral (see Bicknell (1996:115)).

[70] Were braided strings to be used there is likely to be indications where the strings cross the bridges and by the lowest hitchpin.

superfluous in normal use (particularly when there is only an extra C) it provides the only acceptable solution. It is possible that the effect was used sparingly with the extra jack usually kept in the toolbox. On an instrument such as the 1644 TW the voicing (and possibly the stringing) would have taken the double stringing into account and both strings were always active.

TUNING

Tuning does not strictly fall into the bounds of the thesis, since that is normally the domain of the player rather than the maker, but there are aspects that should be considered. In the sixteenth century it is likely that meantone tuning was commonly used, where the comma[71] is divided between the four perfect fifths *f-c*, *c-g*, *g-d* and *d-a*, producing a pure major third between *f* and *a*.[72] Once those notes had been set the other notes were tuned in pure thirds, usually *c-e*, *e-g*$^{\#}$, *e*^{b}*-g*, *g-b*, *b*^{b}*-d*, *d-f*$^{\#}$ and *a-c*$^{\#}$. The result of this temperament is that the fourth between *e*^{b} and *g*$^{\#}$ is 41 cents sharp (compared to equal temperament), and music in keys requiring more than 3 sharps or two flats is often compromised. This generally presents few difficulties in practice, although some Italian makers or c. 1600 – 1620 used additional split accidental keys for *d*$^{\#}$/*e*^{b} and/or *g*$^{\#}$/*d*^{b}, allowing a wider range of keys to be used.

There certainly are pieces in the English virginal repertoire which cannot be satisfactorily performed using standard meantone temperament, a prominent example being the *Ut, re, mi, fa, sol, la* by John Bull.[73] This suggests that another temperament was also known and used.

Although there is no evidence from the sixteenth- or early-seventeenth centuries to give an indication of this alternative temperament it is clear that makers of organs were using such a temperament following the Restoration, if not before. At least two organs by "Father" Bernard Smith – at Durham Cathedral (1684) and the Temple Church, London (1688) have fourteen notes to the octave, with split keys for d$^{\#}$/e^{b} and

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[71] For full details about temperaments see GDN2, articles on tuning, temperament, and meantone.
[72] This is not the only method of dividing the comma. It is equally possible to divide it between C-G, G-D, D-A and A-E giving a pure third between C and E. Once all of the other notes are tuned in pure thirds to those notes the result is the same as the method described above.
[73] In the Fitzwilliam Virginal Book, number LI. See Fuller Maitland and Barclay Squire (1899:183).

$g^{\#}/a^{b}$.[74] This alone does not rule out the likely use of meantone, but a passage by Francis North, written in 1677[75] makes clear that meantone was not always used on instruments with only twelve notes per octave:

> Quarter Notes have been invented, which placed into those parts where these Schismes are the greatest, make the Instrument serve those Keys to which otherwise it would not be in tune. *Organs* and *Harpsichords* that have no quarter Notes are tuned with allowances, so that there is but one perfect fifth in the compass of an Octave, the rest bear on the one hand or the other, and so are indifferently well in tune to all Keys, but exactly in tune to none.

Earlier in his work North describes the setting of the true scale:

> There are all of the Notes of the Scale within the compass of an Octave, and by this method should they be Tuned, *Viz.* Third *b* and third #, fourth, fifth, sixth *b*, and sixth #, by the Key Note, second and seventh *b*, and seventh # by the fifth above the Key or its Octave :, false fifth or fourth # must be third # to the second, and the ½ Note above the Key must be a sixth *b* to the fifth below the Key.

These instructions cannot be used as an indication of a practical temperament for an instrument, and North explains that it only serves music in the key it has been set to. The actual temperament North had in mind clearly contains fifths which are tuned narrow and wide ("the rest bear on the one hand or the other"), and, according to his instructions, a single pure fifth.[76]

There is no evidence that English virginall makers ever built instruments with split accidentals to allow meantone tuning to be used in a wide variety of keys.[77] However, given the close relationship between virginal makers and organ makers it is clear they must have been aware of such instruments. The instructions given by North may apply to music of one hundred years earlier, and those English pieces that use extreme chromaticism may have been played without temperment problems by using a system similar to that described by North.

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[74] For a description of these instruments see Bicknell (1996).
[75] See North (1677:27).
[76] It could be argued that his phrase "in the compass of one octave" implies there might be more than a single pure fifth in the scale, but only one of them between c and c^1, for example. This reading cannot be discounted, but is unlikely to be what was intended. Alexander Mackenzie of Ord (PC) believes that the passage should be read in such a way, and that the temperment had five narrow fifths, four pure fifths, and three wide fifths. Another possiblitity would be six narrow fifths, four pure fifths and two wide fifths.
[77] This idea has been proposed by Field (1996) when discussing the Bull *Ut, re, mi, fa, sol, la* piece.

THE DECLINE OF THE VIRGINAL

THE EARLIEST MENTIONS OF THE SPINET

The arrival of the spinet in England is often attributed to Girolamo Zenti, the Italian-born harpsichord maker. Hubbard (1965:151) states that:

> The earliest English spinet known to me is dated 1660 and was made by Thomas Hitchcock the elder. This is about the time that Zentis was in England, and may very well have been made under his influence.

This statement can be shown to be incorrect in several respects. It is now known that Zenti did not arrive in England until 1662 at the earliest – a record exists of a pass (issued on January 29, 1663/4) allowing him to travel from the English Court to Italy.[1] His name does not appear elsewhere in the Court records. The present whereabouts of the instrument Hubbard refers to are no longer known, and it is unlikely that he saw the instrument himself. Instead, the number is probably – following Hitchcock's custom – a case number. A second instrument is supposedly signed on the lowest key "Thos. Hitchcock his make in 1664". The location of this instrument is also unknown. James (1930:65) states the instrument is by Blunt (who was made a Freeman of the Joiner's Company in 1700). It is most likely that there is an error in the reading of the inscription. With caution needed in accepting the attribution of both of those instruments, the earliest extant dated spinet is believed to be by John Player, 1680.[2]

A well known, and unambiguous, reference to a bentside spinet can be found in the diary of Samuel Pepys in 1668:

> 4 April, 1668. "Up betimes, and by coach towards Whitehall; and took Aldersgate-street in my way and there called upon one Hayward that makes virginalls, and did there like of a little Espinettes, and will have him finish them for me; for I had a mind to a small Harpsicon, but this takes up less room and will do my business as to finding out of Chords - and I am very well pleased that I have found it..."

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[1] See Ashbee & Lasocki (1998:1186).

[2] This instrument is signed "John Player Fecit" on the nameboard, and is a rare example of a double-strung spinet. The compass is GG/BB – c^3, with a broken octave. The date is early for a broken octave, and the location of the date is not known, but the instrument is nevertheless considered as genuine. It is in a private collection in Wiltshire. It has not been examined for this thesis.

10 July, 1668. "... Home to dinner; thence to Haward's to look upon an Espinettes, and I did come near the buying one, but broke off. I have a mind to have one..."

13 July, 1668. "... I to buy my Espinette, which I now did agree for, and did at Haward's meet with Mr. Thacker and heard him play on the Harpsicon, so as I never heard man before, I think..."

15 July, 1668. " At noon home to dinner, where is brought the Espinette I bought the other day of Haward; costs me £5."

Pepys is quite explicit in his descriptions of instruments, clearly differentiating between virginals, spinets and harpsichords. Therefore this could only refer to a bentside spinet. It appears that, from at least 1668, Charles Haward was making spinets, probably on a speculative basis. It is almost certain that the spinet was known in England earlier than 1668, as also found in Pepys' Diary:[3]

14 June 1661. "...I sent to my house, by my Lord's order his shipp and Triangle-virginall..."

18 March, 1662/3."...This day my triangle (which was put in tune yesterday) did please me very well, Ashwell playing upon it pretty well..."

1 April, 1663. "...home, calling on the virginall-maker, buying a Rest for myself to tune my Tryangle and taking one of his people along with me to put it in tune once more; by which I learned how to go about it myself for the time to come..."

1 May, 1663. "...went to hear Mrs. Turner's daughter (at whose house Sir J. Mennes lies) play on the Harpsicon; but; Lord, it was enough to make any man sick to hear her; yet I was forced to commend her highly..."

Given the precise nature of Pepys' terminology this instrument could not be either a virginal or a harpsichord, as both of those are specifically mentioned in the quoted text. A "triangle" clearly implies an instrument with its spine at an angle to the front of the keyboard. There is no evidence of English-made virginals being built in anything but a rectangular form. Therefore the great probability is that the instrument is a spinet, probably at octave pitch. Fourteen months later, on 1 July, 1664, Pepys clearly differentiates between his triangle and a spinet.

July 1, 1664 "...first bringing down my Tryangle to my chamber below, having a new frame made proper for it to stand on..."

[Later in same entry]"...and then [to Pepys' office] came Mr. Hill and Andrew and one Cheswicke, a maister who plays very well upon the Spinette, and we sat singing Psalms till 9 at night..."

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[3] The listed quotations are not all of the references to the triangle found in the Diary, but are representative, and give an indication of his preciseness of terminology.

The arrival of the spinet in England can be dated to 1661 (in a technical sense) or 1664 at the latest (see above), but was still not well established by 1668 when Pepys purchased a speculatively built instrument from Charles Haward. It is likely that the popularity of the spinet overtook the virginal during the 1670s.

REASONS FOR THE DECLINE

In his 1668 entries, Pepys refers to purchasing an *espinette*, and it is likely that the instrument was introduced to England via France, probably at the time of the Restoration (1660) or shortly beforehand. The return of Charles II from exile brought about a renewed interest in French fashions and music, as can be seen in the formation of the "24 violins" at the English Court. This royal interest would take some years to filter though to lower strata of society, but was probably boosted – in London at the least – by the Great Fire in 1666. Pepys records many virginals being saved in the fire, although his "one lighter in three" is almost certainly an exaggeration, and many of those that were saved from the fire itself were probably ruined by water damage.[4]

A great reason for the decline of the virginal and rise of the spinet may be the desires of the makers themselves. As the entries by Pepys concerning the purchase of a spinet show, Haward (and probably other makers) was making spinets speculatively. There are various advantages, from a maker's perspective, in spinets over virginals which should be considered.

- A spinet is easier to build than a virginal. This may not be intuitively obvious due to the presence of a bentside on the spinet which appears more complicated to construct than an instrument in a rectangular shape. The bentside was probably curved using dry heat, either by the application of a burning flame (probably rushes) whilst applying pressure by forcing the piece of bentside wood against solid uprights,[5] or by the use of a large "bending iron" – a heated piece of metal – either iron or brass – over which the wood is pressed. In either method, once the wood fibres reach a certain

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[4] The decorative paintings of various surviving English virginals show evidence of water damage showing that water-soluble paints were used. It is impossible to imagine that in the panic of a major fire that extreme care was taken over protecting the decorative work, and the resulting damage probably rendered the instruments as beyond repair in the eyes of their owners.

[5] Grant O'Brien (PC) described this method to the author, following a visit he made to the Low Countries during which he saw this construction method used in wooden boat manufacture. It is consistent which the scorch marks found on the bentsides of several Ruckers harpsichords.

temperature the wood can easily take a permanent deformation. Bending irons were familiar to makers of other stringed instruments and do not leave any bad scorching on the wood surface, making it more likely that this method was used. The use of dry heat does not require further cramping over a "former" to retain the shape, and once cooled the bentside can be cut to the correct length and joined to the other case parts. Regardless of any apparent difficulty in this process,[6] the construction of a spinet action is both simpler and less likely to need adjustment, usually consisting of a series of slotted blocks which are cut to a consistent angle and glued to the rear surface of the wrestplank. The jacks pass through these slots to rest on the back of the keys. Some earlier spinets (see below) retain the separate upper- and lower-guides, as found in all of the English virginals, but the close proximity of the register slots to the wrestplank reduces any risk of case deformation causing an alteration of the jack/string alignment.[7] The spinet also used a flat lid, rather than the coffered lid originally found on all English virginals.

• Spinets have a simpler style of decoration. In contrast to English virginals which have flowers and birds painted on the soundboard, full lid and keywell flap paintings, and gilt pressed papers around the soundwell, faceboards, keywell sides, nameboard and on the jackrail, all separated by pieces of moulding, the English bentside spinets usually have no soundboard decoration[8] and plain interiors. No extant spinet has a lid painting. The soundwell and keywell are usually veneered in plain wood, often cedar, although occasionally raised mouldings are used on the nameboard,[9] or the keywell has marquetry panels.[10]

• Spinets appear to have been made as specific "models". In contrast to the surviving English virginals, which are rarely of the same design and which appear to be custom-ordered, the surviving spinets show a similarity from instrument to instrument. It is likely that makers were able to adopt different working practices with the

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[6] The surviving spinets of Charles Haward use a S-shaped double curve bentside and no tail, which suggests that he thought the bending process was not that much (if at all) more difficult than making a bentside/tail joint. Likewise, Thomas Hitchcock made spinets in the eighteenth century with both double-curved bentsides or a single curve and separate tail.

[7] For an excellent description of historical spinet woodworking techniques see Barnes (1985).

[8] Some instruments by Charles Haward have painted border patterns around the edge of the soundboard.

[9] On, for example, the spinet by John Player in the Victoria and Albert Museum.

[10] For example, the unsigned (probably by John Player) spinet in the Russell Collection, Edinburgh.

establishment of the spinet, establishing models with standardised compass, keyboard size, pitch, and materials. Although variations are found within an individual maker's output, this can often be the result of model adaptation rather than any customer choice. For example, the earliest spinets by Stephen Keene have scalings suitable for iron treble stringing,[11] whereas his later instruments appear brass strung[12]; and the earlier spinets by John Player have only a single case piece between the left faceboard and the spine,[13] whereas his later instruments have two pieces.[14] I am unaware of any examples of a workshop producing more than a single model at any particular time. This lends itself to speculative production, and even the opportunity to produce parts for instruments in small batches.

It is possible, perhaps probable, that the maker's original motives for the production of spinets were inspired by the "novelty value", but the constructional advantages would have soon become apparent. It is obvious, however, that customers perceived the spinet as an instrument preferential to the virginal by the last decades of the seventeenth century. Although, subjectively, the tone of a spinet is inferior to a virginal – usually as a result of the shorter bass string lengths and more restricted soundboard area – the instrument was clearly visually more desirable than the virginal. No spinet survives with decoration modelled on that found on virginals, and only one spinet (the Player in the Victoria and Albert Museum, London) uses oak as the case wood, despite its almost exclusive use in virginals. The spinet takes up less floor area than a virginal, and its curved shape was more in keeping with general furniture trends of the later seventeenth century. The use of veneered interiors, rather than the application of gilt-pressed papers and mouldings, also lent the spinet to decoration with marquetry panels, as found on other larger items of furniture.

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[11] Instruments in the Royal College of Music, London and Hall in th' Wood Museum, Bolton.
[12] His instrument in the Russell Collection, Edinburgh, and at Colonial Williamsburg, VA, USA.
[13] As found in his instruments at the Castle Museum, York, and Sizergh Castle, Cumbria.
[14] As in his instrument in the Victoria and Albert Museum, London, and the unsigned instrument in the Russell Collection, Edinburgh.

THE EARLY SPINETS BY KEENE, PLAYER AND HAWARD

SPINET BY STEPHEN KEENE, c. 1685

Plate 6.1 – Three-quarter (above) and top view (below) of Keene spinet.



Photographs reproduced by permission of The Royal College of Music, London.

Provenance: Royal College of Music, London. (RCM 179) Formerly Sir George Grove.

Signature: "STEPHANVS KEENE LONDINI FECIT" on the front of the jackrail.

Construction:

Baseboard: Deal, c. 12 thick.

Spine: Walnut, 1546 long, 169 high, 5.5 – 7.0 (core) thick, 10.5 thick (including veneer).

Bentside: Walnut, double-curved S-shape, 6.3 – 5.7 (core) thick, c. 8.9 thick (including veneer).

Left end: Walnut, 118 long, 6.2 (core) thick, c. 9.0 thick (including veneer).

Left front: Walnut, 107 long, c. 9.0 thick (including veneer).

Right front: Walnut, 63 long, c. 9.0 thick (including veneer).

Keywell sides: Walnut, 90 long, c. 10 thick.

Keywell length: 760 (outside width).

Nameboard: Deal, veneered in laburnum, c. 10 thick.

Lid: Walnut, c. 7.5 thick.

Lid flap: Walnut, c. 8.5 thick.

Wrestplank: Beech. Soundboard extends over wrestplank. Nut beech.

Soundboard: coniferwood. Bridge of beech. Rose of wood on parchment.

Keyboard:

Compass: GG/BB - d^3, short octave.

Keywell: 737 internal width.

Keyboard: 687 between endblocks, 683 total width, 466½ three octave span.

Keylevers: Deal. GG/BB total length 240½, front to balance point 93. d^3 total length 216, front to balance point 86.

Natural touchplates: Ebony, headlength 30½. Three scribed lines.

Accidental touchplates: "Skunktail" (ivory - ebony - ivory), 48 long.

Keyframe: Deal with oak balance rail.

String lengths (left) and plucking points (right):

d^3	142	40
c^3	152	43
f^2	227	51
c^2	288	47
f^1	460	60
c^1	595	58½
f	840	68
c	977	68
F	1215	106
C	1344	137
GG/BB	1361	123

Jacks: Pear with holly tongues.

Commentary: The signature, written in ink on the front of the jackrail has probably had a date scraped the right end.

This spinet is probably the earliest surviving example by Keene, as can be surmised by the long scale which follows the principles of his virginals, by the rose, and by the double-curved S-shaped bentside. Another early, also undated, spinet of Keene's is in the Hall in th' Wood Museum, Bolton. This instrument has the virginal-inspired scale and the rose, but a separate tail section. John Barnes has suggested a date of c. 1685 for the Royal College of Music spinet.

The instrument is presently strung in brass wire at a pitch of c. 392 Hz. The use of brass follows the practice of Keene's later spinets. However, the treble scalings are very close to those of Keene's virginal of 1668 which has a c^3 scaling-design note string length of 151½ mm. Both are 6", and imply the spinet should be at the same pitch. However, in the virginal the c^3 is a "long" string, whereas in the spinet (as with all of Keene's spinets) it is a "short" string. The likelihood that the instrument is iron-

strung in the treble is increased when the string lengths are graphed against later Keene spinets which have shorter treble, and longer bass, string lengths. This has been done in Chapter Two, page 71. A possible complication in this particular instrument is that the string length of the top note (d^3) is 142 mm, which has a c^3-equivalent length of 159 mm, perhaps implying a lower pitch. It is likely that Keene made this instrument using c^3 as the scaling-design note. It is not known if Keene took the relative "long" and "short" strings into account when using that string length, so it cannot be determined if the intended pitch was V or V - 1s. In a practical sense it is very unlikely that the instrument could play comfortably at V without breaking the d^3 string on a regular basis.

There is a groove on top of the bridge and nut. It has been suggested (by John Barnes) that this was intended to hold a piece of wire over which the strings passed. Similar grooves also appear on several English virginals. No virginal with this groove shows any evidence of having had any wire attached, and this author has seen no evidence for a wire on any spinet bridge either. It is unlikely, therefore, that a wire was ever the intention, and that the groove is merely left as part of the construction process.

The register of this spinet follows, in concept, that found in English virginals, consisting of separate upper and lower registers, but uses a strip of wood, rather than a piece of leather as the guide on top of the soundboard. The soundboard extends over the wrestplank. Later spinets by Keene use a register made as a series of rectangular blocks which have been glued together and then cut to size, in a manner similar to the box-guide registers found in some Italian harpsichords and virginals.

SPINET BY JOHN PLAYER, 1686 (?)

Plate 6.2 – Three-quarter view of Player spinet.



Provenance: Castle Museum, York. Number DA 1729.

Signature: "IOHANNES PLAYER FECIT" on the front of the nameboard. The numbers "1 4 /86" is seen below the lowest nameboard band, just above the keyboard.

Construction:

Baseboard: Deal, c. 14 thick.

Spine: Deal, 1457 long, 159 1/2 high, 9.8 (core), 13 (including veneer) thick.

Tail: Walnut, 239 long, 5.5 (core), 9.3 (including veneer) thick.

Bentside: Walnut, 5.5 (core), 9.3 (including veneer) thick.

Left end: Walnut, 199 long, 5.5 (core), 9.3 (including veneer) thick.

Left front: Walnut, 105 long, 5.5 (core), 9.3 (including veneer) thick.

Right front: Walnut, 105 long, 5.5 (core), 9.3 (including veneer) thick.

Keywell sides: Deal, 105 long, 8.7 thick, 15.8 thick (including veneer).

Keywell length: 768 long (outside width).

Nameboard: 748 - 745 long. Core of deal 5.0 thick. Veneer of Virginian cedar. Total thickness 10.5.

Lid: Walnut, 8.0 thick.

Lid flap: Walnut, 8.5 thick.

Wrestplank: Oak. Soundboard extends over wrestplank. Nut not original.

Soundboard: coniferwood. Bridge of pearwood.

Keyboard:

Compass: GG/BB - c^3, short octave (originally). Now extended to d^3.

Keywell: 733 internal width.

Keyboard: 680 GG/BB - c^3 original width, 476 three octave span.

Keylevers: Poplar. GG/BB total length 286, front to balance point 106. d^3 total length 230, front to balance point 96.

Natural touchplates: Ebony, headlength 31.2. Two scribed lines.

Accidental touchplates: Black stained pear, topped with ivory. 57 total length.

Keyframe: Deal with oak balance rail.

String lengths (left) and plucking points (right):

d^3	95	
c^3	117½	44½
f^2	194½	35
c^2	250½	60
f^1	388	48½
c^1	496½	71½
f	732	63
c	888½	84
F	1142½	75
C	1231	99½
GG/BB	1259	106½

Commentary: The signature is in ink on the front of the nameboard. There is also a further inscription "1 4 /86" at the bottom of the nameboard. This appears to be inked at the same time as the signature, and could be taken to read that this is Player's 14th spinet, and was made in 1686. Player's earliest surviving spinet - a double-strung instrument - is dated 1680. Given that Player was making spinets for at least six years prior to the construction of this instrument (although it is probable he was also making harpsichords, and possibly virginals during this period) it would appear to be a low number of instruments were the serial number to be consecutive from his first spinet. It is possible that it was the 14th spinet he made in 1686. This would imply a yearly production of perhaps 15 to 20 spinets a year (one every 2½ to 3½ weeks).

The string lengths imply brass stringing was used in the treble, at a pitch level which was probably V - 1s. The instrument has long *f* strings. As the nut is a replacement it is not possible to determine what note was used as the scaling-design note, although it was probably c^2. The string length of c^3 has a c^2-equivalent length of 235 mm, more than a semitone below the c^2 string length. Assuming that Player still used a scaling-design note which was a simple fraction of the English inch, it is likely that a c^2 string length of 10" (254 mm) was used. Ignoring, for the moment, that the scaling-design note strings are "short" in this instrument, and "long" on virginals, and using (for the sake of argument) a difference of 350 cents between iron and brass treble scalings, it would suggest that the pitch should be approximately 34 cents below V. Based on the evidence in Table 2.25 (page 77), plus a comparison of the iron and brass treble scales found in the instruments of the Hass family, it is likely that the pitch would be a little lower. A pitch level of V - 1s is entirely reasonable for this instrument. As the *c* strings are "short" it would further suggest that the pitch should be V - 1s.

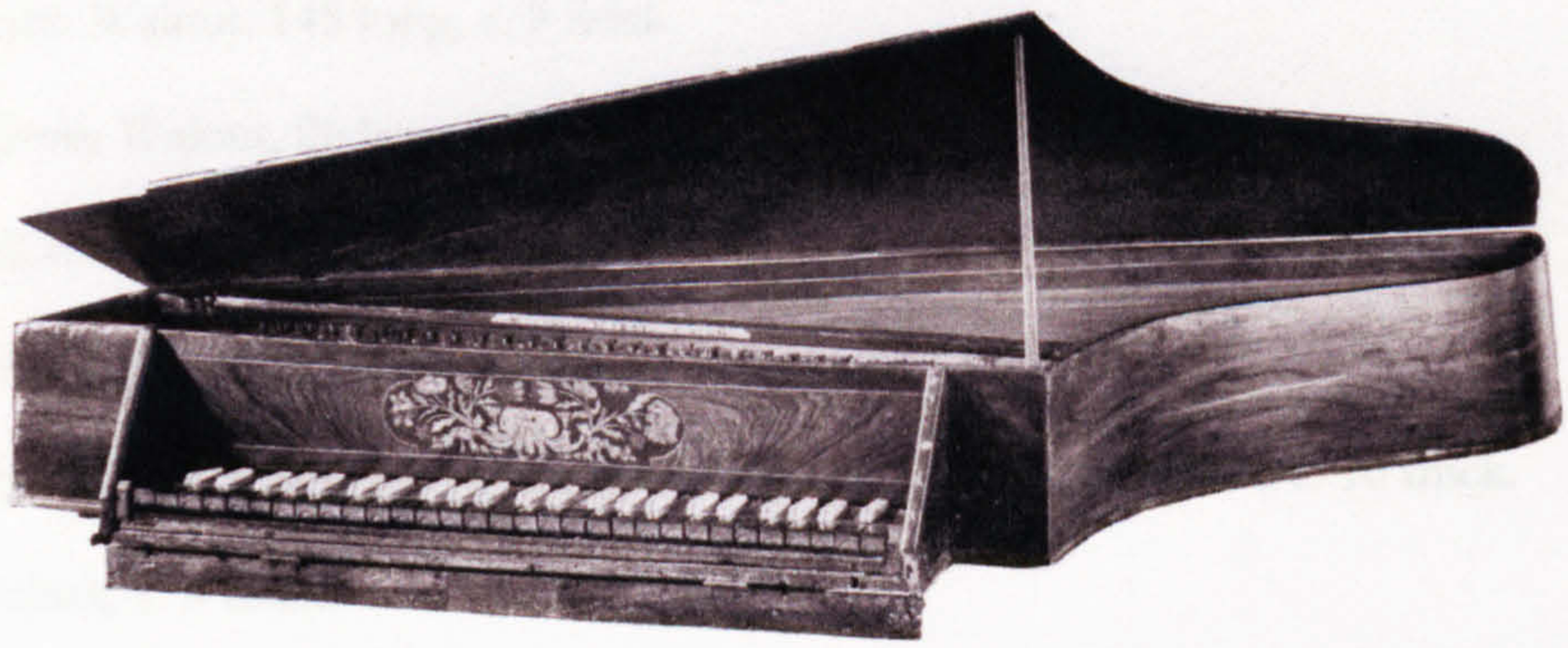
The soundboard extends over the wrestplank. The register is made of blocks glued together, and is the thickness of the combined wrestplank and soundboard (35 mm).

Plate 6.3 – Detail of the Player spinet, showing the soundboard extended over the wrestplank.



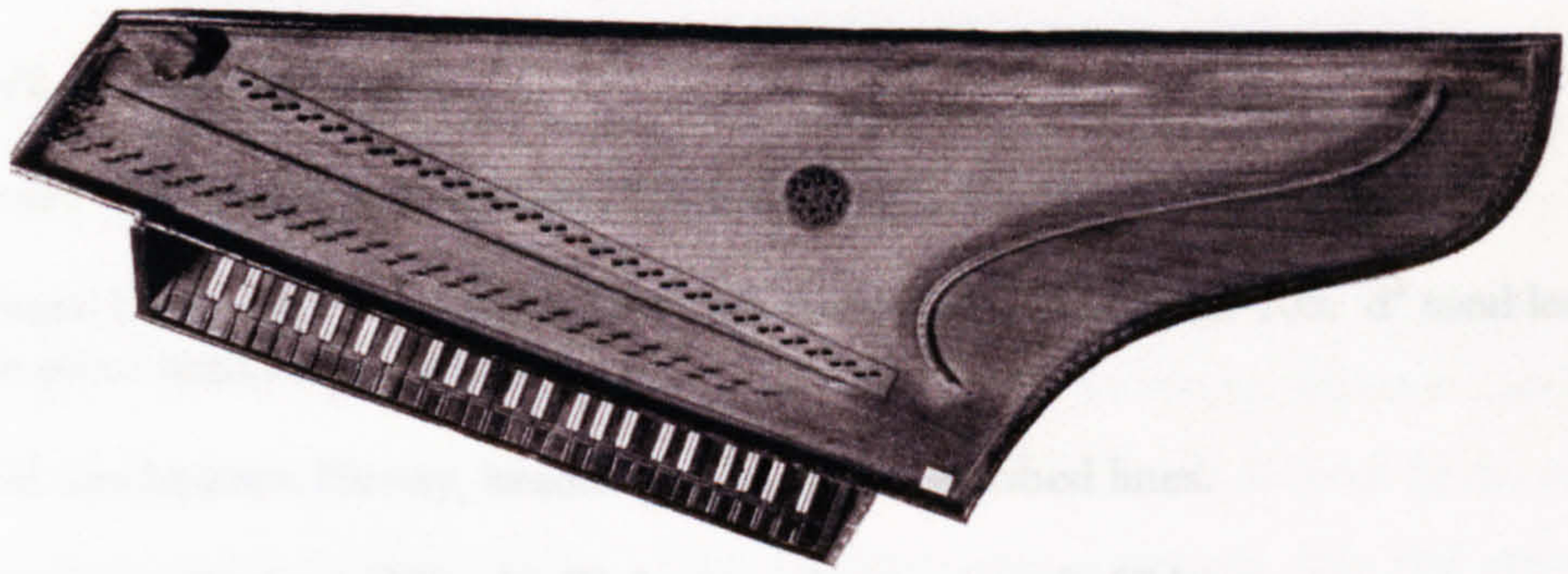
SPINET BY CHARLES HAWARD, 1687

Plate 6.4 – Three-quarter view of the Haward spinet.



By kind permission of the Musical Instrument Museum of the University, Leipzig

Plate 6.5 – Top view of the Haward spinet.



By kind permission of the Musical Instrument Museum of the University, Leipzig

Provenance: Musical Instrument Museum, Leipzig.

Signature: "Carolus Haward Fecit 1687" on the front of the jackrail.

Construction:

Baseboard: Deal, 12 - 13 thick.

Spine: Walnut, 1457 long, 179 high, 12 - 13 thick.

Bentside: Walnut, double-curved S-shape, c. 9 thick.

Left end: Walnut, 210 long, c. 9 thick.

Left front: Walnut, 145 long, c. 9 thick.

Right front: Walnut, 96 long, c. 9 thick.

Keywell sides: Walnut, 106 long, c. 12 thick.

Keywell length: 793 (outside width).

Nameboard: Deal, veneered in walnut with marquetry centre panel, c. 10 thick.

Lid: Walnut, c. 9 thick.

Lid flap: Walnut, c. 9 thick.

Wrestplank: Oak. 45 thick.

Soundboard: Coniferwood. Bridge of maple (?). Rose of wood on parchment.

Keyboard:

Compass: GG/BB - d^3, split E^b key.

Keywell: 770 internal width.

Keyboard: 730 between endblocks, 726 total width, 492 three octave span.

Keylevers: Deal. GG/BB total length 316, front to balance point 105. d^3 total length 281, front to balance point 93.

Natural touchplates: Ebony, headlength 36. Three scribed lines.

Accidental touchplates: "Skunktail" (ivory - ebony - ivory), 57 long.

Keyframe: Deal with oak balance rail.

String lengths (left) and plucking points (right):

d^3	117	44
c^3	135	48
f^2	231	69
c^2	299	73
f^1	460	94
c^1	578	96
f	878	116
c	1050	117
F	1242	134
C	1346	146
GG/BB	1352	138

Jacks: Pear.

Commentary: The signature, written in ink on the front of the jackrail has been cut off at the bottom.

The spinet is in Haward's usual style, with the left case end at an angle of less than 90 degrees to the front of the case, and a centrally placed rose.

There is a noticeable foreshortening in the top octave compared to c^2, and the scalings at f^2 and f^1 proportionally exceed c^2 as a result of the *f* strings being "long". The c^2 string length, 299 mm converts to 11 ¾". This could suggest that, like the 1656 JW virginal (see the Catalogue, page 245), Haward compensated for the fact that c^2 was a short string, and made the scale a quarter-inch shorter, allowing the instrument to play at V. The surviving Haward harpsichord, dated 1683 (Hovingham Hall, Yorkshire), has a replaced wrestplank, but using the surviving keyback cloths and jackrail slots as a guide, it is possible to suggest that a 6" c^3 scale is most likely, and that the instrument also played at V. This supports the argument that the spinet was intended for the same pitch level.

There are separate upper and lower registers, the soundboard register glued on top of the soundboard.

The spinet has wooden arcades, rather than the usual pressed paper designs. These are almost certainly not original.

COMMENTARY ON THE EARLY SPINETS

The spinets described above are representative of the earlier examples by those makers. Keene has left many surviving spinets, most with brass treble stringing, although at least one other instrument has iron stringing. Player and Haward have fewer extant instruments. Player's spinets fall into two groups - the earlier ones are recognisable by the single left end, whereas his later instruments have two pieces between the left front and the spine. All of the spinets made by Player were brass-strung in the treble. The spinets made by Charles Haward date from the 1680s, and are iron-strung in the treble.

One notable feature about the early spinet is the lack of compass standardisation. By 1700 spinets almost always had a GG/BB (broken octave) - d^3 compass, but the earlier instruments, as discussed above, have a variety of compasses. The bass is always GG/BB, but there can be a short-octave, a full broken-octave with two split sharps, or a single split sharp (as seen on the 1687 Haward spinet above). The treble compass extends to either c^3 or d^3. Several spinets by John Player show alterations to the treble compass, being extended from c^3 to d^3. In addition to the

spinet from Castle Museum, York, which is described here; the alterations are also found on instruments by him at Sizergh Castle, Cumbria, and an unsigned instrument (which is almost certainly his work) at the Russell Collection, Edinburgh.

Although walnut is used almost exclusively as a case wood it is possible that exceptions were made as specific requests, or offered as standard. A notable (later) example of this can be seen in the Player spinet at the Victoria and Albert Museum, London, which has an oak case.

In addition to a generally graceful shape, there are several features of the early spinet which made them attractive to late-seventeenth-century customers. The size is generally quite small - all of the examples mentioned above are approximately 4'1" to 5'2", compared to a virginal which is commonly 5'6" or more. The general shape and smaller case height both act to emphasise the smaller dimensions. The casework - both outside and inside - is simple. There is no painted work (although some Haward spinets do have blue soundboard borders, probably a specifically-requested option), and limited mouldings. The pressed paper is restricted to the arcades, and is black rather than gilded. The only occasional use of any elaborate decoration is found in marquetry panels which appear in the centre of some nameboards.

The smaller size does have corresponding implications for the string length and tone. The use of c^2, rather than c^3, as a scaling-design note in the instruments by Player and Haward has been mentioned, and this practice was also followed in the later (brass strung) Keene spinets as well. This is a consequence of trying to ensure a bentside shape which was both attractive to look at, and not too difficult to bend. Were the instruments to be Pythagorean-scaled to the top of the compass the bentside would need to join the right case front further from the keyboard. The bass notes are also generally shorter than those found in virginals as well. The bass string lengths of the Keene spinet are generally around five inches shorter than those of his 1675 virginal. This absolute string length reduction, plus the smaller soundboard area (approximately two-thirds of a virginal) and the shallower case, results in a tone which is noticeably different from that found in virginals. Although the timbre is similar (both produce an unmistakenly "English" sound), the sound can be described (subjectively) as "tubbier" in the bass and "thinner" in the treble.

It is likely that, with the development of the spinet in England, makers ceased to consider the harpsichords and the smaller instruments as equals, and that the spinet became a tonally inferior, but cheaper, alternative to the harpsichord. In this sense the relationship between the harpsichord and spinet parallels the grand and upright piano of today.

It is clear that the decline of the virginal and rise of the spinet was mirrored with harpsichords as well. The importance of the harpsichord in seventeenth-century England has been played down, mostly due to the lack of surviving examples. However, an examination of the references to keyboard instruments mentioned by Samual Pepys (see Appendix Four) shows that the harpsichord was very common in Restoration England, at least in his social circle. These instruments were probably virginal-inspired, being decorated in a similar manner to 1579 Theewes harpsichord. Although these instruments no longer survive, there is no doubt they were relatively common. Probably the very large number of harpsichords built in England by Kirckman, Shudi and their contemporaries has resulted in the destruction of many earlier instruments. It can, nevertheless, be seen that the harpsichords built at a period contemporary with the earlier spinets share many of the same characteristics. The 1683 Charles Haward harpsichord at Hovingham Hall is closely related to the spinets both decoratively and constructionally, and the harpsichord measured by James Talbot, plus his descriptive notes, also show many similarities with the early spinets.[15] Although they fall outside the period covered by this thesis, the harpsichords by Slade (Mirrey Collection), Barton (Mirrey Collection), Smith (Bate Collection) and others also show that the relationship between the spinet and harpsichord was constantly emphasised.

THE USE OF THE VIRGINAL IN THE EIGHTEENTH CENTURY

It should not be thought that the arrival of the spinet saw the immediate abandonment of the virginal, even allowing for a number of years to pass before an owner may purchase a new instrument. There is clear evidence that several virginals were used in the eighteenth century.

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[15] This instrument has been tentatively attributed to John Player. See Martin (1995).

The 1641 GT has a number of replacement jacks taken from the third register of an eighteenth-century English harpsichord. Although it is possible that this work could have been carried out after the eighteenth century, the style of handwriting on the jacks matches the gauge numbers found on the wrestplank capping piece. These numbers follow the gauges in use in the eighteenth century, ranging from 4 in the treble to 13 in the bass, suggesting that the same gauge system was in use. As the jacks came from an eighteenth-century double manual harpsichord it would suggest that a repair date in the last third of the eighteenth century is most likely.

The 1651 TW has the date 1726 over 1651, and then the number 75 to the right of it. This inscription is found on the underside of the cedar piece below the nameplate on the jackrail. There seems no doubt that the inscription records a repair carried out in 1726 and a calculation to find out the age of the instrument.

The 1664 RH has a scratched inscription "TC 1732" on the keywell-back liner. This date refers to repairs carried out, amongst which was the flattening of the lid. The repairer (TC) is unknown - the date being too early to make it the work of Thomas Culliford.

The 1684 TB has a number of replaced natural keys. These keys are from various parts of the compass and suggest the keyboard received some major damage. The replacement keys are competently made, but do not match the work of Bolton. As this virginal was made in 1684, at a time when virginals were being replaced in popularity by spinets, the repairwork must postdate this. The replacement keys have been lettered using a white paint or ink, but this has been done incorrectly. This suggests that the replacement natural touchplates (at least) have been taken from another instrument.

A number of other instruments have have their lids flattened or other significant work, but it is not possible to determine when the work was carried out. It is reasonable to assume that any cabinet work was carried out at the same time as an attempt to get the instrument in playing condition, but it cannot necessarily be shown that this was in the eighteenth century. But the above-mentioned instruments (four out of a total of 22 - 18%) show that the virginal was still well-known and used in eighteenth-century England.

SUMMARY

This thesis has considered all major aspects of the English virginal from its earliest documented mentions in c. 1500, to 1688, when it was largely replaced as the major domestic plucked keyboard instrument by the bentside spinet. It has also looked at how the instrument itself affected the performance of music that was played upon it.

CHAPTER ONE – BACKGROUND PERSPECTIVES

In 1500 England was under the rule of the earliest Tudor - Henry VII - who was effectively able to rule personally with assistance from hand-picked advisors. The period from 1500 - 1688 included the Civil War, the beheading of Charles I, and the subsequent Interregnum. The decision to restore the Monarchy was made by those involved in the Government during the Interregnum, and did not involve the use of force. Likewise the "Glorious Revolution" of 1688 came about following an invitation from Parliament to William of Orange and his wife Mary to become joint rulers, and the subsequent abdication of James VII and II.

Population in England increased from (very) approximately 2 million people in 1500, to 4.11 million in 1600, and about 5 million in 1700. The capital city, London, increased its population from 50000 in 1500, to 190000 in 1600, and 575000 in 1700. As a percentage of total population, in 1600 some 5.8% lived in towns of 10000 or more inhabitants, which increased to 13.3% by 1700.

Society could be (and was by writers at the time) divided into various social groupings, the virginall makers best fitting into a group that can be defined as the "lesser middle orders" - a group of which 39% of the total population belonged. The "Statute of Artificers", passed in 1563, set out the rules for apprentices, stating that their apprenticeship should start at the age of fourteen and last for seven years, during which time the apprentice lived with the master as one of the family. The Statute also stipulated that no one could commence their own business under the age of 24, forcing apprentices to spend several years as journeymen. The working hours were 5am - 8pm

from mid-March to mid-September, and daylight hours for the remainder of the year. Two-and-a-half hours a day were set aside for eating and drinking.

The earliest mentions of plucked domestic keyboard instruments in England are references from 1360 to the "checker". There are illustrations of both clavichords and harpsichords from the first half of the fifteenth century, and both instruments are found in the English Court records from the early part of the sixteenth century. Although England probably produced the majority of instruments used, there were also foreign instruments. Spain and her dominions (including Flanders) probably provided the majority of these foreign instruments, judging from the Inventories of instruments belonging to Henry VIII. References include a number of instruments which were likely to be made of maple - a wood commonly used in Naples (which was under Spanish rule) and Flanders, and decorated with leather and / or arabesques - both found in Spanish and Flemish decorations. There are also specific mentions of (non-keyboard) instruments which originated in Spain. Some 80% of England's trade was with Flanders, and some sixteenth-century makers working in London (including Lodewyk Theewes, who made the earliest surviving dated English-built instrument) were of Flemish origin. The soundboard barring found in the surviving English virginals has its origin in the early (pre-Ruckers) Flemish instruments. Italian-made instruments were also known - Henry VIII's Inventories mention instruments built in cypress, which may be of Italian origin, and a later instrument bearing Elizabeth I's arms can be shown to be Venetian. Although there were makers of German origin in England there are only rare references to German-built instruments.

Instruments made in England during the sixteenth and seventeenth century were usually described as being "single" or "double". This nomenclature has its origins in the writings of Guido d'Arezzo (writing in c. 1026), who devised a system of overlapping hexachords covering a range from G - e^2. If the lowest note on an instrument falls within this range the instruments were considered "single", whereas if the lowest note was in the octave below G they were referred to as "double". This is complicated by the existence of instruments at organ pitch, a fourth above quire (vocal) pitch. Quire pitch can be shown to be c. 474 Hz, and organ pitch is c. 632 Hz. Comparing the absolute pitch of organ registers and vocal pitch, it can be shown that the organ 5' register was considered the unison register and the 10' register was a sub-bass stop. As

the 5' C key on an organ produces quire pitch F, a tone below the gamut G, it is quire pitch standard which was used to devise the octave nomenclature.

CHAPTER TWO – DESIGN CONCEPTS

Virginals can be strung, theoretically, with either brass or iron strings in the treble. Iron strings can be longer for a given pitch, but geometrically there is no practical reason why either material cannot be used. All English virginals have jacks placed in between pairs of strings, so that the strings on the player's side of the jack are longer, and those behind the jack shorter, than their theoretical lengths that would be found if the strings were evenly spaced. Both the plucking point distances, and the angle of the strings to the spine have geometric implications. Although it is possible to design an instrument in which the strings are parallel to the spine, all of the extant English virginals have their strings at an angle. This allows slightly longer string lengths than if they were parallel to the spine, and can allow an action in which the balance pins can be further from the front of the key whilst still allowing the action to be well balanced. The plucking points can be manipulated independently of string length. By noticeably increasing the plucking point in the bass the left bridge becomes longer, and the horizontal span of the right bridge becomes shorter. It also affects the distance between the spine and the bridge pins (assuming the same string lengths and angle of the strings to the spine). The more central the plucking point, the closer the strings are to the spine if the top-most strings were equally spaced from the spine. It can also be shown that it is the angle of the right bridge to the spine, at the point of the individual pin, which is the main feature that determines the distance of the right bridge-pins to the spine assuming a constant string length and angle.

There are several ways of determining the length of the English foot and inch. These included the 1558 Act defining the "Queen Elizabeth Yard" and surviving official Yardsticks of the period. There are also documentary sources, usually in the form of tables that compare the foot length of England with those of other major cities and countries. Finally, it can be possible to determine the foot length from the instruments themselves. Care needs to be taken with interpreting the evidence from each of the methods, in particular the last. Although it can be shown that individual instruments such as the 1664 RH have a large number of measurements which can be defined as

simple fractions of the English inch and give a resulting very accurate figure, using basic measurements of instruments by the same maker show inconsistent results. It also reveals drawbacks with this method, in that it requires an *a priori* assumption about the parts of the instrument that were actually measured by the maker, and an acceptance that the maker worked accurately enough for the method to be applicable. A final approach using surviving instruments is to tabulate the scaling-design note string lengths. Both this method and the figures obtained from an analysis of the 1664 RH reveal figures which are very close (within one-twentieth of a millimetre) of the inch determined from the most reliable physical source - the official Yardstick of 1659 which was housed in the Tower of London. The foot length from this Yardstick is 304.563 mm, and the inch 25.38 mm.

An examination of the c^2, f^2, c^3, and the top note string lengths reveals that only half of the surviving instruments have c^2 string lengths which can be defined as simple fractions of the English inch, implying that another method was used to determine the instrument's scale. It can be seen that 19 of the surviving 22 instruments have the highest string on the player's side of the jack. This can be shown to have significance, as instruments in which c^3, d^3, or e^3 is the highest note the c^3 string length is (with one exception) a simple fraction of the English inch, and in instruments in which f^3 is the top note, it is always a simple fraction of the inch. Therefore c^3 is used as the scaling-design note unless the compass extends to f^3, in which case that note is used. Below the scaling-design note there is no consistent pattern, with instruments variously having Pythagorean scaling, constant foreshortening, or a foreshortening towards c^2 and then having the scale increase again towards c^1. This may be partially explained by the use of right-bridge templates which were originally designed for instruments built at a different pitch.

There are only two instruments which have any evidence of English virginal stringing practice. The 1671 PJ has remains of old strings on the tuning pins, some of which form a regular gauge reduction, and have consistently made loops. The second instrument is the 1641 GT, which has gauge numbers in an eighteenth century hand. These gauges do not follow any recognisable eighteenth-century stringing system and may be indicative of the original stringing. There is an ambiguity with the markings as copper is indicated above brass. It is possible that the scribe inadvertently transposed

the words, implying brass treble stringing, or that copper alloy should be used between the designated notes.

It has been shown by other authors that there were a variety of different pitch levels, each a semitone apart, were used in seventeenth-century England. By graphing the surviving English virginals according to their nominal scaling-design note string lengths for both c^3 and f^3 (having a 4:3 ratio relationship) it can be seen that the instruments fall into four different pitch groupings, each separated by a semitone (plus another instrument seven semitones above the highest pitch level). All of the instruments are strung with the same treble stringing material. These pitch standards have been designated as V, V - 1s, V - 2s, and V - 3s from highest to lowest. Numerically the instruments at the V pitch level are the most numerous. It is possible that two instruments (the AH and the 1656 JW) were designed to a pitch a semitone above V (V + 1s). Using the right-bridge templates it is possible to group the instruments according to different pitch-groupings which reflect the original template designs.

There is no direct method of determining the actual intended pitch for the given scaling-design note string lengths. Therefore other traditions must be examined to see if any absolute levels can be determined. The most reliable evidence comes from claviorgans, revealing that - when all (iron-scaled) string lengths are converted to a specific length (12 English inches - 304.563 mm, chosen because it is twice the length c3 in instruments at pitch V) - there is a range of calculated pitches from c. 440 Hz to c. 500 Hz. This range is just over two semitones. Less reliable evidence can also be found from other sources also falls within the same extremes. Most of the evidence suggests that the usual pitch extremes are c.465 - c. 485 Hz. Therefore the likely pitch level of the English virginals (if strung in iron) at V is c. 474 Hz, approximately 1½ semitones above modern pitch. This evidence can be further supported by comparing the string lengths of English virginals with instruments by the Ruckers family, and to early English spinets and organs. It can be seen that English virginals and organs fall into similar pitch groups and numbers assuming the virginals were strung in iron, and that the virginals play at lower overall pitch levels were they to be strung in brass.

Assuming the strings of the 1671 PJ are original it is possible to determine the string tensions once its pitch level (V – 3s) had been determined. It is also possible to compare the brass/iron changeover point of the 1671 PJ with instruments from other traditions. It can be seen that the changeover point for the 1671 PJ is low, but not outside the limits found in other instruments. The tensions of the 1641 GT can also be calculated. Finally the stringing of the 1671 PJ and 1641 GT virginals can be compared to stringing evidence from other seventeenth- and early-eighteenth century English instruments.

CHAPTER THREE - CONSTRUCTION

It is possible that either the "inside-out" order of construction (in which the baseboard or soundboard is made first, and then the case built around it); or the "outside-in" method (in which construction commences with the case, and then the soundboard and action are fitted inside it) could have been used by various makers. It is impossible to determine the answer by a simple examination of the instruments as the results would appear identical. It is even possible that both methods could have been used in different surviving English virginals, depending on the maker or the workshop tradition. An examination of external and internal case measurements shows there is no consistency to imply that one method was used in preference to the other. It is possible that English virginal makers were not concerned with specific case measurements, or else that a different method of construction was used. Any identifiable method relies on the *a priori* assumption the makers were concerned with obtaining exact measurements, but historical sources such as Douwes and Tannenberg imply otherwise. An attempt to analyse instruments using design methods proposed by other modern authors has failed to identify any alternate method.

This lack of an identifiable design method suggests that there was no attempt to follow a specific design "recipe", and that, instead, the master would have been involved in all of the instrument's design as the construction progressed. Although this is inefficient to an extent, it is probably the inevitable result of having to build instruments at a variety of different pitches and compasses, rather than being able to offer specific "models". It is likely that the workshop used a variety of different templates and

marking-out sticks for many of the layout processes, including the register, right bridge, right bridge-pin positions, basic string lengths, and the keyboard.

The thickness of the various case parts can show noticeable variations. This can be attributed to the working by hand, where (for example) one side of a piece of wood is planed first, and then the wood is turned over and the other side planed. Larger deal pieces such as the baseboard and the spine generally show greater variations than oak case sides, lid and keywell flap. The lengths of the various case parts also show a large variation. A difference of three or four millimetres is not uncommon, and some examples have length differences of up to six millimetres from top to bottom. Such general inaccuracy in measurements suggests that the makers were not concerned with absolute measurement accuracy. This is probably reflected in the generally random results when converting the case dimensions into the English inch. It is likely that makers were concerned with accuracy to the nearest inch over the case length, and half inch over the case width.

The first part of the action layout to be positioned is the register. As the register must be marked out four times (twice for the soundboard, and twice for the lower guide) it is likely that a template was used, something confirmed by the existence of positioning holes at the ends of the registers on several instruments. The angle of the register to the spine - called the "slope" – varies from 1:5 to 3:10. There is no consistency of slope in the surviving instruments by the same maker, with the exception of the White family. This cannot be attributed to either different keyboard widths or the left-to-right difference between the jackslots. The right bridge is sawn to shape using a template, and then positioned on the soundboard to ensure the correct scaling-design note string length and a suitable plucking point. The right bridge pin positions are marked-out using a graduated stick which is held against a virtual spine that is perpendicular to either the spine or the strings. In some instruments no marking-out positions can be seen, but this does not imply that a different method was used, but rather that the actual position of one (or both) of the bridge pin pair was marked directly. English virginal strings are not parallel to each other throughout the compass, generally being less acute towards the treble. There are usually marks on the register leather, positioned centrally between the wide pairs of jackslots. These marks are left

from upright pins, positioned as guides for the strings to ensure they pass centrally between the jackslots.

The scaling-design note acts to determine the position of the left bridge in the treble, but there is no obvious method used to position the remainder of the bridge. Some instruments have Pythagorean scaling from the treble to c^1, whereas other instruments have Pythagorean or nearly Pythagorean) scalings at c^3 and c^1, but a reduced scale in between; and other instruments show a constant (but not necessarily consistent) foreshortening in the treble. It is difficult to determine how instruments with any foreshortening were marked out. The foreshortening is generally either one or two semitones over two octaves. The maker can use simple triangles to determine the scaling reduction without any need for complex calculations. It is likely that the maker used a long stick with the basic string lengths marked on it. In order to use the same right-bridge template for different pitch levels the stick could have an extension on the end.

The woods used on English virginals are standardised, although exceptions do occur. Oak is the usual wood for the case sides, lid, keywell flap, and the wrestplank capping pieces, although walnut and deal are found. Deal is used for the baseboard, spine, frames and faceboards, although other woods can occasionally be found for some parts. Both spruce (*picea abies*) and pine (*pinus strobus*) have been identified microscopically as soundboard woods. Both deal and lime are found as keylever materials, and the natural touchplates are usually boxwood, although both snakewood and ebony are also found. A variety of different materials (including softwoods) are used for the accidentals.

CHAPTER FOUR - DECORATION

English virginals have a standard type of decoration - a dark oak exterior decorated only by iron strapwork hinges, lockplates, turnbuckles and hasps; and an interior that features painted flowers and birds on the soundboard, landscaped paintings on the lid and keywell flap, and mouldings and gilt pressed papers around the soundwell, keywell and faceboards.

This style of decoration became standardised between about 1550 and 1580. The harpsichord by Theewes and the AH and Mar virginals are decorated artists from the same workshop tradition, but this style can be seen to evolve on the different instruments, although with the exception of using landscaped paintings in panels rather than full lid paintings all of the characteristics of the standard seventeenth century decoration are present. Only the Hasard harpsichord at Knole is decorated in a different manner - a simpler style, probably without any soundboard paintings and with Latin mottos painted in orpiment instead of gilt papers.

It is clear that the decoration was not carried out by a member of the instrument-maker's workshop, as different makers use the same decorator in several instances. Although not actually a permanent member of the workshop, it is nevertheless obvious that there was a close relationship between the maker and the decorator. The decorator must have been involved with the instrument at various stages of construction.

English virginal mouldings are always applied to the instruments, and can be made of oak, cedar or conifer wood. They can be cut with either a scratchstock or with a pair of moulding planes, although it is likely that a scratchstock was used in the majority of examples. The mouldings usually form a contrast to the gilt papers, with only the Theewes harpsichord and the 1675 CR having natural mouldings which show little contrast. Some instruments - the 1664 JP, 1671 PJ and 1675 SK have painted or stained green mouldings, and the mouldings on the 1679 CR are painted a maroon colour. The same moulding cutter is often used for several differently placed mouldings - both the Mar and the 1664 RH each use only two different moulding shapes even though each has nine different places where moulding are applied.

The decorative papers are always gilded, and a variety of different designs is found. Even designs which seem superficially identical can be shown to have been cast from different moulds. No actual moulds used for pressing the papers are known to survive, although it can be surmised that they were made of a non-porous material, probably pewter or a similar non-rusting metal alloy. The pressed papers are made by gluing together several layers of paper and then pressing the paper into a mould with a negative design cut into it. The back of the papers is relatively flat, showing that the

papers are not embossed in the true sense of that word. The instruments by Rewallin are an exception to this in having papers made from pulp or *papier maché*. The gold used appears to have generally been sheet gold rather than powders. Although it is not necessary to varnish over gold papers (unlike bronze powders), microscopic analysis of the 1671 PJ shows that the papers were finished with a layer of varnish. Some instruments show evidence of the use of powders rather than sheet gold. The roses are often also gilded, and usually made of wood on top of parchment, although card is also found.

The painted decoration is naive in execution. It appears that it was the same artist who was responsible for both the lid and the soundboard paintings. The pigments were mixed in a water-soluble medium. The soundboard paintings feature flowers and birds, often with border patterns and arabesques. The lid and keywell flap paintings are landscaped scenes, often referred to (without foundation) as "St James' Park". Another common scene found on lid paintings is Orpheus playing to the Beasts, and biblical scenes are also found. The images used for the soundboard and lid scenes were probably copied from prints, and one example - the centre lid panel of the Mar virginal is clearly from the same original source as a print which has been used as the frontspiece of "A Book of Beasts" by Thomas Johnson, dated 1630. There are other painted decorations on the flat moulding bands, inside the inner faceboard moulding, and around the lid and keywell flap paintings on some instruments.

The natural touchplates of some of the instruments by the White family have a stamped decoration. Inlaid accidental decoration is found on several early instruments, usually in the form of a chequered design. The last dated instrument to have this decoration is the 1656 JW. Several late instruments - the 1668 SK, 1671 PJ and 1675 SK have snakewood naturals, and the 1684 TB has ebony naturals. The 1664 RH originally had a dark keyboard, almost certainly either snakewood or ebony. These five instruments have solid ivory accidentals. Rather than the three or four scribed lines found on other instruments, the virginals by Rewallin have a snakewood strip in between the front and rear touchplates.

The exterior of the cases is coloured artificially rather than darkened naturally. This can be most clearly seen on the top of the lid of the 1684 TB where a piece of

moulding is missing. It is not possible to determine what type of finish was used on English virginals - many are now varnished but these could possibly be later finishes. It is possible that the original finish was wax, as found under a previously un-removed hinge of a Kirckman harpsichord.

Original stands are rare. The stand under the 1644 TW appears original. This stand is of varnished lime or cedar with turned legs, and is at a height which is only comfortable for the player when seated on a high stool. The stand under the 1671 PJ is old and may be contemporary. It has been altered in some respects, but is probably still at its original height. The stand under the 1661 JW is from old wood, and may be contemporary with the instrument. The stand under the Hasard harpsichord is of very fine workshop, featuring fluted legs and carved upper panels, and the organ section of the Theewes acts as its stand.

CHAPTER FIVE – PERFORMANCE CONSIDERATIONS

It has been shown earlier in the thesis that English virginals were designed to sound at four different standard pitch levels, plus an instrument sounding at V + 7s. In addition, the Hasard harpsichord may well have also been designed to play at V - 5s / V + 7s, assuming a GG,AA - c^3 compass. This confirms what others, most notably Dominic Gwynn and Bruce Haynes, have found from examining other types of instrument in seventeenth-century England. Of the pitch levels found in virginals, V can be associated with quire pitch - the predominant vocal pitch according to the evidence found in organs from the period. The four pitch groups can be divided into two groups, those at V and V - 2s being predominantly used for church music, and the V - 1s and V - 3s instruments being mostly associated with secular music.

In considering the usage of English virginals it is important to determine the pitch levels of non-keyboard instruments which were in use during the sixteenth and seventeenth century in England. It is wind instruments which generally give the most reliable evidence of pitch frequencies. Although there are no English-made instruments, renaissance flutes were regularly used in consorts, and the surviving instruments fall into two groups a semitone apart at c. 455 Hz and c. 483 Hz (essentially V - 1s and V). At the end of the seventeenth century French-inspired woodwind instruments became common, particularly through their manufacture by Peter Bressan.

His instruments typically play at V - 3s. Brass instruments such as trumpets - although they can be shortened without leaving any obvious evidence - can be shown to play in *D* at V - 2s. Several surviving trumpets have additional tone crooks which allow the instruments to play in *C* at V - 2s. Without the tone crooks they can also be considered as playing in *C* at V. Stringed instruments are less reliable indicators of pitch as it is impossible to determine how close to breaking point the strings were tuned, although it is possible to compile a Table showing the longest string lengths for given pitch levels using several broad assumptions of the pitch to string-length relationship. Although there is little evidence of lute making in England, there is a surviving bandora by John Rose which is at a pitch of V - 2s (assuming the top string is tuned to d^1), and an orpharion by Francis Palmer which plays at V (assuming the top string is tuned to d^1).

These different pitch levels are probably the result of the development of new instruments, combined with the reluctance for makers to build organs at lower pitch levels due to financial reasons. As various different types of instrument began to be used side-by-side it became essential to transpose between instruments. From a Table of pitch levels, and the instruments which play at each pitch level, it is clear that no particular pitch level can be shown to have "priority" over the others. This is reflected in the surviving English virginals, which show that makers were willing to build instruments at a variety of different pitch levels. Of the five makers with more than one surviving instrument, four of them have examples at more than one pitch level. Two instruments, the 1638 TW and Hasard, play at V - 5s / V + 7s. In this they resemble the R-4 instruments built by members of the Ruckers family. This is not to allow the instruments to be used as substitute organs (which play at V - 7s / V + 5s), and the most likely use is for accompanying consorts of large viols.

English keyboard instruments were built with a chromatic bass as standard from the early sixteenth century. This probably originated as a development of the dual (quire and organ) pitch system. It is necessary for the organist to transpose to play at the same pitch as the choir so that when the choir sang a bass F the organist would need to play the C key. By the 1520s solo keyboard music was written which required a compass down to C rather than only descending to F. The top note of the earlier extant virginalls is c^3, although the notes d^3 and e^3 are also found. The earliest instrument to descend to GG/BB is the 1644 TW, which also ascends to f^3 in the bass. This GG/BB

- f^3 compass became standard after the Restoration, used in all instruments except the Rewallin virginals (both GG/BB - d^3), and three virginals from the mid-1660s built with long bass compasses - the 1664 JP (GG - d^3), 1664 RH (FF,GG - c^3) and 1668 SK (FF,GG - d^3). With the exception of the 1683 Haward harpsichord (also with an FF,GG - d^3 compass), and the Hasard, these are the only English made instruments before about 1700 with a long bass. Their musical purpose (with the exception of use for transposition) is unknown.

Neither the C or GG/BB bass compasses was used in England in its "continental" form. The $C^{\#}$ in a C chromatic compass is tuned to AA, as required for many pieces of the period. The GG/BB compass should be seen as an extension of the C bass compass, rather than a change from a chromatic to short-octave compass system. The GG/BB compass, as used in England, is simply the earlier C compass (with the $C^{\#}$ tuned to AA), plus an added BB key which was tuned to GG.

The natural headlengths of English virginals are generally quite short, falling into two groups 32 mm and 35 mm long. Three octave span measurements cover a large range, from 459½ - 498 mm, with a large number being around 483 mm. The rounding at the edge of the keys also contributes to the general "feel" of the keyboard, and is normally quite pronounced, resulting in a keyboard which gives the impression of being small and requiring a precise touch. This is amplified by the balance ratios, which are quite forward, typically between 0.50 and 0.55. The balance ratios are comparable to what is found in virginals of the Italian tradition, and instruments by the Ruckers family, but consistently more forward-balanced than those found in eighteenth-century instruments. Only one instrument - the 1675 CR - retains all of its original action cloths, which result in a typical depth of touch between 5.5 and 6.5 mm.

All of the extant English virginals built up to the Restoration, and some later ones, have an extra string and jack playable by the C key, referred to as the "extra C". It has been argued by others that this extra C was tuned to AA, but this can be shown to be incorrect as the great majority of pieces requiring an AA also require a C. Three instruments have more than one note with double stringing - the 1644 TW (GG/BB - A), 1675 CR (GG/BB and C), and the 1679 CR (GG/BB - D). The use of this double stringing is almost certainly related to the use of the extra C. The reasonable

possibilities for the tuning of these extra strings (unison, octave above, octave below and quint) can all be tested, showing that the extra strings could not be an octave higher. It can also be shown they were not an octave lower, since braided strings would be required, and no marks supporting their use can be seen over the bridges. Quint strings would be possible, although musically unacceptable apart from as drones. Therefore, the only likely possibility is that they were tuned at unison pitch.

CHAPTER SIX – THE DECLINE OF THE ENGLISH VIRGINAL

The earliest mention of the spinet came from the years following the Restoration. Although there are several reported instruments by Thomas Hitchcock which have dates from the 1660s, the location of these instruments is not known, and therefore they cannot be assessed. There is no other evidence to support such an early date for the Thomas Hitchcock who made a harpsichord and spinets in the second quarter of the eighteenth century, nor is there evidence of an earlier Thomas Hitchcock. The information previously published about these instruments suggests that the instruments are most probably not as early as the inscriptions state.

The earliest unambiguous reference to a bentside spinet in England is found in the diary of Samuel Pepys. There are well-known references to his purchase of a spinet by Charles Haward in 1668. An earlier reference in his diary occurs on 1 July, 1664, when he mentions his "triangle" and later in the same entry mentions a Mr Cheswicke (a spinet-master). The clear difference of description between the triangle and the spinet - from a writer who was most specific with his terminology - shows that Pepys was familiar with the bentside spinet by this date. It also shows that the triangle, which is first mentioned in the diary in June 1661, was not a bentside spinet. Given that the term "triangle" is clearly descriptive, the instrument is almost certainly an octave spinet.

The spinet may have been promoted by the makers in the first instance. The spinet purchased by Pepys was clearly built speculatively, and this probably reflects a common practice by which the makers introduced the instrument to the public, having them available for purchase when potential customers visited the workshop. For the makers there were several advantages in offering spinets. It allowed a change of "balance of power" from the customer to the maker. The virginals were built with a large variety of compasses and pitch levels, whereas spinets had less variety, introducing

the concept of specific "models" of spinets. The decoration of the spinet is far simpler and cheaper than that of a virginal. The advantages of speed and cost would be considerable. The construction is also (even including the bentside) generally simpler than what is required for a virginal.

The early spinets by Keene, Player and Haward are all of walnut with ebony natural touchplates and ivory-topped or ivory/ebony/ivory skunktails. The spinets by Keene and Haward are iron strung in the treble, whereas the spinet by Player is brass strung. Later Keene spinets were brass strung. The spinet by Keene in the Royal College of Music has treble string lengths which are close to those of his 1668 virginal, in which the scale of c^3 is longer than at c^2, whereas the spinets by Player and Haward have shorter scales at c^3, suggesting that c^2 was the scaling-design note. In all of the spinets the *c* strings are comparatively "short", being on the player's side of the jack. Whether the maker compensated for this with his string lengths cannot be determined, although it probably was done so in the Haward instrument. The compass of early spinets are always GG/BB (with a short or broken octave) in the bass, to c^3 or d^3 in the treble, some instruments having been extended in the treble from c^3 to d^3. The harpsichords of the era have the characteristics of the spinets.

Four virginals show clear evidence of being used in the eighteenth century. This evidence ranges from replacement eighteenth century jacks found in the 1641 GT, and replacement keylevers found in the 1684 TB, to dates found on both the 1651 TW and 1664 RH instruments. Alterations to other virginals, often in the form of flattening the lids, has been carried out to other instruments, but they cannot be shown to be eighteenth-century work.

INSTRUMENT COMPARISON TABLES

The following instrument comparison Tables give raw data information collected from the instruments, or measurements which have been calculated from those figures. The purpose of these tables is to enable the reader to make quick comparisons of the measurements or materials of the various relevant parts of the instruments. The 1653 TW has not been included in the tables, apart from the string length, plucking point and plucking point ratio sections. The tables are arranged as follows:

1. Case dimension details – top, middle and bottom case measurements in millimetres.
2. Case details – materials, types of joints and measurements in inches.
3. Wood thicknesses – the thicknesses of the case members, lid, keywell flap, keywell liner and frames in millimetres.
4. Materials (1) – the materials used for the case, lid, keywell flap, frames, wrestplank capping and mouldings.
5. Materials (2) – the materials used for toolbox lid, jackrail and supports, bridges, jacks, tongues, pins, keyframe and nameboard.
6. Keyboard details – dimensions and materials of the keyboard and keyframe
7. String lengths – the string lengths of the top note, all the *c* and *f* notes and the bottom note in millimetres.
8. Plucking points – the plucking points of the top note, all the *c* and *f* notes and the bottom note in millimetres.
9. Plucking point ratios – the plucking point ratio has been calculated by dividing the plucking point by the string length and is given to three decimal places.
10. Decorative details – description of the decorator, mouldings, painted decoration, roses, touchplates and spine hinge.

CASE DIMENSION DETAILS

	AH	Mar	1662 TB
Spine Length(top)	1501	1652	1699
Spine Length(middle)	-	-	1699
Spine Length(bottom)	-	-	1699
Front length (top)	1498	1653½	1702
Front Length (middle)	1499	1652	1703
Front Length (bottom)	1499	1652	1701½
Left Case End (top)	486 *	509	531½
Left Case End (middle)	486	507½	531½
Left Case End (bottom)	485	505	531½
Right Case End (top)	485	507	528
Right Case End (middle)	485	506½	529
Right Case End (bottom)	483	505	528
Baseboard (front plank)	?	277	63
Baseboard (middle plank)	n.a.	n.a.	228
Baseboard (rear plank)	?	?	223

	1684 TB	1664 RH	1671 PJ	1668 SK
Spine Length(top)	1775	1673	1744	1821
Spine Length(middle)	-	1673	-	1820
Spine Length(bottom)	-	1674	-	1821
Front length (top)	1773	1678	1745	1824
Front Length (middle)	1772	1677	1745	1822
Front Length (bottom)	1770	1674	1746	1820
Left Case End (top)	555	522	558	547
Left Case End (middle)	554	522	558	548½
Left Case End (bottom)	552	521	558	551½
Right Case End (top)	548	519	560	551
Right Case End (middle)	547	520	560	552
Right Case End (bottom)	548	519	560	552
Baseboard (front plank)	280	n.o.	?	402
Baseboard (middle plank)	n.a.	n.o.	n.a.	n.a.
Baseboard (rear plank)	?	n.o.	263	137

	1675 SK	1666 AL	1670 AL	1655 JL
Spine Length(top)	1773	1689	1705	1733
Spine Length(middle)	-	1690	1704	-
Spine Length(bottom)	-	1692	1704	-
Front length (top)	1774	1686	1698½	1731
Front Length (middle)	1776	1689	1701	1730
Front Length (bottom)	1777	1690	1701	1732
Left Case End (top)	515	517½	547	517
Left Case End (middle)	515	516	543	518
Left Case End (bottom)	515	516	541	521
Right Case End (top)	516	518	547	514
Right Case End (middle)	517	517	545½	517½
Right Case End (bottom)	517	515	544	520
Baseboard (front plank)	?	77	298	277
Baseboard (middle plank)	n.a.	174	n.a.	n.a.
Baseboard (rear plank)	248	255	240½	225

	1664 JP	1675 CR	1679 CR	1641 GT
Spine Length(top)	(1783)	1627	1656	1748
Spine Length(middle)	(1784)	1628	1657	1747
Spine Length(bottom)	(1785)	1626	1656	1749
Front length (top)	(1784)	1627	1660	1752
Front Length (middle)	(1783)	1627	1658	1747
Front Length (bottom)	(1784)	1627	1658	1745
Left Case End (top)	(525)	526	528	542
Left Case End (middle)	(527½)	526½	529	542
Left Case End (bottom)	(529)	528	529	540
Right Case End (top)	(525)	526	528	542
Right Case End (middle)	(527)	526	528	542
Right Case End (bottom)	(527)	526	528	542
Baseboard (front plank)	254	-	211	-
Baseboard (middle plank)	238	-	n.a.	-
Baseboard (rear plank)	(30)	-	304	-

	1656 JW	1661 JW	1638 TW	1642 TW
Spine Length(top)	1672	1697	913	1647
Spine Length(middle)	1672	-	913	-
Spine Length(bottom)	1671	-	914	-
Front length (top)	1669	1693	-	1648
Front Length (middle)	1669	1695	912	1646
Front Length (bottom)	1669	1697	-	1646
Left Case End (top)	517	535	-	520
Left Case End (middle)	517	535	448	521
Left Case End (bottom)	517	533	-	521
Right Case End (top)	517	534	-	520
Right Case End (middle)	517	535	448	522
Right Case End (bottom)	516	533	-	521
Baseboard (front plank)	235	?	291	-
Baseboard (middle plank)	?	?	n.a.	-
Baseboard (rear plank)	229	62	146	-

	1644 TW	1651 TW
Spine Length(top)	1694	1656
Spine Length(middle)	1693	1656
Spine Length(bottom)	1693	1657
Front length (top)	1686	1659
Front Length (middle)	1685	1657
Front Length (bottom)	1687	1654
Left Case End (top)	548½	517
Left Case End (middle)	548½	517
Left Case End (bottom)	548½	517
Right Case End (top)	548	518
Right Case End (middle)	549	519
Right Case End (bottom)	549	519
Baseboard (front plank)	278	268
Baseboard (middle plank)	n.a.	n.a.
Baseboard (rear plank)	263	235

CASE DETAILS

	AH	Mar	1662 TB
Spine Material	n.o.	deal	deal
Spine Length (Inches)	59.14	65.09	66.94
Spine / Case End Joint	n.o.	dovetail	dovetail
Case End Material	oak	oak	oak
Left Case End Length (Inches)	19.11	19.90	20.94
Right Case End Length (Inches)	19.03	19.90	20.80
Case End / Faceboard Joint	dovetail	mortice/tenon	mortice/tenon
Left Faceboard Length (Inches)	10.19	9.69	9.97
Left Faceboard Length (inc Case End)	n.a.	10.02	10.35
Right Faceboard Length (Inches)	21.36	27.15	24.11
Right Faceboard length (inc Case End)	n.a.	27.45	24.46
Faceboard Material	oak	deal	deal
Faceboard / Keywell Sides Joint	dovetail	dovetail	dovetail
Keywell Sides Length	129½(L), 131(R)	128(L), 129(R)	132(L), 138½(R)
Keywell Sides material	oak	deal	deal
Case Front Length (Inches)	59.06	65.09	67.04
Case Height (Inches)	7.49	7.21	8.85
Spine on baseboard ?	no	no	no
Spine inside length (Inches)	58.57	64.45	66.19
Case End inside Length (Inches)	18.81	19.46	20.57(L), 20.33(R)
Case Front inside Length (Inches)	58.47	64.45	66.31

	1684 TB	1664 RH	1671 PJ	1668 SK
Spine Material	deal	deal	deal	deal
Spine Length (Inches)	69.94	65.96	68.72	71.75
Spine / Case End Joint	half lap	dovetail	butt, nails	dovetail
Case End Material	oak	oak	oak	oak
Left Case End Length (Inches)	21.75	20.53	21.99	21.73
Right Case End Length (Inches)	21.59	20.45	22.06	21.75
Case End / Faceboard Joint	mortice/tenon	mortice/tenon	nails	mortice/tenon
Left Faceboard Length (Inches)	8.41	5.99	6.32	8.31
Left F/brd Length (inc End)	8.77	6.37	6.80	8.65
Right Faceboard Length (Inches)	28.29	26.99	29.83	30.24
Right F/brd length (inc End)	28.66	27.36	30.30	30.59
Faceboard Material	deal	deal	lime(L), deal(R)	-
Faceboard / Keywell Sides Joint	butt	dovetail	dovetail	dovetail
Keywell Sides Length	130(L), 131(R)*	117 (L&R)	123(L), 122½(R)	125(L&R)
Keywell Sides material	oak	oak	deal	walnut
Case Front Length (Inches)	69.74	65.96	68.79	71.71
Case Height (Inches)	8.79	8.75	8.75	9.77
Spine on baseboard ?	no	no	no	no
Spine inside length (Inches)	69.18	65.93	67.90	71.04
Case End inside Length (Inches)	21.28(L), 21.14(R)	20.13(L), 20.05(R)	21.51	21.28
Case Ft inside Length (Inches)	69.01	65.20	67.85	71.03

	1675 SK	1666 AL	1670 AL	1655 JL
Spine Material	deal	deal	deal	-
Spine Length (Inches)	69.86	66.67	67.14	68.28
Spine / Case End Joint	dovetail	dovetail	dovetail	dovetail
Case End Material	oak	oak	oak	oak
Left Case End Length (Inches)	20.29	20.33	21.32	20.53
Right Case End Length (Inches)	20.37	20.29	21.43	20.49
Case End / Faceboard Joint	-	butt and dowel	butt and dowel	mortice/tenon
Left Faceboard Length (Inches)	9.02	10.01	10.40	8.27
Left F/brd Length (inc End)	9.43	10.31	10.79	8.59
Right Faceboard Length (Inches)	28.57	23.84	23.40	31.82
Right F/brd length (inc End)	28.98	24.09	23.74	32.14
Faceboard Material	deal	deal	deal	deal
Faceboard / Keywell Sides Joint	dovetail	dovetail	dovetail	butt
Keywell Sides Length	117(L), 119(R)	123(L), 122(R)	129½(L), 128(R)	128½(L&R)
Keywell Sides material	oak	oak	deal	oak
Case Front Length (Inches)	70.02	66.59	67.02	68.24
Case Height (Inches)	8.87	8.79	8.75	8.88
Spine on baseboard ?	no	no	no	no
Spine inside length (Inches)	69.01	66.14	66.33	67.66
Case End inside Length (Inches)	19.90	19.83	20.81(L), 20.91(R)	20.09(L), 20.08(R)
Case Ft inside Length (Inches)	69.19	66.04	66.29	67.60

	1664 JP	1675 CR	1679 CR	1641 GT
Spine Material	n.o.	deal	deal	n.o.
Spine Length (Inches)	(70.33)	64.07	65.25	68.87
Spine / Case End Joint	n.o.	dovetail	dovetail	dovetail
Case End Material	n.o.	oak	deal	walnut
Left Case End Length (Inches)	(20.84)	20.80	20.84	21.28
Right Case End Length (Inches)	(20.76)	20.72	20.80	21.36
Case End / Faceboard Joint	mortice/tenon	nailed	nailed	butt and dowel
Left Faceboard Length (Inches)	9.38	8.83	9.34	9.46
Left F/brd Length (inc End)	(9.87)	9.18	9.75	9.76
Right Faceboard Length (Inches)	28.01	25.06	26.04	28.37
Right F/brd length (inc End)	(28.55)	24.99	26.44	28.70
Faceboard Material	deal	deal	deal	deal
Faceboard / Keywell Sides Joint	butt	butt	butt	?
Keywell Sides Length	136½(L), 136(R)	111(L), 109(R)	117(L), 118(R)	134½(L), 135(R)
Keywell Sides material	walnut	oak	deal	walnut
Case Front Length (Inches)	(70.29)	64.11	65.33	69.03
Case Height (Inches)	(8.59)	8.51	8.63	8.67
Spine on baseboard ?	-	no	no	no
Spine inside length (Inches)	69.31	63.39	64.44	68.32
Case End inside Length (Inches)	20.35(L), 20.28(R)	20.46(L), 20.42(R)	20.46(L), 20.44(R)	20.80(L), 20.88(R)
Case Ft inside Length (Inches)	69.27	63.43	64.52	68.40

	1656 JW	1661 JW	1638 TW	1642 TW
Spine Material	deal	deal	deal	deal
Spine Length (Inches)	65.84	66.86	36.01	64.89
Spine / Case End Joint	dovetail	dovetail	dovetail	dovetail
Case End Material	oak	oak	deal	oak
Left Case End Length (Inches)	20.37	21.00	17.65	20.53
Right Case End Length (Inches)	20.33	21.00	17.65	20.53
Case End / Faceboard Joint	butt and dowel	butt and dowel	?	rebate & dowels
Left Faceboard Length (Inches)	9.89	9.97	n.a.	11.39
Left F/brd Length (inc End)	10.27	10.35	4.65	11.73
Right Faceboard Length (Inches)	26.87	24.43	n.a.	24.92
Right F/brd length (inc End)	27.22	24.80	3.43	25.24
Faceboard Material	deal	deal	deal	deal
Faceboard / Keywell Sides Joint	dovetail	dovetail	dovetail	dovetail
Keywell Sides Length	126½(L&R)	128(L), 126½(R)	125(L), 122(R)	131½(L), 128 (R)
Keywell Sides material	oak	oak	oak	oak
Case Front Length (Inches)	65.76	66.86	35.93	64.85
Case Height (Inches)	8.31	8.75	5.36	8.87
Spine on baseboard ?	yes	no	no	no
Spine inside length (Inches)	65.09	66.03	35.30	64.26
Case End inside Length (Inches)	19.98	20.49	17.00	19.72
Case Ft inside Length (Inches)	65.11	66.12	35.24	64.20

	1644 TW	1651 TW
Spine Material	deal	deal
Spine Length (Inches)	66.71	65.29
Spine / Case End Joint	dovetail	dovetail
Case End Material	oak	oak
Left Case End Length (Inches)	21.61	20.37
Right Case End Length (Inches)	21.63	20.45
Case End / Faceboard Joint	butt and dowel	butt and dowel
Left Faceboard Length (Inches)	10.44	10.48
Left F/brd Length (inc End)	10.80	10.81
Right Faceboard Length (Inches)	24.15	24.39
Right F/brd length (inc End)	24.48	24.69
Faceboard Material	deal	deal
Faceboard / Keywell Sides Joint	dovetail	dovetail
Keywell Sides Length	127(L), 128½(R)	129 (L&R)
Keywell Sides material	oak	oak
Case Front Length (Inches)	66.47	65.17
Case Height (Inches)	8.90	8.75
Spine on baseboard ?	no	no
Spine inside length (Inches)	66.05	64.70
Case End inside Length (Inches)	21.09(L), 21.19(R)	19.92(L), 19.97(R)
Case Ft inside Length (Inches)	65.78	65.17

WOOD THICKNESSES

	AH	Mar	1662 TB
Spine – Left	n.o.	10.7	9.4
Spine – Middle	n.o.	11.5	11.0
Spine – Right	n.o.	11.4	12.0
Baseboard – Left	10.7	-	11.0
Baseboard – Middle	10.2	-	11.4
Baseboard – Right	9.7	-	12.9
Left Case End – Front	7.4	8.4	9.6
Left Case End – Middle	6.9	-	10.0
Left Case End – Back	6.4	-	10.0
Right Case End – Front	7.7	7.8	8.9
Right Case End – Middle	7.9	-	9.0
Right Case End – Back	8.0	-	9.2
Lid – Left	9.0	-	10.8
Lid – Middle	8.2	-	10.5
Lid – Right	8.7	-	10.9
Keywell Flap – Left	8.0	9.3	11.2
Keywell Flap – Middle	8.2	-	10.8
Keywell Flap – Right	8.4	9.7	11.7
Left Faceboard	7.1	9.9	9.8
Right Faceboard	6.6	9.9	13.0
Left Keywell Side	7.5	10.2	10.9
Right Keywell Side	7.9	10.5	10.9
Keywell Liner	-	-	13.0(L), 13.4(R)
Keywell Frames	-	-	21.8(L), 23.5(R)

	1684 TB	1664 RH	1671 PJ	1668 SK
Spine – Left	11.9	10.1	12.9	11.2
Spine – Middle	11.4	9.9	14.6	11.6
Spine – Right	11.4	10.2	13.6	13.0
Baseboard – Left	11.3	n.o.	12.5	12.8
Baseboard – Middle	-	n.o.	11.5	16.9
Baseboard – Right	11.4	n.o.	11.7	13.6
Left Case End – Front	9.1	9.7	12.0	8.5
Left Case End – Middle	9.4	9.0	11.1	8.4
Left Case End – Back	9.6	7.9	10.2	9.0
Right Case End – Front	9.5	9.4	11.9	8.8
Right Case End – Middle	9.3	9.8	11.7	8.2
Right Case End – Back	9.6	10.5	10.6	8.1
Lid – Left	6.2	8.6	11.0	8.4
Lid – Middle	8.4	8.6	9.8	9.1
Lid – Right	9.3	8.3	11.0	8.1
Keywell Flap – Left	10.5	10.0	11.1	6.9
Keywell Flap – Middle	12.1	8.7	10.6	8.8
Keywell Flap – Right	10.7	9.4	10.6	8.3
Left Faceboard	9.3	9.0	13.9	11.2
Right Faceboard	9.4	10.8	14.3	11.0
Left Keywell Side	8.7	8.0	11.7	10.2
Right Keywell Side	8.9	8.4	10.9	11.0
Keywell Liner	12.0(L), 9.1(R)	18.8(L), 18.9(R)	14.3(L), 12.8(R)	12.3(L), 13.6(R)
Keywell Frames	22.0(L), 23.5(R)	24.3(L), 24.0(R)	23.8(L), 26.0(R)	18.0(L), 17.1(R)

	1675 SK	1666 AL	1670 AL	1655 JL
Spine – Left	10.5	12.4	12.9	11.0
Spine – Middle	10.0	-	13.2	10.5
Spine – Right	11.1	11.9	13.4	10.4
Baseboard – Left	12.3	12.0	10.8	13.0
Baseboard – Middle	11.9	11.9	12.8	13.6
Baseboard – Right	12.6	12.5	11.8	13.8
Left Case End – Front	10.4	7.7	9.9	8.1
Left Case End – Middle	9.8	6.6	10.1	7.7
Left Case End – Back	9.7	6.2	10.5	7.6
Right Case End – Front	10.6	6.3	8.6	8.1
Right Case End – Middle	10.5	7.8	10.1	8.2
Right Case End – Back	10.0	7.2	10.0	8.3
Lid – Left	8.2	7.0	8.3	6.6
Lid – Middle	8.6	8.1	8.3	6.5
Lid – Right	9.0	9.7	8.8	6.4
Keywell Flap – Left	11.4	7.9	8.6	7.2
Keywell Flap – Middle	11.0	8.3	9.4	6.8
Keywell Flap – Right	10.9	9.3	9.8	7.0
Left Faceboard	8.4	9.1	11.0	12.0
Right Faceboard	9.8	9.1	11.6	12.1
Left Keywell Side	7.7	10.3	11.1	8.8
Right Keywell Side	7.8	10.2	10.4	8.7
Keywell Liner	11.3(L), 11.0(R)	15.0(L), 15.5(R)	16.2(L), 15.5(R)	12.6(L), 12.5(R)
Keywell Frames	30.4(L), 31.3(R)	16.8(L), 16.7(R)	21.1(L), 22.4(R)	15.9(L), 16.5(R)

	1664 JP	1675 CR	1679 CR	1641 GT
Spine – Left	n.o.	8.8	9.8	n.o.
Spine – Middle	n.o.	9.8	10.6	n.o.
Spine – Right	n.o.	7.8	9.2	n.o.
Baseboard – Left	10.7	13.7	13.8	11.5
Baseboard – Middle	10.8	13.8	14.8	-
Baseboard – Right	9.7	11.0	13.6	-
Left Case End – Front	n.o.	8.9	10.4	7.8
Left Case End – Middle	n.o.	-	11.2	7.5
Left Case End – Back	n.o.	9.9	10.6	7.0
Right Case End – Front	n.o.	8.2	10.0	8.3
Right Case End – Middle	n.o.	-	9.9	8.6
Right Case End – Back	n.o.	7.3	9.9	7.0
Lid – Left	n.o.	6.8	6.0	8.5
Lid – Middle	n.o.	6.5	7.2	9.5
Lid – Right	n.o.	6.5	7.5	8.0
Keywell Flap – Left	n.o.	9.6	12.0	9.5
Keywell Flap – Middle	n.o.	9.4	11.0	9.0
Keywell Flap – Right	n.o.	9.2	10.1	9.5
Left Faceboard	10.6	4.8	4.4	10.0
Right Faceboard	11.0	4.3	4.2	10.0
Left Keywell Side	8.8	8.3	11.4	8.7
Right Keywell Side	8.9	8.3	11.9	9.0
Keywell Liner	n.o.	18.8(L), 18.9(R)	16.8(L), 17.0(R)	12.8(L), 10.5(R)
Keywell Frames	18.7(L), 19.8(R)	19.6(L), 20.0(R)	17.1(L), 16.6(R)	26.3(L), 29.0(R)

	1656 JW	1661 JW	1638 TW	1642 TW
Spine – Left	10.6	12.6	8.0	10.6
Spine – Middle	-	12.8	8.0	-
Spine – Right	9.0	13.1	8.1	10.0
Baseboard – Left	9.0	14.9	9.6	8.7
Baseboard – Middle	9.1	-	9.6	-
Baseboard – Right	10.6	11.8	9.8	9.9
Left Case End – Front	9.7	9.6	9.4	8.7
Left Case End – Middle	10.0	10.2	9.7	8.1
Left Case End – Back	9.5	11.2	9.4	7.1
Right Case End – Front	8.9	9.4	8.3	8.0
Right Case End – Middle	9.4	10.0	8.8	8.0
Right Case End – Back	9.4	10.0	8.8	9.1
Lid – Left	8.1	9.4	n.a.	-
Lid – Middle	8.1	9.0	n.a.	-
Lid – Right	8.5	10.1	n.a.	-
Keywell Flap – Left	9.9	10.3	n.a.	10.1
Keywell Flap – Middle	8.8	10.8	n.a.	8.4
Keywell Flap – Right	9.5	9.7	n.a.	9.3
Left Faceboard	8.8	10.5	8.6	-
Right Faceboard	9.3	9.9	8.4	-
Left Keywell Side	8.0	9.9	8.5	8.5
Right Keywell Side	9.8	8.9	8.2	9.0
Keywell Liner	11.3(L), 12.1(R)	12.6 (L&R)	-	13.5(L), 14.1(R)
Keywell Frames	16.8(L), 21.8(R)	21.1(L), 20.4(R)	-	-

	1644 TW	1651 TW
Spine – Left	13.2	11.5
Spine – Middle	13.0	12.5
Spine – Right	11.2	12.1
Baseboard – Left	12.9	11.9
Baseboard – Middle	12.3	11.9
Baseboard – Right	12.4	11.9
Left Case End – Front	9.1	8.3
Left Case End – Middle	8.0	7.2
Left Case End – Back	8.1	7.2
Right Case End – Front	8.3	7.6
Right Case End – Middle	7.6	7.1
Right Case End – Back	8.6	7.7
Lid – Left	7.8	8.7
Lid – Middle	8.3	9.1
Lid – Right	8.4	8.1
Keywell Flap – Left	9.3	8.8
Keywell Flap – Middle	9.9	8.6
Keywell Flap – Right	9.2	8.8
Left Faceboard	8.0	7.4
Right Faceboard	8.1	7.9
Left Keywell Side	7.0	8.2
Right Keywell Side	8.5	7.6
Keywell Liner	10.9(L), 13.1(R)	12.7 (L), 11.5(R)
Keywell Frames	19.9(L), 19.7(R)	19.4(L), 20.0(R)

MATERIALS (1)

	AH	Mar	1662 TB
Spine	n.o.	deal	deal
Left Case End	oak	oak	oak
Right Case End	oak	oak	oak
Left Faceboard	oak	deal	deal
Right Faceboard	oak	deal	deal
Keywell Sides	oak	deal	deal
Lid	oak	oak	oak
Keywell flap	oak	oak	oak
Frames	deal	deal	deal
Wrestplank Capping	n.o.	oak	oak
Hitchpin rail mouldings	oak	oak	oak
Soundboard mouldings	conifer	oak	oak
Soundwell mouldings	conifer	oak	cedar
Faceboard Cap mouldings	conifer	oak	cedar
Faceboard / Keywell Face mouldings	conifer	oak	cedar

	1684 TB	1664 RH	1671 PJ	1668 SK
Spine	deal	deal	deal	deal
Left Case End	oak	oak	oak	oak
Right Case End	oak	oak	oak	oak
Left Faceboard	deal	deal	lime	deal
Right Faceboard	deal	deal	deal	deal
Keywell Sides	oak	oak	deal	walnut
Lid	oak	oak	oak	oak
Keywell flap	oak	oak	oak	oak
Frames	deal	walnut (?)	deal	deal
Wrestplank Capping	oak	oak	oak	oak
Hitchpin rail mouldings	oak	cedar	conifer	cedar
Soundboard mouldings	cedar	cedar	conifer	cedar
Soundwell mouldings	cedar	cedar	conifer	cedar
Faceboard Cap mouldings	cedar	cedar	conifer	cedar
F/brd / Keywell Face mouldings	cedar	cedar	conifer	cedar

	1675 SK	1666 AL	1670 AL	1655 JL
Spine	deal	deal	deal	-
Left Case End	oak	oak	oak	oak
Right Case End	oak	oak	oak	oak
Left Faceboard	deal	deal	deal	deal
Right Faceboard	deal	deal	deal	deal
Keywell Sides	oak	oak	deal	oak
Lid	oak	oak	oak	oak
Keywell flap	oak	oak	oak	oak
Frames	deal	lime	deal	deal
Wrestplank Capping	oak	oak	oak	oak
Hitchpin rail mouldings	cedar	oak	oak	oak
Soundboard mouldings	cedar	cedar	cedar	oak
Soundwell mouldings	cedar	cedar	cedar	oak
Faceboard Cap mouldings	cedar	cedar	cedar	oak
F/brd / Keywell Face mouldings	cedar	cedar	cedar	oak

	1664 JP	1675 CR	1679 CR	1641 GT
Spine	n.o.	deal	deal	n.o.
Left Case End	n.o.	oak	deal	walnut
Right Case End	n.o.	oak	deal	walnut
Left Faceboard	n.o.	deal	deal	deal
Right Faceboard	n.o.	deal	deal	deal
Keywell Sides	walnut	oak	deal	walnut
Lid	n.o.	oak	deal	walnut
Keywell flap	n.o.	oak	deal	walnut
Frames	deal	deal	deal	deal
Wrestplank Capping	oak	oak	oak	walnut
Hitchpin rail mouldings	oak	oak	oak	walnut
Soundboard mouldings	oak	oak	oak	cedar
Soundwell mouldings	conifer	conifer	conifer	cedar
Faceboard Cap mouldings	conifer	conifer	conifer	cedar
F/brd / Keywell Face mouldings	conifer	conifer	conifer	cedar

	1656 JW	1661 JW	1638 TW	1642 TW
Spine	deal	deal	deal	deal
Left Case End	oak	oak	deal	oak
Right Case End	oak	oak	deal	oak
Left Faceboard	deal	deal	deal	deal
Right Faceboard	deal	deal	deal	deal
Keywell Sides	oak	oak	oak	oak
Lid	oak	oak	n.a.	oak
Keywell flap	oak	oak	n.a.	oak
Frames	deal	deal	deal	deal
Wrestplank Capping	oak	oak	oak	oak
Hitchpin rail mouldings	cedar	oak	oak	oak
Soundboard mouldings	cedar	cedar	cedar	cedar
Soundwell mouldings	cedar	cedar	cedar	cedar
Faceboard Cap mouldings	cedar	cedar	cedar	cedar
F/brd / Keywell Face mouldings	cedar	cedar	cedar	cedar

	1644 TW	1651 TW
Spine	deal	deal
Left Case End	oak	oak
Right Case End	oak	oak
Left Faceboard	deal	deal
Right Faceboard	deal	deal
Keywell Sides	oak	oak
Lid	oak	oak
Keywell flap	oak	oak
Frames	deal	lime
Wrestplank Capping	oak	oak
Hitchpin rail mouldings	oak	oak
Soundboard mouldings	cedar	cedar
Soundwell mouldings	cedar	cedar
Faceboard Cap mouldings	cedar	cedar
F/brd / Keywell Face mouldings	cedar	cedar

MATERIALS (2)

	AH	Mar	1662 TB
Toolbox lid	pine and pear	-	cedar?
Jackrail	-	-	deal
Bass Jackrail support	deal	deal	deal
Treble Jackrail support	-	oak	deal
Left bridge	n.o.	beech	fruitwood
Right bridge	n.o.	beech	fruitwood
Jacks	elm?	beech	-
Tongues	boxwood?	beech	-
Bridge Pins	n.o.	iron	brass
Hitchpins	iron	iron	iron
Tuning pins	n.o.	iron	iron
Balance rail	oak	oak	oak
Keyframe	deal	deal	deal
Rack	-	conifer	n.o.
Nameboard	deal	deal	deal

	1684 TB	1664 RH	1671 PJ	1668 SK
Toolbox lid	-	lime	deal	deal
Jackrail	deal	deal	deal	deal
Bass Jackrail support	deal	deal	deal	deal
Treble Jackrail support	deal	?	?	deal
Left bridge	oak	fruitwood	beech	fruitwood
Right bridge	oak	fruitwood	fruitwood	fruitwood
Jacks	beech	-	beech	n.o.
Tongues	beech	-	beech	n.o.
Bridge Pins	brass	brass	brass	brass
Hitchpins	?	iron	iron	brass
Tuning pins	iron	iron	iron	iron
Balance rail	beech	n.o.	beech	oak
Keyframe	deal	deal	deal	deal
Rack	poplar	beech	maple?	poplar
Nameboard	deal	deal	deal	deal

	1675 SK	1666 AL	1670 AL	1655 JL
Toolbox lid	oak	oak	oak	oak
Jackrail	deal	deal	deal	deal
Bass Jackrail support	deal	deal	deal	deal
Treble Jackrail support	deal	deal	deal	deal
Left bridge	fruitwood	walnut	pear	fruitwood
Right bridge	fruitwood	walnut	pear	fruitwood
Jacks	beech	n.o.	pear	pear
Tongues	beech	n.o.	holly	holly?
Bridge Pins	brass	iron	brass	brass
Hitchpins	brass	iron	brass	?
Tuning pins	iron	iron	iron	iron
Balance rail	beech	oak	oak	oak
Keyframe	deal	deal	deal	oak
Rack	pear?	n.o.	n.o.	ash?
Nameboard	deal	deal	deal	deal

	1664 JP	1675 CR	1679 CR	1641 GT
Toolbox lid	-	-	pear	-
Jackrail	deal	deal	deal	deal
Bass Jackrail support	deal	deal	deal	deal
Treble Jackrail support	deal	deal	deal	?
Left bridge	fruitwood	fruitwood	fruitwood	fruitwood
Right bridge	n.o.	fruitwood	fruitwood	fruitwood
Jacks	n.o.	lacewood	-	pear
Tongues	n.o.	holly	-	holly
Bridge Pins	brass	brass	brass	?
Hitchpins	iron	brass	iron	iron
Tuning pins	n.o.	iron	iron	iron
Balance rail	n.o.	oak	poplar?	oak
Keyframe	deal	mahogany/deal	oak/deal	deal
Rack	lime	mahogany	mahogany	pear
Nameboard	deal	deal	deal	deal

	1656 JW	1661 JW	1638 TW	1642 TW
Toolbox lid	oak	-	cedar	deal
Jackrail	deal	deal	deal	deal
Bass Jackrail support	deal	deal	?	deal
Treble Jackrail support	deal	?	?	deal
Left bridge	fruitwood	beech	fruitwood	fruitwood
Right bridge	fruitwood	pear	fruitwood	fruitwood
Jacks	pear	pear	n.o.	pear
Tongues	holly	holly	n.o.	?
Bridge Pins	?	brass	brass	iron
Hitchpins	iron	iron	brass	brass
Tuning pins	iron	iron	iron	iron
Balance rail	oak	oak	oak	oak
Keyframe	deal	deal	lime	deal
Rack	poplar	deal	lime	lime
Nameboard	deal	deal	deal	deal

	1644 TW	1651 TW
Toolbox lid	cedar	lime
Jackrail	deal	deal
Bass Jackrail support	deal	deal
Treble Jackrail support	deal	deal
Left bridge	fruitwood	fruitwood
Right bridge	fruitwood	fruitwood
Jacks	beech	pear
Tongues	beech	boxwood (?)
Bridge Pins	brass	iron
Hitchpins	iron	iron
Tuning pins	iron	iron
Balance rail	oak	oak on deal
Keyframe	deal	deal
Rack	lime	lime
Nameboard	deal	deal

KEYBOARD DETAILS

	AH	Mar	1662 TB
Compass	C-c³	C – c³	GG/BB – f³
Keylever material	deal	deal	deal
Natural touchplates	boxwood	boxwood	boxwood
Accidental touchplates	inlaid pear	inlaid walnut	stained deal
Keywell Width	701	702	819½
Width Between Endblocks	659	662	767
Keyplank Front Width	656	658	765
Three-octave span	476	478	488½
Touchplate overhang	3.0	2.5	3.6
Natural Headlength	35.1	35.8	35.6
Bass Keylength	336	318/321½	335
Bass Balance Point	118	117½	124
Treble Keylength	440	458/460½	478
Treble Balance Point	159	168	170
Balance Point Separation	18.4	12.3	6.5
Accidental Lengths	63	71½	58½ - 63
Arcade type	trefoil	n.o.	sunflower
Balance rail material	oak	oak	oak
Back rail material	deal	deal	deal
side rail material	deal	deal	deal
rack material	missing	conifer	n.o.
Keylever thickness	13.0 – 9.8	15.0 – 11.6	15.4 – 9.4
Touchplate thickness	3.1 – 2.2	2.9 – 1.4	2.6 – 1.8
Scribed lines	3	4	4

	1684 TB	1664 RH	1671 PJ	1668 SK
Compass	GG/BB – f³	GG/BB – f³	GG/BB – f³	FF,GG – d³
Keylever material	deal	n.o.	deal	deal
Natural touchplates	ebony	n.o.	snakewood	snakewood
Accidental touchplates	ivory	bone	ivory	ivory
Keywell Width	822	819	802	825
Width Between Endblocks	776	749	763	789
Keyplank Front Width	775	745	762	787½
Three-octave span	491	474	484	486
Touchplate overhang	2.0	(1.4)	3.0	2.9
Natural Headlength	31.8	(28.5)	31.4	32.3
Bass Keylength	334	(273)	409	263
Bass Balance Point	121	(106)	117	107½
Treble Keylength	496	(469)	499	502
Treble Balance Point	192	(185)	192	192
Balance Point Separation	10.0	(18.8)	0	10.0
Accidental Lengths	64	55	55	57
Arcade type	trefoil	n.o.	trefoil	sunflower
Balance rail material	beech	n.o.	beech	oak
Back rail material	deal	deal	deal	deal
side rail material	deal	deal	deal	deal
rack material	poplar	beech	maple	popler
Keylever thickness	11.9 – 9.7	(12.4 - 12.6)	14.1 – 10.3	15.1 – 12.3
Touchplate thickness	2.0 – 0.5	(2.4 – 3.0)	2.4 – 1.3	2.6 – 1.4
Scribed lines	3	-	2	4

	1675 SK	1666 AL	1670 AL	1655 JL
Compass	GG/BB – f^3	GG/BB – f^3	GG/BB – f^3	C – d^3
Keylever material	deal	lime	deal	deal
Natural touchplates	snakewood	boxwood	boxwood	boxwood
Accidental touchplates	ivory	blk. painted oak	bog oak	oak
Keywell Width	803	818	821	697
Width Between Endblocks	758	782	787	678
Keyplank Front Width	755	779	782	675
Three-octave span	481	498	496	474
Touchplate overhang	3.7	3.5	2.1	1.6
Natural Headlength	34.7	33.2	33.0	31.7
Bass Keylength	310	316	317	337
Bass Balance Point	117	109	114	113
Treble Keylength	471	468½	487	463
Treble Balance Point	181	160	169	158
Balance Point Separation	14.8	8.0	8.6	14.9
Accidental Lengths	62	67	66½	67
.Arcade type	sunflower	unique	trefoil	floral
Balance rail material	beech	oak	oak	oak
Back rail material	deal	deal	deal	oak
side rail material	deal	deal	deal	oak
rack material	pear?	n.o.	n.o.	ash (?)
Keylever thickness	14.3 – 12.0	15.1 – 8.2	12.7 – 8.7	13.8 – 9.9
Touchplate thickness	2.7 – 1.0	3.4 – 1.1	2.7 – 2.3	3.0 – 1.1
Scribed lines	3	4	4	4

	1664 JP	1675 CR	1679 CR	1641 GT
Compass	GG – d^3	GG/BB – d^3	GG/BB – d^3	C – e^3
Keylever material	deal	deal	deal	lime
Natural touchplates	boxwood	boxwood	boxwood	boxwood
Accidental touchplates	blk. st. walnut	snakewood	blk. paint. oak	snakewood
Keywell Width	808	748	739	770
Width Between Endblocks	769	701	695	712
Keyplank Front Width	764	699	693	708
Three-octave span	484½	473½	471	478
Touchplate overhang	2.4	2.7	3.0	2.9
Natural Headlength	33.0	34.8	34.0	34.3
Bass Keylength	303	303	299	348
Bass Balance Point	124	102	104	119½
Treble Keylength	478	489	493	486½
Treble Balance Point	176	180	179	174½
Balance Point Separation	13.5	10.5	8.2	20 – 23
Accidental Lengths	63	57½	63 – 61	70
Arcade type	sunflower	floral	floral	trefoil
Balance rail material	n.o.	oak	poplar (?)	oak
Back rail material	deal	ash (?)	deal	deal
side rail material	deal	deal	oak	deal
rack material	lime	mahogany (?)	mahogany (?)	pear
Keylever thickness	14.7 – 11.1	14.7 – 8.6	14.7 – 9.6	12.5 – 9.5
Touchplate thickness	2.5 – 1.5	2.9 – 1.3	3.0 – 1.8	3.8 – 2.7
Scribed lines	4	snakewood *	snakewood *	4

	1656 JW	1661 JW	1638 TW	1642 TW
Compass	GG/BB – c^3	GG/BB – f^3	C – c^3	C – c^3
Keylever material	poplar	deal	lime	lime
Natural touchplates	boxwood	boxwood	boxwood	boxwood
Accidental touchplates	inlaid lime	stained pear	inlaid fruitwood	blk. st. walnut
Keywell Width	718	803	709	706½
Width Between Endblocks	691	767	668	674
Keyplank Front Width	690	764	663½	669
Three-octave span	482½	486	481	483
Touchplate overhang	2.2	3.4	2.0	2.4
Natural Headlength	36.0	35.3	34.1	31.5
Bass Keylength	304	336	262	298
Bass Balance Point	107	117	96	111
Treble Keylength	465	484½	418	470
Treble Balance Point	160	166	137	160½
Balance Point Separation	12.0	17.8	15.0	10.5
Accidental Lengths	65½	64	55½	66
Arcade type	Moresque	trefoil	trefoil	trefoil
Balance rail material	oak	oak	oak	oak
Back rail material	deal	deal	lime	deal
side rail material	deal	deal	lime	deal
rack material	poplar	deal	lime	lime
Keylever thickness	14.0 – 9.1	12.0 – 8.1	14.6 – 8.9	12.5 – 7.5
Touchplate thickness	3.0 – 1.6	2.8 – 1.5	2.9 – 1.5	2.8 – 2.2
Scribed lines	4	4	4	4

	1644 TW	1651 TW
Compass	GG/BB – f^3	GG/BB – d^3
Keylever material	lime	lime
Natural touchplates	boxwood	boxwood
Accidental touchplates	blk. st. walnut	stained pear
Keywell Width	791½	755½
Width Between Endblocks	759	714
Keyplank Front Width	755	711
Three-octave span	483½	482
Touchplate overhang	2.4	3.1
Natural Headlength	35.0	34.5
Bass Keylength	281 *	297
Bass Balance Point	111	110½
Treble Keylength	495	463
Treble Balance Point	173	164
Balance Point Separation	15.4	16.0
Accidental Lengths	67	65
Arcade type	trefoil	trefoil
Balance rail material	oak	oak on deal
Back rail material	deal	deal
side rail material	deal	deal
rack material	lime	lime
Keylever thickness	14.5 – 8.1	14.7 – 9.7
Touchplate thickness	2.9 – 1.3	2.9 – 1.7
Scribed lines	4	4

STRING LENGTHS

	AH	Mar	1662 TB
f^3			125
e^3			
d^3			
c^3		176½	161½
f^2		238	244½
c^2		324½	319
f^1		466½	496½
c^1		633½	628
f		836½	875
c		1028	1034½
F		1253	1301
C		1434	1475
Extra C		1448	
GG/BB			1531½
GG			
FF			
"long string"		*c*	*f*
design scale note		c^3	f^3

	1684 TB	1664 RH	1671 PJ	1668 SK
f^3	112		133	
e^3				
d^3				131½
c^3	143	153	158½	151½
f^2	226½	208	253½	215½
c^2	290½	266	328½	287
f^1	430½	378	496	395½
c^1	541½	518	620½	535½
f	813	703	885	732
c	987½	890	1049½	912½
F	1315½	1112	1349½	1142
C	1506	1311	1543½	1361
Extra C				
GG/BB	1592		1612	
GG				
FF		1525		1624
"long string"	*f*	*c*	*f*	*c*
design scale note	f^3	c^3	f^3	c^3

	1675 SK	1666 AL	1670 AL	1655 JL
f^3	120½	115½	112½	
e^3				
d^3				155
c^3	158	150½	153	172½
f^2	225	233½	231½	231½
c^2	307½	290	290	304½
f^1	429	465	450½	445
c^1	573½	594	582	646½
f	786½	867	848	913
c	979½	1031	1030½	1142½
F	1231½	1329	1316	1403½
C	1478	1502	1488½	1624½
Extra C	1500			1643
GG/BB	1589½	1560	1548	
GG				
FF				
"long string"	*c*	*f*	*f*	*c*
design scale note	f^3	f^3	f^3	c^3

	1664 JP	1675 CR	1679 CR	1641 GT
f^3				
e^3				136
d^3	131	141	130	
c^3	151½	159½	142½	172½
f^2	231	219½	220½	246½
c^2	295	295	304½	328½
f^1	445	424½	451	474½
c^1	569	570	605	644½
f	813½	763	802	866
c	962½	927½	968½	1055½
F	1230	1147½	1183	1296
C	1383½	1330 / 1356½	1388 / 1401½	1501
Extra C				1524½
GG/BB		1406½ / 1433	1435 / 1499	
GG	1578			
FF				
"long string"	*c*	*c*	*c*	*c*
design scale note	c^3	c^3	c^2	c^3

	1656 JW	1661 JW	1638 TW	1642 TW
f^3		122		
e^3				
d^3				
c^3	145	150	104	151
f^2	220	218½	144	220
c^2	274	284½	187	295
f^1	423	479½	289	419
c^1	542½	602½	387	576
f	786	844½	503	790
c	948	1006	610	984½
F	1246	1283½	731½	1230
C	1414	1439½	821	1440
Extra C	1497	1518½	824	1457
GG/BB	1480	1496½		
GG				
FF				
"long string"	*f*	*f*	*c*	*c*
design scale note	c^3	f^3	c^3	c^3

	1644 TW	1651 TW	1653 TW
f^3	126		
e^3			
d^3		133	
c^3	168½	153½	152
f^2	250	224	227
c^2	302	300½	303
f^1	448½	426½	419
c^1	561	580½	568
f	778	784½	790
c	885	983	999
F	1189 / 1200½	1216	1251½
C	1453 /1469	1415½	1463½
Extra C		1497	
GG/BB	1507 / 1521	1435	
GG			
FF			
"long string"		*c*	*c*
design scale note		c^3	c^3

PLUCKING POINTS

	AH	Mar	1662 TB
f^3			52
e^3			
d^3			
c^3		57½	48½
f^2		48	59½
c^2		57½	55
f^1		59	74½
c^1		65½	69
f		64	93½
c		75½	93½
F		79	131½
C		88	137
Extra C		94½	
GG/BB			151½

	1684 TB	1664 RH	1671 PJ	1668 SK
f^3	51		40	
e^3				
d^3				49½
c^3	46½	49	31½	51½
f^2	57½	49	45	48
c^2	51	55	47½	58½
f^1	62½	54	59	61
c^1	59½	65	57	68½
f	80½	66	68½	69½
c	80½	85	65	82½
F	115½	94	92½	91
C	125	117	115	112
Extra C				
GG/BB	135		135	
FF		130		151

	1675 SK	1666 AL	1670 AL	1655 JL
f^3	36½	31½	47	
e^3				
d^3				49
c^3	43½	29	48	47½
f^2	36	54	78	45
c^2	45	46	77	57
f^1	45	76	105	56
c^1	62	74	106½	71
f	67	113	139	78
c	87	127	137	101
F	95	168	169	121½
C	123	180	169½	165
Extra C	130½			174
GG/BB	146	200	182	

	1664 JP	1675 CR	1679 CR	1641 GT
f^3				
e^3				53
d^3	54	52	52	
c^3	53	54½	46	53
f^2	72	46½	52½	44½
c^2	66	51	55	55
f^1	81	52	56	51
c^1	80	59½	69	60
f	102½	60	81	56½
c	95	78	98	69½
F	121½	94½	125	73
C	119	123 / 126	145½ / 154	88½
Extra C				97
GG/BB		139 / 141½	147 / 153	
GG	140			

	1656 JW	1661 JW	1638 TW	1642 TW
f^3		41		
e^3				
d^3				
c^3	34	31	50	43
f^2	43	39½	41	41
c^2	62	32	51	53
f^1	55	54	46½	55
c^1	80	48½	56½	73
f	77	79	54	77
c	108	88	73	99
F	121	121	76	116
C	133	130½	76	151
Extra C	170	168	80	157
GG/BB	148	146		

	1644 TW	1651 TW	1653 TW
f^3	41½		
e^3			
d^3		41	
c^3	39½	41	38
f^2	62½	42	33
c^2	63½	57	49
f^1	96½	56	41
c^1	105½	72½	57
f	137	81	52½
c	113	107½	68
F	117½ / 122½	123½	66½
C	145 / 150	152	84
Extra C		193½	
GG/BB	152 / 160	147	

PLUCKING POINT RATIOS

	AH	Mar	1662 TB
f^3			0.416
e^3			
d^3			
c^3		0.326	0.300
f^2		0.202	0.243
c^2		0.177	0.172
f^1		0.126	0.150
c^1		0.103	0.110
f		0.0765	0.107
c		0.0734	0.090
F		0.0630	0.101
C		0.0614	0.093
Extra C		0.0653	
GG/BB			0.099
GG			
FF			

	1684 TB	1664 RH	1671 PJ	1668 SK
f^3	0.455		0.301	
e^3				
d^3				0.376
c^3	0.325	0.320	0.199	0.334
f^2	0.254	0.236	0.178	0.223
c^2	0.176	0.207	0.145	0.204
f^1	0.145	0.143	0.119	0.154
c^1	0.110	0.125	0.092	0.128
f	0.099	0.094	0.077	0.095
c	0.082	0.096	0.062	0.090
F	0.088	0.085	0.069	0.080
C	0.083	0.089	0.075	0.082
Extra C				
GG/BB	0.085		0.084	
GG				
FF		0.085		0.093

	1675 SK	1666 AL	1670 AL	1655 JL
f³	0.303	0.273	0.418	
e³				
d³				0.316
c³	0.275	0.193	0.314	0.306
f²	0.160	0.231	0.337	0.194
c²	0.146	0.159	0.266	0.187
f¹	0.105	0.163	0.233	0.126
c¹	0.108	0.125	0.183	0.110
f	0.085	0.130	0.164	0.085
c	0.089	0.123	0.133	0.088
F	0.077	0.126	0.128	0.087
C	0.083	0.120	0.114	0.102
Extra C	0.087			0.106
GG/BB	0.092	0.128	0.118	
GG				
FF				

	1664 JP	1675 CR	1679 CR	1641 GT
f³				
e³				0.390
d³	0.412	0.369	0.400	
c³	0.350	0.342	0.323	0.307
f²	0.312	0.212	0.238	0.181
c²	0.224	0.173	0.161	0.167
f¹	0.182	0.122	0.124	0.107
c¹	0.141	0.104	0.114	0.093
f	0.126	0.079	0.101	0.065
c	0.099	0.084	0.101	0.066
F	0.099	0.082	0.106	0.056
C	0.086	0.092 / 0.093	0.105 / 0.110	0.059
Extra C				0.064
GG/BB		0.099 / 0.099	0.102 / 0.102	
GG	0.089			
FF				

	1656 JW	1661 JW	1638 TW	1642 TW
f³		0.336		
e³				
d³				
c³	0.234	0.207	0.481	0.285
f²	0.195	0.181	0.285	0.186
c²	0.226	0.112	0.273	0.180
f¹	0.130	0.113	0.161	0.131
c¹	0.147	0.080	0.146	0.127
f	0.098	0.094	0.107	0.097
c	0.114	0.087	0.120	0.101
F	0.097	0.094	0.104	0.094
C	0.094	0.091	0.093	0.105
Extra C	0.114	0.111	0.097	0.108
GG/BB	0.100	0.098		
GG				
FF				

	1644 TW	1651 TW	1653 TW
f³	0.329		
e³			
d³		0.308	
c³	0.234	0.267	0.250
f²	0.250	0.187	0.145
c²	0.210	0.190	0.162
f¹	0.215	0.131	0.098
c¹	0.188	0.125	0.100
f	0.176	0.103	0.066
c	0.128	0.109	0.068
F	0.099 / 0.102	0.102	0.053
C	0.100 / 0.102	0.107	0.057
Extra C		0.129	
GG/BB	0.101 / 0.105	0.102	
GG			
FF			

DECORATIVE DETAILS

	AH	Mar	1662 TB
Decorator	"Theewes" sch.	"Theewes" sch	"Body"
Moulding Designs	3	9	4
Moulding Material	oak	oak	cedar (oak hpr)
Lid Painting Illustration	unique	Orpheus +	Biblical
Keywell Flap Painting illustration	text	text	landscape
Other Painted Decoration	fb	none	fb, fb/kw panels
Soundboard Decoration	fl, bird	fl, bird ar	fl, bird, bor, ar
Roses	1	3, ledge	2
Natural Touchplates	boxwood	boxwood	boxwood
Accidental Touchplates	pear, inlayed	walnut, inlayed	bl pnt. pine
Scribed Lines and Stamped Decoration	3	3	4
Gilt Paper Arcade Design	trefoil	missing	sunflower
Gilt Paper Strip Designs	bird and heads	n.o.	Eliz. sh
spine hinges	wire	strap	wire

	1684 TB	1664 RH	1671 PJ	1668 SK
Decorator	"Keene" sch.	"Hatley"	"Keene"	"Keene"
Moulding Designs	9	2	8	?
Moulding Material	cedar (oak hpr)	cedar	pine	cedar
Lid Painting Illustration	landscape	landscape	landscape	landscape
Keywell Flap Painting illustration	landscape	landscape	landscape	landscape
Other Painted Decoration	fb, fb/kw panels	fb, fb/kw panels	fb, fb panels	fb, fb/kw panels
Soundboard Decoration	fl, bird	fl, bird, bor	fl, bird, bor, ar	fl, bird, bor, ar
Roses	1, glued under	2	3	4
Natural Touchplates	ebony	ebony (n.o.)	snakewood	snakewood
Accidental Touchplates	ivory	bone	ivory	ivory
Scribed Lines /Stamped Decoration	3 (2 ft+1)	n.o.	2	4
Gilt Paper Arcade Design	trefoil	n.o.	trefoil	sunflower
Gilt Paper Strip Designs	Eliz. sh.	Eliz. sh.	vinework	Carolus sh
spine hinges	strap	wire	wire	wire

	1675 SK	1666 AL	1670 AL	1655 JL
Decorator	"Keene"	"Keene" sch	"Keene" sch.	"Loosemore"
Moulding Designs	8	9	7	9
Moulding Material	pine (cedar hpr)	cedar (oak hpr)	cedar (oak hpr)	oak
Lid Painting Illustration	landscape	landscape	landscape	mythical
Keywell Flap Painting illustration	missing	landscape	landscape	landscape
Other Painted Decoration	fb, fb/kw panels	fb, fb/kw panels	fb, fb/kw panels	fb, fb/kw panels
Soundboard Decoration	fl, bird,bor, ar	fl, bird, bor, ar	fl, bird, bor, ar	fl, bird, bor, ar
Roses	3, bars under	1	1, glued under	2, bars under
Natural Touchplates	snakewood	boxwood	boxwood	boxwood
Accidental Touchplates	ivory	blk, pnt. oak	bog oak	oak
Scribed Lines /Stamped Decoration	3	4 (2+2)	4 (2+2)	4 (2+2)
Gilt Paper Arcade Design	sunflower	moorish	trefoil	floral
Gilt Paper Strip Designs	Carolus sh	Moresque	Moresque	vinework
spine hinges	strap	strap	strap	wire

	1664 JP	1675 CR	1679 CR	1641 GT
Decorator	"Keene" (?)	"Rewallin"	"Rewallin"	"Townsend"
Moulding Designs	6	7	7	7
Moulding Material	pine (oak hpr)	pine (oak hpr)	pine (oak hpr)	cedar
Lid Painting Illustration	n.o.	landscape	landscape	Orpheus
Keywell Flap Painting illustration	n.o.	landscape	landscape	land / seascape
Other Painted Decoration	fb, nb/kw panels	fb, fb panels, lid	fb, fb panels, lid	fb, nb/kw panels
Soundboard Decoration	fl, bird, bor, ar	fl, bird, bor, ar	fl, bird, bor, ar	fl, bird, bor, ar
Roses	2, glued under	2, bars under	2, bars under	1, ledge
Natural Touchplates	boxwood	boxwood	boxwood	boxwood
Accidental Touchplates	blk st. walnut	snakewood	blk pnt. oak	snakewood
Scribed Lines /Stamped Decoration	4 (2+2)	snakewood line	snakewood line	4(2+2)
Gilt Paper Arcade Design	sunflower	floral	floral	trefoil
Gilt Paper Strip Designs	n.o.	Rewallin vine	Rewallin vine	Eliz. sh.
spine hinges	n.o.	wire	wire	wire

	1656 JW	1661 JW	1638 TW	1642 TW
Decorator	"Body" (?)	"Body" (?)	"Townsend"	"Townsend"
Moulding Designs	10	6	7	8
Moulding Material	cedar	cedar (oak hpr)	cedar (oak hpr)	cedar (oak hpr)
Lid Painting Illustration	landscape	Orpheus	n.a.	Landscape
Keywell Flap Painting illustration	missing	Mythical	n.a.	landscape
Other Painted Decoration	fb, kw panel,	fb, kw panel	fb, papers, tool, endblocks	fb, fb panels, lid,
Soundboard Decoration	fl, bird, bor, ar	fl, bird	fl, bird, bor	fl, bird, bor, ar
Roses	1, glued under	2, glued under	1, ledge(?)	1, ledge (?)
Natural Touchplates	boxwood	boxwood	boxwood	boxwood
Accidental Touchplates	lime, inlayed	st. pear	fruit, inl. eb+syc	blk st. walnut
Scribed Lines /Stamped Decoration	4 (2+2)	4 (2+2), stamp+V	4 (2+2), stamp	4 (2+2), stamp
Gilt Paper Arcade Design	moorish	trefoil	trefoil	trefoil
Gilt Paper Strip Designs	Eliz. sh.	Eliz. sh.	Eliz. sh,/monkey	Moresque
spine hinges	wire	wire	n.a.	wire

	1644 TW	1651 TW
Decorator	"Townsend"	"Body"
Moulding Designs	9	9
Moulding Material	cedar (oak hpr)	cedar (oak hpr)
Lid Painting Illustration	Orpheus	Christ/Samar: a
Keywell Flap Painting illustration	landscape	Elisha/Bears
Other Painted Decoration	fb, lid, kw panel	outer fb
Soundboard Decoration	fl, bird, bor, ar	fl, bird, bor, ar
Roses	2, under strips	1, ledge
Natural Touchplates	boxwood	boxwood
Accidental Touchplates	blk st. walnut	st. pear
Scribed Lines /Stamped Decoration	4 (2+2), stamp	4 (2+2)
Gilt Paper Arcade Design	trefoil	trefoil
Gilt Paper Strip Designs	Moresque/monkey	Moresque/monkey
spine hinges	wire	wire

APPENDIX ONE

THE INVENTORIES OF HENRY VIII

There are two inventories of the goods of Henry VIII which are listed in Ashbee (1993:383). The earlier is an inventory of furniture and fittings in the Palace of Westminster, taken by Sir Anthony Denny, and dated 1542/3, now in the Public Record Office (PRO: E315/160). The better known inventory, also published in Galpin (1929) and in Russell (1959), was taken following Henry VIII's death, and dated 14 September 1547 is now in the British Library, Harley MS 1419. This second list includes instruments in building other than just the Palace of Westminster.

In the following list the earlier inventory is listed in normal type, and the corresponding 1547 inventory is in bold type. Marginal notes in the 1542/3 manuscript, have been reproduced in italics following the relevant entries. All entries retain the spelling as quoted by Ashbee (1993).

Stuffe and Implements at GREENWICHE

One paier of regales with the case.

One faire Instrument being regales and Virgynalles.

A paier of Virgynalles.

At WESTMINSTER

Item oone peir of doble Regalles with twoo Stoppes of pipes coverid with purple vellat alover enbraudred with Venice golde and damaske pirles having the Kinges Armes and badges likewise enbraudred standing upon a fote coverid with fustian of Naples garnished with red rybond the same fote being the case for the same Regalles.
FIRSTE a paire of double Regalles with twoo Stoppes of pipes couered in purple vellat all over enbrawdered with Venice gold and damaske pirles havinge the Kinges Armes and badges likewise enbrawdered standinge uppon a foote couered with fustian of Naples and garnished with redd ribbon the same foote beinge the Case for the same Regalles.

Item oone peir of doble Regalles of latten with 3 stoppes of pipes coverid with purple vellat enbraudred alover with damaske pirles and Venice golde, And the cover thereof thinner pte coverid wth crimson vellat likewise Anbraudred with damaske pirles having a stele Glasse in the same the Kinges Armes and Quene Janes Armes likewise enbraudred with a cover over the pipes coverid with crymsen & purple vellat likewise enbraudred, having a rose crownyd upon the same standinge upon a fote of waynscott paynted with Rabaskewoorke wherein liethe the Bellowis.

Item. A paire of double Regalles of latten with 3 Stoppes of pipes couered with purple vellat enbrawdered all over with damaske pirles and Venice golde and the Cover thereof the inner parte couered with crimeson vellat likewise anbrawdered with damaske pirles havinge a stele Glase in the same and the Kinges Armes and Quene Janes Armes likewise enbrawdered with a couer the pipes couered with crimeson vellat likewise enbrawdered having a rose crowned uppon the same standinge uppon a foote of wainscott painted in Rabeske woorke wherein liethe the Bellowes.

Item oone peir of doble Regalles with twoo stoppes of pipes coverid with purple vellat alover enbraudred with Venice golde and damaske pirles having the Kinges Armes and badges likewise enbraudred standing upon the case of the same coverid with fustian of Naples.

Item. A paire of double Regalles with twoo Stoppes of pipes couered with purple vellat all over enbrawdered with Venice golde and damaske pirles havinge the Kinges Armes and badges likewise enbrawdered standinge upon the Case of the same couered with fustian of Naples.

Item oone peir of single Regalles with 3 stoppes of pipes, of wode vernisshed yellowe standinge upon a frame of wode with 3 pillours.

Item. One paire of single Regalles with 3 stoppes of pipes, of woodde vernisshed yellowe standinge uppon a frame of woode withe 3 pillors: it hathe but one Stoppe pipe of tinne one Regall of Tinne and a Cimball.

Item oone peir of single Regalles with 2 stoppes of pipes of wode vernisshed yellowe and painted with blac Rabaskewoorke standinge upon a fote of wainscott with the Bellowis lyeng in the same.

Item. One paire of single Regalles with twoo Stoppes of pipes, of woode vernisshed yellowe and painted with blacke Rabeske woorke standinge uppon a a foote of wainscott the Bellowes liynge in the same: it hathe but one Stoppe of pipes of woode with a Cimball of Tinne and the Regall of papire.

Item twoo peir of single Regalles every of them with 6 half Stoppes of brasse pipes, of wode gilt and paintid and having the Kinges Armes within a garter and badges paintid upon the Bellowis standing upon a fote of wodde cheste fashion painted blac.

Item. Twoo paire of single Regalles euerie of them with 6 halfe stoppes of brase pipes, of woode gilte and painted and hauinge the Kinges Armes within a gartier and badges painted uppon the Bellowes standinge uppon a foote of woodde like a Cheste painted blacke.

Item oone peir of doble Regalles with 8 half stopper and oon hole stoppe of pipes, of wodde gilte silverid and paintid with Rabaskewoorke & stories havinge the Kinges Armes within a Garter supportid by his graces bestes paintid and gilt upon the Trymer

of the same standing upon a fote of wodde being paintid whereon lyeth the Bellowes. *Deff the Trymer.*

Item. A paire of double Regalles with 8 halfe Stoppes and one hole stoppe of pipes, of woodde gilte siluered and painted with Rabeske woorke and histories havinge the Kinges Armes with a gartire supported by his graces beastes painted and gilt uppon the trimmer of the same standinge uppon a foote of woode beinge painted wherein liethe the Bellowes.

Item six smale peir of Single Regalles thre of them being in cases of tymber coverid with lether and thither 3 in cases of tymber uncovered.*

**one w*^t* a cace of lether A*^o^* 34 H. VIII to go to the ks M*^d^* to purgoe. And the other five paire w*^t* theire Cases to phillip vanwilder ut supra.*

Item. 5 small single Regalles twoo of them beinge in Cases of Timbre couered with leather and thother 3 in cases of Timbre not couered.

Item oone peir of dobre Regalles with 3 stoppes of pipes, of wodde vernysshed yellowe and paintid with Antigue worke having the Kinges Armes and Quene Janes Armes, with two playinge upon a harpe and a lute and two singing paintid upon the same standing upon a fote of waynscott paintid yellowe with Antigue woorkes wherein lyethe the Bellowis.

Item. A paire of double Regalles with 3 stoppes of pipes, od woode vernisshed yellowe and painted with anticke woorke hauinge the Kinges Armes and Quene Janes armes with twoo playinge uppon a lute and a harpe and twoo singinge painted uppon the same standinge uppon a foote of wainscott painted yellowe with anticke woorkes wherein liethe the Bellowes: the same hath but two stoppes of pipes and thother Stoppe is but a Cimball.

Item oone peir of single Regalles with twoo stoppes of pipes of tymber and oone stoppe of pipes of tyn, of wodde painted with blac Rabaske woorke & vernisshed standing upon a fote of wainscot wherein lieth the Bellowis.

Item. One paire of single Regalles with twoo Stoppes of pipes of timbre and one Stoppe of pipes of Tinne, of woode painted with blacke Rabeske woorke and vernisshed standinge uppon a foote of wainscott wherein liethe the Bellowes: the same hathe but one Stoppe of pipes of woode the Regall of papire and hath a Cimball.

Item oone Instrumente with a single Virginall and a single Regall with a stopp of Tymber pipes, of wodde vernysshed grene and red.

Item. An Instrument with a single Virgynal and single Regall with a Stoppe of timbre pipes, of woode vernisshed grene and redde.

Item oone peir of single Regalles with 4 stoppes of pipes, of wodde vernysshed yellowe and paintid with blac Antigue worke standing upon a fote of wainscott and the Bellowes lyeng in the same.

Item. One paire of single Regalles with 4 Stoppes of pipes, of woode vernisshed yellowe and painted with blacke anticke woorke standinge uppon a foote of wainscott the Bellowes lieing in the same: it hathe but one Stoppe of pipes of woode a Cimball of Tinne and a Regall.

Item oone peir of single Regalles with two stoppes of pipes coverid with grene vellat garnished on the fore parte with a narrowe frenge of Venice golde standing upon a fote of waynscott paintid grene with the Bellowis lyenge in the same.
Item. One paire of single Regalles with twoo stoppes of pipes couered with grene vellat and garnished on the foreparte with a narrow fringe of Venice golde standinge uppon a foote of wainscott painted grene with the Bellowes liinge in the same havinge a Cimball.

Item oone peir of single Regalles with 7 half stoppes of pipes, of wodde vernisshed yellowe and paintid with blac Rabaske woorke with a fote of waynscott And the Bellowis lyeng in the same.
Item. One paire of single Regalles with 7 halfe Stoppes of pipes, of woode vernisshed yellowe an painted with blacke Rabeske woorke with a foote of wainscott unpainted wherein liethe the Bellowes: the saide 7 stoppes are but 7 Registers diuided in three Stoppes with a Cimball.

Item oone Instrument that goithe with a whele withowte playing upon, of wodde vernisshed yellowe and painted blewe, with 6 Rounnde plates of silver pounced wth Antigue garnished with a edge of copper and gilt.
Item. An Instrumente that Goethe with a whele without playing uppon, of woode vernisshed yellowe and painted blewe with 6 rounde plates of siluer pounced with anticke garnished with an edge of copper and guilte.

Item two peir of doble Virgenalles thone coverid with blac Lether and the lyd lyned wth grene bridges Satten and thother coverid with red Lether.
Item. Twoo paire of double Virgynalles thone couered with blacke Leather and the lidde lined with grene bridges Satten and thother couered with redde leather.

Item two peir of single virgenalles thone having keys of Ivery and thother of boxe with two cases to them of red lether ptely gilt and lyned with blac vellat.
Item. Twoo paire of single Virgynalles those of them havinge keies of Ivorie and thother of Boxe with twoo Cases to them of redde leather partelie gilte and lined with blacke vellat.

Item oone peir of single Virgenalles coverid with Red Lether and the lyd lyned with grene bridges Satten.
Item. A paire of single Virgynalles couered with redde leather and the lidde with grene bridges satten.

Item oone peir of doble Virgenalles coverid with blac Lether ptely Silverid the lyd lyned with grene bridges Satten.
Item. A paire of double Virgynalles couered with blacke Leather partelie siluered the lidde lined with grene bridges satten.

Item oone peir of single virgenalles coverid with grene bridges Satten with 3 Tilles in them.
Item. A paire of single Virgynalles couered with grene bridges Satten with 3 Tilles in them.

Item Two peir of single vergenalles coverid with blac Lether.
Item. Twoo paire of single Virgynalles couered with blacke Leather.

Item two peir of single Virgenalles cov[r]id with red lether thone being bigger then thither.*
**One payer to go to the Eliz. her grace A° primo Rs E. VI And thother pce to phip vanwilder ut sup[a]*
Item. One paire of single Virgynalles couered with redde Leather.

Item oone peir of single Virgenalles with pipes underneath in a case of tymber coverid with blac Lether.
Item. A paire of single Virgynalles with pipes underneath and in a case of timbre couered in blacke Leather.

Item oone peir of doble Virgenalles of Cipers in a case of Wainscott.
Item. A paire of double Virgynalles of Cipres in a case of wainscot.

Item oone peir of Clavicordes coverid with gilt lether.
Item. A paire of claricordes couered with gilte leather.

Item oone peir of Clavicordes coverid with Lether Silverid.
Item. A paire of Claricordes couered with leather siluered.

Item oone peire of single virgenalles coverid with red lether ptey gilt.
Item. A paire of single Virgynalles couered with redde leather partelie guilte.

Item. An Instrument with a double Virgunall and a double Regall with 3 Stoopes of pipes, of woode painted with grene Rabeske woorke with a foote of wainscott and the Bellowes lyinge in the same.

FYRSTE, one newe paire of of double Virginalles couered with blacke leather with smale roses printed and gilte upon it the lidde lined with grene satten and garnished upon with redde silke Ribonne lozenge wise.

Item. Another newe paire of double Virginalles vernisshed yellowe and painted all ouer with redde rabeske woorke the lidde beinge lined with purple serrconet and havinge the Kinges armes painted and guilte in the middes of hit.

Item. A little paire of Virginalles single couered with redde leather in a Case of woode couered with blacke lether.

Item. Twoo faire paire of newe longe Virginalles made harpe fasshion of Cipres with keies of Iuorie havinge the Kinges armes crowned and supported by his graces beastes with a gartier guilte standinge ouer the said keies with twoo caeses to them couered with blacke leather the inner partes of the liddes to the saide caeses beinge of walnuttre with sondrie antickes of white woode wroughte in the same.

AT HAMPTON COURTE

One payre of portatives with the Kynges and Quene Janes Armes.

A paire of Virgynalles the case couered with blacke leather.

A paire of Regalles in a case couered with crimson vellat.

Seven paires of Virginalles in cases of printed lether.

A paire of Virginalles facioned like a harp.

One paire of portatives couered with crimeson Satten and embrawdered with passumynt of golde and Siluer standing upon a square table of wainscotte.

Paire of Regalles in a case of lether.

AT WYNSORE

One doble Regall with doble pipes painted and gilte with Antique woorke with a great Rose painted and gilte uppon the foreparte of the foote thereof.

AT THE MORE

One olde paire of Regalles broken in peces.

Two paires of olde Virginalles.

AT NEWHALL

A paire of faire greate Organes in the Chappell with a curten afore them of lynnen clothe staynd redd and blewe paned.

A paire of Virginalles verye olde and broken.

AT NOTYNGHAM CASTELL

An olde paire of Organes.

AT SAYNT JAMES HOUSE

A paire of Organes standinge in the Chapple.

APPENDIX TWO

ENGLISH COURT INSTRUMENT BUILDERS

The following lists show successions of keyboard instrument makers at the Royal Court from commencement until 1688. It is arranged according to the specific appointed position. The information of salaries and titles comes from Ashbee and Lasocki (1998).

Keeper, tuner and maker of instruments to the King

William LEWES (1514 – 1547) – Appointed March 3, 1513/4, fee of £5 per year. Salary doubled at Christmas 1516.

William TREASOURER (1550 – 1584) – Appointed in place of William Lewes in Christmas 1550 at a salary of £10 a year. Listed specifically in 1553 as "regal maker".

Edmund SCHETTS (1587 – 1603) – Replaced William Buck (see below) in 1567, and replaced William Treasourer following the latter's death in 1587 at a salary of £50 per year. Assisted in later years by Robert Henlake.

Robert HENLAKE (1603 – 1610) and Andrea BASSANO (1603 – 1626) – Jointly appointed in 1603 at a combined salary of £60.

Following the death of Robert Henlake in 1610, Andrea Bassano continued in the job with Edward Norgate.

Edward NORGATE (1611 – 1642) – Replaced Robert Henlake following his death, officially appointed in 1611.

John HINGESTON (1660 – 1683) – Replaced Edward and Arthur Norgate at the Restoration at a salary of £60 per year, sworn in on July 2, 1660. Assisted from 1673 by Henry Purcell.

Henry PURCELL (1683 – 1685) – Appointed Keeper of the wind and keyboard instruments, replacing John Hingeston from Christmas 1683.

The post was discontinued at the accession of James II in 1685.

Organmaker

John de JOHN (1525 – 1532) – Listed as a priest and organ maker with a salary of £10 per year.

William BETON (1537 – 1553) – Probably appointed to succeed John de John on November 27, 1537, receiving £20 per year as "the King's Chief Organist", despite later document showing him to be the tuner of regals and organs.

William BUCK (1553 – 1567) – Appointed in 1553 by Queen Mary to the post of organ maker and keeper of the storehouse of the queen's instruments at a salary of £10 per year.

Edmund SCHETTS (1567 – 1603) – Appointed in place of William Buck at a salary of £10 per year. Schetts succeeded William Treasourer as Keeper of instruments in 1587, effectively absorbing the organ maker's job into that of the Keeper.

Organ Tuner

Henry PURCELL (1685 – 1695) – Given the newly created post of Organ Tuner by warrant dated March 5 1687/8, paid from Christmas 1688.

Organ maker

Miguel MARCATOR (1527 – 1544) – Received annual wages of £22 10s from Michaelmas 1528, continuing until at least 1544 (the records are missing from 1544 until the end of Henry VIII's reign.

Oversight and Tuning of Organs at St James Palace and Whitehall

Thomas CRADDOCK (1626 – 1636/7) – Granted a salary of £20 per year for the above job, having previously made an organ at St James Palace in 1521.

The position was not filled from the death of Craddock until after the Restoration.

James FARR (1661 – 1681) – Appointed to the post in a patent dated May 8, 1661 at a salary of £20 per year.

Bernard SMITH (1681 – 1708) – Listed as "the King's organ maker" in 1671, possibly having succeeded James Farr. A warrant was issued for the post on May 30, 1681.

APPENDIX THREE

THE DISCOVERY DATES OF ORIGINAL INSTRUMENTS

The various lists of English virginals published in GD3 and GD4, and B1, B2, and B3, as well as being mentioned in previous studies, gives the opportunity to list the instruments in the order that information concerning them was made available to the public. For the purposes of this list an instrument must be mentioned in a reference book, displayed at an exhibition, or sold at auction.

1655 JL — Mentioned in Rimbault (1860). Exhibited in South Kensington, 1872. Purchased by the Victoria and Albert Museum, 1873.

1653 TW — Exhibited in South Kensington, 1872.

1651 TW — Exhibited at the International Inventions Exhibition, 1885.

1656 JW — Exhibited at the International Inventions Exhibition, 1885.

1666 AL — Exhibited at the International Inventions Exhibition, 1885. This instrument was the one referred to in Rimbault (1860:64) as being owned by T. Mackinley, though not mentioned by name.

1671 PJ — Exhibited at the International Inventions Exhibition, 1885.

1684 TB — Exhibited at the International Inventions Exhibition, 1885. Until the publication of B3, this instrument was referred to as probably being made by Charles Haward, and as being undated.

1644 TW — Included in the Catalogue of the Boddington Collection, 1888. Various dates of manufacture have been given, the Boddington Catalogue offering 1664.

1641 GT — Listed in Mahillion (1893-1922). Also included in the Dictionary of English Furniture (1924-7).

1675 CR — Mentioned in the Connoisseur, October 1916.

1670 AL — Included in the Dictionary of English Furniture (1924-7).

1668 SK — First listed in GD3 (1927).

1642 TW — Given to the Victoria and Albert Museum, 1933. First published mention in GD4 (1940).

1664 RH — Sold by auction by Puttick and Simpsons, November 1933. First published mention in GD4 (1940).

1661 JW — Sold at auction by Christies, January 1946. First published mention in B1 (1956).

1679 CR — Obtained by the Royal Albert Memorial Museum, Exeter, 1953. First published mention in B1 (1956).

1664 JP — Sold by Captain Lane to Raymond Russell via auction at Sothebys, November 1955.

1675 SK — First listed in B1 (1956).

1662 TB — Sold to W. Lee of York, August 1967. First published mention in B2 (1974), including illustrations.

1638 TW — First listed in B2 (1974). Illustrated in the Catalogue of the *Made for Music* Exhibition, 1986.

AH — First mentioned in Napier (1986), when on loan from the National Museums of Scotland to the Russell Collection.

Mar — First mentioned in Napier (1986), when on loan from the National Museums of Scotland to the Russell Collection.

APPENDIX FOUR

MENTION OF KEYBOARD INSTRUMENTS IN PEPYS

The following passages have been taken from Pepys' diary, using the transcription by Robert Latham and William Matthews, and published in Latham, R., and Matthews, W., (eds.)*The Diary of Samuel Pepys*, (London, 1970 - 1983). In all examples the spellings used are those that appear in the published text. Only passages concerning domestic keyboard instruments have been included.

The identity and position of several of the individuals mentioned should be made clear. "My Lord" is Lord Sandwich, Pepys' immediate line manager. Ashwell, Mercer and Tom are all people living in his household as Elizabeth Pepys' "girls" or Samuel Pepys' "boy". Mrs. The. is the daughter of Mrs. Turner, personal friends of the Pepys family.

17 March, 1659/60 "...and hearing of old Mrs. Crisp playing of her old lessons upon the Harpsicon..."

9 November, 1660 "...From thence to Whitehall, where I found my Lord, who hath an organ set up today in his dining-room, but it seems an ugly one, in the form of Bridewell..."

15 November, 1660 "...Mr. Childe playing upon my Lord's new organ - the first time I ever heard it..."

20 November, 1660 "...Then to the organ, where Mr. Childe and Mr. Mackworth (who plays finely upon the viallin) were playing, and so we played till dinner..."

8 December, 1660 [at the house of Mr Pierce] "...and her daughter played after dinner upon the virginalls..."

22 February, 1660/1	"...In the evening Mrs. The. and Joyce took us into the coach home, calling in at Bishop's-gate street, thinking to have seen a new Harpsicon that she hath a making there; but it was not done, and so we did not see it..."
26 February, 1660/1	"...Then Mrs. The. and I, and a Gentleman that dined there and his daughter..., (and Mr. Thacker the Virginall-maister) to Bishopsgate-street, and there saw the new Harpsicon made for Mrs. The. We offered £12 - they demand £14. The master not being at home, we could make no bargain; so parted for tonight..."
10 April, 1661	"...So to Captain Allens (where we was last night and heard him playing of the Harpsicon; and I find him to be a perfectly good Musician)..."
29 April, 1661	"...to Mrs. Turner's, where we were all at a collocion tonight till twelve o'clock, there being a gentle-woman there that did play well and sang well to the Harpsicon..."
22 May, 1661	"...Before dinner, my Lady Wright and my Lady Jem. sang songs to the Harpsicon..."
14 June, 1661	"...I sent to my house, by my Lord's order his shipp and Triangle- virginall..."
18 June, 1661	"...and afterwards had a very handsome treate and good musique, that she made upon the Harpsicon..."
16 March, 1662/3	"...to my wife at my Lord's lodgings, where I heard Ashwell play first upon the Harpsicon, ...Thence home by coach, buying at the Temple the printed virginall-book for her..."
18 March, 1662/3	"...This day my tryangle (which was put into tune yesterday) did please me very well, Ashwell playing upon it pretty well..."

28 March, 1663	"...After being a little while hearing Ashwell play of the Triangle..."
1 April, 1663	"...home, calling on the virginall-maker, buying a Rest for myself to tune my Tryangle and taking one of his people along with me to put it in tune once more; by which I learned how to go about it myself for the time to come..."
3 April, 1663	"...and after dinner up to my Tryangle, where I found that above my expectation Ashwell hath very good principles of Musique and can take out a lesson herself with very little pains..."
8 April, 1663	"...after hearing Ashwell play my father and me a lesson upon he Triangle..."
15 April, 1663	"...and after dinner up with my wife and Ashwell a little to the Tryangle..."
1 May, 1663	"...went to hear Mrs. Turner's daughter (at whose house Sir J. Mennes lies) play on the Harpsicon; but; Lord, it was enough to make any man sick to hear her; yet I was forced to commend her highly..."
1 May, 1663	"...Ashwell playing upon the Tryangle very well before I went to bed."
3 May, 1663	"...and up to teach Ashwell the grounds of time and other things on the Tryangle, and made her take out a psalm very well, she having a good eare and hand..."
21 June, 1663	"...and after dinner went up and tried a little upon my Tryangle, which I understand fully and with a little use I believe could bring myself to do something..."
27 June, 1663	"...I a little to my Tryangle and so to bed."

24 July, 1663	"...They had a kinswoman they call daughter in the house, a short, ugly, red-haired slut, that plays upon the virginalls and sings, but after such a country manner, I was weary of it but yet could not but commend it..."
21 August, 1663	"...to the Musique-house, where we had paltry musique till the Maister Organist came..."
16 March, 1663/4	"...to hear Mrs. The. play upon the Harpsicon though the Musique did not please me neither..."
1 July, 1664	"...first bringing down my Tryangle to my chamber below, having a new frame made proper for it to stand on..."
1 July, 1664	"...and then [to Pepys' office] came Mr. Hill and Andrew and one Cheswicke, a maister who plays very well upon the Spinette, and we sat singing Psalms till 9 at night..."
9 September, 1664	"...there my wife and Mercer and Tom and I sat till eleven at night, singing and fiddling ...The girle plays pretty well upon the Harpsicon, but only ordinary tunes; but hath a good hand..."
5 October, 1664	"...Thence to the Musique-meeting at the Post-Office, where I was once before ...And the new instrument was brought, called the Arched Viall - where being tuned with Lutestrings and played on with Kees like an organ - a piece of Parchment is alway kept moving; and the strings, which by the keys are pressed down upon it, are grated, in imitation of a bow, by the parchment; and so it is intended to resemble several vyalls played on with one bow - but so basely and harshly, that it will never do. But after three hours stay it could not be Fixt in tune; and so they were fain to go to some other Musique of instruments, which I am grown quite out of love with..."

2 September, 1666	"...and only, I observed that hardly one lighter or boat in three that had the goods of a house in, but there was a pair of virginalls in it..."
10 November, 1666	"...Mr. Temples wife after dinner fell to play on the Harpsicon, till she tired everybody, that I left the house without taking leave, and no creature left standing by her to hear her..."
23 January, 1666/7	"...to St. James' to see the organ Mrs. Turner told me of the other night of my late Lord Aubigney's;and I took my Lord Bruncker with me, he being acquainted with my present Lord Almoner, Mr. Howard, brother to the Duke of Norfolke; so he and I thither and did see the organ, but I do not like it, it being but a bauble, with a virginall joining to it, so I shall not meddle with it..."
12 February, 1666/7	"[Draghi] Himself is the poet as well as the Musician, which he is very much; and did sing the whole from the words without any Musique pricked, and played all along upon a Harpsicon most admirably; and the composition most excellent..."
12 February, 1666/7	"...And so we all thither, and there she [Mrs. Knipp] did sing an Italian song or two very fine, while he [Draghi] played the bass upon a Harpsicon there..."
16 February, 1666/7	"...They sent two Harpsicons before; and by and by, after tuning them, they begun; and I confess, very good music they made..."
11 November, 1667	"...but I did go into the music-room, where Captain Cooke and many others; and here I did hear the best and the smallest Organ that ever I saw in my life, and such a one as, by the grace of God, I will have the next year if I continue in this condition, whatever it cost me."
5 January, 1667/8	"...After dinner, my Lord Brereton very gentilely went to the Organ and played a verse very handsomely..."

24 February, 1667/8 "...meeting Dr. Gibbons there, he and I to see an Organ at the Deane of Westminster's lodgings at the Abbey...Here I saw the organ; but it is too big for my house and the fashion doth not please me enough, and therefore will not have it..."

23 March, 1667/8 "...and so away thence and to Bishopsgate-street, thinking to have found a Harpsicon-maker that used to live there before the fire, but he is gone; and I have a mind forthwith to have a little Harpsicon made me - to confirm and help me in my music notions, which my head is nowadays full of, and I do believe will come to something that is very good..."

4 April, 1668 "Up betimes, and by coach towards Whitehall; and took Aldersgate-street in my way and there called upon one Hayward that makes virginalls, and did there like of a little Espinettes, and will have him finish them for me; for I had a mind to a small Harpsicon, but this takes up less room and will do my business as to finding out of Chords - and I am very well pleased that I have found it..."

10 July, 1668 "...So home to dinner; thence to Hawards to look upon an Espinettes, and I did come near the buying one, but broke off. I have a mind to have one..."

13 July, 1668 "...I to buy my Espinette which I now did agree for; and did at Hawards meet with Mr. Thacker and heard him play on the Harpsicon, so as I never heard man before, I think..."

15 July, 1668 "...At noon home to dinner, where is brought home the Espinette I bought the other day of Haward; cost me £5..."

20 July, 1668 "..And so home and took occassion to buy a Rest for my spinet at the Ironmonger's by Holborn Conduit..."

APPENDIX FIVE

BIOGRAPHIES OF KNOWN VIRGINALL BUILDERS

The following is a list of all known virginall makers and apprentices recorded in England, Scotland and Eire before 1688. No personal archival research has been carried out, but the list has been compiled from various sources. Generally this information has come from B3, James (1930), Ashbee and Lasocki (1998) and Russell (1959). Other sources are listed in the relevant text entries. Care has been taken to try and resolve any discrepancies that occur between different sources and to provide the most accurate listing of makers presently compiled. The spelling of names in documents is occasionally arbitrary so for the purpose of this list precedence has been given to spelling on surviving instruments, then that used by Ashbee and Lasocki (1998), then B3.

Adam, A. Scottish virginal maker. *fl.* 1659.

Albright, J. Listed as a member of the house of Lodewyk Theewes in 1568, and possibly a member of his workshop.

Avery. H. Apprenticed in 1652 to John Haward, made Freeman of the Joiners' Company in 1672.

Barfoot, W. Apprenticed in 1651 to John Haward, made Freeman in 1659.

Barres, C. Apprenticed in 1658 to "John Haward the Elder", made Freeman in 1667.

Bate, J. Apprenticed in 1641/2 to John Haward. No record of Freedom.

Becher, E. Apprenticed in 1638/9 to Thomas White. No record of Freedom.

Beton, W. Primarily an organmaker, but might have made virginalls as well. Made a Freeman in Lynn. Norfolk, in 1518/9. From 1537 to his death in 1563 he held a Court position as a tuner or regalls and organs. See Appendix Two, page 291.

Blanckart, J. Arrived in London from Flanders in 1566. Worked as the "servant" of William Treasorer, and had, by 1582, set up on his own in Aldgate.

Blunte, T. Recorded as a virginall maker in the parish of St Giles, Cripplegate, 1594.

Body, T. Apprenticed in 1647 to Joseph Boddy, an organ builder (probably a relation), and made Freeman in 1656. Came to London from Handborough, Oxon. **Surviving instrument : 1662 (Private Collection, London).**

Bolton, T. On stylistic grounds can be shown to be an apprentice or journeyman of Stephen Keene or Philip Jones. **Surviving instrument : 1684 (Warrington Museum)**

Brome, H. Apprenticed to Thomas Haward in 1650. No record of Freedom.

Browne, T. Organ maker, and possibly a virginall maker, having dealings with Robert Colyns (a wireseller).

Bryne, I. Virginall maker in Bristol. Master of Philip Brown, Stephen Fudger, Bartholemew Bristoll and Humfrie Bryne between 1620 and 1643.

Buck, W. Organ maker and possibly virginall maker, replacing William Beton in 1553. In his will, proved 14 May, 1567 he left "a paier of Orgaines all my mettall orgeyn pipes and all my shop gere asteach and my towels and the tymber wch is in the shop..." to his son-in-law William Randall.

Cassus, J. Uncertain reading of a name on a possibly English harpsichord of c. 1660. This instrument has not been discussed in this thesis.

Cloys, B. A maker of *Klavierautomaten, fl.* London 1623.

Cooke, J. Apprenticed to John Haward, and made Freeman of the Joiners' Company in 1624/5.

Cooly, J. Apprenticed in 1647 to Gabriel Townsend, made Freeman in 1656.

Cowtes, . A repairer of virginals belonging (or used by) Princess Mary, during the reign of Henry VIII. Ashbee (1993:374) lists the following references to him:

March 1536/7	Itm geven to one Cowtes for mending my lades gce virginalles 5s.
April 1537	Itm geuen to Cowtes coming from London and mending my lades gce virginalles 3s. 4d.
[May 1537	Itm paid to the man that sett the virginalles 5s.]
September 1537	Itm geven to one Cowtes of London for mending my lades gce virgynalles 7s. 6d.
November 1537	Itm geven to one Cowtes of London for mending of my lades gce vrginalles at soundry tymes 7s. 6d.
March 1537/8	Itm geven to Cowtes of London for mending of my lades gce virginalles 2s. 4d.
May 1538	Itm geven to oon Cootes mending my lades gce virginalles 5s.

Crosse, J. Apprenticed to Thomas Makeham in 1656, made Freeman of the Joiners' Company on the relation of Thomas Haward in 1663.

Davidson, J. Scottish virginal maker. *fl.* 1652.

Dawson, B. Apprenticed in 1627 to John Haward, made Freeman in 1634/5.

Defield, P. Born in Louvain, fled (for religious reasons) to England in September 1567 or 1568. Worked with Lodewyk Theewes, but left him by 1571 to work with John James. Last mention of him is in 1582/3. Name sometimes spelt as Pawyl Fandevell, Polle Fyeld, and Pawle Defield.

Dermore, J. Apprenticed to Thomas White in 1629, made Freeman in 1637/8.

Dutton, L. Apprenticed to Stephen Keene in 1682. No record of Freedom.

Dutton, W. Apprenticed to John Haward, and made Freeman of the Joiners' Company in 1623/4.

Ede, J. Lute, and possibly harpsichord maker in London. *fl.* 1466.

Edwardes, O. Apprenticed to John Haward in 1622. No record of Freedom.

Elliot, P. Apprenticed to Thomas Haward in 1653, made Freeman in 1660.

Estamproy, G. Maker of organs and possibly virginalls in London, *fl.* 1526.

Everatt, J. Listed as a virginall maker in the parish of St Giles, Cripplegate, London, 1664.

Farnaby, N. Maker of virginalls in London, died in 1630 in the parish of St Olave Jewry. Master of John Haslupp and Henry Walker. His son, also Nicholas, was recorded as a virginall maker during his father's lifetime.

Forcer, T. Apprenticed to John Haward in 1628/9. No record of Freedom.

Frawlins, B. Apprenticed to John Haward in 1661. No record of Freedom.

Gill, G. Possibly a virginall maker in London, *fl.* 1641.

Goodman, W. Virginall maker of Chester during the second half of the sixteenth century. An Inventory taken of Goodman's property is printed as Appendix Seven, page 315.

Green, T. Apprenticed to John Haward in 1648, made Freeman in 1655.

Greetham, D. Apprenticed to Gabriel Townsend in 1645, No record of Freedom.

Gundet, R. Virginall maker in Westminster, *fl.* 1551.

Harris, J. Apprenticed to Stephen Keene in 1675, made Freeman in 1685. Son of James Harris of Sherbourne, Glos. Master of John Sison (post 1688).

Hartwell, T. Virginall maker in the parish of St Giles Cripplegate, London, *fl.* 1589-92.

Hasard, E. The son of John Hasard. Probably a virginall maker. Admitted Freeman of the Joiners' Company by patrimony in September 1633.

Hasard, J. Probably the John Hasard, living in the parish of St Bartholomew behind the Exchange (see MacTaggart (1978:2)). Married Elizabeth Adams on 23 May, 1604 (she died 8 January, 1618/9), and later Mary Pattison in 1621. John Hasard was buried on 5 November, 1630. John Hasard's daughter, Elizabeth, born 13 December, 1607 married Gabriel Townsend in 1628. Ashbee (1991:207) records:

> Paid to Hazard that keepeth her graces virginalls in tune for his stipend for the qrter ending at xpemas 1612 10s.

"Her grace", in this passage refers to Princess Elizabeth, later Elizabeth of Bohemia, the daughter of James VI and I, and sister of Charles I. It is

possible that one or more of the early apprentices attributed to John Haward were in fact apprenticed to John Hasard, whose name was believed to be Haward when the list of apprentices (found in B3) was first compiled. **Surviving instrument : harpsichord dated 1622 (Knole Park, Sevenoaks, Kent).**

Haslupp, J. Apprenticed to Nicholas Farnaby in 1626/7. No record of Freedom.

Hassorde, W. Virginall maker in the parish of St Giles Cripplegate, London, first mentioned in the parish records in 1610. He died in 1617.

Hatley, R. Virginall maker in the parish of St Giles Cripplegate, London. **Surviving instrument : 1664 (Fenton House, London).**

Haward, C. Virginall maker. In 1668 he lived in Aldgate Street, London. Admitted Freeman of the Joiners' Company by patrimony in 1660. Charles Haward is the first person that can positively be shown to make bentside spinets in England, on the basis of his dealings with Samuel Pepys (see page 299). Thomas Salmon (*Vindication of an Essay to the Advancement of Music*, (1672:68) refers to a "curious pair of Phanatical Harpsichords made by that Arch Heretick Charles Haward". In 1674 he was paid £6. 10s:

> for mending the harpsichords and pedals in the Great Hall in the Privy Lodgings and for the private musick, for 2 whole years

In 1675 paid £2 for "...for mending the harpsichords". Queen Anne had a virginal of his. The books of Thomas Green record his purchase of a "Chas. Howard" harpsichord in 1745, and a tuning of an instrument by Haward in 1760. Charles Haward was the master of John Robinson, and was the second master of Joseph Sandles. **Surviving instruments include a harpsichord dated 1683 and several spinets.**

Haward, J. (i) A John Haward is recorded as the master of Orlando Edwardes in 1622, Leonard Dutton in 1623/4, John Cooke in 1624/5, Benjamin Dawson from 1627 - 1634/5, Thomas Forcer in 1628/9, Arthur Norton from 1630 - 1639/40, John Hudson in 1631, Edward Poole from 1632 - 1641/2, John Bate in 1641/2, and from 1658 - 1667 Correy Barres was apprenticed to "John Haward the Elder", who is almost certainly this

man. It is probably this John Haward who died in 1667, and this man or Haward, J. (ii) is probably the maker mentioned by Thomas Mace (*Musick's Monument*, (1676:235)) as having "contriv'd" the *Pedal.* (see Hubbard (1965:147) or B3 (page 84) for a full transcription of the passage).

Haward, J. (ii) Virginall maker, in 1649 residing in the parish of St Helen Bishopsgate. Made Freeman of the Joiners' Company 1647/8. Perhaps the master of Wiliam Barfoot, Benjamin Frawlins, Thomas Green, Roger Leigh and Thomas Thorne (any of whom may have equally been apprenticed to Haward, J. (i), and almost certainly the master of Henry Avery who completed his apprenticeship in 1672.

Haward, J. (iii) Admitted to the Joiners' Company by patrimony in 1652. His relationship to John Haward (i), or any other maker named Haward is unknown, but most likely.

Haward, T. Virginall maker, living in Bishopsgate in 1650 and the parish of St Giles Cripplegate in 1663. The master of Hugh Brome.

Haward, T. (?) See Howard, T.

Hedger, J. Apprenticed to Gabriel Townsend in 1645. No record of Freedom.

Henlake, R. Virginall maker and Court instrument repairer (1603-10). Ashbee and Lasocki (1998:560) record a warrant dated 7 February, 1607/8 for "a payer of Virginalls by him made for her Mats use".

Hill, R. Apprenticed to Adam Leuersidge in 1658, made Freeman in 1668.

Hill, T. Apprenticed to John Player in 1662, made Freeman in 1670. First master of Joseph Sandles, but had probably died by 1689 when Sandles completed his apprenticeship.

Hingeston, J. Possibly a virginall maker, held the Court position of "keeper and repayrer of his majesty's organs, pedalls, harpsichords and other instruments". See Appendix Two, page 290.

Howard, T. Admitted as Freeman of the Joiners' Company by patrimony in 1657. Possibly a member of the Haward family whose name was spelt incorrectly (several times) in the records of the Joiners' Company. Master of John Crosse when he completed his apprenticeship in 1663.

Hudson, J. Apprenticed to John Haward in 1631. No record of Freedom.

James, J. English virginall maker of Flemish origin, living in the Parish of St Stephen in 1571. Paul Defield worked for James after leaving Theewes.

John, J. de. An organ, and possibly virginall maker in London, working at the English Court from before 1525 until around 1532. See Appendix Two, page 291.

Jones, P. Born c. 1643, Apprenticed to John Haward in 1658, made Freeman in 1667. Possibly worked as a journeyman for Stephen Keene. Set up on his own by 1671. The catalogue of the sale of instruments following the death of Thomas Britton, 1714 lists "a good harpsichord by Philip Jones". Master of Thomas Small. **Surviving instrument : 1671 (Tabley House, Cheshire).**

Keene, S. Born c. 1640, son of Richard Keene of Sydenham, Oxon. Apprenticed to Gabriel Townsend, 1655, turned over to John Player. Made Freeman of the Joiners' Company in November 1662. Master of the Joiners Company 1704/5. Master of John Harris, Abraham Richardson, Robert Smith and Richard Vesey (plus others after 1688). An advertisement at the end of the sixth edition of Playford's *Introduction*, 1671, announces:

> ...Mr Stephen Keene, maker of Harpsycons and Virginals, dwelleth now in Threadneedle Street, at the sign of the Virginal, who maketh them exactly good, both for sound and substance.

Surviving instruments: 1668 (Russell Collection, Edinburgh); 1675 (Private Collection, Cheshire); plus numerous spinets.

Leigh, R. Apprenticed to John Haward in 1653, made Freeman in 1663.

Leuersidge, A. Admitted as Freeman of the Joiners Company 1649/50, and to the Livery 1657/8. Son of William Leversidge. Master of Robert Hill and probably the master (or final master of Thomas White (iii). **Surviving**

instruments : 1666 (Yale University, New Haven, CT, USA); 1670 (Ashmolean Museum, Oxford).

Leversidge, W. Probably a virginall maker, *fl.* 1641/2. Father of Adam Leuersidge, and Master of Thomas Makeham.

Lewes, W. Held a Court position as "keeper, tuner and maker of instruments to the king" from 1513/4 until his death in 1547. The Court records for 6 April, 1530 record the following:

> paied to Willm lewes for 2 payer of virginalles in one coffer wt 4 stoppes brought to Greenwiche, £3.
>
> And for 2 payre of virginalls in one coffer brought to the More other £3.
>
> And for a little payre of virginalls brought to the more: 20s.

See Appendix Two, page 290.

Loosemore, J. Organ builder and virginall maker of Exeter, born 1613, died 1681, buried in Exeter Cathedral. First mentioned as an instrument maker in the 1630s at Hartland:

> 1634/5. Pd. Loosemore for keeping the organs this year 5s.
>
> 1637/8 Pd. John Loosemore for setting of the Organs upon the roudeloft £4.

His best known instrument is the organ in Exeter Cathedral, built in 1665. **Surviving instruments : 1655 (Victoria and Albert Museum, London); plus organs in Exeter Cathedral and Nettlecombe Court.**

Luxton, R. Virginall maker in the parish of St Ethelborrowe's, London, *fl.* 1611.

Makeham, T. Born c. 1626. Apprenticed to William Leversidge in 1641/2, made Freeman in 1649/50. In 1652 he resided in the parish of St Michael Bassishaw, and later (for several years up to 1661) in the parish of St Giles Cripplegate. Probably had died by 1663, as his apprentice John Crosse was admitted Freeman of the Joiners' Company in that year on the relation of Thomas Howard.

Marcator, M. Organ, and possibly virginall maker, holding position as organ maker to the English Court from 1528 - 1544. See Appendix Two, page 291.

Marsam, A. Virginall maker of Leicester, granted his Freedom in that Borough in 1579/80. By his death in 1601 he had probably moved to Coventry, where a record of payment to his widow was made.

Marsh, G. Virginall maker in the parish of St Giles Cripplegate, London, *fl.* 1604/5 - 1608.

Moore, J. Apprenticed to John Player in 1669. No record of Freedom.

Mussard, H. Virginall maker in the parish of St Andrew's Holborn, London, *fl.* 1621.

Norgate, E. Held position of Keeper and Tuner of organs and keyboard instruments, and possibly also made new instruments. See Appendix Two, page 290.

Norton, A. Apprenticed to John Haward in 1630, made Freeman in 1639/40.

Norton, W. Virginall maker in Bishopsgate Street, in the parish of St Ethelburga, London, before 1584.

Player, J. Born c. 1634, the son of Giles Player of Longborough, Glos. Apprenticed 24 June, 1650 to Gabriel Townsend, made Freeman of the Joiners' Company in June 1658, and Master of the Joiners' Company 1687/8. He is believed to have retired or died between 1705 and 1708. Correspondence (with the Tisseran harpsichord in the Bate Collection, Oxford), written by Thomas Day on 10 June, 1712 states:

> I have this morning been to see another harpsichord: it is of Player's making, with split of quarter notes

The workbooks of Thomas Green, Herford, records a tuning in 1746 of a "double", later (1750) referred to as "Player's D str" and in 1753 as "double strung". Master of Thomas Hill, Jarvis Moore, Josiah Rogers and James Welsbourne. **Surviving instruments : 1664 (Cobbe Collection, Hatchlands); plus numerous spinets.**

Poole, E. Apprenticed to John Haward in 1632, made Freeman in 1641/2.

Purcell, H. Composer. In 1673 he was appointed "Keeper, maker, mender, repayrer and tuner of the regalls, organs, virginals, flutes and recorders...[without fee]...and assistant to John Hingeston, and upon the death or other avoidance of the latter, to come into the ordinary with fee." He succeeded Hingeston in 1683. See Appendix Two, page 290.

Purchas, T. Apprenticed to Gabriel Townsend in 1640/1. No record of Freedom.

Rand, J. Virginall maker in Threadneedle Street, London, *fl.* 1663.

Rewallin, C. Maker of virginalls and - as shown by an inventory taken at his death - organs in the parish of St Sidwell's, Exeter. On 23 September, 1657 he married Hester Gosticke in Exeter Cathedral. He died in 1697. The inventory dated 5 July 1697 is included as Appendix Six. **Surviving instruments : 1675 (Castle Museum, Taunton); 1679 (Royal Albert Memorial Museum, Exeter).**

Richardson, A. Apprenticed to Stephen Keene in February 1664, made Freeman in 1671.

Robinson, J. Apprenticed to Charles Haward in 1670. No record of Freedom.

Rogers, J. Apprenticed to John Player in 1677. No record of Freedom.

Rowley, H. Apprenticed to Gabriel Townsend in 1637. No record of Freedom.

Russell, T. Apprenticed to Gabriel Townsend in 1629. No record of Freedom.

Sandles, J. Apprenticed to Thomas Hill in 1680, then turned over to Charles Haward. Made Freeman of the Joiners' Company in 1689

Schetz, E. Instrument maker, replacing William Treasourer as Keeper, tuner and maker of instruments to the King from 1567 until 1603. That he was also a maker of instruments is suggested by his gift of "a smale payre of virginalls" to the Queen on New Year's Day 1676/7. See Appendix Two, page 290.

Sison, B. Virginal(?) and spinet maker of London. Apprenticed to John Needler on 10 October, 1673. His son, John Sison was apprenticed to John Harris. In 1695 he was living in Birchin Lane, parish of St Michael's Cornhill, London. He was buried on 12 November, 1712. **Surviving instruments include several bentside spinets.**

Slade, B. Born c. 1669, Apprenticed to James Aland in September 1684, his apprenticeship was turned over to George Castleman. Made Freeman in March 1698. **Surviving instruments include a harpsichord and several bentside spinets.**

Small, T. Apprenticed to Philip Jones in 1671. No record of Freedom.

Smith, R. Apprenticed to Stephen Keene in 1670. No record of Freedom.

Sowley, J. Apprenticed to Thomas White and made Freeman of the Joiners' Company in 1642/3.

Standly, R. Apprenticed to Thomas White in 1645. No record of Freedom.

Stanley, T. Apprenticed to Thomas White in 1643. No record of Freedom.

Stephens, H. Apprenticed to Gabriel Townsend in 1633. No record of Freedom.

Stevens, H. Apprenticed to Gabriel Townsend in 1635?. No record of Freedom. Probably the same person as listed above.

Stevenson, T. Apprenticed to Thomas White and made Freeman of the Joiners' Company in 1628/9.

Strong, A. Virginall maker of Dublin, *fl.* 1639 - 55. Married Mary Meade on 19 August, 1651.

Testa, A. Virginall maker, born in Rome c. 1621, worked with Girolamo Zenti for four years from 1638. In c. 1667 a petition by Testa records his being sent by Girolamo Zenti as a replacement at the English Court.

Thamer, T. Organ, and possibly virginall maker of Peterborough, paid £7 in 1648 for "repairing and setting in order both the Orgaines and Harpsicale" at Haddon Hall. He built the organ for Framlingham Church, Suffolk.

Theewes, L. Son of Jacob Theewes, a harpsichord and lute maker in Antwerp. Admitted to the Guild of St Luke (Antwerp) in 1561 as the son of a master. He moved to England in September 1567 or 1568, and in 1571 was recorded as living in the parish of St Martin-le-Grand, London as "Lodewyke Tyves, virginall maker, a Dutchman...". see James (1930:29). Theewes is probably the maker mentioned in 1578/9 when Edmund Schetts was paid £2 12s. 6d. for various things including taking a virginall "one other tyme from Greenwiche to Whitehall for a payre of virginalles paynted whiche Lodowicke at hir Mats commandemt and from thens back ageyne...". Last recorded date 1585. **Surviving**

instrument : harpsichord dated 1579 (Victoria and Albert Museum, London).

Thorne, T. Apprenticed to John Haward in 1652. No record of Freedom.

Tolley, R. Probably a misreading of Hatley. A "spinet" of his dated 1661 was reported in England in 1947.

Townsend, G. Virginall maker of London, born c. 1604. Completed his apprenticeship with Thomas White. Freedom granted 1624/5, and made Master of the Joiners' Company 1657/8. He had probably died by November 1662 when Stephen Keene was made Freeman of the Joiners' Company on the relation of John Player. In 1628 he married Elizabeth Hasard, daughter of John Hasard (see MacTaggart 1978:2). Master of John Cooly, Daniel Greetham, John Hedger, Thomas Purchas, Henry Rowley, Thomas Russell, Henry Stephens, Henry Stevens (?) and Thomas Vernam. **Surviving instrument : 1641 (Musical Instrument Museum, Brussels).**

Treasorer, W. Replaced William Lewes as Keeper and tuner of instruments to the King in 1550. Primarily a maker of organs and regals, but also made virginalls. Born in Germany and lived in the Christ Church from his probable arrival in Britain in 1549. On New Year's Day 1558/9 he presented Queen Elizabeth with "oone peire of Virginalls". See Appendix Two, page 290.

Trippet, S. Apprenticed to Thomas White in 1635. No record of Freedom.

Vernam, T. Apprenticed to Gabriel Townsend in 1630, made Freeman in 1637/8.

Vesey, R. Apprenticed to Stephen Keene in 1687, No record of Freedom. **Surviving instrument a spinet.**

Walker, H. Apprenticed to Nicholas Farnaby and made Freeman of the Joiners' Company in 1628.

Welman, R. Apprenticed to Thomas White in 1651. No record of Freedom.

Welsborne, J. Apprenticed to John Player in 1684. No record of Freedom.

White, J. Son of Thomas White (ii). Admitted Freeman of the Joiners' Company by patrimony 1 December, 1656. Lived in Old Jewry, London in 1664. Became the partner of organ builder Ralph Dallam, mentioned in the latter's will as "Mr James White Citizen and virginal maker of London", and finished several organs after Dallam's death. In 1676 subscribed (as an organ maker) to Thomas Mace's *Musick's Monument.* **Surviving instruments : 1656 (Museum of London); 1661 (Bunratty Castle, Eire).**

White, T. (i) The existence of this man rests on the fact that Gabriel Townsend completed his apprenticeship in 1624/5, and must therefore have started before Thomas White (ii) was granted his freedom. There may be other circumstances by which Townsend commenced his apprenticeship - which began before present records survive - and this individual may not have existed. Assuming there is a Thomas White (i), it is not possible to determine whether he or Thomas White (ii) was the master of Edward Becher, John Denmore, John Sowley, Robert Standly, Thomas Stanley, Thomas Stevenson, Samuel Trippet and Richard Welman.

White, T. (ii) Son of Thomas White (i) (?) and father of James White and Thomas White (iii). Freeman of the Joiners' Company 1621. Lived in Old Jewry, London. Buried on 5 January, 1659/60, but probably retired from work when his son James became Freeman of the Joiners' Company in December 1656. **Surviving instruments : 1638 (Private Collection, London); 1642 (Victoria and Albert Museum, London); 1644 (Welsh Folk Museum, Cardiff); 1651 (Castle Museum, York); 1653 (Hardwick Hall, Derbyshire).**

White, T. (iii) Freeman of the Joiners Company 1669, on the relation of Adam Leuersidge. Son of Thomas White (ii).

Zenti, G. Born in Viterbo, north west Rome c. 1609 - 11 and died 1666-7. Much travelled, working in Rome, Sweden, Paris and London. On 29 January, 1663/4 he was granted a pass from the English Court to visit Italy. **Surviving instruments include a bentside spinet, an octave spinet and several harpsichords, none of which was built in England.**

APPENDIX SIX

THE INVENTORY OF CHARLES REWALLIN

This Inventory has previously been published in *The Connoisseur*, July 1916, and Portman, D., 1966, *Exeter Houses 1400 – 1700* (Exeter, 1966).

	£	s	d
Imprimis his wearing apparel		15	0
one chest in the lower fore chamber	1	5	0
Fyve joynt stools in the same room		3	0
fower chares in the same chamber		6	0
Three boxes and part of a tabell board		6	3
on jack, on spit, on pare and irons and one pare of dogs		7	0
two pare of tongs, on firepan and a pot brooke		1	6
one pare of billis and a turner of grinding stone		1	0
five stilling irons and on corn bag and on form		2	6
In the higher fore chamber two brass pots and one iron pot		10	0
three brass Kittles on skillet and on pestell ans Mortar		8	0
two pewter dishes & o0n flagon & three chandlesticks		2	0
on dissen of trachers & a salt box		1	0
in the Easter high chamber on tabell board and on form		3	0
on bed and bedstead		15	0
Three trunks and two boxes		6	0
in the high back chamber on Argon [organ] & on spinet and on little cabinet	17	5	0
In the loft on half hed bedstead & two boxes		6	0

fower score Argon pipes & Lumber in the house	2	0	0
for old iron		7	0
for goods not seen and unpraysed		5	0
for an organ at the Globe [Inn]	15	0	0
The whole sum is	40	15	3

Appraisers: Martha Rewallin, Richard Venner, Christopher Sandford.

APPENDIX SEVEN

THE INVENTORY OF WILLIAM GOODMAN

This inventory has previously been published in Boston, J., 1954, "An English Virginal-Maker in Chester, and his Tools", *Galpin Society Journal VII* (1954).

An Inventory of the goodes of Wm Goodman al's Goodale.

Imprimis five great Joynctures, 3 hand planes, 1 fyle, x small working cheasells, a little halmer, a brest wymble, 3 sawes, 2 squyres, a Joyncture unmade (2 platters, 2 sausers, 3 spones of pewter) an old capcase, a little panne of brasse, 2 cheares, a petticote of flannen, an apron, a wooden quiver, a chest, pented cloth, a carven bedde, a pented clothe over the bed, a coverlet, 2 sheets, 5 pece of brassel, 16 pece of boxe, a little stythye, a bowlster, a whetston, a pair of virginalls undrest, a lute case appreciat' *ad valenciam* 23s 4d.

APPENDIX EIGHT

AN APPROACH TO DESIGNING A PYTHAGOREAN-SCALED VIRGINAL

As was shown in Chapter Three, English virginal makers used bridge templates to make their bridges. A number of the surviving instruments are Pythagorean scaled, and other virginals were intended to be Pythagorean scaled if they played at a different pitch. This Appendix considers how a maker would design the original bridge template to ensure it was Pythagorean.

Unlike constructing an instrument in which the marking-out commences with the register, followed by the right bridge, and then the left bridge; a different order must be used to design a right bridge template.

It is not necessary to design a bridge template on a soundboard. It is perfectly possible to do it on a baseboard or even a work bench. It is probable that the register was still positioned first. The maker probably commenced with a long virtual spine and then positioned the register template in relation to this virtual spine as he would in a normal instrument.

The second part to be positioned is the left bridge. This must be placed in order to ensure a correct angle for the strings, and for suitable basic plucking point positions. The maker would be able to make any refinement such as curving the left bridge at this stage.

Once both the register and the left bridge were correctly positioned the maker could mark out his right bridge position. This would be done by using "dummy strings" (in practice the maker would probably use a long straight edge), which pass from the left bridge, past the jackslot (with an appropriate amount of clearance for the quill), and finish to the right of the register. As the Pythagorean section usually extends only as far as c^1 the maker can use a yardstick which would give ample length.

Assuming a right-bridge template for a C – c^3, quire pitch, instrument was required, the maker would mark the position of the c^3, c^2 and c^1 right bridge pins (6, 12 and 24 inches respectively), as well as some intermediate notes, possibly the f^2 and f^1 strings. Once these positions are marked he could simply create a smooth curve for the other treble notes, and continue a straight line for the tenor and bass.

It would be possible for the maker to use a pre-existing right bridge pin ruler if he wished by marking the position of the bridge pins in relation to the virtual spine before using the dummy strings. Alternatively he could create a new stick from the newly marked-out bridge.

Once the line of the bridge pins was measured and marked the maker could add offset lines at the appropriate distances for the distance of the front of the bridge and its total width.

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