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The Development of the Keyboard Through the Grand Piano and Its Effect on Piano Literature

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Abstract

The keyboard instrument was improved through a long series of developments until the pianoforte was developed, which reached beyond the capabilities of the harpsichord. Christofori developed the pianoforte which would lead to the ultimate development of the concert grand piano. Not all composers were privileged to have the pianoforte at their fingertips, let alone the grand piano with all of its improvements. Therefore, each composer's musical style can be correlated to the piano's development during each time period. Each musical era signifies where the piano was developmentally during that century. Through this progression the piano came to be a means of emotion and imagination, allowing audiences to see the colors, moods, and pictures that can be created through music.

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Early Versions of the Keyboard Instrument

Stringed instruments involving a keyboard can be traced back to the beginning of the Christian era. Vitruvius is credited with first describing a stringed instrument containing a pivoted keyboard, which was most closely associated with the organ. Instruments related to the hurdy-gurdy (played by cranking a handle that is connected to a resin-coated wheel that vibrates the strings, and notes are changed by use of a keyboard) introduced keys which provided the stopping of the strings. This was new because hand-stopping was used in the monochord before the use of keys; stopping by means of the player's hand ended with Guido of Arezzo. The twelfth century brought about key-like finger stops found on the regal, a portative organ (Wier, 1941).

During the middle of the 1300s the keyboard was based on the Greek tetrachord scale. In 1493 the keyboard compass (range) was extended, as seen in the organ at Bamberg, to include three octaves and a third. As the compass was extended, it allowed for a narrower key width; this allowed a player to span an octave with one hand, as opposed to being able to reach only a fifth before the extension of the compass. During the sixteenth century the spinet contained thicker strings that were also arranged differently; deeper tones came from the increased thickness of the strings. The chromatic scale became prominent in the seventeenth and eighteenth centuries. There was now a "greater equality of semitones, and the lowest sharps or raised keys were frequently divided, each half being provided with a separate key." (Wier, 1941, p. 2) Organ and spinet keyboards were similar, but differentiated from the clavichord by the fact that the clavichord was still based on the hexachordal ideas of Guido of Arezzo (Wier, 1941). The white keys of the keyboard, which are now made of ivory, were formerly composed of various types of lighter colored wood. Ebony or stained wood was used for the black keys (Wier, 1941). A more in depth description will now be given to the predecessors of the piano.

The Monochord and the Improvements Brought to It by Guido of Arezzo

The pianoforte was preceded by many early stringed instruments, with one of the biggest differences being that the early instruments lacked dynamic capabilities. The monochord is one of the earliest stringed instruments dating back to around 582 B.C. It was widely used by the Greeks, and was also used in church choirs. Pythagoras used this instrument to find mathematical relationships between the sounding pitches. Visibly, the musical relationships could be seen in part by how the monochord was constructed. The monochord consisted of a wooden box with a single string strung across it. A piece of paper was glued to the box underneath the string, which contained the written subdivisions and intervals of the scale. The instrument was played by simply pressing the string down on the written marks of the paper, and then plucking the string while continuing to hold part of it down. Each mark represented a different interval of the scale; therefore, the player could produce different pitches by holding the string down on different marks (Dolge, 1972).

Another influential figure associated with the monochord is Guido of Arezzo. Guido of Arezzo was credited with improving the monochord by adding a moveable bridge under the string. This gave the monochord better intonation. Eventually, the monochord consisted of more than a single string, and then came to have the addition of keys. With these improvements the player would no longer have to hold the string down on a given mark with his finger in order to produce a sound. The keys contained tangents (medal wedges that struck the strings) so that when each key was pressed, the tangent would be responsible for placing the string on the correct division of the scale. Throughout the twelfth and thirteenth centuries, improvements were made to cause all of the degrees of the scale to sound correctly on the monochord (Dolge, 1972). The on-going desire to improve the monochord led to the eventual construction of the clavichord (Dolge, 1972).

The Clavichord

The clavichord emerged during the fifteenth century. It was composed of twenty or twenty-two brass strings which used vibrations to emit sound. Vibrations were emitted by the use of a clavis, which had an attached tangent. The tangent would strike the strings to cause vibrations in the strings, which would then produce a sound (Dolge, 1972). Throughout the following centuries many improvements were made to the clavichord. Even after the invention of the pianoforte, the clavichord still remained popular. During the sixteenth through eighteenth centuries, more keys were added to the clavichord to make a total from fifty to seventy-seven keys. Half of the instrument also contained a soundboard with five bridges (Dolge, 1972).

Early forms of the clavichord required advanced technique to produce the correct sounds. This was because there were two tangents attached to each key. The performer would have to put forth extra effort to make the tangent hit in the correct place because of the added tangent. Later clavichords had two or three keys per string. In 1725 Daniel Faber invented a clavichord which contained one string and one key per note (Dolge, 1972). It is at this stage of development that we see the upcoming emergence of the pianoforte. Author Alfred Dolge makes this statement:

> Thus the clavichord possessed four of the most vital points of the modern pianoforte: the independent soundboard, metal strings, the percussion method of agitating the string, the tangent touching or striking the string, instead of plucking or pricking, and lastly the application of the damper. (1972, p. 31)

The sensitive touch of the keys allowed crescendos and decrescendos (Dolge, 1972). Though the clavichord did not produce as majestic a sound as future versions of the piano would, many great composers still widely used and appreciated the clavichord. Even Mozart, touring Europe as a renowned pianist, still practiced on a clavichord because it was easy to carry. *The Magic Flute*, a famous opera by Mozart, was composed using this instrument (Dolge, 1972).

The Spinet

Next in the line of keyboard instruments was the spinet. The spinet was invented in 1503 by Giovanni Spinnetti. The notable aspects of the spinet were its oblong shape, long strings, and a large soundboard. Because the soundboard of the spinet occupied most of the space of the instrument, unlike the spinet's stringed predecessors, it produced a much greater sound. However, though the long shape of the spinet appeared to be an advancement in stringed instruments, its string action seemed to take it a step back. When a tangent would hit these strings, they would not vibrate effectively because of their increased length (Dolge, 1972). Therefore, the strings were sounded instead by a plucking, rather than striking, action. The sound begins with the spinet's clavis, which contains a jack (a piece of wood that holds the quill or leather which plucks the string). The upper portion of the jack contains a quill (responsible for plucking the string), which is attached to a spring. When a key is pressed down on the spinet, it causes the jack to move up, which then causes the point of the quill to pluck the string (Dolge, 1972). The movement of the string is dulled by a piece of cloth on the jack, once the jack returns down to its original position (Dolge, 1972).

On the clavichord the performer was able to produce dynamic contrasts; however, the spinet was unable to produce varying dynamics. Spinets were frequently set upon tables to be played because they were usually no more than five feet wide. The table also offered the spinet greater resonance. Spinnetti, the man for whom the instrument was named, constructed the keyboard outside of the case. However, a few years later in 1550, Rossi of Milan invented a keyboard enclosed in a case. In England, the spinet was given the name "virginal" (Dolge, 1972). Although some writers would disagree, studies have shown no distinct difference between the spinet and the virginal (Dolge, 1972).

The Harpsichord

When harpsichords were first constructed, they were more or less a larger version of the spinet. Just as the spinet produced an increased tone volume because of its elongated strings, likewise the harpsichord produced an even louder tone because its strings were longer than that of the spinet (Dolge, 1972).

The harpsichord differed from the spinet by having two or more strings per note. The shape of the modern grand piano is a good model of what the harpsichord looked like. The long shape behind the keyboard of the harpsichord provided for the greater length in strings that it contained. In German the harpsichord was named *kielflügel*, meaning "quill-wing." The instrument was called *Staartstuk* by the Dutch and *Clavecin à queue* by the French (Wier, 1941). The English term, harpsichord, comes from the Latin term *harpsichordum*. Harpsichords were often called *virginals* and were unable to produce a dynamic change. During the seventeenth century the harpsichord was introduced as a primary instrument in the orchestra (Wier, 1941).

The increased volume of the harpsichord, due to the longer strings, led to a tone problem. The sound of the harpsichord was not so harsh sounding and problematic when it was accompanied by other instruments. However, during solo performances the harsh sound of the harpsichord was not pleasing and enjoyable for audiences. This prompted a long series of experiments to try to add something to this instrument that would dull the sound. Some of these additions included: mechanical orchestras with flute-like devices which were controlled by stops; and pedals to create sounds of bass drums, cymbals, triangles, and bells. As many as twenty-five pedals were eventually added (Dolge, 1972). Dolge states:

> Of all those manifold experiments only four have proved of permanent value. The "forte stop," which lifted the dampers; the "soft stop," which pressed the dampers onto the strings to stop the vibration; the "buff stop," interposing soft cloth or leather between the jacks and the strings; and lastly the "shifting stop,"

> which shifted the entire keyboard, a movement later applied to the transposing keyboard. (1972, pp. 35-36)

In trying to increase the sound of the harpsichord even more, inventors expanded the size of the instrument. Because of this, harpsichords were up to sixteen feet long. Due to the frailty of these expanded cases, thinner wires had to be used because the tension of the thicker wires would damage the instrument. However, as the strings became longer and thinner, the sound became less musical. Harpsichord makers then reduced the size of the instrument to eight to ten feet, and increased the number of strings from two to four, for each note (Dolge, 1972). During the seventeenth century harpsichords were built with two keyboards and three strings for each note. The third string was thinner and tuned an octave higher than the first two strings. Because of the added keyboard the player could use two or three strings at once or separately. These improvements along with the pedals helped to create a more pleasant tone. This became the preferred instrument, over the spinet, for composers from Scarlatti until the time of Beethoven's "Moonlight Sonata" in 1802 (Dolge, 1972). In concluding his study on the harpsichord, Dolge writes:

> The fact that the harpsichord, like the spinet, gave the player no possible opportunity to exercise any artistry, as on the clavichord or the pianoforte, sealed the doom of the instrument, and with the end of the eighteenth century the end of the harpsichord had come, leaving for the pianoforte maker, however, the valuable inventions of the wing-formed case, the use of the two and three strings for one note, and lastly the forte piano pedal and shifting keyboard, all of which are embodied in the present-day piano. (1972, p. 38)

The harpsichord contained many of the same ideas that would soon be instituted and revised in the pianoforte.

The Need for the Pianoforte

Why were so many keyboard models produced? Each model came with its own limitations, which were often surpassed by the model to come after it; however, each later model still possessed certain limitations. The pianoforte was needed because it was the instrument that would solve many of the previous keyboard limitations. The progression of keyboard instrument inventions struck within inventors the desire to combine two of the earlier models. The harpsichord produced a powerful sound, but lacked stylistic capabilities. The clavichord provided stylistic freedom for the player, yet it did not have as powerful a sound. Three men came up with the pianoforte model at nearly the same time. Bartolommeo Christofori's model appeared in 1707, Marius' in 1716, and Schröter's in 1717 (Dolge, 1972).

This is the instrument which is considered to be the modern day piano. Christofori named his invention the *piano e forte* or the *pianoforte*. The pianoforte surpassed all previous keyboard instruments because it produced a range of volume, soft to loud; this dynamic change was something that earlier keyboard instruments, like the harpsichord, could not do (Wier, 1941). In modern dynamic markings "piano" means "soft" and "forte" means "loud." Therefore, Cristofori's invention was appropriately named the pianoforte, because of the dynamics that it was able to express.

The earlier forms of keyboards were still in wide use. The organ was common in orchestras and used for pleasure in private homes. The clavichord was a suitable model for contrapuntal music. However, none of these instruments could satisfy the desire for what the pianoforte would bring (Harding, 1973). The pianoforte had something that no other keyboard type possessed—dynamic expression (Harding, 1973). Christofori was not the only one to discover the dynamics that could be accomplished with the pianoforte; many other pianoforte models were being built not only in Italy, but in England, Germany and France (White, 1975). Musical expression, and more specifically dynamic expression, is an important key to reaching the emotions of the listener. It moves the listener to react to the music, whether positively or negatively.

The Action of the Piano and Improvements Made to It

The following discussion will describe the action of the piano, since this impacts the sound and tone quality emitted from the instrument. The action of the piano fascinated inventors, who produced many types of piano actions over the years. In 1717 Schröter invented an action in which the hammer moved in a downward motion. However, a problem arose because once the hammer hit the string, it had no way of again being lifted from the string. This fault discouraged many musicians, such as Bach, from using Schröter's device (Dolge, 1972).

Christofori came up with a device that contained what Schröter's action mechanism was missing—an escapement device and a device for repetition (Dolge, 1972). Christofori truly overcame the limitations of the harpsichord when he replaced the harpsichord jacks with hammers (Harding, 1973). Here is a brief description of the action of the early pianoforte (see Appendix I):

> When the key is depressed the block at its further extremity knocks up the pivoted lever E, causing the upright jointed piece G which we have called the escapement to jerk up the hammer to strike the string. The escapement G is controlled by a spring and bends under the blow, 'escaping' to its original position, thus leaving the hammer free to return immediately after striking. Whilst this has been happening the further extremity of the lever G was lowered, bringing the damper away from the string. Upon releasing the key, the lever regains its position and the end Q rises and presses the damper against the string. (Harding, 1973, pp. 7-8)

Christofori's device was still in need of some improvement. In 1720 his escapement device was revised and resulted in a better function. Also the original silk cord that Christofori used to catch the hammer, after striking the string, was replaced with a back check. The back check proved to be better at catching the hammer (Dolge, 1972).

Several inventors further developed the piano action. One of them, Johann Baptist Streicher, developed a model which was popular in Germany and Vienna. Virtuoso musicians, such as Mozart, found the Schröter-Stein action to be agreeable (Dolge, 1972). About mid-way through the eighteenth century Gottfried Silbermann improved upon the pianoforte model built by Christofori. Silbermann is credited with making a more detailed model of the pianoforte, yet the ingenious action and function of the instrument by Christofori remained unchanged. After Silbermann, Zumpe changed the action so that the hammer fit the square-shaped clavichord. The change resulted in the square pianoforte; however, no attention was given to escapement in Zumpe's model

(White, 1975). Zumpe is credited with placing a second jack between the first jack and the hammer. This allowed for easier repetition because the jack of the middle lever (between the first and second jacks) was able to fall back before the hammer came in contact with the string. This is often termed *Zumpe's Second Action* (Harding, 1973).

Several different types of actions were attempted for improving the grand piano. Johann Andreas Stein and his daughter, Nannette Stein-Streicher, improved upon the Schröter action to create more elasticity, and to create a tone that better resembled the clavichord. From 1780 on, musicians preferred the grand pianos created by Stein (Dolge, 1972).

A model was developed in 1821 that would be perfect for grand pianos. Christofori's model displayed double escapement and repetition. This device (see Appendix II), patented by Sebastian Erard, combined the Viennese action and the English action to provide a light, elastic touch with a powerful hammer stroke (Dolge, 1972). In 1826 Robert Wornum devised a revolutionary action device for the upright piano, just as Erard had done for the grand. It was termed the "piccolo" upright action, and served to function as a model for the modern upright piano. It was later named the "French" action because of the improvements made to it by Ignace Pleyel and Henri Pape. The popularity of this model spread throughout the world in Germany, Italy, Spain, Scandinavia, and many other countries (Dolge, 1972).

The Square Pianoforte

The pianoforte was seen in various versions as inventors made their personal improvements to the instrument. However, metal framing brought the eighteenth century instrument into a more contemporary form. Alpheus Babcock, an American, applied a metal frame to the square pianoforte in 1822. In 1840, a cast-iron plate was added to the grand pianoforte by Jonas Chickering. He used cast-iron to bind together one piece containing the string-plate, agraffe-bridge, and resistance bars (White, 1975). The square pianoforte would eventually disappear from the pianoforte models because of the construction errors it contained. The frame was weakened because of the gap in the center of the instrument, which allowed excess movement of the hammers. This instrument also was not balanced because the bass keys were the shortest while the treble keys were the longest. In addition to the above mentioned weaknesses, the upright piano was responsible for diminishing the interest in the square piano because its mechanism contained better elasticity and quicker repetition (White, 1975).

The Construction and Stringing of the Upright Piano

With the disappearance of the square piano, the upright and grand piano took precedence. The following discussion concerns mechanics of the upright piano. The foundational pieces of the upright piano are the sound-board and frame. The frame is composed of wood and metal, with strings stretched across the frame. The lower strings increase in length and thickness. The frame also has sides which connect with the wooden board upon which the keys are laid (White, 1975).

The framing of the upright piano holds strings which run vertically from top to bottom. The bass notes are not strung vertically, but are instead placed diagonally above the treble strings. As the pitches become higher, the strings become shorter; they eventually reach a length of less than two inches. The thickness of the string is also directly related to its length. The vertically placed strings are composed of cast-steel wire and the diagonal bass strings are composed of the same with added copper or iron. The framing of the instrument is responsible for keeping the strings at the correct amount of tension (White, 1975).

The strings' vibrations are amplified by the sound-board. Sound-boards are commonly composed of spruce fir and differ in their thicknesses. The piece of spruce fir is bowed toward the strings. The sound-board also has attached to it a series of bridges upon which the strings are laid, and are also responsible for capturing the vibrations of the strings. Strips of wood are glued to the side of the sound-board, forming a "rib-like" structure. The above structure, in its entirety, is then placed into the back of the instrument, which is also composed of wood. An iron plate then covers the whole of these two structures put together. An iron bridge limits the length of vibration of the strings, and it is connected to the "hitch pins," with the ends of the strings. These pins are part of the iron plate. After the strings are looped over the pins, they pass over the bridges, and make their way up to the tuning pins. The piano is then enclosed by placing the side walls on the instrument. Pedals are attached to the bottom portion of the instrument, as well as to the action. The instrument contains eighty-eight keys, which translate into seven octaves and a minor third (White, 1975).

The Construction and Stringing of the Grand Piano

The next major form of the pianoforte is the grand pianoforte. The upright and grand pianofortes differ dramatically in appearance. The strings of the upright pianoforte run vertically, whereas the strings of the grand pianoforte are laid horizontally. In the grand version, the hammers actually strike the strings from below. While the frame of the upright functions more as a support system, the frame of the grand enables a greater resonance of sound. Instead of being built upwards, the frame of the grand forms a curved, shaped rim around the instrument. This bent rim also contains the sound-board and iron plate. Space is left within the frame for the upward action of the hammers to the strings (White, 1975).

The grand piano is preferred by almost all musicians because of the expression and pitch quality that it so easily possesses. The resonance offered by the concert grand is unmatched by other keyboard instruments. Musicians can create the most powerful fortissimos or the quietest pianissimos on this one instrument (Dolge, 1972). A concert grand piano can be up to nine feet long. Shorter grand pianos are about five feet long (Dolge, 1972). The grand piano was the result of continued developments in keyboards. Where one kind of early keyboard instrument maintained powerful tone, it lacked dynamic range. Where dynamic range was possible, tone was sacrificed. The grand piano combined the best aspects of the early keyboards into one dynamically expressive, rich sounding instrument.

The Making of Hammers

The hammers, used for striking the strings in pianos, went through a series of improvements. The hammers found in Christofori and Silbermann's models were simply constructed of a wooden block covered with soft leather. However, as the piano developed and the tone volume was improved, these small block hammers changed to a longer, wedge-shaped device. The wedge shape meant that it had to be reinforced for strength; therefore, it was covered with a piece of sole leather. A soft piece of sheepskin was then glued on top of the sole leather. The complexity of making the hammer further increased when a larger hammer of wood was formed (see Appendix III). The layer over the wood was composed of more durable sole leather, then covered with less firm elk skin, and finally covered with soft deer or buck skin (Dolge, 1972). The reason that the outer layers of the hammer were composed of softer materials was because softness and elasticity was needed to produce a soft, pianissimo tone. The core material of the hammer had to be hard and durable so that it could withstand the strong blows needed for fortissimo playing (Dolge, 1972).

Alpheus Babcock, and later P. F. Fischer, saw that the leather of the hammer was not a good match for the heavier strings, and introduced hammers with felt. Gradually leather, elk skin, and buckskin disappeared from use in hammers; instead, they were replaced with layers of felt (Dolge, 1972). Each layer of felt constituted a different thickness so that the desired tone could be produced. Up until this time the hammers were made by hand. Obviously, this became impractical in view of the amount of time required and because the hammers needed to be more powerful as the strings increased in weight. It is at this point that a series of machines were invented to produce hammers. However, each machine possessed its own problem. In 1887 Alfred Dolge developed a machine similar to the machines that exist today. With this machine the “single coat” hammer was introduced (Dolge, 1972). Grand piano hammers are made from a sheet of felt which weighs seventeen to eighteen pounds; sheets weighing thirteen to fourteen pounds are used for upright pianos (Dolge, 1972).

The Player Piano

For interest's sake, the unique development of the player piano should be discussed. Though the player piano is a more recent development, the idea could be seen in the seventeenth and eighteenth centuries. Inventors then attempted to connect pedals, swells, and many other devices to the keyboard in hopes of improving the sound. In 1731, Justinian Morse of England developed a mechanical way to play a keyboard instrument (Dolge, 1972). Much construction took place to find a suitable method of making a working player piano.

In 1868 attachments were made to organs so that they could be played automatically. Strips of paper were perforated to symbolize musical notes. Music could also be played in any key through a transposing mechanism. These devices were located inside the case of the organ (Dolge, 1972). A wind motor that worked in connection with pneumatic motors was developed by G. B. Kelly in 1886. R. W. Pain invented a pneumatic self-playing piano, containing only 39 notes. By 1888 he developed an electric player with 65 notes. Wm. D. Parker had a patent in 1892 for a piano that could be played either manually or automatically. It contained a mechanism that was operated pneumatically and guided by a perforated music sheet (Dolge, 1972). In 1897, White and Parker developed a player piano with a cabinet (Dolge, 1972). The cabinet could be placed onto a piano with the "fingers" of the device resting on the tops of the piano keys (Dolge, 1972). In 1904 Thomas Danquard constructed the flexible finger (Dolge, 1972). More and more revisions were made to continually improve the mechanic playing devices. Though this device is ingeniously constructed and can provide much entertainment, it will never be able to match the musicianship that a human player can offer. Each musician's interpretation can be seen through his or her performance. He/she can make full use of the expressive capabilities of the piano.

Scales and Intonation

A somewhat complicated matter will ensue as to the intonation and pitch proportions of the keyboard. Stuart Isacoff brings the full scope of this topic to light when he states:

> The piano is perhaps the most generous instrument ever invented. Its range, from bass to treble, is as large as an orchestra's. It allows ten tones—sometimes even more—to be struck simultaneously, and holds them in the air at a pianist's will. The piano can growl and sing and beat time. It can render arid fugues and impressionist waterfalls with equal naturalness. And, unlike the ungrateful French horn or the finicky oboe, if you keep it in tune, it will be an obedient servant. But the principle that truly underlies the piano's versatility is hidden beneath the geometry of its white and black keys. (2001, p. 3)

Discovering the ingenuity behind the black and white keys begins with a discussion of scales. Scales are fundamental to music, and each scale is built from a series of pitches. The diatonic scale is the basis of the scale system. Each scale is composed of seven different pitches and is named according to the first seven letters of the alphabet. This means that the last note of the scale is named the same letter as the first note. The pitch difference between the first and last notes is one octave (White, 1975). To find out the intervals that separate the tones, the frequency of each tone must be divided by the tone's frequency that follows it (White, 1975). Interestingly enough, after dividing to find the intervals in between each tone frequency, three different intervals of 9/8, 10/9, and 16/15 are found to exist. These ratios allow us to find the frequencies of a diatonic series, remembering that 9/8 stands for the major tone, 10/9 stands for the minor tone, and 16/15 stands for the diatonic semitone (White, 1975).

The chromatic scale was developed for the purpose of placing sounds in between the tones of the diatonic scale. The chromatic scale allows musicians a greater range of options. White explains the frequencies of the chromatic scale in the following way. A chromatic semitone has a ratio of 25/24. If C has a frequency of 528, then C sharp would be 550. However, following the D Major scale, because D is the supertonic of C, C sharp is 1113 ¾. The octave below this is C sharp which is the chromatic semitone above C 528. As previously stated this C sharp would have a frequency of 550. However, the octave below a specified note will have one-half the frequency of the specified note. One-half of 1113 ¾ is 556 7/8. This proves that between the chromatic semitone above C 528 and the C sharp below the major seventh of the D scale, there is a difference of 6 7/8 vibrations per second. This study shows that sounds, though denoted by the same letter name, do not sound the same in different keys (White, 1975). Naturally, enharmonic notes are said to produce identical pitches, though they are each represented by a different letter name. However, this assumption is false once the calculations are done and if one is not working with an equal temperament system. Remembering again that the chromatic semitone ratio is 25/24, the frequency of C sharp is found by multiplying C's frequency by 25/24. The frequency of D is then divided by the same ratio. After computing the frequencies, C sharp has a frequency of 550 and D flat has a frequency of 570 6/25. Surprisingly, the frequencies are different for enharmonic equivalents. White now shows that C sharp and D flat have a difference of 20 6/25 vibrations per second (White, 1975).

Just Intonation Defined and the Problems It Creates

This discussion of frequencies leads to what is termed "just intonation." Isacoff defines "just intonation" as "the name given to a system that yields both pure fifths and pure thirds in the same musical scale." (2001, p. 97) The average musician will be surprised to find how many sounds just intonation requires for each key. The table in Appendix four shows exactly what the frequencies are. White gives a more organized progression of each sound and its frequency, including the scale in which it is found (see Appendix 5). One will find that the diatonic intervals for twelve keys demand thirty-one separate sounds (White, 1975). The average musician often bypasses the intricacies of tuning because it is an arduous and difficult process. However, learning how tuning works certainly has its rewards by helping the player to understand exactly all that is entailed within the simple notes of a diatonic scale.

The just intonation system causes a series of problems for the musician, and for that matter, the listener as well. To begin with, in the just intonation system the octave must be purely tuned (Isacoff, 2001). The strings of a purely tuned octave have a ratio of 2:1. Next, a perfect fifth will be tuned from *do* in a ratio of 3:2. A perfectly tuned major third is tuned above *do* in a ratio of 5:4 (Isacoff, 2001). A perfect fourth is established with a ratio of 4:3. The scale degrees of *ti* and *la* will be tuned according to the third that is below them, as opposed to tuning *ti* from *do* which is a seventh. *Re* is tuned a fourth below *sol* (Isacoff, 2001). However, with this just intonation system the distances between the intervals are not equal, which causes some problems with certain interval relationships. A root, a third, and a fifth in this system (*do*, *mi*, *sol*) would create a beautifully, pure sounding chord. However, creating chords on other degrees of the scale in this system would not create a harmony that anyone would want to hear (Isacoff, 2001). Therefore, this system severely limited the composer and player. A new system would soon arise to solve the problems of the just intonation system.

Equal Temperament

Equal temperament was the system that was found to make the greatest use of harmony. The chromatic semitones, as well as major and minor tones, that were previously discussed are not valid in the equal temperament system. Rather, this system does what its name implies—makes the tones equal. Any two sounds within a scale are equally sharp and flat to the sounds before and after it. Obviously, this system is going to create a problem within the scale because the pitches are not equally separated and must be altered. The octave is the only interval in this system that is purely tuned. This system does have its downfalls, such as no clear distinction between true consonances and dissonances (White, 1975). Because the equal temperament system must have equal distances between the intervals, the previously mentioned difference of 20 6/25 between the enharmonic of C sharp and D flat is no longer valid. The equal distances now cause C sharp and D flat to be identical in pitch; thus it produces enharmonic pitches. This is the system that is in use today, and provides an easier means of modulation in some instances (White, 1975). Although the octave is the only pure interval, fourths and fifths are very close as well (White, 1975).

The Effect of the Keyboard's Development on Piano Literature

Just as the keyboard developed throughout the centuries, keyboard literature also changed to match the instrument of the day. One must then consider how a composer's particular style reflected the development of the piano at that time. Bach, for example, had the harpsichord at his disposal. The fugues and inventions that he composed fit well with the harpsichord. The harpsichord does a fine job of bringing out the clear contrapuntal lines of many of Bach's pieces. His pieces demonstrate a creative use of line, with several different lines often occurring simultaneously. Though the harpsichord was not an expressive instrument, it was sufficient for the time. Expressiveness still existed in the Baroque, as it did in all eras, yet it had more options as the piano developed.

However, the piano literature of Liszt stands in great contrast to that of Bach. Liszt was instrumental in introducing the virtuosity that could be accomplished on the piano with his *Transcendental Etudes* (Longyear, 1969). Longyear expresses the influence that Liszt had on music by stating:

> Liszt, rather than Berlioz or Wagner, is the true seminal figure for twentieth-century music, occupying the same position in the history of music as Dunstable for Renaissance music or C. P. E. Bach for Romantic composers. The variegated facets of his musical personality found many echoes—the heroic in Mahler, the satanic diabolism in late Mahler, Stravinsky, and Prokofiev, the landscape

> painting (how different from Mendelssohn's) in Debussy and Ravel, the economy of means and use of striking dissonances in Schoenberg's Op. 11 piano pieces and in the works of Bartok (who considered Liszt more important than either Wagner or Richard Strauss in the development of music). (1969, p. 114)

Liszt had the grand piano which was an invention able to produce resonance and tone not previously heard. The beauty and depth of expression heard in the music of Liszt is not present because Liszt was somehow a better musician than Bach; Liszt rather had a totally new instrument influencing his compositions. A more detailed description will now be given to the time periods of several different composers and how the development of the keyboard shaped their literature.

The Influence That the Expansion of the Keyboard Had on Piano Literature

As previously noted, in the early stages of keyboard construction, a keyboard had only about three octaves. This was much smaller than what would later be used in the works of Romantic composers, such as Liszt. Three octaves give players very little room with which to work. Beethoven is known for how he developed motives and restated them in several different ways throughout his music; therefore, even he would struggle with such a limited range. After many years, clavichords began to be expanded to seventy-seven keys. However, this is still eleven keys short of the modern piano's compass. A brief comparison follows between a Baroque piece and a work from the Romantic era. Scarlatti's Sonata *K. 119* requires a keyboard compass of four octaves and a fourth. Liszt's popular *Un Sospiro* is characteristic of the Romantic era with its emotionally expressive phrases. In it, Liszt makes use of almost the entire keyboard, spanning six octaves, from F_1 to F_7. The structure of this piece is remarkable as widely ranging arpeggios are played by both hands, notated on the normal two staves. However, a treble staff is added above the original treble staff, for a total of three staves, indicating the left hand crossing over the right hand to play the melody line. *Un Sospiro* not only takes advantage of the extended keyboard, but also makes use of the soft pedal to quiet the tone, and the sustaining pedal to bring out the contour of the phrases. An expanded keyboard took piano music to a new level by giving it more range possibilities.

How the Frame of the Piano Influenced Piano Literature

The original wooden structure of the piano limited the tone of the piano. In thinking of the wooden piano frame, one would wonder how the wood affects the sound of the strings. Wood, being a softer material than metal, would keep the vibrations of the strings relatively quiet. As was noted previously, the frame of the piano eventually came to be constructed of metal. A metal frame encasing vibrating strings would obviously create a much stronger tone. However, there is another advantage that a metal frame would offer. It would be capable of supporting much greater weight. The player would now be able to exert a much greater force on the keys, which would require that the strings be heavy enough to support the forceful blows. In order for the strings to increase in weight, the frame of the piano would have to substantially increase in weight to be able to support the strings. With the metal frame of the grand piano, the lid of the piano can also be propped up. This exposes the strings which creates the greatest resonance possible for keyboard instruments. To summarize, the frame of the piano had a dramatic effect on the development of piano literature.

The Effect of the Action Mechanism on Piano Literature

One must consider the effect that the action mechanism has on producing terms such as *Allegro*, *Vivace*, *Presto*, etc. If the hammer which hits the string is unable to rebound quickly from its original strike, many sonata movements would be unplayable. Fast sonata movements would not exist without an effective repetition device. Beethoven's sonatas would lose their intensity and character if *Allegro* would have to be replaced with *Andante*. However, an efficient keyboard action makes possible the quick and rapid touch of the keys, making faster tempos realistic.

Comparison of Baroque and Classical Style

Domenico Scarlatti's music is a prime example of the articulated phrase structure found in Baroque music (Rosen, 1997). Also, Bach's inventions use imitation as the driving force of the piece. Sequences are found throughout the Baroque and Classical styles. In Classical style, sonata form also uses sequences, but they are separated by periods of modulation. The sequence is used in the Classical style to further harmonic progression. The phrases were often grouped to form a pattern that would resemble patterns used for dance (Rosen, 1997). Mozart showed the true style of the Classical period by his use of symmetry in phrase structure. An excellent example of his balanced phrasing is *Concerto for Piano and Orchestra K. 271* (Rosen, 1997).

Throughout much of Classical music, the first part of the sonata would move from the tonic key to the dominant key, and the second part of the sonata would move from the dominant back to the tonic (Rosen, 1997). One must consider why such a simple analysis would be the case. Obviously, there is nothing wrong with the tonic to dominant form of modulation, and it is still frequently used in today's music. Though dissonances were explored by some composers at that time, equal temperament was not yet in full use, nor was it wanted. The tuning of the just intonation system would provide for pure sounding fifths, which creates a pure tonic to dominant relationship. Attempting to play other scale tones would have been of little use musically with the just intonation system. Equal temperament allowed composers to use a much wider range of modulations, which affected music from that point forward.

The Pedal's Influence on Piano Literature

Dramatic intensity and expression can be more easily seen throughout the works of Bach, Haydn, Mozart, and Beethoven. Even more noticeable is the intensity of contrasting movements, subjects, and themes. Mozart's expression and emotional drama can be seen throughout his operas and piano works; however, it has been observed that he restricts his compositions to a limited use of tonalities (Einstein, 1968). Though Mozart transcribed fugues from the Well-Tempered Clavier, he transposed them into simpler keys (Einstein, 1968). The subjects seen in the works of these four composers are usually constructed so that the second subject is radically different than the first subject. An example of this can be seen in Beethoven's *Appassionata,* Op.57. Beethoven's Op. 53 and Op. 57 show use of rapid harmonic movement. A more nervous use of harmony is used in Mozart's K.310 and Beethoven's Op. 31 no. 2 (Rosen, 1997). The clear and distinct use of phrasing used in these pieces correlates to the piano's development in the late eighteenth century, which did not require extensive use of pedals. The grand piano included a pedal system that was not seen until after the Classic period. The body of the grand piano allows for more resonance, which combined with the use of pedals, could produce a sound equivalent to the power of an orchestra. However, pedals must be used carefully when playing a Baroque piece, such as one by Bach or Scarlatti, while holding the damper pedal down. In some instances, continuing to hold the pedal down would result in the phrase structure being blurred, and the intensity and articulation of the rhythm being lost. This should serve as a reminder to today's pianist not to allow all the improvements of the modern piano to ruin the composer's original intent.

The Development of the Piano During the Time of Beethoven

Beethoven was privileged to have the pianoforte during his lifetime. More expressive capabilities could be produced on the pianoforte, yet its wooden frame caused it to emit a quieter tone. Metal framed pianos would emerge after Beethoven's time. The range of the piano was extended during Beethoven's time, and he made use of it in many of his works (Lockwood, 2003). Beethoven favored Streicher's version of the pianoforte, and found no use for the version made by Erard (Lockwood, 2003). Beethoven's style necessitated an action mechanism sufficient for rapid movement. As was mentioned, use of the pedal must be carefully considered so as not to completely mask the rhythm and character of the piece.

Romanticism Seen in Schumann's Abegg Variations Op. 1, and Carnival Op. 9

The Romantic era brought to music tonalities that were previously unheard of by classical composers. Wilfrid Mellers paints a picture of the change Romanticism brought in the opening of his book, which affirms:

> Sonata, we have seen, was the expression of a creative ideal. Because it involved conflict, it implied too a basic conception of order, associated with a clearly defined scheme of tonality; throughout the works of Haydn, Mozart, and Beethoven the dualism between individual passion and the accepted norm grew increasingly acute. Ultimately, the force of the personal will was to destroy the old notions of tonality and order, creating in Wagner's operas a new mythology out of subjective dream . . . The general tendency in instrumental music around 1820 was for the sonata principle to be superseded by small forms expressive of the passing whim and fancy; and this intimate approach to personal feeling was in particular associated with the development of the piano. (1969, p. 1)

The expressiveness of sound that the piano developed, brought to life the emotion of the Romantic period. Dissonances were now found, such as in the music of Debussy, which broke the confines of tonic to dominant to create hidden functions of harmony. The previously mentioned Romantic composer, Liszt, created emotion that would have been impossible to produce on any of the early keyboard models, due to key tonality and sound restrictions. Liszt played on Broadwood, Streicher, Pleyels, and Erard pianos; the pianos that he performed on often were dependent on what could be provided in the town where he was performing. In one performance, the Tompkinson upright piano that Liszt was performing on shook as he played; this kind of reaction from the piano was often due to the instrument's smaller compass and more delicate tone. Greater pianos were needed to support Liszt's more massive works (Walker, 1983).

Schumann characterized the Romantic style through his music. Some of his works were drawn from his experiences and inner feelings, so as to tell a story. Schumann's Opus 1 is an example of his love for a woman named Abegg. Interestingly enough, it is from her name that he draws his opening notes, which are: a, b, e, g, g (Mellers, 1969). The listener will find that the first variation gives a simple, happy, dance-like tune. The second variation brings a greater intensity to the work. As the work progresses to the fifth, and last variation, the dance-like rhythm underlying this piece is again heard. Schumann needed a piano action that would allow quick repetition to facilitate his rapid arpeggio passages, and permit dynamics that would bring character and intensity to his work.

Similar to the *Abegg variations*, there is also meaning imbedded into Schumann's *Carnival* which was published in 1837. This is an extensive work made up of twenty-two separate parts. The theme for this work, written for the piano, is a masked ball. This is another work by Schumann that seemingly grew out of a romantic relationship (Taylor, 1982). The notes of *Carnival* do not follow any single diatonic scale, and through sequences he explores over seven different keys (Taylor, 1982). Schumann's works exhibit imagery and imagination. The pianoforte was a means by which he was able to achieve this romantic ideal of music. This instrument offered him expressiveness, through which he was able to create the differing moods exhibited in his piano style. It also offered him a mellower tone through the piano's improved framework. The pianoforte gave Schumann the ability to show his imagination through music.

Concluding Thoughts on the Piano's Influence

The keyboard had its origins with the ancient Greeks and Pythagoras. At that time it had few capabilities, but was continually developed in the upcoming centuries. The keyboard went through a process of revisions until most of its potentials were reached; an instrument was created that would keep the keyboard idea, but overcome most of its restrictions. One restriction that still exists is the ability to crescendo a single note after it is played. The performer can try to compensate for this by building a crescendo in the other notes surrounding it. The piano came to be one of the most popular instruments. It could accompany other instruments, or present solo performances. The styles of past piano composers can be correlated to the piano's development. Baroque and Classical compositions possessed the beauty and intricacies of counterpoint, detailed articulations, and the detached clarity of the musical notes. The Romantic ideal embodied imagination and art that was expressed through music. The contour of a melodic line was brought to life with the introduction of the pianoforte and pedal system. Today's musicians now have at their disposal the final product from a long line of revisions.

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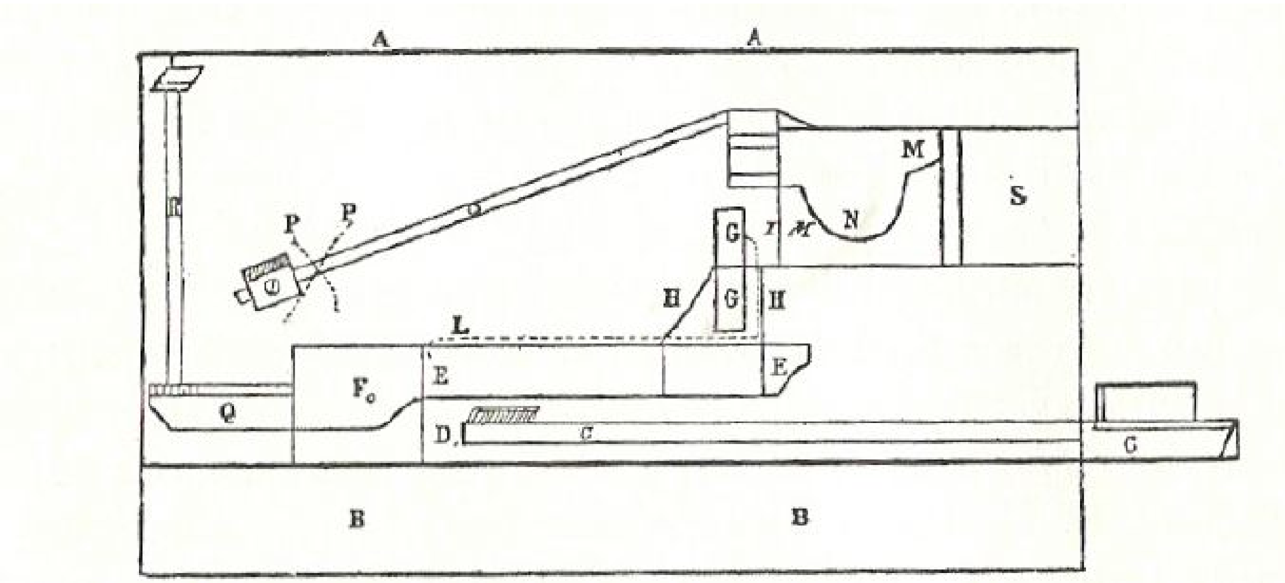
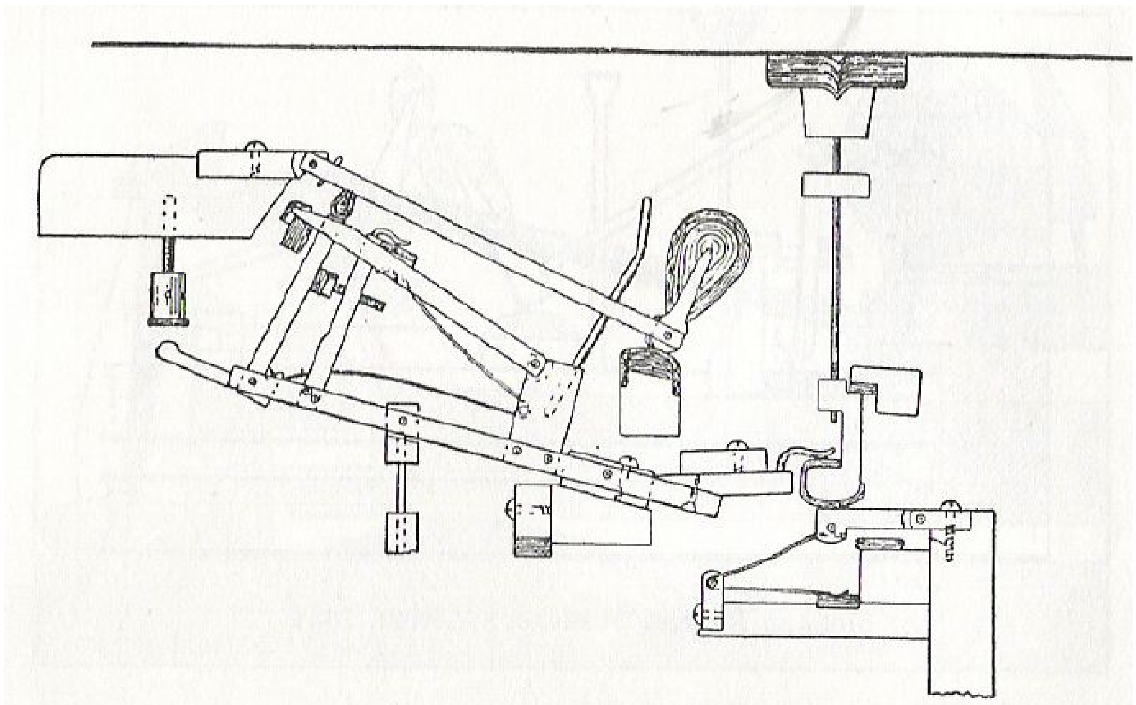
Appendix I



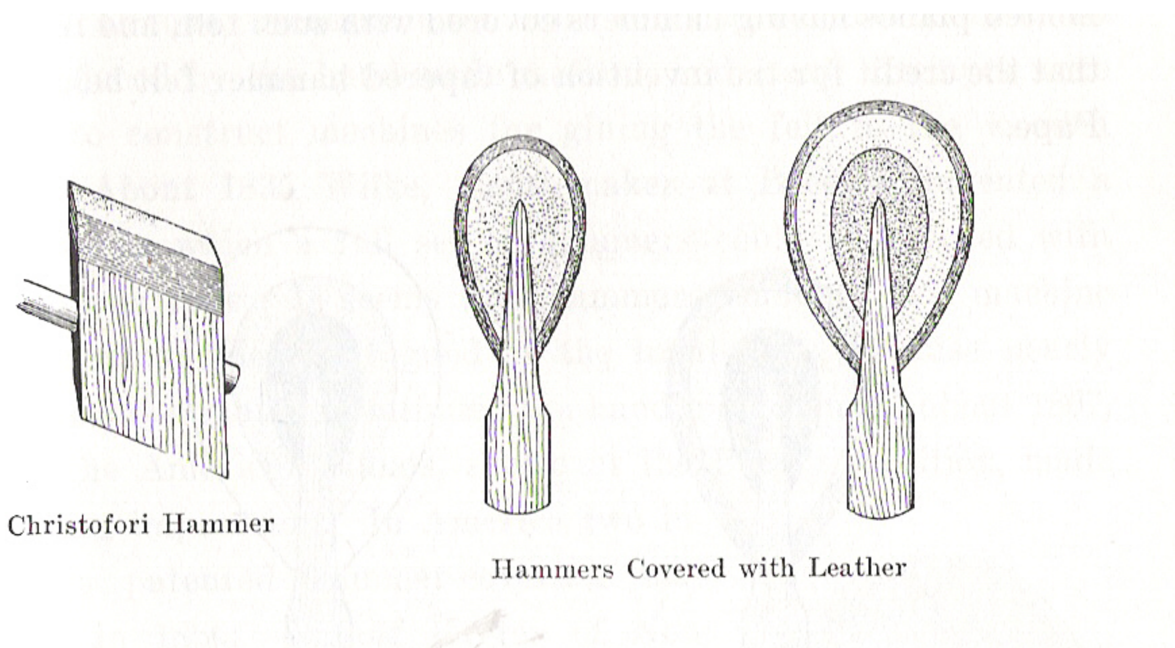
Christofori's action device (Harding, 1973, p. 8)

Appendix II



Sebastian Erard's Grand Action developed in 1821 (Dolge, 1972, p. 88)

Appendix III



(Dolge, 1972, p. 97)

Appendix IV

C	D	E	F	G	A	B	C
528	594	660	704	792	880	990	1056
C-sharp	D-sharp	E-sharp	F-sharp	G-sharp	A-sharp	B-sharp	C-sharp
$556\frac{7}{8}$	$626\frac{3}{64}$	$696\frac{3}{32}$	$742\frac{1}{2}$	$835\frac{5}{16}$	$928\frac{1}{8}$	$1044\frac{9}{64}$	$1113\frac{3}{4}$
D	E	F-sharp	G	A	B	C-sharp	D
594	$668\frac{1}{4}$	$742\frac{1}{2}$	792	881	990	$1113\frac{3}{4}$	1188
E-flat	F	G	A-flat	B-flat	C	D	E-flat
$625\frac{4}{9}$	$703\frac{45}{72}$	$781\frac{34}{36}$	$833\frac{25}{27}$	$938\frac{1}{18}$	$1042\frac{11}{27}$	$1172\frac{59}{72}$	$1250\frac{8}{9}$
E	F-sharp	G-sharp	A	B	C-sharp	D-sharp	E
660	$742\frac{1}{2}$	825	880	990	1100	$1237\frac{1}{2}$	1320
F	G	A	B-flat	C	D	E	F
704	792	880	$938\frac{2}{3}$	1056	$1173\frac{1}{3}$	1320	1408
F-sharp	G-sharp	A-sharp	B	C-sharp	D-sharp	E-sharp	F-sharp
$742\frac{1}{2}$	$835\frac{5}{16}$	$928\frac{1}{8}$	990	$1113\frac{3}{4}$	$1237\frac{1}{3}$	$1392\frac{3}{15}$	1492
G	A	B	C	D	E	F-sharp	G
704	792	880	938	1056	1173	1320	1408
G-sharp	A-sharp	B-sharp	C-sharp	D-sharp	E-sharp	Fx	G-sharp
825	$928\frac{1}{8}$	$1031\frac{3}{4}$	1100	$1237\frac{1}{2}$	1375	$1546\frac{1}{8}$	1650
A	B	C-sharp	D	E	F-sharp	G-sharp	A
880	990	1100	$1173\frac{1}{3}$	1320	$1466\frac{2}{3}$	1650	1760
B-flat	C	D	E-flat	F	G	A	B-flat
$938\frac{2}{3}$	1056	$1173\frac{1}{6}$	$1258\frac{8}{9}$	1408	$1564\frac{4}{9}$	1760	$1877\frac{1}{3}$
B	C-sharp	D-sharp	E	F-sharp	G-sharp	A-sharp	B
990	$1113\frac{3}{4}$	$1237\frac{1}{2}$	1320	1485	1650	$1856\frac{1}{4}$	1980

Frequencies in the Just Intonation system (White, 1975, p. 39)

Appendix V

				Appears in the scales of
1.	The sound	C	= 528	C, F, G, B-flat.
2.	"	C	= $521\frac{11}{54}$	E-flat
3.	"	C-sharp	= $556\frac{7}{8}$	D, B, F-sharp, C-sharp
4.	"	C-sharp	= 550	A, E, G-sharp
5.	"	D	= 594	C-G
6.	"	D	= $586\frac{2}{3}$	A, F, B-flat, E-flat
7.	"	D-sharp	= $618\frac{3}{4}$	E, B, F-sharp, G-sharp
8.	"	D-sharp	= $626\frac{81}{64}$	C-sharp.
9.	"	E-flat	= $625\frac{4}{9}$	B-flat
10.	"	E	= 660	C, G, A, E, B-flat
11.	"	E	= $668\frac{1}{4}$	D
12.	"	E-sharp	= $696\frac{8}{32}$	F-sharp, C-sharp
13.	"	E-sharp	= $687\frac{1}{2}$	G-sharp.
14.	"	F	= 704	C, F, B-flat
15.	"	F-sharp	= $742\frac{1}{2}$	G, D, E, B, F-sharp, C-sharp
16.	"	F-sharp	= $753\frac{1}{3}$	A
17.	"	G	= 792	C, D, F, G
18.	"	G	= $782\frac{4}{13}$	B-flat
19.	"	G	= $781\frac{34}{36}$	E-flat
20.	"	Fx	= $773\frac{6}{16}$	G-sharp
21.	"	G-sharp	= 825	A, E, B, G-sharp
22.	"	G-sharp	= $835\frac{5}{16}$	F-sharp, C-sharp
23.	"	A-flat	= $833\frac{25}{27}$	E-flat
24.	"	A	= 880	C, E, F, A
25.	"	A	= 881	D
26.	"	A	= 891	G
27.	"	A-sharp	= $928\frac{1}{8}$	B, F-sharp, C-sharp, G-sharp
28.	"	B-flat	= $938\frac{2}{3}$	F, B-flat, E-flat
29.	"	B	= 990	C, G, D, A, E, B, F-sharp
30.	"	B-sharp	= $1031\frac{1}{4}$	G-sharp
31.	"	B-sharp	= $1044\frac{8}{64}$	C-sharp

The frequencies and their related scales (White, 1975, p. 40)