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Chladni's clavicylinder and some imitations

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Abstract. Chladni's accomplishments in the field of instrument making were until recently not nearly as well-respected as his studies on the modes of vibration of plates and rods. However, he had developed his own friction instruments based on the glass harmonica, a popular instrument of his time. The instruments, which he partially built himself, had keys, which distinguished them from the glass harmonica. Additionally, these instruments differed from traditional keyboard instruments as they enabled the crescendo and decrescendo of individual notes after the key had been struck.

Although Chladni's clavicylinder fascinated audiences and prompted imitations by many instrument makers, it was largely ignored by composers and pianists and therefore never became part of standard orchestration.

The Museum of Musical Instruments of the University of Leipzig features three rare examples of friction instruments which have outlasted the centuries. These instruments were built according to the Chladni principle. After a thorough analysis, including the production of individual notes, these instruments will be presented in their cultural-historical as well as their technical context, followed by a discussion of their advantages and disadvantages. These originals exhibits allow for a conclusive comprehension of Chladni's ideas and his quest for new, unusual tone colors.

1 Introduction

Today, Chladni's accomplishments in the field of instrument making are not nearly as well-known as his studies on the modes of vibration of plates and rods. However, he developed several musical instruments, part of which he even built himself. His *"friction instruments"* were highly regarded around 1800. Apart from audiences' rave reviews, many imitations of Chladni's ideas give clues about the significance of his instruments, namely Chladni's euphonium (not to be confused with the brass euphonium) and the clavicylinder. However, the composers of Chladni's time seem to have regarded such instruments as mere experiments. Not a single piece of music explicitly demanded the use of Chladni's instruments.

Felix Mendelssohn-Bartholdy, then merely twelve years of age, apparently took quite an interest in getting to know the great physicist. He poignantly described Chladni's sparse way of living and compared his sound apparatuses to wind instruments and the glass harmonica:[1] *"... Um 3 Uhr fuhren wir also nach Kemberg, einen kleinen Flecken, oder Dorf, wo*

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[1] Letter to his father from October 30, 1821: *"... at 3 o'clock, we drove to Kemberg, a tiny patch, or village, where Dr. Chladni received us and invited us to be his guests. Immediately, we went to his dwelling, which consists of a single room. The little room also houses his instruments, three clavicylinders and one euphon (ask Beckchen [his sister Rebekka], if you want to know what euphon means). This room is his bedroom, his workshop, his guest room. It contains all of his work equipment, and a new, yet to be finished euphon in a small commode. He played for us on all of his instruments. The clavi-cylinder's tone is like that of a very gentle oboe. The euphon is made from glass rods, which are*

uns Dr. Chladni empfing und uns sagte, wir sollten seine Gäste sein. Wir begaben uns also gleich nach seiner Wohnung, einem einzigen Stübchen, in der seine Instrumente, drei Clavi-Cylinder und ein Euphon steht (Fragt doch Beckchen, was Euphon heißt). Diese Stube ist seine Schlafstube, seine Werkstätte, sein Besuchzimmer. All sein Arbeitszeug ist darin, und in einer kleinen Commode ist ein neu angefangenes Euphon. Er hat uns auf allen seinen Instrumenten vorgespielt. Der Ton des Clavier-Cylinder ist wie der einer sehr sanften Oboe. Das Euphon besteht aus Glasstäben, welche naßgemacht und mit nassen Fingern gestrichen werden, es klingt wie wenn man mit genäßten Fingern an eine Glasglocke streicht. Du kannst Dir also, liebe Fanny vom Klange dieses Instrumentes sehr leicht einen Begriff machen . . . ".

Although young Mendelssohn seemed to be truly impressed, he later failed to incorporate these instruments into his numerous works. The classical instruments clearly seemed to have been sufficient. This poses the question what Chladni was planning to do with his newly developed friction instruments. In his opinion, what kind of sound was still missing? In order to answer these questions, one must first address the glass harmonica, the most important friction instrument.

2 Keyboard instruments having a "singing" tone and "pure" timbre

Being possibly the best known and one of the most important friction instruments, amazingly, the glass harmonica flourished from its invention by Benjamin Franklin until about 1850. It produces sounds when the player's wetted fingers are rubbed against the rims of the instrument's revolving glass bowls, which are set in motion by a treadle. The instrument's carefully tuned glass bowls were arranged in a manner similar to a keyboard. Indeed, the ethereal sounds of the glass harmonica impressed listeners in the decades before and after 1800 to an extent not matched by the impressions made by any other contemporary instrument. Christian Friedrich Daniel Schubart (1739–91), e. g., recommended that only a sensitive player whose *"heart's blood trickles from his fingertips"* be allowed to play this *"deeply-moving, melancholy instrument"*. Puschkin found something *"other-worldly"* in the instrument's *"magical tones"*, and Mozart, Beethoven and Donizetti all wrote for the instrument.

But despite the euphoria its *"music of the spheres"* evoked, its disadvantages were undeniable: very high purchase cost, extreme fragility of the glasses and associated transportation problems as well as the lack of a keyboard which could from its inception have facilitated performance on it by pianists and organists. In the opinion of Johann Adam Hiller,[2] the bowls of the harmonica were, moreover, arranged too confusingly and this almost completely prevented a performer from playing quick passages.[3] Traditional keyboard instruments such as pianos, organs, harpsichords and clavichords, however, left some wishes concerning their sound unfulfilled: *"Die gewöhnlichen Instrumente, welche mit Tasten gespielt werden, haben die Unvollkommenheit, daß sie nicht s i n g e n, d. i. daß man die Töne nicht, so lange sie eigentlich dauern sollten, mit anwachsender, gleichbleibender, oder abnehmender Stärke fortdauern lassen kann."*.[4]

Glass harmonicas provided with a keyboard (as described, e. g., by Karl Leopold Röllig in 1787) were even more expensive and as fragile as conventional harmonicas and did not gain acceptance. Friction instruments with vibrating sounding bodies that were not made of glass seemed to be the solution. Ernst Friedrich Chladni completed in 1800 the construction of his

wetted and stroked with wet fingers. It sounds as if one was stroking a glass bell with wet fingers. Dear Fanny [his sister Fanny], you should easily be able to imagine the sound of this instrument. . . " (see *Felix Mendelssohn-Bartholdy: Briefe*, edited by Rudolf Elvers, Frankfurt/Main 1984, S. 19–20).

[2] Hiller (1728–1804) worked as the Gewandhaus conductor and choirmaster-organist at St. Thomas' church in Leipzig, among other positions.

[3] Anhang zu dem dritten Jahrgange der Nachrichten und Anmerkungen die Musik betreffend (Annex to the third volume of news and annotations concerning music), Leipzig, p. 171.

[4] *"Ordinary instruments played by the use of keys show the imperfection of not s i n g i n g, i. e., you cannot make the tones sound as long as needed, with increasing, constant or decreasing volumes."* Chladni, 1821, p. 33.

Fig. 1. Glass harmonica, about 1800, Museum für Musikinstrumente, Leipzig, Inventory No. 351.

clavicylinder, a keyboard instrument with vibrating iron rods. The inventor expressed *"Die Idee eines Clavicylinders ist gewissermaßen das Entgegengesetzte von der Idee der Harmonika ..."*,[5] meaning that sounding glass bodies turned on their own axis and were rubbed with fingers in case of the harmonica, while, with the clavicylinder, a non-sounding glass cylinder rotated which caused tuned friction rods to vibrate when they were brought in contact with the cylinder surface by means of a keyboard. Numerous imitators picked up his ideas; friction instruments having vibrating wooden boards, metallic tubes etc. were built subsequently.

Yet there is still another decisive difference between the glass harmonica and those novel friction instruments. As a result of the search for a sound that was to be as *"pure"* as possible without any friction-induced noises, instruments were built in which the sounding bodies themselves did not directly contact the cylinder: *"Es ist kein Geheimnis, dass die Stäbe ... nicht die klingenden Körper sind, sondern nur das Mittel, durch welches der Klang aus den verborgenen klingenden Körpern gezogen wird [...]. Eine Saite nämlich, oder ein Metallstab, welcher von dem Bogen unmittelbar berührt und gestrichen wird, lässt außer dem Klang noch ein, mehr oder weniger vernehmliches Geräusch hören. [...] Könnte man den klingenden*

[5] *"The idea of a clavicylinder is, in a way, the opposite of that of the harmonica ..."* Chladni, 1821, p. 9.

Körper in Schwingung setzen, ohne dass der reibende ihn unmittelbar berührte, so würde man den Klang rein erhalten." [6]

In simple words, that implies separating the violin bow from the string or the finger tips from the glasses of the harmonica in order to prevent the noise of stroking from being generated. Thus the metal tubes or iron rods that were responsible for the sound being produced were in contact with the cylinder only indirectly – through small elastic metal platelets, wooden rods (friction rods) or the like. On being pressed onto the rotating cylinder, these friction rods were set vibrating and subsequently the generated vibrations were imparted to the connected sounding rods, thus creating music with a minimum of mechanical noise. The friction rods had to be adapted to the size of sounding rods since they too affected the frequency generated. The rods were additionally provided with adjustable weights for exact tuning. Chladni himself used the principle of friction rods for his improved clavicylinder after 1811.[7]

3 Chladni's clavicylinder

In the publication of his *"Beyträge zur praktischen Akustik und zur Lehre vom Instrumentenbau, enthaltend die Theorie und Anleitung zum Bau des Clavicylinders und damit verwandter Instrumente"* [8] in 1821, Ernst Friedrich Chladni gave detailed information on the structure, mode of operation and style of playing of his invention. As early as twenty years before, in early 1800, he had presented his clavicylinder for the first time to a larger audience, without revealing the secret of sound generation. In 1810, Chladni got to know the harp maker Concone in Turin and permitted him to build his clavicylinder. Concone made the instrument, among others, that is present in the Leipzig University Museum für Musikinstrumente (Inventory No. 356), which clearly shows that he followed Chladni's instructions exactly. It corresponds to a clavicylinder of an earlier type of construction and contains friction rods only for lower registers. At that time the inventor had just had *"the quite immature idea"* of his more recent type with separate sound and friction rods *"in mind"*.[9]

The instrument bears an external resemblance to a small square piano. Actuating the treadle causes a cylinder with an attached flywheel to rotate. The cylinder, which needs to be moistened with water, is made of wood and has four attached glass cylinders. Below the cylinder, there are the ends of key levers with 63 curved iron rods mounted on them. At the touch of a key, the iron rod immediately below – or in low registers above – a felt-covered friction rod is brought into contact with the cylinder. Sound generation thus can be traced back to the principle of friction of freely suspended tuned sounding rods.

The famous physicist had occupied himself with the oscillatory response of iron rods for years. He ascertained that the nodal points of vibration moved closer when the rod is bent, resulting in a change of pitch, but hardly of tone colour. All the rods in the clavicylinder have their ends bent. Chladni recommends that this should be done *"am besten vermittelst eines Schraubstocks und einer Zange von der Art, wie man zum Ausziehen der Nägel gebraucht"*.[10] This required sensitivity, for *"Die Biegung darf nicht etwa in einem Punkte gar zu eckig seyn ..."*.[11] For the material of the sounding rods, iron and brass were especially suitable *"oder*

[6] *"It is no secret that the rods ... are not the sounding bodies proper, but only a means which allows to draw the sound from the hidden sounding bodies [...]. A string or a metal rod, which is immediately touched or stroked by the bow will produce, besides its sound, a more or less clearly audible noise. [...] If it were possible to cause the sounding body to vibrate without being touched by the rubbing one, then you would get the sound in clean form."* In: A. Apel, Über Herrn Uthe's Xylharmonicon, und einige verwandte Instrumente, in: Allgemeine Musikalische Zeitung 12, Leipzig 1809/10, Sp. 385–390.

[7] Chladni, 1821, p. 69 and following pages.

[8] *"Contributions to practical acoustics and to the science of instrument making, which comprises the theory and instructions for making the Clavicylinder and related instruments"*.

[9] *"die sehr unreife Idee... im Kopfe"*, ibid., p. 121.

[10] *"best by means of a vice and a pair of pincers as used for extracting nails"*, ibid., p. 21.

[11] *"The bend must not be too sharp in a point ..."*, ibid., p. 22.

Fig. 2. Clavicylinder: Louis Concone, Turin, the 1810s. Shelf mark: *"Clavicylindre/d apres Mr. Chladni, fait par/Louis Concone/A Turin"* Leipzig: Museum für Musikinstrumente, Inventory No. 356. Dimensions (in mm): Case length 1050, width 568, height 965. Cylinder length 910, diameter 67. Sounding rods width 11, thickness 2.5 ... 3.8 (decreasing towards treble), length 610 ... 115 Pitch: chromatic G1 – a3; a1 ca. 445 Hz.

wenn jemand einen überflüssigen Luxus treiben wollte, Silber". [12] Pitch depends on the rods' length and thickness, but not on their width: *"Um also einen Stab höher zu stimmen, muss man dessen Länge vermindern, und um ihn tiefer zu stimmen, muß man von der Dicke etwas wegfeilen"*.[13] Fine tuning is effected by changing the curvature; it was recommended that the instrument should be tuned in equal temperament.

Chladni compares the sound of the instrument to an organ as the duration of a note can be made to last as long as desired. He suggests that it would be suitable mainly for singable, slurred phrases, but not for rapid scale passages, though it would never be able to emulate the volume and sonority of the organ. It was, however, superior to the organ in that the volume of individual notes could be increased and decreased by varying the pressure applied to the keys. Chladni also recommended appropriate organ compositions, primarily the works of the Darmstadt organist Johann Christian Heinrich Rinck (1770–1846),[14] as being suitable for performance on the clavicylinder.

4 The melodion invented by Dietz

By presenting his instruments, Chladni not only delighted a large audience, but involuntarily also stimulated clever imitators to construct keyboard instruments using similar means of sound production. Especially the melodion seems to have been known to a wider public as newly

[12] *"or silver if anybody would like to allow himself the unnecessary luxury of using it"*, ibid. p. 27.
[13] *"For tuning up a rod, its length has to be reduced, and for tuning it down, some of its thickness has to be removed by filing"*, ibid., p. 29.
[14] Ibid., p. 124 ff.

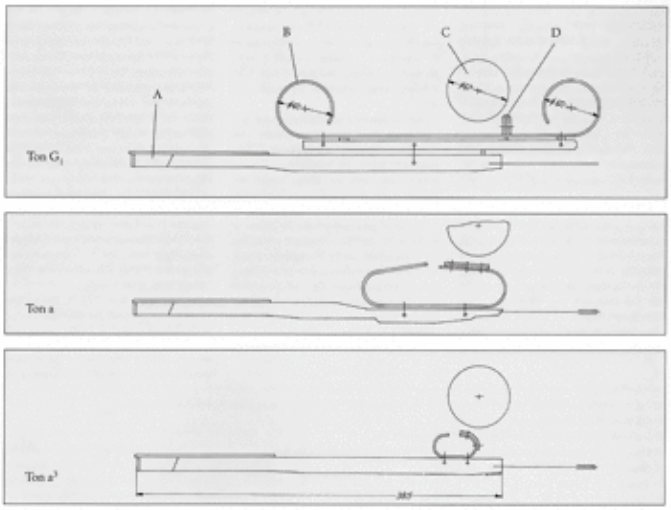

Fig. 3. Clavicylinder: Cross section of the mechanism. A = Key, B = Sounding rod, C = Cylinder, D = Friction rod.

presented friction instruments were often compared to the melodion or the glass harmonica. The melodion was constructed by Johann Christian Dietz. Dietz[15] is supposed to be born in Darmstadt in 1773 and died in Holland in 1849. From his father, he learned the trade of a joiner, and after vocational training, he married and settled in Emmerich and Nijmegen (Holland). His experiments in the field of instrument making culminated in the construction of the melodion in 1805. In addition, he occupied himself with improvements in the field of machine construction. Napoleon had him come to Paris in 1813. Here Dietz made a great contribution to the sewage disposal system and moreover took out a patent for his claviharp. After the emperor had abdicated, Dietz moved to Brussels and set up a factory for hydraulic machinery and horse-drawn passenger carriages.

Dietz had his melodion, which he finished in 1805, presented by a Mr. Betzold (also spelled Petzold) from Gotha in many concert halls in 1806.[16] He is reported to have sold several specimens in Westfalia and Holland in the same year.[17] According to a newspaper report, *"Seine Fabrik [ist] bereits in solchem Flor, dass beständig gegen dreyssig Instrumente in Arbeit sind"*[18] at that time. The cost of such an instrument was approximately that of a good piano.[19]

The appearance of the instrument is similar to that of a delicate square piano. Mounted on the rear internal upright wall of the case (which also serves as a soundboard) there are 68 brass tubes fixed to the case at one end, and these produce the instrument's sound. They are brought into contact with a revolving tin cylinder indirectly – via metal platelets (springs). The player makes the axle of the cylinder rotate by using the treadle. When a key is pressed, a metal platelet (spring) mounted on a felt-covered sounding tube is pressed against the cylinder with the platelet acting as a means of transmitting the resulting vibrations from the cylinder

[15] For his biodata cp. *"Ein vergessener Meister des Instrumentenbaues"* (*"A forgotten master of instrument making"*) in: Zeitschrift für Instrumentenbau (Journal of Instrument Making), Leipzig 1896, pp. 139–141, Kinsky 1910, p. 414, Cranmer 1984.

[16] Cp. article Dietz, in: Gerber, 1812, columns 891–892 as well as *"Notizen"* (notes) in: Allgemeine Musikalische Zeitung 8, Leipzig 1805/06, columns 526–527, and 12, 1809/10, columns 469–471.

[17] Cp. article Dietz in: Gerber, 1812, columns 891–892.

[18] *"His factory [is] already in such a state of prosperity that permanently about thirty instruments are being worked upon"*. (Article *"Melodion"*, in: Allgemeine Musikalische Zeitung 8, Leipzig 1805/06, Sp. 526–527 und 715–718.)

[19] Ibid.: *"... that it can be bought at a cost not higher than that of a good pianoforte."*

Fig. 4. Melodion: Without a shelf mark, Johann Christian Dietz, Emmerich, in about 1810, Leipzig: Museum für Musikinstrumente, Inventory No. 357. Dimensions (in mm): Case length 1162, width 592, height 830. Cylinder length 914, diameter 7072. Metal platelets length 64 . . . 48, width 9 . . . 12, thickness 0.5 . . . 1. Sounding tubes diameter 6 . . . 7, oscillatory length 155 . . . 15 Pitch: chromatic F1 - c4.

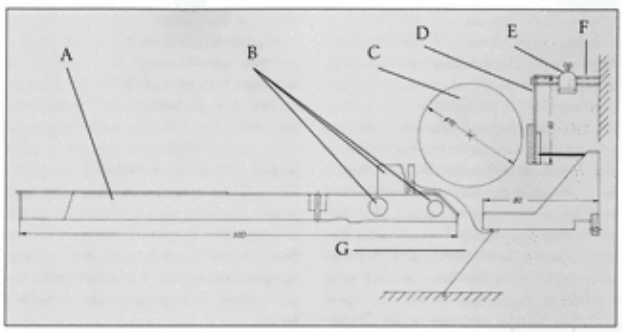

Fig. 5. Melodion: Cross section of the mechanics. A = Key, B = Weights, C = Cylinder, D = Friction rod (spring), E = Weight for intonation, F = Sounding tube, G = Wire.

to the sounding tubes. For fine tuning, Dietz provided every sounding tube with an adjustable weight, the size of which he adapted to the tube length. The melodion purportedly allowed *"in der Zeit von zehn Minuten bequem einen Viertel- oder halben Ton höher oder tiefer stimmen . . . Übrigens braucht es nicht gestimmt zu werden, und kann . . . viele Jahre hindurch ohne Reparatur gebraucht werden."*[20]

[20] Ibid.: *"to be easily tuned up or down by a crotchet or minim within a period of ten minutes . . . By the way, it does not require tuning and can . . . be used for many years without any repair."*

Its volume depends on the speed of rotation and increases with higher rotational cylinder speed. Contemporaries emphasized as a particular advantage that the cylinder did not have to be treated either with water or with rosin.

Unfortunately, the melodion present in Leipzig is no longer in working order, however contemporary listeners described its tone colour in different ways. An outstandingly positive assessment was written by an anonymous author, one *"als Komponist und Kunstkenner rühmlichst bekannter Mann"*[21] from Amsterdam: *"... es lässt zu, dass nicht nur singbare und gebundene Stücke aller Art sehr gut und besonders mit schönem Crescendo und Diminuendo, sondern selbst sehr schnelle Bravourstücke lebhaft, nett und präcis vorgetragen werden (Hr. B[etzold] spielte z.B. Suiten Haydnscher und ähnlicher Klaviervariationen, und zwar ganz unverändert, arrangierte Konzerte, selbst ursprünglich für die Violin geschriebene, u. dergl.). Der Ton ist äusserst angenehm, und wird dies um so mehr, da er alle Gradationen vom leisesten Piano bis zu beträchtlichem Forte zulässt. Man hat diesen Ton mit einer verstärkten Harmonika verglichen; wir finden ihn einer Harmonie von Klarinetten, Bassetthörnern (in der Tiefe) und Flöten, (in der Höhe) wenn man sie aus einiger Entfernung hört, am ähnlichsten."*[22] In another article written shortly afterwards, the same author again praised the melodion and stressed that it had a very soft expression in common with the glass harmonica, but surpassed it by the feature that tones did not get blurred, but died away more quickly when a key was released. It was said to have the light action of a piano and to have a full-voiced sound like that of the piano in all registers.

There were other listeners who gave less positive assessments: *"Als ich das Melodion, wohl von Petzold gespielt, hörte, fand ich, dass die Basstöne verhältnissmässig zu schwach waren ..."*.[23] Gerber also was discriminating in his judgement on it in his lexicon: *"Beym langsamen harmonischen Vortrage eines Chorals übertrifft es vielleicht noch die Harmonika in Erweckung sanfter Gefühle. Im Vortrage von geschwinden Sätzen und Passagen hingegen hat es täuschende Ähnlichkeit mit einer guten Berliner Flötenuhr. Der Fall und die Bewegung der Tasten ist aber noch sehr ungleich an diesen Instrumenten [...]"*.[24]

In his article, Chladni made sceptical remarks about friction instruments having sounding bodies mounted at one end. Their tuning was too highly dependent on the consistency of wood in which they were fixed and thus too sensitive to humidity and temperature variations. They hence needed an adjusting screw for fine tuning, which was not required for the clavicylinder.[25]

The melodion was not destined to exist for a longer period of time, and the expectations of an Amsterdam author did not come true at all: *"Ganz sicher wird einmal dieses Instrument bey den vielen Eigenheiten und Vorzügen unter den Klavier-Instrumenten die erste Stelle einnehmen ..."*.[26]

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[21] Ibid.: *"man praiseworthily known as a composer and art connoisseur"*.

[22] Ibid.: *"... it allows not only singable and slurred pieces of music of all kinds to be played very well and especially with a pleasant crescendo and diminuendo, but even very rapid bravura pieces to be performed in a lively, nice and precise way (for example, Mr B[etzold] played suites of Haydn or similar piano variations and, in fact, entirely without any changes, adapted concertos which had been originally composed for violin, and the like). Its tone is extremely pleasant and this applies all the more so since it allows all gradations between the softest piano and a forte of considerable volume. This tone has been compared to that of a reinforced harmonica; we find it to be most similar to a harmony of clarinets, basset horns (in the low register) and flutes (in the upper register) when heard from some distance."*

[23] *"On listening to the melodion which was played by Petzold, I found the bass tones to be relatively weak ..."*, Allgemeine Musikalische Zeitung 12, Leipzig 1809/10, columns 469–471.

[24] *"In the slow harmonic performance of a chorale, it may surpass even the harmonica, regarding the awakening of soft emotions. When rapid movements and passages are played, however, it strikingly resembles a good Berlin musical clock. The touch and movement of keys are still very dissimilar on this instrument [...]"*, Gerber, 1812, Sp. 891–892.

[25] Chladni, 1821, p. 19.

[26] *"Surely this instrument will some day occupy the first place among keyboard instruments, considering its many peculiarities and advantages ..."*, Allgemeine Musikalische Zeitung 8, Leipzig 1805/06, columns 526–527.

Fig. 6. Terpodion: Johann David and Friedrich Buschmann, Berlin, about 1825. Shelf mark *"J.D.Buschmann in Berlin"*, Leipzig: Museum für Musikinstrumente, Inventory No. 358 Dimensions (in mm): Case length 1300, width 672, height 830. Cylinder length 1025, diameter 104. Sounding boards length 276...284, height 36 ...46, thickness 8 ...10 Pitch: chromatic F1 - f4.

5 The terpodion

Johann David Buschmann from Friedrichsroda near Gotha, who had occasionally appeared in public as a glass harmonica player began to work on a novel friction instrument in 1805, thus in the same year when Dietz completed his melodion. He was supported by the art-loving August, duke of Coburg-Gotha, who also sonorously named the instrument *"Terpodion"* (refreshing song).[27] After a long phase of development and improvement, Buschmann presented his invention, the design of which is based on Chladni's ideas, for the first time in public in 1813.[28] In 1816, he was allowed to present it to the king in Dresden and only shortly afterwards, he succeeded in getting Carl Maria von Weber to write a favourable report on the terpodion for a Dresden newspaper.[29]

Externally, the terpodion resembles a square piano, with the case being larger than that of the clavicylinder and the melodion. A wooden cylinder, which has to be treated with rosin before playing, is made to rotate by pedalling. When keys are pressed, felt- or suede-covered wooden friction rods contact the cylinder. Their vibrations are transmitted via connecting arms made of wood or metal to the wooden sounding boards located below them (73 are present), where with increasing pitch their length decreases and their height increases. For fine tuning,

[27] Article *" Hundert Jahre Harmoniumbau und anderer Zungeninstrumente, 1810-1910; Notizen aus dem Buschmann-Archiv von Gustav Adolf Buschmann in Hamburg"* (One hundred years of making harmoniums and other reed instruments, 1810–1910, Notes from the Buschmann archive by Gustav Adolf Buschmann in Hamburg) in: Zeitschrift für Instrumentenbau XXX, Leipzig 1910, pp. 996–997.

[28] Cp. Buschmann, 1938.

[29] Dresdner Abendzeitung, early in September 1817, cited in Buschmann, 1938, p. 10.

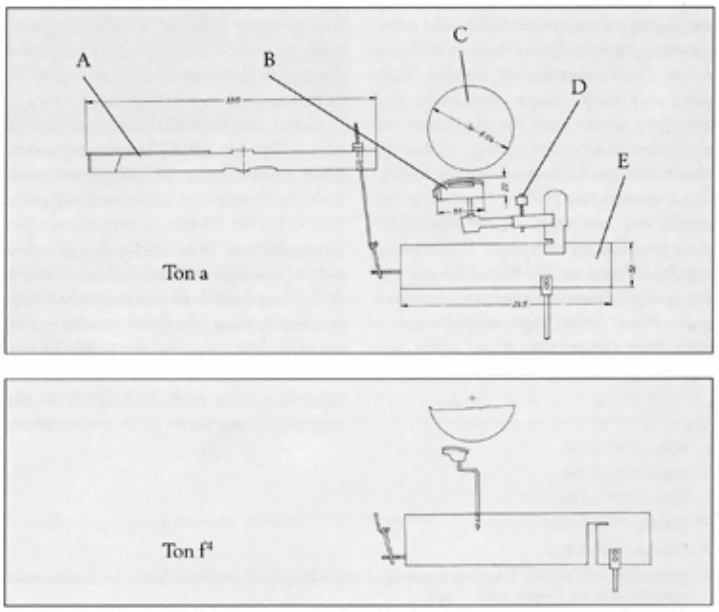

Fig. 7. Terpodion: Cross section of the mechanism A = Key, B = Friction rod, C = Cylinder, D = Weights, E = Sounding boards.

Buschmann attached weights on connecting arms, which can be adjusted in lower registers by means of screw threads. Volume was controlled by varying key pressure.

The tone colour of the terpodion was said to be similar of the melodion, the glass harmonica and various different wind instruments: *"Die Qualität des Tones nähert sich [...] der Harmonika [...]. Einzelne Regionen des Instruments ahmen bis zur lebendigen Täuschung manche Blasinstrumente [...] nach."*[30] *"Man glaubt eine auf das genaueste eingeübte Harmonie mehrerer Blasinstrumente als Flöte, Klarinette, Fagott, Horn etc. zu hören [...]".*[31] Buschmann himself recommended the use the instrument when playing slow pieces, such as chorales and adagios, but stated that figures of a faster tempo could also be performed *"bei näherer Kenntniß der Behandlung des sehr leicht spielbaren Instrumentes".*[32]

It was only after some extended use of instruments that their disadvantages showed up, for the condition of wooden sounding rods was much too dependent on the weather conditions. Repairs were frequently needed, and according to records, many owners urgently asked the inventor to call on them to restore the terpodion.[33] Chladni also gave his opinion on these problems: *"Holz läßt sich zwar auch anwenden, es würde aber wegen des Schwindens und Anquellens nach Verschiedenheit der Nässe und Trockenheit zu sehr einer Verstimmung ausgesetzt seyn."*[34]

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[30] *"The tonal quality comes close [...] to that of the harmonica [...]. Some of the instrument's tonal ranges imitate some wind instruments [...] in a deceptively clever way."*, C.M. von Weber in der Dresdner Abendzeitung, ibid.

[31] *"You think you can hear a perfectly practised harmony of several wind instruments, such as flute, clarinet, bassoon, horn, etc. [...]"*, Allgemeine Musikalische Zeitung 19, Leipzig 1817, p. 618–19.

[32] *"if [the player] has some deeper knowledge of how to treat the very easily playable instrument"*, Note under the heading Music sent in by *"J.P.S."*, in: *"Vossische Zeitung"*, 9 May 1820.

[33] Buschmann, 1938, p. 12.

[34] *"Though wood can also be used, it tends to be put out of tune owing to shrinking and swelling up in humid and dry conditions"*, Chladni, ibid., p. 28.

From 1821, the Buschmann family produced their instruments in Berlin. It was there that they took out a patent for the terpodion for a period of ten years.[35] Following this, production increased to such an extent that the instrument, which initially was not exactly cheap at *"66 carolins in gold"*, eventually became available for the price of a good pianoforte.[36]

In 1832, Johann David and Friedrich Buschmann moved to Hamburg and established a factory for pianos and physharmonicas. At this time, it was mainly Friedrich who further distributed the terpodion. Among the many artists who called on the workshop in Hamburg, reportedly there was also Franz Liszt who ordered a terpodion.[37] Johann Nepomuk Hummel also praised the instrument in 1832.[38]

6 Summary

During the decades between 1800 and 1830, several types of friction instruments, not having glass bells, but equipped with a keyboard were developed. Three of them (probably the three most important and most wide-spread types) have been described here. These inventions with very similar modes of operation can all be traced back to Chladni's clavicylinder construction. In summary, an outline of their most important features is given in the following table:

	Cylinder surface	Sounding body	Method of tuning	Material rubbed into cylinder
Clavicylinder	Glass	iron rods	degree of bending	water
Melodion	Tin	Brass tubes	adjustable weights	
Terpodion	box wood	wooden boards (oak and maple)	lower registers: adjustable weights upper registers: dropped-on lead	rosin

Much was reported on these instruments, especially in the noted Leipzig professional journal *"Allgemeine musikalische Zeitung"* and it is astonishing to read what a great future was forecast for them. Why they did not prevail can only be conjectured. On the one hand, interest in the sounds of the glass harmonica and similar instruments generally decreased in the course of the 19th century. On the other hand, the tonal quality of friction instruments, despite the praise of some contemporaries, appeared to be insufficient to ensure their wide-spread use. Playing rapid music pieces remained problematic. For a trained pianist, operating the cylinder was an additional impediment. A very high maintenance expense has to be added. With respect to the instruments preserved in the Leipzig Museum für Musikinstrumente, even after careful restoration, only a few notes can still be played only on the terpodion and clavicylinder. Subjective auditory sensations can be described as follows: Making notes to grow louder and to decrease in loudness involves handling a keyboard instrument in a really unusual way. The sound itself turns out to be lacking in overtones and is similar to that of woodwind instruments, such as flutes (in middle and upper registers), but lacks their expressive capabilities. It was not possible to avoid mechanical noises caused by pedalling; it seems probable that noise-free performance was achieved in former times only through optimum maintenance.

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