

ONE

KEYBOARD ORIGINS

THE KEYBOARD

A musical instrument keyboard consists of a row of levers used to actuate a mechanism that produces the notes of a musical scale. Our conception of a keyboard implies the use of a light “finger technique,” as opposed to a pounding “arm technique” (such as the use of fists in playing the keyboard of a baton carillon), or ancient systems in which individual organ sliders were pulled back and forth (as illustrated in the early eleventh-century Pommersfelden Bible and the early twelfth-century Harding Bible) or pushed against springs (as was employed in operating the sliders of the ancient, Byzantine, and medieval *hydraulis* as described by Hero and Vitruvius, and the remains of one preserved in the Aquincum Museum in Hungary).¹ While these primitive organ mechanisms placed notes and intervals within ready reach of the hands, they were operated by pulling and pushing rather than by an up-and-down movement. Although an organ mechanism utilizing keys having a rocking motion and spring return is described in the eleventh-century Bern Codex, such key-levers (having gravity or spring return) were evidently not widely used in the organ until the thirteenth century. One such thirteenth-century “finger-action” organ keyboard is illustrated in the Rutland Psalter (formerly known as the Belvoir Castle Psalter).² In 1619 the German organist and theorist Michael Praetorius (born Michael Schultze or Schultheiss, 1571–1621) wrote that earlier organ keys were so cumbersome that

they had to be played with the fists,³ although this assertion is not supported in other literature.⁴ His Italian contemporary, the organist Girolamo Diruta (1546–1624), employed the term *percuotere* (to strike) in reference to organ and harpsichord key-touch, though he distinguished between pressing (*calcatto*) and beating (*battuto*) the keys for legato and detached phrasing.⁵ Unlike fingering instructions given in earlier treatises by Bermudo (1555), Henestrosa (1557), Santa María (1565), and Cabezón (1578), Diruta eschewed use of the thumb, thereby requiring an awkward crossing-over of the ring finger by the middle finger when playing scales and runs.⁶

Another instrument that used a primitive keyboard was the *organistrum*, a name given to the medieval ancestor of the hurdy-gurdy (a stringed instrument that uses a rotating friction wheel to cause its strings to vibrate). As depicted in twelfth-century sources (such as a relief carving on the cathedral of Santiago de Compostela in Spain), the *organistrum* tended to be larger than the later hurdy-gurdy and is often shown being played by two people – one operating a crank that rotates a friction wheel, and the other playing a keyboard with both hands. In the later hurdy-gurdy, the keys, which operate frets, may either be pressed inward against springs, which return them when finger pressure is released, or the instrument is held in such a manner that the keys return by gravity. The most popular later type is played by one person, often depicted as a street musician. That instrument was typically suspended by a neck strap in such a way that one hand cranked while the other operated the keys.

EARLY REFERENCES TO KEYBOARD INSTRUMENTS

Although keyboard music survives from the early fourteenth century (the Robertsbridge fragment, ca. 1320, is considered the earliest) the first references to stringed keyboard instruments in written sources are of a somewhat later date. These include numerous allusions to the *chekker* (a term most likely derived from the alternating light and dark colored keys typically used in chromatic keyboard instruments, which are reminiscent of a checkerboard) in the account books of French and Burgundian courts dating from 1360, including Philip the Bold's purchase of an *échiquier* upon the arrival of the Flemish organist Jean Visée in 1384,⁷ and its mention in letters dated 1387 and 1388 of King John I of Aragon.⁸ Other early references to keyboard instruments include a passing remark in a letter of 1397 regarding the invention of the *clavicembalum* by the astrologer/physician Hermann Poll,⁹ and their mention in the writings of Johannes de Gerson (1363–1429).¹⁰ The terms *schachtbret*, *monocordium*, *clavicordium*, and *clavicymbolum* can be found in Eberhardus Cersne's *Der Minne Regel* of 1404, a lengthy poem in the *Minnesang* tradition of courtly love.¹¹ *Schachtbret* (meaning chessboard) is another term referring to the light and dark

keys of a keyboard. *Monocordium* could either be a reference to the monochord, generally a single-stringed, keyboardless device used to study musical intervals and temperaments, or to the clavichord (as it is used in Marin Mersenne's *Harmonie universelle* published in 1636; for further references to the monochord see pp. 8–9, 14–15).¹² The Italian term *clavicinbalo* first appears in a letter dated November 15, 1461 addressed to the Duke of Modena, Borso d'Este (1413–1471) by the instrument maker Sesto Tantini.¹³ The earliest known depiction of a stringed keyboard instrument is thought to be a wood carving dating from 1425 of angels playing a clavichord and *clavisimbalum* in an altarpiece in the cathedral of Minden (see Chapter 3, Figure 3.6).¹⁴ Perhaps it is not coincidental that Cersne, a canon and minstrel poet, hailed from Minden.

The *Liber viginti artium* (ca. 1460) of Paulus Paulirinus of Prague (1413–ca. 1470), an encyclopedic manuscript devoted to twenty arts, including grammar, logic, rhetoric, mathematics, astronomy, biology, geography, medicine, metaphysics, theology, and law, includes a section on music that describes several types of instruments, including two stringed keyboard instruments termed *clavicordium* (clavichord) and *clavicimbalum* (harpsichord). The *clavicordium* is described as follows:

The clavichord is an instrument in an oblong cabinet, having pairs of metal strings and keys in front, some of which produce tones and semitones, but shorter keys produce B♭s. When used in the preliminary study of the organ and others, it serves as a good instructor of gathered knowledge. It is an instrument that truly enables one to recognize musical consonances.

[C]LAVICORDIUM est instrumentum oblongum in modum cistule, habens cordas metallinas geminatas et claves abante, quorum quidam ostendunt tonos quidam simitonia, sed breviores claves ostendunt b molles. Quo cum suo calcatorio datur magnum preambulum in studium organorum et aliorum, ut in isto instrumento bene edoctus, illius per se accipiat scienciam. Et est instrumentum vere musice tradens consonanciarum agnitiones.

At this early point in the history of keyboard instruments, b♭ was the only accidental key available on the keyboard. Such a keyboard layout is illustrated in Sebastian Virdung's *Musica getutscht* of 1511.¹⁵ Paulus then describes the *clavicimbalum* as follows:

[C]LAVICIMBALUM is a tool of intense sweetness in sound, having strings of metal for all its courses and keys in front like those of the organ, which when touched by the fingers, quills connected inside make the strings resonate. It provides an introduction to the art of music and an apprehension of all the different modes and pitches. It is similar in percussion to that of the clavichord, but it sounds sweeter and more sonorous.

[C]LAVICIMBALUM est instrumentum mire suavitatis in simfonisando, habens cordas metallinas per omnes suos choros et abante clavos uti organum, qui forinsecus digittis tacti per pennam introrsus coannexam faciunt cordas resonare, dans modum in artes musicalis introitum et apprehensionem omnium differenciarum in tonis et vocibus. Et concordat in percussione cum clavicordio, nisi quod dulcius et sonosius sonat.¹⁶

Also described in his *Liber viginti artium* are stringed instruments without keys: the monochord (which Paulirinus states is said to have been invented by Boethius, ca. 477–524 CE) and the *dulce melos*, or dulcimer. Regarding the monochord, this device certainly preceded Boethius, for it was described centuries earlier in the *Harmonics* of Claudius Ptolemy (fl. 146–ca. 170 CE), though he refers to it as the *kanon* (a Greek term for “measuring rod”); it may have even earlier origins (though probably not as far back as Pythagoras) as some have speculated.¹⁷ The *dulce melos*, an instrument distinguished from the psaltery because it used handheld mallets rather than plectra, is also the name given by Henri Arnaut around 1440 to stringed keyboard instruments employing a striking mechanism (see Chapter 3, pp. 155–163).

EARLY KEYBOARD RANGES AND THE INCLUSION OF ACCIDENTALS

Keyboards and mechanical systems of tangents, jacks, rotating friction wheels, and hammers are complex, so it follows that stringed keyboard instruments developed after the more rudimentary monochord, psaltery, and dulcimer, which were essentially box-zithers whose strings were either plucked with the fingers or handheld plectra, struck with handheld mallets, or bowed. It has been suggested, for example, that the nineteen-string “monochord” mentioned in Johannes de Muris’s *Musica speculativa* (1323) might have had a keyboard (and thus would qualify as a clavichord).¹⁸ Were it a monochord, its nineteen strings might have been tuned to sound the nineteen notes represented on the front of the “Guidonian hand.” Another possibility is that the strings were tuned to the notes of a fully chromatic octave, such as those of the *cembalo cromatico* devised in Prague by Carolus Luython (1557–1620) and described by Michael Praetorius in his *Syntagma musicum* (1619); the nineteen-note-per-octave keyboard of that instrument had all of the accidental keys split, plus extra accidentals positioned between the Es and Fs as well as Bs and Cs.¹⁹ If the nineteen-string monochord was a clavichord, it could have accommodated any number of keyboard ranges by fretting nine pairs of strings (plus one), similar to the nine-pair arrangement described and illustrated in Henri Arnaut of Zwolle’s manuscript of ca. 1440 (see Chapter 3, p. 145).

Early drawn or painted depictions, intarsias, stone and terracotta sculptures, impressions on coins, and carved reliefs cannot be relied upon as accurate renditions of compass or the arrangement of natural and accidental keys. For example, *pentimenti* (original paint showing through later changes) reveal that the positive organ depicted in Jan van Eyck's 1432 *Adoration of the Lamb* did not originally have the now familiar arrangement of natural and accidental keys, but instead had a keyboard similar to that of the so-called Norrlanda organ (discovered in Gotland and now preserved in the Musikhistoriska Museet in Stockholm), which is believed to date from the late fourteenth century. The twenty-two-note compass (c–a¹) of the Norrlanda organ's manual keyboard was made with a different arrangement of accidentals – its solitary b \flat (“b” in German notation) was shaped like a natural key positioned between a and b (h), with the shorter C \sharp , D \sharp , F \sharp , and G \sharp keys arranged in two pairs positioned above the natural keys. (What appears to be a twenty-third key, centrally located above the other keys, may have operated a drone or a dump valve used to empty the bellows after playing.) Another fourteenth-century Scandinavian organ has a similar arrangement of keys, and one of the keyboards of Nicolaus Faber's 1361 Halberstadt organ (as depicted in 1620 by Praetorius) also has raised pairs of accidentals (C \sharp , D \sharp ; and F \sharp , G \sharp).²⁰ The depiction of the organ by van Eyck was overpainted to conform with the five accidentals per octave that we are familiar with today, though which had already come into use in keyboard instruments contemporaneous with the painting's installation as an altarpiece in the Church of St. Bavo in Ghent in 1432.²¹ Van Eyck's initial rendition of the keyboard may have been accurate (though anachronistic) when he first painted it; nevertheless, many early depictions of keyboards are schematic at best.

Diruta noted the distinction between organ and stringed keyboard instrument repertoire (“with organs of the church one should not play *Passi e mezzzi* and other *Sonate da ballo*, or lascivious and dishonorable *Canzoni*”), and he cited the Council of Trent's decree of 1562 that

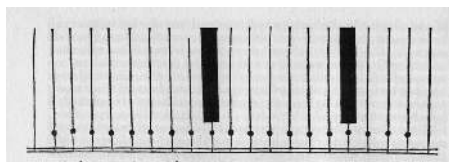
banished from churches all those kinds of music, in which, whether by the organ, or in singing, there is mixed up anything lascivious or impure; as also all secular actions; vain and therefore profane conversations, all walking about, noise, and clamor, that so the hours of God may be seen to be, and may be called, truly a house of prayer.²²

The arrangement of accidental keys in early organs therefore differed from those of stringed keyboard instruments. Because organs were primarily intended for liturgical use, very early ones depicted in the eleventh and twelfth centuries were generally made with diatonic keyboards plus the B \flat (notes of the medieval gamut), though in later practice, when church modes were more freely transposed, other accidentals were required; Juan Bermudo indicates in

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his *El arte Tripharia* (1550) that the modes can be transposed up a whole tone if F \sharp and C \sharp are available on the keyboard, or transposed up a fifth or down a fourth with F \sharp , down a whole tone using B \flat and E \flat keys, and down a minor third with F \sharp , C \sharp , and G \sharp (thus, such a keyboard would have to be equipped with five accidental keys).²³ Stringed keyboard instruments could be used to practice organ repertoire, but they were also used in secular entertainment (dancing and singing) and thus required inflexions provided by a chromatic keyboard (as well as by the practice of *musica ficta*); consequently, many of the earliest known keyboard compositions require B \flat , C \sharp , F \sharp , and G \sharp (such as the *estampies* of the fourteenth-century Robertsbridge fragment and the Faenza Codex, as well as most of the fifty-eight examples transcribed by Willi Apel in his *Keyboard Music of the Fourteenth and Fifteenth Centuries*).²⁴ Furthermore, the earliest known depictions of clavichords and harpsichords (such as the those depicted in the fifteenth-century Minden altarpiece) show them with five-accidentals-per-octave keyboards.

Sebastian Virdung's *Musica getuscht* of 1511, the earliest printed book devoted exclusively to musical instruments and their classification by type, depicts various keyboard arrangements, including one having a twenty-two-note compass of G–e² with two short accidentals, b \flat and b \flat ¹ (Figure 1.1), and another keyboard having a thirty-eight-note chromatic compass (with five conventionally positioned accidentals) and a range of F–g² (with the F \sharp omitted). He also illustrates



1.1. Woodcut illustration of early keyboard layout showing diatonic naturals and B \flat keys. Sebastian Virdung, *Musica getuscht* (1511).

two rectangular keyboard instruments, which he terms *Clavicordium* and *Virginal*, both of which have an apparent thirty-eight note keyboard range of A–b² with the b \flat ² omitted (Figure 1.2a), as well as a rectangular *Clavicimbalum* and an upright *Claviciterium* (Figure 1.2b) having respective apparent ranges of D–f² and A–b², the latter again with the b \flat ²

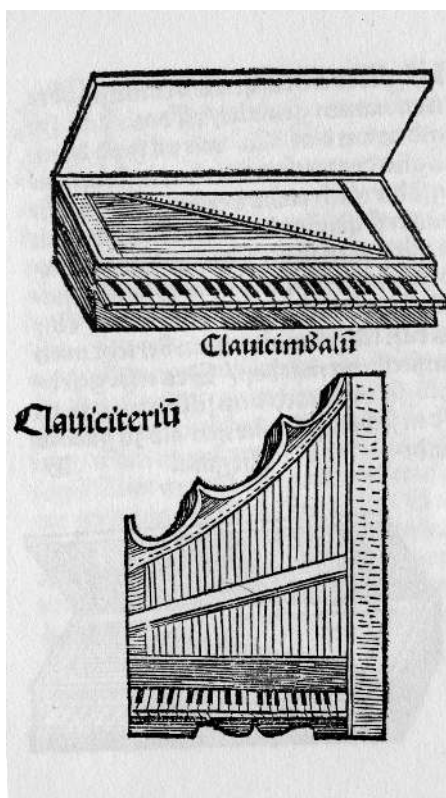


1.2a. Woodcut illustration of *Clavicordium* and *Virginal* in Sebastian Virdung, *Musica getuscht* (1511).

omitted.²⁵ The *Virginal* and *Clavicordium* appear to be accurately depicted, as the *Virginal*'s shortest string is played by the top key and its longest string is played by the bottom key, and though the *Clavicordium*'s stringing arrangement is crudely represented, its tuning pins are located on the right side of the case, as they are on the *Virginal*; however, the images of the *Clavicimbalum* and *Claviciterium* appear to be reversed left to right, as their longest strings are played by the top keys and their shortest strings by the bottom keys – a printing error that often occurs in engravings and woodblock prints due to the inversion of the paper over the copper plate or woodblock in the printing process if the engraver or block cutter has not reversed the image prior to the engraving or cutting process. It is unclear why the keyboards represented on Virdung's page B1 are accurately depicted, whereas those on the verso of that page are reversed.

If Virdung's images of the *Clavicimbalum* and *Claviciterium* are flipped (Figures 1.3a, b), then the compass of the forty-key *Clavicimbalum* becomes B [possibly G/B]–d³, and the thirty-eight-key *Claviciterium* becomes F–g².²⁶ The latter compass is in agreement with the depiction of the thirty-eight-note chromatic keyboard noted above.

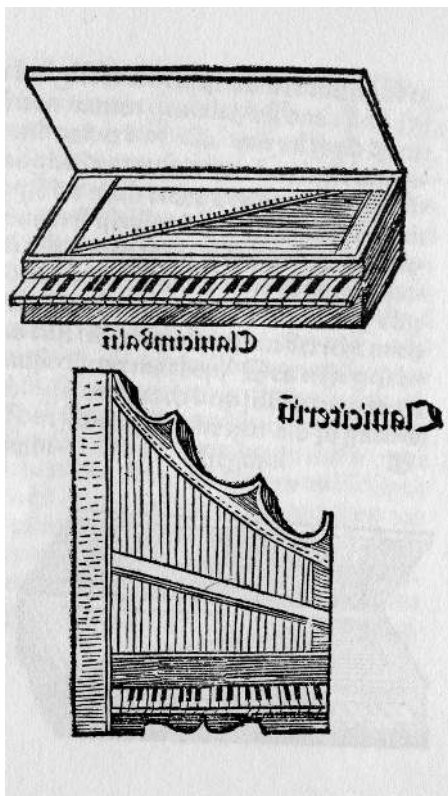
Illustrations in Martin Agricola's *Musica instrumentalis deudsch* (1528) are essentially copies of Virdung's, though the perspective



1.2b. Woodcut illustration of *Clavicimbalum* and *Claviciterium* in Sebastian Virdung, *Musica getutscht* (1511).



1.3a. Reversed woodcut illustration of *Clavicordium* and *Virginal* in Sebastian Virdung, *Musica getutscht* (1511).



1.3b. Reversed woodcut illustration of *Clavicimbalum* and *Claviciterium* in Sebastian Virdung *Musica getutscht* (1511).

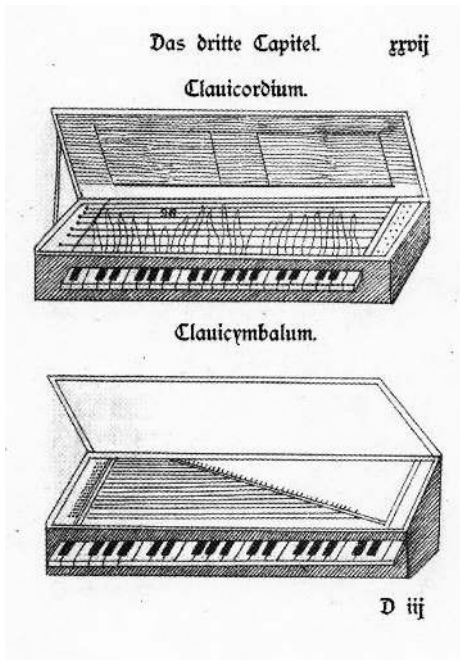
is reversed and the compass of his virginal is $D-f^2$, which differs from Virdung's (Figures 1.4a, b and 1.5a, b).

As indicated above, Virdung postulated that the earliest clavichords were derived from diatonically divided monochords and thus lacked accidental keys, except for the addition of two B \flat s, and he illustrates such a hypothetical twenty-two-note keyboard having the gamut range of $G-e^2$. A similar keyboard layout can be found in Ercole Bottrigari's *Il desiderio* of 1594, though his descends to F and includes an additional B \flat in the lowest octave.²⁷ Virdung remarked that as a result of Boethius's addition of the chromatic genus to the divisions of the monochord (ca. 500 CE), clavichords commonly had a thirty-eight-note keyboard, and he illustrates this with a keyboard spanning $F-g^2$. Virdung further informs us that newer clavichords were then being made with four or more octaves of keys, as well as the addition of pull-down pedalboards.²⁸ Diruta (1593) notes that keyboards were made beginning with different notes and mentions those that began with two white keys followed by three black keys (suggesting the short-octave C/E) and another having three white keys followed by one black key (most likely F, G, A, B \flat).²⁹

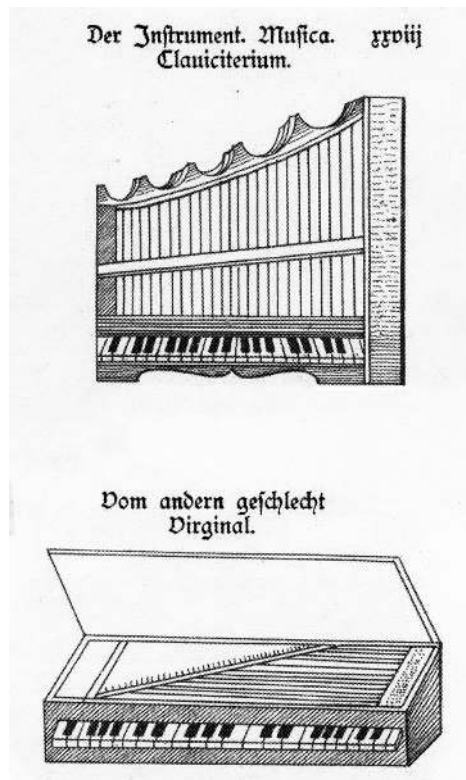
Writing in 1619, Praetorius reiterated and elaborated on Virdung's historical account:

The clavichord developed from the monochord (according to the Scale of Guido, has never had more than twenty notes) and has not been divided; for instead of every fret on a monochord, a key has been made on the clavichord. And in the beginning, the twenty keys were no longer made in diatonic notes alone, but included only two black claves, the b [b \flat] and b' [b \flat ¹] because in an octave they were no more than three semitones, a–b, h–c, and e–f, as can still be seen in the old organs. But afterwards they had thought things over and included more semitones from Boethius's chromatic genus. So that the following keyboard was made:

F, G, G \sharp , A, B, h, c, c \sharp , d, d \sharp , e, f, f \sharp , g, g \sharp , a, b, h, c¹, c \sharp ¹, d¹, d \sharp ¹, e¹, f¹, f \sharp ¹, g¹, g \sharp ¹, a¹, b¹, h¹, c², c \sharp ², d², d \sharp ², e², f², f \sharp ².



1.4a. Woodcut illustration of *Clavicordium* and *Clavicymbalum* in Martin Agricola, *Musica instrumentalis deudsch* (1528).

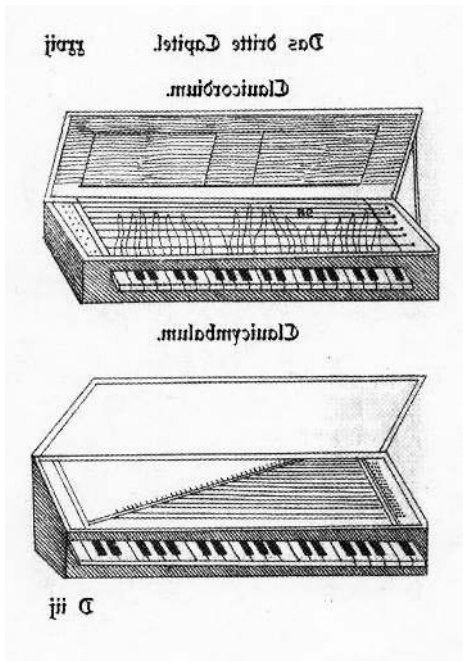


1.4b. Woodcut illustration of *Virginal* and *Claviciterium* in Martin Agricola, *Musica instrumentalis deudsch* (1528).

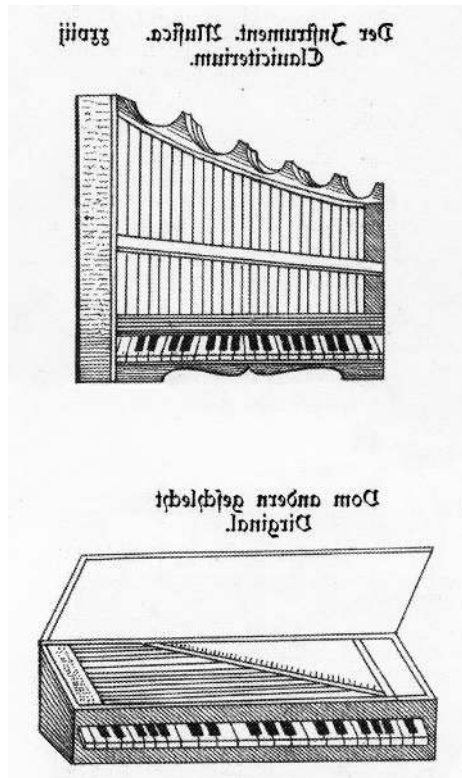
But these days all harpsichords and clavichords start from the bottom C and most of the time go up to a^2 , c^3 or d^3 (which is the best), and even up to f^3 , of which few will be unaware.

Das Clavichorium ist aus dem Monochordo (nach der Scale Guidonis, welche nit mehrmals 20. Claves gehabt hat) erfunde un außgetheilet worden; denn an statt eines jeden Bundes uffm Monochordo, had man ein Clavem uffm Clavichordio gemacht; Und sind anfangs nicht mehr den 20. Claves allein in genere Diatonico gemacht worden darunter nur zweene schwarze Claves, das b und b' gewesen: Denn sie haben in einer Octav nicht mehr als dryerley Semitonia gehapt, a–b, h–c, und e–f, wie desselbe noch in den gar alten Orgeln zu ersehen. Hernacher aber had man den Sachen weiter nach gedacht und aus dem Boëtio nach dem genere Chromatico mehr Semitonia darzu gebracht. Also daß ein solch Clavir draus worden:

F, G, $G\sharp$, A, B, h, c, $c\sharp$, d, $d\sharp$, e, f, $f\sharp$, g, $g\sharp$, a, b, h, c^1 , $c\sharp^1$, d^1 , $d\sharp^1$, e^1 , f^1 , $f\sharp^1$, g^1 , $g\sharp^1$, a^1 , b^1 , h^1 , c^2 , $c\sharp^2$, d^2 , $d\sharp^2$, e^2 , f^2 , $f\sharp^2$.



1.5a. Reversed woodcut illustration of *Clavicordium* and *Clavicymbalum* in Martin Agricola, *Musica instrumentalis deusch* (1528).



1.5b. Reversed woodcut illustration of *Virginal* and *Claviciterium* in Martin Agricola, *Musica instrumentalis deusch* (1528).

Daß aber jezo alle Symphonien und Clavichordia unten vom C anfangen und benmeistentheils ins a², c³ oder d³ [welches dann zum besten] Auch wol im f³ sich endigen wird wenigen unwissend und unbekant seyn.³⁰

Below are keyboard ranges of several early manuscript sources of keyboard works whose compasses are compatible with those of Virdung's woodcut depictions (in uninverted form).

Work	Keyboard Range
Robertsbridge fragment (Brit. Mus. Add. 28550; ca. 1320)	c–e ²
Oxford Bodleian Library, Douce MS 381 (ca. 1400)	c–a ¹
Faenza Codex (ca. 1430) ³¹	Bb–f ²
Vienna Nat. Bibl. <i>Cod. 3617</i> (ca. 1520)	A–b ¹
Breslau Staatsbibliothek <i>I Qu 438</i> (ca. 1520)	A–d ²
Buxheimer Orgelbuch (ca. 1460) ³²	G–f ²