

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 (*calcato*) 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 Bbs. 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 agniciones.

At this early point in the history of keyboard instruments, bb 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 sonorosius 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.

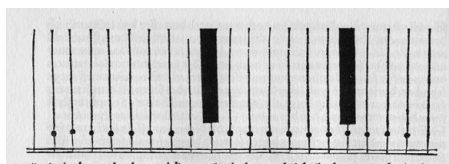
Diruta noted the distinction between organ and stringed keyboard instrument repertoire (“with organs of the church one should not play *Passi e mezzzi* and other *Sonate da ballo*, or lascivious and dishonorable *Canzoni*”), and he cited the Council of Trent's decree of 1562 that

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

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

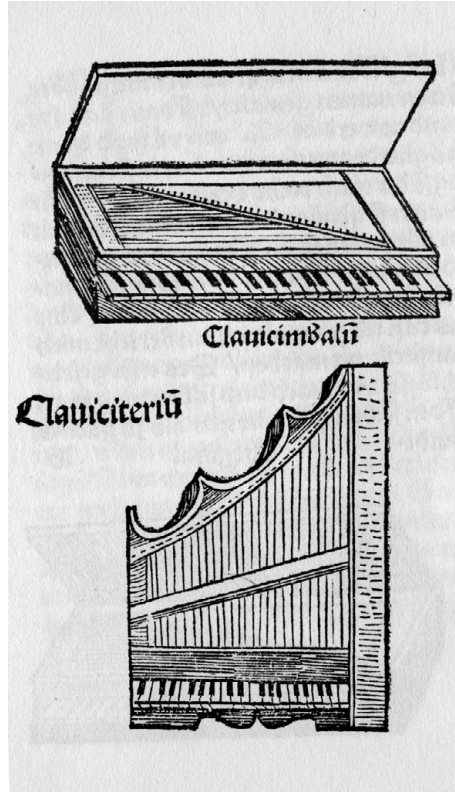


1.2a. Woodcut illustration of *Clavicordium* and *Virginal* in Sebastian Virdung, *Musica getuscht* (1511).

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.

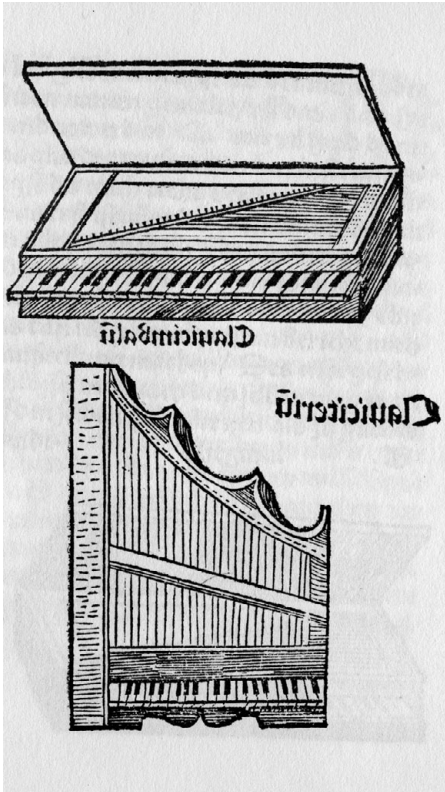
Illustrations in Martin Agricola's *Musica instrumentalis deudsch* (1528) are essentially copies of Virdung's, though the perspective



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



1.3a. Reversed woodcut illustration of *Clavicordium* and *Virginal* in Sebastian Virdung, *Musica getutsch* (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–f², which differs from Virdung's (Figures 1.4a, b and 1.5a, b).

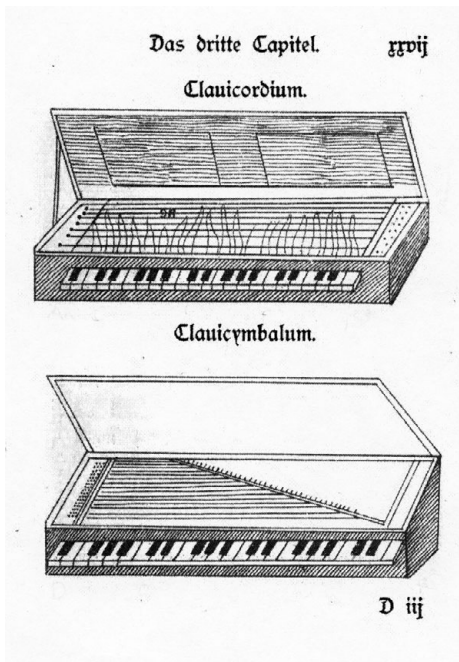
As indicated above, Virdung postulated that the earliest clavichords were derived from diatonically divided monochords and thus lacked accidental keys, except for the addition of two Bbs, and he illustrates such a hypothetical twenty-two-note keyboard having the gamut range of G–e². A similar keyboard layout can be found in Ercole Bottrigari's *Il desiderio* of 1594, though his descends to F and includes an additional Bb 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–g². 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, Bb).²⁹

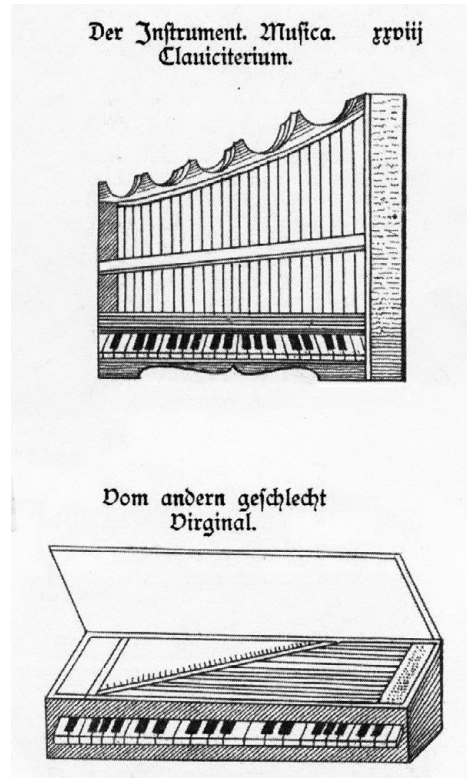
Writing in 1619, Praetorius reiterated and elaborated on Virdung's historical account:

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 [bb] and b' [bb¹] 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#, A, B, h, c, c#, d, d#, e, f, f#, g, g#, a, b, h, c¹, c#¹, d¹, d#¹, e¹, f¹, f#¹, g¹, g#¹, a¹, b¹, h¹, c², c#², d², d#², e², f², f#².



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

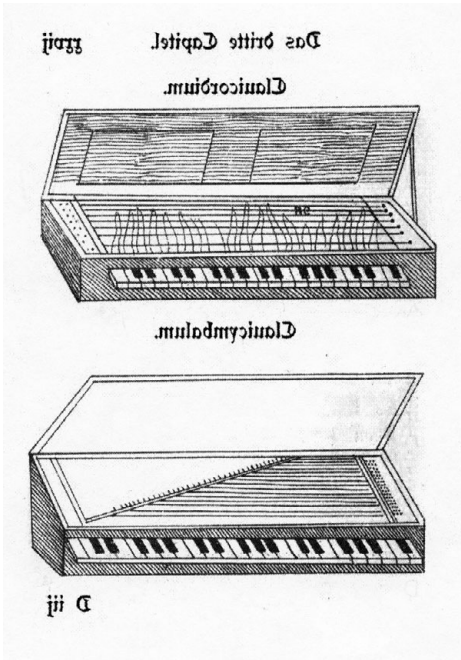


1.4b. Woodcut illustration of *Virginal* and *Claviciterium* in Martin Agricola, *Musica instrumentalis deutsch* (1528).

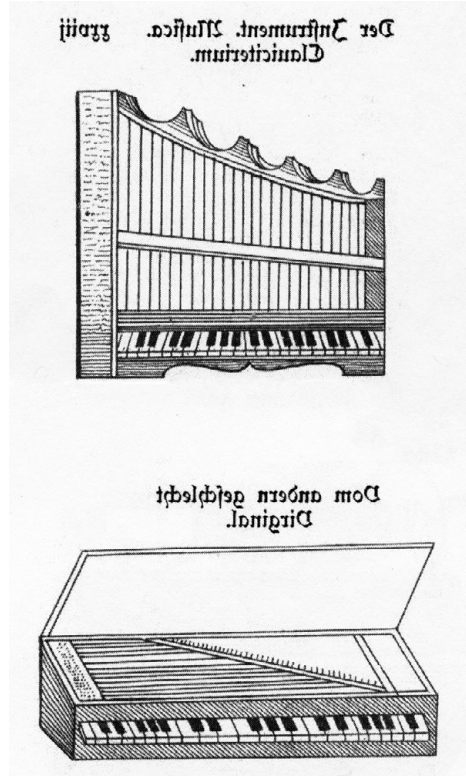
But these days all harpsichords and clavichords start from the bottom C and most of the time go up to a^2 , c^3 or d^3 (which is the best), and even up to f^3 , of which few will be unaware.

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

PRINCIPAL TYPES OF STRINGED KEYBOARD INSTRUMENTS: EARLY NOMENCLATURE

As is revealed in the manuscript of Henri Arnaut of Zwolle (see Chapter 3, pp. 149–164), stringed keyboard instruments featuring touching (clavichord), plucking (harpsichord), and striking (piano) mechanisms coexisted at the beginning of the fifteenth century.³³ His *clavisimbalum* featured a bentside and had strings that ran in line with the key-levers, and he indicates that it could be fitted with either plucking or striking mechanisms. The *dulce melos* was rectangular with strings running perpendicular to the key-levers and could be made either with a striking mechanism or with tangents (a touching mechanism), as in his *clavicordium*. For some inexplicable reason, the striking mechanism fell into disuse, and aside from disconnected and unheralded reintroductions,³⁴ this method of activating the strings remained in obscurity until Bartolomeo Cristofori's brilliant invention of a pivoted hammer and escapement mechanism around 1700 (see Chapter 6, p. 313).³⁵

As indicated above, one of the first terms used to denote stringed keyboard instruments was “chekker,” otherwise spelled *chequer* and *l'eschaquier d'Engleterre*, the latter spelling as it appears in the French poet Guillaume de Machaut's (ca. 1300–1377) list of musical instruments in his *La Prise d'Alexandrie* (after 1369); an earlier (1340s–1357) list in his *Le Remède de fortune* does not include this term, suggesting he had not learned of such an instrument at that time of writing. As Machaut refers to it as *d'Engleterre* around the time stringed keyboard instruments are believed to have come into use, it is possible that the chekker was an English invention.³⁶ The term itself derives either from the similarity in appearance between the black and white keys of a keyboard instrument and the alternating light and dark squares of a chessboard, or perhaps those of a counting board or table (a square surface covered with a striped or checked cloth that was used to keep track of finances in medieval times). In the English language, spellings such as *cheker* and *chequer* (in reference to the board game), can be traced back to 1297, while the term *exchequer* (in reference to financial accounting) extends back to 1178.³⁷ With regard to keyboard instruments, the term was in general use up to around 1400 (as indicated above, in 1387 and again in 1388 King John of Aragon requested the Duke of Burgundy to send him an *exaquir*).³⁸ The Latin term *abacus*, which in medieval times referred to a counting or gaming board, was also used in reference to keyboard instruments, as in Athanasius Kircher's discussion of enharmonic keyboards in his *Musurgia universalis* (1650).³⁹

Foreign-language terms for the various types of stringed keyboard instruments include *arpicordo*, *cembalo*, and *sordino* (Italian; the last term denoting the clavichord), *clavecín* and *épinette* (French), *Flügel*, *Clavier*, or *Klavier* (German), and *clavicordio* (Spain). Vincenzo Galilei (Florence, 1581), believed the term

arpicordo was derived from the Italian word *harpa* (harp), as its strings varied in length according to their pitch like those of a harp (unlike instruments such as the lute, lyre, guitar, mandolin, violin, and viol, whose strings of different pitches are generally of the same length) – that it was in a sense an *arpa giacente* (recumbent harp).⁴⁰ The term *corda* is the Italian word for “string,” though the word *acorda* means to “bring into accord,” or to “tune.” The term *claviorganum* indicates a combination stringed keyboard instrument and organ. The terms *organa* and *organum* first appear in 757 CE in reference to a musical instrument (most likely a pipe organ) that was presented by Emperor Constantine V to the Frankish King Pepin.⁴¹ Onward of the ninth century, the term *organum* referred to a form of plainchant employing a second voice, often sung in parallel harmony a fourth or fifth apart. In that sense, the *claviorganum* possesses a second voice by virtue of combining two instruments in one.

The German word *Flügel* means “wing” and refers to the shape of a “grand” instrument’s case, which resembles the outstretched wing of a bird and is a reflection of the exponential progression of its string lengths proceeding from treble to bass. This term was used by Michael Praetorius, who in 1619 described the shape of the *Clavicymbalum* as resembling a pig’s head (*Schweinskopf*).⁴² Jakob Adlung described the shape of the *Clavecin* or *Clavicymbal* as that of a “triangle” (*Triangul*).⁴³ The term “grand,” incidentally, first appears in a patent taken out by the London maker Robert Stodart in 1777. Throughout the early nineteenth century, the Broadwood firm termed them “horizontal grands,” while the French referred to them as *pianos à queue* (pianos with tail). In the Low Countries during the sixteenth through early eighteenth centuries, the wing-shaped harpsichords were referred to as *Steert-stukken* or *Staatstukken* (meaning tail pieces), in reference to their tapered cases.⁴⁴

The French term *épinette* and English term “spinnet” are thought to be derived from the Italian word *spina*, meaning “thorn,” and may either be a reference to the elongated, pointed shape of the popular pentagonal *spinetta* or perhaps to the thorn-like plectra used to pluck its strings. (In Italy, a small spinnet was termed a *spinettina* and a large one a *spinettone*.) Adriano Banchieri (1609) suggested that the term *spinetto* was derived from the name of its purported inventor, a Venetian instrument maker named Giovanni Spinetti, based upon an instrument he had seen inscribed *Ioannes Spinetus Venetus Fecit. A. D. 1503*, though that instrument was not elongated or pointed, but had a “long, square shape (*forma longa quadrata*).⁴⁵ In any case, it is clear that the term in its French form pre-dates 1500.⁴⁶

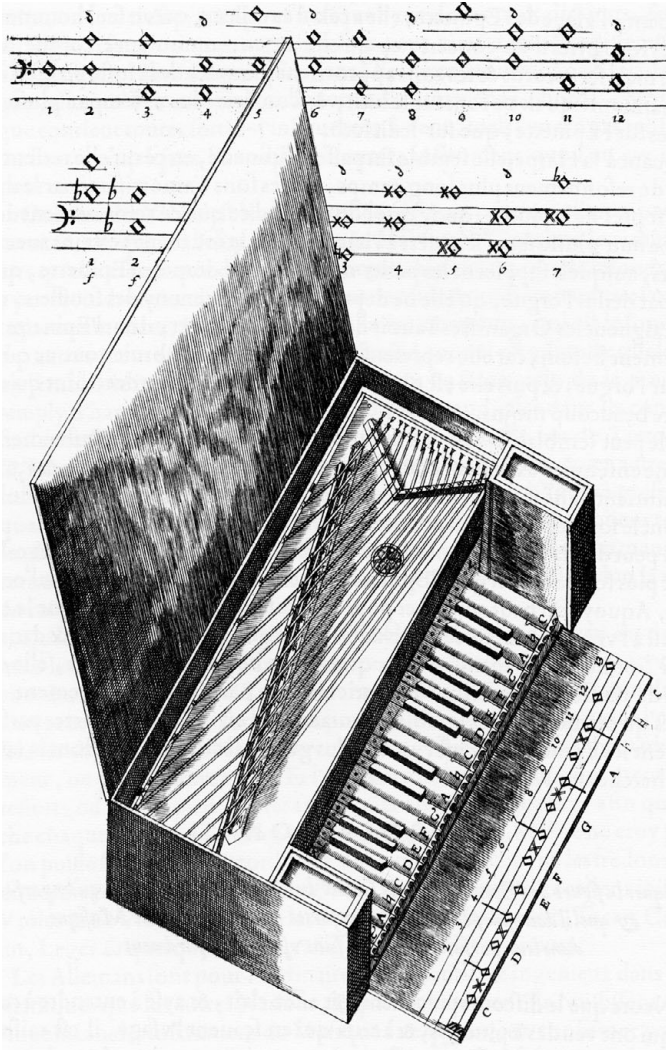
The French term *clavecin* (meaning “keyboard instrument”) and the German *Clavier* or *Klavier* (meaning “keyboard,” though sometimes used in reference to an entire keyboard instrument) are derived from the Latin *clavis*, which means “key.” The English term “clavichord,” which refers specifically to a type of keyboard instrument that employs tangents (thin metal blades) that

touch its strings, may be derived from a medieval Latin instrument termed the *clavichordium*, or perhaps more directly from the German *Clavichord* (or *Klavichord*), all of which combine the terms for key and string. An early term for the clavichord, and perhaps for keyboard instruments in general, was *manichordion* – perhaps because the clavichord’s key-mounted tangents “fret,” or establish the length and pitch of its strings, just as a moveable bridge does in the monochord. Another possibility is that it is derived from the Latin, meaning a string instrument manipulated by the hand (*manus*). In France as late as 1785, the term *manicorde*, or *manicordion*, was still used in reference to the ancestor of the *clavicorde*.⁴⁷ The Spanish words *clave* and *clavicordio*, which today refer specifically to the clavichord, up through the eighteenth century referred to any type of stringed keyboard instrument. The Italian term *cembalo*, the archaic German word for harpsichord, *Klavizimbel* (or *Clavicymbel*), and the Flemish term *clavicimbel* are derived from the Latin *cymbalum*, which means cymbal – a percussion instrument having neither strings nor keys, though one that produces sound nonetheless.

Some keyboard instrument historians maintain that in the sixteenth and early seventeenth centuries the French term *épinette* referred to any type of keyboard instrument employing a plucking mechanism, including what we today refer to as wing-shaped harpsichords as well as the smaller spinets and virginals.⁴⁸ By around 1640 French writers such as Marin Mersenne and Pierre Trichet were making a clear distinction between the smaller instruments, which they termed *épinettes* or *espinettes* (and pictured by Mersenne as being rectangular in shape; Figure 1.6) and the larger, wing-shaped instruments (Figure 1.7), which they termed *clavecins*. Mersenne nevertheless still also uses the term *Epinette* in reference to what we would today term a *clavicitherium* (an upright harpsichord), suggesting that this term was still being employed as a catch-all for any keyboard instrument that could not be properly classified as a *clavecin*.⁴⁹

Trichet characterizes the *clavecin* as a modern instrument and states that its Latin names *clavicymbalum* and *clavicitherium* had been recently coined:

Because the *clavecin* (harpsichord) is a modern instrument, you shouldn’t find it strange if the name imposed upon it is also new. Jules de l’Escale and Jean Heyden’s translator call it *clavicymbalum* in Latin, and others *clavicitherium*. Though it is similar to the *espinette* with regard to having a keyboard and has a number of keys equal in number to that of the *manichordion* [clavichord] and organ, it is different in form and in the arrangement of its strings. The shape of the harpsichord is almost triangular and that of the *espinette* resembling a parallelogram whose length exceeds its width. In the harpsichord the strings are arranged lengthwise, extending from their wrestplank their great length from the front board to the other end, though in the spinet they are steeply angled. Besides, in the position of the parts of these two instruments, there is this disagreement in the placement of the keyboard: in the harpsichord it is at one

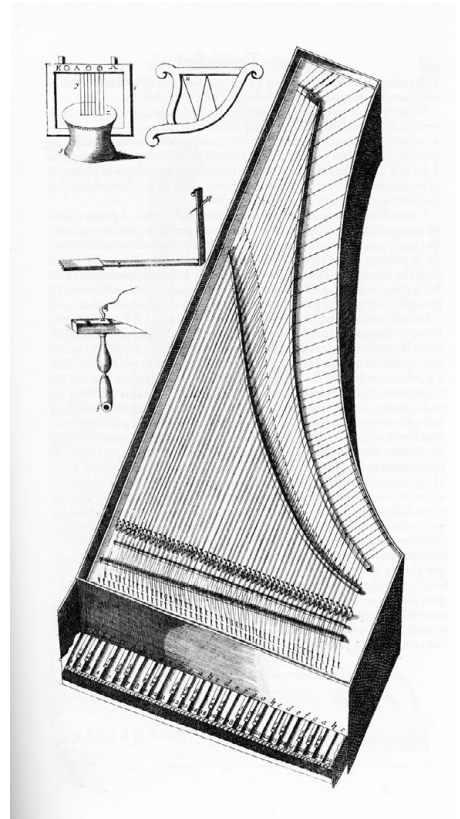


1.6. Engraved illustration of a rectangular *Epinette* pictured in Marin Mersenne, *Harmonie universelle* (1636).

end, but in the *epinette* it is always in the middle, as in the *manichordion*. The harmony and the resulting sound are almost similar; though that of the harpsichord is louder and more brilliant. We usually do not make *epinettes* in the same way as harpsichords, with two or three keyboards and with seven or eight stops, each of which we can use separately, and play them alternatively for diversity, mixing them or joining them all together, in the same way one does with organs, and this by means of some springs and registers which are easy to pull, which cause the jacks to strike whatever set of strings we desire.

Le clavecin estant un instrument moderne, il ne faut pas trouver estrange si le nom qu'il a fallu lui imposer est aussi nouveau. Jules de l'Escale et le traducteur de Jean Heyden le nomment en latin *clavicymbalum*, et d'autres

clavictherium. S'il a de la conformité avec l'espinnette en ce qui est des appartenances du clavier, qu'ils ont esgal en nombre de marches à celui du manichordion et de l'orgue; il est aussi différent en ce qui est de la forme, et de la disposition de leurs cordes. La facon et la forme du clavecin est presque triangulaire, et celle de l'espinnette ressemble un parallélograme dont la longueur excède la largeur. Au clavecin les cordes sont toutes mises et continues de long en tirant depuis le bout du fontispice jusques a la plus grande estendue tant de l'autre bout que du retranchement: et en l'espinnette elles [sont] toutes mises en escharpe et de travers. D'ailleurs, en la situation des parties de ces deux instruments, il y a cette disconvenance que la place qu'occupe le clavier du clavecin est à une extrémité, et la place du clavier de l'espinnette est toujours au milieu; comme aussi celui du manichordion. L'harmonie et le son qui en résulte est presque semblable: néantmoins le son du clavecin est plus fort et plus esclattant: aussi ne fait-on pas ordinairement des espinnettes de mesme que des clavecins a deux ou trois claviers, et a sept ou huit jeux: chacun desquels on peut produire separement, et les faire jouer alternativement en les diversifiant, les meslant ou joignant tous ensemble, de mesme façon que l'on fait aux orgues, et ce par l'entremise de quelques ressorts et registres aisés à tirer, qui sont cause que les sautereaux frappent tel rang de cordes que l'on veut.⁵⁰



1.7. Engraved illustration of a *Clavecin* in Marin Mersenne, *Harmonie universelle* (1636).

Trichet's descriptions and distinctions between the *espinnette* and *clavecin* are clear, though his contention that the *clavecin* was a new instrument is surprising, as in his day sixteenth- and early seventeenth-century keyboard instruments having wing-shaped cases (in distinction to virginal- or spinet-shaped cases) were plentiful, and there were widely circulated iconographic depictions of such instruments dating back to the fifteenth century. Nevertheless, if one peruses inventories of keyboard instrument makers extending from the mid-sixteenth through Mersenne's and Trichet's lifetimes and beyond, one notes that in the sixteenth century, French keyboard instrument makers are invariably referred to as *faiseurs d'espinnettes* and *épinetiers*, whereas by the mid-seventeenth century, they are more often called *faiseurs de clavecins*. It is most interesting that families that plied the craft of keyboard instrument making over many generations (such as the Denis family in Paris) are referred to in sixteenth-century inventories as

facteurs de épinettes (such as Robert I Denis, dates ascertained 1520–1589) and as *épinetiers* (Claude and Robert II Denis, dates ascertained 1544–1589), whereas in later years family members such as Jean II and Jean III Denis (dates ascertained ca. 1600–1685) are identified as *facteurs de clavecins*, though Jean Denis II titled the 1643 and 1650 editions of his study on harpsichord tuning *Traité de l'accord de l'épinette*.⁵¹ The seventeenth-century Parisian maker Michel I Richard (dates ascertained 1659–1670) is listed as a *faiseur de clavecins et d'épinettes*, presumably referring in this instance to two distinct types of instruments, and confirming Mersenne and Trichet's mid-seventeenth-century terminological distinction, whereas Michel II Richard (active ca. 1686) is listed as a *faiseur de clavecins*, and members of the Richard family active in the eighteenth century, Robert and Richard, are listed as *facteurs de clavecins*.⁵² Inventories of some mid-seventeenth-century makers, such as one made in 1661 of the estate of Claude Jacquet, list both *clavecins* and *épinettes*.⁵³ Later inventories, such as the 1774 inventory of the *clavessiniste* Benoit Stehlin, use only the term *clavessins*, which by that time had become the catch-all that *épinette* had been in earlier times. Corrette chose to use the term *clavecin* in the title of his *Le Maître de clavecin* (Paris, 1753), in contrast to Denis's choice a century earlier of *épinette* in his *Traité*. A similar transition in terminology (from virginal to harpsichord) occurred in England around the same time. Thus, either a distinction began to be made between spinet and harpsichord around the mid-seventeenth century, or there was a shift in production away from the small *épinette* and virginal to the larger and better appointed wing-shaped *clavecin* or harpsichord, with makers preferring to be recognized as makers of the latter rather than of the former.

In early seventeenth-century Italy, there was also a clear distinction between what they termed *arpicordi*, *gravicembali*, and *spinetti*; Adriano Banchieri (1568–1634) simply refers to *arpicordi* as having its name derived from the harp (*arpa*), the *grave cembalo* “long and played in front” (*la forma di tale strumento e long, & suonasi davanti*), and the *spinetto* having a long, square shape (*di tal forma longa quadrata*).⁵⁴ It has been suggested that *grave* (meaning heavy, grave, serious) might indicate an extension in keyboard range below C, though this does not conform to Banchieri's definition.⁵⁵ The terms *arpicembalo* (also spelled *arpicimbalo*) and *gravicembalo* (also spelled *gravecimbalo*) were both used in descriptions of Bartolomeo Cristofori's newly invented piano.⁵⁶ His 1720 piano originally had a bass extension of F, G, A, though his piano identified as an *arpicimbalo* inventoried in 1700, as well as his two other extant pianos dated 1722 and 1726, had more conventional compasses of C–c³.⁵⁷ Scipione Maffei, writing about the three pianos Cristofori had constructed as of 1711 (without indicating their keyboard range or ranges) referred to them variously as *gravicembalo* (1711) and *gravicembalo* (1719).⁵⁸

Curiously, in England, Samuel Pepys used the term “*épinette*” in distinction of the “*virginal*” in a diary account of July 15, 1688: “At noon is

brought home the espinette I bought the other day of Haward, costs me £5.” This was likely a bentside spinet by the London maker Charles Haward (ca. 1660–1687). On April 4, 1668 Pepys wrote in his diary: “To White Hall. Took Aldgate Street in my way, and there called upon one Haward that makes virginals, and there did like of a little espinette, and will have him finish them for me.” The extant instruments of Charles Haward do not include rectangular virginals (English-made virginals were popular from around 1640 to the 1680s, when the bentside spinet came into vogue).

Today, a distinction is made between the spinet and virginal: spinets are defined as having transversely mounted strings with the bass strings positioned at the back of the case and the treble strings at the front, whereas the virginal’s transversely mounted strings have bass strings positioned at the front of the case and treble strings at the back. Historical terminology, however, is not always consistent with modern usage. For example, Flemish virginals made in the sixteenth and seventeenth centuries fit the modern definition of virginal, but they came in two configurations: while both had their strings oriented in “virginal” fashion, those having strings that were plucked more or less centrally were termed *muselars* (Figure 1.8), while those whose strings were plucked closer to one end were termed *spinetten* (Figure 1.9).⁵⁹ Thus, one could have a “virginal” that was a



1.8. Plan view of *muselar* virginal by Ioannes Ruckers, Antwerp, 1622. The Metropolitan Museum of Art; photograph by the author



“spinnet” – a clear violation of today’s distinction! In Italy, the term “virginal” (or *virginale*) was rarely (if ever) used in reference to locally made harpsichords having rectangular or polygonal cases with bass strings positioned at the front of the case; there, they were referred to as *spinette*. The bentside spinet (whether made in Italy, England, France, or Germany) usually conforms to the modern definition of a spinet, as its transversely mounted bass strings are positioned at the back of the case (Figure 1.10). Johann Gottfried Walther’s *Musicalisches Lexicon* (1732) makes no structural distinction between the *Spinetta*, which he defines as “a small harpsichord” (*ein kleines Clavicymbel*) and the *Virginale*, which he identifies as “a keyboard instrument for women” (*ein Clavier vors Frauenzimmer*).⁶⁰

When the piano was reinvented in Florence around 1700, the first documented reference to it in the Medici musical instrument inventory of 1700 refers to it simply as an *arpicimbalo*, a catch-all Italian term for a keyboard instrument having a harp-like shape; i.e., with strings increasing in length from treble to bass in exponential fashion and a case shaped to follow the curve of the bridge (see Figure 1.11). In that inventory entry, it was distinguished from other keyboard instruments (harpsichords and spinets) as “A harp-shaped keyboard instrument of Bartolomeo Cristofori, of new invention, that makes soft and loud” (*Un Arpicimbalo di Bartolomeo Cristofori, di nuova invention, che fa il piano, e il forte*).⁶¹ It took decades before the piano began to acquire its own

1.9. Plan view of *spinett virginal* by Lodewijck Grouwels, Middelburg, 1600. The Metropolitan Museum of Art; photograph by the author

independent designation; a transitional example can be found in the 1758 inventory made after the death of Queen Maria Bárbara of Spain which lists each of her Florentine and locally made pianos as *clavicordio de piano* – perhaps the first use of the contracted form of pianoforte. Up through Mozart’s day, when both harpsichords and pianos were simultaneously in use, the piano was not always clearly distinguished from the harpsichord; for example, in both Leopold and Wolfgang Mozart’s letters, it is clear from the context that they sometimes used the terms *Clavier* and *Flügel* in reference to harpsichords, though at other times to pianos; for example, in Wolfgang’s October 17, 1777 letter to his father in which he recounts his visit to Johann Andreas Stein’s shop in Augsburg, he alternately refers to the Stein fortepiano that he had tried there as a *Clavier*, *Piano forte*, and *Pianoforte*.⁶² In his 1802 catalog of keyboard instruments, maker Karl Lemme of Braunschweig uses the term *Pianoforte in Klavierform* in reference to square pianos he has patterned after those of Longman and Clementi, *Große Pianoforte-Flügel* in reference to wing-shaped (grand) pianos, and *Klaviere* in reference to clavichords of various sizes having compasses up to FF–a³ in an ovoid case (an example of such a clavichord, dated 1787, is preserved in the Grassi Museum für Musikinstrumente, Leipzig).⁶³ In contradistinction to Lemme’s terminology, the Érard firm in Paris, which concentrated on making square pianos in its early years (termed *pianoforte carré*), continued to refer to the grand shape as the *pianoforte en forme de clavecin* (piano in the form of a harpsichord) until around 1840, when they began to consistently identify them as the *pianoforte à queue* (piano with tail).



1.10. Bentside spinet, John Crang, London, 1753. The Metropolitan Museum of Art.



1.11. Wing-shaped harpsichord, 1777, Girolamo Zenti, Rome, 1666. The Metropolitan Museum of Art.

EARLIEST EXAMPLES OF STRINGED KEYBOARD INSTRUMENTS

The earliest surviving stringed keyboard instrument is a *clavicytherium* believed to have been made in Ulm around 1480 (Royal College of Music Museum of

Instruments, London). The oldest known conventional wing-shaped harpsichord is signed Vincenti (Livigimeno Vincentius) and dated 1515 (Accademia Musicale Chigiana, Siena).⁶⁴ Prior to Denzil Wraight's discovery of the date and signature on that instrument, the earliest wing-shaped harpsichord was thought to be one signed Hieronymus Bononiensis and dated 1521 (Victoria and Albert Museum).⁶⁵ The earliest wing-shaped German harpsichord is the Hans Müller harpsichord made in Leipzig in 1537 (Museo Nazionale degli Strumenti Musicali, Rome). Two fretted clavichords (ca. 1540) in the Grassi Museum für Musikinstrumente, Leipzig have also been attributed to Müller (or to an unknown Nuremberg maker), though others believe they are of Italian origin.⁶⁶ (For a technical description of the 1537 harpsichord see Chapter 4, pp. 179–180.) The earliest signed and dated clavichord is a fretted one inscribed DOMINICVS PISAVRENSIS M D XXXXIII (Domenico of Pesaro, 1543) in the same Leipzig collection.

CONFIGURATIONS AND STRUCTURAL PARTS OF THE BASIC TYPES OF KEYBOARD INSTRUMENTS

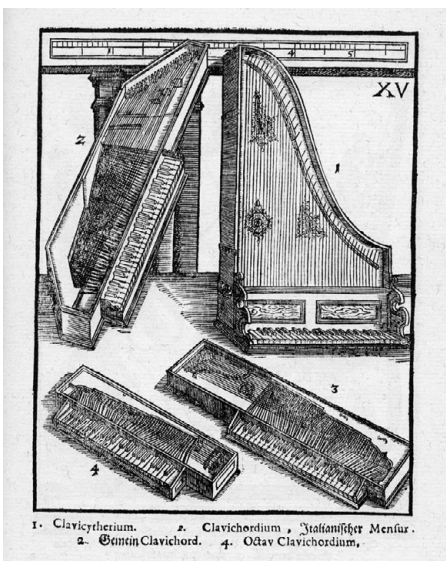
Though stringed keyboard instruments have been made for six centuries in three basic types (harpsichord, clavichord, and pianoforte), they were constructed in a variety of shapes, sizes, and configurations. The basic configurations of the harpsichord include the wing-shape (Figure 1.11), bentside spinet (Figure 1.12), pentagonal spinet (see Chapter 2, Figure 2.12), virginal (Figures 1.13), and clavictherium (Figure 1.14); the clavichord (Figure 1.15) is generally rectangular in shape, though some early examples were polygonal; types of pianos include the grand (Figure 1.16), square (Figure 1.17), cabinet upright (Figure 1.18), giraffe (Figure 1.19), lyre (Figure 1.20), and pyramid (Figure 1.21).



1.12. Bentside spinet, French, ca. 1700. The Metropolitan Museum of Art.



1.13. Virginal by Ioannes Ruckers, Antwerp, 1622. The Metropolitan Museum of Art.



1.14. Woodcut of *Clavicytherium* pictured among three clavichords in Michael Praetorius, *Sciagraphia* (1620).



1.15. Fretted clavichord, German, ca. 1800. The Metropolitan Museum of Art.



1.16. Wing-shaped “grand” piano, John Broadwood, London, 1792. The Metropolitan Museum of Art.



1.17. Square piano, John Broadwood, London, 1797. The Metropolitan Museum of Art.



1.18. Cabinet upright piano, Loud & Brothers, Philadelphia, 1830. The Metropolitan Museum of Art.



1.19. Giraffe piano, Johann Jacob Könnicke, Vienna, ca. 1810. The Metropolitan Museum of Art.

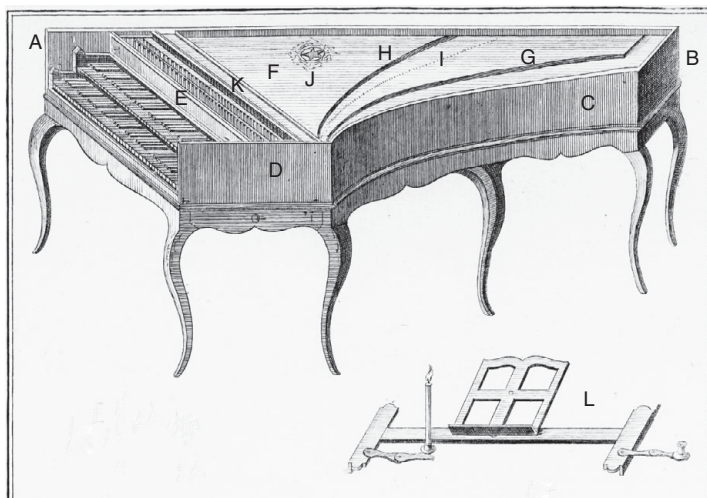


1.20. Lyre piano, Johann Christian Schleip, Berlin, ca. 1820–1832. The Metropolitan Museum of Art.



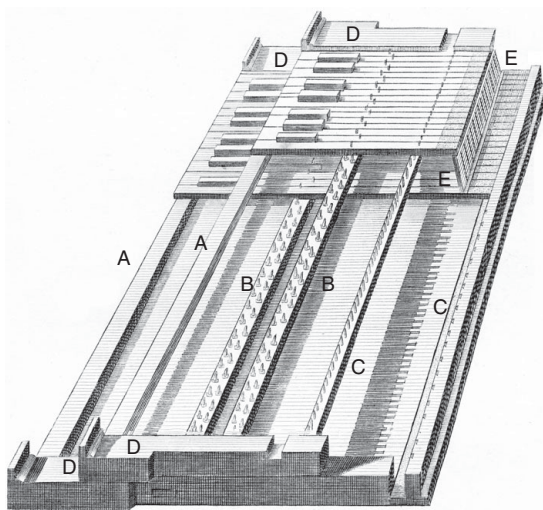
1.21. Pyramid piano, Christian Ernst Frederici, Gera, 1745. Goethe-Museum, Frankfurt am Main; photograph by the author

FIGURES ILLUSTRATING BASIC PARTS OF KEYBOARD INSTRUMENTS

Keyboard Instrument Case Structure (Figure 1.22)

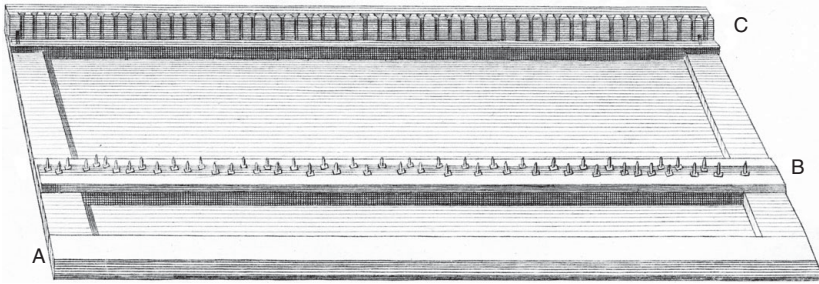
1.22. Plate from Dennis Diderot and Jean-Baptiste le Rond d'Alembert, editors, *Arts et métiers mécaniques*, vol. IV, *Instruments de musique et lutherie (art du faiseur d')* (Paris, 1785) showing parts of a harpsichord.

A, spine; B, tail; C, bentside; D, cheek; E, faceboard; F, soundboard; G, 8' bridge; H, 4' bridge; I, 4' hitchpins; J, rose; K, jack rail; L, music desk. The tuning pins and wrestplank are positioned behind the faceboard.

Harpsichord keyboards (Figures 1.23a and 1.23b)

1.23a. Plate from Dennis Diderot and Jean-Baptiste le Rond d'Alembert, editors, *Arts et métiers mécaniques*, vol. IV, *Instruments de musique et lutherie (art du faiseur d')* (Paris, 1785) showing details of harpsichord keyboards.

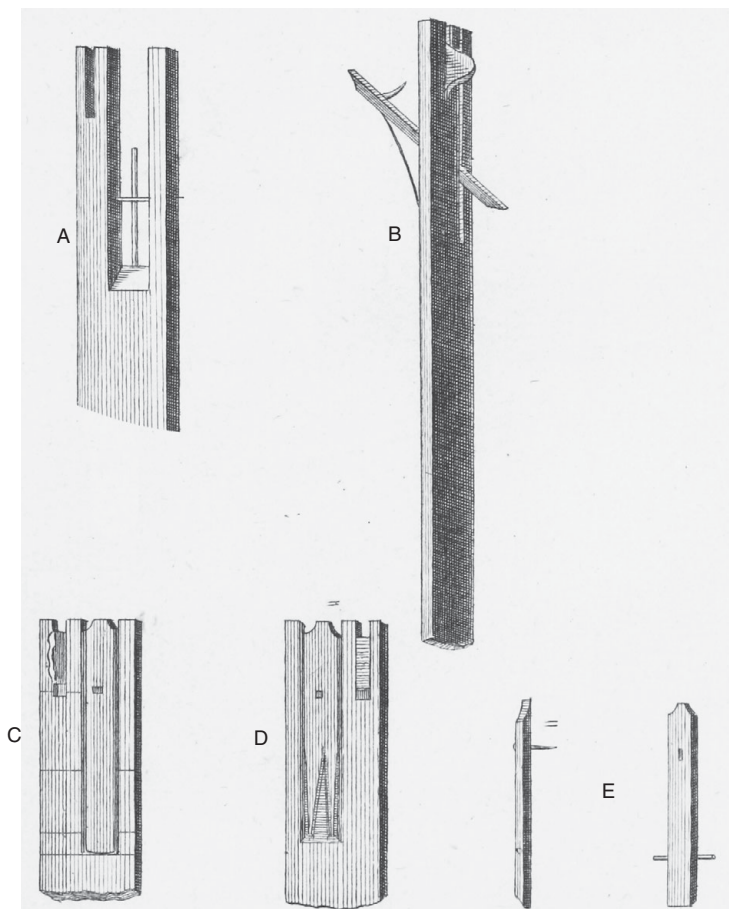
A, front rails of lower and upper keyboard; B, balance rails of lower and upper keyboards; C, back rails of lower and upper keyboards; D, keyboard end blocks of lower and upper keyboards; E, coupling dogs.



1.23 b. Plate from Dennis Diderot and Jean-Baptiste le Rond d'Alembert, editors, *Arts et métiers mécaniques*, vol. IV, *Instruments de musique et lutherie (art du faiseur d')* (Paris, 1785) showing a harpsichord key frame.

A, front rail; B; balance rail showing balance pins; C, back rail fitted with pin rack for aligning and guiding metal pins or slips of horn, whalebone, or wood that extend from the back ends of key levers.

Details of a harpsichord jack (Figure 1.24)

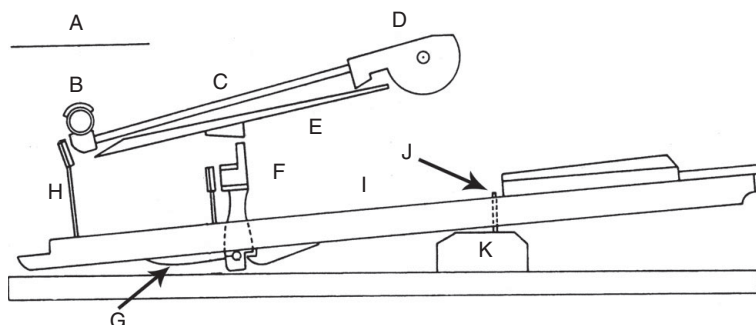


1.24. from Dennis Diderot and Jean-Baptiste le Rond d'Alembert, editors, *Arts et métiers mécaniques*, vol. IV, *Instruments de musique et lutherie (art du faiseur d')* (Paris, 1785) showing views of a harpsichord jack.

A, jack with cloth damper and tongue removed, showing bristle spring and axle made from a dressmaker's pin; B, quilled jack showing how the tongue pivots against the spring; C, front view of jack with tongue and cloth damper in place; D, back view of jack showing spring bearing on the tongue and trimmed cloth damper; E, views of tongue with quill and axle.

Piano hammer actions

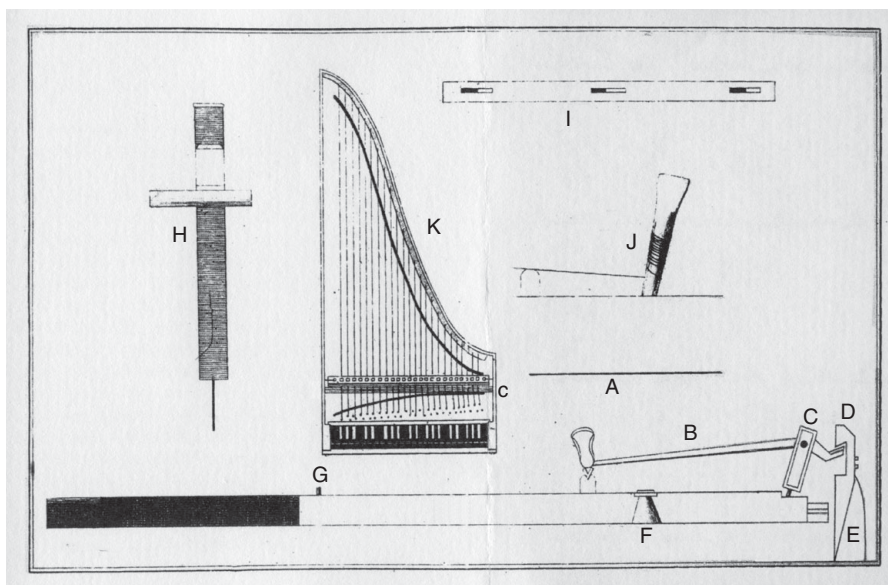
Cristofori Hammer Action (Figure 1.25)



1.25. Drawing of Cristofori piano action, ca. 1726.

A, string; B, hammer head; C, hammer shank; D, hammer butt; E, intermediate lever; F, escapement jack; G, escapement jack spring; H, backcheck; I, key lever; J, balance pin; K, balance rail.

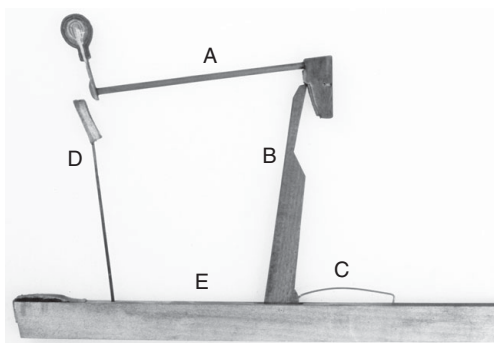
Viennese Hammer Action (Figure 1.26)



1.26. Engraving of Austro/German piano action in *Kurze Bemerkungen über das Spielen, Stimmen, und Erhalten der Fortepiano welche von den Geschwistern Stein in Wien verfertigt werden* (Vienna, 1801).

A, string; B, hammer; C, hammer fork or *Kapsel*; D, escapement jack shown in position above the hammer's beak; E, escapement spring; F, bushed opening in the key lever to admit the pin that extends from the damper; G, balance pin extending through mortise in key lever; H, damper jack fitted with leather-padded damper (note pin extending from bottom of jack); I, schematic representation of the jack rail cover showing slots and folded-over pins – this cover must be shifted from left to right to disengage the pins in order to remove the cover to gain access to individual dampers; J, tuning pin showing atypical angling; K, plan-view of fortepiano showing a double-curved bent-side typical of those by Johann Andreas Stein of Augsburg, as well as his son and daughter, Mattäus Andreas and Nannette Stein, who worked together in Vienna after their father's death.

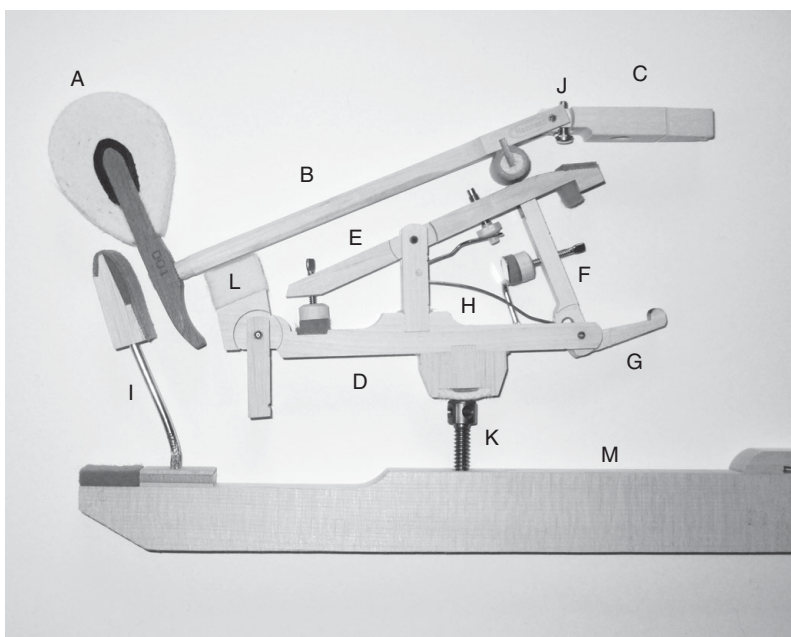
English Grand Action (Figure 1.27)



1.27. English grand action (Broadwood).

A, hammer, B, escapement jack; C, escapement spring; D, backcheck; E, key lever.

Modern Piano Action (Figure 1.28)



1.28. Modern piano action.

A, hammer head; B, hammer shank; C, hammer flange; D, wippen or support; E, repetition lever or balancier; F, escapement lever, jack, or fly; G, tender; H, spring acting upon escapement lever and repetition lever; I, backcheck; J, drop screw; K, capstan; L, hammer rest; M, key lever.

NOTES TO CHAPTER 1

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3. Michael Praetorius, *Syntagma musicum 2, De organographia* (Wolfenbüttel, 1619), p. 97.
4. *The New Grove Dictionary of Musical Instruments* (London, 1980), s.v. “keyboard.”
5. Girolamo Diruta, *Il Transilvano* (Venice, 1593), pp. 5v–6.
6. Diruta (1593), pp. 6–7; Hans Buchner, *Fundamentbuch* (1555); Juan Bermudo, *Declaración de instrumentos musicales* (Ossuna, 1555); Luis Venegas de Henestrosa, *Libro de cifra nueva para tecla, arpa y vihuela* (1557); Tomás de Santa María, *Arte de tañer fantasia, assi para tecla como para vihuela* (Valladolid, 1565); Hernando de Cabezón, preface in Antonio de Cabezón’s *Obras de musica* (1578); Catherine Pearl Crozier, “The Principles of Keyboard Technique in *Il Transilvano* by Girolamo Diruta” (Master’s thesis, Eastman School of Music, 1941), pp. 8–35.
7. Archives départementales de la Côte-d’Or, B 1462, fol. 127, doc. 55; Bernard Prost, *Inventaires mobiliers et extraits des comptes des ducs de Bourgogne de la maison de Valois (1363–1477)*, 2 vols. (Paris, 1902–1913), Vol. 1, p. 496; Vol. 2, p. 196; W. H. Grattan Flood, “The Eschequier Virginal,” *Music and Letters* 6 (April 1925), pp. 151–153; Henry George Farmer, “The Canon and Eschaquiel of the Arabs,” *Journal of the Royal Asiatic Society* (April 1926), pp. 239–256; Edwin M. Ripin, “Towards an Identification of the Chekker,” *The Galpin Society Journal* 28 (April 1975), pp. 11–25; Christopher Page, “The Myth of the Chekker,” *Early Music* 7/4 (October 1979), pp. 482–489; Nicolas Meeùs, “Keyboard Scholarship,” *Early Music* 8/2 (April 1980), pp. 222–226; Nicolas Meeùs, “The Chekker,” *The Organ Yearbook* 16 (1985), pp. 5–25.
8. Felipe Pedrell, *Organografía musical antigua española* (Barcelona, 1901), pp. 65–77; Ripin (1975), pp. 11–25.
9. Standley Howell, “Medical Astrologers and the Invention of Stringed Keyboard Instruments,” *Journal of Musicological Research* 10/1–2 (1990), pp. 1–17; Ripin (1975), pp. 11–25.
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 27. Ercole Bottrigari, *Il desiderio* (Venice, 1594), p. 37.
 28. Virdung (1511), p. F.
 29. Diruta (1593), p. 2.
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 36. I have used Sophie Hardy's spelling of *l'eschaquier d'Engleterre* as it appears in her "Édition critique de la Prise d'Alexandrie de Guillaume de Machaut" (doctoral dissertation, Université d'Orléans, 2011), p. 35.
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50. Trichet (ca. 1640/1987), p. 176.
51. Colombe Samoyault-Verlet, *Les Facteurs de clavecins parisiens, notices biographiques et documents (1550–1793)* (Paris, 1966), pp. 29–37.
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59. Douwes (1699), p. 105.
60. Johann Gottfried Walther, *Musicalisches Lexicon oder musicalisches Bibliothec* (Leipzig, 1732), s.v. *Spinetta, Virginal*. The term *Frauenzimmer*, technically meaning "women's room" came to mean "woman," sometimes in a contemptuous way.
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