Harpsichord, §1: Structure

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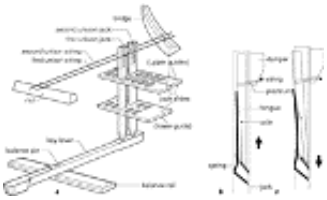
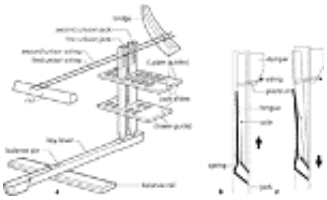
1. Structure.



Mechanism of the harpsichord

The heart of the harpsichord's mechanism is the jack, a slender slip of wood (replaced by plastic in many modern instruments) that stands resting on the back of the key (fig.1*a*). The top of the jack has a wide vertical slot fitted with a swinging tongue, which in turn carries a plectrum of QUILL, leather, plastic, or, rarely, metal. When the front of a key is depressed, the jack rises, and the plectrum is forced past the string, thereby plucking it (fig.1*b*). When the key is released, the jack falls, the plectrum touches the string (fig.1*c*) and forces the tongue to pivot backward until the plectrum can pass the string, after which a light spring (formerly made of bristle or thin brass but now often of plastic) returns the tongue forward into its original position. Meanwhile, a piece of cloth held in a slot next to the tongue makes contact with the string, damping its vibrations and silencing it. A padded bar placed overhead – the jackrail – prevents the jack from flying out of the instrument when the key is struck. In many instruments the jackrail alone limits the vertical motion of the jacks and thereby defines the depth of touch, in other instruments the depth of touch is controlled by a padded rail above the back ends of the keys or below their fronts.

This elegant and simple mechanism, though capable of producing any degree of legato or detachment of notes with great sensitivity, cannot produce any appreciable change in loudness in response to a change in the force with which the key is struck, since, regardless of force, the string is displaced virtually the same amount by the plectrum – although a few late 18th-century instruments have an extra set of jacks bearing plectra of soft materials, such as *peau de buffle* (buff leather), permitting some dynamic nuance. Accordingly, unless there is more than one keyboard (or unless swell louvres are placed over the strings, as in some late 18th-century English instruments; *see* SWELL, §II), the harpsichord can produce conspicuous changes in loudness only if it has devices that can change the degree to which the plectrum extends beyond the string (thereby changing the amount the string is displaced when it is plucked), or if each key has additional jacks and strings that the player may engage or disengage. The second of these options, much the more important, is facilitated by the harpsichord's longitudinal stringing, which permits each set of jacks to be placed in a row perpendicular to the strings, with as many rows as desired set one behind another. A set of jacks is engaged (shifted towards the strings) by a lateral movement of the slotted jackslide that supports it; the plectra of the jacks are thus positioned below the strings and will pluck them when the keys are depressed. When the set is disengaged the plectra pass the strings without plucking them.



Mechanism of the harpsichord

Although some harpsichords have only a single set of strings and jacks, most have at least two sets with the jacks facing in opposite directions (see fig.1*a*; the strings associated with each key are usually spaced to permit the jacks to pass between them, and the closely spaced pairs of strings on such a harpsichord are not tuned to the same pitch but, rather, to adjacent notes). This arrangement permits two strings associated with a single key to be placed on a

single level; but if there are more than two sets of strings, some must pass the jacks at a different level. Ordinarily no more than two of the sets are tuned to the same pitch. A third set is likely to be tuned an octave above normal pitch; a rare, fourth set an octave below; and a still rarer fifth set two octaves above. (As on organs, normal pitch is termed 8′ pitch; an octave higher is 4′; an octave lower 16′; and a pitch two octaves above 8′ is termed 2′ pitch.)

These higher and lower pitches are best sounded by strings proportionally shorter and longer than those sounding 8′ pitch; such strings are best arranged on their own bridges with the shorter ones at a lower level and the longer ones at a higher level. On a typical 18th-century harpsichord with two sets of 8′ strings and one set of 4′ strings (known as 2 × 8′, 1 × 4′ disposition), the 4′ strings would be at a low level, with the wrest plank (pin block) bridge (nut) near the jacks and close to the edge of the wrest plank, and the bridge on the soundboard at an appropriate distance away. The two 8′ sets would both pass over a separate, higher nut placed further from the edge of the wrest plank and a separate, higher bridge further back on the soundboard. A string plucked near its midpoint will have a more fundamental, flute-like tone than a string plucked near its end, which has a brighter tone, rich in upper partials. Thus each row of jacks yields a distinctive tone quality according to its proximity to the nut. Sometimes there is a special **LUTE STOP** (‘nasal stop’) with jacks very close to the nut, the jackslide usually being placed in a separate gap which divides the wrestplank between the 8′ and 4′ nuts.

The ‘scale’ of an instrument is conventionally measured as the length of the string played by the *c″* key, measuring the longest of the 8′ *c″* strings when multiple choirs are present. For comparative purposes, string lengths other than that of *c″* may be measured and their measurements converted into their equivalents at *c″*; for example, a measurement of the *c′* string would be halved to determine its *c″* equivalent. Instruments in which the strings double in length for each lower octave (i.e. with the *c″* equivalent lengths remaining constant) are said to have ‘Pythagorean’ scaling. Usually, so that instruments are not impracticably long, only the upper strings have Pythagorean scaling, while the bass strings are ‘foreshortened’: the *c″* equivalent lengths become progressively shorter toward the lowest note. A typical 18th-century French harpsichord, for example, with a *c″* string about 36 cm long, has *c″* equivalent lengths of about 30 cm at *c* and 15 cm at *F*′. The comparative shortness of the lower strings is compensated for with thicker strings and different stringing materials.

Comparisons of the *c″* scalings of different instruments must take into consideration the possibility of different pitch levels. Thus, if one instrument has a *c″* scale of 36 cm and another a scale of 24 cm, the ratio of 24:36 (2:3) might suggest that the latter instrument was tuned a 5th higher. Alternatively, different scalings may imply that different stringing materials were used. Iron and brass were both widely used throughout the history of the harpsichord. Iron wire was a hard-drawn, comparatively pure material (without strengthening carbon, i.e. not ‘steel’ in the modern sense) and brass was of two types depending on the proportions of zinc and copper: ‘yellow brass’ (about 25–30% zinc) and ‘red-brass’ (about 10–15% zinc). An ideal string would vibrate such that all its upper partials are precise integral multiples of its fundamental frequency. Since an actual string has a certain stiffness resulting from its thickness and the elasticity of its material, its upper partials are sharp in pitch; in extreme cases the string may sound false. The higher a string is stressed, the purer the upper partials will be. It is generally assumed, therefore, that historical harpsichord makers made their scalings as long as the tensile strength of their wire would permit.

The pitch at which a string of a given length breaks is practically a constant for each material and substantially independent of diameter. The strength contributed by additional thickness is exactly offset by the additional tension necessary to bring a heavier string to the same pitch as a thinner string: the stress remains the same. In fact, because wire gains slightly in hardness and tensile strength as it is drawn thinner, a thinner string can be tuned to a slightly higher pitch than a thicker string of the same material and length.

Since the tensile strength of iron is greater than that of yellow brass, their scalings differ. Instruments at ‘normal’ 8′ pitch (*a′* = *c*̄415) may be strung in iron with *c″* about 35·5 cm long, or in yellow brass with *c″* about 28·5 cm. Because the modulus of elasticity of yellow brass is about half that of iron, its tone quality is acceptable despite short scaling. Instruments scaled for iron in the treble are usually markedly foreshortened, with yellow brass in the lower part of the compass and, often, red brass – which has an even lower tensile strength and modulus of elasticity – for the lowest notes. With extreme foreshortening or for the very short scalings found in some 16′

choirs, overspun strings may be used. Modern harpsichords occasionally have *c″* scalings greater than 40 cm, intended for steel strings.

While the historical use of two basic scalings, one for iron, the other for brass, has been firmly established, some latitude must be admitted. Wire from different sources may have varied in tensile strength; makers may have adopted different margins of safety; instruments intended for thinner strings may have been made with longer scales; and makers may have planned scalings in integral numbers of local units of measurement, which varied from place to place. Further, some evidence suggests that in certain traditions another scaling system, with iron *c″* strings about 32 cm long, was occasionally employed.

The relatively rare harpsichords with three sets of 8′ strings carry them at two different levels where they pass the jacks. This is sometimes accomplished by using two bridges, with two shorter sets of brass strings on one bridge and one longer set of iron strings on another, all tuned to the same pitch. Otherwise either a stepped nut or two separate nuts are used; however, since the separation of levels is required only where the strings pass the jacks, a single bridge without a step may be used on the soundboard. On instruments with a 1 × 8′, 1 × 4′ disposition, each set passes over its own bridge and nut, with the 4′ strings on a lower level.

The position of the tuning pins and the hitch-pins for the 4′ strings raises difficulties, since if placed with those of the 8′ strings (in the front part of the wrest plank and in the case liners respectively) the 4′ strings would have to pass through the 8′ nut and bridge and there would be an inordinate length of unused 4′ string beyond the 4′ bridge which would tend to make the 4′ strings go out of tune easily. Accordingly, the tuning pins for the 4′ strings are usually placed between the 8′ and 4′ nuts. 16th-century Italian harpsichords, however, had the 8′ and 4′ tuning pins together. 4′ hitch-pins are driven into the soundboard between the 4′ and 8′ bridges. A strengthening bar or 4′ hitch-pin rail is usually glued to the underside of the soundboard to withstand the string tension on the 4′ hitch-pins. This bar also divides the soundboard into two areas; one, lying between the 4′ hitch-pin rail and the curved side of the case, serves the 8′ strings, while the other, between the 4′ hitch-pin rail and (usually) an oblique cut-off bar, serves the 4′ strings. The triangular area of the soundboard to the left of the cut-off bar is generally stiffened by transverse ribs. In some traditions there are no cut-off bars, and ribs may cross under the bridges.

A harpsichord case consists of five basic parts. Clockwise from the player's left, these are: the spine, the long straight side at the left; the tail, a short straight piece at an acute angle to the spine; the bentside, a curving section running more or less parallel to the bridge (occasionally the bentside and tail are combined in a single S-shaped piece, yielding a curved tail rather like that of a modern grand piano); the cheekpiece, a short straight piece at the player's right; and the bottom ('bottom board' or baseboard), which on all harpsichords from the 16th century to the 18th is a piece of wood that closes the instrument and thereby performs both a structural and an acoustical function. In some instruments (including all historical Italian harpsichords) the walls are attached to the edges of the bottom, while in others (as made by most north European makers) the walls are assembled first and the bottom is applied to the lower edges. The ends of the case that protrude on either side of the keyboard, from the spine on the left and the cheekpiece on the right, are known as the 'cheeks'. The wrest plank is set between the cheekpiece and the spine, with space below it for the keyboard. Occasionally, the wrest plank is quite narrow, such that the thin layer of wood with which it is covered functions as a supplementary soundboard under the nuts. There is a space for the jackslides between the wrest plank and the belly rail (or header), a transverse member which is sometimes divided into separate upper and lower parts, with the lower part set behind the upper one to leave room for the keys to extend beyond the jacks and reach the slotted rack by which they are usually guided at the back. The upper surface of the belly rail supports the front edge of the soundboard, the other edges of which rest on liners glued to the inside of the spine, tail, bentside and cheekpiece; the 8′ hitch-pins are driven into the liners along the tail and bentside. In some traditions the case walls are very thin, and the delicate instrument is kept within a thick-walled outer case. This separate 'inner-outer' style was sometimes simulated by 'false-inner-outer' construction, in which veneer and mouldings applied to the inside of thick walls mimic the appearance of a separate inner instrument.

Although the total string tension in a harpsichord is substantially less than that of a piano, it is nevertheless a considerable load for a wooden structure, especially where two or three strings are provided for each note. The cases of historical instruments are braced by numerous

methods, all with the same function: to prevent the bentside, tail and wrest plank from collapsing inwards under the pull of the strings. There are four basic components, used alone or in combination. Bottom braces are occasionally very light pieces, similar to soundboard ribs, intended to stiffen the bottom board; more typically they are about 8 to 10 cm high, with their ends butted against the bentside and spine. Knees are triangular blocks glued to the bottom and to the case walls or belly rail. Diagonal struts have their upper ends set against the soundboard liners or the upper portion of the belly rail, and their lower ends toed into the bottom or occasionally into a bottom brace. Upper struts have one end bearing against the bentside or tail liner, while the other bears against the spine liner or the upper portion of the belly rail. In some instruments, the inward force of the wrest plank is transmitted to the belly rail by several narrow ‘gap spacers’ set between the jacks. A few exceptional surviving historical harpsichords have no internal framing. Many early instruments were restrung in the 19th century more heavily than was desirable, which resulted in warped cases, wrenched-out wrest planks and collapsed soundboards. Some modern harpsichords have metal frames similar to those in pianos.

Edwin M. Ripin/Howard Schott/John Koster