 *Neueste Temperatur.*
An Equal Temperament
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by
Johann Mattheson

The Hänfling/Bümler Temperament
a Trigger for Bach's
Well-Tempered Clavier?

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Introduction

With the wide dissemination among German musicians of the specifics for tuning keyboard instruments in Equal Temperament assured by the Johann Mattheson's publication, *Critica musica*, Vol. 1 (Hamburg, 1722), it becomes increasingly possible that Johann Sebastian Bach might have made his acquaintance with this temperament at this time, if he had not already done so earlier. Mattheson's publication may well have been the causal trigger for assembling and composing the *Well-Tempered Clavier*.

Although Equal Temperament (hereafter designated simply as 'ET') was known theoretically before the Renaissance, possibly even back to the time of Aristoxenos, and even found proponents in the 16th century like Vincenzo Galilei who applied it mainly to fretted instruments like the lute, the inevitable movement toward acceptance of ET more generally

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for all keyboard instruments gained momentum around the turn of the 18th century particularly among German theorists.²

This investigation will focus primarily on the likelihood that Bach would have had ample opportunity to make an acquaintance with ET, a temperament which would fit his general view on even intonation while, at the same time, specifically answer the problematical aspects of modulation and transposition into remote keys (primarily the keys/tonalities with a number of flats and sharps where ‘out-of-tune’ intervals and chords were more likely to exist with temperaments other than ET.)

Bach’s Criticisms and Recommendations to Organ Builders

In rendering his expert opinion on the condition of an organ, Bach had in mind a certain standard according to which he judged all the results of an organ builder’s efforts: the organ needed to conform to this standard of *Aequalität* (“equalness, equality”)³ in all respects such as: 1) the wind pressure must be even and made to remain the same; 2) the keys should not fall too far when they are depressed or even ‘stick’ on a note when played; 3) the proper positioning of the organ with easy access to its inner parts. But Bach particularly emphasizes that the following defects are to be remedied immediately: 4) the *Intonation* of the pipes should be improved to attain *Aequalität* in every way – the attack, the steady duration of the tone and the temperament/tuning, all of which must be brought to the condition of being the same. *Intonation*, in German as well as in English, can refer both to the quality and the specific pitch of any given sound. As a precondition to an *aequale* tuning, the mechanical speaking of each pipe must be made the same after which another tuning of the entire organ must take place. It may be argued that an unequal temperament (non-ET) is contrary to the goal of *Aequalität*, which Bach had in mind as providing the ideal playing conditions for an organ as he would best envision it.

² Mark Lindley, in his article on “Temperament” in the *Grove Music Online*, Oxford University Press, 2005, acc. 11/15/05 states: “In the late 17th century and early 18th, however, a circle of German theorists became interested in Equal Temperament, including Werckmeister, Meckenheuser, Neidhardt and Mattheson. The wave of interest that they represent never thereafter lost momentum....”

³ All of the following references on judging the condition of an organ are taken from *Bach-Dokumente* I, pp. 163-165, item 87, which pertains to an autograph document containing Bach’s opinion and certification of the organ at St. Paul’s Church in Leipzig, December 17, 1717. Here are critical excerpts from this document referred to above: “daß der Wind durchgehends *aequaler* gemacht werden muß” – “that the wind pressure everywhere should be made equal”; “Die *Tractierung* des Wercks sollte zwar etwas leichter seyn, und die *Clavire* nicht so tief fallen...daß man eines Stecken Bleibens im Spielen sich nicht zu befürchten” – “The depression of the keys should be somewhat lighter and the keys/manuals should not fall as deep as they do now...so that a key would not remain stuck while playing”; “Die gantze ‘Struktur’...ist...sehr enge gefast und daher schwerlich iedem Stücke beyzukommen...”--“the entire structure is too compact and for this reason it is difficult to get at each part inside”; “Die etwanigen *defecta* ... müßen und können so fort...verbeßert werden” – “these defects must and can be corrected immediately”; “fleißig *corrigit* und zur Gleichheit gebracht werden” – “carefully corrected and brought into the condition of sameness as compared to sound of other pipes”; “vermittelst nachmahliger Durchstimmung des gantzen Wercks” – “by tuning, once again, the entire organ.”

Bümler, a Key Figure to Consider

To proceed further it is useful to consider a short biography of Georg Heinrich Bümler based upon his biography as given in two important musical dictionaries.⁴



Figure 1: Copper Engraving depicting Georg Heinrich Bümler by Johann Christoph Sysang after a painting by Johann Christian Sperling (from the *MGGI*, Vol. 15, Plate 42)

Georg Heinrich Bümler
born October 10, 1669 in Berneck, Upper Franconia
died August 26, 1745 in Ansbach (Ornoltzbach)

Born in Berneck in Upper Franconia, Bümler received his first music instruction from his father who was a cantor. Unfortunately, his father died when he was 10. After being a student in a Latin school in Münchberg (also Franconia), he became affiliated with the Brandenburg Court Orchestra and Choir where he had a position as a chamber discantist at

⁴ Franz Krautwurst, *MGGI*, Bärenreiter, 1986 [see also Figure 1], and George J. Buelow, *Grove Music Online*, Oxford University Press, 2005, acc. 11/15/05.

the Bayreuth court. There he received further musical instruction in singing and keyboard playing from the Capellmeister Ruggiero Fedeli. After his voice changed, Bümmler was hired as a chamber musician at the Wolfenbüttel court. From there, over a span of many years, he also had engagements or temporary positions, primarily as a singer, in Hamburg, Berlin, and Bayreuth. Mattheson reports having heard Bümmler sing at the Hamburg Opera where he sang a trill for 20 measures (*Takte*) without taking a breath. Finally he was given a position as a chamber musician and alto voice with the Brandenburg court in Ansbach in 1698, where he stayed on until 1723. During this period there were two court Capellmeister, F.A.M. Pistocchi, from 1697 to 1701, and J. C. Rau, from 1698-1717, and eventually Bümmler, from 1717 to 1723. In 1703, however, Bümmler had, according to his own report to Mattheson,⁵ asked a certain Mr. Hänfling,⁶ a Privy-Councilor in Ansbach (also known as Onoltzbach) to calculate a temperament which he might use for his keyboard instruments. Mr. Hänfling obliged with the exact numbers needed to set up an ET. When Bümmler began using it, he discovered that “it was a good one” and began applying it not only to harpsichords, but to *Positivs* (small portable pipe organs without pedal) as well. When it came time to renovate the large church organs in the Stadtkirche (City Church) and the Stiftskirche (Monastery Church) of Ansbach, Bümmler also tuned these organs entirely to the new ET he had been using. Other musician visitors who came from distant cities were duly impressed with ET and asked for the details of this ‘new’ temperament. Bümmler reported to Mattheson regarding one such incident with the son of a local organist, Abdias Schneider, who was at that time the Director of Music and Organist in the great cathedral in Ulm. His son, Conrad Michael Schneider (1673-1752) reported great success with this new temperament and had ample

⁵ Mattheson, *Critica musica*, volume/part 1, p. 11, footnote: [my complete translation of this footnote into English follows]: “On February 8, 1722, Mr. Bümmler, the Capellmeister in Onoltzbach, wrote to me: ‘On this occasion I wanted to have it noted (because I was just reminded of this in this regard) that already 19 years ago I not only had had the now-deceased Privy-Councilor, Mr. Hänfling calculate for me a temperament, but I also had the good fortune to be able to use and apply this temperament after I had found out that it was a good one. During this time I used it not only for tuning all harpsichords; but, in addition to two *Positivs* (small portable pipe organs without pedal), also used it on two large church organs here in Onoltzbach, of which one was located in the *Stadt=Kirche* ‘City Church’ and the other in the *Stifts=Kirche* ‘Monastery Church’. This was done in connection with the renovation of both organs. And then it happened about a year ago that the son of the organist in the *Stadt=Kirche* who is now a music director and organist in Ulm, was visiting here and played on these organs. He was so satisfied with this particular temperament that he demanded to obtain it from me for his own use. I was glad to oblige. In this temperament all the intervals having a specific name [3rds, 4ths, 5ths and such categories] are alike: that means that one 5th is the same as another 5th and to your hearing sounds clean (*rein* here means not ‘pure’ or ‘without beating’ but rather that certain 5ths do not stand out because they may be oddly ‘pure’ or a only a little ‘wide’); this despite the fact that mathematically they are not in a 2/3s relationship to each other. The difference is so small that your hearing cannot determine which ones are not “rein” [see above]. In the same manner, one major 3rd is just like another (no slow 3^{rds} among some very fast beating ones) so that you can play in all 24 keys/tonalities without ‘damaging’ (‘without being an affront to’) your hearing. This temperament has a greater degree of perfection than the one by Mr. Neidhardt which you mentioned in your [directed to Mattheson regarding his book] *Organisten Probe* in §28 on p. 253, a copy of which I have yet to put my hands on. For it is not the 80 to 81 fraction, or what is usually called the ‘comma’, that makes the difference which becomes apparent here when you calculate proportionately the 5ths by 1/12 comma. For this reason, when 1/12 is subtracted from this ‘comma’, the result can not be a perfect temperament. If you so desire, I will send you the details when I receive your request for them. (Mattheson continues): This is as much as I have heard so far from Mr. Bümmler. When I receive this temperament, (I have already sent a letter to him requesting it), it will be published here (‘placed at the service of the general public.’)”

⁶ Without a doubt, this Mr. Hänfling is the same Conrad Henfling [slightly different spellings of family names were rather common at the time when he lived] noted in Rudolf Haase’s article on Gottfried Wilhelm Leibniz in Grove Music Online, Oxford University Press, 2005, acc. 8/16/05, where Henfling is referred to as “a mathematician from Ansbach” with whom Leibniz corresponded for several years, particularly regarding matters of temperament. Here is a pertinent quotation from Haase’s article: “Between 1705 and 1711 his [Leibniz] studies in the theory of music were stimulated by his correspondence with Conrad Henfling, a mathematician from Ansbach. In a letter dated 30 August 1706 which deals with many music-theoretical issues, Henfling set out detailed calculations for a method of temperament. After making some revisions of his own, Leibniz had Henfling’s work published as ‘Epistola de novo suo systemate musico’ (in *Miscellanea berolinensia*, 1710; Ger. trans. in *Musiktheorie*, ii (1987), 169–81; iii (1988), 171–81).” Rudolf Haase has published a book on the correspondence between Leibniz and Henfling: *Der Briefwechsel zwischen Leibniz und Conrad Henfling*, Frankfurt, 1982).

opportunity to apply it to the great organ in Ulm which underwent repairs, modifications and additions in the years 1715, 1720, 1725, 1726 and a major renovation by G. F. Schmahl (1730-1735), during the time when Schneider served as organist and *Director musices* at the Ulm Cathedral where ET was being generally applied due to Schneider's advocacy.

Returning to Bümler's biography and his activities in Ansbach as Capellmeister, it was at this time in May, 1722, when Mattheson first reported news about the 'newest' temperament without knowing that Bümler, with his first wife, Dorothea Constantia Bauer, a singer, had already left Germany to stay in Italy for a year. Somehow Mattheson just managed to receive a copy of the promised tuning calculations before communication with Bümler would have become more difficult and time-consuming. Mattheson promptly printed the "New Temperament" in June, 1722, in his monthly newspaper/journal for musicians, later republished in book form as *Critica musica* vols. 1 and 2.

Life became more difficult for Bümler when he was recalled abruptly from Italy in February 1723 for the funeral of the Margrave Georg Friedrich, after which he was released from his duties and took on short-term duties as Capellmeister elsewhere before returning to his original post at Ansbach (Ornoltzbach) in 1726, a post he held until his death in 1745. After his first wife died in 1728, he married another singer a year later, Sabina Sophia Schneider, daughter of the above-mentioned Director of Music and Organist at the Cathedral in Ulm. It was during this final period of musical activity in Ansbach, that Bümler (as reported by Mattheson) composed, among other compositions, 2 yearly cycles of cantatas (unfortunately lost.) During this time the court capella under his direction had over 30 musicians.

Not only was Bümler well-educated and experienced as a musician, he also exhibited a lifelong interest in mathematics, astronomy, optics and chronometry; in short, he was a good representative of the Enlightenment.

The Hänfling/Bümler Equal Temperament

Details regarding the Hänfling/Bümler “Newest Temperament” (ET) from 1703/1722 are presented below in Figure 2 as an enlarged scan of the engraving contained in Mattheson’s *Critica musica* Part 1, p. 52, in June, 1722.⁷ This engraving reveals, among other things, the following:

1) The vertical lines with their ‘length’ measurements are intended to be pasted together on the top sounding board of a monochord that has a single string under tension below which a moveable bridge can be shifted to any one of the needed interval locations. The letters increase alphabetically from right to left with the letter at the bottom of each line intended to join with the same letter at the top of another line.⁸

2) The needed monochord intervals calculated to two decimal places are located precisely at the points where the bridge should be moved and set to obtain the proper pitch of each note (all keys on a keyboard instrument) within a single tuning octave. The 12 markings (the 12th completes the octave) are given as follows and read from the highest number (*Sanus fundam.* = 4000.00) to the lowest (*Octava* = 2000.00) with increasing interval from α until the lowest number is reached: ‘minor second’, ‘major second’, ‘minor third’, ‘major third’, ‘minor fourth’, ‘major fourth and/or minor fifth’, ‘fifth’, ‘minor sixth’, ‘major sixth’, ‘minor seventh’, ‘major seventh’, and ‘octave.’

What does all of this information reveal? How do we know that ET temperament was intended by the numbers given? In Figure 2, below, the underlying numbers of the original are repeated with the calculated cents beneath each one.⁹

⁷ The information about Equal Temperament appeared in *MATTHESONII CRITICA MUSICA P.1. Der melopoetischen Licht=Scheere / Zweyte Schneitzung*, Hamburg, June 1722 issue. Mattheson, recognizing the popularity of the musical journal/newspaper that appeared monthly, republished later in book form, the first 12 issues dating from May 1722 to April 1723.

⁸ An indication/instruction in the lower left corner explains that on a monochord (these instruments exist with varying lengths), the entire length of the sequence of 4 sections (lines) when pasted together should amount to half of the string length. If the drawing on the engraving were done to scale, then the total length of the illustration from alpha to beta would be 14 inches, meaning that a 2-foot monochord would be too short, but a 3-foot instrument would be able to accommodate tuning from this instrument.

⁹ I am indebted to Dr. Charles Francis for the mathematical analysis.

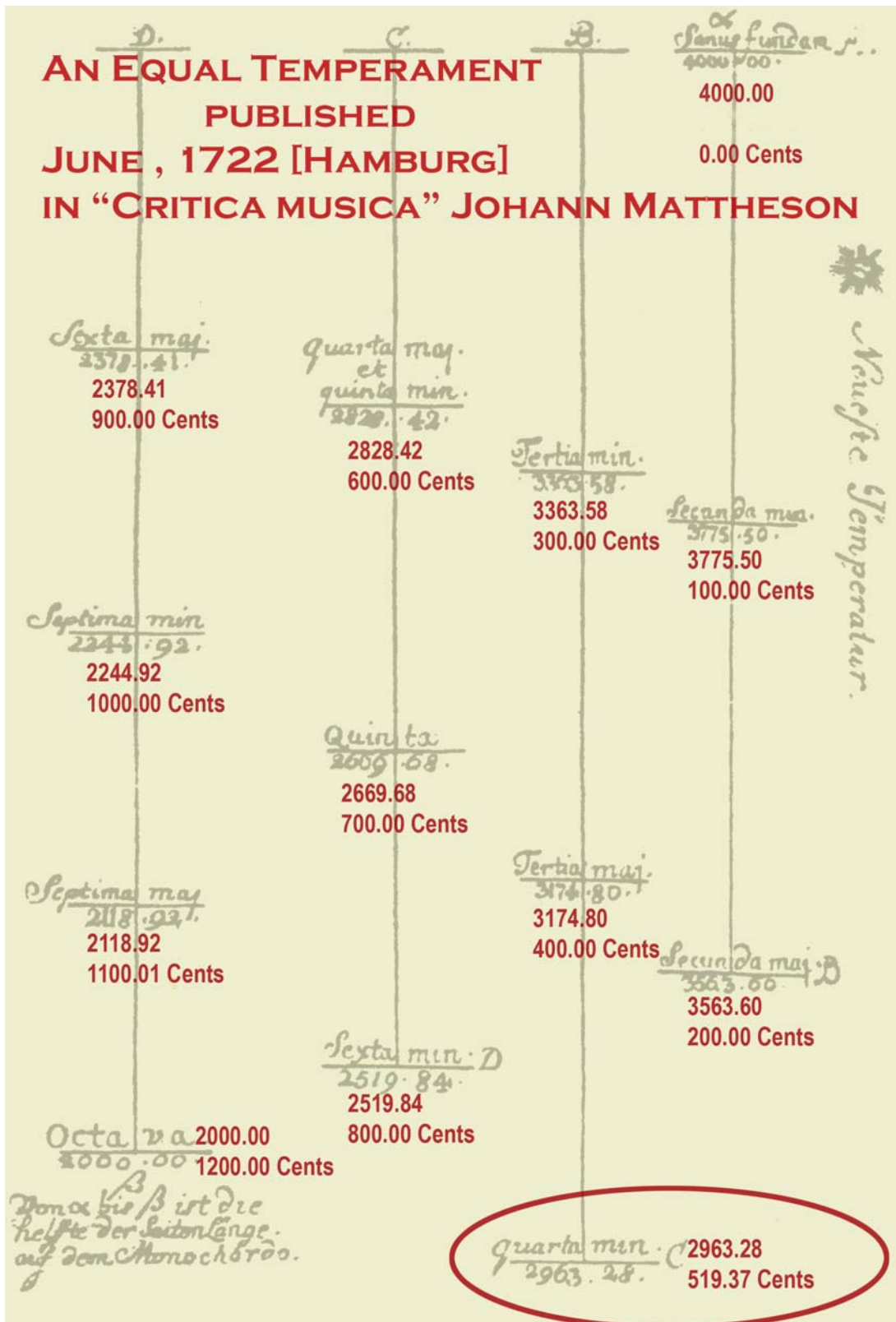


Figure 2: The Hänfling/Bümler ET

The result of the calculations shows this to be an almost perfect ET with one glaring exception encircled in red: the *quarta minor* ‘minor fourth’ does not conform by having an obvious irregularity. The most likely explanation for this is an imperfection on the part of the engraver,¹⁰ a mistake difficult to correct without increasing the cost of preparing this page and without postponing the publication of the ‘newest temperament’ for another month or two.¹¹

Tuning in this fashion from a monochord in the 18th century or from a Korg tuner or similar device in the 21st century by moving up or down the scale by semitones contained within a single octave was and still is not the usual, nor the easiest and fastest way to tune keyboard instruments. More commonly, a circle/cycle of 5ths or a combination of 4ths and 5ths is used with these intervals continually ‘folding back’ into the temperament-setting octave so that no (or very few) notes are tuned outside of this octave until the temperament is properly set by using various checks along the way. It is likely that musicians who attempted to try out the Hänfling/Bümler ‘newest’ ET, after having used the monochord to determine accurately the pitches for ET, would have noted carefully the quality¹² of the 5ths and 4ths and would have listened closely to ascending triads moving by half steps up the scale. With time, practicing musicians would no longer require a monochord for tuning and would quickly discover a short-cut method that would dispense with using it each time for tuning. They would have set the temperament octave from an established pitch, ‘tuning by ear’ as they went. For instance on harpsichords, which need to be tuned very frequently, they would have listened for the slow beating of the narrow 5ths and the faster beating of the wide 4ths, after which they would check the ascending major 3rds so that there would not be any which were beating too slow or too fast.¹³

The advantages of ET would immediately be apparent to a musician/composer like Bümler just as they would to J. S. Bach. As a Well Temperament, ET would enable pleasant modulation to any key. The absence of key coloration would allow free transposition of pieces written in one key to another. Moreover, it would no longer be necessary to tune a transposed temperament for cornet-ton and cammerton. There would be a general evenness throughout all tonalities. Bach’s goal of *Aequalität* would have been achieved by eliminating certain exaggerations in various keys/tonalities still found in unequal temperaments.

¹⁰ Andreas Werckmeister, on p. 112 of *Musicalische Paradoxal-Discourse...*, Quedlinburg, 1707 [published posthumously] complained about similar problems he had dealing with such matters: trying to find an engraver who could accurately reproduce the necessary numbers at the correct distances between the measurements that provide the temperament layout for use on a monochord. He states: “Ich hätte auch solche *Temperatur* durch die 12. Theile *Commatis* laßen aufreißen / weil aber der Kupfferstecher sich beschwerete (und derselbe auch nicht recht *perfectioniret* war) die engen *Spatia* der *Commatum* in 12. Theile zutheilen /musste ich daßelbe anstehen laßen” (“I could also have had such a temperament engraved divided by the 12 parts of a comma; however, because the engraver complained {about this exacting task} [and because he was insufficiently trained for the degree of perfection required by this task] which required dividing the narrow spaces of the comma into 12 parts, I simply had to forget about it/give in {and not have the copper engraving of the temperament prepared for printing in my book.}”)

¹¹ See tables 1 and 2 in the appendix to determine just how close this temperament is to a perfect ET.

¹² The word ‘quality’ indicates how fast they were ‘beating’ and whether they were narrow or wide.

¹³ All of this would be done without the aid of a clock or any other instrument to ‘count the beats’ since the decay time associated with plucking or striking the strings is quite short. The process of checking various other intervals along the way is a time-saving device as it sends signals to the tuner that all is not well and that it may be necessary to go back to an earlier point in the tuning process.

Summary

In June of 1722, Johann Mattheson published a description of Equal Temperament (ET) that had been passed on to him by Georg Heinrich Bümmler who had had it calculated for him by a Mr. Hänfling in 1703, after which Bümmler continued to use it on all keyboard instruments in Ansbach and even passed this formula on to others who requested it. With the publication of the ‘Newest Temperament’ in Mattheson’s *Critica musica*, a monthly newspaper devoted toward reporting newsworthy items in the field of music, the wide dissemination of ET throughout German-speaking countries was assured, even if general acceptance of it would still take time. Bach’s completion of the WTC1 during the same year that the ET was made widely known may well be connected. Not only was ET an answer to Bach’s search for *Aequalité*,¹⁴ but it also became a celebration of modulatory freedom as well as the ability to compose and perform in remote tonalities which were hitherto generally avoided by composers before Bach composed his *Well-Tempered Clavier*.

¹⁴ The German word that Bach also used was *Gleichheit* ‘equality, uniformity’.

Appendix¹⁵

Interval	Measured Length	Cents	Deviation from Equal Temperament (Cents)
<i>Sanus fundam.</i>	0.0	0	0
<i>Secunda minor</i>	39.3	99	-1
<i>Secunda major</i>	76.9	199	-1
<i>Tertia minor</i>	111.9	298	-2
<i>Tertia major</i>	145.9	399	-1
<i>Quarta minor</i>	177.7	500	0
<i>Quarta major</i>	207.2	599	-1
<i>Quinta</i>	236.0	701	1
<i>Sexta minor</i>	262.4	801	1
<i>Sexta major</i>	287.4	901	1
<i>Septima minor</i>	311.0	1001	1
<i>Septima major</i>	333.7	1103	3
<i>Octava</i>	354.2	1200	0

Table 1: Temperament derived by measuring the monochord engraving supplied by Mattheson in his *Musica critica*, June 1722

Root	Minor 3 rd	Major 3 rd	5 th
<i>Sanus fundam.</i>	298	399	701
<i>Quinta</i>	299	401	697
<i>Secunda major</i>	301	400	702
<i>Sexta major</i>	299	398	698
<i>Tertia major</i>	302	402	703
<i>Septima major</i>	296	395	696
<i>Quarta major</i>	302	402	700
<i>Secunda minor</i>	300	401	702
<i>Sexta minor</i>	302	399	697
<i>Tertia minor</i>	301	404	703
<i>Septima minor</i>	298	398	699
<i>Quarta minor</i>	301	401	700

Table 2: Intervals of temperament derived by measuring the monochord engraving (cents)

¹⁵ This analysis has been performed by Dr. Francis based on measurements of the monochord engraving supplied by Mattheson. It is believed to represent the best-case result a musician in 1722 would achieve when following Mattheson's printed instructions in his *Musica critica*.