Zeitschrift: Publikationen der Schweizerischen Musikforschenden Gesellschaft. Serie 2 = Publications de la Société Suisse de Musicologie. Série 2

Herausgeber: Schweizerische Musikforschende Gesellschaft

Band: 54 (2016)

Artikel: Affect in action : hammer design in French Romantic pianos

Autor: Clarke, Christopher

DOI: https://doi.org/10.5169/seals-858666

Affect in action: Hammer design in French Romantic pianos

Christopher Clarke

Introduction

It is probably true to say that the piano, as an instrument, came to its maturity in France, between the July Monarchy of 1830 and the Revolution of 1848. Protected by customs tariffs, encouraged by universal exhibitions, and stimulated by the intense musical life centred round the Parisian Opéra, piano-makers vied with each other to produce instruments capable of fulfilling the most extravagant dreams of composers and pianists alike. The spectrum of what they offered is astonishing, serving and subliming as it did the very different musical approaches of, say, Liszt, compared to that of Chopin, to take only two emblematic Parisian pianists of this period. Those names are associated with those of two piano-makers, respectively Pierre Erard and Camille Pleyel. Erard's and Pleyel's instruments, as different in their design as the music of the two composers was different, served exquisitely to incarnate each. Just as the pianistic scene of those days was peopled by a brilliant host of now-forgotten names, so it was in the domain of piano-building. The context of Parisian musical and instrument-making life was one of discovery and emulation, an echo of the fruitful social and artistic ferment of those years, and the prodigious richness of this legacy becomes the more impressive the more it is revealed.

The standard of craftsmanly excellence of those years has in many ways never been approached since. The mistrustful social climate following the 1848 Revolution vastly hastened the drive of the highly-skilled and labour-intensive craft of piano-building into an increasingly mechanised automation on the one hand, and into sweat-shop practices on the other. Rationalisation and efficiency became more than ever before the means of survival in a world where international competition, helped by steam transport, became daily fiercer. Vast colonies and a growing petit-bourgeoisie opened new markets for less expensive instruments. Craftsmanly prowess was henceforth largely reserved for special orders of expensive and ostentatious case-work, and the piano's working parts, now mostly made by specialist firms, became increasingly standardised and utilitarian. Between 1850 and 1860, the models offered by French piano-makers had been essentially defined, and remained remarkably constant for the next fifty years, until American and German competition obliged makers to produce what may be seen as American instruments with a French accent and French furniture

design. For many people, this later period represents a second Golden Age of French piano-building.[1]

Technical advances in piano construction

Several important technical advances occurred during the 1820's which over the next fifty years helped to transform the nature of the piano:

1) Webster and Horsfall's tempered steel music wire, which by the early 1820's offered a stronger alternative to the work-hardened phosphor iron wire used since mediaeval times. Some builders, such as Pape, may have used it already in the mid-1820's, but most makers in France switched during the latter part of the 1830's.[2] Further improvements continued to follow, first Miller's steel wire and then culminating in Moritz Pohlmann's "patented steel" in the 1850's.[3] In 1865, Claude Montal (1800–1865) gave a succinct account of wire development to date and its implications for scale design:[4]

> Les cordes de piano sont en acier, en fer ou en cuivre. Autrefois on se servait de cordes de Berlin en fer et de cordes anglaises en acier, dites Webster; aujourd'hui l'on emploie les cordes anglaises, de Orsffall [sic] et Webster, reconnues supérieures, et les cordes allemandes de Muller [sic], de Vienne. Il y en a encore en acier de plusieurs autres fabriques en Angleterre, en Allemagne et en Amérique; mais on ne leur accorde pas les mêmes qualités qu'à celles que je viens d'indiquer; les cordes de Berlin sont tout à fait abandonnées ainsi que les anciennes cordes anglaises. Les nouvelles, supérieures, montent facilement 3 1/2 tons plus haut que les anciennes, à grosseur et longueur égales, et les cordes allemandes montent encore un 1/2 ton plus haut que les cordes supérieures.

1 René Beaupain, *Chronologie des pianos de la maison Pleyel,* Paris, L'Harmattan, 2000; René Beaupain, *La maison Erard,* Paris, L'Harmattan, 2005; Jean-Jacques Trinques, *Le piano Pleyel d'un millénaire à l'autre,* Paris, L'Harmattan, 2003.

2 Stephen Birkett and Paul Poletti, "Reproduction of Authentic Historical Soft Iron Wire for Musical Instruments", in: T. Steiner (éd.), *Instruments à claviers – expressivité et flexibilité sonore. Actes des Rencontres Internationales harmoniques Lausanne 2002*, Bern, Peter Lang, 2004, pp. 259–272.

3 Stephen Birkett, "The physical characteristics of historical iron music wire and a report on its replication as a viable modern product", in: T. Steiner (éd.), *Cordes et claviers au temps de Mozart. Actes des Rencontres Internationales harmoniques Lausanne 2006*, Bern, Peter Lang, 2010, pp. 327–346.

4 Claude Montal, *L'art d'accorder soi-même son piano*, Paris, 1865 (3rd edition), p. 88: "The strings of a piano are in steel, iron or copper alloy. Formerly, use was made of Berlin iron strings and of English steel strings, called 'Webster'; today we use English strings, acknowledged to be the best, by Horsfall and Webster, and German strings by Miller of Vienna. There exist steel strings by several other makers in England, Germany and America; but we do not grant them the same qualities as those I have just indicated; Berlin strings are completely abandoned, as are the old English ones. The superior new ones can easily be tuned up three semitones higher than the old with the same thickness and length, and the German strings will go up a further semitone compared to the superior ones."

2) (1820) James Thom and Thomas Allen's use of an entirely independent metal structure to hold the tension of the strings in their design for a "compensation frame" intended to keep iron and brass strings in tune with each other at varying temperatures. The compensation system, used by William Stodart, was quickly forgotten, but the long iron hitch-plate and assembled metal bars holding string tension were rapidly incorporated into standard practice in England and France and remained in use for more than eighty years. The wooden framework of the piano henceforward served almost entirely merely to prevent the strain-bearing metal one from twisting or buckling; tuning stability was immensely improved. In America, Alpheus Babcock (1782–1842) patented a one-piece cast-iron frame in 1825, but his invention remained a dead letter until it was taken up by Chickering and Steinway in the 1860's. It therefore has no part in our story.

3) (1826) The use of felt as a hammer-material by Jean-Henri Pape (1789–1875). The changing aesthetic ideal of sound and the difficulties surrounding the use of leather for hammers were both met by this innovation, fundamental to the development of the Romantic piano.

4) (1821) The invention by Sébastien Erard (1752–1831) of the double-escapement action was at first shunned because of its complexity, and its real importance only began to be apparent during the virtuoso years of the 1830's and 1840's. Many makers, such as Pleyel, continued to use the classic English grand action in all their horizontal instruments. The action[5] by Guillaume-Lebrecht Petzold (1784–1838), a clever variant of the English grand action, was very widely used in France and its escapement lever in the form of a square was incorporated by Erard into his 1821 action.

5) One might add Sébastien Erard's 1809 invention of the *agrafe*, which in an improved form replaced the vulnerable wooden nut and its pins, first in concert grand pianos, then in all types. Its use safely allowed more powerful playing. Jean-Denis-Antoine Bord (1814–1888) furthered this invention in 1843 with the capo tasto, which brought even greater stability to the treble notes.

5 Supposed to have been introduced in 1814 at the moment of separating from his business partner Pfeiffer. Rosamond E.M. Harding, *The Piano-Forte: Its history traced to the great exhibition of 1851*, Cambridge, Cambridge University Press, 1933, reprint Da Capo, New York, 1973, p. 159 gives an often-reproduced diagram which unfortunately omits both the set-off regulating screw which acts on the horizontal arm of the jack and also the hammer-check.

Birth of the Romantic piano

The changes in design that for many people define the Romantic piano were in fact more the causes of the above inventions than the result of them. Almost at a stroke, in the early 1820's makers throughout Europe considerably increased the string tensions of their instruments, strengthened the mechanisms of their pianos, and universally adopted the English-inspired pattern of large hammers with multiple layers of leather. The elegant and slender sound of the Classical piano gave way to a Romantic fullness and intensity; the aesthetic of the instrument changed almost overnight into one which is clearly recognisable to modern ears.

In 1836 Claude Montal described this new approach as follows:[6]

> Pour améliorer la qualité du son, on a augmenté le diamètre des cordes, on a changé leur longueur; le frappement des marteaux a été calculé de manière à donner un son pur, net, égal et intense; les marteaux, garnis avec soin, d'abord très durs, puis recouverts d'une peau élastique et moelleuse, procurent, lorsqu'on joue *piano*, un son doux et velouté, lequel prend de l'éclat et une grande portée au fur et à mesure que l'on presse le clavier; [...].

One of the symptoms of this change was the rapid disappearance of nearly all of the mutation pedals which were so characteristic of the French and Viennese schools of piano-building. Only the *forte* and *una-corda* pedals remained. These various mutation stops, far from being anecdotal, had been a valuable and integral part of the design of the Classical piano, from the late 1780's until the mid 1820's. They had been essential to the piano music of the French Classical era, characterised by its declamatory mixture of structured rhetoric on the one hand and the personal expression of feeling on the other, and which made extensive and explicit use of such pedal registers. Often deployed in an episodic manner, they enlivened and gave sense to all the codified devices of rhetoric.[7] The idea of registration in keyboard instruments, once so essential to the proper manner of their playing, had died away by the mid-1830's, and remained only in the organ.

The variety of tone-colours, the affect obtainable from a piano became, in the Romantic era, the exclusive domain of the pianist's touch, and hence of the

6 Claude Montal, *L'Art d'accorder soi-même son piano*, Paris, 1836 (1st edition; reprint Minkoff, Geneva, 1976), p. 223: "To improve the quality of the sound, the diameter of the strings was increased, their length changed; the strike-point of the hammers was calculated in such a way as to give a pure, clear, equal and intense sound; the hammers, carefully covered, at first very hard, then covered with an elastic and supple skin, give, when played piano, a soft and velvety sound, which gains brilliance and great carrying-power as one further presses the keyboard".

7 For the reflections of a very structured contemporary French composer, see: Pierre Boulez paraphrased in Ziad Kreidy, *Les Avatars du Piano*, Paris, Beauchesne, 2012, p. 64: "[...] en 2010, Pierre Boulez est sceptique quant à l'avenir de la facture pianistique. Il regrette sa rigidité et souhaite que le piano puisse, comme le clavecin, disposer de plusieurs jeux, un jeu de luth, un son pizzicato et une possibilité d'étouffer les cordes lors de leur percussion." ("[...] in 2010, Pierre Boulez is sceptical as to the future of piano-building. He deplores the rigidity of the instrument and wishes that, like a harpsichord, it enjoyed several stops, a harp stop, a pizzicato sound and the possibility of damping the strings at the moment of striking them.")

piano's hammers. Carl Czerny, writing in 1845, confirmed the far-reaching musical effects of this revolution:[8]

> During this epoch the Pianoforte was considerably improved. Thicker strings were used for it, whereby the upper octaves which had previously been so weak in tone, acquired unusual power and melodiousness. And lastly, between the years 1820 and 1830, the important covering of the hammers was brought to such a degree of perfection, especially by the Vienna manufacturers, that, by the mere touch, we could draw from each key numerous shades of tone, and suddenly gain a new feature in Pianoforte playing. Without having recourse to those mechanical contrivances – the pedals, it became possible to execute the lightest *pianissimo*; whilst, in each octave, a more energetic touch produced not only greater power, but in a measure quite another kind of tone. [...] From this period may be dated the invention of the modern style of Pianoforte playing, which has now become general. While the notes of a melody are struck with energy in a middle position and their sound continued by a skilful use of the pedal, the fingers can also perform brilliant passages *piano*, with a delicate touch; and thus arises the remarkable effect, as if the melody were played by another person, or on another instrument.

It was in Paris that this transformation most fully came about. The wonderful Viennese pianos of the 1820's and 1830's and the impressive English ones of the same period were each in their own way emblematic of a generous ripening of ideas and ideals laid down many decades before. Those years saw an apotheosis of their national styles, to be followed imperceptibly by a slow decline as musical interests passed elsewhere. But the Parisian instrument was a completely new synthesis; it was the beginning of the modern piano.

The Romantic Piano's survival

The robustness of construction and the maturity of conception of French Romantic pianos has meant that a surprising number of them has seen continuous service up until the present day. This longevity has exposed most of these venerable instruments to several campaigns of repair and renovation over the years. Since the aim of these running repairs was in general to align the piano as far as possible with current musical aesthetics, most Romantic pianos have thus come down to us in a more or less altered state.

Many pianos were re-strung, sometimes on several occasions, and it is very frequent to find Webster-type steel replacing earlier iron strings, or patented-steel wire replacing either type. Many old instruments have been severely put to the test by the use of heavy strings, more appropriate for later instruments, and pulled up moreover to a higher pitch than the original one. Certain "restorations" in

8 Cited from the English translation: Carl Czerny, *The Art of Playing the Ancient and Modern Piano Forte Works, Supplement to the Piano Forte School, op. 500*, London, Cocks, 1846. Many thanks to Pierre Goy for providing this quotation, which perfectly defines my thesis.

recent years have gone to the opposite extreme, stringing pianos too lightly and lowering the pitch, on the pretext of sparing their fatigued structures. But most often pianos were re-strung in something approaching the original sizes. While the use of different types of steel does make a difference to the timbre, changing string diameters and pitch has a far more radical effect. This is because it changes the relationship between hammer-mass (and hence inertia) and string tension; the hammer is thrown off the string in a different manner.

For it is the nature of the hammers (assuming all the rest of the instrument to be properly designed and made, and in good order) which determines in very large part the timbre, dynamic response and touch of a piano, its musical nature. More or less ephemeral, piano hammers need to be remade or replaced after a few years' intensive playing has worn them out. Naturally, repair technicians "brought them up to date", in the process changing both their materials and their dimensions. As the different schools of piano-building slowly grew to resemble each other, so did repairs to hammers become less and less adapted to the original nature of the instrument and closer to the current consensual ideal. In this way, pianos' original timbres, so intimately bound up with the nature of the hammers which generated them, became completely obliterated and forgotten.

Of course, for the student of Romantic pianos today, telling the difference between an original felt hammer-covering of, say, 1840 and a replacement cover in slightly different materials dating from, say, 1860, is an extremely difficult task, and in no way comparable to the easier one of distinguishing a covering put on in 1930 or 1980. The more so, in that such early replacements were often performed with high competence in the very workshops where the pianos were first made. The nature of the materials used can sometimes be a reliable guide; deer- or chamois-leather coverings on an old hammer are likely either to be original or to date from an 'historically-informed' restoration in quite recent times. Original wool felt is very unlikely to be found on a piano before the end of the 1830's. Soft grey or green Pape felt (see below), in the rare instances that it has survived, is likely to be original to those instruments dating from the late 1820's to the early 1840's, though it could be a contemporary replacement. In any case, the only pianos from this period with hammers still covered in their original felt are likely to be instruments which were either early on crippled or abandoned, or those where the felt is now unserviceable through wear or moth attacks. From the former it is sometimes possible to draw a few notes which can give an idea of the original quality of sound. The somewhat more common survival of leather coverings of the time on instruments which can be brought to playing condition can, however, give us some idea today of how those pianos really sounded, if the leather has remained in fairly good condition, which is sometimes the case. Unfortunately, the rarity of such original hammer-coverings, coupled with often ignorant *a priori* concepts of Romantic piano sounds which are the legacy of some sixteen decades of slow change – usually seen as "progress" – amongst pianists and technicians alike, hamper all efforts to discover the truth in that domain.

Three contemporary texts

What were the characteristics of these hammers? To approach the subject, it is instructive to compare the same passage in two editions of Claude Montal's *L'art d'accorder soi-même son piano*; the first edition of 1836 already quoted, and the third edition of 1865. Montal, though almost blind, was a successful and inventive piano manufacturer, and before starting his own manufactory was closely linked to Camille Pleyel. His books are far more than a simple "how-to" manual for amateurs; they are mines of invaluable information concerning piano technology in France. In the 1836 edition, Montal has this to say about hammers:[9]

> La garniture des marteaux doit fixer notre attention d'une manière particulière; c'est elle qui, avec la frappe, détermine en partie la qualité de son de l'instrument. À présent on garnit les marteaux avec de la peau de daim jaune, ou avec une espèce de feutre particulier gris ou vert. Le daim est très solide, mais on a de la peine à en trouver de bonne qualité, d'où résulte une grande difficulté pour égaliser un piano, ce qui a engagé beaucoup de facteurs à employer du feutre parce qu'il procure une égalité parfaite et une qualité de son préférable pour beaucoup de personnes. Cependant il est moins solide que le daim, les cordes le coupent facilement, surtout dans les dessus, le piano perd de sa bonté, et on est obligé de renouveler la garniture au bout d'un certain temps. Que l'on fasse usage du feutre ou du daim, pour que les marteaux soient bien et solidement garnis, il faut que la garniture soit très serrée, proprement collée et coupée bien net.

In the 1865 edition, the text now reads:[10]

> La garniture des marteaux doit fixer notre attention d'une manière particulière; c'est elle qui, avec le frappé, détermine en partie la qualité de son de l'instrument. Autrefois on garnissait les marteaux avec de la peau de daim jaune ou avec du feutre gris ou vert, fabriqué avec du poil de lièvre ou de lapin teint en jaune ou en vert ; aujourd'hui on garnit tous les marteaux avec du feutre de laine fine, qui est très-supérieur, pour la qualité du son et l'entretien de l'instrument, aux anciennes garnitures. Le daim

9 Montal, *op. cit.* 1836 (see note 5), p. 115: "The manner of covering the hammers should particularly command our attention; it is this, along with the strike [point] which partly determines the quality of sound of an instrument. At present, we cover the hammers with yellow deer leather or with a special sort of grey or green felt. Deer is very solid material, but it is hard to find it of good quality, which results in considerable difficulties in equalising the piano, which in turn has led many makers to the use of felt because it procures a perfect regularity and a sound which is preferable to many people. However, it is less solid than deer; the strings readily cut it, especially in the treble; the piano loses its good qualities, and one is obliged to change the covering after a while. Whether one employs felt or deer, in order for the hammers to be well and soundly covered, the covering must be very tight, neatly glued and cleanly trimmed."

10 Montal, *op. cit.* 1865 (see note 4), p. 142: "The manner of covering the hammers should particularly command our attention; it is this, along with the struck [point] which partly determines the quality of sound of an instrument. In the old days, we used to cover the hammers with yellow deer leather or with grey or green felt, made with hare or rabbit fur dyed yellow or green; today one covers hammers with felt of fine wool, which is by far superior, both for the quality of sound and for the upkeep of the instrument, than the older materials. Deer exhibited

> présentait de la solidité, mais on avait de la peine à en trouver de bonne qualité; il rendait le piano très-difficile à égaliser, et donnait souvent une qualité de son inférieure; le feutre de lièvre ou celui de lapin donnait une bonne qualité de son, mais il a été abandonné à cause de son peu de durée.
> Pour que les marteaux soient bien garnis, il faut qu'ils soient gros, qu'ils décroissent bien régulièrement de la basse dans les dessus, que les garnitures de dessous soient dures et le feutre blanc de dessus fort et bien tendu; [...][11]

A report by N. Boquillon – incidentally a friend of Jean-Henri Pape – on the Paris *Exposition Universelle* published in June 1844 contains the following passage:[12]

> Jusqu'en 1826, la peau fut la matière exclusivement employée à la garniture des marteaux; et, si l'on considère que la même peau présente des parties plus ou moins sèches, plus ou moins poreuses, et qu'il fallait choisir, dans tous les points, les portions qui convenaient le mieux à la note dont on garnissait le marteau, qu'il fallait serrer plus ou moins ces marteaux en les collant, pour donner à chaque marteau le degré de dureté ou de mollesse qui lui convenait, afin de compenser, par cette condition, les défauts reconnus de la peau employée, on comprendra l'importance que prenait, dans un atelier, un bon garnisseur, et on ne s'étonnera pas d'apprendre que les grandes réputations, dans la facture, ne se sont, presque toujours, fondées que parce que le chef de l'établissement était le seul garnisseur de ses pianos, et ne s'en rapportait à personne sur l'exécution de cet important travail. A Vienne, le facteur Graft [sic], à Paris, M. Petzold, ont dû leur fortune à leur habileté comme garnisseurs.

a certain solidity, but it was hard to find it of good quality; it rendered the piano very hard to equalise, and often gave an inferior sound; hare or rabbit felt gave a good quality of sound, but its use was abandoned owing to its lack of durability.
For hammers to be well covered, they should be large, their size should diminish perfectly regularly from bass to treble, the under-coverings should be hard and the white felt of the outer covering should be thick and well-tensioned; [...]"

11 This ideal is still echoed in 1911 by the American hammer-maker Alfred Dolge: "The art in hammer making has ever been to obtain a solid, firm foundation, graduating in softness and elasticity toward the top surface, which latter has to be silky and elastic in order to produce a mild, soft tone for pianissimo playing, but with sufficient resistance back of it to permit the hard blow of fortissimo playing." Cf. A. Dolge, *Pianos and their Makers. A Comprehensive History of the Development of the Piano*, Covina (California), Covina Publishing Company, 1911, reprint Dover Publications, New York, 1987, p. 97. Although thoroughly unreliable on history before about 1850, Dolge nevertheless gives much interesting material on the later history of hammer-making pp. 97–106, felt-making pp. 120–123, wire pp. 123–126.

12 N. Boquillon, "Études techniques sur l'exposition des produits de l'industrie française en 1844", in: *Revue Scientifique et Industrielle sous la direction du docteur Quesneville*, 2e série, tome 1, Paris, 1844, pp. 384–385. The text was probably written by Pape himself. "Until 1826, leather was the material exclusively used for covering hammers; if one considers that the same skin presents more or less dry and porous parts, and that one must choose, from every point of view, that part of the skin which best suits the note whose hammer is being covered, that one must press each hammer more or less in gluing the skin in order to impart the appropriate degree of hardness or softness, thus compensating for the perceived faults of the skin, one will understand the importance that a good hammer-coverer took in a workshop, and one will not be astonished to learn that the highest reputations in piano-building were almost always founded on the fact that the head of the establishment was also the only hammer-coverer, and who confided the execution of this important work to no other. In Vienna, the builder Graf, in Paris, M. Petzold, owed their fortune to their skills in hammer-covering."

He goes on to maintain that even though a leathered piano might sound evenly at first, after a few months some notes would become too hard and after a while all the hammers would harden and the initially round sound would become dry and shrill. Pape's felt renders bad hammer-covering almost impossible, can be made in many degrees of firmness, and keeps its good qualities almost indefinitely.

Comparing the texts quoted above gives us a little idea of the changes in thirty years, not only in the use of materials, but also, in shadow-play, those of tonal aesthetics. Both Montal and Boquillon (or Pape) point out the difficulty of making good hammers consistently using a somewhat rare and very variable raw material. The yellow deer leather that Montal mentions is no doubt the oil-tanned material to be found on many instruments from around 1790 onwards.[13] Skins of many types of deer were used, but also those of chamois and sheep. Other types of leather may be found either in the voicing layer (the layer which touches the strings) or in the underlayers. The first-choice deer-leather, whose durability and sound-quality were considered the best by Montal in 1836, already by 1844 was proscribed by Boquillon as being inferior (even though it was still being offered by Pleyel), and the soft grey or green Pape felt whose more regular sound-quality made many prefer it in 1836 in spite of its lack of durability (Montal), was highly praised by Boquillon in 1844 but had been definitively abandoned in favour of fine wool felt by 1865 (Montal).

Materials and Design: history and development

Early leathered hammers were relatively simple in construction, with one or two layers of leather glued on a hard core made of wood or other materials.[14] As the Romantic piano took form and makers sought a variety of timbres across the dynamic range, it became necessary to construct hammers with more complex structures, carefully graduated in elasticity and softness from their inner cores to their outer playing surfaces. Due to the increased inharmonicity of the thicker strings now being used, these hammers also had to be softer in order to damp out discordant overtones[15]. Makers experimented ceaselessly with materials, with

13 Cf. S. Wittmayer, "Hammerkopfleder – ein Beitrag zu seiner Geschichte und Herstellung", in: T. Steiner (*éd.*), *Instruments à claviers – expressivité et flexibilité sonore. Actes des Rencontres Internationales harmoniques Lausanne 2002*, Bern, Peter Lang, 2004, pp. 175–223.

14 Cf. C. Clarke, "Fortepiano Hammers; A Field Report", in: T. Steiner (éd.), *Instruments à claviers – expressivité et flexibilité sonore. Actes des Rencontres Internationales harmoniques Lausanne 2002*, Bern, Peter Lang, 2004, pp. 225–258.

15 It may be considered as axiomatic that the thicker the strings for any given sounding-length and pitch, the more inharmonically they will sound (the pitch of the overtones is raised due to the stiffness of the wire). These overtones can be diminished in intensity by the use of softer hammers, favouring the fundamental. Thus thicker strings demand softer hammers. Inharmonicity is reduced with higher tensions, so using a wire material which has increased tensile strength to increase the string-lengths for any given pitch can lower the inharmonicity. Cf. also: Birkett, *op. cit.* (see note 3).

layering techniques, with viable and foolproof methods of production. In the 1830's, hammers were often of a bewildering complexity; with the generalization of the use of wool felt, the 1840's saw considerable simplification of structure, standardization of materials, and mechanization of the covering process. Hammer construction henceforward could be confided to semi-skilled workers, an essential step towards successful mass production.

In the following sections, I have chosen to present the illustrations of various hammers in chronological order and tried here to provide a sort of collective vision of the evolution of French hammers in the Romantic period.[16] The illustrations are shown at the end of these sections, beginning on p. 287.

Piano design in England, beginning with Zumpe in the 1760's, quite early on emphasised shorter and thicker strings than was usual on the Continent, and hammers were more generously leathered, producing a 'rounder' sound. This trend towards thicker strings and more padded hammers was amplified over the years, and to the layers of sheepskin was added a further layer of oil-tanned deerskin, at first with the skin side out, then with the flesh side out. This outer, or "voicing" layer, was often considerably thicker than the others. By 1825, which may be considered the start of the period which concerns this article, most English piano-makers were using (treble to bass) from three to eight superimposed layers of leather, including a fairly thick deerskin voicing layer, to cover their hammers; in grand pianos the core was made up of a thin blade of hard wood, sometimes bulked out with extra wood added just below the leather layers. The increase in string-tension in English pianos of all types seems to have been an ongoing and continuous process right from the start[17] and neither is there any break in the design of their hammers until the use of felt. However, several makers occasionally used green or buff-coloured molton cloth[18] for covering the bass and tenor hammers – I have seen examples from the mid-1820's in pianos by John Broadwood and Sons and by James Ball. Later instruments show the use of a thick layer of hard sole-leather next to the cores of the hammers in place of the older sheepskin, thereby simplifying the structure and ensuring even greater firmness at the centre.

Viennese makers started by using much larger hammer-cores than the English, but in general covered with considerably less leather, only two or three thin layers, until they changed their designs to embody heavier stringing (which however remained noticeably lighter in the treble compared to English or French pianos). They then employed many thin layers of vegetable-tanned deer- or sheep-skin, of apparently identical composition, stretched firmly over a relatively massive hammer-core (Illustration 1; Graf 1825). These layers may well have been applied

16 I would like to thank Jean-Claude Battault, Michel Chaillan, Olivier Fadini, Pierre Goy, Jean Haury, Alexander March, Max di Mario, Christopher Nobbs, Aya Okuyama and Jean-Marc Touron for their generosity in providing documents, materials and photos.

17 Malcolm Rose and David Law, *A Handbook of Historical Stringing Practice 1671–1856*, Lewes, self-published, 1991.

18 Rosamond E. M. Harding, *op. cit.* (see note 5), pp. 179–182.

all at once, with the exception of the voicing layer, at least in the tenor and bass regions (Illustration 29). This method ensured that the inner layers of leather were in compression, the outer ones in tension, producing a firm and elastic whole. In addition to their lighter treble stringing and elastic hammers, in the interests of tonal clarity Viennese makers favoured a strike-point closer to the nut than French or English builders (typically, 1/11 rather than 1/8 or 1/9), giving a basic tonal spectrum somewhat richer in overtones.

French makers, whose designs by and large followed the English pattern, favoured multi-layered structures composed typically of layers of oil-tanned deer or chamois (Illustrations 2, 3; Freudenthaler 1814 resp. 1817). These two illustrations show how hammer-design was changing at the end of the first decade of the nineteenth century: the earlier instrument has hammers typical of pianos by Erard from the mid-1790's, whereas the later one already has larger and more sophisticated hammers which prefigure those of the 1830's.

The graduation of firmness from a hard interior to an elastic and soft exterior was at first achieved, as before, largely by the use of oil-tanned leathers; under the softest chamois and deer skins used for the voicing layer were added oil- or vegetable-tanned skins of increasing density, including deer, sheep, goat, buffalo or calf for the inner layers. It is noticeable that each maker seems to have had quite different ideas as to the gradient of hardness. It is this gradient which determines to what extent and how quickly the tone-colour changes with increasingly energetic playing. For example, Pape and Pleyel favoured a steep gradient with a great contrast between an extremely soft voicing layer and firm inner layers; Erard favoured less contrast and a flatter gradient (Illustrations 4–8, 10, 12, 15–18; leather-covered hammers 1828–1842. Abbreviations for Pleyel registers: RA = registres d'atelier; RC = registres comptables).

The Voicing Layer

However, as Montal pointed out, it was difficult to find leather of sufficiently good quality, especially for the critical voicing layer; production of pianos was rising fast, and it was becoming a matter of some urgency to find alternative materials, preferably manufactured ones of consistent quality. Makers undertook countless trials of many different materials[19] in different combinations, but the first really satisfactory substitute for leather was a special sort of felt which Henri Pape, after unsuccessfully experimenting with hat-felt, patented in 1826. It consisted of two layers;[20] an inner one of rabbit-fur and silk floss, and an outer one of hare-fur mixed with eiderdown (Illustrations 7, 9, 13; Erard, Pape, Soufléto):

19 *Ibid.*

20 This method of felting at once two layers of differing materials is known as "poil posé" (verbal communication, Sig. Mondolfo, Conservator of the Museo dell'Arte del Cappello, Ghiffa).

> Je prends une partie de poil de lapin et un sixième de bourre de soie que je fais carder ensemble; ce mélange sert à former une première couche. Je prends ensuite une partie de poil de lièvre que je mêle avec un tiers d'édredon, et je fais également carder ensemble ces deux matières dont je forme une seconde couche. Ces matières ainsi disposées, je les fais fortement feutrer par les procédés connus, jusqu'à ce que l'étoffe ait une consistance convenable et la souplesse nécessaire. Je suis convaincu qu'une étoffe ainsi composée n'éprouve aucune altération par l'usage et qu'elle est à l'abri des influences de la température. Je fais observer que les matières que je viens d'indiquer ne sont pas les seules que l'on puisse employer pour composer une étoffe de ce genre ; mais comme personne, jusqu'à ce moment, n'a imaginé de garnir les marteaux à l'usage des pianos avec un feutre composé, je réclame le droit exclusif d'employer cette étoffe, quelque soit d'ailleurs les matières qui pourraient servir à la fabriquer.[21]

The outer layer of this felt was impregnated with an arsenical solution to discourage moths. The presence of long guard-hairs in the outer layer is particularly noticeable; classic felt-making techniques carefully eliminated these, as not contributing to the felting process. These two distinct layers are very noticeable in all samples known to me and are specific to Pape felt. The firmer lower layer[22] is capable of maintaining a certain tension when it is glued to the hammer, whereas the extremely soft and elastic outer layer is responsible for the "doux et velouté" sound it gives while caressing the strings in soft playing. With more vigorous playing the sound becomes remarkably bright and "centred" as the lower layer comes into play – exactly as Montal described.[23] There can be no doubt that the two layers' intimate connection, acquired by being felted simultaneously together, eliminates the considerable energy loss which would otherwise occur when a soft separate outer layer is applied loosely to a firmer underlayer, and which precludes the possibility of *forte* playing. Unfortunately, some well-publicised recent experiments with hammers covered with loosely-applied single layers of

21 "I take one part of rabbit fur and a sixth of silk floss, which I card together: this mixture serves to form a first layer; I then take one part of hare fur which I mix with a third of eiderdown, and I card these together in the same way so as to form a second layer: these materials thus disposed, I cause them to be strongly felted by the usual methods until the material has acquired a proper consistency and the necessary suppleness. I am convinced that a fabric thus constituted undergoes no alteration through use and that it is safe from the influence of temperature. I would have it observed that the materials that I have just indicated are not the only ones suitable for the composition of such fabric; but since no-one until now has imagined covering hammers for pianos with a composite felt, I claim the exclusive right to use such a fabric, whatever its component materials might be." Description des Machines et Procédés spécifiés dans les brevets d'invention, de perfectionnement et d'importation dont la durée est expirée, 1st series, Paris, 1811–1863, vol. 44, p. 441. Cited in part by Harding, *op. cit.* (see note 5), pp. 179–180. Max di Mario gives a fac-simile of the patent manuscript in his online article Pleyel Hammer Coverings in the Chopin Era <http://www.scribd.com/doc/111111984/Pleyel-Hammer-Coverings-in-the-Chopin-Era>, Varese, 2012, p. 2.

22 Julia de Fontenelle states that hare-fur is less susceptible to felting than rabbit but is incomparably fine and light in texture, cf. Jean-Sébastian-Eugène Julia de Fontenelle, *Manuel Complet des Fabricans de Chapeaux en tous genres*, Paris, Roret, 1830, p. 14.

23 Cf. note 6.

rabbit-fur felt have given rise to the myth that French Romantic pianos, especially Pleyel's, were in fact designed not to be able to play above *mezzo-forte*.

The Pape type of felt was used in many instruments by many reputable makers until the early 1840's, almost invariably combined with leather-covered hammers in the treble; Pape's original felt seems to have come in only one thickness and was too tender for notes above about c^3. Owing to its extremely fragile nature, it is very rare to find it in surviving instruments, and never in any that have been regularly played. However, on 24th April 1835, Pape applied for an addition to his 1826 patent for an improved version of his felt, this time in cashmere or vicuña fibres and in tapering sheets:

> Je viens aujourd'hui demander une addition pour perfectionnement du feutre à l'usage de la garniture des marteaux; ce perfectionnement consiste à augmenter sa solidité et donner plus de qualité aux sons en employant dans le feutrage une étoffe de laine fine, soit cachemire, vigogne ou autre fabriquée à cet effet et à lui donner, en feutrant, le dégré d'épaisseur graduelle qui est nécessaire pour cet emploi. Ce feutre, ainsi préparé, acquiert plus d'élasticité et de consistance, et par conséquent est très convenable pour cet usage.[24]

During the 1830's and 1840's, experiments throughout Europe continued to be made with other types of felt, especially wool felt, and also, apparently, in the manufacture of counterfeit versions of Pape's material. Boquillon says:[25]

> M. Pape avait pris, tant en France qu'en Angleterre, un brevet pour l'application du feutre à la garniture des marteaux. Mais, tandis que les facteurs anglais lui payaient loyalement une prime pour employer cette matière, les facteurs français s'en servaient

24 "I come today to request an addition for the perfecting of felt destined for the covering of hammers; this improvement consists in augmenting its solidity and giving a more even quality to the sounds by employing in the felting a fine wool, such as cashmere, vicuña or another prepared for this purpose, and to give it, in felting, the graduated degree of thickness which is necessary for this employment. This felt, thus prepared, acquires greater elasticity and consistence, and consequently is very suitable for this use."
Di Mario, *op. cit.* (see note 21), p. 6, gives a fac-simile of the manuscript and erroneously gives its date as 1836. The patent was granted 21/07/1835. The London Journal of Arts and Sciences, and Repertory of Patent Inventions, Vol. 14, London 1839, mentions a patent of 13th May 1835 awarded to Pierre Frederick Fischer, merchant, "for certain improvements in pianofortes, communicated to him by a foreigner residing abroad" (Harding, *op. cit.* (see note 5), p. 182) says Fischer patented felt coverings in varying thicknesses in this year; Dolge, *op. cit.* (see note 11), p. 98, 121) says the patent is "identical" to Pape's. Harding (*op. cit.* (see note 5), p. 179) quotes Welcker (Heinrich Welcker von Gontershausen, *Der Flügel oder die Beschaffenheit des Piano's in allen Formen,* Frankfurt am Main, 1856, p. 47, 48) who clearly conflates Pape's 1826 and 1835 patents.
Di Mario, *op. cit.* (see note 21), p. 12 gives a fac-simile of an advertisement for Blue Felt by the Dolge company in an 1895 edition of the Music Trade Review. Rabbit fur is "woven [...] into the white felt, in a graduated manner, to the depth of about one-sixteenth of an inch" in a manner clearly reminiscent of Pape's material. Cf. also note 11.

25 Boquillon, *op. cit.* (see note 12), p. 385–386: "M. Pape had taken out, in France as in England, a patent for the use of felt in covering hammers. But, while the English makers loyally paid him a royalty for the use of this material, the French makers used it without any sort of scruple, on

> sans aucune espèce de scrupule, sous le prétexte qu'ils employaient du feutre anglais, dont la couleur était blanche, et que le feutre employé par M. Pape était vert. Un premier procès, dont les lenteurs et les tracasseries de tout genre avaient appris à M. Pape le peu d'appui que la propriété industrielle trouvait alors dans la jurisprudence des tribunaux français, l'empêcha de faire valoir ses droits légitimes à l'application exclusive de cette importante invention, et les facteurs français purent impunément lui faire la guerre avec ses propres armes, en négligeant toutefois la couleur verte, parce que M. Pape ne leur avait pas appris que son caractère vénéneux empêche le feutre d'être attaqué par les insectes ...

Three examples from around 1840 are particularly interesting. The first, from 1837, is of a cream-coloured medium-staple soft wool felt, found in a Pleyel pianino (Illustration 11; Pleyel pianino no. 5,998). It is used for all the notes, unlike Pape felt. Compare this with the very similar leathered hammer from 1839 (Illustration 16; Pleyel pianino no. 7,904, which uses a particularly thick skin.

The other two felt examples survive in Pleyel grand pianos nos. 10,941 and 11,126, of 1844.[26] The earlier felt is of a light greyish-khaki colour, and it may be a proprietary mixture of rabbit and wool. The wool staple is of medium length and very curly, and the texture is quite soft. The hammers of the later example, which are grey (preponderantly rabbit-fur?) and have a shorter staple, have an outer layer of oil-tanned leather which seems to have been added subsequently, no doubt to compensate for wear (Illustrations 22, 23). Neither of these felts has the characteristic two-layered structure of the Pape material and so cannot be considered to be infringements of Pape's patent.

Compact grey rabbit-fur felt was regularly used as an underlayer in Erard hammers, from the late 1830's onwards (Illustration 19).

In 1840, Eugène-Hippolyte Billion took out a patent for a short-staple ("agneline")[27] lambs-wool felt[28]. This type of felt quickly superseded the earlier ones, and although oil-tanned leather continued to be used for certain instruments until the late 1840's, nearly all pianos henceforward used the Billion type. Billion felt was compact and resistant enough to be used in the treble part of the compass

> the pretext that they were using English felt, which was white, as opposed to M. Pape's, which was green. A first law-suit, by its slowness and obstructions, showed M. Pape how little weight industrial property rights carried in French courts, and prevented him from benefitting from his rights to the exclusive application of this important invention; and the French makers could wage war on him with his own weapons, neglecting however the green colour, as M. Pape had not informed them that by its poisonous nature it protected the felt from insect attack ..."

26 Flavio Ponzi "Nuove prospettive per la ricerca interpretativa: il restauro scientifico dei pianoforti romantici" in: *Trecento anni li dimostra? Il pianoforte nella società di oggi. Atti del convegno di Villa Gallia, Como 5 e 6 giugno 1999* gives some details of the original hammers of Pleyel grand no. 10,966 of 1844, which appear visually to be of this same type (p. 5–7; figs. 7, 9). The graph of total hammer-covering thickness shows great similarities to that of no. 10,941 (see my figure 2 giving total hammer diameters; the hammer-cores diminish only slightly across the compass). Unfortunately, amongst the extremely numerous test measurements and graphs provided by Ponzi, there is no information whatsoever about the felt beyond its density.

27 Cf. Julia de Fontenelle, *op. cit.* (see note 22), p. 9.

28 French Patent N° 7767. Harding, *op. cit.* (see note 5), pp. 390–391 gives Billion's patent.

(Illustration 14 (where it is probably a later re-covering); 18; 20 (a re-covering of about 1865); 21, 24, 25, 27).

The felt was produced in layers of uniform thickness. Until around 1860, the felt voicing layer was applied in a stepped series of different thicknesses over the underlayers of the various hammers. It would seem that the 'joins' between the sections covered in different thicknesses were compensated for either by adjusting the dimensions of the under-layers or by thinning-down by hand the treble end of each strip. In general, the treble-most hammers were made from a felt strip thinned down in this way over an octave or more.

Billion took out a further patent in 1845 to obviate this problem by making tapered sheets of felt much as Pape had done ten years earlier. However, this new format, no doubt more costly, did not find much favour until fifteen or so years later (Illustration 26: Erard 1866; Illustration 28: Pleyel 1894).

From at least this period, weight-driven, hand-operated machines were used to position and tension the felt at the moment of gluing it to each individual head (Illustration 30). Because of the uniform nature of felt, there was no longer any need to adapt[29] the tension of each cover to suit the individual characteristics of that particular piece of leather, and a constant tension could be given to the covers. The first patented machine (Guillaume Truchot's of 1857) was probably anticipated in practice by many years, perhaps by simpler versions using the same general principle. Truchot describes his machine merely as a 'new combination' and the first half of the patent description is concerned with a more economical way of cutting chamfered strips from felt sheets.

The combination of a homogeneous material and mechanised tensioning meant that good hammers with predictable characteristics could be produced using semi-skilled labour. Boquillon says:[30]

> L'emploi du feutre pour la garniture des marteaux est, dans mon opinion, l'un des plus grands progrès qu'on ait pu faire dans la facture des pianos; c'est à lui qu'on doit évidemment l'immense développement qu'a pris cette industrie dans ces dernières années; car, ainsi que je l'ai démontré plus haut, c'est grâce à lui qu'on parvient aujourd'hui à exécuter sans peine une bonne garniture de marteaux, opération que se réservaient autrefois les chefs de maison, tant elle présentait de difficultés d'exécution et d'importance dans ses résultats. Aujourd'hui, cette application peut être faite par des ouvriers très ordinaires; le facteur, débarrassé d'un travail fastidieux, peut consacrer tout son temps à surveiller la bonne exécution des autres parties de l'instrument, et donner à

29 See note 12.

30 Boquillon, *op. cit.* (see note 12), p. 393: "The use of felt is, in my opinion, one of the greatest advancements that could be made in the manufacture of pianos; it is evidently to this that we owe the immense development of this industry in recent years; for, as I showed above, it is thanks to this that today we can cover hammers well and with ease, an operation hitherto reserved for the heads of firms owing to the difficulties of its execution and the importance of its results. Today, this operation may be performed by very ordinary workers; the piano-maker, relieved of a taxing task, can devote his time to supervising the proper execution of the other parts of the instrument, extend his manufacturing operations in a way previously not possible, and at the same time, by augmenting his production, considerably lower its price."

> sa fabrication une extension qu'elle n'eût jamais pu comporter, en même temps qu'il peut, par cette augmentation de produits, en abaisser considérablement le prix.

This development accords perfectly with the mid-century adoption by the piano-making trade of industrial revolution principles of mechanisation which had long been resisted as being inappropriate to a highly-skilled and noble craft.[31]

Finally, in the last three decades of the nineteenth century, extremely thick tapered felt sheets and powerful presses began to be used in America; a whole set of hammers could be covered at once, in a single layer if desired[32] (Illustrations 28, 31). On the whole, French makers were reticent about the quality obtainable by these means and continued to use multi-layered hand-covering methods for their best instruments until the turn of the century.

Hammer-structure

As already stated, French pianos of the 1830's and early 1840's are characterised by an extremely soft *piano* timbre, with very little attack; for pianos equipped with Pape felt, the note seems to swell into existence from nowhere. Even Erard used the soft Pape felt for a while, at least for square pianos. *Forte* response in most French pianos is remarkably sinewy and the attack is quite percussive, more so in instruments by makers such as Erard, less so with those who followed Pape or Pleyel. Hammers with leather voicing layers were proposed as an alternative option to felt well into the 1840's and may have offered a more colourful timbre; they were certainly more durable than the early forms of felt (Illustrations 15–18). Indeed, in later Viennese-action pianos, the felted hammers were always covered with an outer layer of leather to prevent the strings cutting the felt as it struck them elliptically.

The composition of underlayers varied very considerably, according to the particular ideas of each maker. The Erard firm seems to have maintained a very similar basic design over many years, despite a certain experimentation as to the voicing layer. In general, it consisted of a thin layer of grey rabbit-fur felt under the voicing layer, followed successively by several layers of oil- and vegetable-tanned leather, of increasingly firmer consistency. Later practice replaced the various layers of leather by felts of varying density, dyed in different colours (yellow, purple, &c.) (Illustrations 7, 19, 26).

31 Cf. George Dodd, *Days at the factories; or, the manufacturing industry of Great Britain described. Series I – London.* London, Charles Knight & Co., 1843, pp. 407–408: "The pianoforte manufacture is one in which nothing but highly-skilled manual dexterity can make and adjust the numerous pieces of mechanism involved in it; and those workmen who possess this skill are not likely to be supplanted by any automatic machinery. Hence it happens that the same workmen are seen, year after year, occupying their old benches, using their old tools, coming to work and leaving at the old hours, and seeming as if the old shop belonged to them and they to the shop."

32 Cf. Dolge, *op. cit.* (see note 11), pp. 97–106; 120–123.

The Pleyel firm, on the other hand, engaged in constant experimentation from around 1815 until the mid-1850's. One is tempted to see the hand of Camille Pleyel in this progression, but in the early years it was probably Jean-Henri Pape who first defined the firm's ideals of timbre. Almost no two surviving Pleyel pianos have identical hammers. Using, by and large, the same palette of materials as Erard, Pleyel hammers were declined in an astonishing range of shapes and sizes (Illustrations 4, 5, 8, 10, 11, 14–18, 20–24, 27). It is as if Pleyel sought the perfect hammer in the same way as Chopin sought his "blue note". As already noted, his hammers share a marked graduation of firmness from the outside inwards, in order to provide the widest possible range of tone-colours across their dynamic range. Earlier models seem to have been constituted entirely of oil-tanned skins (chamois, deer, elk, buffalo ...) in accordance with the existing French tradition. From the mid-1830's, special vegetable-tanned leathers (goat, sheep, calf, horse ...) were increasingly used, in a complex series of combinations designed to define and control timbre at every dynamic level. At around this time, no doubt in order to modify their response at *fortissimo* levels, the innermost part of the hammers was made more resilient. In Pleyel grand pianos and in some pianinos, this was done by hollowing out the hammer-core in an oval[33] (Illustration 14), so leaving thin, supple walls at each side. This expedient was not possible in square pianos, due to the oblique shape of the hammers, and so Pleyel introduced a soft leather capping to the core of these (Illustrations 15, 21). Treble hammers in grand pianos were often capped by a cylinder of sole-leather – perhaps leather machine belting? With the increasing use of Billion felt for the voicing layers came a concomitant shrinking and simplification of the underlying structure, because this new material could be used in greater thicknesses than those readily offered by leather (typically 5 mm compared to 2–3 mm). The graduation in tension and compression within this one layer, generated by shaping it round the core and by the tension applied to it while gluing, provided a gradient of firmness which had previously been generated by the use of different layers of leather. Some hammers were made with a felt underlayer and leather voicing layer – for example, the hammers of the Pleyel grand no. 9,250, of 1842, now in the Musée de la Musique (Illustrations 17, 18). The innermost layers of hammers from the mid-1840's onwards were often made of hard ox- or horse-hide, and so reversed the supple-core tendency.

Pleyel used fairly similar designs for the hammers of square and grand pianos, whereas the pianino hammers usually had much larger cores and simpler structures (Illustrations 11, 16, 27).

Broadly speaking, we can say that this period saw a considerable rise both in complexity of structure and variety of materials. However, in the later part of the decade and in the 1840's and 1850's, with the definitive adoption of felt, builders began to simplify the structure, using fewer, thicker layers of various materials.

33 This practice harks back to Cristofori's and the Silbermann's use of cardboard rolls for hammerheads. Pape made cylindrical hollow hammers for his down-striking grand pianos.

The Billion felt, although very soft and resilient by today's standards, was much firmer in surface texture than either Pape felt or the soft oil-tanned chamois or deer previously used for voicing layers. Its use, coupled with the adoption of ever-stronger string materials and metal structures, at once made possible and led the way to a second phase in the developing aesthetic of the Romantic piano, in which pianos gained still further in loudness and breadth of sound. Thus the extremely soft hammers of the 1830's gradually gave way to firmer hammers capable of producing more intense sounds from taut steel strings. The adoption in the late 1830's and early 1840's of Webster steel for strings enabled a notable increase in tension by lengthening the strings, often without changing their diameters; an expedient not previously possible with iron wire. In the 1850's to the 1870's, first Miller's steel wire, then patented-steel Pohlmann wire began to be used which permitted further radical increases in string-lengths and hence tension.[34] Since the wire for any note was now in general not much thicker than before, but longer and strained tighter, it behaved more nearly like an ideal string than the shorter iron wires had; its overtones were better in tune and thus it became possible once again to seek a more brilliant timbre. This effect was enhanced in the treble registers by the use of *agrafes*[35] and capo-tasto[36] bars, which provided more stable end-points for the vibrating strings than the fragile old pinned wooden nuts had done; the increased inertia of iron hitch-pin plates and reinforced wrestplanks had a similar effect. (Those who attended the concert during the 2010 Lausanne meeting in which four Pleyel pianos were compared, were struck by the powerful sound of a pianino of 1856 – Webster strings, Billion-type felt hammers – compared to a grand of 1839 – iron strings, leather hammers). Pianos were changing fast, and professionals bought new pianos remarkably frequently.[37]

34 See notes 3 and 4.

35 Sébastien Érard, English patent no. 3170, 24/03/1809.

36 Invented by Antoine Bord in 1843, no patent found. In effect, the capo tasto is a massive agrafe spanning an octave or more.

37 Cf. Jean-Jacques Eigeldinger, *Chopin et Pleyel*, Paris, Fayard, 2010, chapter VIII, pp. 257–307.

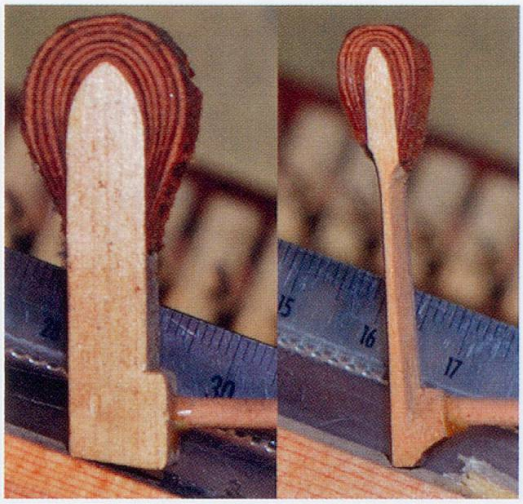


Illustration 1. Hammers for CC♯ and c^4, grand piano no. 825 by Conrad Graf, Vienna, 1825. (Musée de Bastia, France)

Illustration 2. Hammer for GG, grand piano by Jean-Guillaume Freudenthaler, Paris 1814 (seen at auction, 2011, Lyon, France)

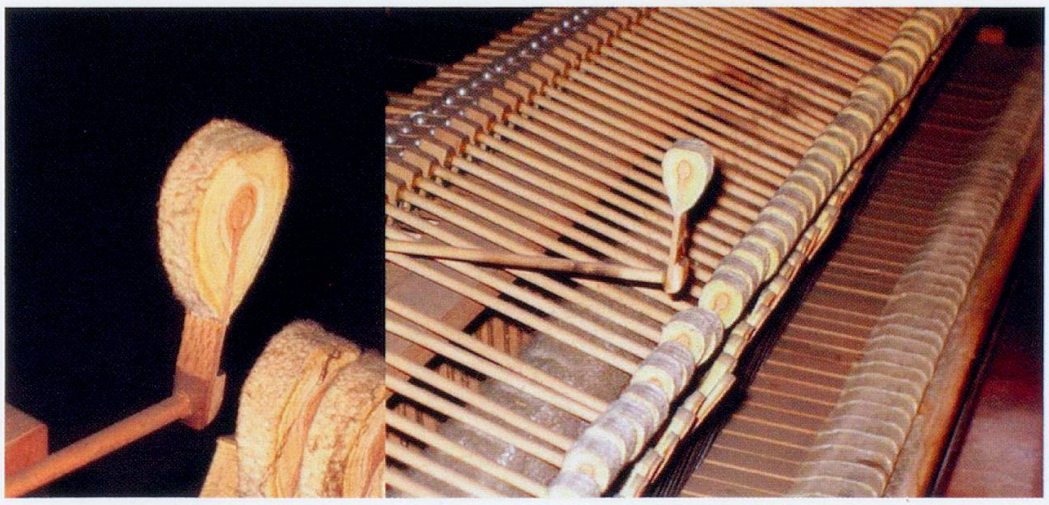


Illustration 3. Hammers, grand piano by Jean-Guillaume Freudenthaler, Paris 1817 (seen at auction, 2009, Paris, France)

Illustration 4. Hammer from grand piano no. 1,232 by Pleyel et Cie., Paris April 1829 (RC M. Lambert) (private collection, France)

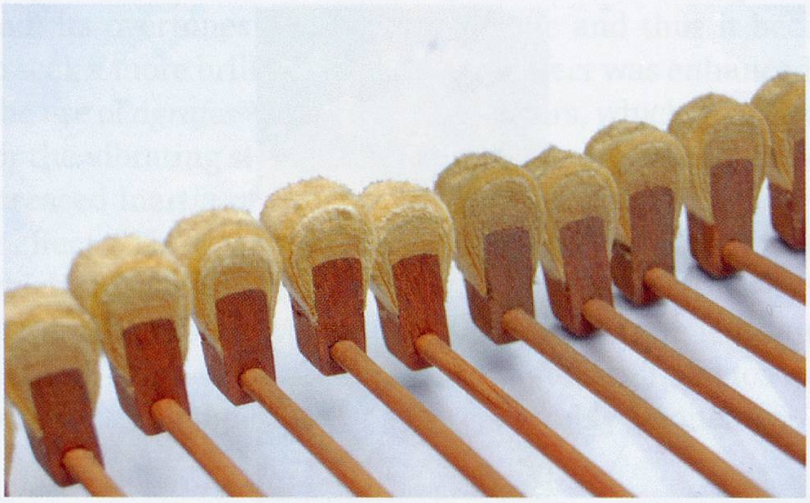


Illustration 5. Hammers, square piano no. 1,354 by Pleyel et Cie., Paris July 1829 (RC M. Peters, Bordeaux) (private collection, France)

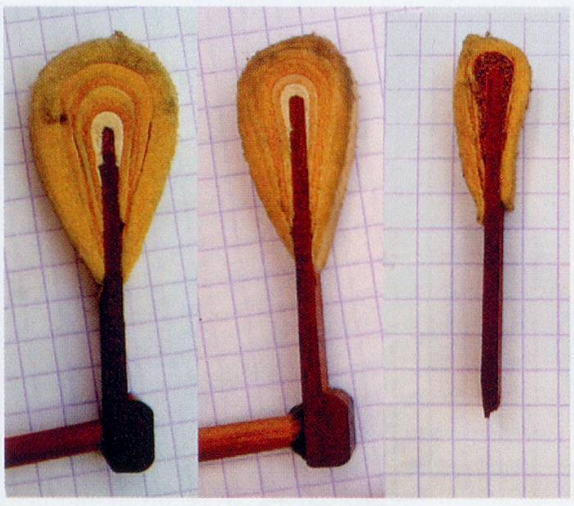


Illustration 6. Hammers for CC♯, e^2, $f♯^4$, grand piano no. 1,619 by Pleyel et Cie., Paris November 1830 (LV M. Boisselot, Marseille) (private collection, France)

Illustration 7. Hammers for CC, c^2, e^4, square piano no. 13,107 by Sébastien & Pierre Erard, Paris 1834 (private collection, Switzerland)

Illustration 8. Hammer for FF, square "unicorde"piano no. 2,381 by Pleyel et Cie., Paris October 1832 (RC M. E. De Champeaux) (private collection, Switzerland)

Illustration 9. Hammer from a square piano, probably by Pape, Paris c. 1835 (private collection, France)

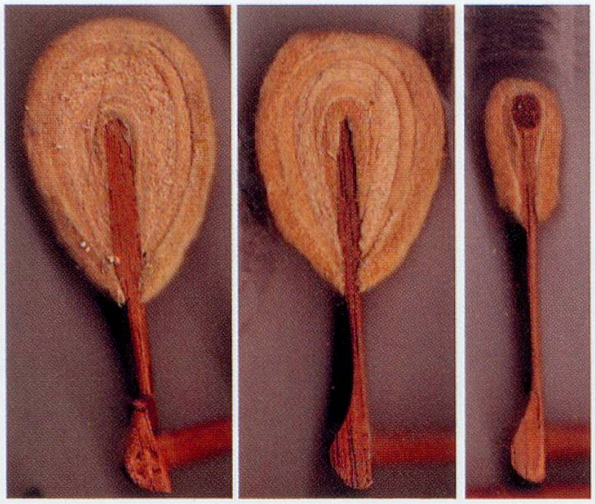


Illustration 10. Hammers for CC♯, g, e^4, grand piano no. 5,610 by Pleyel et Cie., Paris May 1837 (RC M. Hermé, Mamers) (private collection, France)

Illustration 11. Hammer for FF, pianino no. 5,998 by Pleyel et Cie., Paris October 1837 (RA) (RC November M. Henniquin (?), Paris) (private collection, France)

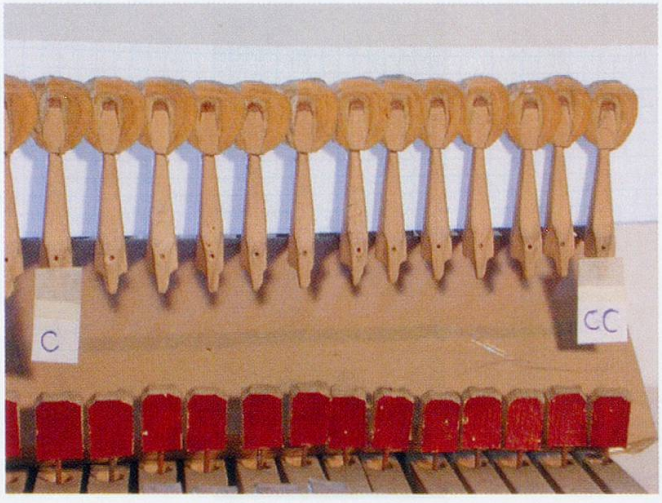


Illustration 12. Bass hammers of square piano no. 1,418 by Guillaume-Lebrecht Petzold, Paris 1837 (private collection, France)

Illustration 13. Hammers around c^1, "dog-kennel" upright no. 890 by Soufléto & Cie., Paris 1838 (private collection, France)

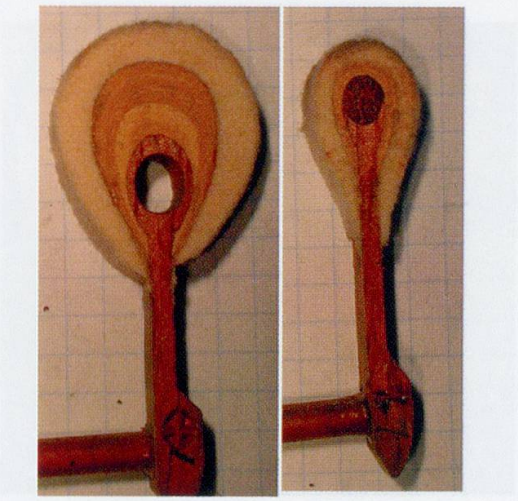


Illustration 14. Hammers for CC & e^4, grand piano no. 7,245 by Pleyel et Cie., Paris September 1839 (RC Lafaux, St. Quentin) (private collection, France)

Illustration 15. Bass hammers, square piano no. 7,872 by Pleyel et Cie., Paris October 1839 (RA) (private collection, France)

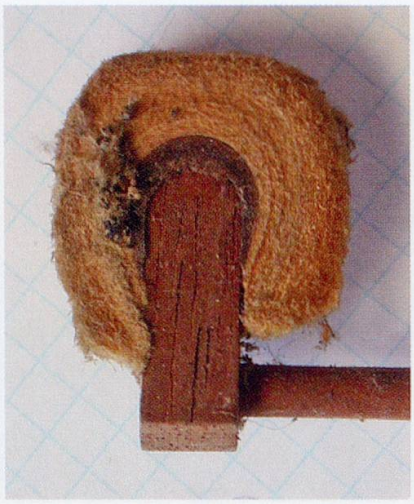


Illustration 16. Hammer for C, pianino no. 7,904 by Pleyel et Cie., Paris March 1840 (RC Blanche pr. Arrault) (piano now destroyed)

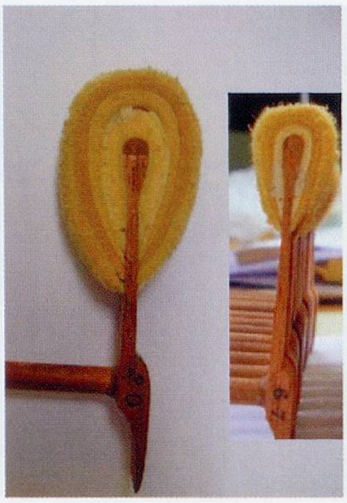


Illustration 17. Hammers for G and g^3, grand piano no. 9,250 by Pleyel et Cie., Paris May 1842 (RA) (Musée de la Musique, Paris)

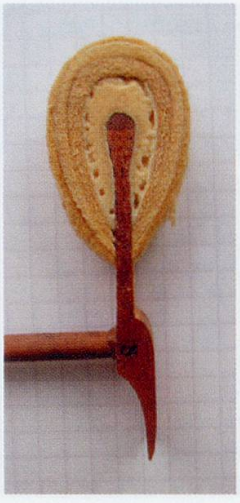


Illustration 18. Hammer for EE, grand piano no. 9,250 by Pleyel et Cie, Paris May 1842 (RA) (Musée de la Musique, Paris)

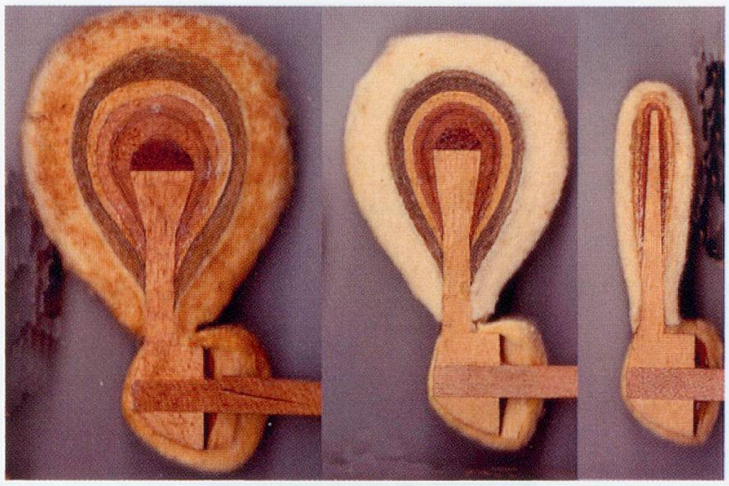


Illustration 19. Hammers for CC, c^1, g^4, grand piano no. 15,700 by Erard, Paris December 1842 (sold 2nd February 1843, Mon. Laurent, Namur) (private collection, Switzerland)

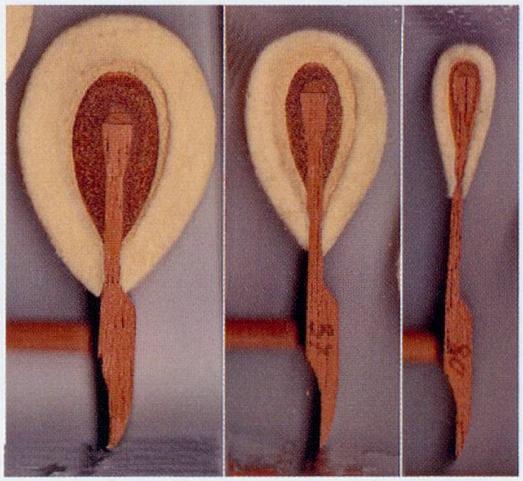


Illustration 20. Hammers for CC, c^1, g^4, re-covered in around 1865, grand piano no. 10,035 by Pleyel et Cie, Paris July 1843 (RC Dalvingen, Paris) (private collection, France)

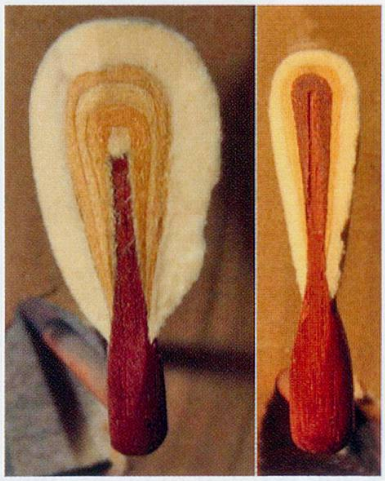


Illustration 21. Hammers for CC, c^4, square piano no. 10,200 by Pleyel et Cie, Paris August 1843 (RC Woelffle, Angoulême) (private collection, England)

Illustration 22. Hammer, grand piano no. 10,941 by Pleyel et Cie, Paris October 1844 (RC Mr. de Neuvesel, Lyon) (private collection, Italy)

Illustration 23. Hammers for CC♯, c^1, g^4, grand piano no. 11,126 by Pleyel et Cie, Paris October 1844 (RC Mr. Magnier, Moulins) (private collection, France)

Illustration 24. Hammer for c^2, grand piano no. 14,000 by Pleyel et Cie, Paris July 1847 (RA) (private collection, France; this serial number was provided by the owner) (Author's note: No. 14,000 is listed in LA as "piano droit 1/2 oblique": the nearest grand pianos to this are no's 14,043-14,050, 14,068-70 all "petit patron" or 14,062-66 "grand patron")

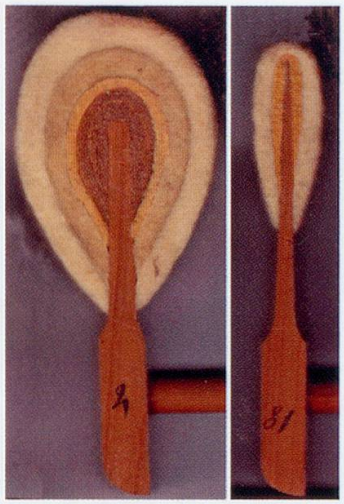


Illustration 25. Hammers for CC♯ and g♯4, grand piano no. 2,894 by Boisselot et Fils, Marseille 1847 (private collection, France)

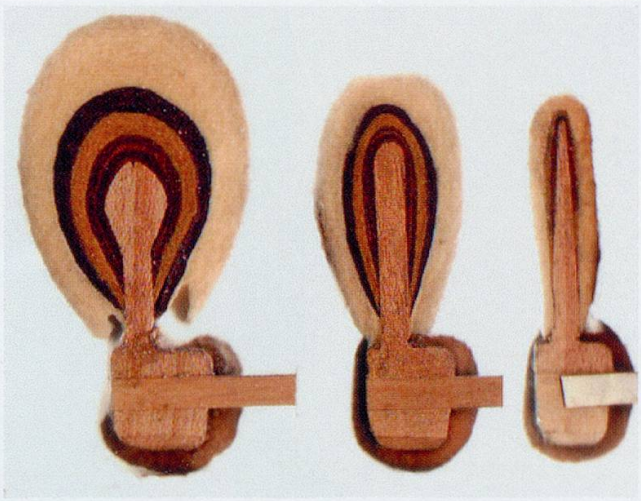


Illustration 26. Hammers for AAA, a1, a4, grand piano no. 9,772 by Erard & Co. London 1866 (Finchcocks Collection, England)

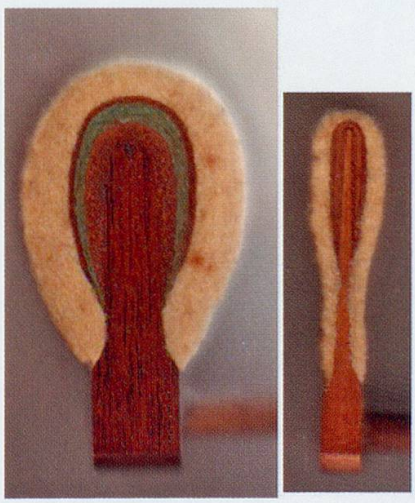


Illustration 27. Hammers for AAA and g♯4, pianino no. 21,975 by Pleyel et Cie, Paris January 1856 (RC put out to hire) (private collection, Switzerland)

Illustration 28. Hammers for AAA and a^4, grand piano no. 109,187 by Pleyel, Wolff et Cie, Paris 1894 (private collection, France)

Illustration 29. Method for covering under-layers in leather (author's fac-simile, Erard 1802)

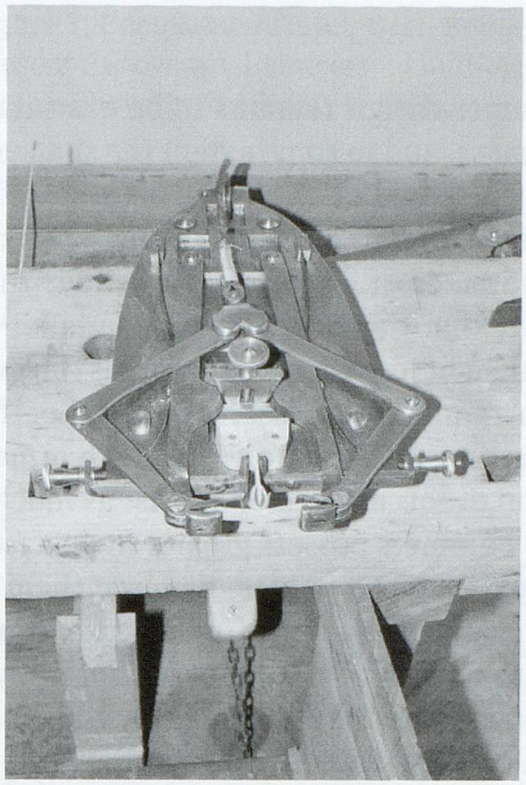


Illustration 30. Hammer-covering machine, author's copy of anonymous 19th-century machine in the Musée de la Musique, Paris

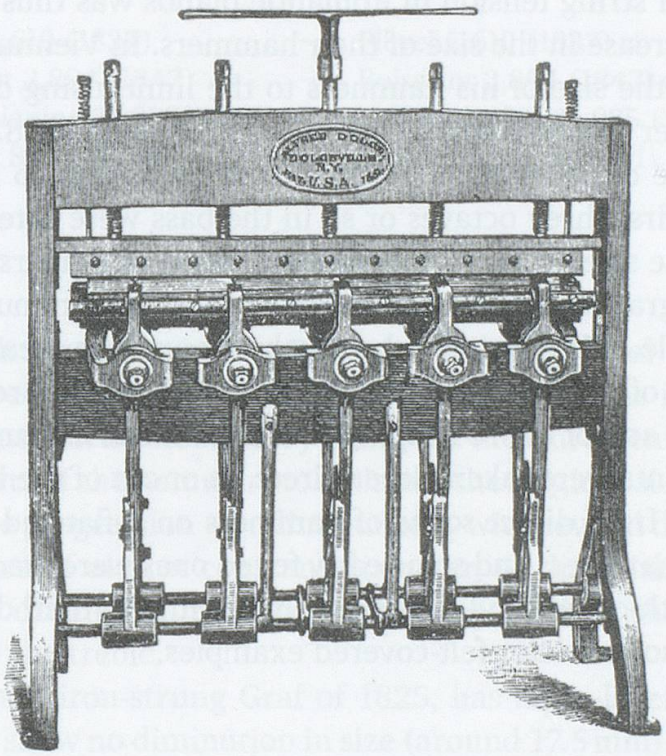


Illustration 31. Machine for covering a full set of hammers in felt, Alfred Dolge 1887 (Dolge op. cit. (see note 11), p. 101)

Hammer-size

One parameter of hammer-design remains to be examined, that of size, which directly influences its mass, and to some extent the shape of its crown and hence its footprint.[38]

The relationship between hammers and strings determines to a very large extent the musical character of a piano. To consider this relationship briefly, we should first consider that the motion of the hammer towards the strings is reversed after the moment of impact; the hammer is thrown off the string like an acrobat bouncing from a trampoline. Clearly the mass of the hammer, its relation to the tautness of the strings and the point at which it meets them all influence the nature and duration of this encounter at least as much as the composition of the hammers. Heavier hammers possess greater inertia (store more energy) and, within the limits imposed by the strings, displace them more effectively than would lighter ones, thus favouring their fundamental tone. The sound initiated by larger hammers is thus "fuller" than that produced by small ones. However, hammers which are too massive for the strings (or which strike too far from their ends) stay too long in contact with them when they are propelled fast, and so the vibration of the strings is damped by the hammer during hard playing. The ideal size, for any given string configuration, is one which gives a full sound at any reasonable dynamic level, without audible damping during *fortissimo* playing. String scaling and hammer scaling go hand in hand.

The increase of string tension in Romantic pianos was thus accompanied by a considerable increase in the size of their hammers. In Vienna, Conrad Graf by 1826 had pushed the size of his hammers to the limit, using dimensions twice those of some other makers. He also introduced, by the mid-1820's, a non-linear progression in the dimensions of his hammers from bass to treble, in such a manner that the first three octaves or so in the bass were fitted with hammers of almost the same size, before diminishing by differing tapers into the treble.

The following graphs show how makers conceived the diminution of their hammers, bass to treble. It is difficult to be absolutely exact in measuring hammers: to the difficulties of measuring soft materials consistently are added the complications of wear and of the re-shaping of felt hammers as part of maintenance work. Measurements were taken either direct, in or out of the instrument, or by photogrammetry, from direct scans of hammers on a flat-bed scanner. On the whole, leathered hammers and some early felted ones were made with materials which differed in thickness and sometimes in texture, so their diameters are less consistent than those of later felt-covered examples.

38 Cf. Clarke, *op. cit.* (note 14).

Figure 1. Comparison Pleyel, Graf, Boisselot.
The upper lines represent the overall diameters, in millimetres, of the hammers.
The lower traces show the thickness of their voicing layers (vl).

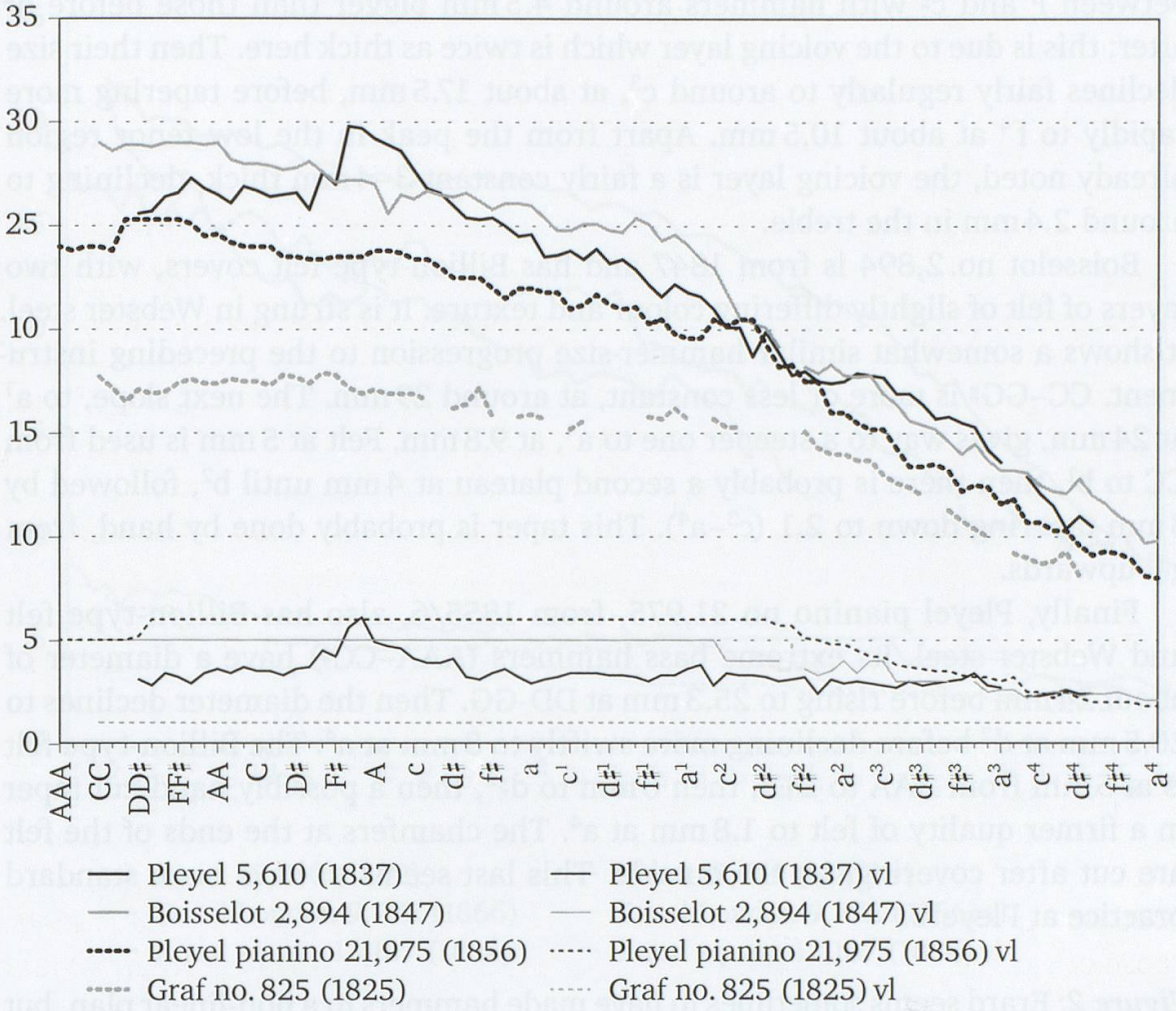


Figure 1: The felt coverings of the Boisselot and the Pleyel pianino had been partially re-shaped at some period, and so the dimensions in the middle and treble regions have been corrected by using the measurements of the thickness of untouched parts of the hammers to estimate the original sizes. All four instruments show a size progression – or diminution – with several distinct slopes. The bass hammers are of almost constant diameter, or diminish only very slowly in size, then the diminution proceeds slowly for much of the compass, before accelerating into the treble.

The earliest, the iron-strung Graf of 1825, has multi-layered brown leather hammers. These show no diminution in size (around 17.5 mm) from CC to F. This is followed by a gentle decline in size to about f^2, at 15 mm, followed by a much steeper decline down to f^4, at just over 8 mm. The occasional gaps and spikes are due to missing or misplaced hammers. The voicing layer is more or less constant in thickness, at around 1 mm.

Pleyel grand no. 5,610 dates from 1837 and has oil-tanned leather-covered hammers; it is iron-strung. The bass series of hammers, CC–d, are of very similar size, between 25 and nearly 30 mm in diameter. There is a peak in this region between F and c♯ with hammers around 4.5 mm bigger than those before or after; this is due to the voicing layer which is twice as thick here. Then their size declines fairly regularly to around c^3, at about 17.5 mm, before tapering more rapidly to f^4 at about 10.5 mm. Apart from the peak in the low tenor region already noted, the voicing layer is a fairly constant 3–4 mm thick, declining to around 2.4 mm in the treble.

Boisselot no. 2,894 is from 1847 and has Billion-type felt covers, with two layers of felt of slightly differing colour and texture. It is strung in Webster steel. It shows a somewhat similar hammer-size progression to the preceding instrument. CC–GG♯ is more or less constant, at around 29 mm. The next slope, to a^1 at 24 mm, gives way to a steeper one to a^4, at 9.8 mm. Felt at 5 mm is used from CC to b^1, then there is probably a second plateau at 4 mm until b^2, followed by 3 mm tapering down to 2.1 (c^3–a^4). This taper is probably done by hand, from $g♯^3$ upwards.

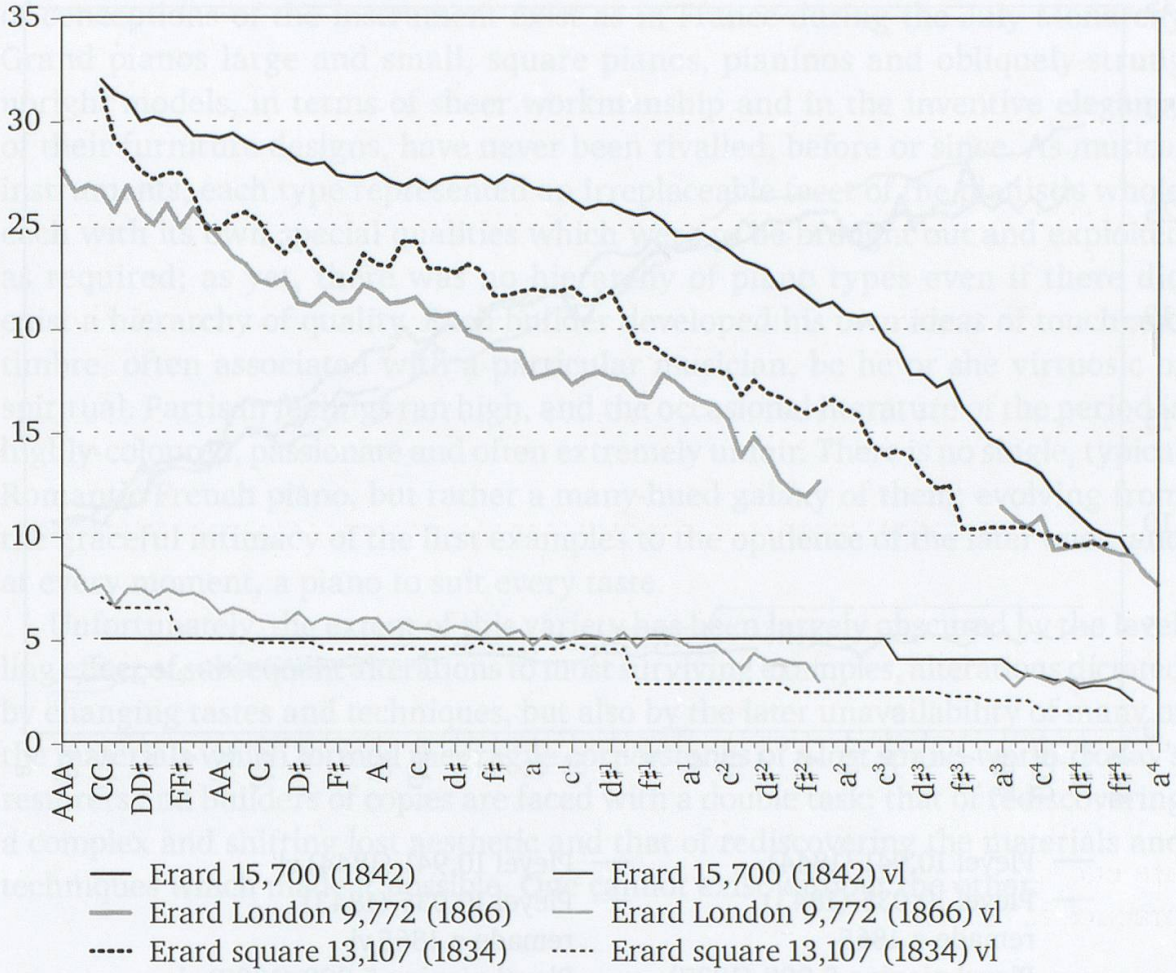
Finally, Pleyel pianino no. 21,975, from 1855/6, also has Billion-type felt and Webster steel. Its extreme bass hammers (AAA–CC♯) have a diameter of about 24 mm before rising to 25.3 mm at DD-GG. Then the diameter declines to 20.5 mm at d^2 before declining more swiftly to 8 mm at a^4. The Billion-type felt is at 5 mm from AAA to DD♯, then 6 mm to $d♯^2$, then a possibly hand-cut taper in a firmer quality of felt to 1.8 mm at a^4. The chamfers at the ends of the felt are cut after covering, on the outside. This last seems to have been standard practice at Pleyel's.

Figure 2: Erard seems sometimes to have made hammers to a non-linear plan, but more often used a fairly linear diminution from bass to treble. The graph shows three instruments; a large square piano, no. 13,107, made in 1834, iron-strung and with Pape felt hammers in the lower half and oil-tanned leather in the treble; a grand, no. 15,700 of 1842/3, in Webster steel with Billion-type hammers; a London-made grand of 1866, no. 9,772 strung in harder steel and with a tapered sheet of Billion-type felt.

Square no. 13,107 is by and large linear in diminution, 31.5 mm at CC to 9.6 mm at f^4. In detail one might discern a rapid decline from CC to F (31.5–23.3 mm), a slight regain in diameter to c♯, a slow decline to about $c♯^1$, followed by a slightly steeper decline thereafter. It has a Pape felt covering of around 5 mm from CC to e^1. The first six notes are covered in thicker Pape felt, around 6.5 mm. There is a very slight taper in thickness of the felt, down to 4.5 mm, which was probably not intentionally manufactured but which has been exploited by the hammer-coverer. The oil-tanned leather coverings, from f^1 upwards, are noticeably thinner, at 2.8 mm to e^2, then 2.2 mm to g^3, afterward tapering to 1.5 mm at f^4.

Grand no. 15,700 follows a rather similar curve; an initial decline from CC to c (32–27 mm) is followed by a slight swell to g (27.4 mm), a decline to b^2 (20.7 mm)

Figure 2. Comparison of Erards.
The upper lines represent the overall diameters, in millimetres, of the hammers.
The lower traces show the thickness of their voicing layers (vl).

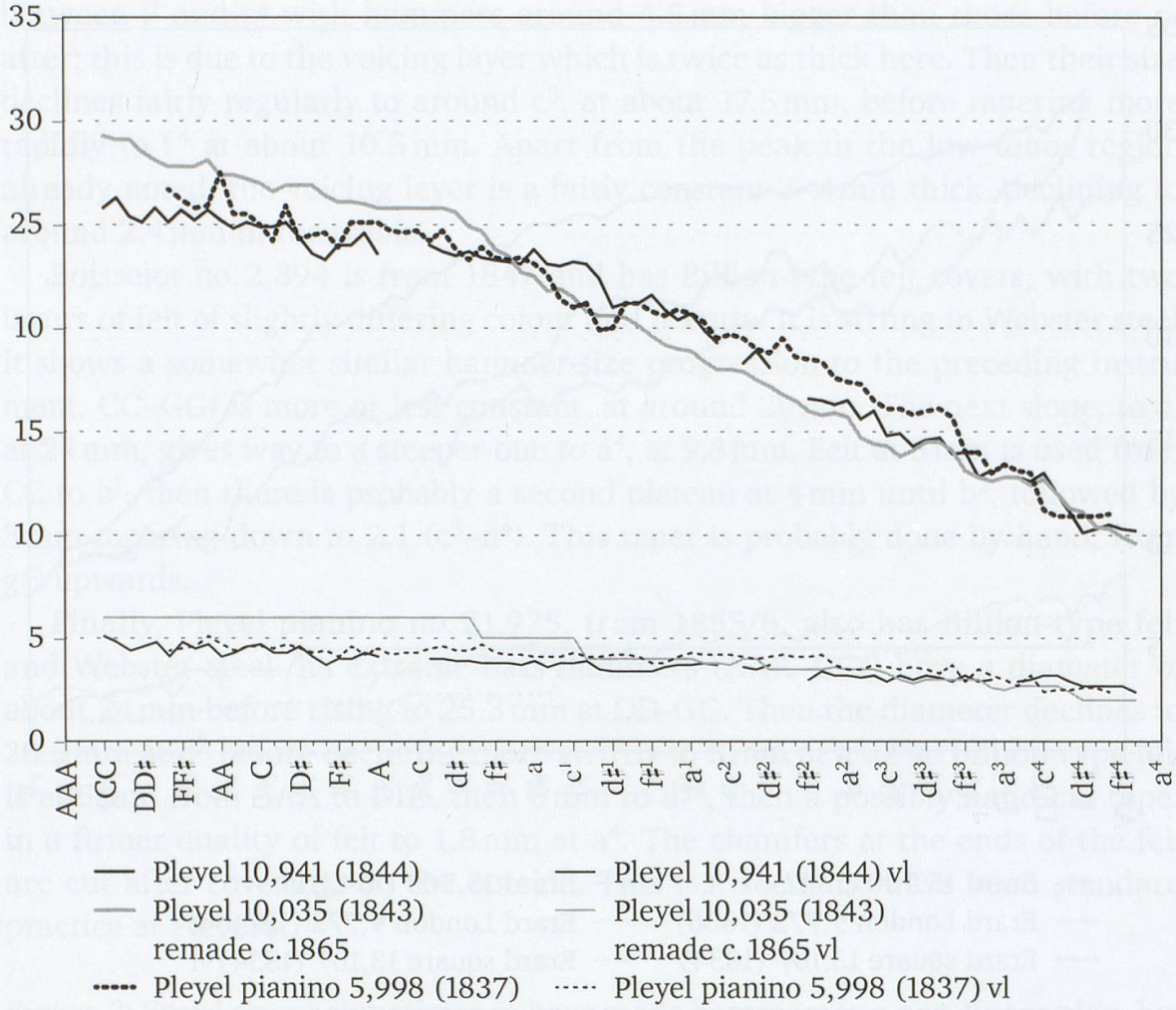


and then a steeper one to g^4 (8.9 mm). The voicing layer is at 5 mm from CC to c^3, 4 mm to a^3, then (hand?) tapers to 2 mm at g^4.

Grand no. 9,772 is the only one of our sample to use a tapered sheet of Billion-type felt for the coverings. Unfortunately data for notes $g\sharp^2$ to $g\sharp^3$ is missing, due to a corrupt computer file. Hammer-sizes decline quite regularly from 27.7 mm for AAA to 7.6 mm for a^4, and the felt diminishes from 8.6 mm to 2.4 mm over the compass. It is interesting to note that this piano, the latest in date of all in our study, also has the smallest hammers overall of any but the Graf, the earliest.

Figure 3: This group consists of two grand pianos, no. 10,941 of 1844, strung in Webster steel, with a greyish-khaki wool or mixed fur and wool felt covering; no. 10,035 of 1843, also strung in Webster wire, but rebuilt by Pleyel in around 1865, when the hammers were re-covered in somewhat thicker, firmer Billion-type felt and the hammer-notches were built out with added wood in order to minimise the increase in touch-weight. Finally, pianino no. 5,998, of 1837, is strung in iron. It has hammers covered in a soft long-staple wool felt.

Figure 3. Comparison of Pleyels around 1840.
The upper lines represent the overall diameters, in millimetres, of the hammers.
The lower traces show the thickness of their voicing layers (vl).



Grand no. 10,941 and pianino no. 5,998 share an almost identical profile. An initial gentle decline from CC to d^1 (25.8–22.4 mm) for the grand, FF–c (26.7–22 mm) for the pianino, accelerates somewhat thereafter, to 10.2 mm at g^4 (grand) and 11 mm at f^4 (pianino). The soft felt voicing layer seems to be about 4.8 mm thick in the bass of the grand, settling to around 4 mm from E to e^2 (it is not in good condition), then around 3 to 2.4 mm in the treble. The pianino starts at about 4.5 mm in the bass, settling to around 4.2 mm from F♯ to g^2, tapering to 2.4 mm at f^4. The gently-tapering thickness of the main sequence may be due to tighter stretching of this very elastic material.

Grand no. 10,035 shows an inner structure of its hammers which is very similar to that of no. 10,941. It looks as if it may have originally had a voicing layer very similar in thickness (and possibly in composition) to its younger brother; the use of 6 mm Billion felt for the notes CC–e instead of 5 mm or a bit less makes the bass hammers bigger; subsequently 5 mm (f–c^1) and 4 mm (tapering from maybe $d♯^2$ down to 2 mm at g^4) resembles the other two schemes.

Conclusion

Perhaps at no other time and place in the history of the piano did such a variety of conceptions of the instrument exist as in France during the July Monarchy. Grand pianos large and small, square pianos, pianinos and obliquely-strung upright models, in terms of sheer workmanship and in the inventive elegance of their furniture designs, have never been rivalled, before or since. As musical instruments, each type represented an irreplaceable facet of the pianistic whole, each with its own special qualities which were to be brought out and exploited as required; as yet, there was no hierarchy of piano types even if there did exist a hierarchy of quality. Each builder developed his own ideas of touch and timbre, often associated with a particular musician, be he or she virtuosic or spiritual. Partisan feelings ran high, and the occasional literature of the period is highly-coloured, passionate and often extremely unfair. There is no single, typical Romantic French piano, but rather a many-hued galaxy of them; evolving from the graceful intimacy of the first examples to the opulence of the later ones, and at every moment, a piano to suit every taste.

Unfortunately, the extent of this variety has been largely obscured by the levelling effect of subsequent alterations to most surviving examples, alterations dictated by changing tastes and techniques, but also by the later unavailability of many of the materials which formed the fragile cornerstones of a lost sound-world. Today's restorers and builders of copies are faced with a double task: that of rediscovering a complex and shifting lost aesthetic and that of rediscovering the materials and techniques which made it possible. One cannot exist without the other.

Abstract

Numerous literary sources testify to the radical changes in the nature of the piano in the decades following 1820. The instrument became more powerful and more flexible, in such a way that intensity and timbre could be controlled entirely by the pianist's touch over a greater range than ever before. Advances in metallurgy allowed higher string tensions, and innovations in structure ensured stability of tuning. New hammer designs provided a wide palette of nuances which before had been achieved by the use of mutation pedals. To achieve this, at first ever more layers and variety of types of leather were employed, in combinations of increasing complexity. This demanded a high level of skill and also considerable waste of material. The introduction of felt, at first in a two-layered form made principally from rabbit- and hare-fur, and then in single-layered forms made from wool permitted simpler construction and less-skilled labour, while ensuring a more uniform result. The rationalisation and the increasing mechanisation of the piano trade following the Revolution of 1848 tended towards a still greater simplification, made possible by the use of thicker layers of felt, and then of felt sheets tapering in thickness.