Listaháskóli Íslands
Tónlistardeild
Hljóðfærabraut

Theobald Boehm

Elva Lind Þorsteinsdóttir
Leiðbeinandi: Atli Ingólfsson
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- The Reinvention of the Flute -

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Introduction

The late 19th century is often referred to as the golden age of flute playing. This was a time when the flute became fully developed and came to be a popular virtuoso instrument, a time when an increasing number of composers composed great pieces for the flute, causing the repertoire to expand greatly in only a few decades. What is the reason for this sudden change? The answer is Theobald Boehm.

When I learned that the flute as we know it today is the result of the work of one man I became curious. Who was Theobald Boehm? Why did he reinvent the flute? What was the flute like before he started his work, and what was the difference between the old flute and the new? How was the new version received?

In trying to answer these questions, I will be looking at his life, the different stages of his work, and find out if he was alone in developing the flute or if ideas or improvements came from other sources.

Method of research and presentation

My research of this subject is based on books covering the development of the flute from the Renaissance period to the present, as well as books and essays written by Boehm himself. As my knowledge of how the old-system flute worked was very limited, I borrowed a six-keyed flute from my teacher to get a first hand look at the various keys and levers, and the experience of playing one.

Before getting into the developments of the Boehm flute, I will be looking at his background, talk about where he came from, and what influenced him to devote his life to the studies of the flute.

In order to understand how drastic a change it was to try to adapt to the new system, having already spent decades learning the standard system, we must become familiar with the early 19th century flute. After introducing it I will be describing the various stages of the Boehm flute, from his development of the old-system flute, to his finished product in 1847. A chapter about the diverse materials that have been experimented with when flute makers attempted to improve the flute

will follow this. The change from wooden to metal flutes will also be mentioned, after which I will be discussing new flute's effect on composers.

Following the account of the developments of the flute, I will be explaining the diagram Boehm made. In the final chapter I will be introducing the controversy of Boehm and Captain Gordon.

Theobald Boehm

Theobald Boehm was an extremely interesting man. He was a flute player and maker, composer, and a goldsmith with an advanced understanding of mechanics. He devoted himself entirely to the flute, and reinvented it in a course of about 20 years.

He was born on 9th of April 1794 in Munich, Bavaria. He was born, lived, worked, and died (25th November 1881) in the same house at No. 20 Altheimereck where he occupied a flat. His father was a renowned jeweller and goldsmith, a profession the young Boehm showed a mature talent for. Already by the age of fourteen he was entrusted with important repair work. These technical skills would become very useful to him in his chosen profession.

As a boy, Boehm was very fond of music and taught himself the flageolet[1] and the one-keyed flute[2] (fig. 1). In 1810, at the age of 16, he made himself a copy of a Grenser instrument, a four-keyed flute (similar to the one in fig. 2). It was around this time that Johann Nepomuk Capeller (1776-1825), the flutist of the Royal Court Orchestra, saw his enthusiasm and offered to give him lessons. Within two years, Capeller confessed he had nothing more to teach him.

By the time Boehm was 18 years old he had acquired the position of first flute at the Royal Isarthor Theatre in Munich. In 1819, at the age of 25, Boehm ended his career as a goldsmith, and devoted himself fully to music. A versatile musician, he composed and arranged a lot for the flute, his first composition, a Concerto in G Major, being published in 1822, and his last composition in 1881. Throughout his life, Boehm composed a great deal of music for the flute, 47 of which have opus numbers. He was known for having composed music for the alto-flute, a flute in G,

[1] A forerunner of today's tin whistle
[2] An instrument made by Proser (active 1777-1795), now No. 152 in the Collection of Dayton C. Miller.

which he invented around 1854. This flute was the pride of his life, and he played it almost exclusively in the last twenty years of his life. Among his works are a concerto, fantaisies, variations, potpourris, and numerous arrangements for flute and piano, and alto-flute and piano. During his time as a performer and first flutist at the Royal Court Orchestra (1818-1828), he had little time to make flutes as he had done before, and so he had other makers make flutes for him using his own improvements. He finally gave this up as he was always dissatisfied with the results and opened a flute workshop in 1828.

Boehm had an extraordinary understanding of the standard flute's deficiency and spent his whole life working on improvements; first, by improving the old-system flute, and then by inventing a whole new system, which brought a dramatic change to the world of flute playing.

The early 19th century flute

The old-system flute had a cylindrical head joint and a conical bore[3]. This was a form introduced by Christopher Denner (1655 – 1707) of Nuremberg and later improved by Johann Joachim Quantz (1697 – 1773) and Johann George Tromlitz (1725 – 1825) among others. It had a small embouchure-hole (mouth-hole) and six tone-holes (for the fingers) of different sizes. It would usually have metal keys for D♯, F, G♯, and B ♭ , although depending on the make it could have up to twelve additional keys (fig.2). As a result, a majority of the fingers of each hand operated up to three keys each. Some notes, i.e. F♮, G♯, and B ♭ had two or even three alternative keys or levers to make the fingerings easier and to improve the intonation. For instance, F♮ could be played using three different keys. The first key to be added had been placed between the F♯ and E holes (fig. 3) operated by the third finger of the right hand. This made it difficult to slur from F to D without sounding the E as well; so another hole was made on the far side covered by a lever which was operated by the left hand little finger (which also controlled the G♯) (fig. 4). The third option was to have a key controlled by the left hand thumb.

Another unusual lever is the long C lever, situated on the inner side of the flute. It was operated by the right hand first finger, which was surprising as the position of

[3] The flute tube, wider at the top and narrower at the bottom

the C hole was between the first and second fingers on the left hand (see fig. 4). It is not known who invented the long C lever, but it has been attributed to both Claude Laurent (*fl* 1805 – 1848)[4] and Boehm's teacher J.N. Capeller.

Boehm's flute workshop and his 1829 model flute

Before he established his workshop, Boehm made minor improvements to the simple-system flute, such as new types of springs, linings and corks for the joints. But in 1828, Boehm established his own flute factory, situated on the fourth floor in the same house where the Boehm family lived, their flat being on the floor below. Boehm made all his major inventions and modifications to the flute in this workshop.

Before Boehm could start making flutes he had to have the right devices to make them accurate. The first thing he did was to construct machines and appliances to accurately make better key mechanism. For instance, one had the function of accurately screwing the metal posts into the wood in the line of radius of the bore; another was for boring the holes in the spherical heads of the pillars.

Boehm finished his first flute in the new factory already in 1828. While touring Paris and London in 1831, he played a flute made in 1829, in his own workshop. It was a simple-system flute, made of cocus-wood. It had silver springs and flat gold springs. It produced a beautiful, sweet and mellow tone, though not powerful, and was surprisingly well in tune for having a simple-system scale. Boehm had improved the standard flute to the fullest.

Knowing the importance of quality rather than quantity, Boehm never kept more than three workers at his factory; therefore the instruments produced in his workshop were of the highest quality, fitted with tuning slides, hardened gold springs, and with the keys mounted on screwed-in pillars. He had even started to experiment with longitudinal rod-axles of his own invention to connect the keys. While working on the standard model, he had concluded that the flute's main flaw was the placement of the holes. They were situated for the comfort of the fingers and not according to acoustical principles. He knew that the addition of keys would

[4] Parisian flute maker famous for making crystal-glass flutes

not solve the problem; a whole new system would have to be devised. However, he was reluctant to change the fingering, as it would cause problems for those who had been playing on the simple-system for years.

The 1831 model

As I mentioned earlier, Boehm performed in Paris and London, in 1831, on an 1829 model flute from his own workshop. During that tour he had the privilege to listen to Charles Nicholson, a great flutist renowned for his strong and voluminous tone. He had a great impact on Boehm, who knew that he could never match his power of tone, which he understood was a result of Nicholson's very big tone holes; and while still in London, constructed a new model in the workshops of Gerock and Wolf. As Boehm remarked in a letter to Mr. W.S. Broadwood many years later: "Had I not heard [Nicholson], probably the Boehm flute would never have been made."[5]

The model known as the 1831 "Patent Flute" is likely to have never been produced commercially. There are only two changes that separate this model from the simple-system flute. The A hole was moved further down, to its acoustical position. It was moved too far for the third finger to reach, so Boehm placed an open key on top of the hole to avoid any inconvenience (fig. 5). The changes for the right hand consisted of moving the E, F, and F♯ holes further down the tube (this had already been introduced by H.W. Pottgiesser in 1803). The F hole that had previously been situated at the side of the bore was now placed in line with the other three. There were now four holes, which had to be covered by three fingers. To solve this problem, Boehm placed double-jointed ring keys (we first hear of ring keys being used by Rev. Frederick Nolan in 1808) on the F♯ and the E holes. This allowed the first and the third fingers to close the G hole as well as their original holes. As a result, what had previously been the fingering of F♯ was now F♮. The reason for this manoeuvre was to avoid the "forked" F fingering, and all the additional F keys of the standard flute. F♮ was now played using the first finger,

[5] *The Flute*, by Philip Bate, p. 120

and F♯ using the third (fig. 5). This proved to be the first step towards our modern flute.

The 1832 model

During his trip to London, Boehm became increasingly aware that the tone holes were placed incorrectly. He started immediately to work on the model that would be known as the 1832 flute. He was now resolved on making an entirely new fingering system. Recollecting the voluminous tone of Nicholson, he started by experimenting with the placement and sizes of the tone holes. To figure out the correct position of each hole, he progressively cut the end of a wooden tube of the same diameter as the flute bore, to the exact lengths in which the air had to travel to sound the correct notes (a similar concept used for the pan flute and the organ). He then used the measurements of each note to find the exact location in which the hole was to be bored. This did not work as well in practice as in theory, owing to the fact that the holes were considerably smaller than the diameter of the flute, making the notes sound flat. He corrected this by moving the holes back towards the head joint. Boehm then found out that if the holes were all of equal sizes, the first two octaves were in tune, but the third wasn't. His solution was to move the six upper holes, and change their sizes to correct the intonation.

As the holes were too large and too many for the fingers to cover, Boehm had to come up with a key system to control them. The only way to do this was to work out all the possibilities, and try them out. In the process of experimenting with the fingering systems, he discovered the importance of an open-holed key system. "It is necessary, for obtaining a clear and strong tone, that the holes immediately below the one sounding should remain open, for the air confined in the lower part of the tube tends to flatten the notes, and renders them less free."[6]

As in the old-system flute, the three lowest keys, C, C♯ and D♯, were operated by the right hand fourth finger; the only closed key being the D♯. Keeping a key closed seems to be opposing to Boehm's theory of an open keyed system. The

[6] *An Essay of the Construction of Flutes* by Theobald Boehm p. 20

reason is that as the D♯ key must almost always be kept open, and the constant pressure from the fourth finger improved the balance when holding the flute.

The changes that involved the right hand were few. The concept consisting of closing the G hole using the F and F♯ keys, introduced on the 1831 flute, was retained. The improvement was that a ring-key was added to the F hole, and the system was now constructed with horizontal rod-axles of his own invention. The F♯ ring key was connected to a different axle to the other two, in order to enable it to close the B ♭ key as well.

Boehm made numerous changes to the left hand mechanism. He removed the key covering the A hole, and brought the other holes lower so the left hand third finger could reach the A hole. This maneuvre left the top hole (C♯) too far away for the first finger to reach, so using the same concept as he had with the key covering the A hole in 1831, he created a key covering the C♯ hole, bringing the touch key lower. The B ♭ hole, which had previously been on the inner side of the bore, was now moved to be inline with the other holes. Again, Boehm was faced with the problem of having to close four holes with only three fingers. He covered the B hole with a padded key, and connected it to the B ♭ ring-key using an axle. This same axle was also used to connect the B key to the F♯ ring-key. The C hole was moved to the inner side of the flute, covered with an open padded key, which was controlled by the left thumb.

By introducing the open G♯ key Boehm proved that he was acting in accordance to his theory "that the holes immediately below the one sounding should remain open" in order to keep the note in tune. Therefore, he opened the G♯ for three reasons. It acted as a vent hole for A when kept open, he felt it was accoustically better, and it made more sense mechanically to keep the left hand fourth finger down for sounding G and taking it off for G♯, instead of the opposite principle of the old system.

Two trill keys were added to this new model. A key connected to the C key, was added between the second and third fingers on the right hand, controlled by the third finger. Its purpose was to make it easier for the musician to make a B/C trill, as using the thumb might prove awkward. The second trill key, invented by Capeller, was used to make a C♯/D trill. This key controlled a key opening the small D hole, situated above the C♯ hole (fig. 6)

The tuning slide was removed, as Boehm felt it hardened the sound of the flute. Instead, he added several silver rings to fill up the space in the joint, so the flute could be lengthened. At this time, all of Boehm's flutes were made of hard wood, such as cocus wood and grenadilla wood from South America.

It took Boehm a few months to develop enough skill to be able to play this flute in concert. He then introduced it in Munich, London and Paris in 1833, having completely laid aside the old-system. Its reception was good, people appreciated the full and even tone, and the pure intonation, "but most of them were discouraged by the new system of fingering. Flautists of old standing decided against it, because they could not resolve upon studying an entirely new instrument; and, possibly, they sometimes saw with displeasure that young artists, by adopting it, acquired an accession of means for producing greater effects in their performance."[7]

It wasn't until the first flutist at the Opéra Italien, Paul Camus, with the help of a few colleagues, introduced it to Paris in 1837 that flutists and flute makers became interested in this new invention. One of those flute makers was Auguste Buffet, an esteemed instrument maker who with his colleague Victor Coche[8] made several significant mechanical improvements. Buffet disagreed with Boehm's use of axles on both sides, and placed all the axles to the inner side of the flute. He did this by introducing the rods and sleeves system. By attaching keys to an axle, which went through a sleeve with other keys attached to it, he managed to simplify Boehm's key system without changing the fingering (fig. 6). He also decided to use needle springs instead of flat leaf springs to improve the mechanism.

Keeping the G♯ key open as suggested by Boehm proved a difficult change for flutists to accustom to so Buffet, influenced by Coche, changed it back. Nevertheless, this change did not survive, as it affected the intonation. Coche is more known for adding a trill key for C♯-D♯ in the second and third octaves. It is operated by the right hand third finger. Buffet joined both trill keys (D and D♯ keys) in the same sleeve.

Vincent Dorus (1812-1896), a flute professor at the Paris Conservatoire and solo flutist of the Opéra was the man who made the change to the G♯ key, which principle remains in use to this day. Knowing of the objections flutists had to the

[7] *An Essay on the Construction of Flutes*, by Theobald Boehm, p. 13
[8] Victor Coche (1806-1881) was a renowned flutist and a professor at the Paris Conservatoire

open G♯ key he designed a closed G♯ which would act as a vent hole for A, and keep the old fingering. He added a ring key to the A hole and attached it to the G♯ key with a sleeve and a clutch. This way, whenever the ring key was pressed, the G♯ key would close. Nonetheless, the key could be opened independently by pressing the lever operated by the fourth finger on the left hand.

These changes made by Buffet, Coche and Dorus made the transition easier for flutists and by 1838 the French version of the Boehm flute had been adopted by the Paris Conservatoire. Soon flutists in London became influenced by their French brothers and started to take up the Boehm flute.

Boehm turned his attention to the steel and iron industry in 1833 (he invented the modern smelting process) as there was no demand for his flutes, which resulted in him closing his flute workshop 1839. When he received news of his flute becoming increasingly popular in France and England he made contracts with flute makers Clair Godfroy, ainé in Paris, and Rudall & Rose in London.

The 1847 model

Having developed the key mechanism to his satisfaction, Boehm was still having trouble with the acoustics:

"I was never able to understand why, of all wind instruments with tone-holes and conical bore, the flute alone should be blown at its wider end: it seems much more natural that, with a rising pitch and shorter length of air column, the diameter should become smaller. I experimented with tubes of various bores but I soon found that, with only empirical experiments, a satisfactory result would be difficult of attainment."[9]

In order to answer this question, Boehm engaged in studies of the principles of acoustics in 1846-47 with Dr. Carl von Schafhäutl at the University of Munich. There he discovered that the sound was better when the bore was cylindrical. His work in the steel industry had influenced him to start experimenting with metal in 1846, and found that a silver flute had the most sonorous tone. In addition, he

[9] *The Flute* by Philip Bate, p.127

found that the metal's capacity for vibration increased with thin, hard-drawn tubes and therefore a clearer tone was obtained. After experimenting with these factors, he reopened his workshop and finished a flute in the latter part of 1847 with a cylindrical bore and a parabolic headjoint.

The flute had an internal bore of 19 millimetres in diameter. The headjoint decreased in diameter to 17 millimetres at the cork. This change in the internal bore required changing the tone holes as well. Furthermore, Boehm believed that the shape of the embouchure hole was crucial to acquire the best tone possible. It should be large and have the shape of a rectangle with rounded corners. Until then, the flute had always had a round or an oval embouchure hole. Boehm enlarged the tone holes making them impossible to cover with the fingers alone. As a result, he had to replace all ring-keys and cover all tone holes with padded hole covers; similar to the ones he used to cover the B and G holes on the 1832 model. The idea was that all keys had to be able to be opened and closed individually, but at the same time be connected with the keys which could not be closed by the fingers. He consequently adopted Buffet's sleeves and rods, and connected each key to it's own sleeve. He used needle springs to keep the keys open (also invented by Buffet) and clutches to connect the keys together. The padded keys consisted of wool disks covered with membrane or skin (double thickness), then card with a hole punched in the centre for enabling the padding to be screwed in properly. A silver washer was used under the screw for a tight fit. This way, Boehm eliminated the problem of constant trouble with air leakage.

The only mechanical change made to Boehm's 1847 flute was made in 1850 by Giulio Briccialdi (1818-1881), an Italian flutist living in London. The flute originally had only one thumb lever, which was an open key for B. To play B ♭, one had to finger B and simultaniously press the key covering the F♯ hole using the right hand first finger. Briccialdi wanted an easier way to finger B ♭, as it would be more convenient in flat keys, and added a second thumb lever. This key was placed on top of the B key so that it would close that hole as well. B ♭ could now be fingered using the left hand index finger and thumb. Boehm accepted this change, but he disagreed about the order in which the thumb levers were placed. Briccialdi's placement of the keys resulted in the player having to move the thumb

upwards from fingering B to play B ♭ . Boehm felt that it would be more logical if the B were the higher lever, as it is a higher tone. Even so, Briccialdi's thumb system prevailed (fig. 7).

Already in 1847, Boehm sold the patent to the same flute makers as he did with his 1832 model, Rudall & Rose in London, and Clair Godfroy and his son-in-law Louis Lot in Paris.

Boehm's 1847 flute gained the Gold Medal at the Universal Exhibition in London in 1851. A report written by Sir Henry Bishop stated, "Mr. Boehm has acquired not only a perfection in the tone and tuning never before attained but also a facility in playing those keys which were hitherto difficult and defective in sonorousness and intonation."[10]

This flute also achieved the gold medal at the Paris Exhibition in 1855.

The Boehm flute became very popular with professional flutists in France and England. However it took the Germans a long time to adopt it, the reasons being that the wooden flute looked better in traditional woodwind ensembles and there were no qualified teachers. In fact, the Boehm flute wasn't standardised in Germany, Italy, or Russia until early 20th century.

Material

Many flute makers experimented with different materials when trying to improve the flute's sound and intonation. By the time Boehm started experimenting, they had already tried numerous kinds of wood, ivory, crystal-glass, porcelain, papier-mâché, and wax, these being only a few examples. Very hard wood was the most commonly used.

In 1846, Boehm experimented with silver, German silver, brass, copper, and tin. Finding silver the most desirable choice, Boehm started making flutes of silver in 1847, and was the first one to introduce a flute made entirely of metal. It was superior to the wooden flute for several reasons: it wasn't prone to splitting, the bore was dimensionally stable and less affected by temperature. Moreover, this new material produced brilliant sound and sonority and has today replaced the

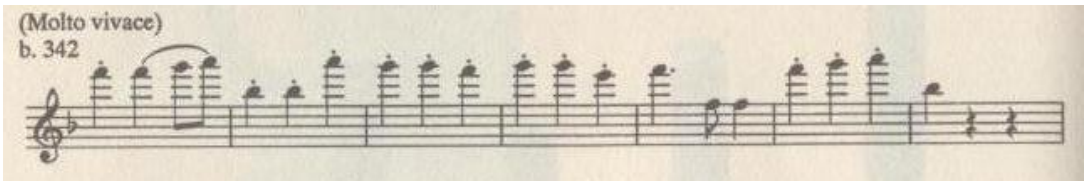
[10] *The Development of the Modern Flute* by Nancy Toff, p. 76

wooden flute entirely. Nevertheless in the 19th century the embouchure of most flute players was accustomed to wood, making them over blow when playing the silver flute. For this reason, Boehm continued to produce wooden flutes made of hard wood, such as cocus wood and grenadilla wood from South America. He strongly recommended combining wood and silver, making the headjoints of wood and the body of silver. This combination has not been popular with other makers and is not much used today.

The effects of the Boehm flute on composers

While developing his flute, Boehm made sure to improve the flute's range. The standard system flute's typical range was $d^1 - a^3$, which presented a problem for composers who were increasingly demanding the flute to play in the higher octave. As a result, there were few composers who composed virtuoso pieces for the flute.

Composers used the flute's ability to the fullest in orchestral works. A good example would be Beethoven's 9th symphony where B ♭ was played an octave lower as it was almost impossible for the flute to play it in the required octave (see below).

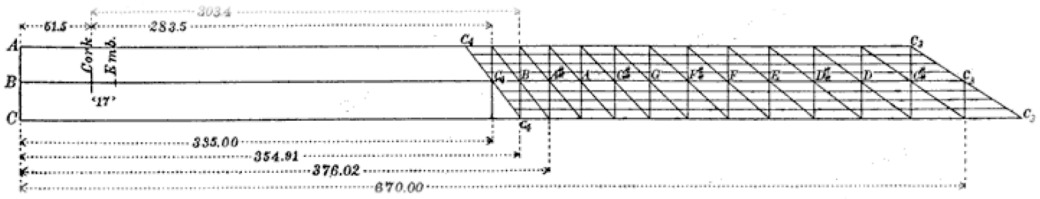


As the Boehm flute increased in popularity, composers became more aware of the larger range and the quality of the instrument, which resulted in a rapid increase in composition for the flute as a solo instrument in the late 19th century.

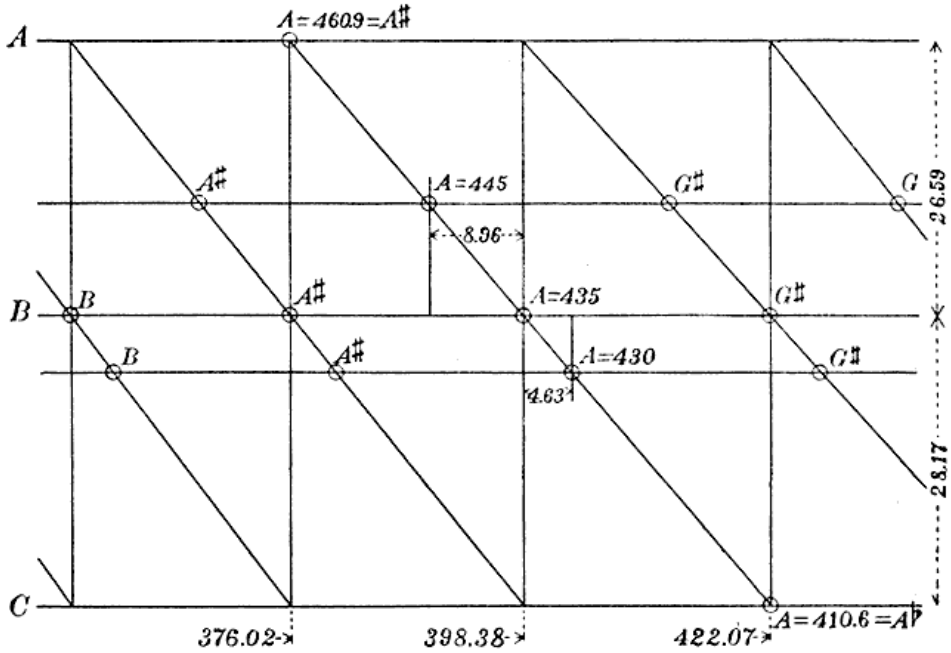
The Schema

In 19th century Europe, each country had its own standard pitch. In France and Germany the pitch was A=435. In England, however, the pitch varied from the A=430 most commonly used in an average household, to A=452-455 used by the Philharmonic Orchestra. This was a problem, as the flute cannot be tuned in this range of pitch and stay in tune. As Boehm was planning to manufacture his flutes in both England and France, he had to make a diagram of where to place the holes

in accordance with the pitch. He called this diagram *The Schema* (see below). The first reference made to this diagram was in connection with the London Exhibition of 1862. It then appeared at the Paris Exposition in 1867, but according to Dayton C. Miller in his translation of Boehm's book *The Flute and Flute Playing* on p. 39 the jury would not study it as they felt it did not have artistic value. *The Schema* was also published in 1868 in the *Kunst und Gewerbeblatt*, a magazine published by the Bavarian Polytechnic Society.



The horizontal middle line (B) signifies the pitch of the Boehm flute A=435, the most common pitch in Europe at the time. It shows the position of the cork, the embouchure hole and each of the tone holes. The line above (A) represents the same flute pitched one semitone higher (A=460.9), and the line below (C) one semitone lower (A=410.6). The six shorter parallel lines represent the different pitches in between lines A, B, and C. This way, the flute maker could decide to which pitch the flute should be tuned by looking at the intersections of the relevant horizontal and diagonal lines. The vertical lines reveal the space between each tone hole.



A closer look at the Schema in the figure above reveals that Boehm gave flute makers two options when making his model. They could work out the placement of the holes by pitch, where they could pull out the tuning slide to the preferred pitch and work out the distance of the remaining tone holes. For example, if the pitch preferred is A=430, the headjoint should be drawn out until the chosen pitch is obtained. The length drawn out should be 4.63 mm. The vertical line for A should be moved 4.63 mm to the right and a horizontal line drawn through it. The diagonal lines now show the correct placement for each tone hole in the correct pitch.

If the flute maker only had *The Schema* and no Boehm flute to work with, the correct pitch could be worked out by numbers. Underneath each vertical line is the distance from the cork to each tone hole. If again, the pitch preferred is A=430 one could calculate the distance by which the vertical line should be moved. By multiplying the original pitch (A=435 vibrations) with the distance from the cork, 398.38 mm, the result is 173,295.3. This outcome should be divided by the chosen pitch vibrations, 430, the result being 403.01 mm. This is the distance at which the A hole in the new pitch (A=430) should be placed. If the difference between the two lengths should be measured, the outcome would be 4.63 mm.

Even though *The Schema* seems to be the perfect guide to flute making, it has its limitations. For instance, it does not allow the flute to tune sharper than the given

pitch. However, Boehm made his tuning slides 2 mm shorter to allow the required flexibility of tuning. It doesn't allow for holes of different sizes, and it leaves out the small holes for upper C♯, and the trill keys. These defects of this otherwise brilliant diagram, and the fact that there was little demand for it, have made people conclude that Boehm had another motive in mind when publishing it. He was trying to prove his innocence in the controversy described in the next chapter.

Boehm vs. Gordon

A question of whether the Boehm flute really was Boehm's invention was raised in Paris in 1838. Victor Coche, who had been among the first to play the Boehm flute, wrote to Boehm, 25th of May, 1838: "They say in musical society, that the flute which bears your name, was discovered by a person of the name of Gordon, an old pupil of Drouet[11]."[12]

Captain William Gordon was a Swiss of English decent, an amateur flute player, who had served as officer in the Garde Royale of Charles X. He was pensioned after the king's abdication in 1830, and is thought to have been mentally disturbed after the Louvre massacre of July 1830. He, like Boehm, was fully aware of the deficiencies of the contemporary flute and was working on improving it. He lost his reason in 1836 and was placed in a mental institution, where he is believed to have died two years later.

His first acquaintance with Boehm was in 1831 when the latter was performing in London. Gordon, like Boehm, had previously had ideas of improving the contemporary flute, and had already designed several flutes by 1826. He made an instrument in 1826 based on an open-keyed system and using touch-pieces to control distant holes (both invented by Heinrich W.T. Pottgiesser in 1803). These features formed the basis of the modern flute. Even if these innovations had a positive effect on the flute, his mechanism was an awkward one.

During Boehm's stay in London, they showed each other their improved instruments (Boehm most likely showing him his 1831 model). Gordon's flute had

[11] Louis Francois Philippe Drouet (1792 – 1873), a famous French flute player of the Beethoven period.
[12] *History of the Boehm Flute* by Christopher Welch p. 33

"a number of keys and levers, some of which were ingeniously devised; but they were much too complicated, and of no use, as the instrument wanted throughout a correct acoustical basis."[13] Boehm had for a long time had the impression that the only way to make a flute that was in tune and had a good quality of sound, was to change the system of fingering. He was reluctant to make the change, however, as it would prove difficult to persuade the musicians to learn another system after having already studied one.

When Boehm, in 1833, introduced his 1832 flute in London and Paris, Captain Gordon was among his audience. He immediately comprehended the improvement and renewed his acquaintance with Boehm. Boehm shared his system with Gordon, and from then on, Gordon's goal was to simplify Boehm's system using only eight keys where Boehm had used thirteen. He persuaded Boehm to provide him with a flute tube without the keys, so that he himself could experiment with it. Despite the failure of his attempts, his conviction that Boehm's system could be simplified did not waver.

His failures led him to contact Boehm and request the use of one of his very best workers to work on his model. Boehm replied that it would be better if he came to Munich. Gordon arrived in July 1833, and stayed until March the following year. Boehm was in London at the time, leaving Gordon with the disposal of one of his assistants. After several failed attempts, he managed to produce a well-made flute, which he called *La Flûte Diatonique* and in July of 1834 he advertised it in Paris. He produced a "Table of Fingering" in which he revealed that he used Boehm's F♯ and d" trill key with Boehm's permission. The flute had the 13 holes of the Boehm system. Five of them were left open, whereas the other eight had keys that were too complicated to be of general use.

In his bitter disappointment, Gordon withdrew to Lausanne, where he continued his experiments until his mental breakdown in 1836.

Rumours arose in both Paris and London in 1838, that Gordon had been the true inventor of the Boehm flute. The argument used, was that Boehm had stolen Gordon's idea of closing multiple keys with one finger. This accusation is entirely

[13] *An Essay of the Construction of Flutes* by Theobald Boehm p. 12

false, as this idea had been introduced by Rev. Nolan in 1808. However, the proof that Boehm didn't take this idea from Gordon lies in his 1831 model. He had already applied this feature to his flute by the time he met Gordon. In denying this accusation, Boehm made a mistake of one year when recounting Gordon's visit in 1833. This mistake strenghened people's belief in favour of Gordon. As this controversy began two years after Gordon's death, there was no way of acquiring his view of the matter. Boehm, however, wrote a detailed account of his work in *An Essay on the Construction of Flutes*, in 1847, which should prove that he is the true inventor of the Boehm flute. As previously mentioned, it is also believed that he published his *Schema* in defence of this accusation made against him.

Conclusion

The changes made to the flute in the 19th century were extraordinary. The old key system became more and more complicated, and the demands for a higher range could not be met using the standard flute. Theobald Boehm recognised its faults and decided that something should be done. He dedicated his life to improving the flute and found that he could not bring out the best tone and easiest fingering just by improving the standard system of that time, so he invented a new system. After creating the new key system and moving the tone holes around, he was still not satisfied. He was constantly aware of the flute not being all that it could be. This led him to begin experimenting with metal and studying acoustics. The result was a metal flute with a cylindrical bore that produced a clear and sonorous tone. A flute that has hardly changed in 160 years.

Boehm's researches in acoustics have influenced the development of other instruments of the woodwind family, including the clarinet, oboe and the bassoon. The key mechanisms on these instruments are largely based on Boehm's mechanism and are referred to by his name.

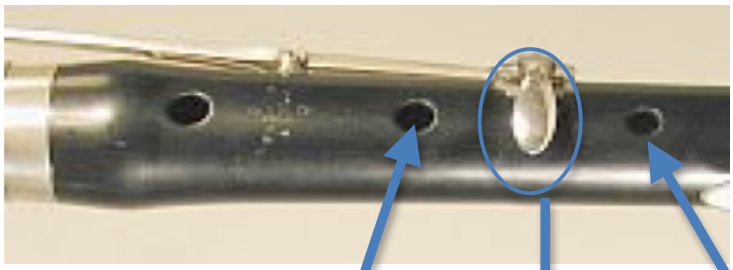
Fig. 1

Fig. 2

Four-keyed flute

Ten-keyed flute

Fig. 3



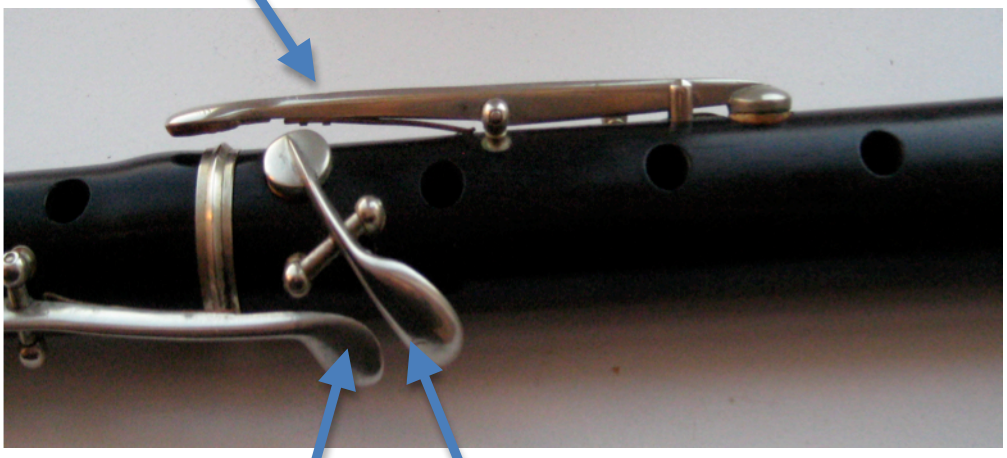
F♯ hole

E hole

F♮ key operated by right hand 3rd finger

Long C lever
Operated by right hand 1st finger

Fig. 4

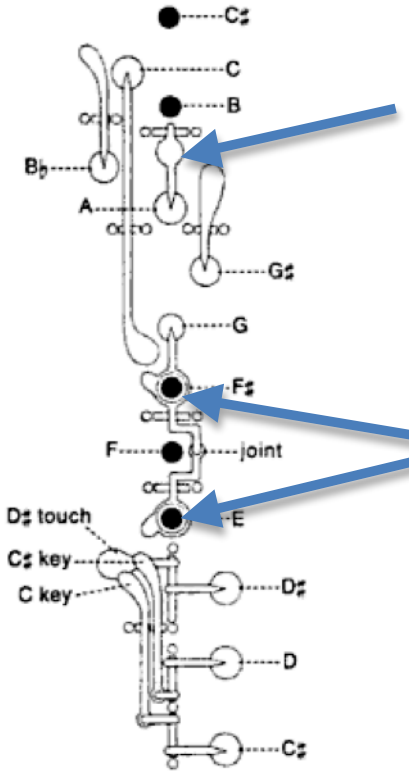


F♮ key

G♯ key

Both keys are operated by left hand little finger

Fig. 5

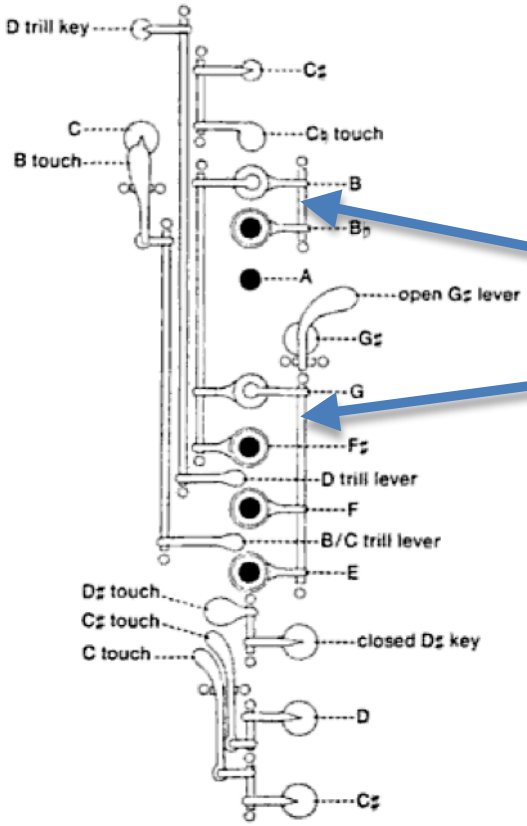


Touch piece connected to the key covering the A hole

Ring keys, both of which were connected to the key covering the G hole and could close that key independent of each other

Boehm's 1831 flute

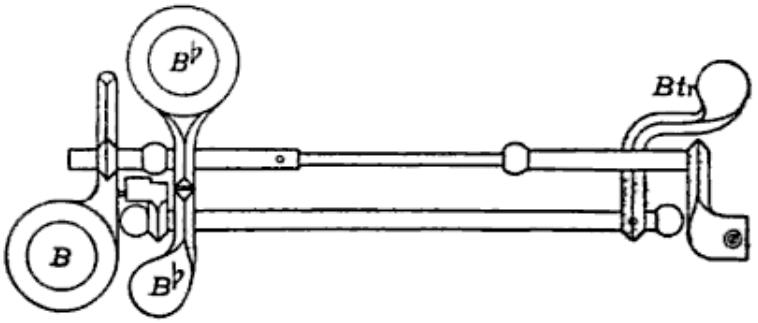
Fig. 6



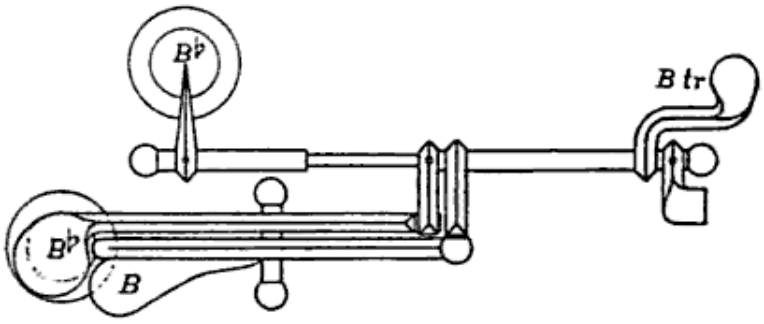
These axles were moved to the inner side by Buffet

Boehm's 1832 flute

Fig. 7



Boehm's B♭ thumb lever



Briccialdi's B♭ thumb lever

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Illustration – References

Beethoven 9th symphony – p. 14
Rut Berg Guðmundsdóttir. *Flauta í Mótun*. p. 20

The Schema (both diagrams) – p. 15
Terry McGee, Flute Maker. Flutes for Irish, Classical and Early Music
http://www.mcgee-flutes.com/index.html
4th of February 2010

Fig. 1 – Dayton C. Miller Flute Collection
http://memory.loc.gov/cgi-bin/map_item.pl?data=/home/www/data/service/music/dcmflute/0100/0152f1.jp2&itemLink=r?ammem/dcm:@field%28NUMBER+@band%280152+dcmflute%29%29&title=DCM+0152:+++Proser+/+Flute+in+C&style=dcmflute&legend=
October 2009

Fig. 2 and 3 – Rick Wilson's Historical Flute Page
http://www.oldflutes.com/index.htm November 2009
Explanation: Elva Lind Þorsteinsdóttir

Fig. 4 – Photo and explanation: Elva Lind Þorsteinsdóttir

Fig. 5 – 1831 model
Toff, Nancy. *The Flute Book. The Complete Guide for Students and Performers*
p. 51 Explanation: Elva Lind Þorsteinsdóttir

Fig. 6 – 1832 model
Toff, Nancy. *The Flute Book, The Complete Guide for Students and Performers*
p. 52 Explanation: Elva Lind Þorsteinsdóttir

Fig. 7 – Thumb lever

Toff, Nancy. *The Flute Book, The Complete Guide for Students and Performers*
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