A brief history of covered bass strings in English early pianos

Their implications in the early piano design up to 1837 and manufacturing replicas today.

Figure 1: A typical open wound string of a square piano with the cover wire around the hitchpin loop.

The struggle between tensile load and tone

The predecessors of the fortepiano, plucked-strings instruments like harpsichords, spinets, virginals, and tangent-struck clavichords, share certain technical and acoustical challenges in their building that were solved more or less satisfactorily for centuries. Their construction techniques had no major changes and they were built invariably in wood, and no significant metal parts were used in their structure.

For most of the 19th century, the only stringed keyboard instruments produced in Europe were fortepianos, albeit clavichords were still produced in Scandinavian countries during the first decade and some revival instruments started at the end of the century, especially in France and England. They all had the problem of an increased tension in their case as a consequence of two factors: the use of more strings as the compass expanded due to musical demands, and of the increased tension required by struck strings, especially when one note required three strings (a trichord). The high tension problem was particularly acute in the bass strings, which are the thickest of the instrument and made of heavier alloys, mostly brass. It is consider that to provide a stable and pleasing sound, a metal string must be tensioned above 60% of its breaking load, roughly speaking; an optimal point must be obtained in order to achieve a desirable timbre without deforming the instrument or risk breaking strings. In this article, I will refer as bass strings to the copper-wound or covered strings (also called spun strings) that are present from the lowest pitch, usually FF note and that can be up to two octaves, or less, depending on different building traditions. Grand fortepianos from their appearance in 1780s and until the beginning of 1820s had plain strings in the bass. Harpsichords and clavichords mentioned before had mostly plain strings in the bass, meaning a simple metallic string with no wire wrapped around it. There were exceptions, but we assume that the majority of them were experimental. The need for wrapped or covered strings came from the fact that there are three ways in which a string can reach a desired low frequency: to be longer, heavier or have reduced tension in comparison to a reference one, as we know from Pythagoras. Longer strings would mean impractically long instruments, with a greater vibrating amplitude, which probably will make them collide with their neighbours. A reduced tension would be a very limited solution as the sound becomes weaker and at some point the pitch is not stable, which is the reason to aim to that 60% of the breaking load mentioned above. The third possible solution, a heavier string, could be reached in two ways, by using thicker wire, or by combining two or more wires. A single thick string produces a musically unsatisfactory sound and may be beyond the limits of the *hammer action* that produces the sound. In fact, the final solution for fortepianos was a mix of the three previous resources, and the decision about how much of each to implement became the quest until mid-nineteenth century.

The evolution of music wire and its implications in the fortepiano design

Wire for music instruments have been produced since ancient times. The history of iron and steel wire is documented significantly, especially since the mid-nineteenth century, but the one of copper alloys (i.e. brass), is more difficult to trace. There were specialised mills only for brass in England, like the Saltford Mill. There were other prominent production centres of wire in Europe with which English mills had to compete, especially in Germany and Sweden. English gauges nomenclature system is different to the Nuremberg one, but it seems that instrument makers always found their way to fit foreign wire in their instruments. An easy intuitive way to compare eighteenth century wire with the mid- or late-nineteenth one is by bending it by hand. It becomes clear that wire in those times was softer and weaker. A chemical analysis confirms that the minimal amount of carbon in iron is one of the main differences in the pre-nineteenth century wire [Goodway and Odell]. The Industrial Revolution's discoveries in metallurgy, like the *puddling* process or the addition of carbon and other elements, improved the physical properties of iron alloys from the point of view of its strength, so it started to be called *steel*, though *modern steel* is different. By the beginning of the 1820s iron and steel wire benefited from these advancements, especially from the addition of manganese in the alloy (Horsfall). Horsfall, who was possibly the main producer of wire in England by mid-nineteenth century, commercialised it as 'music wire' and was awarded a prize medal at England's *Great Exhibition* of 1851. This wire became known as *patented wire* as a royal patent was granted for it [Horsfall].

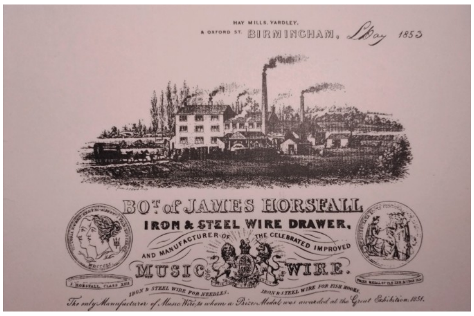

Figure 2: Advertisement of the patented music wire by Horsfall.

This wire was very different not only chemically, but in its heat treatment and drawing processes, rendering its very specific properties that matched perfectly with the recently invented cast-iron frame. Because of the tension that this new wire could withstand, more energy was needed to make it vibrate as intended, therefore, a more robust *action* (the assembly of keys, hammers and other mechanical parts including dampers) with heavier hammer heads was necessary. The extra energy required to perform on these actions have to come from the player, and that implied a change in their technique. Grand pianos with this new greater sonority had the capacity to perform in bigger concert halls. The evolution of music wire making continued through the nineteenth century, and by its end we found a wire very similar to what we can call modern piano wire, but more research is needed to know how different it was from earlier wire and from the actual one. It seems to me that the stronger wire produced from the 1820s, along with the increase of the compass were responsible for the evolution of the instrument until its more or less definitive design reached by the last quarter of the nineteenth century. Grand pianos from the 1860s seem much closer in design to the modern piano than to those of 1830s.

Types of bass strings and their scaling

The two main types of covered bass strings are close wound and open wound, also called open or close spun. From the appearance of the square piano in the British Isles and until late 1780s, bass covered strings were manufactured on a core of red brass (as we know, it is a mix of 80% copper and 20% zinc) initially, and by 1790 on yellow brass (70 / 30% of the same elements), with a copper wire plated in tin or silver wound [Watson] around it. The turns' pitch of the wound cover was gradually decreasing as the strings progressed in the musical scale up between approximately 1.3 to 3.2 mm between turns. By the 1790s, the cores were of yellow brass, and the winding pitch became standardised, at roughly 2.1 mm, also referred as twelve turns per inch or shortly 12 T.P.I. Then, around 1810s, some makers started to use bare copper wire instead of the plated one.

Broadwood squares from 1811 with a compass starting in CC had their first five pairs close wound. These shorter instruments needed heavier bass strings, so they were invariably covered, as explained above. But grand pianos had long enough scales to be able to use plain strings. Thus, we find most *grands* have plain brass strings in the bass as trichords until around 1820. Close wound strings with a steel core wire appeared in the 1820s, marking the beginning of the modern bass strings.

Since around 1790, makers started to use a divided or split bridge in grand pianos, and from late 1820s in square pianos. This arrangement consisted in a bridge for the bass strings that was positioned separately from the main bridge at a shorter distance when compared to the main bridge. Researchers and restorers call scaling to the arrangement of string diameters, lengths and alloys in a particular instrument. The scaling for the bass required brass strings (heavier than iron), otherwise the instrument would have to be longer. Brass provided a good compromise between strength and weight, and this was discovered since times immemorial. The bass section, used for the notes up to note *a* before middle octave in grand pianos set a clear indication of what we can consider the *bass section.* This was a traditional transition point in design. The bass section have a different scale to that of the tenor region, which tends to be Pythagorean (meaning that if a string halves its length it will obtain a pitch an octave higher at the same tension), making evident that a different alloy was used.

In grand pianos by 1820s the first bass notes (typically from CC to FF) may have two strings per note, instead of the traditional three, and this is an indication of close covered strings. For restoration purposes, one possible way to know if a piano had covered strings, close or open wound, originally, is to look at the marks left in the bridge and nut, which are characteristic (Fig 3). This is useful when there is no certainty whether a specific note had covered or plain strings, especially in the area of transition from covered to plain strings.

Figure 3: marks of open wound strings left on bridge.

We have seen that each maker had a different way of finishing the string eyes by making a particular termination, or lack of it as in the strings fitted in pianos made by Clementi and Co. (Fig. 4). Some instruments have marks of stringing gauges either inked by the wrest pins or in a list in a label, but for the bass strings, if any marks are present, they refer to the cores. If red or yellow brass was required, that was almost never indicated, but from evidence present in unrestored pianos we know that they had some standards of where to use them, i.e. the denser the alloy, the lower in the compass its position would be. The repetition of a gauge mark, if present, indicates the change in the alloy used [Latcham]. Please see the table below for a summary of this information.

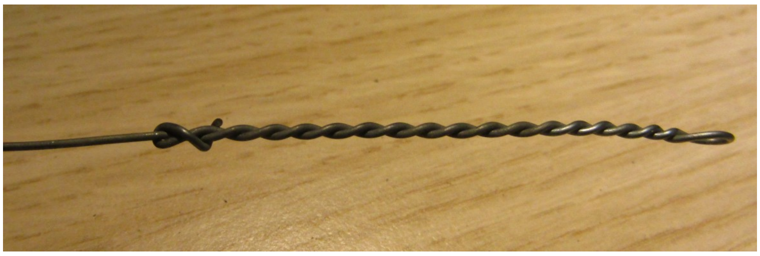

Figure 4: A Broadwood string with his 'signature' termination in the form of an eight.

Making replicas of bass strings

It is useful to know how and what is required to replicate a bass string, though the scope of this section is not to provide guidance on acquiring this skill but to show the different parameters that play a role in a bass string. A problem when replicating bass strings is that when tuning, the cover tends to slip towards the speaking portion of the string, rendering it loose and therefore causing some damping of the whole string. How originally they achieved the necessary grip yp avoid this it is still not very clear to me. Under close examination of period strings, I have not found any device by which the cover wire stays firmly attached to its core. To my understanding, period strings did not suffer this due to a high tension in the cover wire at the moment of wrapping it around the core, and to the imperfection of the cylindricity of both wires. In period strings, It is not uncommon to find slightly oval wire, probably due to worn out dies. In modern string replicas, most craftspeople make a ‘flat’, which is an indentation in the core made in the region between the wrest pin and the first bridge or nut pin encountered. If that indentation is not made in the right place, most probably the cover wire will slip. Modern material and wire drawing techniques produce a perfectly cylindrical and polished wire that makes necessary to make the ‘flat’, unless some treatment of the core is carried out. My solution is to make a very light abrasion of the core wire while it spins in the string-making lathe at high speed by displacing a sandpaper of very fine grit through the whole length. This has the advantage of not having to make measurements to determine the exact position for the 'flat'; and it also makes a string usable in a different note, as long as the gauges are the same. This is not a period practice but to me it produces a practical result.

The direction of the helix in the string eyes was customary in English fortepianos (Fig. 5). The direction does not have any influence on the produced sound, but it is useful to know if one wants to make replicas.

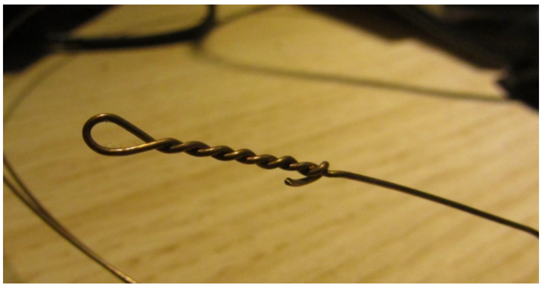

Figure 5: A red brass string of square piano No 130 by Adam Beyer showing the customary direction of the helix and his 'signature' termination.

If the string eye's position is fixed and located in front of the viewer and the helix is created towards them, the direction of the helix would be seen as clockwise. For the copper wire wrapping, the direction can be in any sense and also does not have any influence on the sound produced. Many of the square piano strings before 1780 present a clockwise direction, especially those from Beck, Beyer and Pohlman, but most after that date are counter-clockwise. So the advice here is to have a lathe that can be switched in either direction, and to replicate the strings according to the extant ones or to the marks left in the bridge and nut. The length of the eyes, helix and its end, if known, preferably should be copied. Most makers, but not all, fitted bass strings that had the cover wire around the hitchpin loop (see Fig. 1), looking like a double one along with the core. After 1825 approximately, this practice tended to disappear.

To calculate the necessary gauges in a particular instrument that either has no original strings or the extant ones are suspected not to be suitable, one has to use formulas, parameters and a collection of stringing charts from fortepianos that are very similar in time and scale to the one being restrung. This require some training and information that is not easily available, except for Malcolm Rose's *A Handbook of Historical Stringing Practice*, which is a compendium of charts of instruments with original strings, very useful to help to decide the gauges. Most restorers hold their own archive of string tension charts. Hours of practice and the special lathe are also necessary for the task, so we recommend to order them from a specialist. For conservation purposes of an instrument that is going to be kept tuned and playable it is an advisable practice to reduce the original scaling by one gauge, or roughly 10 % of the diameter of the original strings of the whole compass. This will reduce the total tension in the instrument without affecting perceptibly the tone.

Table 1. A guide to correlate an early piano to the kind of bass strings it had originally. In the last column, string alloys for the adjacent tenor section are offered to complete the overview of the scaling of the area.

Instrument	Period	Covered or plain bass strings	Open or close wound	Single, bichord or trichord	Core alloy	Cover wire	Plain strings in the tenor section
Square pianos	1766 - 1790	Covered, increasing pitch of cover as progressing up the scale	Open	Bichord	Red brass	Plated	Red brass for 6 courses, then yellow brass for another 6 courses, approximately
Grand pianos	1780s -end of 1810s	Plain	N/A	Trichord	Yellow brass	N/A	Plain yellow brass
Square pianos	1790 – end of 1820s	Covered By the end of 1820s the first close wound strings appeared	Open Only some Broadwood from 1811 onwards: from CC to EE: close wound, then open.	Bichord	Yellow brass	Plated	Plain yellow brass
Grand pianos	1820s – 1830s	Covered	Close	Bichord for the first 5 or 6 courses, then trichord	Iron mostly, and yellow brass rarely	Bare copper	Plain yellow brass trichord
Square pianos	1830s – 1850s	Covered	Close	Single or bichord	Iron	Bare copper	Iron

Table notes: All periods are approximate and all had exceptions in the number of strings and alloys used. Grand pianos from the beginning of 1820s had more varied stringing ways. In general, close wound strings had iron cores and the cover was bare copper, but iron cores may present (rarely) open wound covers. Brass cover wire was not a standard for pianofortes in England.

References

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J. Watson, personal conversation. John Watson kindly provided me with laboratory analyses of period strings that show the absence of tin, but a small amount of silver, assumed to be the plating substance.

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