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The deep-rooted microtonality of the bass clarinet

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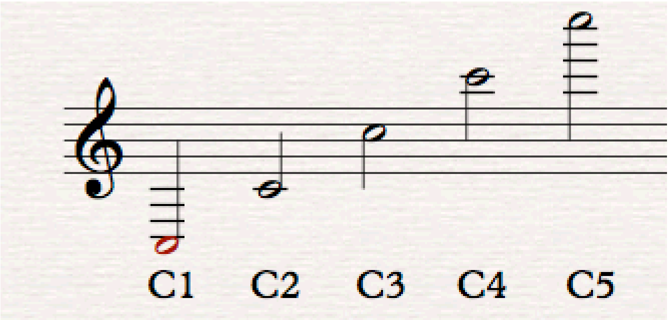
Nomenclature of the octaves

In order to clearly denominate the different octaves of the bass clarinet, the following nomenclature will be used in this study. Using French notation, transposed in B♭, and sounding a 9th lower than notated, the lowest note of the instrument is labelled C1. Each subsequent octave is then given a higher number.

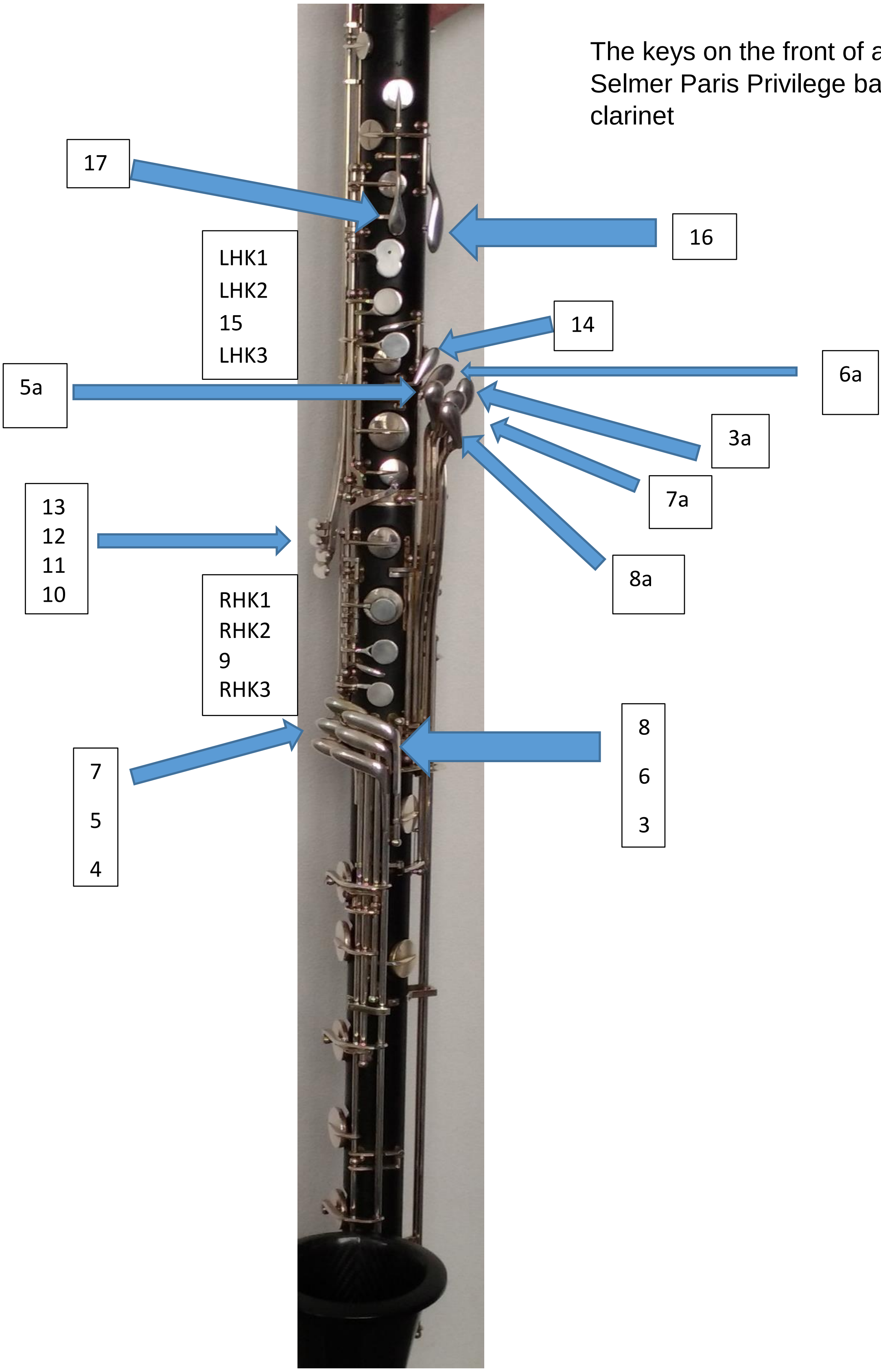


Henri Bok notation	C1	C2	C3	C4	C5

The octave designation and the corresponding pitch in C (concert pitch) is as follows:

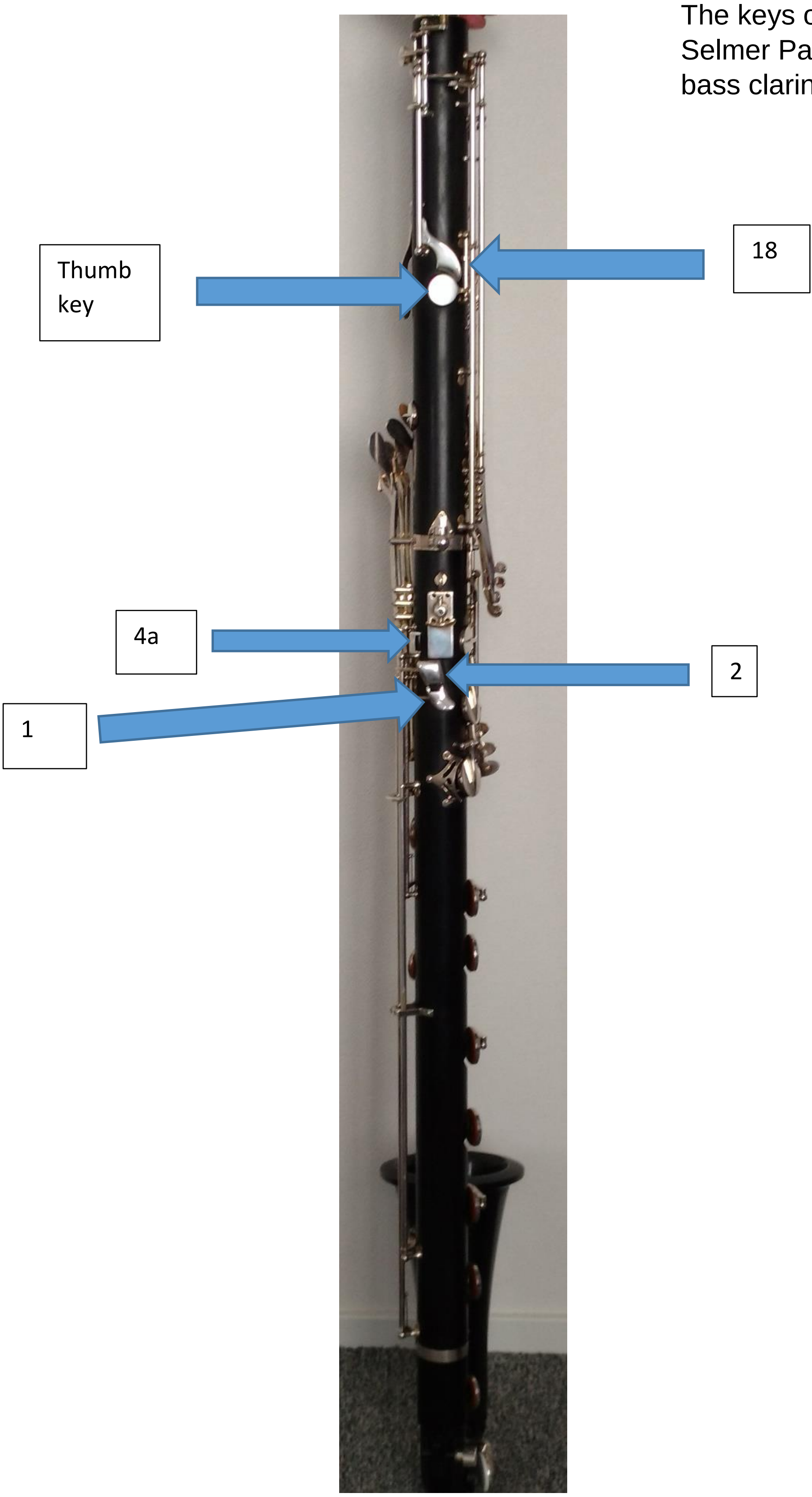
Scientific Pitch Notation	B♭1	B♭2	B♭3	B♭4	B♭5
Helmholtz Notation	B♭´	B♭	b♭	b♭´	b♭´´

Key nomenclature system



The keys on the front of a Selmer Paris Privilege bass clarinet

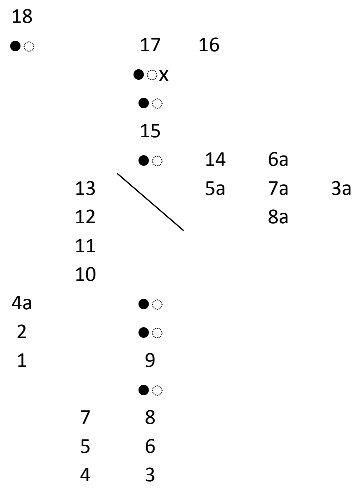
The keys on the back of a Selmer Paris Privilege bass clarinet



Key numbers and corresponding pitches for the lowest fifth to aid with the translation of fingering patterns to other bass clarinet models.

Key	Pitch
8	G♯1/A♭1
7	F♯1/G♭1
6	F1
5	E1
4	D♯1/E♭1
3	D1
2	C♯1/D♭1
1	C1

For the purpose of this research the key nomenclature system will be translated to a simple diagram in the fingering pattern charts:



The circles for LHK2, LHK3, RHK1, RHK2, RHK3, and the thumb key represent open (○) and closed (●) keys. In addition to these symbols, LHK1 also has a symbol to represent half open (x).

Glossary

31 tET see **microtonal divisions**.

altissimo the uppermost register on woodwind instruments.

ambitus the range or the distance between the lowest and highest note of an instrument.

barrel or socket is located between the mouthpiece and upper joint of the soprano clarinet and has a straight form. It is used to fine-tune the instrument. On the bass clarinet it has a curved shape and is called the neck.

bell located at the bottom of the (bass) clarinet, under the lower joint. It reinforces the sound of the lowest notes and facilitates the production of overtones. That is why the material used for the bell (metal, wood, or carbon-fibre) matters.

bisbigliando is a tremolo, often referred to as a timbral colour trill. On the bass clarinet **bisbigliando** is a tremolo between two or more harmonics of approximately the same pitch, using different root fingering patterns.

(the) break the passage from B♭2 to B2 on the (bass) clarinet which marks the exact transition from the root area of the instrument to the overtone area. To make this a smooth transition lower lip adjustment is needed, otherwise there will be a dip in the sound, the sound will 'break'.

eighth-tone see **microtonal divisions**.

embouchure the shaping and position of the lips in the playing of wind instruments.

false fingerings term used to refer to alternative fingering patterns in jazz music, frequently involving pitch change.

fundamental the lowest in a whole series of pitches, called the *harmonic series*. The fundamental is counted as the first harmonic, upon which several overtones can be produced. On the bass clarinet the area of fundamentals (roots) comprises the lowest octave plus the next minor seventh (C1-B♭2).

glissando a glide from one pitch to another.

harmonic an integer (whole number) multiple of the fundamental frequency of a vibrating object. In acoustics the basic vibration is the 'first harmonic'.

harmonic series the whole series of pitches comprising a fundamental and its natural overtones.

keywork the complete set of keys, mounted on the instrument.

microtonal divisions

> **quartertone** a microtone which is half a semitone. There are therefore two quartertones to each semitone, and four quarter tones to each whole tone. A quartertone equals 50 cents.
>
> **31 tET** 31-tone equal temperament is the tempered scale derived by dividing the octave into 31 equal-sized steps (equal frequency ratios). A 31-tone equals 38.7 cents.
>
> **eighth-tone** microtonal interval $1/8^{th}$ the size of a whole-tone, measuring 25 cents.

microtone any interval smaller than a semitone.

monophonic producing one note at a time.

multiphonic extended technique on a monophonic musical instrument whereby several notes are produced at once.

> **type 1 multiphonic** produced by embouchure manipulation of a given fundamental whereby upper partials are sounded on top of the root. The simultaneous production of elements belonging to the harmonic series of the chosen fundamental, by using standard fingerings and embouchure manipulation.
>
> **type 2 multiphonic** produced by using special (unorthodox, alternative, bastardized) fingering patterns.

multiple sound/multisound see multiphonic.

nano tones the term I have used in this study to refer to microtonal intervals of less than an eighth-tone.

neck is located between the mouthpiece and upper joint of the bass clarinet. It is curved in shape and has the same function as the barrel on the soprano clarinet (to fine-tune the instrument).

overblow using a root fingering pattern (fundamental) with an overtone lower lip position (position 2, 3, or 4) so that an upper partial from the natural harmonic series is generated.

overtone term used to refer to any resonant frequency above the fundamental frequency. It is important to note that the term ‘overtone’ does not include the fundamental frequency. The first overtone is therefore already the second harmonic or second partial.

partial (tone) see **harmonic**.

quartertone see **microtonal divisions**.

root is the fundamental frequency of a vibrating object. It is the first harmonic of a harmonic series. See also **fundamental**.

smorzando is obtained by small movements of the lower lip on the reed, similar to the jaw movements (not diaphragm) used in normal vibrato.

standard fingering patterns fingering patterns in general use for semitonal pitches.

split sound also called ‘son fendu’, a multiphonic sound comprised of only two pitches.

underblow playing an overtone with such a relaxed embouchure that it generates an isolated or simultaneous undertone.

CHAPTER 1

Introduction, parameters, and guidelines

1.1 Introduction

My first contact with the bass clarinet was in 1964, through jazz legend Eric Dolphy. I was 14 years old when I heard Dolphy, who had just died in a Berlin hospital, on the radio. His bass clarinet improvisations in *Epistrophy* (1964) contained a lot of sonic extravaganza or, in other words, extended techniques. Dolphy used the bass clarinet to its full potential, expanding its ambitus and vocabulary.

Therefore, it seems fair to say that I have been embedded in 'new sounds for woodwind' (the title of Italian composer Bruno Bartolozzi's famous book) ever since I became involved with the bass clarinet. My conservatoire studies with bass clarinet specialist Harry Sparnaay added to my fascination for the sonic potential of the instrument. When I started my own career, there were basically two paths to choose from: try to become an orchestral player, or choose a solo and chamber music career, which for a bass clarinettist automatically meant specialising in contemporary music. Duo Contemporain, the duo I started in 1980, which combined bass clarinet (and saxophone) with tuned percussion instruments (marimba and vibraphone),[1] depended solely on new pieces being written. After 20 years of existence several hundreds of pieces were at the duo's disposal.

Many composers prescribed extended techniques which meant a lot of research had to be done on techniques such as multiphonics, microtonality, and timbral variations. This personal data collection led me to write my book *New Techniques for the Bass Clarinet*, which was published in 1989 by Salabert, Paris. As mentioned, many pieces written for Duo Contemporain contained microtonality, in most cases quartertones. However, it was only when duo Hevans, the ensemble with British tenor saxophonist Eleri Ann Evans, was formed in 2006 that I developed a real fascination for microtonal playing on the bass clarinet. Evans and I share a passion for this extended technique and

[1] Evert le Mair was the percussionist of the ensemble during the first ten years. He was succeeded by Miquel Bernat.

wanted to demonstrate that several forms of microtonality are indeed possible on our single reed closed-key instruments.

A pivotal year for my microtonal research was 2014: I was invited by the Huygens-Fokker Foundation to play a concert at Muziekgebouw aan ‘t IJ, Amsterdam, in their organ series, together with Evans. This meant that in order to be able to play together with the 31-tone Fokker organ, we had to try to find fingering patterns for this uneven division of the tone, matching our instruments’ 31-tone pitches with the organ’s.

As a composer I have become more and more interested in microtonal writing and have been able to apply my growing microtonal knowledge as a performer directly to my work as a composer. The juxtaposition of contrasting microtonal systems became a clear artistic goal in my recent compositions. When writing pieces for duo Hevans, another artistic motive was the merging of the two different instruments in the context of small microtonal intervals, such as eighth-tones and 31-tones.

Highly motivated to find out as much as I could regarding the microtonal possibilities of the bass clarinet by adapting fingering patterns, I also wanted to explore another kind of microtonality, one which is ‘rooted’ in the instrument. The acoustics of the bass clarinet, the way overtones are produced on top of roots according to the natural harmonic series, made me aware of the ‘inherent’ microtonality of the instrument and the additional microtonal options it offers.

My research covers the aforementioned microtonal areas and will discuss and develop the microtonal challenges and opportunities the bass clarinet has to offer. Focussing on the different aspects of the microtonal realms I wanted to explore, and dividing the general aims of my research into subsections, I formulated the following research questions:

- Which information concerning microtonal possibilities on the bass clarinet is currently available and is this information correct?
- Is it possible to play (more) precise quartertones, eighth-tones, and 31-tones on the bass clarinet, and if possible, which fingering patterns can be established to do so?
- Is it possible to use the root-overtone system in order to expand the microtonal language of the bass clarinet and are there ways to microtonally alter the root-overtone pitches?

The research questions have been applied to a standard, unmodified bass clarinet (that is without any modifications done to the keywork). The material I used for this research comprise a Henri Selmer Paris Privilege bass clarinet (low C model), a Bok-Wiseman carbon-fibre bell, a crystal Pomarico mouthpiece model HB, a Silverstein ligature, and D'Addario Reserve reeds (strength 3.5).

All measurements were done using a Peterson Strobe tuner.

This research is practice-based and undertaken from my intertwined perspectives as a performer, composer, and improviser. It is therefore focussed on the musical and artistic aspects of microtonality. More microtonal possibilities on the bass clarinet will enrich the creative processes of bass clarinettists, composers, and other instrumentalists. The research is aimed at these fellow artists in the first instance, but with the hope that the output of creative products will reach out to audiences which are open to new experiences.

1.2 Parameters of the instrument

The bass clarinet is a single reed instrument belonging to the woodwinds, more particularly to the clarinet family. Clarinet tubes are cylindrical, unlike saxophones, which have a conical bore. Whilst many woodwind instruments, including saxophones, flutes, and oboes, over-blow at the octave, clarinets over-blow at the twelfth.

Bass clarinets come in two versions: one has E♭ as its lowest note, the other the C a minor third below this (both pitch names are transposed in B♭). As much of its core repertoire has been written for an instrument with low C, this research concerns the long bass clarinet, as it is sometimes called.

1.2.1 Transposition and music notation systems

The bass clarinet is a transposing instrument in the key of B♭. This means that the written pitch and the sounding pitch are different.

The transposition of written music for this instrument is either a major ninth or a major second higher than the sounding pitch. The exact transposition depends on the form of notation used, as bass clarinet music can be notated using three different systems.

The most common notational systems are referred to as ‘French notation’ and ‘German notation’. In French notation only the treble clef is used. The transposition in French notation is a major ninth: a note sounds a major ninth below the written pitch. The player simply reads the written pitch, as all the transposition which ensures that the correct pitches and octaves are played, has already been completed in the written score.

In German notation both the bass clef and the treble clef are used. The transposition is a major second, meaning that a note sounds a major second below the written pitch. In this notation system there is a difference between music written in the bass clef and music written in the treble clef. In the bass clef the player simply reads the written pitches, whereas in the treble clef the player is required to transpose notes up one octave.

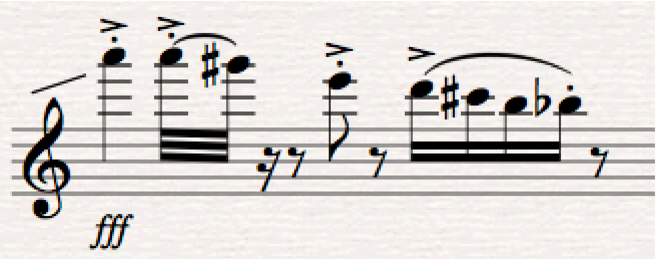



Figure 1: Téhéricsen (2016) an extract from *Progression Bureaucratique* written in French notation

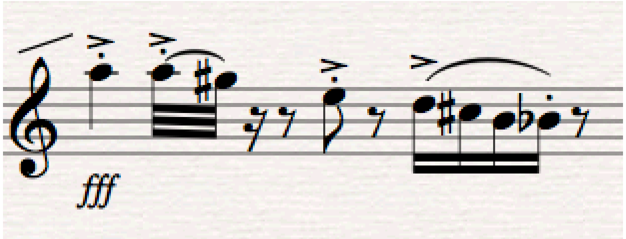



Figure 2: The same extract (Figure 1) written in German notation

Figure 1 is an extract from *Progression Bureaucratique* (2016) by French composer Fabien Téhéricsen, a composition which uses the French notation system. If this extract were to be written in the treble clef, but using German notation, the result would be Figure 2. This is because the player would automatically transpose the written pitch up one octave. Figures 1 and 2 therefore give the same sonic results although two different notation systems have been used.

Bass clarinet notation became yet more ambiguous with the advent of what is commonly known as Russian notation. This notation system acquired its name because Russian composer Igor Stravinsky used it in *Le Sacre du Printemps*. The Russian notation system combines elements of the two pre-existing notation systems: German and French. In the Russian notation system, music is written in both the bass clef and the treble clef. Despite using both clefs, as does German notation, the player is not required to transpose any notes. The player simply reads the written pitches, as all the transposition needed to ensure that the correct pitches and octaves are played, has already been completed in the written score. It can therefore be said that notes written in the bass clef use German notation and notes written in the treble clef use French notation. This combination of notational systems does however mean that notes written in the bass clef will sound a major second lower than the written pitch, and notes written in the treble clef will sound a major ninth lower than the written pitch, an aspect which can be disconcerting for the player when scores move between the bass and treble clefs. Sparnaay spoke of the French, the German, and the “confusing notation”:

> In this notation (half French and half German), the bass clarinet sounds an octave + maj. [major, HB] second lower in the treble clef (“French notation”) and in the bass clef only a major second lower (“German notation”). This will cause major confusion particularly when this is not mentioned in the score. (2011, pp.46-47)

The bewilderment caused by the different notation systems is therefore further magnified as composers do not always specify which system they are using. Knowledge of which notation system has been used is absolutely crucial in order to allow players to differentiate between the requirements of German and Russian notation.

One argument for using French notation, and for making it the preferred notation system, is uniformity. Music written for all saxophones and the vast majority of clarinets is only ever notated in the treble clef. The bass and contra-bass clarinets are the exceptions to this rule. As French notation treats the bass clarinet in the same manner as the other single reed instruments, it facilitates reading when players have to swap between different single reed instruments. Instrumental ‘doubling’ is still a frequent practice, especially in North American recording and film music studios. As American saxophonist Larry Teal remarks, “most saxophone players are expected to play clarinet, and from a commercial angle this is practically a necessity” (1963, p.96). The main reason to be in favour of the French notation, however, is that this notation diminishes the chance that music will be misread or misunderstood, leaving a player without any doubt as to which notes or octaves to play from a written score.

Some composers, such as Dutch composer and composition teacher Joep Straesser, have argued that writing notes in the higher register require too many leger lines when using the French notation system. However, the use of the 8va sign considerably decreases the number of leger lines required, thereby making life easier for both composers and performers. It is common practice to use the 8va sign for any pitches written more than five leger lines above the stave.

So, unless otherwise stated in the text, French notation will be used for the remainder of this work.

1.2.2 The ambitus

Whilst many twentieth century orchestration manuals have recommended not to write higher than F4-A4 (Adler, 1982; Blatter, 1997; Forsyth, 1937; Piston, 1955), the bass clarinet’s build allows for an immense richness in overtones. This provides the instrument with a large ambitus of almost five octaves (Figure 3).

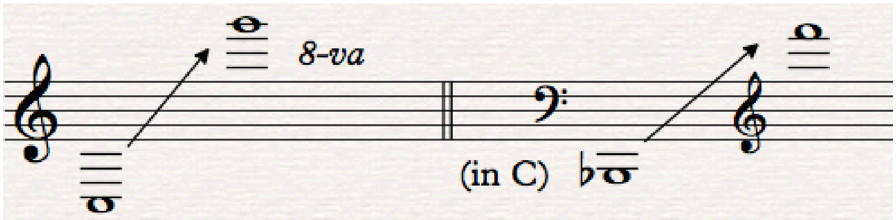


Figure 3: The bass clarinet ambitus in B♭ and in C

The pitch G5, notated in Figure 3, can be considered a reliable guideline for composers as the highest note to be used. From my many years of teaching I have found that the majority of bass clarinet specialists will not encounter considerable problems in playing the pitches up to this point, although ‘speed limits’ may apply: the complicated nature of fingering patterns and sudden changes in lower lip positions restrict the tempo at which sequences can be played. The remainder of the fifth octave, though, is risky and prone to instability. For this reason, the focus of this study has remained within the range C1-G5.

Video 1: The ambitus of the bass clarinet

1.2.3 Build systems: Oehler, Boehm, and ‘Reform’ Boehm

Oehler-system (sometimes called Albert-system) and Boehm-system clarinets are the two main clarinet builds encountered today. “Although Boehm-system clarinets are the most common, clarinettists in Germany and Austria play on Oehler-system clarinets, and there is a considerable difference in the design of the keywork and bore of the two types” (Hoeprich, 2008, p.4). A third system, the ‘Reform’ Boehm-system, which is a combination of the Oehler-system bore and mouthpiece and the Boehm-system keywork is “especially popular today in the Netherlands” (Hoeprich, 2008, p.5). The same three build systems are also found in bass clarinets. Inventor and instrument maker Adolphe Sax contributed largely to the Boehm-system bass clarinet. Both the Oehler-system and the ‘Reform’ Boehm-system bass clarinets are almost exclusively used by orchestral players, and it is quite exceptional to find bass clarinet soloists using these systems, especially in contemporary music.[2]

[2] There are exceptions, of course, such as German (bass) clarinettist Volker Hemken.

Figure 4: The Oehler-system bass clarinet (left) and the Boehm-system bass clarinet (right)

Figure 5: Necks and mouthpieces: Oehler-system bass clarinet (bottom) and Boehm-system bass clarinet (top)

This research will focus on the microtonal possibilities of the Boehm-system bass clarinet. Compared to its Boehm-system counterpart, the Oehler or Albert system, which is commonly known as the ‘German’ bass clarinet, has fewer dynamic possibilities. This is due to its bore being much narrower and its much smaller mouthpiece (about the size of an alto saxophone mouthpiece). The keywork on the ‘German’ bass clarinet also makes extended techniques, including microtonality, harder or even impossible to produce, as there is a less ergonomic placement of the keys used for the lowest third of the range, and there are fewer alternative keys.

1.2.4 Roots and overtones

With an ambitus of almost five octaves, the anatomy of the bass clarinet can be clearly delineated into two sections: that where notes are sounded using the roots or fundamentals, and that where notes are sounded using overtones of these roots.

The lowest octave plus the next minor seventh comprise all the roots of the bass clarinet, C1-B♭2, each played using a different fingering pattern. Although overtones are often associated with high or altissimo registers, the first overtone encountered on the instrument is B2. This pitch is an overtone of the root E1. It sounds a twelfth higher than the root and is overblown with the help of the register key (key number 18). From B2 up all notes are overtones and their fingerings are based upon root fingering patterns. Figure 6 illustrates the overtone series based on E1.

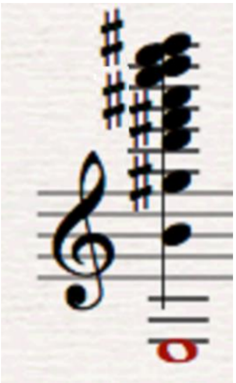



Figure 6: The overtone series of the bass clarinet based on the root E1

Whilst all the notes seen in Figure 6 are overtones of the root E1, they are not necessarily played as an overtone of the root fingering pattern for E1. As Figure 7 shows, the second overtone, G♯3, can also be produced as the first overtone of root C♯2, with the help of the register key, and the third overtone, D4, can be played as the second overtone of root B♭1.[3]

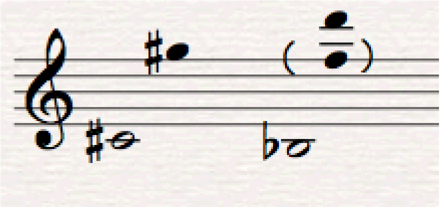



Figure 7: G♯3 based on root C♯2 and D4 based on root B♭1

For most of the notes which are played as overtones it is possible to use a number of different fingering patterns in order to produce the note. These fingering patterns are based upon the different roots which include the required pitch in their overtone series. This phenomenon is especially prevalent for the notes C♯4 and higher. For example, using different roots and overtones could provide up to 17 different fingering patterns to play C♯5 (Bok, 2011, p.11).

Video 2: Basics of the root-overtone system

The root-overtone system of the bass clarinet is of particular interest when studying its microtonal possibilities. As can be heard in Video 2, there are small microtonal pitch differences that occur when using different root fingering patterns for shared overtones. This will be the subject of Chapter 5 'The inherent microtonality of the bass clarinet'.

[3] When speaking about overtones, also in the video, the numbers given refer to the overtones which can be produced on a bass clarinet. For example, "B2, the first overtone we come across on the instrument, based on root E1" is the first overtone which it is possible to sound on the bass clarinet. This is officially called the second overtone, or the third harmonic.

1.2.5 The ‘break’

All clarinets share this feared area, and for many clarinettists going ‘over the break’ poses problems. The passage between B♭2 and B2, the exact place of the transition from roots to overtones, can cause a break in the sound continuum.

American hornist Alfred Blatter writes that “in spite of concern to the contrary, crossing the break B♭ to B is no problem” (1997, p.108). Whilst I believe that Blatter is correct, it is also important to state that the performer has to employ the right technical skills to ensure that moving across the break is not problematic. The player must not only move the fingers, but also change the position of the lower lip by bringing it forward slightly, and accompany this with a contraction of the muscles which control the diaphragm. It is a matter of awareness: players have to realize that they are entering the first overtone zone.[4] This issue is illustrated in Video 3.

Video 3: Technical aspects of going ‘over the break’

1.2.6 The lowest fifth

In the lowest fifth of the instrument, between C1 and G1, the keys are not subject to independent movement. Keys for the lower notes close the pads for any of the other notes between the desired pitch and G1. With the exception of key number 7 (F♯1), all keys close shut (rather than open), and each causes a semi-tonal change (lowering) of the pitch.

In contrast with the rich possibilities for different fingering patterns in the overtone region, the lowest fifth of the instrument is a complicated area, simply because the keywork offers such very limited possibilities for microtonal manipulation. This means that the only options for microtonal playing in this range of the instrument are embouchure manipulation or half-closing keys.

Video 4: The (im)possibilities of the bass clarinet’s lowest fifth

[4] Blatter characterized ‘throat’ tones as “quite pale and almost ‘fuzzy’ in quality” (1997, p.107).

1.3 Guidelines for the performer

1.3.1 The embouchure

A relaxed and flexible embouchure is needed in order to produce a ‘rounded’ and ‘open’ sound. This allows more freedom for the reed to vibrate, therefore allowing the overtones present in the note to sound more prominently. This is an important asset for a full sound quality.

A tight embouchure dampens the lower and middle overtones, and stresses the highest particles. This form of embouchure, which was in fashion in the beginning and middle of the twentieth century, especially in Germany and Austria, results in a metallic sound quality. Still, despite this, many sources appear to advocate a tight embouchure by using terms such as “firm”, “pushing” (Doyle, 2012-2013, p.60), “pressure”, or “compression” (Porter, 1973, p.17), when explaining its necessary qualities.

1.3.1.1 The lower lip: pressure versus position

When writing my book *New Techniques for the Bass Clarinet* in 1989, I followed Bartolozzi’s ideas (1982, p.9) and included symbols for various states of embouchure pressure. These were: “relaxed embouchure”, “relatively relaxed embouchure”, “very relaxed embouchure”, “tight embouchure”, “relatively tight embouchure”, and “very tight embouchure” (Bok, 2011, p.3). I used these symbols in the fingering pattern charts whenever a certain amount of pressure was needed to obtain the desired result.

Many years of performing and teaching have led me to totally change my point of view. I now believe that the lower lip should have very little pressure at all times, but should, instead, take different positions on the reed according to the register or the overtone zone. The most important constituent part of the embouchure is the lower lip, and the movability of the lower lip is crucial for sonority, pitch control, and intonation.

Although, of course, sufficient pressure is required from the lips in order to form the embouchure and to keep it closed and in position when blowing, these are the only, very slight amounts of pressure, which might occur. The main factor in obtaining the desired pitch throughout the whole ambitus of the instrument is controlling lower lip positions.

Notes for which open fingering patterns can be used are good examples to illustrate the notion of lip position.

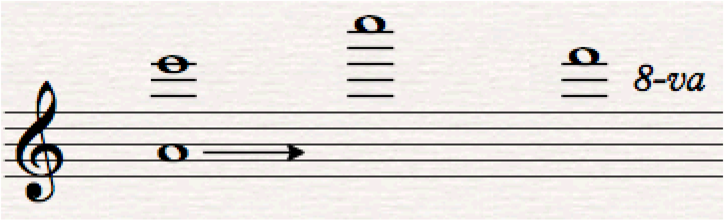


Figure 8: Four different pitches using the fingering pattern for A2

The four notes in Figure 8, A2, E4, C5, and F5, can all be played by moving/re-positioning the lower lip when using the same fingering pattern. Pitch A2 is played using a root fingering pattern, as it falls within the lowest octave plus a minor seventh of the bass clarinet. It is played by opening key 17 with the left hand index finger. The embouchure is in its natural, basic position, referred to here as position 1. The next note in the sequence seen in Figure 8 is the first overtone (or the third harmonic) of A2. In order to play E4, it is necessary to move the lower lip slightly forward (position 2). The same process is followed to generate C5 (position 3), and finally F5 (position 4). The lower lip position changes whilst the fingering pattern remains the same for all four notes.

Video 5: Lower lip positions

Practising the different lower lip positions helps to develop muscle memory, thereby enabling the bass clarinettist to produce any note from the above sequence easily and quickly.

Notes played in the overtone registers often make use of key 18 (the register key), but this is not strictly necessary. As has been demonstrated, overtone production largely depends on the correct position of the lower lip. This means that, with a correct lower lip position, notes in the overtone register can be played without using the register key.

1.3.1.2 Different forms of embouchure manipulation

Despite my belief that it is changes to lower lip position and not to lower lip pressure which allow players to reach different notes of the overtone series, there are occasions when it is necessary to make other changes to the basic embouchure, or to combine a change in lower lip position with another form of embouchure manipulation. These changes enable the player to achieve certain effects or extended techniques.

One of these techniques is vibrato. “Given the fact that vibrato is currently an essential part of sound production for the other woodwinds, it might seem difficult to avoid on the clarinet” (Hoeprich, 2008, p.233). However, despite its use on other instruments in the western music tradition, the clarinet is the only woodwind instrument for which vibrato does not form part of its current playing technique practice. Whilst vibrato is not generally used by clarinet players in German-speaking countries (Hoeprich, 2008, p.169), in Eastern and Southern Europe vibrato is often used as an expressive device. Czech bass clarinettist Josef Horák, for example, took the use of vibrato one step further, and made constant and consistent use of it in his playing.

Vibrato is obtained through embouchure manipulation. By slightly moving the lower lip and lower jaw in a vertical direction, microtonal inflections are created. The speed of the vibrato can be altered, suddenly or gradually; a musical element often encountered in contemporary scores.

In section 1.3.1.1 changes in lower lip position were shown to enable the player to produce different notes from an overtone series based on A2 (Figure 8). Further embouchure manipulation, putting the lower lip in an ‘in between’ position, that is, between position 1 and 2, allows the performer to play a multiphonic, or multiple sound, of the overtones based on a single root fingering pattern. This is called a ‘type 1’ multiphonic.[5]

It is also embouchure manipulation, by moving the lower lip forward or back, going along the different positions or ending up in the middle of two positions, which allows the performer to sound different overtones more prominently whilst continuously playing a multiphonic, and to glide/gliss between the different overtones.

[5] I introduced the term ‘type 1’ multiphonic (and similarly ‘type 2’ multiphonic) in my book *New Techniques for the Bass Clarinet*, but it is now a generally accepted term (for example, see Watts, 2015).

Finally, embouchure manipulation aids in the production of ‘type 2’ multiphonics,[6] multiphonics produced by special fingerings. To generate this type of multiphonic the embouchure is commonly required to relax to a greater extent and to make minuscule changes in lower lip position.

Gliding or glissandi, as demonstrated in Video 6, can also be applied to individual notes (monophonic sounds): the embouchure can be manipulated to lower the pitch of a note. This generates lip glissandi or portamenti. Smorzando is yet another example of embouchure manipulation. A quick and regular embouchure movement will create the smorzando’s characteristic ‘wa-wa’ sound.

This section has highlighted the fact that the embouchure must be manipulated to enable the player to generate many different notes or effects on the instrument. Whilst small lip adjustments allow the player to improve the intonation of any note, embouchure manipulation is of the utmost importance for microtonal playing.

Due to the acoustic design of the bass clarinet, which determines the inherent characteristics of the instrument’s harmonic series, all notes of the overtone series are microtonally varied from equal temperament tuning. It has already been shown that changes in lip position allow the playing of different notes from the overtone series. However, it is also embouchure manipulation which allows notes to be sounded from irregular fingering patterns, as illustrated in Figure 10.

For example, the fingering pattern in Figure 9 is based upon the standard fingering pattern for G3, but by closing RHK3 using the right hand ring finger (Figure 10), the G3 would be raised to a G♮3 (31-tone).

[6] See footnote 5.

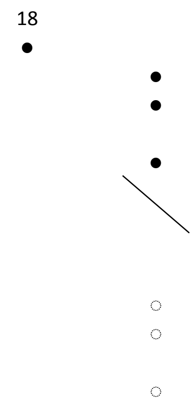


Figure 9: Standard fingering pattern for G3

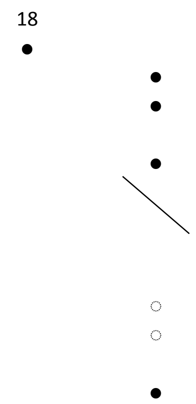


Figure 10: Fingering pattern for G𝄲3 (31-tone)

If the position of the lower lip is not correct, and the basic embouchure is not manipulated in the correct way, the microtonal note will not sound or will squeak (Video 6). Such changes to lower lip position and manipulations of the embouchure can be minute, or extreme, in the case of microtonal work.

The various forms of embouchure manipulation spoken about—vibrato, glissando, portamento, smorzando—can also be applied to microtonal fingering patterns. For example, a glide or gliss can be applied from one (fingered) microtone to the next. In areas where the keywork does not allow for variations to fingering patterns, and in the root register of the instrument, one of the available options for microtonal adjustments is embouchure manipulation (lipping notes down). Such microtonal (mini) glissandi/portamenti work well in this register, including on the lowest note of the instrument, C1, which can be brought down in pitch by relaxing the lower lip.

Although the lack of precision that some of the techniques allow for, means that these options are not valid where strict microtonal practice (such as quartertone or 31-tone divisions) is required, they do allow some forms of microtonality where it is not possible to apply other techniques.

Video 6: Forms of embouchure manipulation

1.3.2 Breathing and blowing

As British brass player and dental surgeon Maurice Porter writes, “trained musicians learn how to control, within certain limits, the degree of pressure and the rate of flow of breath as well as the rate of inspiration and expiration” (1973, p. 71). Whilst it might seem self-evident that ‘wind’ players need maximum control of the air they blow through their instrument in order to make it sound, one of the phenomena I have come across most frequently when teaching, is that performers change their air flow unnecessarily. For example, when they tackle difficult technical passages, they simply ‘forget to blow’. The players are then confronted with dips in the sound and an unstable sonic result.

When playing a wind instrument the air should always be in motion and the air flow should be controlled. As American oboist James Lakin writes, “the quality of the resulting sound depends, in large part, upon the degree of control which he [the wind instrumentalist, HB] is able to exert upon the expiratory mechanism” (2012-2013, p.30). The way in which air is blown through the instrument is an important variable in sound control and sound production. It is the key to a stable and flexible bass clarinet sound.

A lot has been said about the subject of air support, and the role of the diaphragm and the abdominal muscles. In his 1983 interview with music critic Kevin Kelly, American tubist Arnold Jacobs said:

> First of all, the term support raises questions in itself. Many people make the mistake of assuming that muscle contraction is what gives support. The blowing of the breath should be the support, not tension in the muscles of the body, but the movement of air as required by the embouchure or the reed. (1999, p.8)

Whilst Kelly neglects to acknowledge that there must be some movement of the relevant muscles in order to breathe in and blow out, Lakin has stated that “the performer needs to be able to affect the maximum amount of control over the muscles of expiration” (2012-2013, p.31). As a performer and teacher, I have seen that an abdominal movement whereby the sides of the body, just under the ribcage, expand during the intake of breath, supplies the right support for playing the bass clarinet. Contrary to Kelly, I believe that some level of tension in the abdominal muscle is required and provides the control needed for a stable sound production, but this tension is not of the diaphragm muscle itself. As British saxophonist John Harle writes, the diaphragm “has no conscious function in playing. It is a reflex muscle that reacts automatically to the expansion and contraction of your lungs and the movements of your abdominal wall muscle” (2017, p.149). It is fair to say that efficient and effective breathing and blowing profit from a fruitful collaboration between the lungs and the chest muscles. American vocal artist Fred Newman summarises this as follows: “They [the lungs, HB] have no ability to move or inflate themselves, but, as we breathe, they are filled with air by the contraction and relaxation of our chest muscles” (2004, p.2).

To conclude, several medical studies (for instance, Coirault, Chemla, and Lecarpentier, 1999, or Cossette, Monaco, Aliverti, and Macklem, 2008) have looked into the working and the role of the diaphragm muscle in more detail. The latter group of scientists researched breath support during professional flute playing, and at the end of their study tentatively put forward the following definition:

> Flute breath support is a mechanism to avoid the recruitment of expiratory muscles in order to decrease lung volume during playing so that they can best exert fine control over the mouth pressure modulations required for high quality playing without being encumbered

> by other tasks. This is achieved by inspiratory muscle recruitment as demonstrated by their greater electrical activation which keeps the rib cage expanded, lung volumes higher and the expiratory muscles relatively relaxed. (Cossette, Monaco, Aliverti, and Macklem, 2008, p.194)

The manner in which air is inhaled is also of considerable relevance. Observing single reed players, I have noticed that many breathe in through the corners of the mouth. This kind of 'sideways' inhalation has some disadvantages. Firstly, it is noisy, because of the small gaps in the embouchure through which the air must be taken into the body. Due to the same problem, it also takes time to breathe in using this method. The main issue, though, is that due to the noisy and slow intake of air, breathing in using this method can be shallow, that is, not using the full capacity of the lungs. An additional problem is that due to the constant contact between the lower lip and the reed/mouthpiece, it enhances a rigid embouchure.

My preferred method of taking in air is to lower the chin/jaw and breathe in 'downwards', thus allowing a deep and quick breath and each time relaxing the embouchure by disconnecting the lower lip from the reed/mouthpiece combination.

A few other factors lead to good air support on wind instruments. It is important to keep the shoulders down, in their natural position. Raising the shoulders by even just a small amount causes tension in the upper body, making it more difficult to expand the area under the ribcage to the same degree. It is also important to keep both feet on the ground. This ensures a stable base. A lack of balance, caused by 'dancing feet', can inhibit the intake of breath. This is partly because the body is required to use its energy elsewhere: if the player's weight is not centred, muscle tension is required in order to avoid falling over. This constrains the ability to expand the area under the ribcage for inhalation. The entire body of the performer should remain in balance and as relaxed as possible at all times, with the exception of the muscles which supply the air support necessary for a full and stable sound. Respecting and adopting the discussed breathing techniques will enable the bass clarinet player to optimise air management and control.

The 'air column' is the length of vibrating air in the instrument during sound production (Fuks and Fadle, 2002, p. 311). Whilst larger instruments such as the bass clarinet generally require a greater amount of airflow to create pressure waves that travel along the air column toward its end and are then reflected back to the reed, the air requirements also vary from one musical situation to the other. Changes to the amount of air and the manner in which the air is blown into the instrument can be demanded by different dynamic levels. Control of the air speed should be coupled with the right amount of air pressure. For example, in order to play louder dynamics, especially at the higher end (***ff***-***fffff***), not only is more air required, but it should also be blown through the instrument at a faster speed, usually referred to as ‘fast air’.

Whilst scientific studies of the air pressure needed to play different notes have been divided[7] (Fritz, Farner, and Kergomard, 2004; Fuks and Sundberg, 1996; Parncutt and McPherson, 2002) partly due to the complex and difficult to define and measure amalgamation of factors which result in a note sounding from a woodwind instrument, my research has been undertaken from the point of view of a player. Therefore, despite divided scientific opinion, as a player it seems obvious that air must be managed and controlled in order to play in the different registers of the instrument. For example, C1, the lowest note on the bass clarinet, is played with all the (tone) holes closed—this means that there is a greater interaction taking place between the reed and the standing waves in the air column—whereas a note such as G2 requires less air, as no keys are pressed and so fewer tone holes are closed. Perhaps not as evident is that in order to obtain good results in the fourth and fifth octaves of the bass clarinet, the air pressure should be diminished: “La pression de l’air contenu dans la bouche doit être nettement plus faible dans l’aigu et le suraigu que dans le grave” (Marchi, 1994, p.6).[8]

Air speed and air flow can be varied in order to assist performance. Much of this will be done intuitively: for example, when playing crescendo and decrescendo the speed of the air is changed by the performer accordingly in order to achieve the correct change in dynamic level.

A varied air speed can be an important tool to manage differences in dynamics, to aid legato playing, to avoid dips in the sound in the case of large register jumps, and to play accents. Air speed and air flow can also be adapted in order to obtain different effects. For example, if slow air is used to play C1 at a soft dynamic (***p***-***ppppp***) the note can be sustained for quite a long time using a

[7] There are differing points of view, for example, with regard to the question if the lower register has a higher acoustic pressure than the higher register for a given mouth pressure.

[8] “The air pressure contained in the mouth should be clearly lower in the high and altissimo registers than in the low” (Marchi, 1994, p.6).

single breath. Air control is vital for microtonal playing, in order to aid the often subtle embouchure manipulations.

1.3.3 Articulation

According to American clarinettist Phillip Rehfeldt, “articulation on wind instruments is primarily a concern of attack and release. With the clarinet, as with other wind instruments, this is controlled largely by an action of the tongue” (2003, p.10). Most of the different forms of articulation used on single reed instruments are accomplished by a tongue action.

> The tip of the tongue, at the flat surface, on the top, touches the reed, momentarily damping its vibration, causing the tone to be initiated (and sometimes terminated) in a manner consistent with the stylistic requirements of the passage. The force of the release of the tongue on the reed, coupled with the amount of blowing, determines whether the attack is loud and forceful, soft and legato, or somewhere between. (Rehfeldt, 2003, p.10)

I believe that Rehfeldt’s descriptions of ‘loud and forceful’ and ‘soft and legato’ to describe different types of attack are slightly confusing. As is his combination of two elements of playing: the force of the tongue on the reed and the amount of blowing. Whilst they are necessarily combined in order to play a wind instrument, the two factors must also be considered for their individual effects on the whole playing process.

The term ‘forceful’ can be used to refer to a style of playing, as can the term ‘legato’, although this latter term is the only one of the four which denotes a specific form of articulation. The other two terms he uses, ‘loud’ and ‘soft’, are typically used to express dynamic levels. Because ‘soft’ may also be used to refer to the manner in which the tongue articulates, replacing ‘loud’ with the word ‘hard’ might serve to clarify his remarks, as this can also be used to refer to the manner in which the tongue articulates.

In this way, a ‘legato’ attack may be ‘loud and forceful’, or hard and forceful. It could equally be played as a soft and forceful articulation (where soft indicates the dynamic level), or soft and loud articulation (where loud indicates the dynamic level). Therefore, the following discussion about different forms of articulation will endeavour to separate points about force, style, and dynamic level.

1.3.3.1 Position and part of the tongue

The position of the tongue, and the part of the tongue which touches the reed, both have an influence on the types of articulation which can be played. For instance, if a short, unaccented note is required at a low dynamic level, then it would be illogical to place a large section of the tongue against the reed. Therefore, in the following discussions, the different articulations involving tongue action will be considered, for the part of the tongue they use and the position the tongue forms for the articulation.

1.3.3.2 Staccato

Staccato is a short articulation whereby the tip of the tongue is placed very high up closing off the space between the tip of the reed and the tip of the mouthpiece. The player inhales, puts the tongue in this position, closing off the tiny opening, then opens quickly, allowing air to move through the instrument, and closes off again.

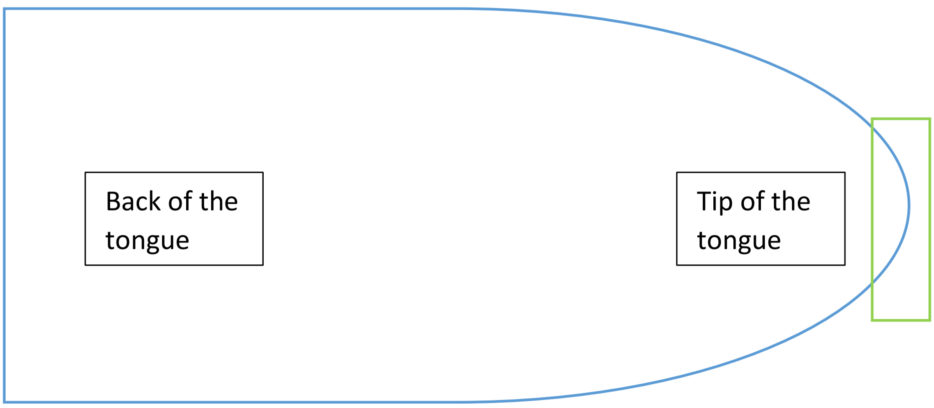


Figure 11: Diagram highlighting (in green) the part of the tongue used for staccato playing

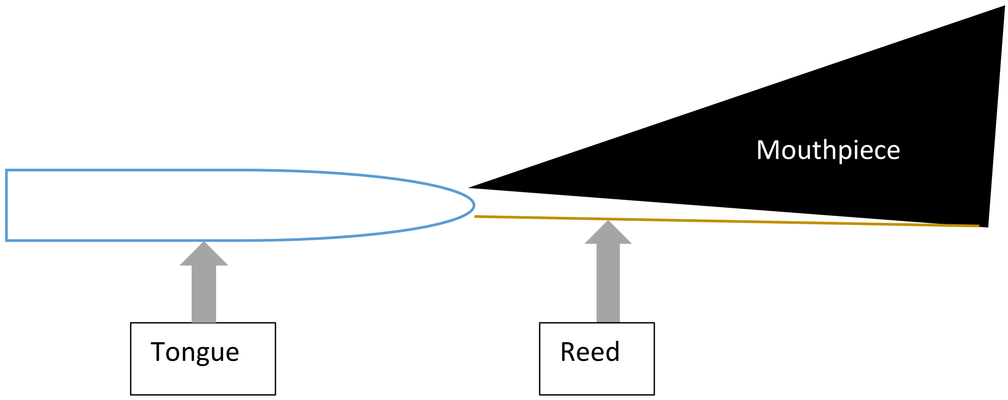


Figure 12: Diagram of the position of the tongue (against the reed) used for staccato articulation

The result is a short ‘tat’ sound. As Rehfeldt writes, “with more rapid, perhaps staccato, passages, the space between the pitches is determined by the amount of time that the tongue remains on the reed at its return for the next attack-called ‘closing off’” (2003, p.10). A series of staccatos would therefore give ‘tat tat tat tat’ as a result. Many performers will play a series of staccatos, but neglect to end the series with a closed position. This leaves the note ‘open’, giving the result ‘tatatata’, which makes the last staccato note sound longer. Since the brain tends to remember most recent events the best, the overall impression of a passage will be less staccato, or it could even be perceived as portato articulation, if the tongue is not replaced on the reed at the end of the last note.

French clarinettist Michel Pellegrino writes that: “playing staccato in the higher register is quite hard on the bass clarinet” (2009, p.9). Indeed the correct technique must be mastered, however, the examples he gives have C4 as their highest pitch. This means that most of the written notes are situated in the third octave, a register of the instrument which should not be problematic for staccato playing.

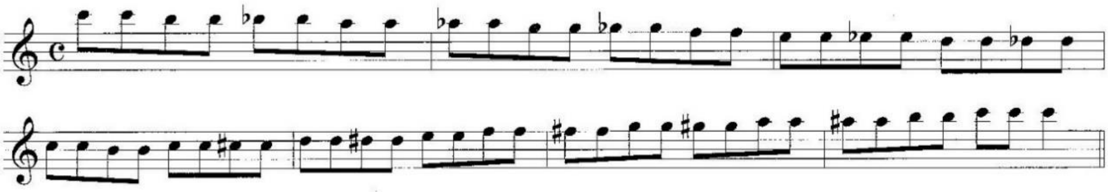



Figure 13: Pellegrino (2009, p.9), example of playing staccato in the higher register

Bringing Pellegrino's example up one octave, that is, into the fourth octave, would make it more of a challenge for staccato playing, since the tongue action could interfere with the lower lip position needed to sound altissimo notes.[9]

1.3.3.3 Portato and legato

To quote Rehfeldt again: "Wind players are taught to articulate (or 'tongue') all pitches which are not tied or slurred" (2003, p.10). However, at the start of a slurred passage the tongue *is* used to clearly time the sequence and starting a legato passage with 'air only' is not recommended.

The articulation at the start of a legato passage and the execution of portato notes is identical: the tip of the tongue is placed slightly further down on the reed than in the case of staccato.

[9] Video 7 will show the details of the altissimo/staccato combination.

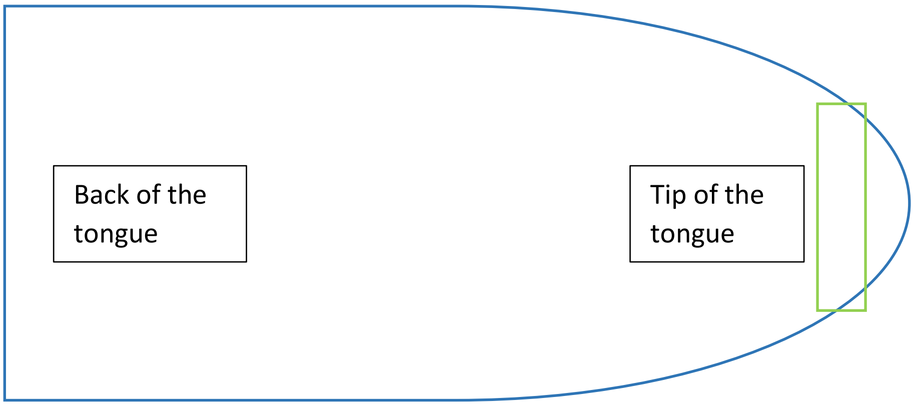


Figure 14: Diagram highlighting (in green) the part of the tongue used for portato and legato playing

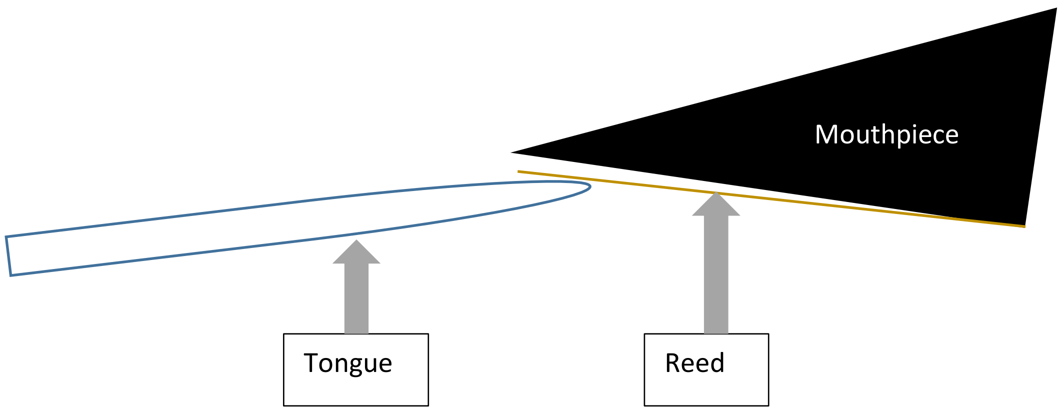


Figure 15: Diagram of the position of the tongue used for portato and legato articulation.

The result is a ‘da’ sound, more mellow than the crisp ‘tat’ sound of the staccato. With a single portato the note is left ‘open’ at the end, that is, not closed off by the tongue, simply stopping the air to stop the note. The same procedure applies to a series of portati. The last note is left open: ‘dadadada’. This is a crucial difference with staccato playing, where every note is closed off by the tongue.

1.3.3.4 Half-tonguing

'Half-tonguing' is a term usually employed to denote a form of articulation used in jazz, for which a greater portion of the tongue comes into contact with the reed. More tongue is used, and the tongue touches the reed midway (half way down the vamp of the reed, hence the terminology), so that a smoother and more relaxed articulation can be achieved. The result is a 'dud' type of sound. It could be characterized as a 'laid back' form of articulation. As opposed to portato playing, the tongue returns to the reed at the end of every note, but this is not done as completely or as precisely as in staccato playing.

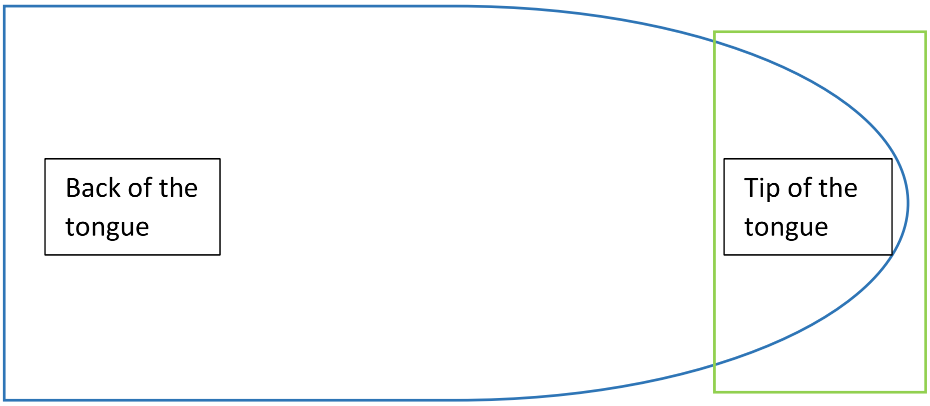


Figure 16: Diagram highlighting (in green) the part of the tongue used for half-tonguing

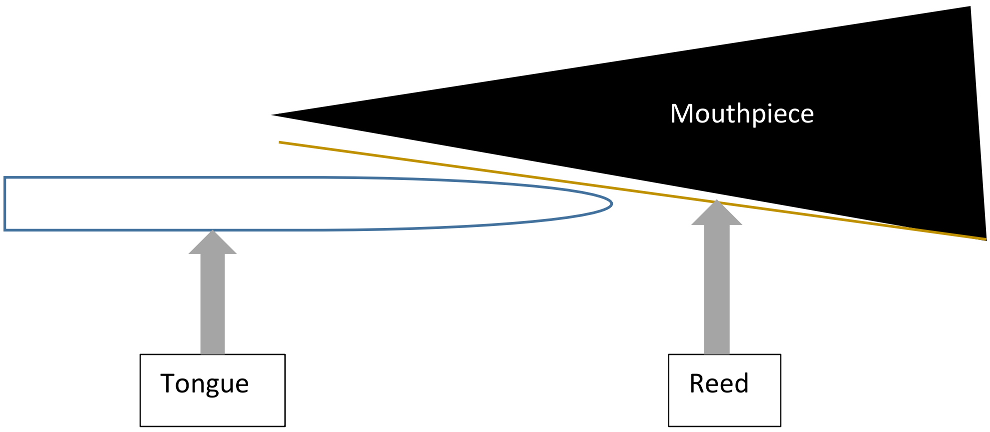


Figure 17: Diagram of the position of the tongue used for half tonguing

1.3.3.5 Slap tonguing

Slap tonguing is the next step in articulation.

> Using the tongue to press the reed against the mouthpiece is the preparation point of playing a slap-tongue….The tongue then pulls the reed away from the mouthpiece and, when the reed and the tongue part contact, the reed moves back towards the mouthpiece. (Evans, 2016, p.72)

Although Evans is a saxophone specialist, the described technique works the same on all single reeds. Even more tongue is used than in the case of half tonguing, and the tongue is pushed flat against the reed. As the tongue starts to move away from the reed, a small 'vacuum' is created. This vacuum causes the reed to move further away from the mouthpiece, together with the tongue. When the contact between the tongue and the reed is broken, a brusque, percussive sound is produced.

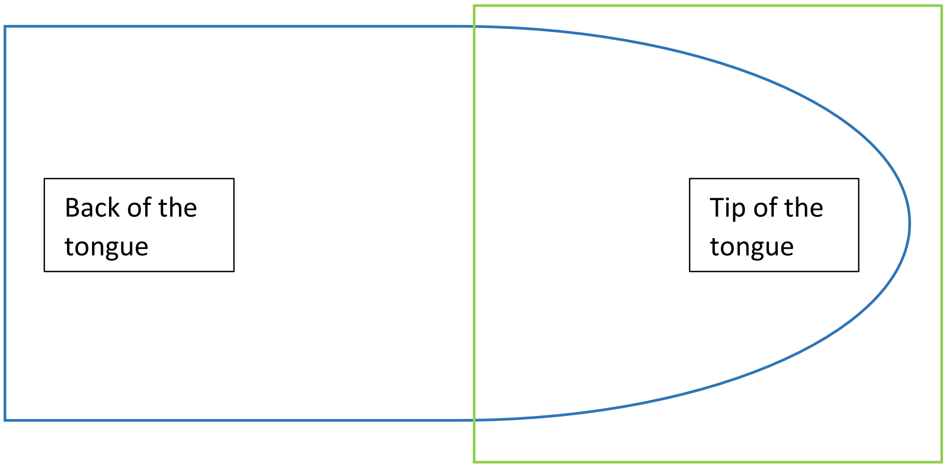


Figure 18: Diagram highlighting (in green) the part of the tongue used for slap-tonguing

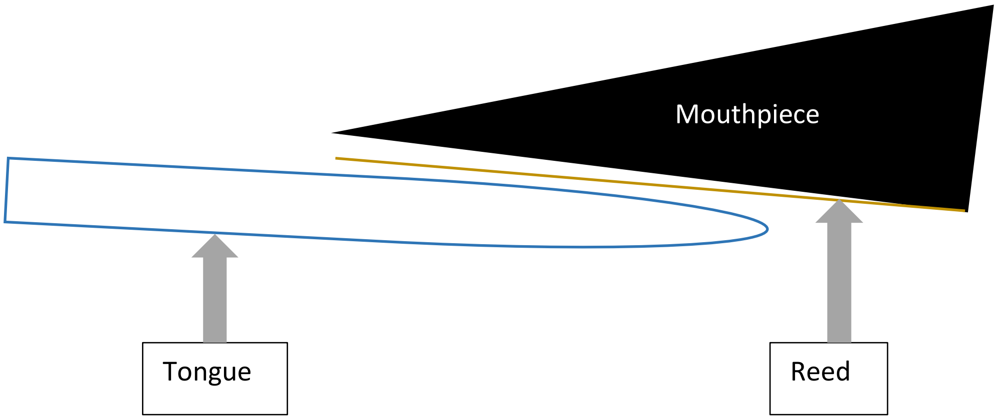


Figure 19: Diagram of the position of the tongue on the reed used for slap-tonguing

Since a tongue action is needed for the production of each individual slap tongue, it is impossible to play a sequence of slap tongues legato, a point which composers should take into account.

Whilst it is very important to realize that slap tongue is a 'dry', percussive effect in which no air is physically blown into the instrument, air can be added immediately after the slap tongue is sounded. The amount of air added to the slap tongue can be varied, so that the result can be more, or less, 'dry' and percussive.

As Evans justly remarks, "as there is no air blown through the saxophone in secco slap-tonguing, the force with which the reed moves away from the tongue is relative to the dynamic level of the sound produced" (2016, p.73).

This technique works well on bass clarinet, particularly in the low and medium registers (Bok, 2011, p.62; Rehfeldt, 2003, p.65)[10], but also functions in its higher regions. Experimenting at the time of writing *New Techniques for the Bass Clarinet*, I discovered that "from the 3rd register on it often occurs that while playing a slap tongue a multiphonic is obtained (1st type) [type 1, HB]. This supplementary 'effect' produces an extremely pleasant sound" (Bok, 2011, p.63).

A special kind of slap tongue has to be mentioned, the so-called 'open slap'. The same, basic slap tongue technique applies, but as soon as the slap sounds, the player opens the mouth, which creates a distorted sound, a barking

[10] Roughly between C1 and C3.

sound. To be more precise: “At the point when the tongue is removed from the reed, the lower jaw is dropped and the mouth opened: due to opening the mouth, this form of articulation can only be played as a short sound” (Evans, 2016, p.74).

1.3.3.6 Air only

‘Air only’ is the exception to the articulation rule: here the tone is started by blowing air into the instrument, either making the reed vibrate or not. In the latter case the result is an aeolian sound with possible pitch variations caused by pressing or releasing keys.

The main disadvantage of using air only in order to make the reed vibrate is a lack of precision: the timing of the resultant pitch is hard to control and often the note ‘speaks’ too late. Therefore, starting a note without the help of the tongue, is a rare phenomenon.

However, playing low notes on the bass clarinet, at very soft dynamics, could benefit from this kind of articulation. There are also occasions when the quasi imperceptible appearance of the sound could add to the musical expression.

1.3.3.7 Articulation and microtonality

All the different forms of articulation that have been discussed here can be applied to microtonal playing, with greater or lesser success. Staccato playing can be difficult, but ‘air only’ can allow the player to sound pitches using microtonal fingering patterns, that would be nigh impossible to play using any form of tongue articulations.

With closed slap tonguing, it can be difficult to sound the desired pitch, which could result, as we have seen above, in a multiphonic, that is, the desired pitch plus overtone(s) sounding simultaneously. Open slap tonguing causes microtonally modified pitches to sound for each fingering pattern used. As Swiss saxophonist Marcus Weiss and Italian composer Giorgio Netti indicate: “Because the embouchure is opened to produce the open slap, the vibrating tube is shortened by approximately the length of the mouthpiece. The sounding pitch does not correspond to the fingered tone but is somewhat higher” (2010, p.143).

Video 7: Different forms of articulation

1.4 Summary and conclusions

The information provided in this chapter is not, at first glance, specific to microtonal playing on the bass clarinet, but the techniques detailed here and in Videos 1-7 are aspects of playing which all require further development and refinement in order to be able to play microtonal music.

An understanding of the root-overtone system and the way the bass clarinet overblows, producing the upper partials which constitute the instrument’s harmonic series, is crucial for the creation and production of the inherent microtonality of the bass clarinet, the subject of Chapter 5.

My explanation and demonstration that the lowest fifth of the instrument offers very little in terms of special (unconventional) fingerings lead to a better understanding of the absence of microtonal options in this area (C1 to G1) and its first overtone zone (B2 to D3).

Showing how to manipulate the embouchure, and how to use the correct lower lip positions, paves the way for the right amount of flexibility needed for successful microtonal playing.

Proper breathing, the right air management, and abdominal muscle control are all essential for a good sound and an efficient technique, elements which are truly indispensable with regard to microtonal performance.

Finally, a closer look at all the different forms of articulation enhances the desired microtonal results, which depend on a more refined application of articulation techniques.

The next chapter will look at the history of the bass clarinet and its repertoire, demonstrating the influence that the evolution of the instrument and its keywork has had on the microtonal possibilities of the bass clarinet models currently in use.

CHAPTER 2

Historical aspects

2.1 Introduction

The bass clarinet has developed, through a variety of shapes and models, from a rather primitive into a very sophisticated musical instrument. The current bass clarinet types owe their advanced keywork for a large part to Adolphe Sax, who made the improvement of the bass clarinet his first project. The many keys and alternative keys at the disposal of today’s performers make microtonality a viable option. Giving the bass clarinet a historical context will help to show the importance that the development of the instrument and its keywork has had on the microtonal possibilities.

Another historical aspect to look at is the development of the solo and chamber music repertoire of the bass clarinet. Few early pieces exist, and it was not until the 1960s and 1970s that the instrument’s repertoire started to grow rapidly. Attracted by the vast array of sound variants the bass clarinet was capable of, composers included extended techniques in their works, so microtonality became part of the new bass clarinet language as early as 1964 and has played an important role ever since.

2.2 Invention and development

The bass clarinet was a rather late arrival in solo and chamber music: it was only in 1955 that the first bass clarinet recital was given, by Josef Horák, in the Czech Republic. However, the instrument was invented in the eighteenth century.

As American clarinettist Eric Hoeprich writes, “from the moment of the clarinet’s inception, various types of bass clarinet appeared, pitched an octave below conventional clarinets, in C and B flat, in a variety of shapes and sizes” (2008, p.259). German instrument collector Günter Dullat (2001), Hoeprich (2008), instrument collector Johan van Kalker (1997), British clarinet expert F. Geoffrey Rendall (1978), British clarinettist Albert Rice (2009), and Sparnaay (2011) all agree that early forms of the bass clarinet appeared in the second half of the eighteenth century. A few early instruments can be found in museums (Brussels, Florence, Paris, Munich, et al.), but many of the earlier models were unmarked or unstamped, and as Rice states, “the earliest attempts to construct a bass clarinet are designated prototypes” (2009, p.252).

Although Rice believed that the earliest term used to describe the instrument was “Baßclarinetten in a 1791 review of Forkel’s *Musikalischen Almanachen*” (2009, p.250), the first time a bass clarinet is referred to in writing, is in the Parisian journal *L’Avant Coureur* on May 11, 1772: mention is made of a ‘Basse-Tube’ or ‘Basse de Clarinette’ invented by le Sieur G[illes] Lot.[11] According to the article this bass clarinet had a considerable ambitus (a full three and a half octaves) and was designed to be played as both a solo and an orchestral instrument (Rendall, 1978, p.139). However, the instrument has not been preserved (Kalker, 1997, p.111).

Looking at the shapes and the names of the bass clarinets developed in the second half of the eighteenth and the first half of the nineteenth centuries, it is a real kaleidoscope: “In fact, eighteenth- and nineteenth-century bass clarinet designs are more diverse than any other woodwind except perhaps the basset horn” and “the variety of names applied to the bass clarinet is impressive” (Rice, 2009, p.250). An assortment of picturesque names are attributed to the bass clarinet: basse guerrière, clarone (still in use as synonym for clarinete baixo in Brazil), bassorgue, polifono, bass clarone (a pleonasm), glicibarifono, clariofon, bimboclarino, and the list goes on. “By about 1860, the name was standardized for use in published music scores and books as Bass Klarinette (German), basse clarinette (French), clarinetto basso (Italian) and bass clarinet (English)” (Rice, 2009, p.252).

Rice writes extensively and in great detail about the early days of the bass clarinet. He has documented the prototypes and early attempts to build a bass clarinet according to the different shapes found (2009, pp.252-322).[12] Rice categorizes them as:

- plank shape (the oldest shape encountered)
- curved or basset horn shape (the Mayrhofers’ model)
- the bassoon shape (with the Grenser’s models as the best-known examples)
- the serpent shape (used by the Italian Papalini)

[11] Mr G[illes] Lot
[12] Dullat (2001) also subdivides the different makes and models according to the different shapes.

- the straight or clarinet shape (the shape that was to become the standard from the second half of the eighteenth century)
- the Ophicleide shape (model used by Widemann, Buffet, and Martin Frères)

According to Kalker "ein weiteres wichtiges Datum für die Entwicklung der Bassklarinette ist das Jahr 1807. In diesem Jahr konstruierte der Uhrmacher Desfontenelles (Lisieux, Frankreich) eine primitive **Bassklarinette** (die erste in der heute gebräuchlichen geraden Form)" (1997, p.115).[13] This model bass clarinet can be said to resemble a saxophone, as it has an upturned bell and a curved barrel. It has been described as a *clarinette à perce conique* (Pierre, 1890, p.50),[14] but "the conicity is only very slight, so it can be considered a true clarinet, and probably the earliest extant straight-model bass [clarinet, HB]" (Hoeprich, 2008, p.262). Whilst the design of this instrument hints at the parabolic cone of Sax's saxophone design, the instrument overblows at the twelfth (as do clarinets), and not at the octave (like the saxophone).

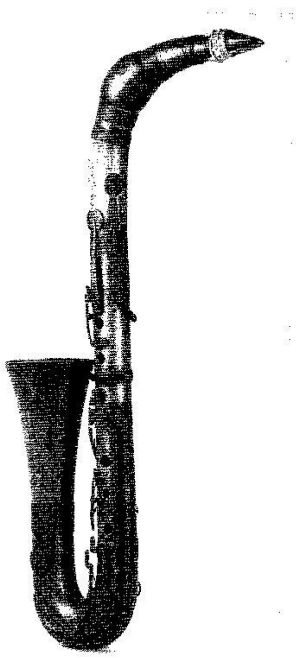


Figure 20: Hoeprich (2008, p.261), image of Desfontenelles's bass clarinet

[13] "Another important date for the development of the bass clarinet is the year 1807. In this year clock maker Desfontenelles (Lisieux, France) constructed a primitive **bass clarinet** (the first in the nowadays customary straight form)" (Kalker, 1997, p.115).
[14] A clarinet with a conical bore.

The collaboration between clarinettist Isaac François Dacosta and Paris instrument maker Louis Auguste Buffet, also called Buffet jeune [the younger, HB], resulted in the production of a clarinet-shaped bass clarinet, later used in Giacomo Meyerbeer's opera *Les Huguenots*. Buffet jeune greatly improved the keywork of both the soprano clarinet and the bass clarinet, by adapting the Boehm system to the clarinet. His instruments were 13 or 14-key straight-shaped bass clarinets, made of rosewood. The model from circa 1834 had a straight, rosewood bell, whilst later models had metal bells. "The evidence of a second register key suggests the influence of Adolphe Sax's bass clarinets" (Rice, 2009, p.288) on Buffet jeune's instruments, as Sax's bass clarinets all included a second register key.

2.3 Adolphe Sax

Antoine-Joseph Sax, better known under his adopted name Adolphe, can be considered one of the most brilliant and creative instrument makers ever. He is, of course, most famous for his invention of the saxophone, but "it was to the clarinet that he first applied his brains and mechanical skill" (Rendall, 1978, p.144). Sax is the person accountable for the "most important advances in the evolution of the bass clarinet" (Rice, 2009, p.291).

Working in his father's instrument workshop, Sax made his reputation as an inventive and excellent instrument maker with his first project: the construction of a *nouveau système de clarinette-basse* (new bass clarinet system). With his new, straight model 21-key bass clarinet, Sax succeeded in solving two major problems that prior bass clarinet models had: poor intonation, and an uneven sound quality between the different registers. In order to improve these issues Sax conceived a second register key, which also facilitated playing altissimo notes. Rendall has said that not only was the range increased at the top by the second register key, but that it also allowed the highest notes to come out more easily (1978, p.144), an invention that players around the world still benefit from every day.

Sax's model bass clarinet required a completely new key operating system, but Sax had the knowledge and the technical facilities to concretize his ideas. The 1838 model was the first bass clarinet model where the tone holes were covered by keywork. "La nouvelle clarinette [basse, HB] de Sax offrait une plus grande justesse dans toute l'étendue de l'instrument par l'emploi généralisé de clefs qui lui permettaient un emplacement mieux calculé de trous, sans devoir tenir compte de l'écartement des doigts" (Haine, 1980, p.47).[15] The instrument's bore was wider than the bore of its predecessors and contemporaries, in order to have "a deep and strong tone quality" (Rice, 2009, p.304). Rice summarizes eight more design elements which, combined together, "led to a greater resonance of sound, evenness of tone, security in blowing, security in fingering, and accuracy of intonation" (2009, p.304).[16] Finally, Belgian saxophonist Jean-Pierre Rorive mentions an extremely important innovation: "Il [Sax, HB] dote l'instrument d'un système compensateur qui permet dorénavant les sons glissés ou 'portamento' ainsi que des trilles jusque-là irréalisables" (2014, p.25).[17] This technical modification opened up the microtonal possibilities of the instrument by allowing pitches between the semitones.

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[15] "Sax's new [bass, HB] clarinet offered better intonation in all the instrument's registers by the generalized use of keys which facilitated a better calculated placement of the holes, without the necessity to take into account the spreading of the fingers" (Haine, 1890, p.47).

[16] These are: (1) large tone holes with corresponding key heads; (2) wide bore; (3) large finger holes covered by conveniently placed wide plateau and open standing keys; (4) the placement of the first register key on a raised metal platform and the second register key with a small pinhole on a metal platform on the front side of the brass crook; (5) use of a large brass, rounded saddle to secure the long levers of the F♯/C♯ and E/B keys; (6) redesign of a large-size mouthpiece with a socket having a brass ferrule at its end, requiring a large reed and a two-screw brass ligature; (7) redesign of key heads in a flat and rounded form; (8) inclusion of a large brass thumb rest with a ring attached to the upper end, designed for a neck strap.

[17] "He [Sax] provides the instrument with a compensating system which from now on makes glissandi or 'portamento' possible, as well as trills unable to be played until then" (Rorive, 2014, p.25).

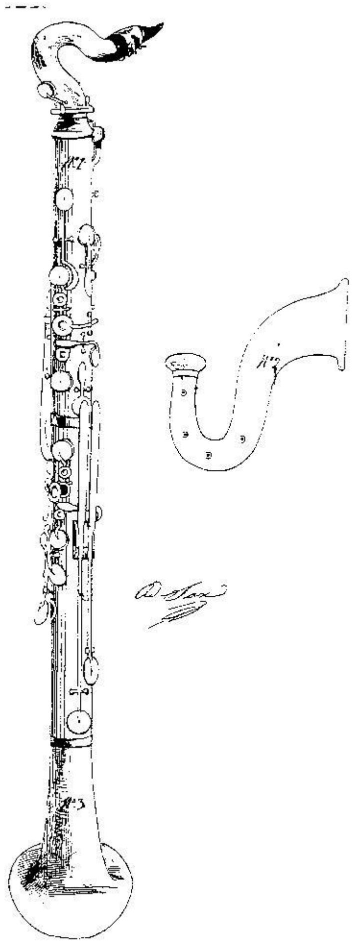

Figure 21: Hoeprich (2008, p.265), Belgian patent drawing for a new bass clarinet by Adolphe Sax (Brussels, 1838, Belgian patent 21.06.1838, Nr. 3739/1051)

Due to his technical innovations it is no wonder that composers of Sax's era became very interested in his improvements of the clarinet and especially the bass clarinet. Meyerbeer, Gaetano Donizetti, Gioachino Rossini, and François Antoine Habeneck were great supporters of Sax's inventions and modifications. They were captured by the wonderful sound, the perfect intonation, and the technical possibilities of Sax's bass clarinet. In December 1843 Meyerbeer visited Sax's workshop and was amazed by the sound of his bass clarinet (Rorive, 2014, p.35).

Hector Berlioz, quite possibly Sax's most fervent supporter, wrote:

> La nouvelle Clarinette Basse de M. Adolphe Sax est bien plus perfectionnée encore. Elle a 22 clés.[18] Ce qui la distingue surtout de l'ancienne c'est une parfaite justesse, un tempérament identique dans toute l'échelle chromatique et une plus grande intensité de son. Comme le tube est fort long, l'exécutant étant debout, le pavillon de l'instrument touche presque la terre, de là un étouffement très fâcheux de la sonorité, si l'habile facteur n'eut songé à y remédier au moyen d'un réflecteur métallique concave qui placé au dessous du pavillon, empêche le son de se perdre, le dirige où l'on veut et en augmente considérablement le volume. (1844, p.150)[19]

Unfortunately, none of the reflectors designed for sound projection and to increase the volume of the instrument have survived (Rice, 2009, p. 293), but they could be considered as predecessors of the curved bell.

With his designs Sax set the standard for the instruments still in use today. As mentioned above, Sax enlarged the ambitus and facilitated the higher registers by using a second register key. But Sax was not only a great instrument maker and inventor, he also was a skilled performer. It is noteworthy that "Sax indeed played up to e'''' [E5, HB] in the presence of Meyerbeer" (Rendall, 1978, p.147). French critics and music publishers Marie and Léon Escudier—les frères Escudier—acknowledged that Sax "est devenu un virtuose très-habile"[20] on the bass clarinet and that the instrument "n'embrasse pas moins de trois octaves et une sixte dans son étendue ordinaire"[21] (1854, p.185).

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[18] This is quite possibly a mistake: Sax's new system bass clarinet had 21 keys.

[19] Mr Adolphe Sax's new Bass Clarinet is even more improved. It has 22 keys. What distinguishes it especially from the old, is a perfect intonation, an even sonority in the overall chromatic scale and a bigger intensity in sound. As the tube is very long, the bell of the instrument almost touches the ground, when the performer plays standing, which would result in a very nasty dampening of the sound, if the skilled manufacturer had not thought to solve that problem by means of a concave metal reflector which, placed under the bell, prevents the sound from getting lost, directs it where required and raises the sound volume considerably. (Berlioz, 1844, p.150)

[20] "has become a very skilled virtuoso" (L. Escudier and M. Escudier, 1854, p.185).

[21] "comprises not less than three octaves and a sixth as its usual ambitus" (L. Escudier and M. Escudier, 1854, p.185).

2.4 Early players and repertoire

Meyerbeer was one of the first composers to write a substantial bass clarinet solo part. It appears in the fifth act of his opera *Les Huguenots* and was first performed on February 29, 1836. This bass clarinet feature was inspired by the collaboration between Buffet jeune and Dacosta. The Buffet jeune bass clarinet was used in the many performances of this successful opera by the Orchestre de l'Opéra de Paris' principal clarinettist Franco Dacosta (Hoeprich, 2008, p.264; Rice, 2009, p.348). For 25 bars the bass clarinet is the only instrument to accompany three singers, and in the 'molto maestoso' introduction "Meyerbeer boldly writes an arpeggio from e [E1, HB], the lowest note of Buffet's bass clarinet, to its highest practical note of g3 [G4, HB]" (Rice, 2009, p.349): an ambitus of three octaves and a minor third.

Some sources, including Hoeprich (2008, p.271), consider Meyerbeer to be the first composer to introduce the bass clarinet into the orchestra, but it was in fact Saverio Mercadante (1795-1870). He wrote a long solo for the bass clarinet in the second act of his opera *Emma d'Antiochia*. This work was premiered on March 8, 1834, two years before the first performance of *Les Huguenots*. Rice justly calls it the "earliest surviving music for the bass clarinet" (2009, p.342). The composition came to fruition through a collaborative process. Mercadante knew Catterino Catterini, a clarinettist and inventor, who had constructed his own bass clarinet model, which he initially, in 1833, called a 'polifono', and a year later renamed a 'glicibarifono'. The glicibarifono is a non-transposing instrument in C. The solo is virtuosic in nature and includes "a level of difficulty that does not commonly appear for the bass clarinet until the early twentieth century" (Rice, 2009, p.343). The solo in Mercadante's opera goes from C1 up to F4: an ambitus of three octaves and a fourth, slightly larger than the ambitus Meyerbeer used in *Les Huguenots*.

The bass clarinet ambitus used by Mercadante and Meyerbeer in their solos is remarkable, as the players would not have had access to the more elaborate keywork systems of today's models. Therefore, they would have had to use their technical skills (embouchure, lower lip positioning) to produce the natural overtones of their instruments in order to play notes higher than B2.

After the introduction of the bass clarinet into the opera orchestra by Mercadante and Meyerbeer, other orchestral and operatic composers followed their example, including Berlioz, Donizetti, Giuseppe Verdi, Richard Wagner, Franz Liszt, and Bedřich Smetana, thus paving the way for a long tradition of writing for the bass clarinet in an orchestral setting.

It is not until the very end of the nineteenth century that the bass clarinet can be found in solo and chamber music repertoire. Two works for bass clarinet and piano were published in the 1890s by Evette and Schaeffer: Jules Pillevestre's *Offertoire (Premier)* and Alexandre-Sylvain Petit's *Evocation*. Two other pieces, coincidentally with the same title, *Romanze*, by Friedrich Diethe and August Klughardt respectively, were published circa 1900. However, as Hoeprich states, "they make but modest use of the instrument's range and its potential as a solo voice" (2008, p.276). A slightly later work, François Rasse's *Lied* (1921), still uses a range similar to the works by Pillevestre and Petit.

A few years later, two more ambitious works were written: *Suite* op. 37a for bass clarinet (or clarinet) solo (1926) by Adolf Busch and *Sonata* op. 41 for bass clarinet and piano (1927/28) by Othmar Schoeck. Both pieces were commissioned by the Swiss maecenas/amateur (bass) clarinettist Werner Reinhart. Reinhart, however, did not give Schoeck's first performance (Hoeprich, 2008, p.276). The premiere took place in Luzern on April 22, 1928, with Wilhelm Arnold, bass clarinet, and Fritz Müller, piano. Both these works now belong to standard bass clarinet repertoire, but only Schoeck really used the instrument to its full potential. He employed a much wider range, from D1-F4, an ambitus of three octaves and a minor third.[22]

In France, Eugène Bozza and Jules Semler-Collery wrote short but interesting works for bass clarinet and piano, entitled *Ballade* (1939) and *Légende et Divertissement* (1953) respectively. A second work by Semler-Collery, *Cantabile*, was published in 1956. However, as in the case of Busch, the lowest pitch used by both Bozza and Semler-Collery is E1. This could be seen as music written for a 'low clarinet', rather than specifically for a bass clarinet, abstaining from the larger ambitus the bass clarinet has to offer.[23] *Légende et Divertissement* was dedicated to Jean Dubois, 'soliste de la Musique de la Garde Républicaine et de l'Opéra Comique', who recorded it in 1953 on a 78-rpm record 'Selmer'. This is arguably the first surviving bass clarinet recording of a European chamber music work.

Between 1900 and 1950 several larger ensemble pieces used the bass clarinet. These include: Arnold Schoenberg's *Pierrot Lunaire op. 21* (1912), Leoš

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[22] Coincidentally, the same ambitus as Meyerbeer, but one tone lower.

[23] Another such work is *Recitative & Slow Dance* (1950), written by the English composer Gordon Phillips: the composition starts and ends with E1, the lowest note of the piece.

Janáček's *Mládi* (1924), Richard Strauss' *Symphonie für Bläser* (1944-45), and Paul Hindemith's *Wind Septet* (1948). Despite this, solo and chamber works for the bass clarinet remained scarce.

2.5 The bass clarinet 'revolution'

The 1960s and the 1970s were 'booming' decades for the bass clarinet as an independent solo instrument. So many works were written for the instrument that it is fair to speak of a veritable emancipation of the bass clarinet. Three pioneers actively promoted the instrument: Eric Dolphy, Josef Horák, and Harry Sparnaay. Their impact on fellow performers and composers has been so great that it can be called a bass clarinet 'revolution'!

2.5.1 Eric Dolphy

The pre-Dolphy history of bass clarinet playing in jazz resembles in many ways the development of the instrument in classical music: it appeared mostly in larger ensembles and big bands. For example, Harry Carney, baritone saxophonist of the Duke Ellington Orchestra, frequently doubled on bass clarinet, big band leader and clarinettist Benny Goodman picked up the bass clarinet on occasion, and another famous clarinettist, Buddy DeFranco, recorded one LP on bass clarinet at the request of his recording company. Herbie Mann's reputation as a flute player did not prevent him from choosing the bass clarinet as "his most suitable second horn, with its unique tonal qualities" (Keepnews in Mann, 2001, liner notes) and on July 3, 1957 Mann travelled to Los Angeles—Dolphy's territory so to speak—to make a recording that Keepnews describes as "what must be the first bass-clarinet album ever (Keepnews in Mann, 2001, liner notes). Mann was joined by 'West Coast' musicians to record six standards and one original composition in a relaxed and smooth jazz style. The ambitus he uses on the bass clarinet is rather limited: mostly keeping within the first two and a half octaves from C1 up. Although Mann uses the lowest third of the instrument in his improvisations, it is notable that the overall range within which he operates is very similar to the French works for bass clarinet and piano written in the same decade (see section 2.4).

A year later Dolphy started changing the whole concept of bass clarinet playing in jazz. Originally a clarinet and saxophone player, he became interested in the bass clarinet when his teacher, Merle Johnston, helped him to test a bass clarinet he had seen in a pawn shop (Simosko & Tepperman, 1996, p.37). In 1958 Dolphy joined the Chico Hamilton Quintet, playing alto saxophone, flute, and bass clarinet (and sometimes soprano clarinet). This signalled the start of his recording career. Until his untimely death in Berlin on June 29, 1964 Dolphy had been one of the most prolific jazz musicians, making more than 120 recordings over a period of five years. More than 100 bass clarinet solos have been documented in Simosko's and Tepperman's discography (1996, pp.140-142). These recordings included his work as a 'sideman'—with Charles Mingus and John Coltrane amongst others—and as a band leader. His debut LP *Outward Bound* was recorded in 1960. Dolphy extensively played bass clarinet on this LP.

"Dolphy's *Out to Lunch* album (Blue Note Records, 1964) is arguably the finest to be released under his own name" (C. Heaton, 2006, p.64). Speaking about Dolphy's bass clarinet playing on the track *Hat and Beard* (Dolphy, 1987, track 1), British producer, keyboard player, programmer, recording engineer, and researcher Chris Heaton writes: "He produces a torrent of timbral gestures, vast leaps in register, barking multiphonics, and intense, labyrinthine runs" (2006, p.64). For many authors and critics this solo is Dolphy's bass clarinet improvisation par excellence. For me, however, Dolphy's bass clarinet playing on *Epistrophy* (Dolphy, 1991, track 1), the opening track on the *Last Date* album,[24] is a more complete demonstration of his bass clarinet mastery. In this recording he makes use of quartertone (trills), a large ambitus, harmonics, and multiphonics, amongst other techniques.

Dolphy's improvised solos illustrate both his free approach to tonality, and his keen interest in microtonality. In his only interview with American jazz critic Leonard Feather, Dolphy talks about his belief that individuals have differing aural capacities:

> Well, that's the idea, you CAN play every note you like. Of course, you only can play what you can hear, and quite naturally…more or less I guess what I hear is not to your hearing, to what you're hearing. So quite naturally, I hear, uh, more notes on uh, on the same thing that's been said before. (Robinson & Ladenson, 1998)

[24] The *Last Date* album was recorded in the Netherlands on June 2, 1964.

Dolphy struck the right chord on that subject: I believe that the ability to 'hear' internally what you want to play is crucial when making music. Microtonal playing requires subtle changes in finger technique and embouchure, therefore, hearing the (microtonal) result you want to achieve is of the utmost importance. Australian/British jazz saxophonist Ray Swinfield said:

> Now when a saxist or bass-clarinettist attempts harmonics he must have a very good ear to produce the notes and get them right. Otherwise he will produce either other notes or more than likely, a sort of cow-like moan from the instrument. (Swinfield in Horricks, 1989, p.48)

The first time Feather had heard Dolphy play bass clarinet, with the Chico Hamilton Quintet, he thought that Dolphy had intonation problems, but Dolphy later explained "his acceptance of quarter-tone intervals" in an interview with American critic Don DeMicheal (Horricks, 1989, p.21). In the interview, which was published in Downbeat magazine (April 12, 1962), Dolphy spoke of listening to bird whistles in relation to his use of quartertones on the flute:

> 'That's the way birds do', he said. 'Birds have notes in between our notes - you try to imitate something they do and, like, maybe it's between F and F-sharp, and you'll have to go up or come down on the pitch. It's really something! And so, when you get playing, this comes'. (DeMicheal, 2009, p.88)

Dolphy also extended the upper range of the bass clarinet. According to Swinfield he did this by using "overtones or harmonics produced by playing natural harmonics" and later, by using "fingerings acquired, modified and then varied" (Swinfield in Horricks, 1989, p.49). The microtones he incorporated in his improvisations are often a direct consequence of his modifications and variations of root-overtone fingerings. A transcription of the 1961 Berlin concert version of *God Bless the Child*, made by British trumpeter Ken Rattenbury, illustrates Dolphy's range on the bass clarinet. Roughly two minutes into the solo Dolphy plays a G♭5, which Rattenbury states is "a generous octave above the credible range of the instrument" (Horricks, 1989, p.65).

Eric Dolphy, the person who inspired me to play the bass clarinet, still occupies a unique place in modern jazz. Notwithstanding his early death, he had a major influence on the development of freer forms of improvisation and was able to push boundaries, especially when playing the bass clarinet. He used a very large range on this instrument and employed an array of extended techniques, including microtonality.

2.5.2 Josef Horák

On March 24, 1955, a date which was incidentally also his birthday, Josef Horák became the first person to give a full-length bass clarinet recital. Asked to replace a sick colleague on bass clarinet in the Brno Radio Symphonic Orchestra, Horák immediately saw its potential as a solo instrument and started to develop the instrument and its techniques (Weston, 1989, p.130). This work led him to be called “The Paganini of the Bass Clarinet”, as “Paganini produced unheard-of effects from his violin and so has Horák on his instrument” (Weston, 1989, p.130). Despite a tendency to play more transcriptions and arrangements later in his career, Horák undertook pioneering work for the bass clarinet. His efforts ensured the creation of new repertoire and brought about “a very important ‘new direction’ for clarinet in the early 1960s…the rise to prominence of the bass clarinet as a solo instrument” (Rehfeldt, 2003, p.158).

Horák founded several contemporary music groups: the Musica Nova Brno ensemble in 1961 (flute, bass clarinet, piano, and percussion), the Sonatori di Praga (with the same combination of instruments) in 1963 after he moved to Prague, and in the same year Due Boemi di Praga together with pianist Emma Kovárnová. Due Boemi di Praga later became his signature ensemble, and despite the restrictions caused by the Iron Curtain, he and Kovárnová were able to travel abroad as Czech cultural ambassadors. The duo was subsequently made an official Chamber Ensemble of the Czech Philharmonic Orchestra and was able to establish a ‘business home’ at Biberach-am-Riss in Germany. It is here, in the Kulturamt, that they were asked to teach chamber music for two days a week from 1969 onwards.

It was through his ability to travel that Horák could connect with the European avant-garde music scene. Bruno Maderna invited Horák to join the famous Kranichsteiner Kammerorchester in Darmstadt as early as 1961, and in 1968 Horák took part in the premiere of Karlheinz Stockhausen’s *Musik für ein Haus* with, amongst others, trombonist Vinko Globokar and oboist Heinz Holliger. Horák was therefore well imbedded in the new music scene during the period in which he was actively researching new sonic possibilities.

The information which he gathered was passed on to composers keen on trying out the new sounds. One such composer, Václav Kučera, wrote *Duodramma* for Due Boemi in 1967. This piece, which is still performed regularly, makes use of several extended techniques: frullati, glissandi, vibrato (at different speeds), smorzando, extreme dynamics, and extension of the ambitus up to C♯5. Whilst there are no specified microtonal pitches in this composition, the effects listed above do require embouchure manipulation. For example, the impetuoso opening starts with a G4 brought up by a lip glissando to A4.
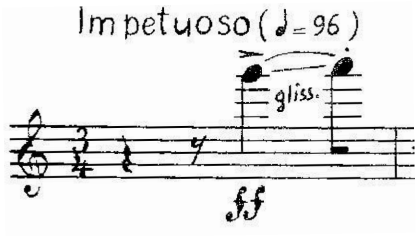
Figure 22: Kučera (1967/68, p.2), *Duodramma*, bar 1, bass clarinet part (G4 brought up by a lip glissando to A4)

2.5.2.1 Alois Hába

Another composition dedicated to Horák was Alois Hába's *Suita* op.96 (1964), written one year after Horák moved to Prague, where Hába also lived. This is thought to be the first work for the bass clarinet in which microtonal pitches have been used. Hába is primarily known for his microtonal compositions, especially using the quartertone scale, although he also used other systems such as third-tones, sixth-tones, and twelfth-tones.[25]

[25] "An important event was Hába's attendance of a lecture by Adriaan Fokker at the International Society of Contemporary Music in 1948; under the influence of this, he engaged in a long study of the fifth-tone (31-tone Equal Temperament) system [fifth-tone does not correspond exactly to a 31-tone, HB], finally using it in his 16th Quartet in 1967". (Battan, 1980, 'Alois Hába's Neue Harmonielehre')

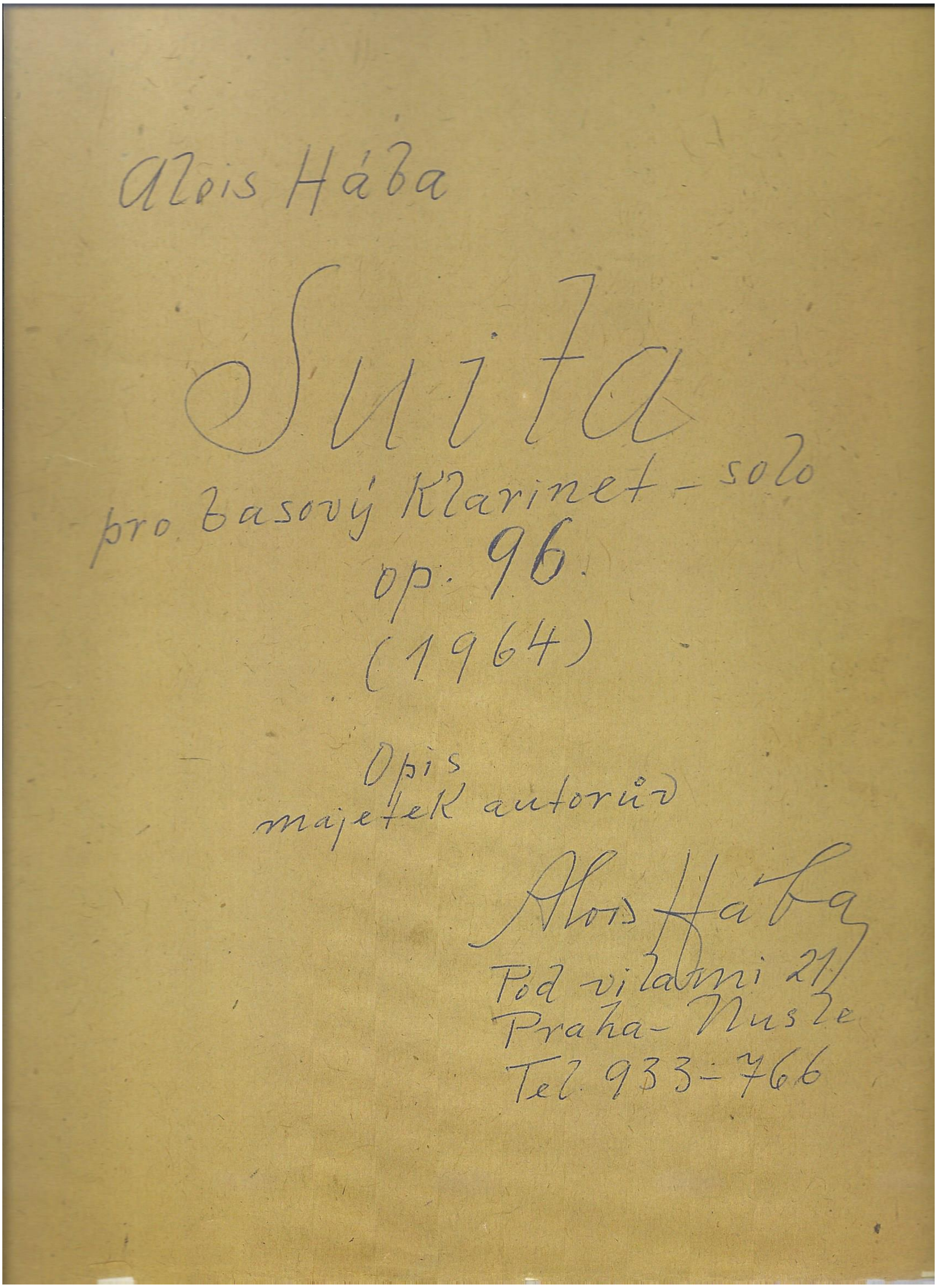

Figure 23: Hába (1964), *Suita* op. 96, title page of the manuscript

Considering Hába's importance as a composer and theoretician of microtonality, his use of microtonality in the *Suita* op. 96 is sparse and uniform. Interestingly, on each occasion in which microtonality is used, Hába raises the pitch by a sixth-tone. His use of this smaller microtonal step is not common. To notate the microtonal variant Hába uses '+', which indicates that the pitch has to be raised by a sixth-tone (2007, p.141).

In the microtonal passages of this work Hába always follows the same, uniform, process: juxtaposition of the semitone pitch and its sixth-tone microtonal variant, always raising the preceding pitch. There may be an advantage to the uniform process Hába applies: the listener can perhaps (more) easily hear and recognize the microtone in relation with the semitone pitches which precede or follow it.

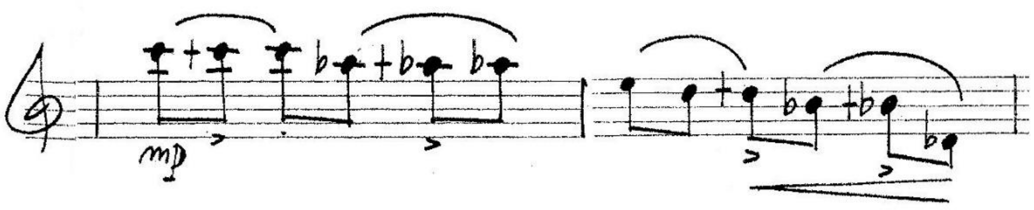

Figure 24: Hába (1964), *Suita* op. 96, second movement, bars 16-17

On his recording of the *Suita* op. 96 Horák does not appear to always completely follow the original score (Due Boemi di Praga, 2000, track 5). This is especially evident in the second and fifth movements, the only movements with microtonal writing, where he cuts out all the microtonal passages. As Horák did not document his work in either books or articles, the only documentation of his microtonal fingering patterns can be found in his personal scores. Whilst it may initially appear that he had not found appropriate fingering patterns for the required microtones, and had therefore made the decision to omit the microtonal passages, upon further investigation Horák's manuscript copy of the score does contain fingering patterns for the sixth-tones.

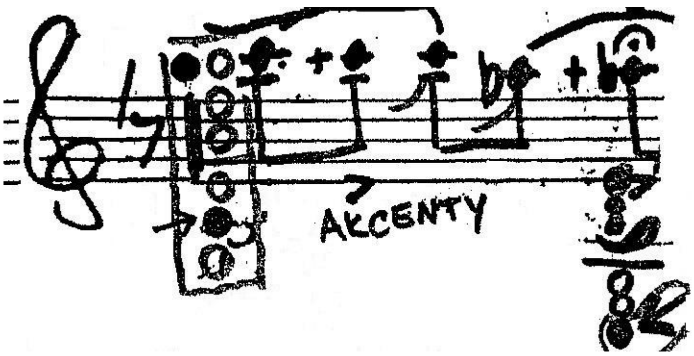

Figure 25: Example of Horák's fingering patterns for sixth-tones in bar 16 of Hába's *Suita* op. 96 (1964)[26]

This work by Hába is one-of-a-kind in Due Boemi's repertoire. In an interview recorded on November 21, 2016, in Prague (Video 8), Kovárnová states unambiguously that there were no other composers who wrote microtonally for them and that they had not encouraged composers to do so, because microtonality posed problems for which they did not have the solutions as she only had semitonal keyboards at her disposal.

Video 8: Interview with Emma Kovárnová, part one (November 21, 2016)

In a second interview (Video 9) Kovárnová elaborates on the musical impact of microtonality and states that for her, descending microtones work better as she believes that they have a bigger emotional impact than the ascending ones. It is therefore notable that in the only microtonal work written for Horák, all microtonal pitches used raise the preceding note by a sixth-tone.

Video 9: Interview with Emma Kovárnová, part two (November 21, 2016)

Although Kovárnová clearly states in Video 8 that the duo did not get involved in the commissioning or playing of microtonal works, she comments very positively on microtonality as a phenomenon and says that for her, microtonality

[26] This example is taken from Horák's own handwritten version of Hába's original score (in treble clef) and differs from Hába's score which does not contain a fermata.

adds to the musical expression, especially when the pitches are in a descending order. Preciseness is important to her, so she states that in order to play exact quartertones or sixth-tones a lot of training is required.

2.5.3 Harry Sparnaay

Harry Sparnaay started playing (jazz) tenor saxophone at the age of 13. When he presented himself with that instrument for the entrance exam at the Sweelinck Conservatoire in Amsterdam, he was met with disapproval: neither a saxophone class nor a jazz course existed at that institute in the 1960s. One of the clarinet teachers, Ru Otto, convinced him to change to the clarinet. Later, when Otto brought the bass clarinet into a class one day, Sparnaay was the only student who was able to blow it and decided that this would be his instrument of choice.

As has been discussed in section 1.3 'Guidelines for the performer', a relaxed and flexible embouchure is needed in order to produce a 'rounded' and 'open' sound. Sparnaay appeared to confirm the need for a relaxed embouchure in his interview with British clarinettist Pamela Weston, stating that playing the bass clarinet "was much easier for him than for those coming to it after years of a normal tighter clarinet embouchure" (1989, p.267). Weston believed that this was due to Sparnaay's background of jazz saxophone playing, which "helped give him the concept of sound and embouchure flexibility which made him into a master of the instrument" (1989, p.267).

In 1972 Sparnaay won the Gaudeamus competition with solo performances, and as a member of duo Fusion Moderne (with Polo de Haas, piano). The same year he was appointed professor of bass clarinet at the Rotterdam Conservatoire, and he played Italian composer Luciano Berio's *Chemins IIc* with the Rotterdam Philharmonic Orchestra.

A long bass clarinet journey followed, full of performing, teaching, researching, and repertoire building, all of which have been documented in his book *The bass clarinet, a personal history* (Sparnaay, 2011). The book also details many extended techniques, as well as over 700 compositions that were written for him.

2.5.3.1 Jos Kunst and Brian Ferneyhough

“For the bass clarinet there are major difficulties to be overcome when producing quarter tones. The instrument is not really designed for it” (Sparnaay, 2011, p.123). Although Sparnaay was very critical regarding the microtonal possibilities on the bass clarinet, two of the first solo pieces written for Sparnaay—Dutch composer Jos Kunst’s *Solo Identity I* (1972) and British composer Brian Ferneyhough’s *Time and Motion Study I* (1971-1977)—both contain microtonal pitches.

It is interesting to note that Kunst’s composition uses sixth-tones, as did Hába’s *Suita* op. 96. Although Kunst makes use of more microtonal variants than Hába, his use of microtonality in the piece is still limited to only four bars. Whilst Hába chose to raise a semitone pitch by only one sixth-tone, on two occasions Kunst uses sixth-tone steps to move between two semitone pitches. He does this between G♮2 and G♯2 in bars 31-32 (Figure 26) and between B♮3 and D♭4 in bars 67-68 (Figure 27).

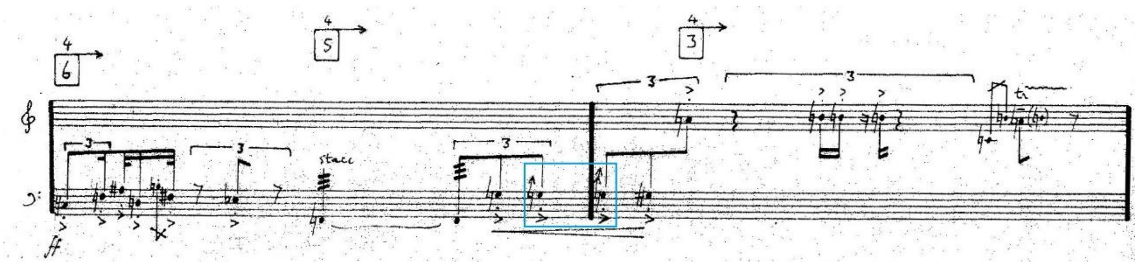

Figure 26: Kunst (1972, p.4), *Solo Identity I*, bars 31-32

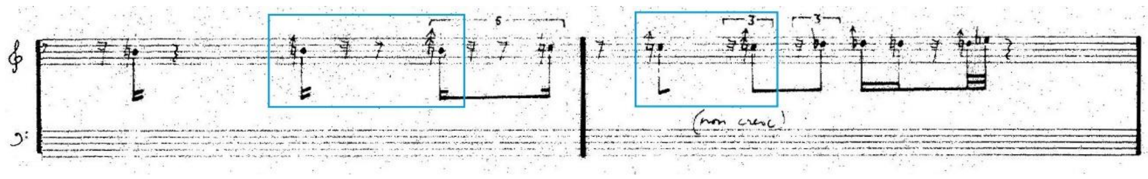

Figure 27: Kunst (1972, p.7), *Solo Identity I*, bars 67-68

Several recordings exist of this piece: the earliest recording is by Sparnaay (1978, side 1, track 1), another, by Barton Workshop co-founder John Anderson

(2003, track 2), and a more recent one, by Brazilian bass clarinettist Sérgio Albach (2016).

Sparnaay and Albach shared their fingering patterns for the sixth-tone pitches with me. Figures 28-31 compare the sixth-tone fingering patterns used by Sparnaay and Albach.

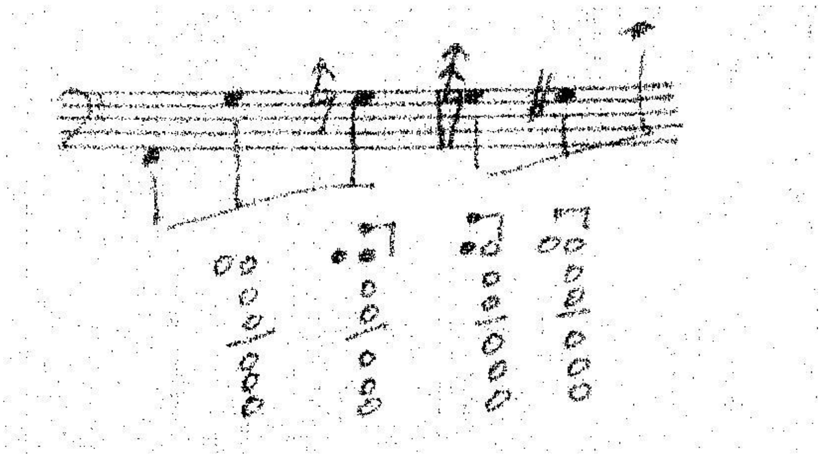

Figure 28: Sparnaay's fingering patterns for Kunst, *Solo Identity I*, bars 31-32

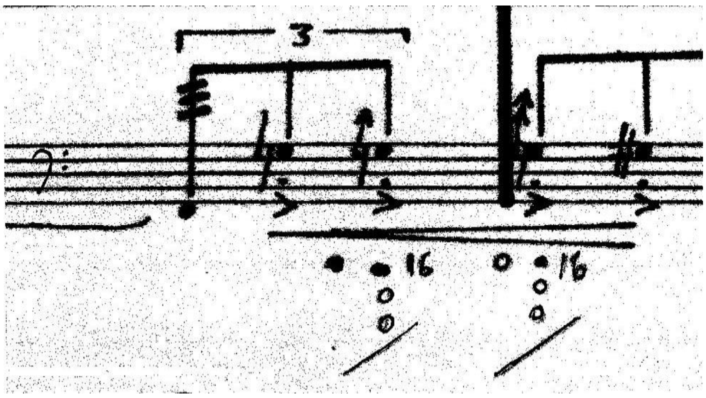

Figure 29: Albach's fingering patterns for Kunst, *Solo Identity I*, bars 31-32

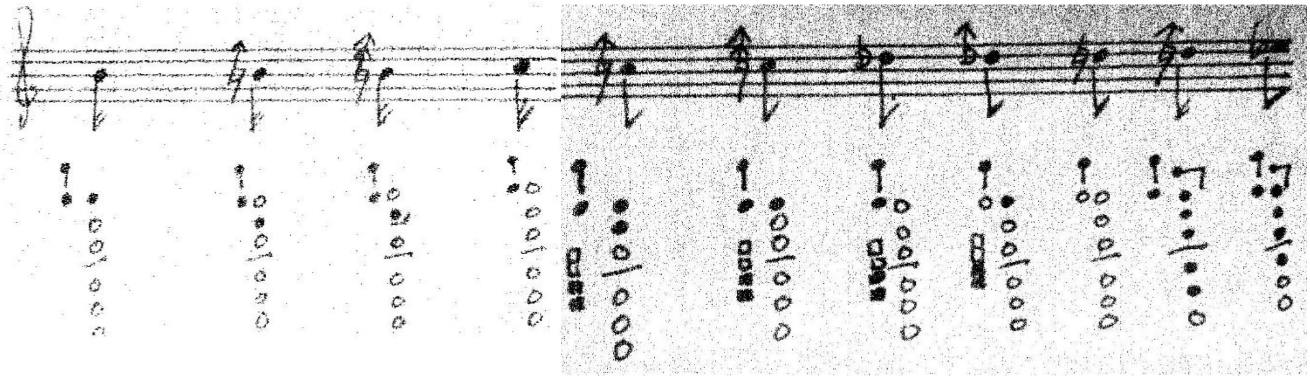

Figure 30: Sparnaay's fingering patterns for Kunst, *Solo Identity I*, bars 67-68

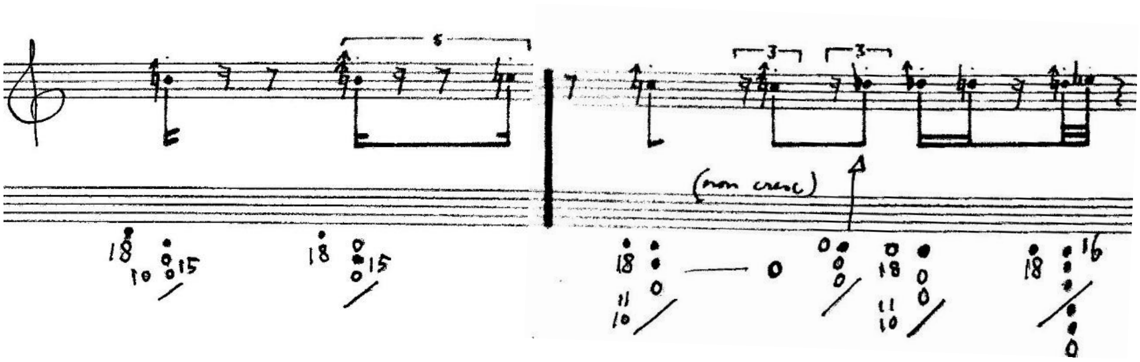

Figure 31: Albach's fingering patterns for Kunst, *Solo Identity I*, bars 67-68

It is notable that of the eight microtonal fingering patterns found in Figures 28-31 six are identical between the two performers. Comparing the suggested fingering patterns with the measured microtones in Appendices A1-F, four of the fingering patterns proved to be quartertone fingering patterns (G𝄲2, B𝄲3, D𝄳4, and D𝄲4). Of the remaining fingering patterns only one could possibly qualify as a sixth-tone: the shared fingering pattern for C↑♮4 (measured as C♯4 -31). The remaining fingering patterns are either closer to eighth-tones (for example, Albach's fingering pattern for B↑♮3, measured as B3 +22) or nano tones (for example, Sparnaay's solution for the same pitch, measured as B3 +8).

Ferneyhough's *Time and Motion Study I* was completed just before the work's premiere in 1976 (H. Sparnaay, personal communication, May 4, 2017).[27] Various recordings have been made of this composition, including by Sparnaay (1989, track 6) and Scandinavian bass clarinettist Tommie Lundberg (1991, track 2).[28]

Whilst Hába and Kunst both chose to use sixth-tones, Ferneyhough uses quartertones. This microtonal interval has been more commonly used than sixth-tones. In contrast with Hába and Kunst, who use microtonality very sparsely in their solo pieces, Ferneyhough uses microtonality as one of the key components of his composition technique. For example, many of the notes in Figure 32 are microtonally altered, but they do not all move in step fashion from semitone pitches as Hába and Kunst have used microtonality.

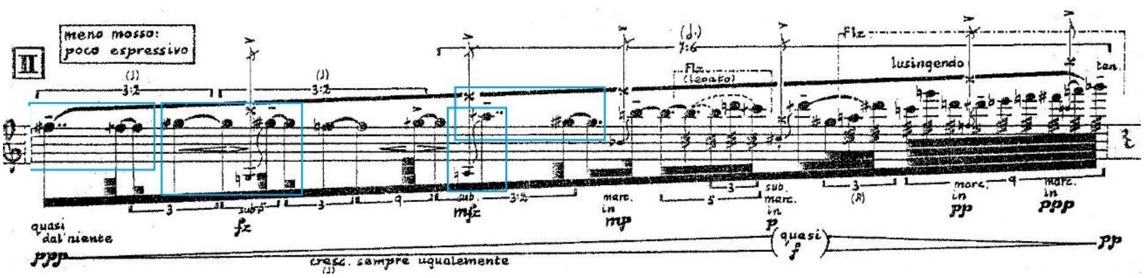

Figure 32: Ferneyhough (1971-1977, p.3, line 1), *Time and Motion Study I*, *meno mosso: poco espressivo*

The F♯3 (Figure 32) does move in a step fashion to the second note, F‡3, but the next microtonal step, between G‡3 and G𝄰3, is interrupted by a grace note on G♮1. Further on in the phrase, the quartertone step, A♮ to A‡, is dislocated by two octaves (A♮1 to A‡3). There is also direct movement between two quartertone pitches, A‡3 and G𝄰3.

[27] There is sometimes confusion regarding the year Ferneyhough completed the final score of *Time and Motion Study I*, as the front page of the Peters edition score gives 1971-77 as the dates, whilst the last page of the score states: "First version: Basle 1971; Recomposed: Berlin 1976/7" (Ferneyhough, 1977, p.8).

[28] Tommie Lundberg was Horák's only 'official' bass clarinet student.

In this piece microtonality is also used in combination with other extended techniques, for example in the last line of the score (Figure 33).

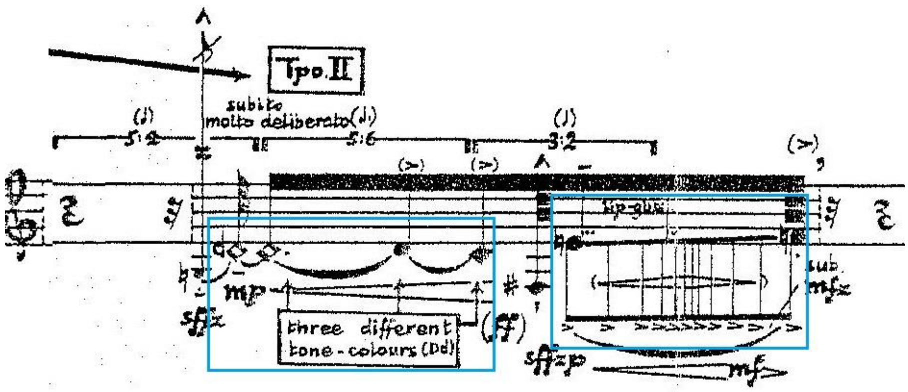

Figure 33: Ferneyhough (1971-1977, p.8, line 5), *Time and Motion Study I*

In the penultimate sequence of the piece (Figure 33) the composer asks for the three different tone colours to be played on a note which is already microtonally altered, D𝄳2. The desired change in tone colours will also bring nano pitch variants. The lip glissando in ten mini-steps between E2 and F2 (in the same phrase) relies on lower lip manipulation. Due to the keywork of the instrument there are not ten different fingering patterns available to raise the pitch towards F2. Any keys situated on the lower joint and pressed by the fingers of the right hand lower the pitch E2, rather than raising it. The availability of possible fingering patterns would have aided the performer in realizing the composer’s wishes. The fact that Ferneyhough chose this effect between E2 and F2 may indicate that the composer did not have detailed information at his disposal concerning this aspect of microtonality.

In my point of view, the lip glissando might have worked slightly better without the smorzando effect, indicated by the marked accents. The musical idea could, though, have worked with the right choice of an overtone pitch, which could then be altered in mini-steps, using the root-overtone production system and generating nano tones through the use of additional keys (the subject of Chapter 5).

2.6 Summary and conclusions

Chapter 2 showed the development of the bass clarinet from a multiform low clarinet to the actual shape and keywork for which Adolphe Sax is mainly responsible. Sax added more keys to the instrument and invented a second register key. This allowed a much larger ambitus, improved the intonation, and offered alternative fingerings, paving the way—in the long term—for microtonality.

Important orchestral and operatic composers, such as Mercadante and Meyerbeer, later followed by Berlioz, Donizetti, Verdi, Wagner, Liszt, and Smetana, favoured the bass clarinet and used its full ambitus in solos and cadenzas. In solo and chamber music repertoire the bass clarinet is not used either extensively or exhaustively and the majority of composers tend to reduce the instrument's ambitus to a mere three octaves, starting on E1 as the lowest pitch (with the exception of Schoeck).

It is not until the 1960s that this situation suddenly changes, due to the pioneering work of Eric Dolphy, Josef Horák, and Harry Sparnaay. The bass clarinet 'revolution' they started has resulted in a whole range of new, interesting compositions, featuring the bass clarinet's extended techniques, including microtonality.

Both Horák and Sparnaay performed music containing microtonal elements at the very start of their respective careers. Compositions by Hába, Kunst, and Ferneyhough remain part of the instrument's core repertoire. Following these examples of microtonality in the 1960s and the 1970s, microtonal possibilities for the bass clarinet have increased. The quartertone microtonal system is today still the most commonly encountered. In the next chapter, quartertone playing on the bass clarinet will be scrutinized and elaborated upon.

CHAPTER 3

Microtones: equal divisions of the tone

3.1 Introduction

The term microtone refers to any division of a tone which is smaller than a semitone. Equal divisions of a semitone result in quartertones, eighth-tones, and so on. The distance between two semitones is 100 cents, which means that the distance between two quartertones is 50 cents and the distance between two eighth-tones is 25 cents.

In the literature both protagonist and antagonist views can be found regarding the bass clarinet's microtonal suitability. In his *Harmonielehre* Schönberg wrote: "Jedenfalls erscheinen Versuche, in Viertel- oder Dritteltöne zu komponieren, wie sie hie und da unternommen werden, mindestens solange zwecklos, als es zu wenig Instrumente gibt, die sie spielen könnten" (1922, p.26).[29] Both Bartolozzi (1982, p.26) and Sparnaay (2011, p.123) use this quote in their writing about quartertones, but for different reasons. Sparnaay to discourage players and composers from using microtonality on the bass clarinet,[30] Bartolozzi, however, to unveil "possibilities woodwind instruments offer in producing organized successions of sounds which are closer together than the semitone" (1982, p.26). Bartolozzi not only acknowledges the microtonal possibilities of woodwind instruments, he also encourages players and composers to do research into these possibilities.

> Seeing that woodwind can emit sounds which are less than a semitone apart, these developments must be examined, and it is evident from the outset that their possibilities are considerable, since woodwind can play intervals as small as one-eighth of a tone and one-sixth of a tone as well as the third- and quarter-tones already mentioned. (1982, p.27)

Bartolozzi published the first edition of his book in 1967 and, since this point in time, the bass clarinet has benefitted from a number of technical improvements. It is my aim in this chapter to exploit the microtonal possibilities of the current

[29] "Anyway, attempts to compose in quartertones or third-tones, as are being undertaken here and there, seem pointless, at least as long as there are too few instruments which would be able to play these" (Schönberg, 1922, p.26).

[30] "The contemporary bass clarinet has not been adapted in this way and I think this is fortunate and for me, Schönberg's statement is still completely valid for the bass clarinet" (Sparnaay, 2011, p.123).

bass clarinet further, and to try to find fingering patterns which enable the performer to play quartertones and eighth-tones.

3.2 Quartertones

A quartertone is “the distance between two tones which are one-half of a semitone (half step) apart” (Cope, 1973, p.124). The bass clarinet has been constructed with keywork that allows the production of semitonal steps. The keywork of the instrument does not always allow for microtones, but despite this it is possible to play many successions of quartertones on modern bass clarinet models.

According to American (bass) clarinettist E. Michael Richards “the quarter-tone is a logical rather than acoustic extension of the chromatic scale” and “in the practice and theory of a variety of Asian musics, for example, where microtonal intervals are employed, exact quarter-tones do not exist” (1995, p.30). However, in ‘Das System der Aliquottöne und das temperierte System der Viertel-, Sechstel- und Zwölfteltöne’ Hába explains the working of the harmonic series (2007, pp.92-102).[31] He shows that, very high up, the distances between the succeeding overtones get narrower and narrower, resulting in third-tones (25:26), fourth-tones [quartertones, HB] (34:35), sixth-tones (51:52), eighth-tones (68:69), and twelfth-tones (103:104).[32] Hába therefore demonstrates that extremely small microtonal intervals are contained in the natural acoustics of instruments. This form of microtonality, which is inherent to the bass clarinet, opens up additional possibilities for microtonal playing by using root-overtone fingering patterns, the subject of Chapter 5. In this chapter, however, my aim is to show that by using corrupted fingering patterns both quartertone and eighth-tone scales are possible. In the next sections existing fingering patterns for quartertone playing will be critically scrutinized for their accuracy, with the aim of establishing my definitive quartertone fingering pattern chart at the end of the process.

[31] ‘The overtone system and the tempered quartertone, sixth-tone and twelfth-tone system’ (Hába, 2007, pp.92-102).
[32] The numbers in parentheses are the ratios.

3.2.1 Existing literature

3.2.1.1 Notation

One of the recurring issues for both performers and composers is how to notate, read, and understand microtonal pitches. When the number of symbols needed for notation increases, so does the complexity of notational systems, often leading to confusion. In the case of quartertones, notation could still be relatively simple, as essentially only one additional symbol is needed between two semitones. However, as shown in Figure 34, many notational varieties can be found in existing sources. As can be deduced from the data, not only the graphics of the symbols vary quite a lot, but also the number of symbols used: from just two in the case of Richards, Sparnaay, and Villa Rojo,[33] to six in the case of Rehfeldt.

[33] Jesús Villa Rojo is a Spanish clarinettist, composer and scholar.

Source	¼ sharp	¾ sharp	¼ flat	¾ flat
Alder (2013)	𝄲	♯	𝄳	𝄳♭
Bartolozzi (1982)	𝄲	♯	⅂♭	
Bok (2011)	♮↑	♯↑	♮↓	♭↓
Hába (2007)	♭	♯	𝄳	
Rehfeldt (2003)	♭↑ ♮↑ ♯↑		♭↓ ♮↓ ♯↓	
Richards (1995)	𝄲	♯		
Sparnaay (2011)	♮↑	♯↑		
Villa Rojo (2003)	𝄲		♭	

Figure 34: Symbols used for quartertones in eight sources

An additional source, British clarinettist Sarah Watts (2015), uses a form of notation which is near identical to Rehfeldt's notation. However, Watts' use of arrows is not to indicate exact quartertone pitches: "dissecting notes into notated quarter and eighth tones may result in inaccuracies and further confusion" (2015, p.32). Therefore, in Watts' notation system "an arrow pointing downwards indicates that the note is sounding below pitch and an arrow pointing upwards indicates that the note is sounding above pitch" (2015, p.32).

Source	Below pitch	Above pitch
Watts	♭↓	♭↑
	♮↓	♮↑
	♯↓	♯↑

Figure 35: Symbols used by Watts (2015)

Watts is not the only person who uses a notation with arrows to indicate ‘slightly higher’ or ‘slightly lower’: quite a number of composers also use this kind of notation to indicate more approximate microtonal pitch variations.[34] As the aim of this study is to enable the playing of precise microtonal pitches, this system of arrows will not be studied further.

3.2.1.2 Fingering patterns

Whilst Figure 34 shows examples of the way the reviewed sources notate microtonal pitches, a second aspect of notation involves the way in which the new fingering patterns are denoted. As these are dependent upon the type (for example, German or Boehm system), make (for example, Selmer Paris or Buffet Crampon), or even model (for example, old versus new Selmer Paris), it is of the utmost importance to include this information. This essential information is, though, missing from several of the sources studied here. For example, Rehfeldt (2003) does not present a clear fingering diagram for the bass clarinet, therefore we have to guess at the specific key nomenclature. Neither is there any information on the type and make of bass clarinet used to verify the fingering patterns. What can be deduced from Rehfeldt’s writing is that most likely a French bass clarinet make has been used, taking into account the keys indicated in the fingering patterns, which are missing on German bass clarinet models. Like Rehfeldt, Richards (1995) does not include a diagram of his key nomenclature system: the diagrams in the tables found in the book have to be filled in by the reader, trying to make sense of a system which uses squares, lines, numbers, and letters.

[34] A further complication of this system is that arrows are also sometimes used to indicate the ‘highest’ or ‘lowest’ note of the instrument as detailed in Villa Rojo (2003, p.112).

A comparison of the different key nomenclature systems used by the existing sources, shows that almost the only thing they all have in common is the seven circles which indicate the left hand thumb, and the index, middle, and ring finger of both hands. The only exception is Richards, who uses squares instead of circles.

The notation of the remaining keys can be roughly divided into three categories: one which uses letters and/or numbers (Sparnaay, Figure 36), one which uses a diagram of the keys (Alder, Figure 37), and one which uses a hybrid of these two (Watts, Figure 38, see also Figure 44). Both Rehfeldt and Richards also use the hybrid system.

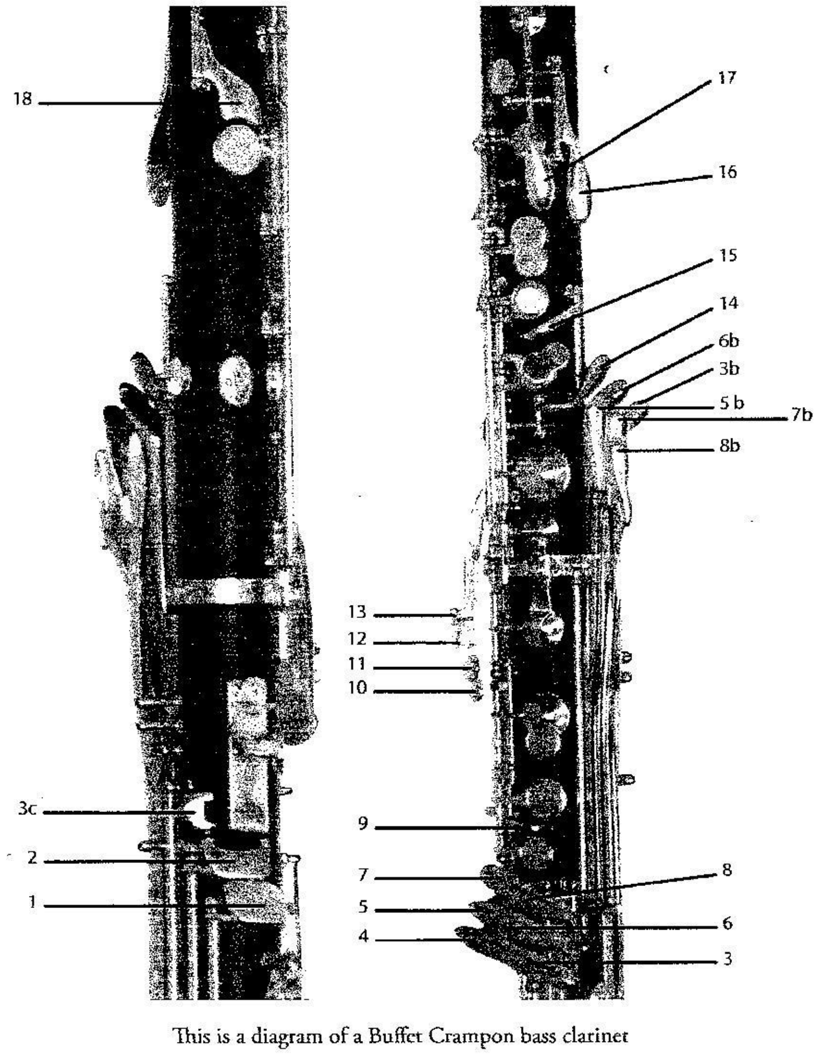

Figure 36: Sparnaay (2011, p.39), key notation system

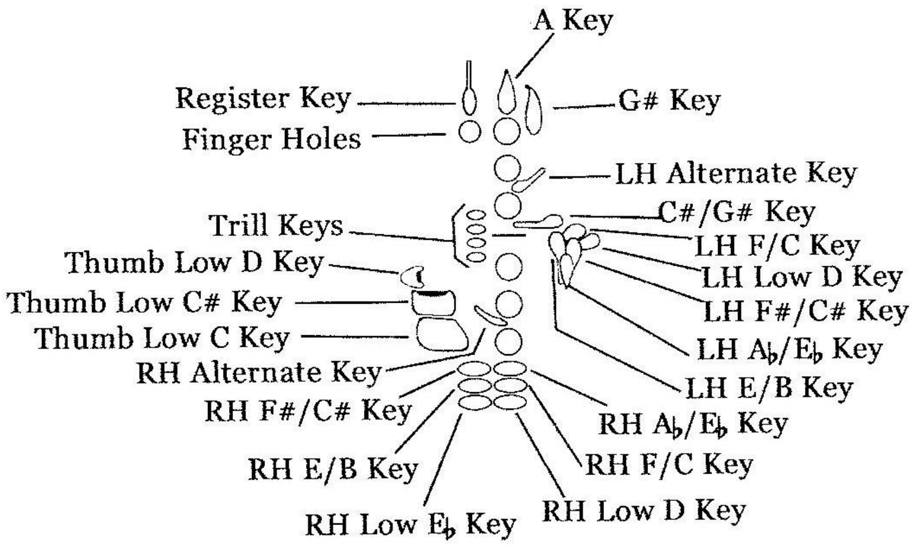

Figure 37: Alder (2013, p.iii), key notation system

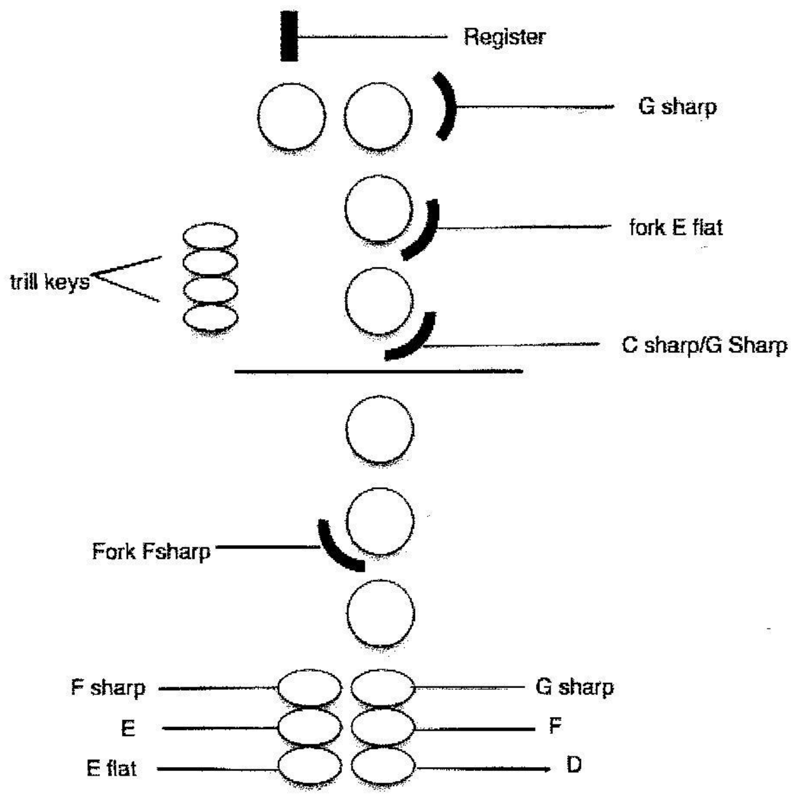

Figure 38: Watts (2015, p.83), key notation system

In Rehfeldt's hybrid system he uses pitch names to indicate keys. This has several disadvantages. Firstly, as the instrument overblows at the twelfth, the same keys are used to play different notes: for example, the F key (F1) is also the C key (C3). Secondly, the choice for sharps or flats, as enharmonic variants, seems rather aleatory. Whereas Rehfeldt calls key 16 'G♯', Richards calls key 16 'A♭' and calls key 8 'G♯' (Figures 39, 40, and 41).

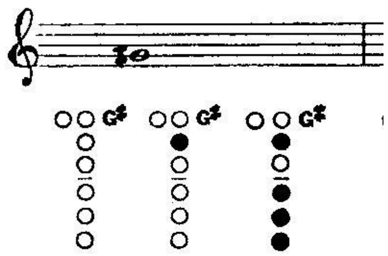

Figure 39: Rehfeldt (2003, p.34), fingering pattern for G♯2

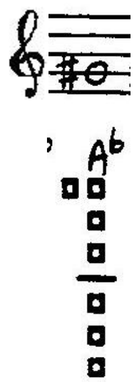

Figure 40: Richards (1995, p.32), fingering pattern for G♯2

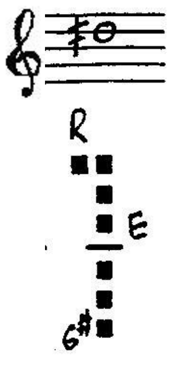

Figure 41: Richards (1995, p.32), fingering pattern for D♯3

An additional problem occurs, as some pitch names are used to label more than one key. For example, Rehfeldt uses the pitch name B♮ twice in his fingering diagram. He tries to differentiate between the two B♮ keys by adding 'tr' (trill) to the pitch name for just one of them (key 13 in my key nomenclature system). Nonetheless, it can be rather confusing to see the two 'B' keys pictured very close to each other and on the same side of the instrument.[35]

The only key for which Rehfeldt does not use the pitch name is the twelfth key or register key. He calls this key 'R', referring to 'register key'. Richards, whose system combines both numbers and pitch names to label the keys calls the same key, key '12', referring to the 'twelfth key'. In both Sparnaay's and my own key nomenclature system key '12' is one of the upper joint side keys. Richards, by contrast, refers to the four side keys at the right hand side of the upper joint as keys 1, 2, 3, and 4. I was, at first, confused when studying Richards' fingering pattern for F♯2 (Figure 42). This was partly due to the disparity of key naming systems and partly due to Richards' lack of explanation of his own key naming system. I initially read key '12', but subsequently realised that he was referring to two separate keys: key 1 and key 2 [key 10 and key 11, HB].

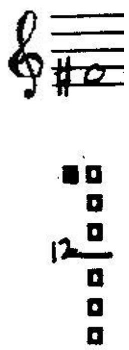

Figure 42: Richards' (1995, p.32), fingering pattern for F♯2

When I wrote *New Techniques for the Bass Clarinet*, the notation system I decided to use was a combination of the (seven) circles, commonly used in clarinet methods, and numbers. I assigned numbers to the keys according to the pitch they produce, rather than the position they have on the instrument. I decided to start with the lowest root fingering, C1, to which I assigned the

[35] For keys 9 and 15 Richards uses oblique lines, without adding any note names. This is very hard to read, especially when the key above is coloured black.

number ‘1’, going up along the pitches and the placement of the keys, ending with the register key to which the number 18 was assigned (see my key nomenclature system).[36] In *Metodo per Clarinetto* Italian clarinettist Giuseppe Garbarino employs a similar notation system for clarinet, using circles and numbers. However, he starts numbering at the top and assigns the number ‘1’ to the register key, then descends towards the lowest note on the instrument which is called number ‘18’ (Garbarino, 1979, p.3). To me, it seemed and still seems, much more logical to start numbering at the bottom end of the instrument, as that is where the roots are. This also corresponds with Adolphe Sax’s key numbering system (Dullat, 2001, p.88).

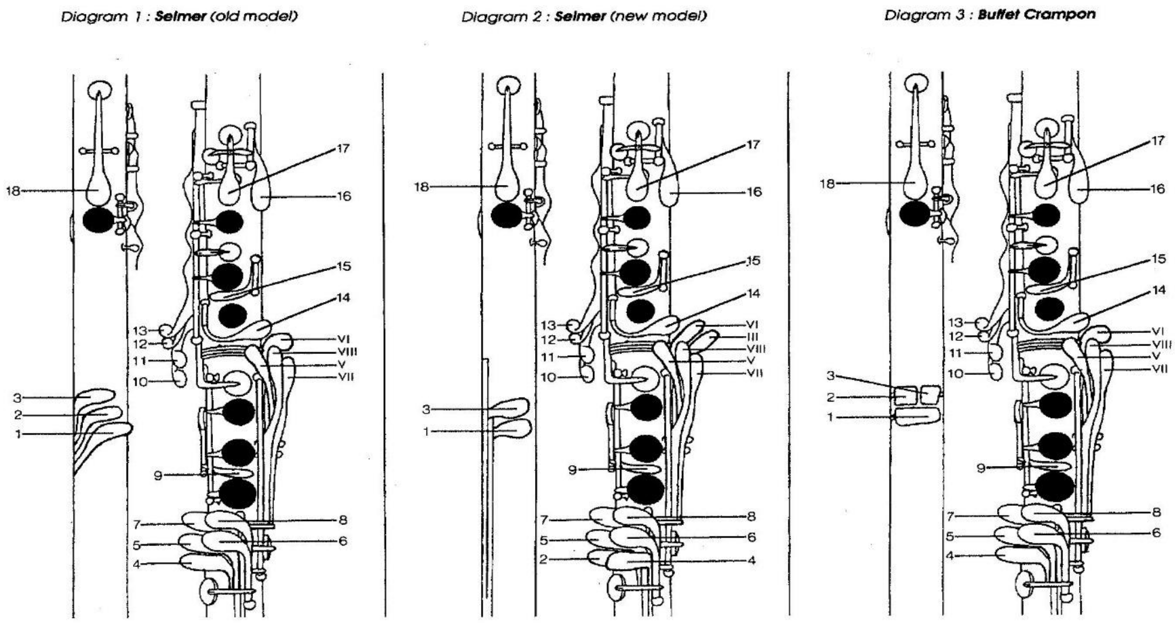

Figure 43: Bok’s key notation system in *New Techniques for the Bass Clarinet* (2011, p.4)

For the pads which can be operated by either a left or a right hand key I used (corresponding) Roman numerals to label the left hand set of keys (Figure 43). For example, to play E1 either key 5 (right hand) or key V (left hand) could be used. I have since slightly adapted my system, by replacing the Roman numerals with an added ‘a’ to the Arabic numeral. For example, instead of ‘V’, I now use ‘5a’. Sparnaay adopted this system in his book (2011, p.39) with only

[36] Therefore, a ‘short’ bass clarinet going down to E♭1 starts with key 4.

two changes: he used ‘3b’-‘8b’ instead of Roman numerals to indicate the ‘doubling’ left hand keys, and ‘3c’ to denote the third D1 key, which the Buffet Crampon model that Sparnaay played possesses.[37] Since many composers already used the notation system I had introduced in my book, it is highly relevant that Sparnaay contributed to more uniformity in the key nomenclature of the instrument. As pitch and key number are connected in this system, all fingering patterns can be applied to any makes and models, therefore misreadings are reduced to the minimum. Whilst certain keys might be located in various positions on different bass clarinets, or might be missing altogether, the numbers which refer to different pitches remain the same.

Another advantage of this system is the relative ease with which a fingering pattern can be written down—in shorthand—in parts, scores, and etudes. Let us take E♭4 as an example. In certain musical contexts the preferred fingering pattern would be the ‘open’ fingering, which requires only key 16 to be depressed. In the systems used by Rehfeldt, Richards, Watts, and American clarinettist Jason Alder, whole diagrams would have to be copied into the score. As Rehfeldt and Richards have two G♯/A♭ indications, one at the bottom, one at the top, the player would still have to include the whole diagram in order to locate which one to use. With the circles and numbers system you can simply put ‘16’ in the score and it is unambiguously clear.

Whilst Alder and Watts both use drawings to represent the keys, and the names they assign the different keys are near identical (see Figure 37 and Figure 38), there are some differences, the most essential of which is the missing key in Watts’ fingering system: the ‘A’ key [key 17, HB] (2015, p.83).[38] Furthermore, the representation of keys 1, 2, 3, and 5a-8a is handled differently by the two sources. Whenever a fingering pattern uses key 1 or key 2 Watts puts the letters (C or C♯) in boxes to the left-hand side of the diagram, and whenever a left hand little finger key is prescribed, Watts puts the letter of the note written on the right hand side of the diagram. Alder relies solely on the drawing of the keywork system.

Various inconsistencies in her work detract from Watts’ system. As Figure 44 shows, in SW48 (2015, p.175)[39] Watts writes ‘e’ to indicate key 5a, whilst in

[37] This key, which is located at the back of the lower joint, has been changed to an alternative E♭1 on the new Tosca model.
[38] Whilst my research here does not specifically cover multiphonics, my investigations of microtonality on the bass clarinet have shown that multiphonics using the ‘A’ key [key 17, HB] do exist. Therefore, Watts’ negligence to include this key, limits the viability of her study.
[39] SW48 refers to Watts’ numbering system of multiphonics: Sarah Watts multiphonic number 48.

both SW52 and SW94—fingering patterns which include key 5a—the notation has been changed to an ‘E’ (2015, p.176, p.183). This is despite the use of capital letters in her key naming system being associated with the right hand thumb keys (1, 2, 4a).

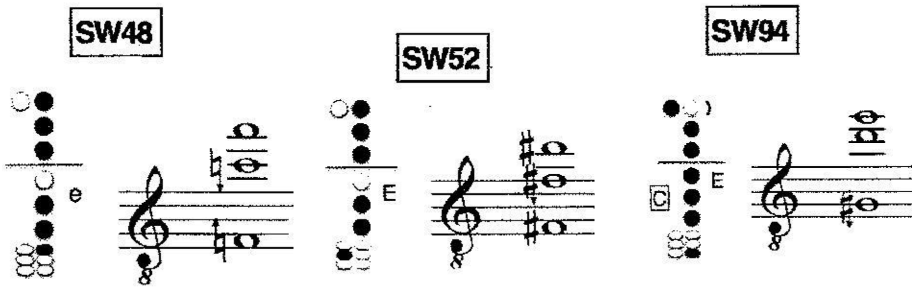

Figure 44: Watts (2015, p.175, p.176, p.183), fingering patterns SW48, SW52, and SW94

There also appears to be some confusion around the use of alternative keys in Watts’ system. For example, the fingering pattern for SW52 (Figure 44) shows that both key 5 and key 5a have to be depressed, but since both keys operate the same pad, this is totally unnecessary. Equally confusing is the fingering pattern SW94 (Figure 44), which prescribes that key E [key 5a, HB], key D [key 3, HB], and key C [key 1, HB] should all be operated. However, depressing key 1 automatically shuts the other two keys, therefore Watts’ notation seems unnecessarily complicated.

Alder’s key nomenclature system is more consistent as it only uses graphical representations of the keys, but reading those graphics can be difficult. This especially applies to the set of keys representing keys 3a, 5a, 6a, 7a, and 8a. Without Alder’s ‘Guide to the Fingering Chart’ at hand it can be a challenge to distinguish between the tiny ‘flower petals’ that he uses to represent these keys (Figure 45).

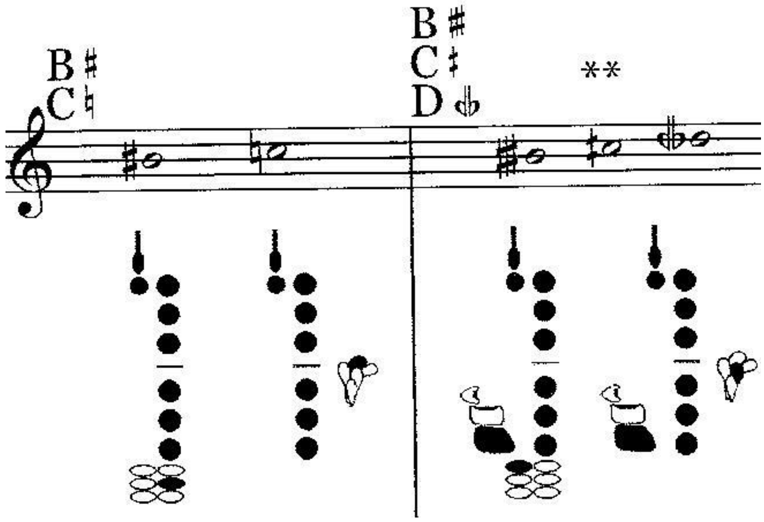

Figure 45: Alder (2013, p.4), two key notation examples showing the difficulty in reading the graphics representing keys 3a and 5a-8a

A general problem with interpreting the visual representation of keys, a problem shared by the notation systems of Alder and Watts, is that keys are not always used to sound the same notes on the different makes and models.

A comparison of the keywork on two different models highlights the issues of visual representation (Figures 46 and 47). For example, the key highlighted in red in Figure 46 [key 4, HB], which Alder calls the “RH Low E♭ Key”, used to have a different function. On one of the Selmer Paris models I used during the research for my book in 1989 (called the ‘new’ model at the time), the key in that position used to be key 2, Alder’s “Low C♯ Key”. On the same model, the key highlighted in green was used for E♭1 [key 4, HB], but is now used to play D1 [key 3, HB]. Finally, on the same model, the key highlighted in blue, on the back of the instrument, was used for D1 [key 3, HB], but is now used to play C♯1 [key 2, HB]. When you own such an instrument (and there are still plenty around), the visual representation in Watts’ and Alder’s notation systems could easily lead to misunderstandings, even with the explanations given by Alder in his ‘Guide to the Fingering Chart’.

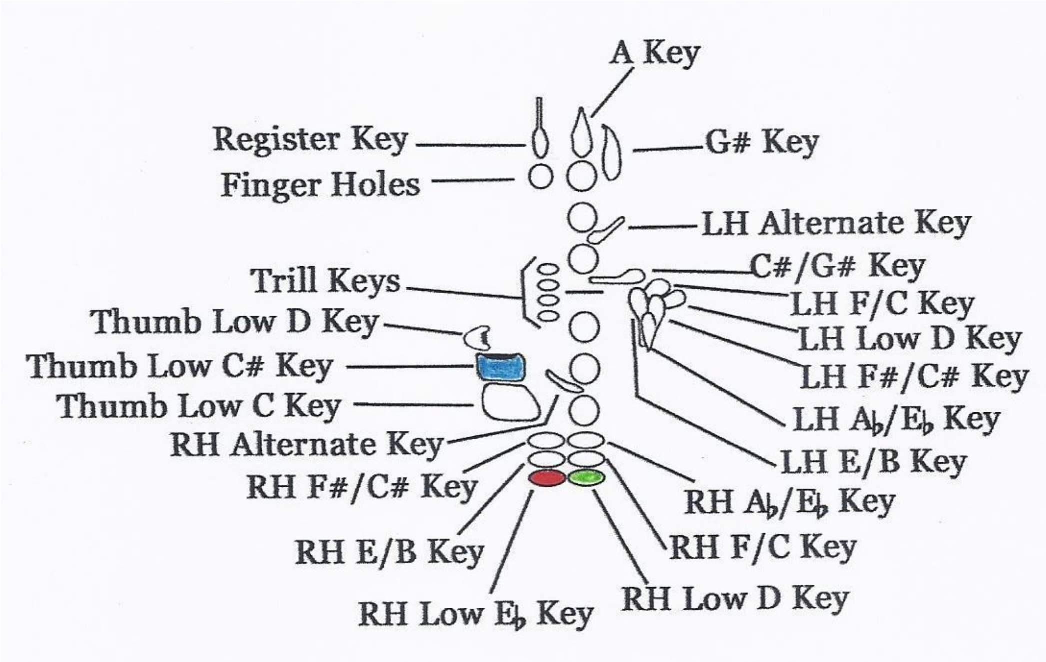

Figure 46: Alder (2013, p.iii), 'Guide to the Fingering Chart'

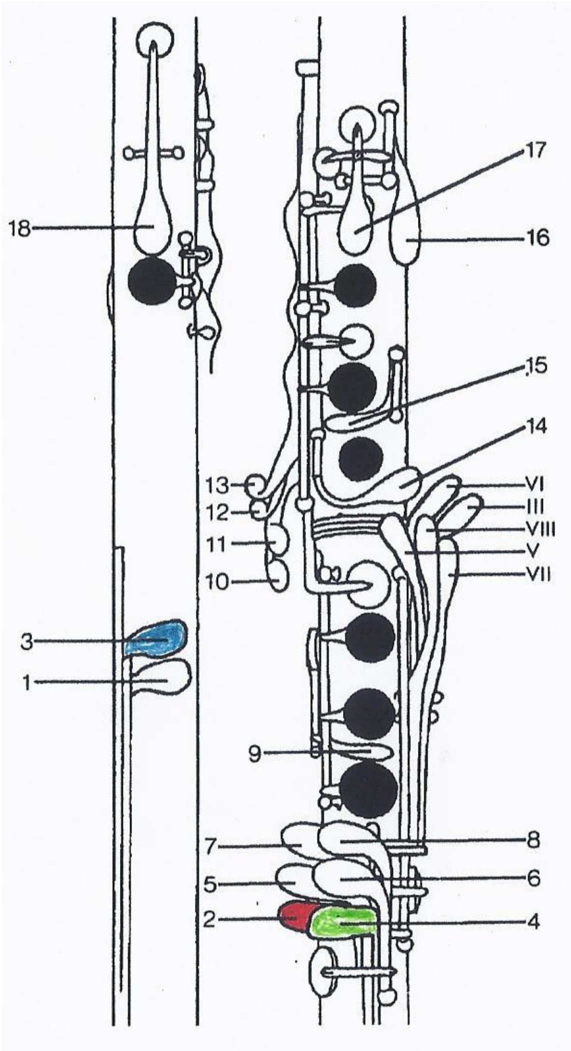

Figure 47: Bok (2011, p.4), diagram of Selmer Paris (new model)

The interpretation of Alder's key notation system also poses problems for current model instruments, as he uses drawings to represent the right hand thumb keys. On Alder's Buffet Crampon instrument, the upper key in this section of the diagram is the "Thumb Low D Key" (Figure 46), which is used to play a D1, but due to the different keywork on Selmer Paris instruments, Selmer players would see it and read it as an E♭1 [key 4a, HB] (see my key nomenclature system).[40] Although these fingering pattern charts are meant primarily for (French) Boehm system and not for German system bass clarinets, one could imagine that certain fingerings would also work on these instruments. However, many German models have four keys at the back and fewer keys at the front for the lowest notes. Of course, from the 'Guide to the Fingering Chart'

[40] On Selmer Paris instruments E♭1 can be played using either key 4 or key 4a.

the corresponding keys can be deduced, but it would not make any sense, visually speaking. The use of numbers aids in the elimination of these issues.

The key depressed by the left hand index finger [LHK1, HB] can be half closed, that is, depressing the key but not covering the vent hole in the middle of the key. For standard semitone fingerings on the instrument the half-closing of this key is usual for notes D4 and higher. Half-closing this key also generates more multiphonic and microtonal possibilities. Both Sparnaay and I use an ‘x’ to indicate half-closed, a form of notation which is, again, easy to write in shorthand. The notation for half-closing, common to Alder, Rehfeldt, and Watts, is a half-coloured circle (top half white, bottom half black).[41] Watts’ use of the half-closing of the left hand index finger key is only sporadic, in 18 of her 257 fingering patterns, whilst in Richards’ fingering patterns the half-closing option for this key is totally absent. His failure to include this additional option has meant that many of his fingering patterns are inexact.

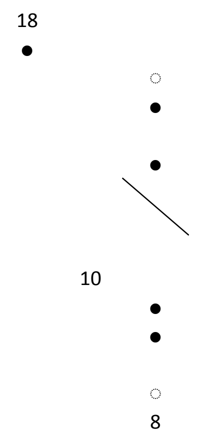

Figure 48: Richards (1995, p.33), fingering pattern for A𝄳4

When tested for this research, the pitch produced using Richards’ fingering pattern for A𝄳4 was actually A♭4 +14 cents, not even close to the quartertone pitch.

[41] Alder is the only one who explains the option of half-closing this key (2013, p.iv).

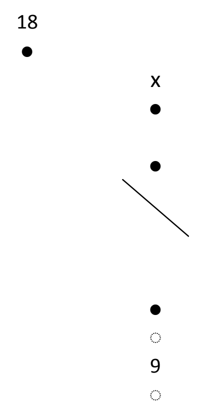

Figure 49: Bok, fingering pattern for A𝄳4 (Appendix B)

By utilizing the half-closing of the LHK1 (Figure 49) I was able to produce an A𝄳4 that fell within the margin of error set for this research (see section 3.2.2).[42]

3.2.1.3 Range, missing pitches, and accuracy

As was discussed in Chapter 1, the lowest fifth of the instrument is a problematic area for microtonality. The keywork in this region offers very limited possibilities for microtonal manipulation, meaning that the only options for microtonal playing in this range of the instrument is by embouchure manipulation or half-closing keys. One of the most salient differences between the quartertone fingering pattern charts found in other sources is where their quartertone scale begins.

Notwithstanding his reservations concerning the use of quartertones on the bass clarinet, Sparnaay still adds a list of fingerings “for those who want to experiment with these intervals” (2011, p.128). The first pitch Sparnaay includes in his chart is G𝄮1 [G𝄲1, HB], but he indicates that between this pitch and B𝄮1 [B𝄲1, HB] the microtonal pitch variants are smaller than quartertones and he describes them as ‘bisbigliando’, and “not even close to a quartertone”

[42] Another example is my fingering for E𝄳2 in my definitive 31-tone pattern chart, Appendix F: the fingering in Appendix D comprised thumb key, left hand index, middle and ring finger keys, plus keys 10 and 15. The measured pitch was a little flat. Half opening the index finger key brought the fingering pattern up to the right pitch.

(2011, p.128). Quartertone fingering patterns are given from B♮1 (Sparnaay, 2011, pp.128-129). Richards gives microtonal fingering patterns from A1: microtonal fingering patterns, that is, not quartertone fingerings. He marks his first two microtonal pitches as "**sl** (slightly low)" and "**sh** (slightly high)", stating that "it was not possible to find equal-tempered quarter-tones for all intervals" (Richards, 1995, p.30). So, both Richards and Sparnaay actually start their *quartertone* scale with B♮1.

Rehfeldt and Alder differ from this consensus and they provide fingering patterns from E♭1[43] and C1 respectively. As Rehfeldt advocates the use of the same fingering patterns for the eighth-tones either side of each quartertone pitch for the notes from E♭1 to D𝄳2, the accuracy of his fingering patterns is questionable. Looking at Rehfeldt's solutions for this area, the techniques used are: controlling key openings by the left calf, the right calf, the left knee and the right knee, lipping notes down, and half-shutting keys. Rehfeldt describes the impreciseness of these pitches as "fluid in nature" (2003, p.22), which contradicts his statement that "it should also be noted that the charts have been developed with pitch as a primary consideration rather than ease of finger movement" (2003, p.39). Alder's solutions for quartertones in the lowest fifth are very similar to those advocated by Rehfeldt: the use of either "half-keying" or embouchure manipulation (2013, p.ii, p.1), although he specifies that "these notes can…be obtained through other manipulations of the mouth rather than the imprecision of half-keys" (2013, p.ii). It is obvious that the use of such hard to control techniques will give very aleatoric and imprecise results, a sharp contrast with "the well-defined order of fingerings" which Bartolozzi advocates (1982, p.27). My review of all four existing quartertone scales (Appendix A1) clearly indicates that no precise quartertones could be measured lower than B1.

The highest quartertone pitch for which Sparnaay supplies a fingering pattern is B♮4, giving his quartertone scale an ambitus of three octaves (2011, pp.128-129). Richards' quartertone scale goes up to G♯5, covering almost four octaves (1995, pp.32-37). Rehfeldt's highest quartertone pitch is F♮5, which makes his ambitus slightly more than four octaves (2003, pp.33-39). Alder's ambitus for the quartertone fingering patterns is from C♮1 up to D𝄳6 (2013, pp.1-8). At slightly more than five octaves this is by far the largest range covered amongst the four sources. However, as Richards justly remarks:

[43] Although there is no information in the book regarding the bass clarinet model Rehfeldt has used for the verification of his fingering patterns, it is very likely that it was a low E♭ instrument. This notion is also supported by his multiphonics chart in which the lowest key used is the same E♭ (key 4).

> Another section of the quarter-tone scale that is weak consists of pitches above F-sharp 6 [F♯5, HB]. The altered air and embouchure pressure necessary to produce these pitches (often on different partials) [roots, HB], as well as awkward fingerings make them treacherous, especially if approached quickly by leap or attacked without preparation. (1995, p.30)

During the process of measuring microtonal pitches it has become clear that from F♯5/G5 and upward, measurements indeed become less precise and less reliable.

Ascending through the bass clarinet's ambitus, in general, fewer 'tricks' are needed, the exception being the pitches roughly between B2 and E3. As shown in Appendix A1, the quartertone fingering patterns in this range of the instrument often came out as imprecise, making the area B2-E3 the second problem zone for quartertones.

Whilst Rehfeldt supplies a distinct set of fingering patterns between A3 and F𝄱5 [F𝄲5, HB], for the pitches C𝄲3, D𝄳3, D𝄲3, E𝄳3, and F𝄲3, half-keying with the help of the calf, knee, and fingers have to come to the rescue again (2003, p.35). Alder brings half-keying and embouchure manipulation in again "for some of the clarion[44] register counterparts in the middle of the staff, where there are no other fingering options available for quarter-tones" (2013, p.iv). Sparnaay's fingering patterns for C𝄲3, D𝄲3, and E𝄳3 are marked "with the aid of the embouchure", and D𝄳3 is marked "only possible with embouchure" (2011, p.129). Richards does not include a fingering pattern for two of these pitches (C𝄲3 and D𝄳3), remarking: "From C4 [C3, HB] to D4 [D3, HB] there are no practical fingerings for quarter-tones, since virtually the entire length of the instrument is employed. Cross fingerings cannot be utilized" (1995, p.30).

[44] As opposed to the 'chalumeau' register (which is basically the root section of the clarinet, including the lowest fifth), the term 'clarion' refers to the overtone sections of the clarinet, notably the altissimo.

3.2.1.4 Hand position and keywork

Richards states that: “Adjacent notes in a microtonal scale” have been chosen “not only according to pitch, but according to several basic guidelines” which include “minimum motion” and the “avoidance of contrary motion, where possible” (1995, pp.3-4). These guidelines, and his avoidance of cross-fingerings, limit his microtonal success.

Other sources do not adhere to the same guidelines or ideals as Richards, but it is interesting to note that, alongside Richards, neither Alder nor Rehfeldt choose to examine the options provided by operating keys with different fingers. Both Sparnaay and Watts do explore this, and use the right hand thumb to operate additional keys to those it normally is used for (keys 1, 2, and 4a). In his quartertone chart Sparnaay only uses this technique once, for B𝄲2, but he clearly explains to the reader that “key 13 must be played with the right hand thumb (away from under the thumb support)” (2011, p.129). Although Watts fails to explain this phenomenon, one only has to look at her diagram labelled “Figure 4.9” (2015, p.89), an example of a type 2 multiphonic, to discern that the only way keys 12 and 13 can be depressed is by using the right hand thumb. That the other sources—Alder, Rehfeldt, and Richards—do not include this technique in their fingering patterns, means that fingering pattern opportunities have been left unexplored. Other, or more exact fingering patterns, could possibly have been found, if they had used the right hand thumb as an additional digit.

As remarked earlier, Rehfeldt provides no information about the type and make of bass clarinet he used to establish the fingering pattern chart in his book, whilst it is known that Alder, Richards, and Sparnaay all used Buffet Crampon instruments for their research. This information is important, as the two main French brands, Selmer Paris and Buffet Crampon, do not offer the same microtonal possibilities. This is due to a combination of the different layout of the lower joint keys and a different functioning of upper joint side key 14, which is used for C♯2 and G♯3. It is opened by the left hand little finger. In the fingering patterns for C𝄲2 proposed by Alder, Richards, and Sparnaay (Appendix A1) the player has to close keys (RHK1, RHK2, or RHK3) on the lower joint with combinations of the right hand index, middle, and ring fingers. On a Selmer Paris instrument closing RHK1 and RHK2 will automatically close key 14. As the pad operated by key 14 must be open in order to sound the quartertone, their fingering patterns for C♯2 therefore do not work on the Selmer Paris instrument.[45]

Richards presents fingering patterns, such as the one for C♯2, involving the use of key 14 and closing holes of the right hand, but does not acknowledge this represents a difficulty for Selmer players. Both Sparnaay and Alder indicate this issue very clearly. Alder comments:

> One particular difference to note is with instruments with articulated C♯/G♯ keys, such as those from Selmer. With these instruments, closing any holes of the right hand will also close the C♯/G♯ [key 14, HB] if it's open.[46] An alternate will need to be found for any notes requiring this hole to open with right hand holes closed. (2013, p.iii)

As the bass clarinet I used for this study is a Selmer Paris instrument, it meant that I could not review and measure the fingering patterns belonging to this category and that I had to come up with alternative fingering patterns for my instrument.

The change in ergonomics of the current bass clarinet makes and models have, on the one hand, made certain fingering patterns which would have had to be discounted in the past, currently possible. On the other hand, some fingering patterns accounted for in the past can no longer be used. For example, as Sparnaay remarks, "with the older models a low E [E1, HB] or E flat [E♭1, HB] could be played and the low C key could be closed separately"[47] (2011, p.124).

3.2.1.5 Additional information

Richards includes indications for timbre (dark, slightly dark and slightly bright) and for pitch deviations (sh=slightly high and sl=slightly low) in his quartertone scale table. He also adds DAT for notes which are "difficult to attack strongly" (Richards, 1995, p.30). Timbre indications and the term 'strongly' are of course prone to subjectivity. Sparnaay also supplies additional information, writing about;

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[45] This construction was made by Selmer Paris to facilitate trills between lower joint notes and the C♯2/G♯3.

[46] However, depressing key RHK3 does not close key 14.

[47] In *New Techniques for the Bass Clarinet* these fingering patterns have been marked with 's.a.' (Selmer Paris ancien/old model).

- the sound ("very poor tone quality")
- the embouchure ("with the aid of the embouchure" and "only possible with embouchure")
- make/model limitations ("not possible on the Selmer bass clarinet")
- additional/special techniques ("key 9 played with the 4th finger of the right hand" and "key 13 must be played with the right hand thumb, away from under the thumb support") (2011, p.129).

Alder adds that it "may require extra manipulation with embouchure and/or tongue to lower [the] pitch" (2013, p.1) of fingering patterns involving half-keying, and Rehfeldt gives additional information whenever 'manipulation' is needed. For instance, "control the 'c♯' opening by obtaining leverage against the left calf" or "control 'e' opening by pressing against right knee, or with R.H. [right hand, HB] third finger" (Rehfeldt, 2003, p.35).

3.2.2 Towards a definitive quartertone chart

In order to be able to determine whether it is possible to play quartertones on the bass clarinet the first step taken was to check and determine the precise pitch of each fingering pattern in the quartertone scales by Alder, Rehfeldt, Richards, and Sparnaay. The measurements, which have been documented in Appendix A1, often show substantial deviation from the desired pitch. Pitch measurements in the fifth octave became more and more difficult, reaching an unacceptable grade of instability above G5. Therefore, notes above G5 have not been included in this research. Also, manipulations using knee, calf, or leg have not been taken into consideration. In the four sources there are no fingering patterns for D𝄳3 and G𝄲3, leaving 39 quartertone pitches between D2 and G5, for which there was a total of 219 measurable fingering patterns.

In order to analyse the results I nominally established categories of ten cents pitch deviation. Appendix A2 gives an overview of pitch deviations per note and makes the comparison between measurement results of a given pitch easier. It is notable that for some quartertones, fingering patterns have been documented which produce a wide range of pitch deviations (from small to extreme). For example, analysing the results for E𝄳4, seven fingering patterns have a pitch deviation of 1-10 cents and three have a pitch deviation of 11-20 cents. However, one fingering pattern has an extreme pitch deviation of more than 51 cents. By contrast, the fingering patterns for E𝄳2 all have a pitch deviation of

1-10 cents. Studying the fingering patterns for C𝄲4 and D𝄳4 reveals a huge disparity in pitch deviation. Each of these two pitches has one fingering pattern which has a pitch deviation of 21-30 cents flatter and one which has a pitch deviation of more than 51 cents sharper. The span between these two results is roughly 80 cents.

Appendix A3 shows the total measurement results in percentages. The majority (67%) of the fingering patterns were found to produce notes with a pitch deviation that was larger than ten cents from the actual quartertone. Huge pitch deviations were measured in the category of 51< cents (7%). Two fingering patterns produced notes with pitch deviations of more than a semitone. The category of 41-50 cents pitch deviation (3%) includes fingering patterns which are a quartertone away from the desired pitch. Similarly, sixth-tones (33.3 cents) and 31-tones (38.7 cents) fall within the category of 31-40 cents (11%) pitch deviation and eighth-tones (25 cents) in the category of 21-30 cents (17%). Only 33% of the fingering patterns produced notes with a pitch deviation of 1-10 cents.

In choosing my quartertone fingering patterns, I therefore wanted to increase the preciseness and reduce the pitch deviation. Adopting a pitch deviation of 1-10 cents either side of the exact quartertone as my margin of error, it was my goal to apply this 20% margin to all of my quartertone fingering patterns. This meant that fingering patterns which did not meet these strict criteria were not accepted.[48]

The next step in the process was to review the data found in two sections of my earlier book. In *New Techniques for the Bass Clarinet* Table 4 documented timbral changes and Table 5, which was aimed at a wider spectrum of microtonal variants, including quartertones, eighth-tones, third-tones, and sixth-tones, was titled ‘Microtones/micro-intervals’ (Bok, 2011, pp.25-39). I decided to check and measure all proposed fingering patterns on my current bass clarinet and set-up, and following my new approach to timbral change, which considers it as microtonal variants, these fingering patterns were also retested.

The decision that precision and reliability should be the main goals for the research meant that options for microtonal fingering patterns involving half-keying, lipping-down, and the use of the legs, ankles, knees, or thighs to close keys, as suggested by Rehfeldt and by Alder, had to be disregarded. As

[48] These are marked in the fingering pattern charts as ‘no fingering pattern fulfilled the research criteria’.

previously stated, these imprecise and unreliable options occur mainly in the lowest fifth and in the first corresponding overtone area (B2-E3), problematic zones for microtonality.

Despite not considering lipping-down as a primary means of adjusting the pitch in order to play a microtone, it is important to state that special fingering patterns alone are not sufficient for the creation of microtonal pitches. They need to be combined with correct embouchure and lower lip positions. It is for this reason that extensive video and audio material has been included in this study.

Sparnaay has called the notes given by the fingering patterns he includes for notes lower than B1, ‘bisbigliando’ (2011, p.128). Whilst I believe that there are some possibilities for microtonal manipulation using special fingering patterns between F♯1 and B1, the results are not close to quartertones. In *New Techniques for the Bass Clarinet* I had therefore categorized these as ‘variations in timbre’ or ‘colour fingerings’ rather than quartertones. My categorization of these small microtonal variants has since changed, and I now would choose to consider them as smaller microtonal entities.

3.2.3 Technical aspects

As explained in section 3.2.2, a margin of error of 10 cents either side of the precise quartertone pitch was allowed when documenting suitable fingering patterns. Only fingering patterns which produced pitches within this area would be considered as quartertones.

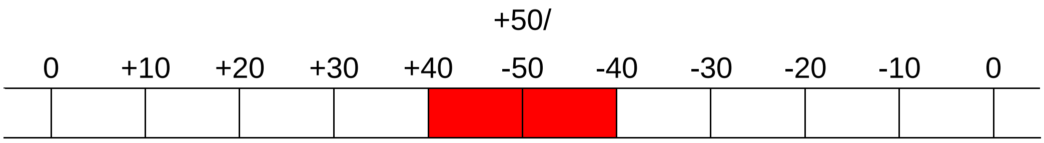

Figure 50: A diagram showing the margin of error allowed for the quartertone pitches between each semitone pitch (The 0's represent any two chromatic semitones. The area in red represents the allowed margin of error)

Measurements were done tuned to A=442 Hz, using the same instrumental set-up throughout, including the reed. The use of the same reed to check and document the microtonal pitches was of particular importance. The reed is a significant variable when doing tests, as the shape, balance, strength, and flexibility vary a lot, therefore using different reeds could have made the results less reliable.

Often fingers had to be re-located and used to depress keys other than the ones they are traditionally used for, in order to find quartertone fingering patterns which met the parameters of this research. The most frequent occurrence of this phenomenon was the use of the right hand thumb (which traditionally operates the keys at the back of the lower joint: keys 1, 2, and 4a) to depress side keys 10, 11, 12, or 13 on the upper joint. These are keys which are traditionally operated by the right hand index finger. The left hand middle finger and the right hand middle finger, ring finger and little finger have had to be re-located occasionally, in order to make quartertone fingering patterns possible.

The choice of logical subsequent quartertone fingering patterns to be used in a scale format may prove to be problematic in other quartertone contexts. Players and composers should be especially careful with combinations of quartertones in which the role of the right hand thumb in subsequent fingering patterns changes from depressing a key at the back of the lower joint (for which this digit is traditionally used) to depressing side keys on the upper joint (keys 10, 11, 12, and 13), since sufficient time must be allowed for the thumb to change position.

Sometimes the relocation of fingers is only needed in certain pitch sequences and not needed in other microtonal contexts. This is included as additional information in the fingering patterns chart.

3.2.4 Preferred notation

I believe that quartertones should be easy to read and easy to write: consistent and unambiguous. Combining these parameters would favour the use of the smallest possible number of symbols. Since there are only two added pitches within a whole tone, the symbols for quartertones can be reduced to two. Although Richards, Sparnaay, and Villa Rojo have each opted for different graphics, they all use only two symbols. In the first edition of his *Bass Clarinet Quarter-Tone Fingering Chart* Alder also had only two symbols, 𝄲 and 𝄳, but in his second edition he added “enharmonic spellings for three-quarters sharp (♯𝄲) and three-quarters flat (𝄳♭)” (2013, p.ii). He comments: “I intentionally omitted them the first time because, frankly, I don’t like them. I would prefer to read quarter-tones in relation to the closest full tone than as three-quarters tones, such as A𝄲 instead of B𝄳♭” (Alder, 2013, p.ii). Not everyone will agree, composers might want to use three-quarters sharp or three-quarters flat symbols for “reasons of desired voice leading” (Richards, 1995, p.30), but from a performer’s point of view, “adherence to either sharps or flats within a work will make visual and technical recognition easier” (Richards, 1995, p.30).

However, performers might also prefer to use the symbols ♯𝄲 and 𝄳♭ in certain instances dependent upon the fingering pattern required to play the microtonal pitch.

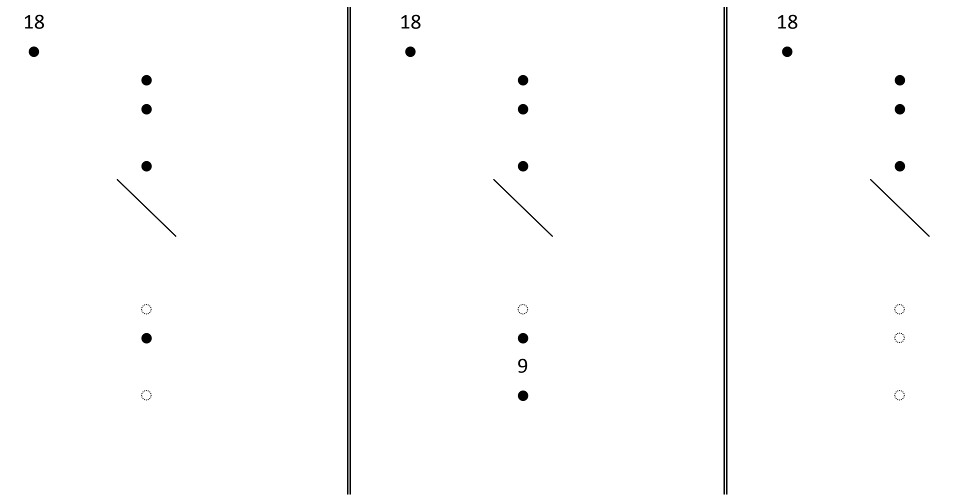

Figure 51: Fingering patterns for F♯3, G𝄳3, and G3 (Appendix B)

In Figure 51 a sequence of three fingering patterns is shown for the notes F♯3, G𝄳3, and G3. As can be seen, the fingering pattern for G𝄳3 bears a closer resemblance to that for F♯3, than that for G3. Key 9 and RHK3 are added to the fingering pattern for F♯3. Key 9 *raises* the pitch of the fingering pattern for F♯3 and for this reason many performers might prefer to read an F♯3 in the notation rather than a G𝄳3.

Alder decided to include the three-quarters symbols in his revised edition, "since notation for three-quarters tones exists and is used" (2013, p.ii), but the result is that for one quartertone pitch he has two, or sometimes even three alternative notation patterns (for example, B♯, C𝄲 and D𝄳♭), which for me complicates matters more. Taking into account all the arguments discussed above, I would, however, like to propose as my preferred notation, for reasons of simplicity and uniformity, a system of two graphics, which consistently indicate a quartertone up or down from the indicated pitch:

𝄲 quartertone higher

𝄳 quartertone lower[49]

[49] Heather Roche, one of the most recent sources on contemporary (bass) clarinet techniques, also uses this notation (www.heatherroche.net).

Laid out in one octave, for example from D2 to D3, this would be the result in writing:

D2 – D𝄲2 – D♯2/E♭2 – E𝄳2 – E2 – E𝄲2/F𝄳2 – F2 – F𝄲2 – F♯2/G♭2 –

G𝄳2 – G2 – G𝄲2 – G♯2/A♭2 – A𝄳2 – A2 – A𝄲2 – A♯2/B♭2 – B𝄳2 –

B2 – B𝄲2/C𝄳2 – C3 – C𝄲3 – C♯3/D♭3 – D𝄳3 – D3

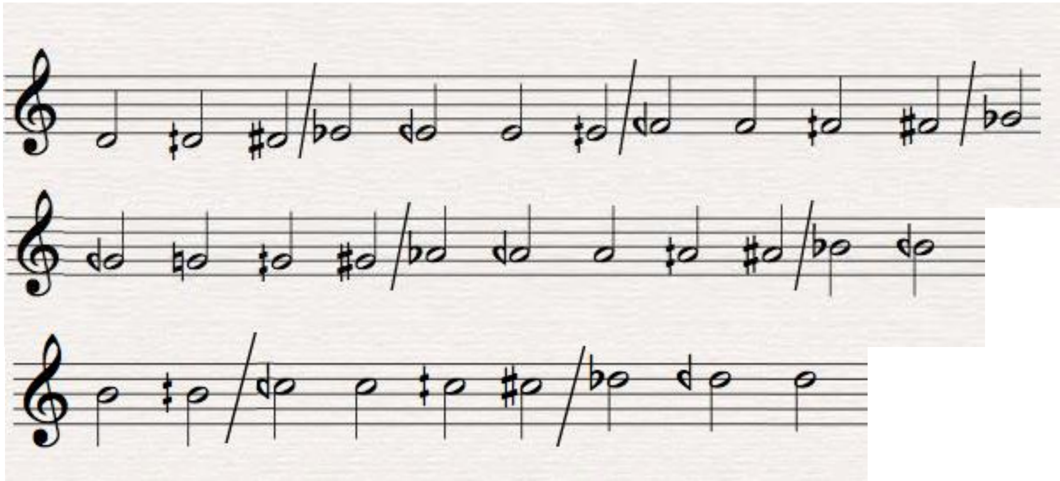

Figure 52: D2 to D3 notated in quartertones

3.2.5 Results

Due to the difficulties encountered in the lowest range of the instrument and as the first quartertone pitch which fulfilled the research criteria was actually D𝄲2, I chose to start my quartertone scale on D2. This means that the lowest ninth of the instrument is not suitable for quartertone playing. Because of the difficulties with pitch measurements above G5, I have decided that this will be the highest note included in my scale.

During my endeavours to find an exact quartertone scale I encountered the same problems as other players had for some of the notes in the range B2 to E3. The only potential fingering pattern which I found for C𝄲3 was the same as that of both Alder and Sparnaay. Upon testing the fingering pattern, the result was C♯3 -19 cents, meaning it was much too high. In his chart Alder states that the fingering pattern “may require extra manipulation with embouchure and/or tongue to lower pitch” (2013, p.4). Albeit the only fingering pattern option, I had to disregard it in the final version of my chart (Appendix B), as it did not meet the set parameters.

I have not been able to find fingering patterns for D𝄳3 or D𝄲3 which fulfil the strict research criteria. D3 is a very problematic note for any microtonal change, since depressing the keys available for changing the pitch—keys 1, 2, 3, 4, 5, 6, 7, and 8—all change the pitch by a semitone or more, as do keys 10, 11, 15, 16 and 17.[50] Neither do the side keys of the upper joint prove to be of much use as far as microtonal changes of D3 are concerned. Key 12 raises the pitch just ever so slightly—not even an eighth-tone—and key 13 does not change the pitch at all. On Selmer Paris instruments key 14 does not operate any pad, when the right hand keys are closed. Due to these technical restrictions of the instrument it is not surprising that no solutions have been found for the microtonal manipulation of D3 (D𝄳3 and D𝄲3).[51]

The range between D2 and G5 includes 41 quartertone pitches. I have been successful in finding fingering patterns that meet the research criteria for 38 of these pitches. Additionally, wherever more than one suitable fingering pattern was found, it has been included as an alternative. In the discovery of this quartertone scale every effort has been made to take into consideration the most convenient and logical sequence of fingering patterns. I continued to refine my quartertone fingering patterns during the process of finding suitable eighth-tone fingering patterns. My definitive quartertone fingering pattern chart can be found in Appendix B and in Video 10.

Video 10: Quartertone scale

[50] Opening key 10 (or 15 which is interchangeable with 10) results in a C4; opening keys 10 and 11—a common combination—results in G♯4 when underblown, and in a D𝄳4, with normal embouchure (a combination of both types of embouchure creates a dual sound); opening key 16 results in a A𝄳2 when underblown and in a D𝄮4 with normal embouchure; opening key 17 results in an A𝄲2.

[51] In her blog, Heather Roche too signals this problem: “You’ll notice that there is no series starting from the D quarter flat on the fourth line. That’s because there is no viable fingering for this pitch and it should be avoided in all cases!” (www.heatherroche.net).

3.3 Eighth-tones

Whilst trying to find fingering patterns which allow quartertones to be played on the bass clarinet I discovered that many of the existing sources of quartertone charts included fingering patterns which actually produced pitches closer to eighth-tones. I made the same discovery when studying my own previous work, *New Techniques for the Bass Clarinet* (2011).

Of the sources consulted, only Rehfeldt presents eighth-tone fingering patterns (2003, pp.33-39), but for many pitches the same fingering pattern is given for three subsequent microtonal pitches. For example, Rehfeldt uses the same fingering pattern for C𝄲2 and for the eighth-tones either side of it. He marks these fingering patterns with an asterisk to indicate that “the pitches are fluid in nature, that is, they do not ‘lock in’ at a definitely prescribed point” (Rehfeldt, 2003, p.22). He also uses less accurate, and less controllable techniques in order to play his eighth-tones: frequently half-closing keys using various body parts.

Such techniques are hard to control exactly, especially in a short amount of time. When playing standing, which is becoming standard procedure when playing solos or duos, the use of parts of the legs to change the pitch can quite literally turn into a balancing act. Left with little information to be found in existing sources, I was challenged to come up with new data and put together an eighth-tone scale.

3.3.1 Towards a definitive eighth-tone chart

The research for eighth-tones was undertaken by applying the same basic principles as the quartertones: measurements were done tuning to A=442 Hz, and using the same instrumental set-up throughout, including the reed. For reasons of preciseness and reliability only specific fingering patterns were considered and lipping-down, half-keying and the use of the legs, ankles, knees, or thighs to close keys were disregarded.

I decided to apply the same margin of error of 20% as I had for my quartertone measurements. So, when measuring eighth-tones, a margin of error of 5 cents either way was allowed. This meant that all quartertone fingering patterns had to be scrutinized once more, under these stricter criteria.

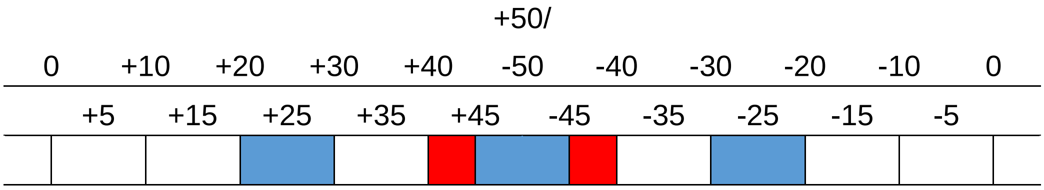

Figure 53: A diagram showing the margin of error allowed for the eighth-tone pitches between each semitone pitch (The 0’s represent any two chromatic semitones. The areas in blue show the margin of error allowed for each eighth-tone pitch. The area in red represents the original margin of error allowed for quartertone pitches)

Work documenting the precise pitch showed that whilst microtonal variants are possible around F♯1 and for the range from G♯1 to D2, measurements showed deviations of only 2-13 cents. It appeared that from C1 up to D2 no eighth-tones could be found which met my criteria. Aiming at finding sequences of eighth-tones rather than odd, isolated ones, I took D2 as my starting point and tried to establish a list of eighth-tone fingerings on my instrument covering three octaves and a fourth: from D2 up to G5.

3.3.2 Notation and preferred notation

As with quartertone notation, many notational varieties for eighth-tones are found in the literature. Rehfeldt uses a ‘+’ sign and a ‘-’ sign to notate eighth-tones (2003, pp.33-39). Interestingly, Hába used the same ‘+’ sign to indicate a sixth-tone in his *Suita* op.96 (1964, for example, second movement, bar 16). Although Sparnaay does not include fingering patterns for eighth-tones, he does include a list of symbols for quartertones and eighth-tones used by composer Gérard Grisey (2011, p.126). Grisey notates an eighth-tone sharp with an arrow up ↑ and an eighth-tone flat with an arrow down ↓. Villa Rojo has a whole inventory of notational options for quartertones, but only three symbols for eighth-tones: 𝄲 (eighth-tone higher) and ♭̸ and 𝄳 (eighth-tone lower) (2003, p.14).

For reasons of readability and consistency the symbols I will use to notate eighth-tone pitches are a combination of the traditional ♮ ♯ and ♭ signs and arrows going up or going down.

Eighth-tone higher: 𝄮 𝄰 𝄬
Eighth-tone lower: 𝄯 𝄱 𝄭

These symbols are very largely the same as those Rehfeldt uses to notate quartertones. Laid out in one octave, for example from D2 to D3, this would be the result in writing:

D2 – D𝄮2 – D𝄲2 – D𝄱2/E𝄭2 – D♯2/E♭2 – D𝄰2/E𝄬2 – E𝄳2 – E𝄯2 – E2 – E𝄮2 – E𝄲2/F𝄳2 – F𝄯2 – F2 – F𝄮2 – F𝄲2 – F𝄱2/G𝄭2 – F♯2/G♭2 – F𝄰2/G𝄬2 – G𝄳2 – G𝄯2 – G2 – G𝄮2 – G𝄲2 – G𝄱2/A𝄭2 – G♯2/A♭2 – G𝄰2/A𝄬2 – A𝄳2 – A𝄯2 – A2 – A𝄮2 – A𝄲2 – A𝄱2/B𝄭2 – A♯2/B♭2 – A𝄰2/B𝄬2 – B𝄳2 – B𝄯2 – B2 – B𝄮2 – B𝄲2/C𝄳2 – C𝄯3 – C3 – C𝄮3 – C𝄲3 – C𝄱3/D𝄭3 – C♯3/D♭3 – C𝄰3/D𝄬3 – D𝄳3 – D𝄯3 – D3

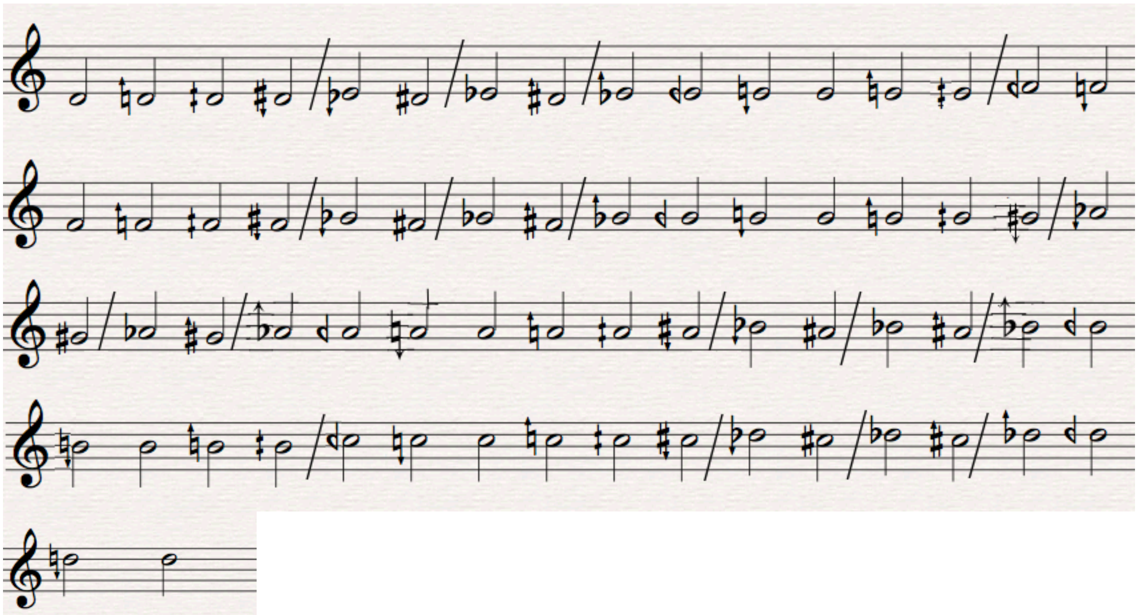

Figure 54: D2 to D3 notated in eighth-tones

3.3.3 Results

Of the 82 eighth-tone pitches accounted for, I could not find fingering patterns for 16: 12 in the first octave (D2-D3) and four in the second octave (D3-D4). The first octave, D2-D3, largely consists of roots (fundamentals), which explains why 12 of the 16 notes for which no fingering options were available, are found in this octave. From D4 up to G5, one octave and a fourth, not a single fingering pattern is missing, which could be expected because of the abundance of root-overtone fingering options.

Looking at the bigger microtonal picture the same area, B2-E3, again has to be signalled as very problematic. Of the eight eighth-tones between C3 and E3, fingering patterns have only been found for three of them.

Wherever more than one fingering pattern was found, it is mentioned as an alternative. Also, in the case of the eighth-tone chart an effort has been made to take into consideration the most convenient and logical sequence of fingering patterns. My definitive eighth-tone fingering pattern chart can be found in Appendix C and in Video 11.

Video 11: Eighth-tone scale

3.4 Applications

In this section I want to look at the way I have applied the newly found data regarding quartertones and eighth-tones to my artistic activities as a performer and as a composer, by interpreting solo works involving microtonality written for this project by other composers, by collaborating on microtonal pieces with other performers, and by performing my own microtonal compositions.

Several composers responded positively when I asked them if they would like to be part of my microtonal artistic journey and wrote new solo pieces for me: Spanish composer Francisco Domínguez, German composer Norbert Laufer, British composer Roger Redgate and French composer Fabien Téhéricsen. Three of these four composers combined several types of microtonality. Domínguez was the sole composer who decided to base his writing largely around quartertones, therefore, his composition will be the only one studied in the next section.

3.4.1 Domínguez: *Cuerpo Negro*

Domínguez started to write his solo work *Cuerpo Negro* in May 2016. I discussed the handwritten sketches of the piece with Domínguez on several occasions, and in March 2017 the composer sent me the first full version of the score. On May 27, 2017 Domínguez sent me a revised version of *Cuerpo Negro* to which he added the text of *Cuerpo Negro*, the poem by Spanish-Cuban author Alfonso Hernández Catá, the source of inspiration for Domínguez to write his composition. As he wanted to use more of the text than the first two lines he used for the solo piece, he subsequently added a second part to the work, for soprano voice and bass clarinet.

Domínguez' writing is quite bass clarinet specific and the sound world he intends to create suits the instrument well. His use of the bass clarinet's resources is very skilled and knowledgeable. However, there were challenges regarding the microtonality in the piece, as Domínguez included a number of quartertone pitches for which I had not found fingering patterns. Through intensive email communication I started a collaborative process with the composer, pointing out the problems and suggesting possible solutions.

I explained to Domínguez that, when I started working on my quartertone fingering pattern chart, I was hoping to establish a measured sequence from D1 up to G5, although I realized that certain areas, C3-E3 in particular, would pose problems. Upon completion of my research I was left with the following problematic quartertone pitches: five fingering patterns were missing (C𝄲2, D𝄳2, C𝄲3, D𝄳3, and D𝄲3). We then started to discuss the bars in the piece which contained these 'drop-out' notes.

- D𝄳2 occurred once in the piece, the last pitch of bar 27 (Figure 55). Domínguez first asked me to "play D♮2 instead of the impossible D𝄳2 at the end of bar 27" (F. Domínguez, personal communication, May 28, 2017), but when he sent me the final version of the score, he had changed all three pitches of the final sequence of bar 27 (Figure 56), in my view a logical continuation of the previous sequence.

- Bars 51-55 contained several C𝄲3 pitches. As Domínguez writes chromatically in quartertones, I assumed that he wanted to have exact outcomes. My suggestion was to bring the whole passage up one octave, as all quartertone pitches are available and sound very easily from C4 upward. Domínguez seemed very happy with this suggestion and decided to transpose the passage (Figure 57).

- There was one last problematic section in the piece, bars 88-90, which contained the ‘missing’ pitches C𝄲3, D𝄳3, and D𝄲3 (Figure 58). In the course of my research I had found approximate fingering patterns which did not meet my margin of error and I decided to mention this to Domínguez. After discussion and deliberation he decided to “accept the C𝄲3 and the D𝄲3 as not exact and to change D𝄳3 in bar 88 to C♯3, and in bar 89 to C♮3” (F. Domínguez, personal communication, May 30, 2017). Figure 59 shows the final version of bars 88-90.

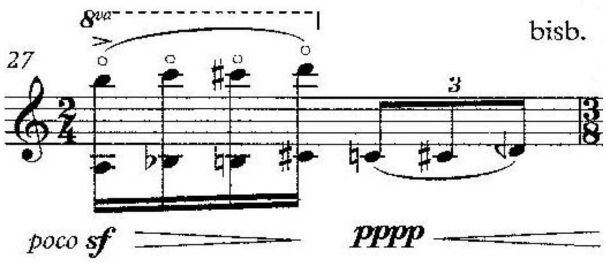

Figure 55: Domínguez, *Cuerpo Negro* part 1, bar 27, original version

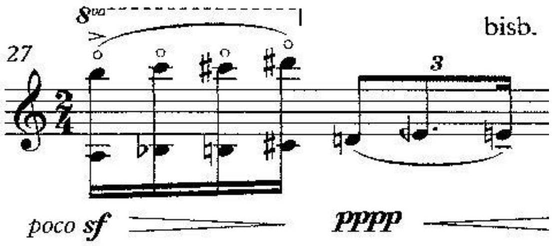

Figure 56: Domínguez, *Cuerpo Negro* part 1, bar 27, final version

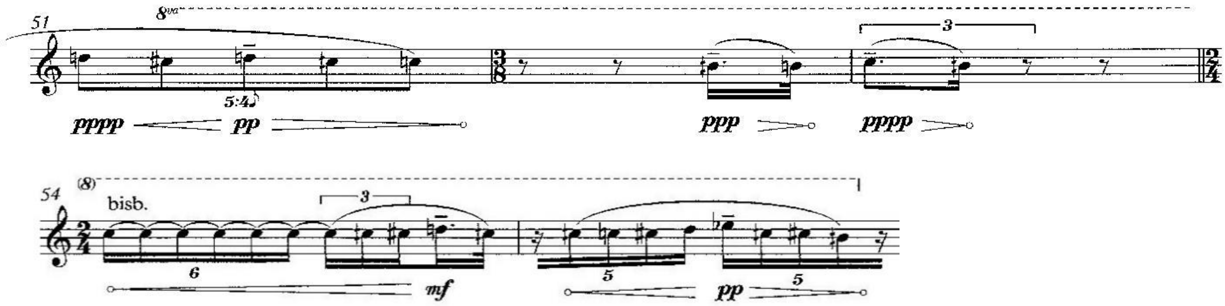

Figure 57: Domínguez, *Cuerpo Negro* part 1, bars 51-55, final version

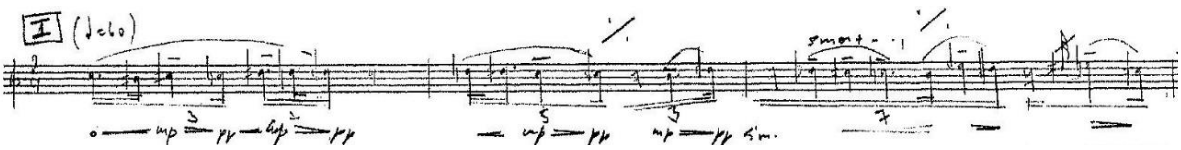

Figure 58: Domínguez, *Cuerpo* Negro part 1, bars 88-90, original version

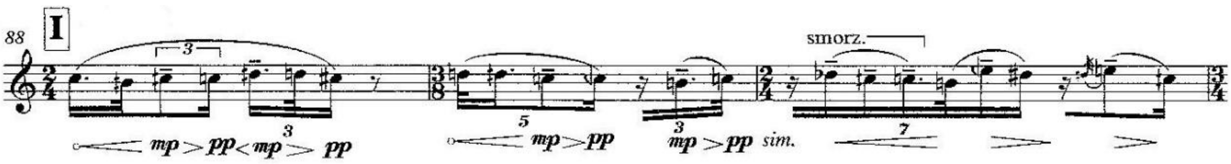

Figure 59: Domínguez, *Cuerpo Negro* part 1, bars 88-90, final version

Audio example 1: Domínguez, *Cuerpo Negro* part 1, bars 88-90, final version

A few of the issues discussed above also appear in the second part of *Cuerpo Negro*. In bar 17 there is another D𝄳3 for which no fingering pattern is available, and in section C (bars 50-63) the problematic pitches C𝄲3 and D𝄲3 occur frequently. However, they are found here in a context of greater pitch fluidity (use of lip glissandi up and down, microtonal trills in the bass clarinet part, and irregular vibrato in the soprano part) therefore the lack of precision of the C𝄲3/D𝄲3 pitches might be acceptable to the composer and I suggested the approximate fingering patterns to him. Having shared this information with Domínguez he has come up with the following solutions: “In bar 17 the D𝄳3 is resulting of a lip gliss. [glissando, HB] with the same fingering as the D♮ [D♮3, HB] (this is the rule for all the notes between brackets after a lip gliss)”. Domínguez writes: “In this part we leave it as it is”, agreeing with my remarks above regarding bars 50-63 (F. Domínguez, personal communication, June 2, 2017).

The exchange of information and feedback during the collaborative process between performer and composer led to a final result which dealt with the microtonal issues to the satisfaction of both parties. The solutions the performer and the composer came up with make the piece a more complete and resourceful work for bass clarinet in a microtonal context.

3.4.2 Own compositions

In my catalogue of works the compositions for solo bass clarinet are the highest in number. I have always included extended playing techniques in my pieces, and my opus one, *Vinho do Porto Brasileiro* (1997), written to be used as an encore, contains a great number of extended playing techniques, albeit without specific microtonal elements.[52] The first solo piece I wrote making extensive use of microtonality was *There is a place for multiphonics* (2012).[53] All the solo pieces written since have an extensive microtonal content.

The compositions written for duo Hevans are the second highest in number in my catalogue of works. Duo Hevans was founded in 2006 and consists of tenor saxophonist Evans and myself. Although pieces for alto saxophone and bass clarinet (for example, by Christian Lauba) and for baritone saxophone and bass clarinet (for example, by Lee Hyla) existed when the ensemble was founded, we were not aware of any existing repertoire for tenor saxophone and bass clarinet. We were attracted by this instrumental combination, since these two single reed instruments are able to merge together perfectly but are capable of huge contrasts as well. Many composers proved to be interested in this unusual chamber ensemble and now, 12 years after the start of duo Hevans, the repertoire has grown explosively.

[52] However, the root-overtone manipulations are used for their microtonal impact.
[53] This piece will be discussed in Chapter 5, as it uses many root-overtone microtonal variants.

Since around 2010 Evans and I have become increasingly interested in microtonality, partly because we met composers for whom microtonality is a regular component of their work, and partly because we started researching the microtonal capabilities of our wind instruments.

There has always been crossover between my roles as performer and composer and the duo gave me a lot of ideas and inspiration for new pieces. As performers, Evans and I like to push boundaries and to set the bar high, which is a great challenge for me as a composer. Such an ensemble offers a unique chance to try things out, an ideal workshop or 'laboratoire' for a composer.

In 2012 I wrote my first two microtonal pieces for the duo, *Fluctuations I* and *ANNalogy*, followed in 2014 by *Multi-Micro I*, and in 2016 by *small change*. The latter work was premiered in Dublin at the Doctors in Performance conference (September 8-9, 2016). The two 2012 works use mainly quartertones, whilst the two more recent works contain different subdivisions of the tone.

3.4.2.1 Bok: *Fluctuations I*

In *Fluctuations I*, and to a lesser extent also in *ANNalogy*, microtonal sequences appear in unison. During the workshop stage of the writing process I had to change pitches a couple of times, as writing crept into areas of one or the other instrument where no fingering patterns were found which were able to produce precise quartertones.

A characteristic example of the unison quartertone duo playing can be found in bars 5-6 of *Fluctuations I* (Figure 60). After playing in unison (heterophonically) at the beginning of bar 6 the two instruments play polyphonically from the third beat on, ending the bar playing a minor second.

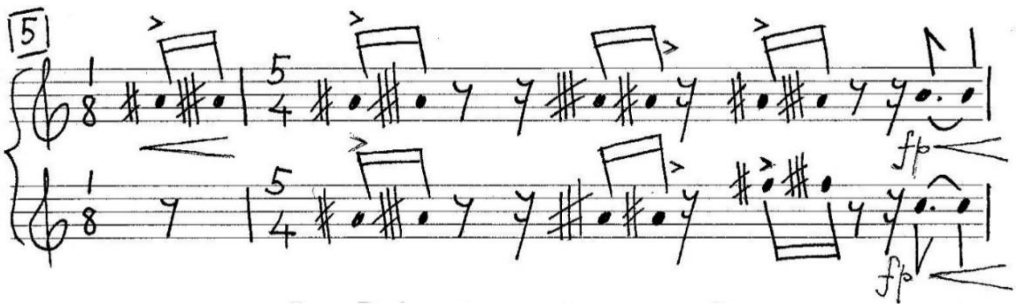

Figure 60: Bok, *Fluctuations I*, bars 5-6

When working on finding suitable quartertone fingering patterns, we allowed 10 cents either way of the exact quartertone pitch for each instrument. Despite this, during initial rehearsals, we discovered that an even greater precision of intonation was required for successful ensemble quartertone playing. For example, if the fingering pattern for the tenor saxophone had a discrepancy of ten cents above the precise quartertone pitch, and the bass clarinet fingering pattern had a discrepancy of ten cents below the exact quartertone pitch, the pitch deviation between the two instruments would be almost 20 cents, or in other terms close to an eighth-tone. In early rehearsals such pitch deviation was deemed unacceptable by both players, as it could cause beating between the two instruments (Audio example 2). Working further on reducing the margins of error we were able to come up with a different solution (Audio example 3).

Audio example 2: Bok, *Fluctuations I*, bars 5-6, original version

Audio example 3: Bok, *Fluctuations I*, bars 5-6, final version

3.4.2.2 Bok: *ANNalogy*

In this piece I chose to tackle an area of the bass clarinet's range that is microtonally limited. The opening of *ANNalogy* illustrates a recurring problem: C‡3. This pitch, the second note of the piece, is to be played in unison, which could be problematic as the microtonal options differ greatly between the bass clarinet and the tenor saxophone, for which this particular area is very rich in microtonal possibilities.
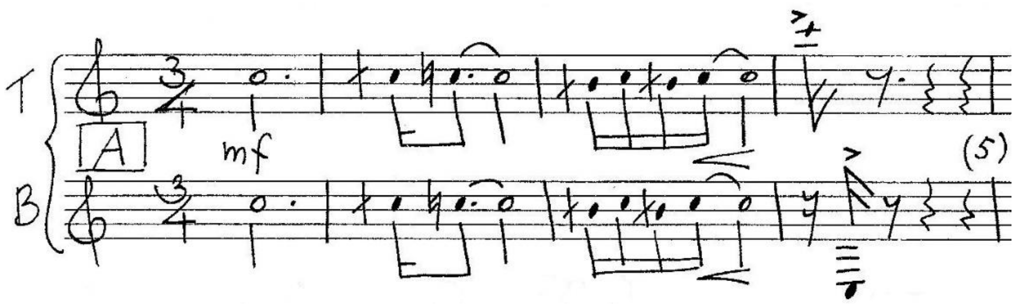
Figure 61: Bok, *ANNalogy*, bars 1-4

I was initially satisfied with a less exact microtonal change to the central pitch C. In early rehearsals, Evans was able to find a fingering pattern which matched the pitch of my less than exact fingering pattern (Figure 62).

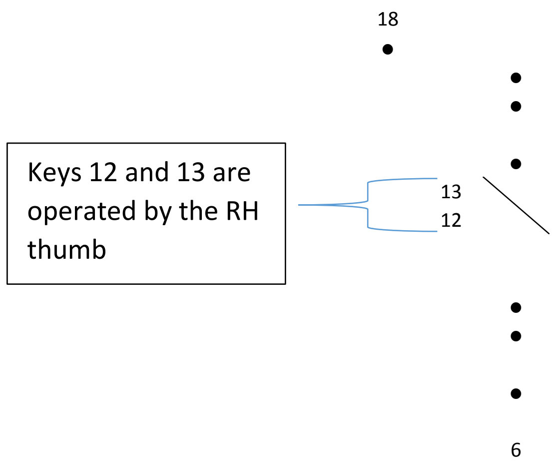

Figure 62: Fingering pattern initially used for the C‡3 in *ANNalogy*

My discovery of a better fingering pattern option (Figure 63), albeit still inexact, presented a new challenge for the duo: would we be able to match the intonation again?

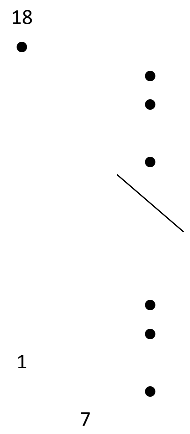

Figure 63: Fingering pattern now used for the C𝄲3 in *ANNalogy*

As this is a region of the bass clarinet that has few microtonal options, I was pleased with the discovery of the second fingering pattern. However, it meant that Evans had to find another fingering pattern which would combine well with my newly found, albeit still inexact, fingering pattern. She did discover an alternative fingering pattern and the old and the new versions can be heard on the two audio examples below.

Audio example 4: Bok, *ANNalogy*, bars 1-4, old version

Audio example 5: Bok, *ANNalogy*, bars 1-4, new version

In *ANNalogy* rehearsal letter D bar 5, the final section of the piece starts building, leading to a climactic outburst of sound in bar 14. To increase the musical tension in this section I mainly used a chromatic scale in quartertones, starting on A3 and ending on E𝄲4. The microtonal textures I used were playing a descending series of quartertones alternating between tenor saxophone and bass clarinet (bar 5), a descending series of quartertones played together in octaves (bars 8 and 9), and an alternating series of ascending quartertones between the two instruments from F♮3 up to C♮4, which is the start of a unison final section ending on E♮4 (bars 10-13).
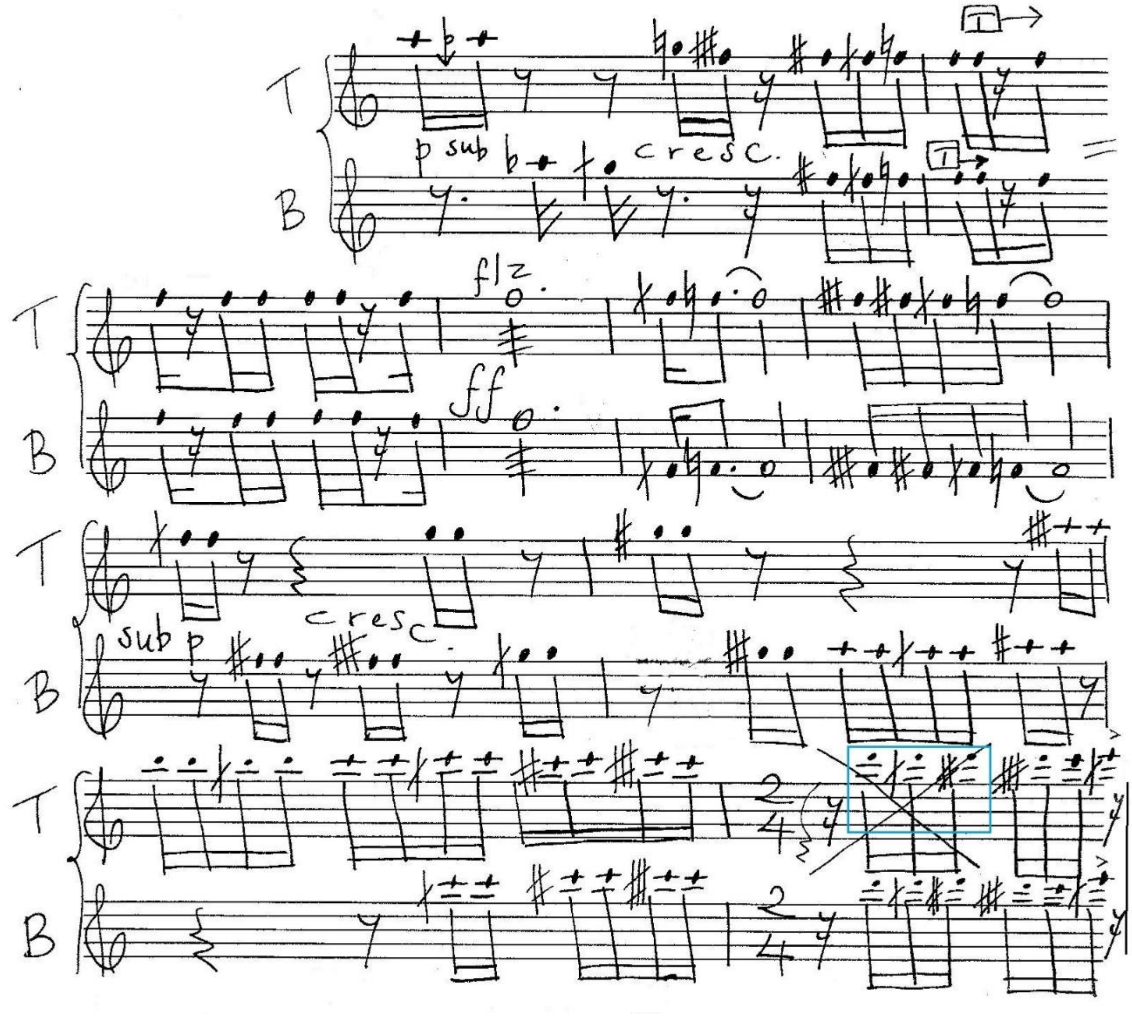
Figure 64: Bok, *ANNalogy*, letter D, bars 5-13

Audio example 6: Bok, *ANNalogy*, letter D, bars 5-13

In the first version of the score I had written the three notes D4, D♮4, and D♯4 in both parts. However, these pitches turned out to be very unreliable for the tenor saxophone because of the quick tempo and the fingering patterns required to play the prescribed pitches. Therefore, I decided to change the first beat of bar 13 to a bass clarinet sequence only and keep the second beat for both instruments in unison (Figure 64).

My writing for the combination of tenor saxophone and bass clarinet largely benefitted from the microtonal opportunities each instrument offered. The differences between the richer and the weaker microtonal areas of the two single reed instruments complimented each other, enabling me, as a composer, to optimally realize my musical ideas.

3.4.2.3 Bok: *E-A-E*

I wrote *E-A-E* in 2015 for my recital programme at the ICA ClarinetFest in Madrid (July 2015). It is a rather introvert work in which I use eighth-tones and other smaller microtonal divisions as the main structural element for the first time. Additional techniques include air sounds, multisounds, key clicks, shadow overtone trills, bisbigliando overtone trills, playing plus singing, and underblowing.

The composition also explores the softer dynamics the bass clarinet is capable of. The ***ppp*** opening of the piece starts with the lowest E available on the instrument, E1, followed by an E4, played as softly as possible, using a standard fingering.

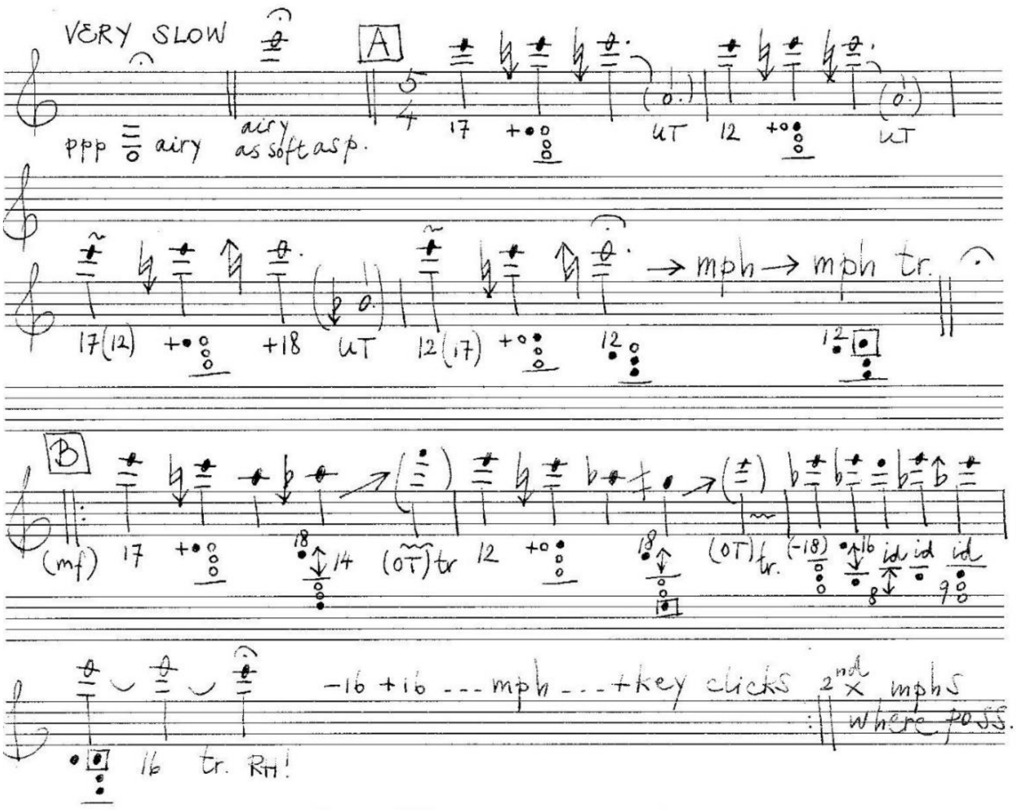

Figure 65: Bok, *E-A-E*, bars 1-10

All the dynamics are lower end dynamics, which means that the performer needs to deploy extreme technical control and to combine efficient finger movement, lower lip manoeuvring, and air management in order to sound the eighth-tone pitches. The influence of an extended dynamic range upon the playability of microtonal fingering patterns was something I first encountered with duo Hevans when working at the opposite end of the dynamic spectrum. The influence of extremely loud dynamics had a negative effect upon the microtonal results by flattening the pitch. By contrast, here I find the quiet dynamic levels in the piece aid the performance of the small microtonal changes, eighth-tones, which I have asked for, as lower end dynamics allow the microtonal pitches to sound more easily and permit greater embouchure manipulation.

Audio example 7: Bok, *E-A-E*, bars 1-10

3.4.2.4 Bok: *smaller change*

To conclude I would like to discuss a piece I have been working on during the process of writing this thesis. *smaller change* is a composition which has three formats: there is a version for bass clarinet solo, one for bass clarinet and tenor saxophone, and one for bass clarinet and piano.[54] For the bass clarinet part—which is the same in all three versions—I have chosen D4 as the central pitch, as it has lots of sonic variants. The version for bass clarinet and tenor saxophone features the instruments separated by one octave, the saxophone playing one octave lower than the bass clarinet. This is largely because of the diverse microtonal possibilities of each instrument. As previously stated, it is notable that this area, which has such limited microtonal possibilities on the bass clarinet, is a microtonally rich region within the tenor saxophone's range.

My idea when composing this piece was that it would represent all the microtonal variants I discuss in my written work and would function as a clear demonstration and illustration of the sonic outcomes. The excerpt shown in Figure 66 uses both quartertones and eighth-tones.
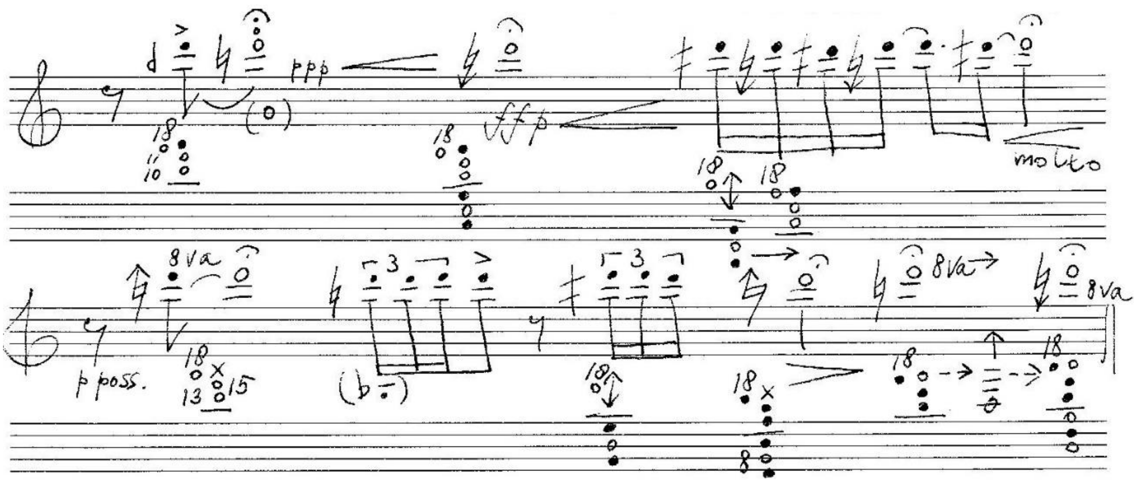
Figure 66: Bok, *smaller change*, quartertone and eighth-tone sections

Audio example 8: Bok, *smaller change*, quartertone and eighth-tone sections

[54] I gave the latter version a different title: it is called *Fifty shades of Dee*. 'Dee' is the Thai word for 'good', but refers, of course, also to the pitch D.

3.5 Summary and conclusions

With the technical improvement of the bass clarinet since Bartolozzi originally made his statement about the microtonal possibilities of woodwind instruments, the possibilities for playing microtones have grown considerably.

Most of the information found in the existing sources concerns the quartertone scale, and the only fingering pattern chart dealing with eighth-tones appears in Rehfeldt's book (2003, pp.22-23, pp.33-39). However, the reliability and the accuracy of all the existing fingering patterns is highly questionable. The (four) quartertone scale fingering pattern charts studied here all acknowledge certain issues with microtonal playing, which were dealt with by including approximate fingering patterns, suggesting half-keying and lip manipulation, or providing no solutions at all. The accuracy of existing fingering patterns has been studied and documented in Appendix A1.

Sparnaay has said that since "the instrument is not really designed for it…there are major difficulties to overcome when producing quarter tones" (2011, p.123). Indeed, there are major difficulties to overcome. New fingering patterns and new techniques have to be learnt, but such microtonal possibilities make the sound world of the bass clarinet much richer. The research presented here not only demonstrates that it is possible to play many quartertone pitches on the bass clarinet, but also to play steps smaller than a quartertone: the research has resulted in a measured scale of eighth-tones, covering more than three octaves. The results of my research into quartertone and eighth-tone playing has been documented and the fingering patterns can be found in Appendix B and Appendix C.

Video 12: Summary of the core elements of quartertone and eighth-tone playing

In the next chapter I want to take my research further and try to discover whether uneven subdivisions of the tone, such as 31-tone intonation, can be realised on the current bass clarinet through a set of measured fingering patterns.

CHAPTER 4

Microtones: unequal divisions of the tone

4.1 31-tone tuning

In May 2014 duo Hevans was invited by the Huygens-Fokker foundation to perform in their microtonal concert series at the Muziekgebouw aan ‘t IJ in Amsterdam. We were told that the 31-tone equal temperament Fokker organ, which is housed in the building, had to form some part of the programme. Although the organ could have played solo, it was our choice to try to perform in a chamber music setting together with the organ. We consulted the list of works documented by the Huygens-Fokker foundation and found that neither bass clarinet nor tenor saxophone were mentioned in connection with 31-tone music (Stichting Huygens-Fokker, n.d.), which was an additional motivation to start our research in this area. We wanted to come up with a pitch range that suited both instruments well, so that the composers who were going to write works for this concert would have many options to choose from. Therefore, we started performer-led research into which 31-tone fingering patterns are possible on our closed-key single reed instruments.

4.1.1 The Fokker organ concert

4.1.1.1 31-tone fingering pattern chart

American composer Julia Werntz writes:

> In the Netherlands in the 1950s, Dutch physicist Adriaan Fokker initiated a revival of the 31-note equal temperament of 17th-century scientist and theorist Christiaan Huygens. . . .Although today the government-funded Stichting Huygens-Fokker (founded by Fokker in 1960) provides a forum for a variety of microtonal disciplines, the influence of Fokker’s ideas is apparent in the high number of Dutch (and some non-Dutch) musicians who write or perform in 31-note equal temperament. (2001, p.162)

Our initial work on finding suitable 31-tone fingering patterns was done with the Scala tuning programme. Because of the organ we had to tune our instruments at A=441 Hz. Working with Scala, we found that the area from D2 up to F4 (31-tone notation, bass clarinet octavation) was a good range for both the tenor saxophone and the bass clarinet. The range of the bass clarinet could be extended a bit further and I was able to come up with fingering patterns up to G4 (31-tone notation).

Finding 31 pitches per octave proved quite a challenge, but pushed by our interest in developing a new pitch language, our efforts were rewarded: at the end of our research we only missed about 5% of the pitches in our chosen range. In the case of the bass clarinet, of the 71 pitches available between D2 and F4, suitable fingering patterns could not be found for just two pitches, D𝄳3 and G♯3. In the case of the tenor saxophone only four fingering patterns were missing.

The next step was to confirm our fingering patterns with the actual organ. When working with the organ, during the first rehearsal, there were a few clashes between our carefully preselected pitches and those of the organ. Organ player Ere Lievonen pointed out that some notes on the organ did not match the Scala tuning programme exactly. Therefore, we had to adapt our findings and fingering patterns to match the organ.

In order to find suitable fingering patterns the same flexibility regarding the use of each digit was applied as in my quartertone and eighth-tone research. For example, in Figure 67, key 12 is played using the right hand thumb.

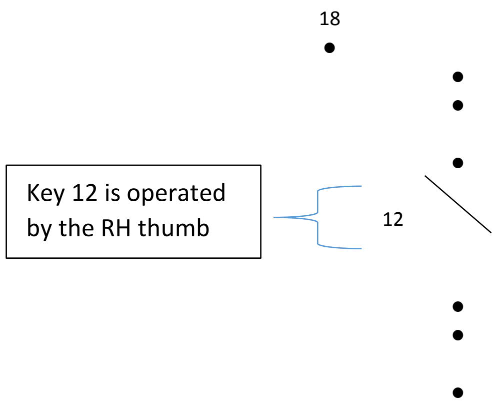

Figure 67: Fingering pattern for D♯3 used for the Huygens-Fokker concert

Due to the difference in construction of the keywork, the bass clarinet and tenor saxophone have different areas that allow more or fewer possibilities in terms of microtones. Because of the different range, the two instruments have different low notes that are unchangeable microtonally. The fact that the tenor saxophone overblows at the octave and the bass clarinet at the twelfth means that microtonally unchangeable pitches often do not coincide. The area from C3 to E3, complicated for the bass clarinet, does not pose particular problems for the tenor saxophone, whereas G3 to G♯3, for which the tenor saxophone only has extremely limited microtonal options, is microtonally viable for the bass clarinet. The results of my work with the Fokker organ can be found in Appendix D and Video 13.

Video 13: 31-tone scale version 1 (Appendix D)

4.1.1.2 Notation

As Evans writes:

> We were unable to find any suggestions for how transposing instruments should be treated when playing in 31-tone. Having studied the existing 31-tone methods of notation for the organ, we decided that given the limited rehearsal time, the simplest notation for both Bok and myself was one that was in some way familiar to us from our previous microtonal work. (2016, p.150)

After ample discussion, my duo partner elaborated a notation system which is a combination of the sharp and flat signs with the well-known symbols for quarter-sharp and quarter-flat, making it easier to get familiar with as performers, because we would recognise the symbols from semitone and quartertone music.

Laid out in one octave, for example from D2 to D3, this would be the result in writing:

D2 – D𝄲2 – D♯2 – E♭2 – E𝄳2 – E2 – E𝄲2 – F𝄳2 – F2 – F𝄲2 – F♯2 – G♭2 – G𝄳2 – G2 – G𝄲2 – G♯2 – A♭2 – A𝄳2 – A2 – A𝄲2 – A♯2 – B♭2 – B𝄳2 – B2 – B𝄲2 – C𝄳2 – C3 – C𝄲3 – C♯3 – D♭3 – D𝄳3 – D3

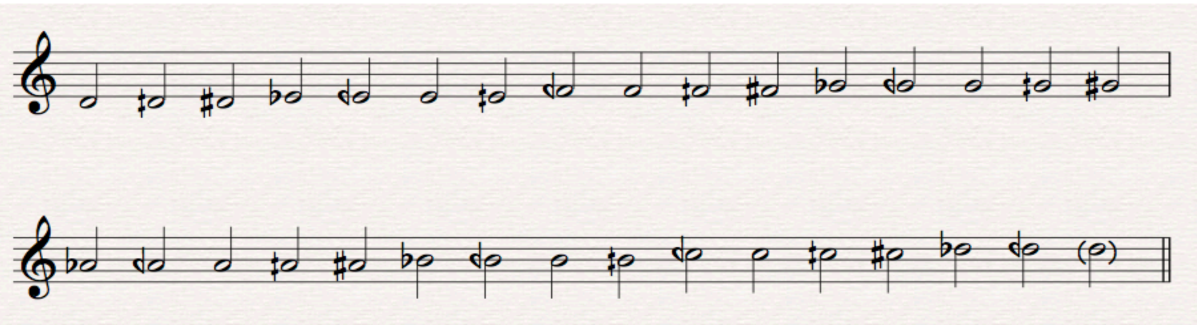

Figure 68: D2 to D3 notated in 31-tone pitches

4.1.1.3 Uijlenhoet: *Radio Istria*

In the May 2014 concert duo Hevans premiered six pieces, written for duo, trio (duo with organ or duo with live electronics) or quartet (with organ and live electronics).[55] The composers made use of several different tuning systems. Dutch electronic music composer René Uijlenhoet, for example, wrote an extensive new work in 31-tone tuning for the Fokker organ, tenor saxophone, bass clarinet, and live electronics (played by the composer), entitled *Radio Istria*.

During the preparation and rehearsal processes the same issues regarding the unavailability or the incompatibility of fingering patterns arose as has been spoken about in relationship with quartertone and eighth-tone playing on the bass clarinet. As my duo partner remarks:

> In the process of working through the score we discovered that whilst individual notes were possible, some of the changes between notes were not practicable. Working together with Uijlenhoet we addressed these areas of the piece, and found that mostly, by simply swapping the bass clarinet and tenor saxophone parts we were able to resolve these issues. (Evans, 2016, p.150)

This problem can be illustrated by studying bars 56-59. In the original version, the composer prescribed the sequence C♮3-F♮3 for the bass clarinet four times (Figure 69).

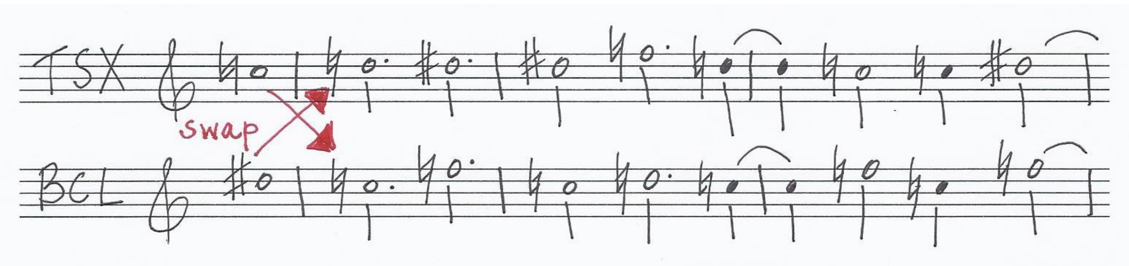

Figure 69: The tenor saxophone and bass clarinet parts for *Radio Istria*, bars 56-59

[55] In programme order, the other composers involved in the concert were: Diana Soh, Rose Dodd and Monty Adkins, Christopher Fox, and Scott Mc Laughlin. My piece *Multi-Micro I* was also premiered in this concert.

However, the C♮3 fingering pattern requires side keys 12 and 13 to be opened by the right hand thumb, whilst the F♮3 fingering pattern needs the same digit to depress key 1 on the lower joint. This creates a complicated sequence (Figure 70).

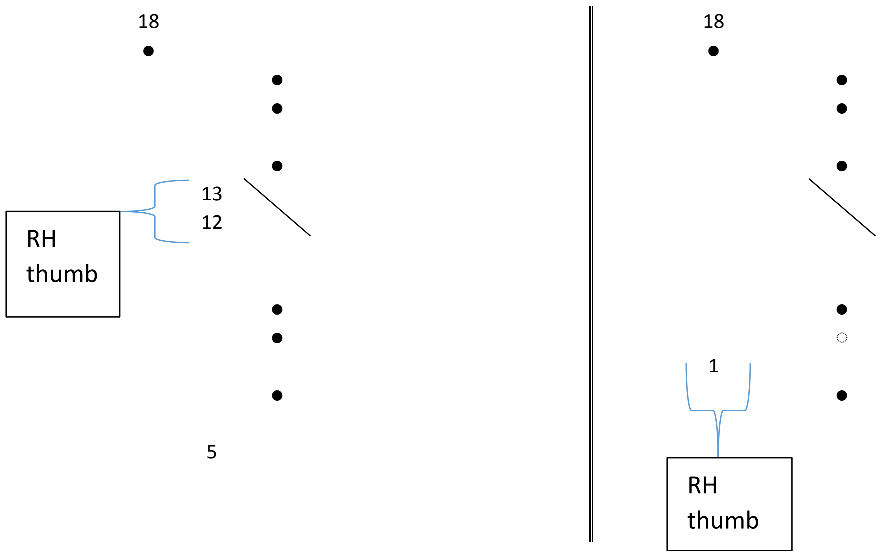

Figure 70: The fingering patterns for C♮3 and F♮3 (Appendix D)

The tenor saxophone does not have any particular problem playing the concerned notes in a row, so we suggested to the composer that the parts were swapped for these bars. Uijlenhoet accepted our suggestion, partly because the tenor saxophone and the bass clarinet can blend quite well, so that the sonic outcome was still the way he wanted.

Another example of problem solving can be found in Figure 71. In the original version of the score, the bass clarinet played together with the organ, and the tenor saxophone had three bars of rest. In bar 40, the bass clarinet has to move from C♯5 (second note) to D♭3 (third note). This succession of notes proved to be tricky at the desired tempo due to the movement from key 12 to key 13. The tenor saxophone therefore came to the rescue and played the D♭3.

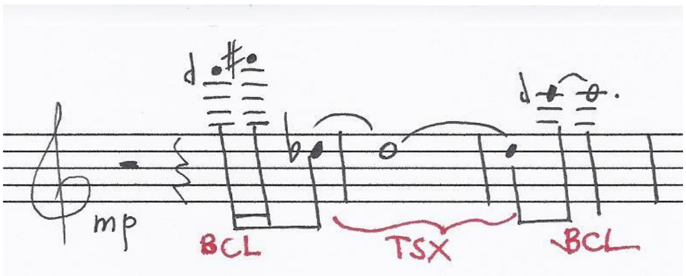

Figure 71: Uijlenhoet, *Radio Istria, part* 2C, bars 40-42

The solutions found by swapping between the two single reed parts proved to be very effective in solving any issues arising with the 31-tone fingering patterns used with the Fokker organ.

Audio example 9: Uijlenhoet, *Radio Istria, part* 2C, bars 40-42

4.1.2 Towards a definitive 31-tone fingering pattern chart

Whilst swapping parts in Uijlenhoet's *Radio Istria* was a simple manner in which to resolve any problems encountered in different successions of 31-tone fingering patterns, I have since felt that further investigation into the 31-tone microtonal possibilities of the bass clarinet could help erase certain incompatibility problems.

Although I would potentially have to revert to the fingering patterns developed for use with the Fokker organ, for any future projects with this instrument, I felt that my initial research on the 31-tone tuning system could be further developed. This expansion of my research had two aims: firstly, to go back to the fingering patterns I had already found, re-measure them and correct them where necessary, and secondly to try to extend the 31-tone possibilities into the altissimo regions of my instrument.

When working towards a second version of the 31-tone fingering patterns I tuned at A=442 Hz. As was found with the quartertones and the eighth-tones, measurements in the fifth octave became more and more difficult. However, I have managed to extend the fingering pattern chart for the 31-tone scale from the highest note in use in the Huygens-Fokker concert (G4) to D5, a full three octaves. This brought the total amount of pitches to 94, of which I was not able to find a suitable solution for only two.[56] The results of this research can be found in Appendix E.

A comparison of the fingering patterns in Appendix D with those in Appendix E shows that quite a few changes have been made. Due to the margins of error used in this research, incidental overlaps could occur between different microtonal tuning systems: a fingering pattern could fall within the margins of error for more than one system. However, great effort has been taken to ensure that the pitches are as exact as possible and therefore these overlaps, where the same fingering pattern is used in more than one microtonal scale, have been kept to an absolute minimum. Of the 76 fingering patterns in Appendix D 32 have been changed in Appendix E, including nine standard fingering patterns.

Video 14: 31-tone scale version 2 (Appendix E)

Checking the measurements of Appendix E again, I was able to further refine several fingering patterns. The few, still existing overlaps with the eighth-tone fingering pattern chart could be repaired (a total of 10 fingering patterns) and between the 94 fingering patterns found in both Appendix E and F, 30 fingering patterns have been altered. This resulted in the third version of my 31-tone fingering pattern chart, my definitive version, which can be found in Appendix F and Video 15.

Video 15: 31-tone scale definitive version (Appendix F)

4.1.3 Preferred notation

Since the concert with the Fokker organ many more composers have shown an interest in writing for the bass clarinet in 31-tone tuning. When a composer writes a microtonal piece in which all the microtonal pitches belong exclusively to the 31-tone scale, the notation proposed in section 4.1.1.2 is adequate, as long as one is aware of the fact that in this notation enharmonic pairs do not

[56] The same missing pitches as in Appendix D.

exist. For example, between a D♯2 and an E♭2 there is a pitch difference of 38.7 cents.

Although the notation system discussed in section 4.1.1.2 worked well for the concert with the Fokker organ, Téhéricsen, Laufer, and Redgate, have chosen to write pieces in which 31-tone tuning is combined with other tuning systems. When different microtonal subdivisions are used alongside each other, though, the system is not acceptable, as, for example, the symbols 𝄲 and 𝄳 are used in both quartertone notation and 31-tone notation, and the symbols ♯ and ♭ are shared between semitone and 31-tone notation, but the four symbols indicate different pitches in the disparate systems. Notation might therefore become ambiguous, if the composer does not find another solution for making the different tuning systems apparent. Different composers have solved the problem of changing between tuning systems in a variety of ways. For example, in his solo piece, *verse & refrain*, Laufer has used colour to indicate the difference. He writes in the score: “black note heads: traditional intonation,[57] red note heads: 31-tone microtonal intonation” (Laufer, 2016, p.1).[58]

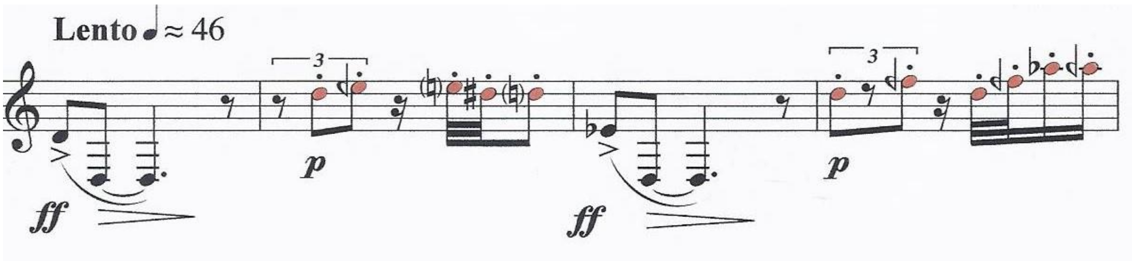

Figure 72: Laufer, *verse & refrain*, bars 1-4

Roger Redgate has combined 31-tone tuning and quartertone intervals in his bass clarinet solo piece. His way of distinguishing between the two tuning systems is simple, but quite efficient: he uses two staves. In his score, the upper stave is reserved for 31-tone writing and the lower stave for quartertone writing (Figure 73).

[57] Laufer refers to semitone writing as “traditional intonation” (2016, p.1).

[58] Laufer also uses red x-shaped note heads to indicate key clicks. Although these key clicks are red and could be presumed to form part of the 31-tone sections, the composer has indicated that the key clicks are not pitch-specific (N. Laufer, personal communication, June 1, 2017).

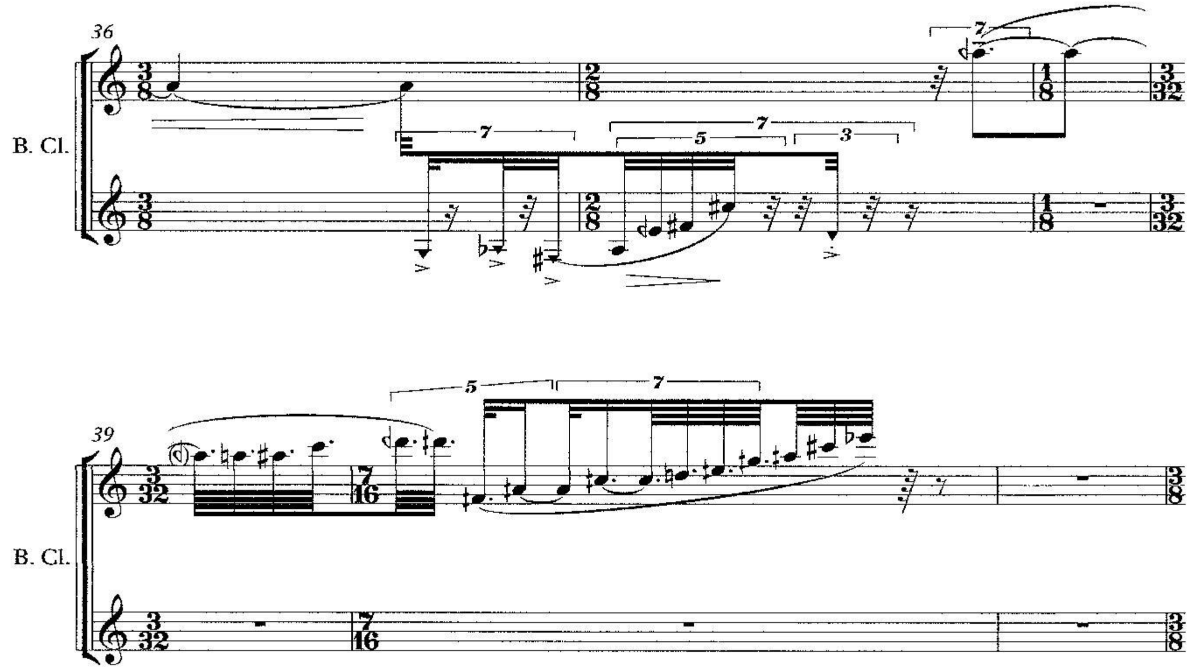

Figure 73: Redgate, *new work*, bars 36-41

In my own compositions the system I have so far used to indicate the difference between quartertone sequences and 31-tone sequences is marking either (1/4T) or (31T) under the first bar of a section (Figure 74).

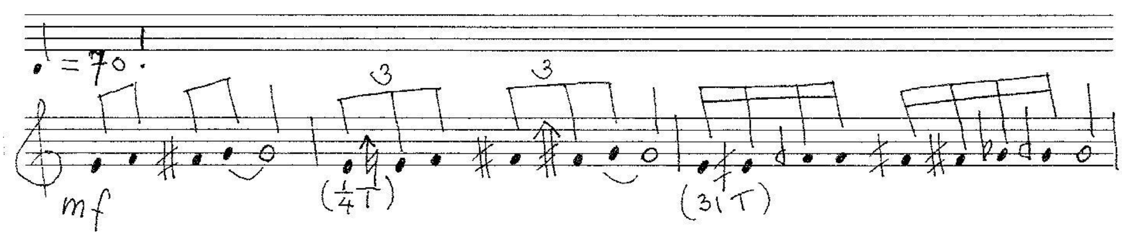

Figure 74: Bok, *Homage*, bars 6-8

Comparing the different solutions discussed above, I will, however, adopt Roger Redgate's notation system from now on, for reasons of clarity and readability.[59] Solutions are context sensitive, though. Whilst colours work well in the score (as can be seen in Laufer's *verse & refrain*), one only has to imagine a situation on tour, when the composer sends the last pages of the score by fax or email and there is no colour printer available, for this option to be rendered unusable.[60] The option to use two staves could complicate reading and performing were a composer to switch systems every few notes or inside the same bar, as the visual aspect of the writing could turn into a patchwork. Although I would like to adopt Redgate's notation system for longer pieces which use two kinds of microtonal subdivisions, I would not change my notation in *Homage* (Figure 74), as the piece is short and linear.

4.2 Applications

Three composers, Téhéricsen, Laufer, and Roger Redgate (in chronological order of receiving the scores) have contributed to my research by committing themselves to engage in collaborative 31-tone projects.

I knew Laufer and Téhéricsen from earlier projects. I had never worked with Roger Redgate before, but wanted to try and convince him to write his first solo work for the bass clarinet.[61] As the first 31-tone compositions in which I was involved were all ensemble pieces, written for the duo Hevans concert with the Fokker organ, I expressed my preference for solo compositions.

Laufer presented the initial version of *verse & refrain* on August 13, 2016, followed by Téhéricsen who sent me the score of *Progression Bureaucratique* on September 9, 2016.[62] At the final stage of this study (Summer 2018), Redgate is still working on his solo piece, but the collaborative process relating to the project has been both intense and highly effective.

I shared the same 31-tone data with all three composers: the fingering patterns documented in Appendix D, accompanied by additional information about

[59] This system suits solo and small chamber music works, but has drawbacks in the case of pieces for larger ensembles.
[60] This problem does not exist, of course, when the score is read on an electronic device such as an iPad.
[61] Redgate is renowned for his complex music, involving microtonality as one of its core elements.
[62] I premiered Téhéricsen's piece in January 2017 during the Festival Musica nas Montanhas, in Poços de Caldas, Brazil.

combinability, reliability, dynamics, and sound quality, as well as information regarding the acoustics of the bass clarinet.

4.2.1 Téhéricsen: *Progression Bureaucratique*

Téhéricsen started working on his piece in May 2016. As indicated earlier the initial range of my 31-tone fingering patterns was from D2 to G4. In an email the composer asked me to continue exploring the high notes, as he wanted to push the limits of instrumental playing, especially regarding the top of the altissimo (F. Téhéricsen, personal communication, May 24, 2016). This request was subsequently withdrawn, as Téhéricsen realised that what I gave him was sufficient for him to start writing his piece. The title of the piece is intriguing, but also a bit mysterious. The composer’s explanation makes it clear: “[it] is because the bureaucratic system progress very small steps after very small steps” (F. Téhéricsen, personal communication, July 9, 2016).

On September 9, 2016 the composer sent me the first version of *Progression Bureaucratique*. After having studied this version of the score I came up with a list of 15 questions. Most of the questions concerned dynamics, accidentals, and the use of extended techniques such as glissandi and harmonic glissandi, singing and shouting. I also had concerns regarding the A♯5 and A5 the composer had written in bar 97 (Figure 75), pitches which are above the range in which I had found 31-tone fingering patterns, and also above the range I generally recommend to composers.

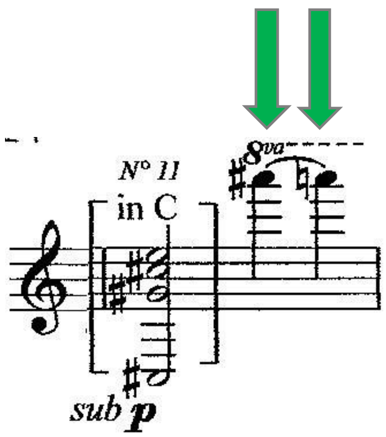

Figure 75: Téhéricsen, *Progression Bureaucratique*, original version, bar 97

I shared my doubts with Téhéricsen despite continuing my search for reliable fingering patterns, but eventually decided that the pitches A♯5 and A5 were unrealistic and asked him for a solution. Therefore, in the second version of the piece Téhéricsen decided to transpose the phrase down one octave, “because the phrase is going down slowly to the melody in bar 101, so no problem at all, one octave lower is ok” (F. Téhéricsen, personal communication, December 5, 2016).

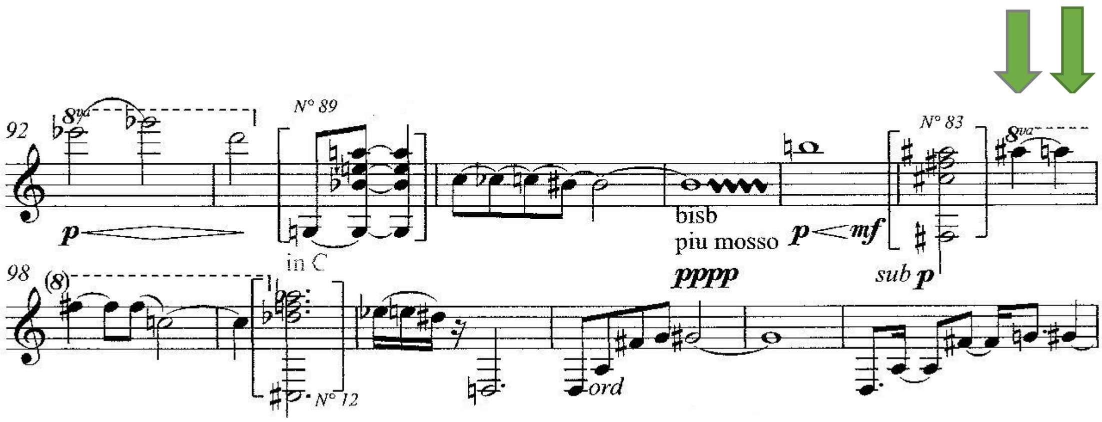

Figure 76: Téhéricsen, *Progression Bureaucratique*, version 2, bars 92-103

Téhéricsen’s music is very energetic, lively, and full of surprises. His use of the 31-tone microtonality illustrates these characteristics. The composer combines semitonal writing with 31-tone microtonal writing, which could sometimes evoke doubts or questions, as he does not use any system to differentiate between semitonal and microtonal writing. However, the context is leading and takes away the hesitations most of the time. The very beginning of the piece is a good example (Figure 77).
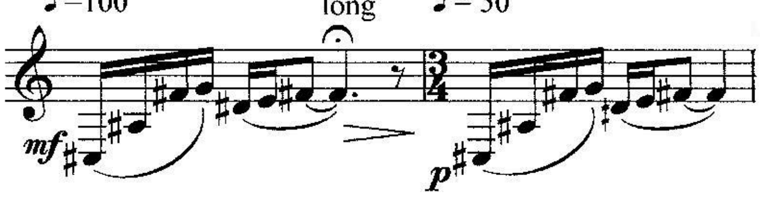
Figure 77: Téhéricsen, *Progression Bureaucratique*, bars 1-2

The pitches of the second bar are the same as in the first (semitonal) bar, except for one microtonal pitch, D‡2 (31-tone), making it really stand out.

Bars 8-10 also have repeated (semitonal) notes, D♯1, B♭1, and G2 in bars 8 and 9, D♯1 and B♭1 in bar 10, with microtonal ‘aliens’ E𝄳3, E3, and E‡3 (31-tone) as long notes, joined by a G‡2 (31-tone) in bar 10.
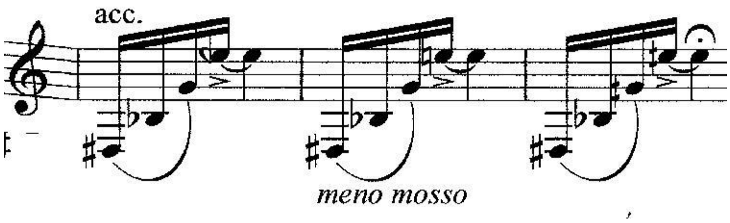
Figure 78: Téhéricsen, *Progression Bureaucratique*, bars 8-10

D♯1 and B♭1 do not have 31-tone fingering pattern options in the chart which I shared with the composer, thus can only be read as semitones. Therefore, this passage could be interpreted as a repeated melody with microtonally varied endings: a grouping of three (semitonal) and one (31-tone). However, the G2 changes to a G‡2 (31-tone) in bar 10, which could point at groupings of two (semitonal) and two (31-tone).

Another example of such a hybrid situation, again contextualised by a repeated motive, is the four note sequence found in bars 30 and 31. Like D♯1 and B♭1, I could not find a 31-tone fingering pattern option for E1, therefore this note can only be read as a semitone. In both bars the two last pitches of the four-note motive are altered: E3 and E4 (31-tone) become E‡3 and E‡4, moving up one step of the 31-tone scale (Figure 79).
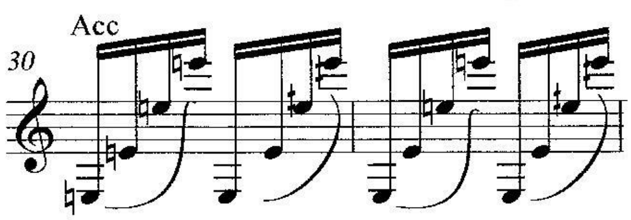
Figure 79: Téhéricsen, *Progression Bureaucratique*, bars 30-31

Still, these bars could be read in different ways, because the same choices of note groupings could be made as in bars 8-10: two plus two or one plus three. Due to the uncertainty of which interpretation to adopt, I had to contact Téhéricsen and ask him to express his wishes: a subdivision of two semitonal pitches followed by two 31-tone pitches in each bar (Audio example 10).

Audio example 10: Téhéricsen, *Progression Bureaucratique*, bars 30-31

On a final note, regarding the choices between semitonal or 31-tone readings in this composition, I used the following system as a rule of thumb (acknowledged by the composer):

- As Téhéricsen's information for 31-tone fingering patterns came from my Huygens-Fokker chart (Appendix D), all notes lower than D2 do not have 31-tone options and should be interpreted as semitones.
- If no microtones appear within a bar, the notes should be read as semitones.
- If the majority of pitches within a bar are microtonal, all notes should be read as 31-tone pitches.

However, there were other occasions when further clarification was needed regarding the application of these rules. For example, the last three notes of bar 119 and the first three notes of bar 120 are seemingly the same. Be that as it may, they are in fact the juxtaposition of one microtonal bar and one semitonal bar. This means that for the last three notes in bar 119, F2, G2, and G♯2, 31-tone fingering patterns should be used and for the same three notes in bar 120 semitonal fingering patterns, as confirmed by the composer. Téhéricsen's writing here alternates between the two systems (Figure 80).

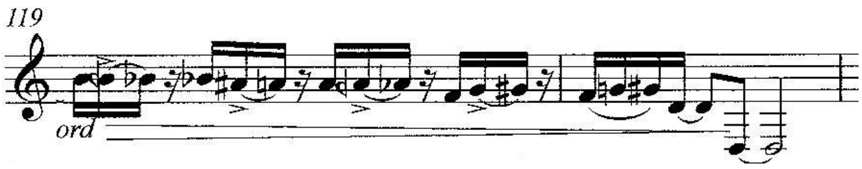

Figure 80: Téhéricsen, *Progression Bureaucratique*, bars 119-120, 31-tone reading and semitonal reading

To conclude, Téhéricsen’s score is not self-explanatory, and although certain decisions are dictated by the (un)availability of fingering patterns, interpretational choices could be multiple due to the absence of an unambiguous notation system.

4.2.2 Laufer: *verse & refrain*

In *verse & refrain* Laufer combines 31-tone microtonality with semitonal writing and also with root-overtone microtonality (this aspect of the work will be discussed in Chapter 5). The subtitle of Laufer’s composition is ‘microtone study’ and it is approximately five minutes long. The piece has a *lento* character (crotchet ≈ 46). As previously discussed, Laufer has used red note heads to indicate pitches in 31-tone tuning.

The initial information the composer received about the 31-tone possibilities of the bass clarinet was for the range D2 to G4 (31-tone pitches).[63] In *verse & refrain* Laufer has used this entire range. On two occasions he also expanded his 31-tone writing below D2. The two notes, D1 and G1, indicated in Figures 81 and 82, are in the lowest fifth of the instrument’s range (see Chapter 1 for an explanation) and therefore I was not able to find suitable fingering patterns for either note.

[63] The fingering patterns can be found in Appendix D.

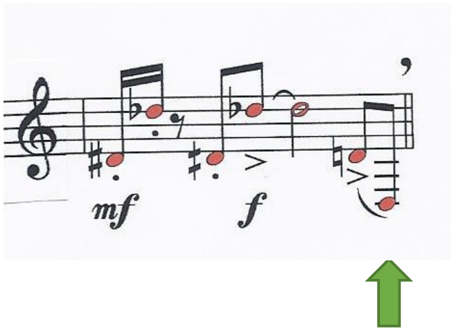

Figure 81: Laufer, *verse & refrain*, version 1, bar 15

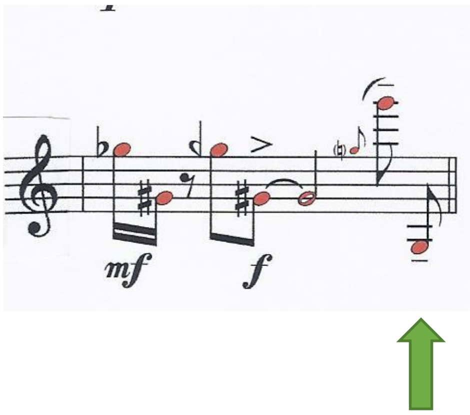

Figure 82: Laufer, *verse & refrain*, version 1, bar 43

I discussed this issue with the composer and suggested putting the notes in semitonal writing. Laufer adopted my suggestion for these two ‘out of range’ pitches and changed them to “traditional intonation” (N. Laufer, personal communication, June 6, 2017).

Upon studying the piece further, I found that it was difficult to play D‡3 (31-tone) staccato as the composer desired. This highlighted an issue which I had not previously had with my microtonal work: the influence of articulation upon the success of microtonal fingering patterns. The combination of notes in bar 2 (Figure 83) and bar 60 (Figure 84) emphasized this issue and I communicated these articulation issues with the composer:

> The D‡3 is very unstable, especially after a higher pitch. This is the case in bar 2 where this pitch follows the higher E. In bar 60 it is slightly less

of a problem, since the D is just before (as a reference point). To make the risk in bar 60 smaller, I would like to suggest to change the staccato to legato just for these two notes. (H. Bok, personal communication, June 4, 2017)

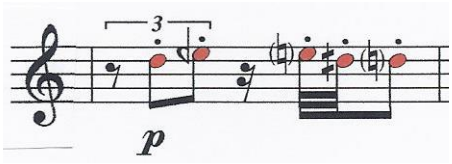

Figure 83: Laufer, *verse & refrain*, version 1, bar 2

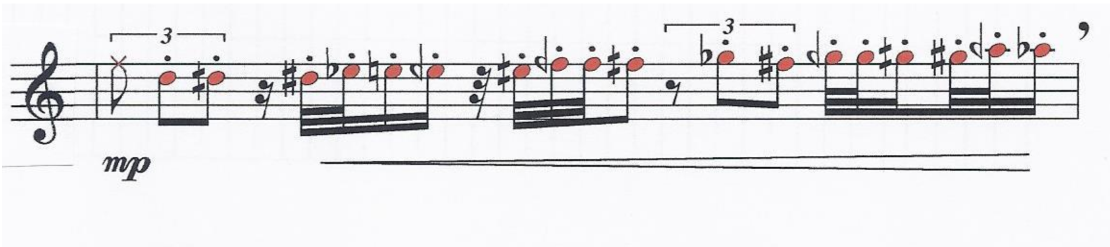

Figure 84: Laufer, *verse & refrain*, version 1, bar 60

Laufer chose to resolve the instability caused by the articulation in two ways: he replaced the note in bar 2, and, following my advice for bar 60, he changed the staccato articulation to legato.

Laufer had also included the pitches D𝄳3 and G♯3 (31-tone) in his composition on several occasions. These notes fell within the range (D2 to G4), but they were notes for which I had not been able to find suitable fingering patterns.
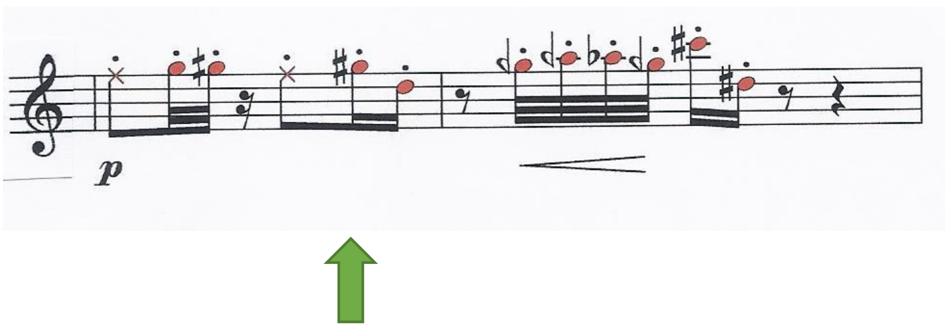
Figure 85: Laufer, *verse & refrain*, version 1, bar 6

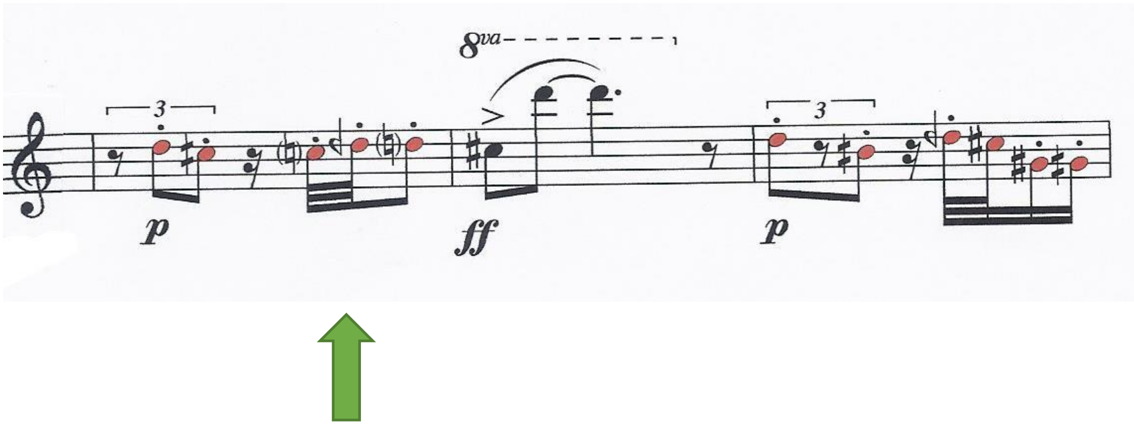

Figure 86: Laufer, *verse & refrain*, version 1, bars 9-11

I explained the lack of fingering patterns for these notes to Laufer, accompanied by some suggestions:

> In the chart I sent to you I had not found a fingering for two pitches: D𝄳3 (nr 31 of the first octave) and the G♯3 (nr 16 of the second octave). In the chart I had put a big X. Sorry, if that was unclear. Although I have tried to find a fingering pattern, even today, nothing can be found at the moment. Here are the bars relating to this problem: 6, 9, 11, 34, 39, 42, 58, and 60. (H. Bok, personal communication, June 4, 2017)

Although Laufer subsequently replaced the D𝄳3 and the G♯3 with other pitches, the solution he came up with for bars 9 and 11, created incompatibility problems.

> Another problem occurs when two fingering patterns are to be used for the 31-tone pitches which separately would work, but not in a sequence. There are two 'culprits': in the complicated fingering patterns for this extreme microtonality the right hand thumb has to be used as an active digit fairly often to motion side keys of the upper joint, normally played by the right hand index finger. The right hand thumb is traditionally needed for key 1 (C1 key) and key 2 (C♯1 key) at the back of the lower joint. Whenever in a sequence of two notes the thumb is used firstly for either key 1 or key 2, and secondly for an upper joint side key (10, 11, 12, 13, or 10/11 and 12/13 as sets), the combination becomes impossible. The opposite is also true: starting on a side key and having to use the thumb for key 1 or 2 is not feasible. The second 'culprit' is the combination of

side keys 12 and 13, either used separately or as a set: it is very hard/impossible to move from 12 to 13 (or vice versa) or to go from one key to two keys. As an example, if the first fingering pattern includes key 12 and the second 12+13, there is a problem. Here are the bars where certain combinations pose problems: bar 4 (combination of third and fourth note), bar 14 (combination of fourth, fifth, and sixth note), bar 15 (combination of first and second note), bar 35 (combination of the first four notes), bar 41 (combination of the first two notes, directly after the key click), bar 42 (combination of third and fourth note), bar 60 (combination between note 3 and 4 after the key click). (H. Bok, personal communication, June 4, 2017)

In the second version of *verse & refrain* Laufer had solved the compatibility problems in bars 14, 15, 41, and 42,[64] but bars 4, 35, and 60 still needed solutions. Due to the revisions made in bars 9 and 11, changing the D𝄳3 (31-tone) to D♭3 (31-tone), these bars now also had issues.

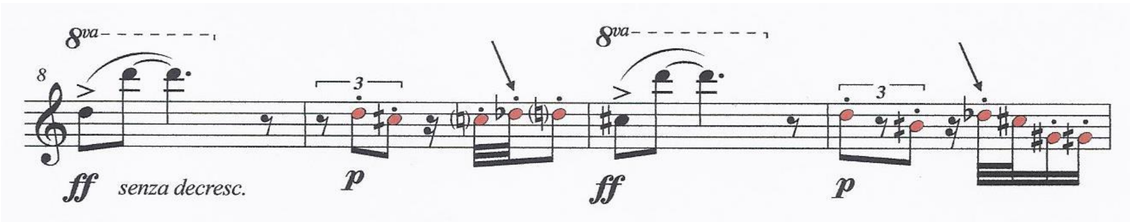

Figure 87: Laufer, *verse & refrain*, version 2, bars 8-11

I communicated these incompatibilities with Laufer and explained to him that the problem of impossible or complicated sequences was caused by the ‘double role’ of the right hand thumb, which would have to jump from lower joint keys (key 1 or key 2) to upper joint keys (key 12, key 13 or keys 12/13 combined). This situation occurred in bars 4, 9, 11, 35, and 60 (H. Bok, personal communication, June 6, 2017).

Laufer then sent me a third version of the score, with the following comment: “This time I tried to stick to the logic of my row: when I changed bar 4, I felt that I also had to change 11, 32, and 39. I really hope that this works” (N. Laufer,

[64] That is when the Huygens-Fokker fingerings (Appendix D) are used in bars 41 and 42 rather than the newly found fingerings.

personal communication, June 6, 2017). Unfortunately, the changed pitches in bar 4 and in bar 11 still did not combine. The process neared its completion, but a number of issues remained: in bars 4, 9, 11, 58, and 60 the right hand thumb still had to execute impossible jumps (H. Bok, personal communication, June 7, 2017).

Shortly after, Laufer sent version 4 of the score with the following comment:

> Now I see a possible solution (from the point of view of the composition) in repeating two notes that came right before the problematic two notes. As I have to change bar 4 and 11, I also want to change 32 and 39. Bar 9 seems to be a special problem; so far I do not want to change the parallel phrases. Last page: for me it is important to have the passages which are one octave higher or lower, just as the 'original' one: so you asked me to change 58 – I want to change bar 62 (one octave higher), the same is with bar 60 and 56 (one octave lower). If this does not work, please make suggestions which fit into the microtonal-chromatic lines". (N. Laufer, personal communication, June 7, 2017)

I did not have to make any suggestions, as all changes proposed by the composer in the fourth version of *verse & refrain* were feasible. Therefore, this version of the work became the final version.

The collaborative process for *verse & refrain* was time-consuming and labour-intensive. The reason for this is largely due to the complexity of the 31-tone fingering patterns which inhibits certain combinations or sequences. Composers have to be made aware of certain incompatibilities caused by the complexity of the fingering patterns and by the additional tasks given to digits, which are unorthodox when compared to playing non-microtonal music. Such incompatibilities are difficult to communicate through fingering pattern charts, as they generally communicate the keys needed rather than the fingers used to operate them. As such I have since added extra information regarding the use of alternative digits to all of my fingering pattern charts. The ability to see the hand and finger positions in the videos which accompany my fingering pattern charts (Videos 10, 11, and 13-15) may serve to aid composers who wish to use microtones in musical sequences.

4.2.3 Redgate: new work

At the point of writing, the collaborative process which I hope will lead to Redgate's first solo bass clarinet work is still taking place. After Redgate received my 31-tone fingering pattern chart (Appendix D), he came back to me with a series of scales he had prepared, and he asked me to record these as a reference for him.

In his series of scales the composer had included D𝄳3 and G♯3 (31-tone), notes for which I have yet to find suitable fingering patterns. Redgate appeared un-phased by the missing pitches and said that: "it doesn't matter about the missing pitches, as I can also use transpositions to avoid them if need be" (R. Redgate, personal communication, December 14, 2016). I therefore recorded the scales (leaving out the unavailable pitches).

Redgate said the recordings were "extremely useful, as it was just important for me to hear how they sound" (R. Redgate, personal communication, December 14, 2016). His comments once again made me realise the relevance of including recordings of my newly found microtonal fingering patterns. In the future, as a direct result of this research, composers will have access to extensive audio and video information to aid their compositional process.

Work on the piece continued and on April 10, 2017 Redgate wrote:

> Work is going well on the piece, but I just wanted to start checking a few things with you. I've attached a page from the score and I wanted to see how feasible this kind of passage is, before I go any further. (R. Redgate, personal communication)

Redgate indicated that "the tempo at this point is pretty much as fast as possible" (R. Redgate, personal communication, April 10, 2017), but the complexity of the 31-tone fingering patterns largely dictates which tempi are feasible. Therefore, I decided to annotate the score (Figure 88) with rough indications of the tempo at which different combinations of fingering patterns were possible.

- VS - very slow
- S - slow
- M - medium
- F - fast
- VF - very fast

I also included two additional markings:

- '- leg.' to indicate that legato playing is not possible
- 'imp.' to indicate that certain pitch sequences are not possible

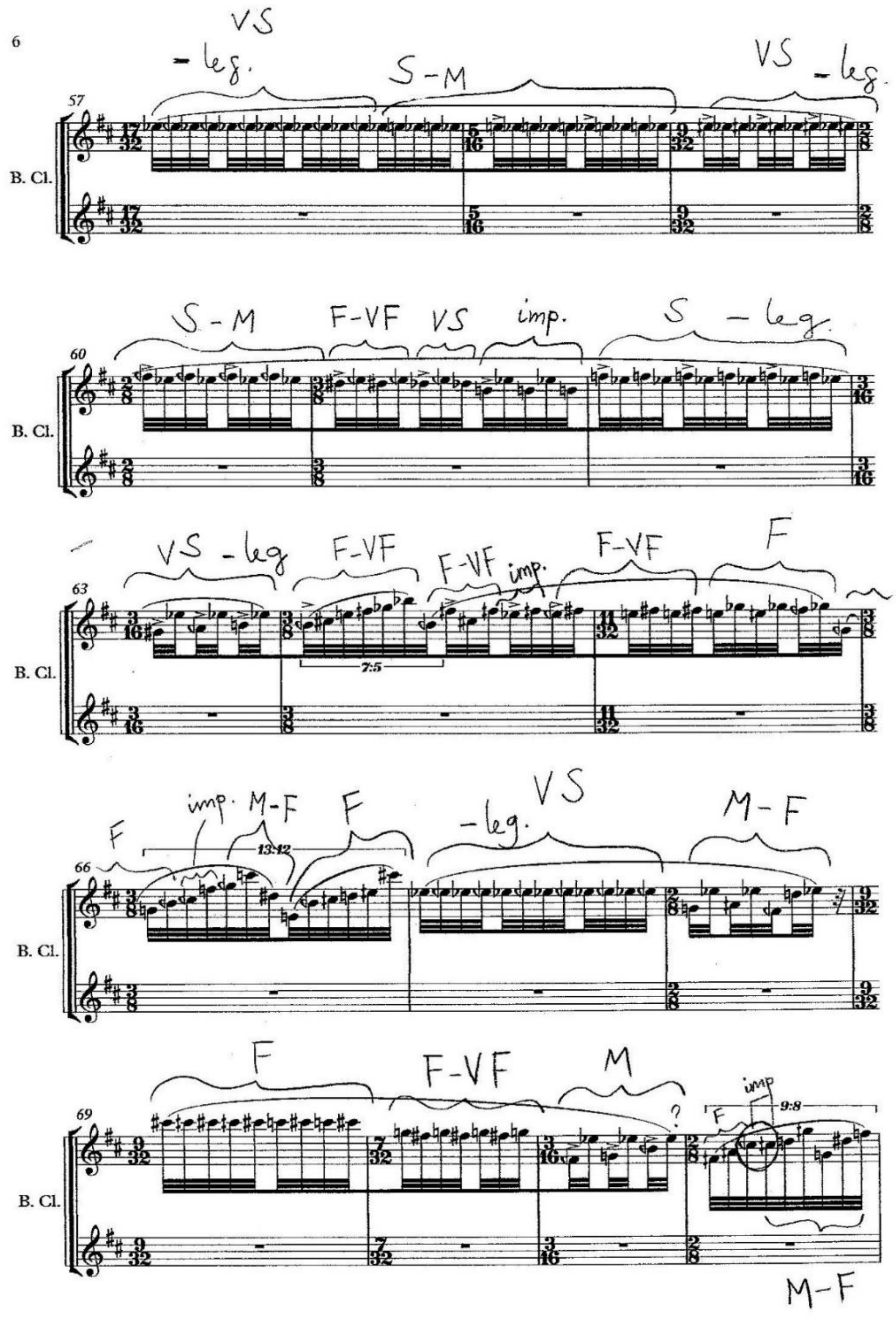

Figure 88: Redgate, bars 57-72 from the score for bass clarinet solo with my annotations

I elaborated that the ‘culprit’ of many problems regarding both the speed at which any given passage (Figure 88) could be played and whether it could be played legato, is E♭3 (31-tone).

> To go from the E♭3 in bar 57 to the second note I have to bring my right hand thumb back from the upper joint (key 13) to the lower joint in order to press key 2. This makes legato impossible and slows down the tempo dramatically, which is not what you want. (H. Bok, personal communication, April 14, 2017)

As E♭3 was quite a central pitch I explained about the double role of the right hand thumb in my microtonal fingering patterns: operating the three keys at the back of the instrument’s lower joint (keys, 1, 2, and 4a), and as an additional digit to operate the upper joint side keys (keys, 10, 11, 12, and 13). The limitations of how quickly the right hand thumb can make this ‘jump’ between lower and upper joint is similar to the issue that Laufer and I had to work through during the collaborative process for *verse & refrain*.

On April 15, 2017 Redgate sent me a second sample page from the score in progress, this time a page combining 31-tone intonation with quartertone writing (Figure 89).[65] I again annotated the score before replying to him.

[65] In Redgate’s score the upper stave is reserved for 31-tone writing and the lower stave for quartertone writing.

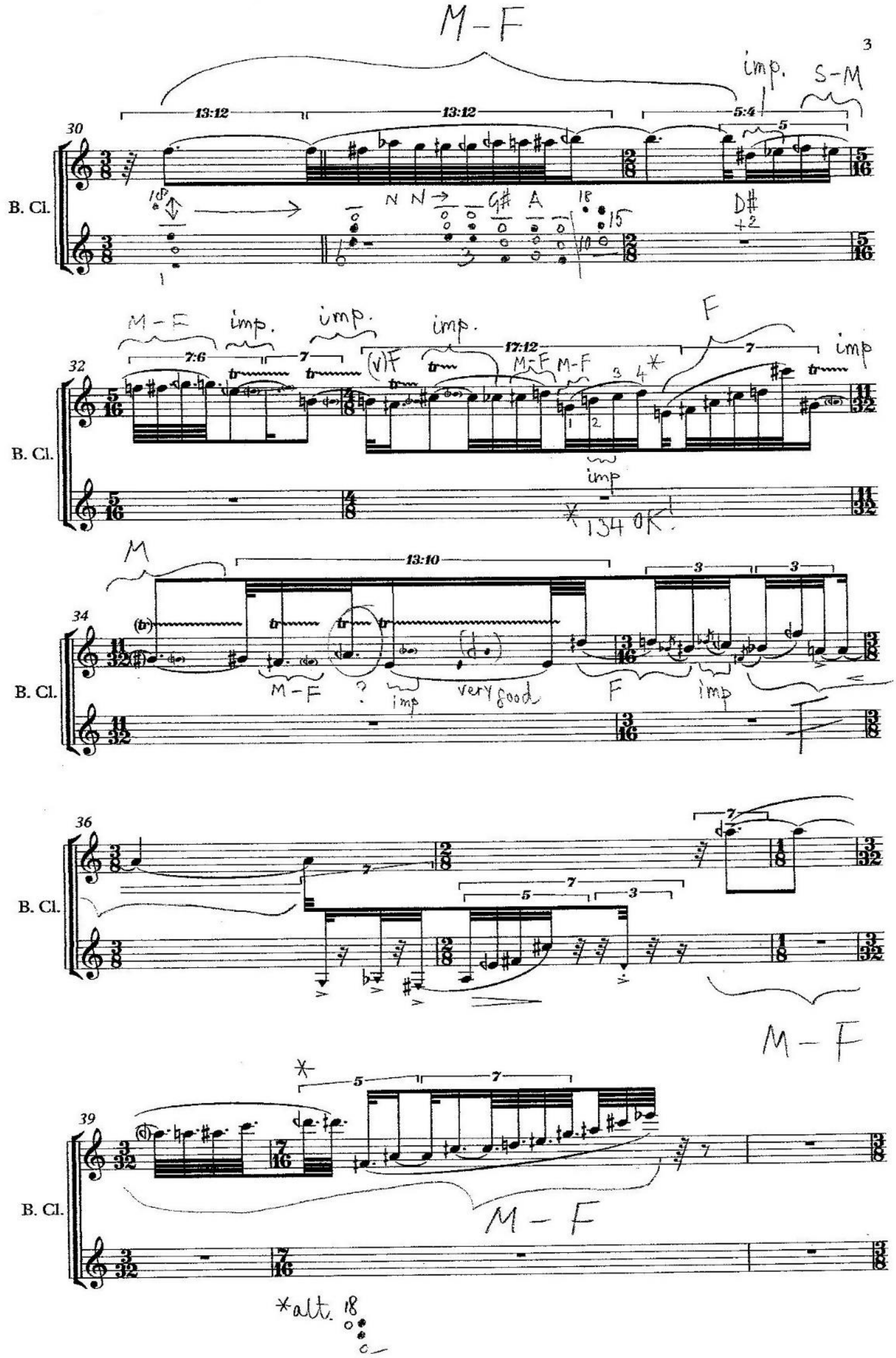

Figure 89: Redgate, bars 30-41 from the score for bass clarinet solo with my annotations

Challenged by the composer's wishes, and not wanting to give in without trying all the alternatives I could think of, I even discovered an additional fingering for the first pitch in bar 40, so that I would be able to play the sequence legato.[66]

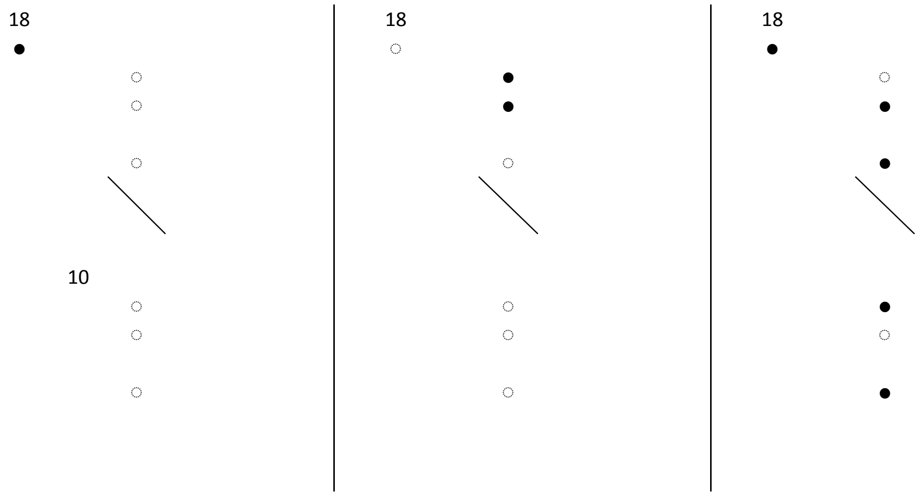

Figure 90: Fingering pattern sequence for C4, D𝄳4, and D𝄲4 (31-tone) in Redgate, bars 39-40

Informed by my feedback, Redgate used transposition to change the problematic E♭3 (31-tone) pitch on sample page 6: "I'm happy to change pitches, as it's not so prescriptive, but based around combinations of various scales" (R. Redgate, personal communication, April 15, 2017). Following this, the composer sent me revised versions of both sample pages which showed that I had managed to sufficiently communicate the difficulties specific to microtonal bass clarinet playing, making him comment: "I don't mind the technical stuff – it helps me understand the practicalities of the fingerings" (R. Redgate, personal communication, April 25, 2017).

Redgate's words led me to an important conclusion: coming up with fingering patterns which fit in the set parameters (of this research) does not necessarily mean that they can be used at the composers' free will. The practicalities of the fingerings also have to be understood. Explaining the instrument's keywork and

[66] The newly discovered fingering pattern is written in on the annotated version of the sample page.

the (extended) use of the digits for microtonal playing to all three composers led to a better understanding of the combinability of fingering patterns for 31-tone intonation and resulted in fewer problems in the scores. Whilst it is difficult to indicate the consequences of combining every single fingering pattern, especially when different microtonal tuning systems are merged in one piece, it is hoped that the additional information regarding unusual finger and thumb positions, which has been included in the fingering pattern charts (Appendices B-F) and can be seen and heard in Videos 10, 11, and 13-15, will aid composers in their microtonal writing for the bass clarinet.

4.2.4 The use and combinability of fingering patterns from Appendices D, E, and F

As mentioned before (see section 4.1.2), after establishing the Huygens-Fokker 31-tone fingering pattern chart (Appendix D) I have been able to further refine the data, in two steps; establishing a second version of my 31-tone scale (Appendix E) and finally coming up with a third version, my definitive 31-tone scale (Appendix F).

In any situation involving the Fokker organ only the fingering patterns found in Appendix D are valid. In other situations, especially in the case of solo pieces, the different sets of fingering patterns could become a (personal) dilemma, creating an almost ethical issue. When Téhéricsen, Laufer, and Redgate started writing their solo pieces for this research project, I shared the fingering patterns included in Appendix D with them, as it was the only information available at the time. Of the 76 pitches contained in Appendix D, 13 were standard fingering patterns, nine of which could be resolved and refined in Appendix E.

An issue which became very important during the collaborative process with the three composers was the combinability of sequences of fingering patterns. The lack or difficulty of fingering pattern combinations led to a substantial number of performance issues, as seen and discussed in sections 4.2.2 and 4.2.3. The importance of this matter led me to include additional information on the combinability of pitch sequences and the alternative use of digits, the right hand thumb in particular, in Appendices E and F.

However, the use of more refined 31-tone fingering patterns, such as those included in Appendices E and F, could present combinability issues which were not there in the original fingering pattern chart (Appendix D).

For example, with the 31-tone fingering patterns found in Appendix D, the transition between C𝄳3 and C3 could be played legato (Figure 91).

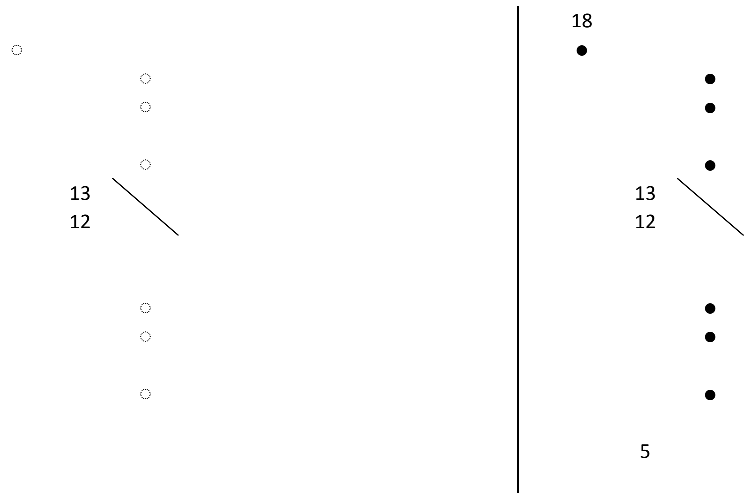

Figure 91: Fingering patterns for C𝄳3 and C3 in Appendix D

However, the same sequence played using the more precise fingering patterns found in Appendix E, would cause an articulation problem: a legato sequence is not possible due to keys 12 and 13 both being operated by the right hand index finger (Figure 92).

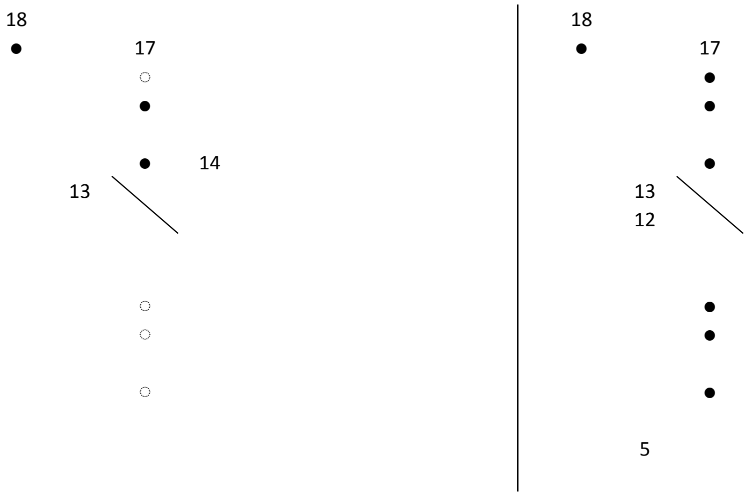

Figure 92: Fingering patterns for C𝄳3 and C3 in Appendix E

Informed performance choices have to be made, in this case between the more precise pitches or the legato possibility. Generally, adopting a pragmatic attitude regarding which fingering patterns should be used seems to be a good approach. This is, of course, somewhat easier in a solo work than in an ensemble setting.

However, pragmatic solutions are dictated by the options found by the knowledgeable performer and the concrete possibilities offered by the research data. Available options are more limited in the case of ensemble playing as different criteria have to be applied when making decisions.

The extensive video material which accompanies this chapter elucidates the information found in the fingering pattern charts, to aid players and composers in their use of fingering patterns from the different appendices.

4.2.5 Own compositions

4.2.5.1 Bok: *Homage*

Although I have included microtonal elements regularly in my solo bass clarinet works, I have only more recently started to use 31-tone intonation, inspired by the fingering patterns I was able to find and document for this research.

In *Homage*, written in May 2016, the first 31-tone section is placed right in the middle of the piece (bars 8 and 9) and the second section right at the end (bar 13), just before the final bar. Both 31-tone sequences are meant to be important 'ear catchers'. They effectively 'stretch' the distance between E2 and G2 by using even more notes within this range (E2-G2) than the quartertone series in the preceding bars (see also Figure 74).

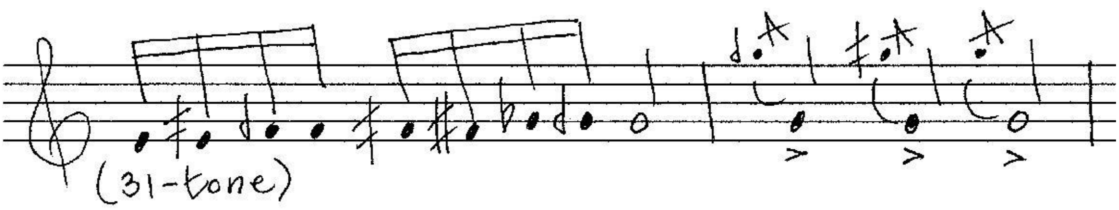

Figure 93: Bok, *Homage*, bars 8-9

Audio example 11: Bok, *Homage*, bars 8-9

Following the discussion about the choice of fingering patterns (see section 4.2.4), two of the nine pitches in bar 8 only have one option (E2 and F♯2), as the fingering patterns are the same in Appendices D, E, and F. For the pitch F2 I have chosen to use the Appendix D fingering pattern, which coincides with the standard fingering pattern for F2, as the more precise option, found in Appendix E, makes the transition to F𝄲2 very complicated. However, for G♭2, G𝄳2, and G2 I opted for the more precise fingering patterns found in both Appendices E and F. This avoids using a fingering pattern which is the same in both Appendix B (G𝄳2, quartertone scale) and Appendix D (G𝄳2, 31-tone).

The next 31-tone section, in bar 13, repeats the sequence found in bar 8 exactly a twelfth higher which, due to the overblowing system of the bass clarinet, means it is a reiteration in overtones. Here I have chosen to stick with my original (Appendix D) fingering patterns, for technical reasons. I composed the piece using Appendix D fingering patterns. When *Homage* is played using Appendix D fingering patterns, the sequence has a very logical development in finger placement, which makes it easier to memorize.
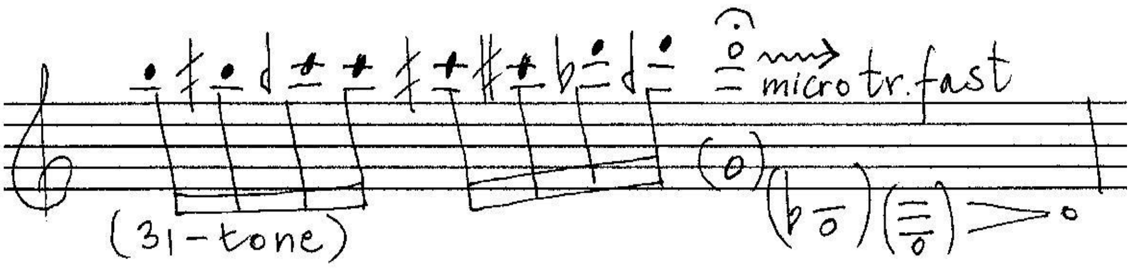
Figure 94: Bok, *Homage*, bar 13

Audio example 12: Bok, *Homage*, bar 13

4.2.5.2 Bok: *GIANT nano Steps*

In *GIANT nano Steps*, written two months after *Homage*, I pay tribute to two icons of music history, jazz saxophonist John Coltrane and American composer Elliott Carter. One of Coltrane's most famous compositions is called *Giant Steps*, and Carter wrote an important bass clarinet solo piece called *Steep Steps*.[67] The 'nano' element of the title refers to my microtonal take on Coltrane's and Carter's music, an initial 'step' in my 31-tone writing.

Bar 21 of my piece contains a short quote from *Steep Steps*, marked in orange on the score (Figure 95). I use this quote as a pivot note to start the opening lines of *Giant Steps* (marked in green on the score). However, I immediately repeat the melody of bars 22-28 in bars 29-32, but this time rubato and in 31-tone intonation, creating a moment of suspense and alienation. I believe that the 31-tone section in *GIANT nano Steps* is effective, as relating it to a well-known melody (from the jazz world), makes the perception of the microtonal variant much stronger.

[67] *Steep Steps* will be analysed in section 5.2.2.

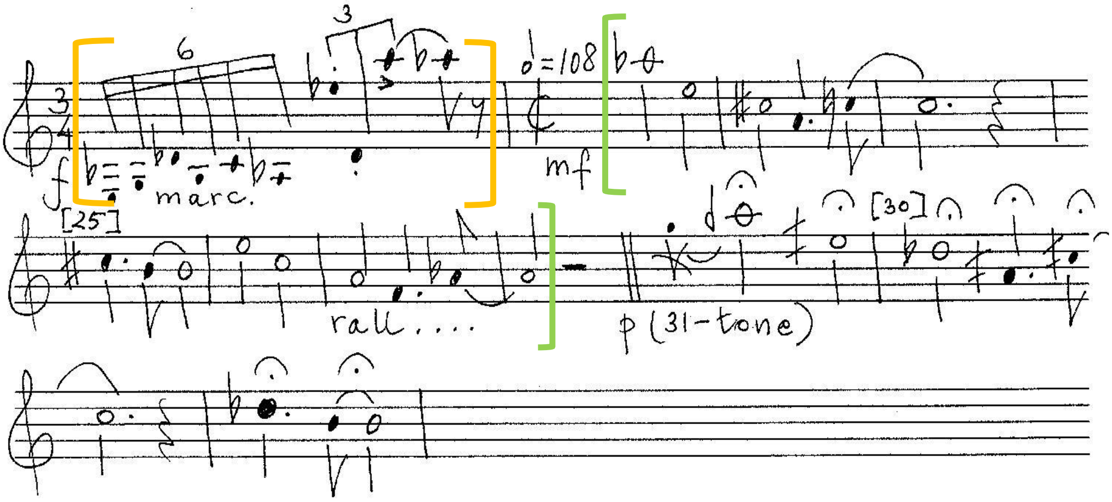

Figure 95: Bok, *GIANT nano Steps*, bars 21-32

Audio example 13: Bok, *GIANT nano Steps*, recording of bars 21-32

4.2.5.3 Bok: *Microclimate I*

Microclimate I for two bass clarinets was written at the end of 2015 and dedicated to my Duo Clarones partner Brazilian bass clarinettist Luis Afonso, generally known as ‘Montanha’. The compositional content of the piece comprises quartertones, microtonal trills, multiphonics (type 1 and type 2), root-overtone microtonal variants, and key clicks. In 2017 I revised the score, changing several quartertone sections into 31-tone sections, as I felt the sonic outcome would benefit from that.

A challenging section, in which ‘false fingerings’ are used in octaves starts at rehearsal letter E. The ‘false fingerings’ (indicated in the score by square note heads), are in fact all 31-tone fingering patterns, and I wanted the octave pitches to match completely.
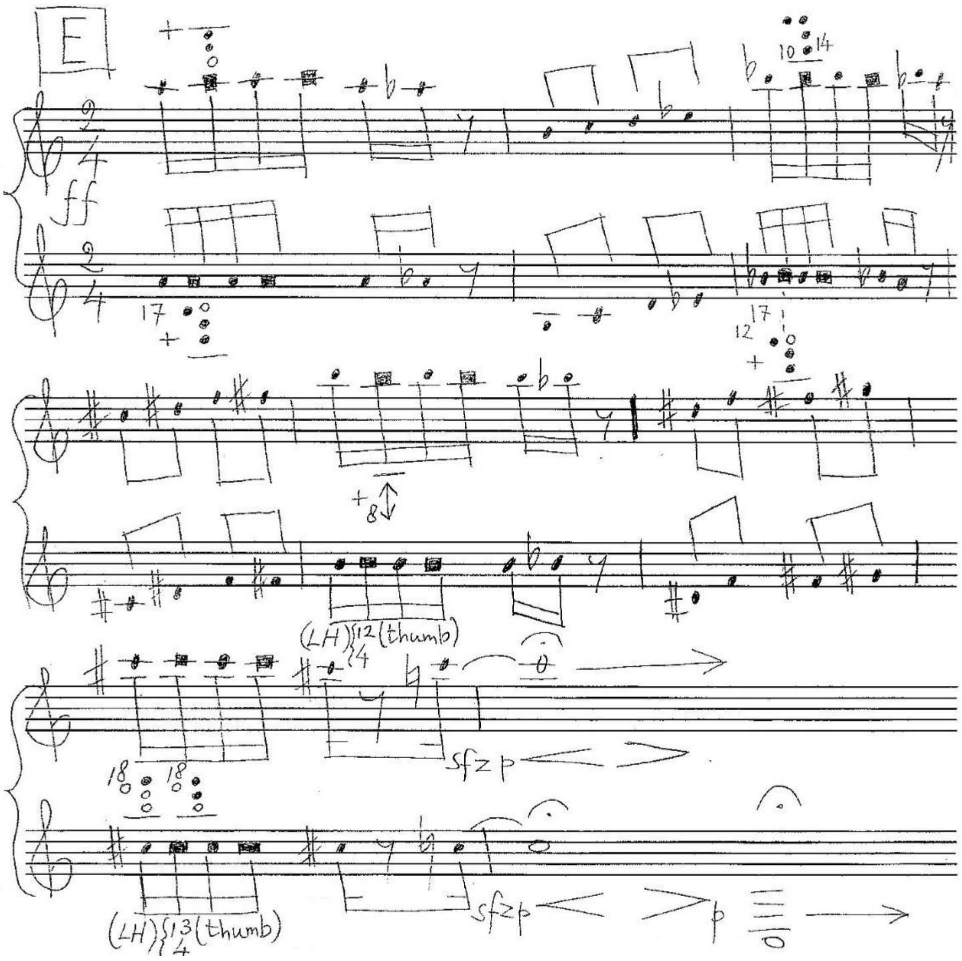
Figure 96: Bok, *Microclimate I* for two bass clarinets, E bars 1-8

Since my duo partner Montanha is not used to playing this kind of extreme microtonality, I included all the fingering patterns in the score, but during the preparation and rehearsal process with Montanha, I noticed that microtonal playing involves much more than learning some new fingering patterns. A player’s mindset has to be different when learning whole series of unusual fingering patterns and getting the ear accustomed to different tuning systems.

As a result of my work with Montanha I decided that a video, in which I explain my own practice when playing 31-tone music, would potentially better enable other bass clarinettists to adopt this tuning system than fingering patterns alone (Video 16).

4.2.5.4 Bok: *smaller change*

My most recent piece, *smaller change* (2017), can be considered an artistic summary of my research into the microtonal possibilities of the bass clarinet so far.

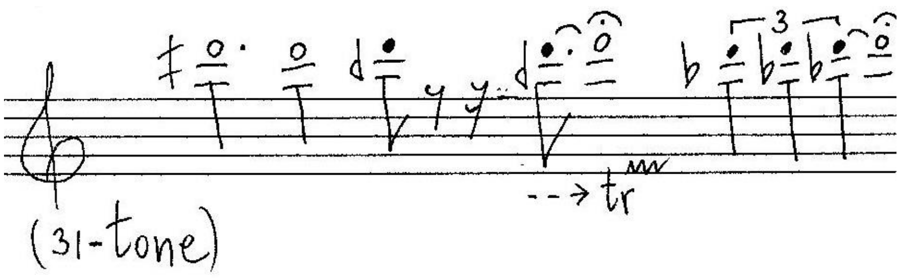

Figure 97: Bok, *smaller change* for solo bass clarinet, 31-tone section

The 31-tone section of *smaller change* uses the 31-tone fingering patterns from Appendices D, E, and F. The merits of mixing fingering patterns from Appendices D, E, and F were that I could create more '*shades of Dee'*,[68] D4 being the binding factor of the composition. Having two sets of fingering patterns available for D𝄳4, D4, and D𝄲4 (from Appendices D and F respectively) gave me six fingering patterns to choose from. As I expanded the ambitus of my 31-tone fingering pattern chart to three full octaves (Appendices E and F), D𝄳5 and D5 also became available. Using these eight fingering patterns I was able to avoid combinability issues. An example of this is the third pitch in Figure 97, D𝄳4, for which I chose the original fingering pattern—found in Appendix D—because it could easily be changed into the trill I wanted. The more precise fingering pattern found in Appendices E and F could not be used to the same effect.

Audio example 14: Bok, *smaller change* for solo bass clarinet, recording of 31-tone section

[68] This is the title of the bass clarinet and piano version of *smaller change*.

4.2.5.5 Bok: *small change*

The predecessor to *smaller change*, *small change*, which represents my first ensemble piece containing structural 31-tone writing, was composed in 2016 for duo Hevans. My previous 31-tone work had been with Evans, a player equally at home in microtonal tuning systems and as preoccupied with pushing boundaries as myself. Therefore, I found duo Hevans an ideal ensemble to write for.

The piece opens with an eight bar phrase which is subdivided into three sections. The first section is a three bar exposition in semitonal writing. The bass clarinet part covers a diminished octave (commonly referred to as a major seventh)—from G♯1 to G2—which the tenor saxophone doubles one octave higher. It is followed by a three bar variation in quartertones,[69] and the eight bar phrase ends with a two bar extension based on the second bar of the exposition (Figure 98).

[69] Most of this section (marked in green) comprises heterophonic writing except for the last quintuplet, which is an example of polyphonic microtonal writing.
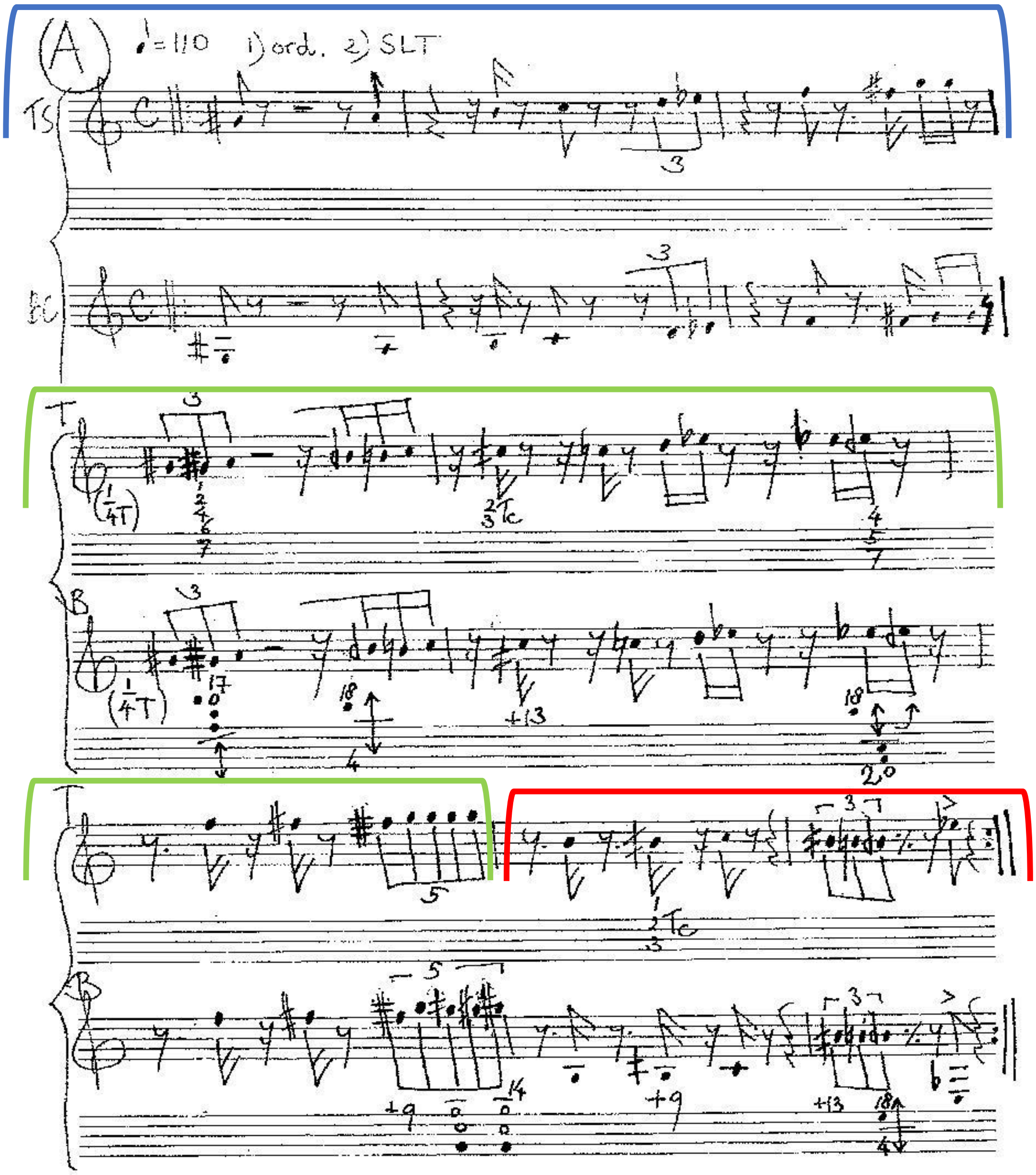
Figure 98: Bok, *small change* for tenor saxophone and bass clarinet, bars 1-8

The second eight bar section, section B, is an elaboration of the material presented in the first eight bars, this time in 31-tone intonation. The phrase starts in unison for the first four pitches (heterophony), after which the two instruments drift away from each other (polyphony), in the beginning only one

31-tone pitch apart but gradually growing wider apart before occasionally meeting in unison again.
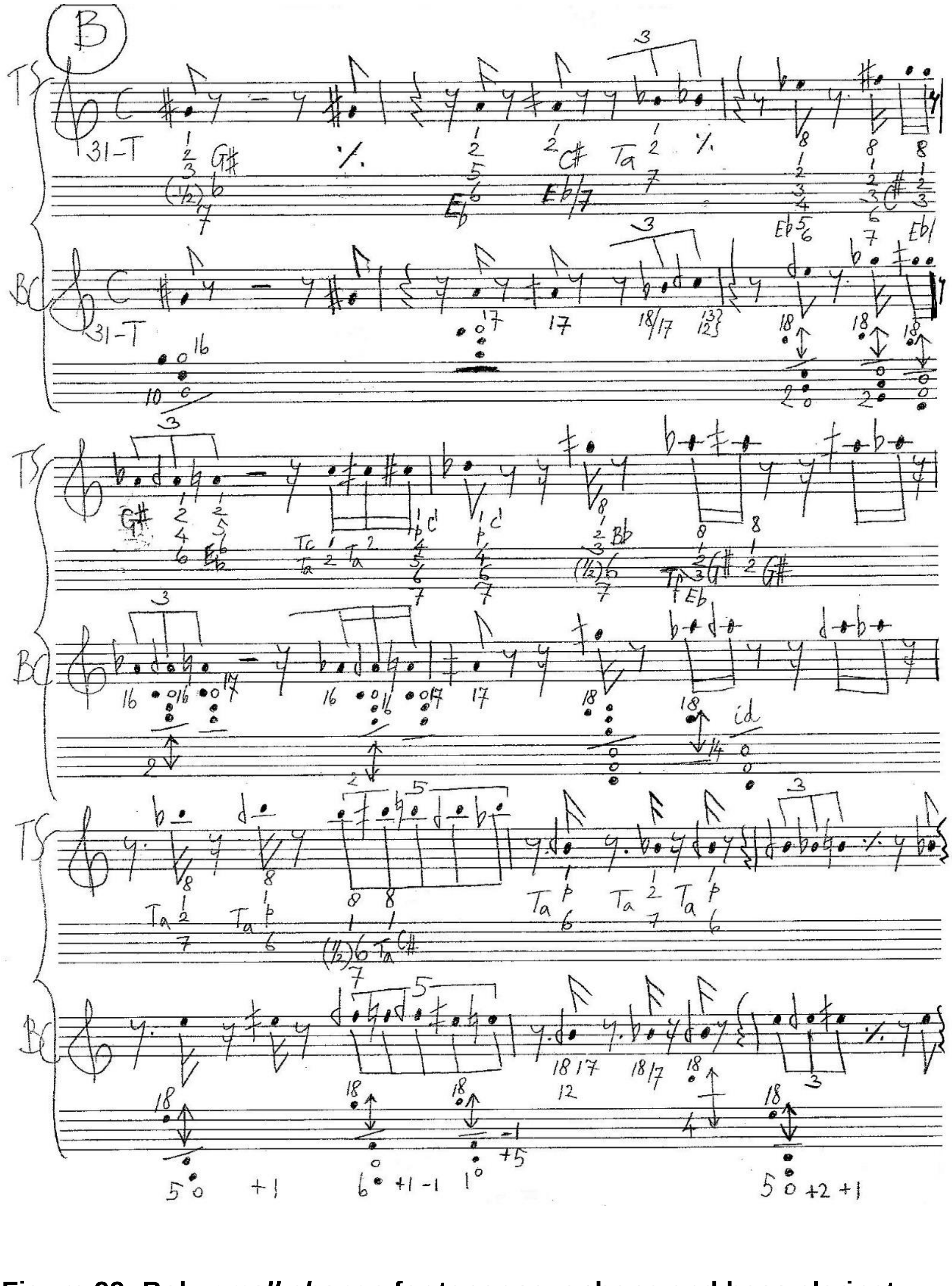
Figure 99: Bok, *small change* for tenor saxophone and bass clarinet, section B (bars 9-16)

As a bass clarinettist I am able to identify fingering pattern combinations which are hard to play and categorize them as either ‘difficult’ or ‘impossible’. Whilst I regularly include ‘difficult’ fingering pattern combinations in my own compositions, my knowledge of the instrument means that I am able to avoid the ‘impossible’ fingering pattern combinations. As a result, for me, the compositional process with such new, different fingering patterns has fewer pitfalls than for composers who do not have an intimate knowledge of the bass clarinet.

Taking into account the differences between the two single reed instruments with regard to intonation, response (attack), and dynamics, when playing microtonally, and looking at the preciseness of pitch control, these passages can only be successfully performed when the musical partners do not only know their own instrument well, but also the instrument of the other person. My knowledge of the saxophone, as a former player, supports my compositional choices for this combination of instruments. Despite this, I do not solely rely upon my own knowledge of the saxophone for such microtonal composition, but also upon the workshop style rehearsals of duo Hevans, where scores are not presented as final versions, but as material to be tried and discussed.

Audio example 15: Bok, *small change* for tenor saxophone and bass clarinet, recording of section B (bars 9-16)

4.3 Summary and conclusions

Initially inspired by the possibility of duo Hevans performing with the 31-tone Fokker organ, Evans and I were challenged to find 31-tone fingering patterns for our respective instruments. At the end of our research we were able to document more than two octaves of 31-tone fingering options (Appendix D). The next step in developing my fingering patterns was to try to expand the ambitus of the 31-tone area on my instrument, so that composers would have more possibilities to choose from when writing 31-tone music. As the data shows, I was able to extend the ambitus to three octaves, from D2-D5 (Appendices E and F). Apart from the extension of the range I aimed at greater accuracy: the goals I set myself for this development could be met, as two subsequent versions of my 31-tone fingering pattern chart, which each represent a step towards greater precision, could be established (Appendices E and F).

Having shared my newly found 31-tone data with several composers I discovered that the most frequently recurring issue, regarding the use of my fingering patterns by composers, was that of combinability. The 'culprit'—the finger responsible for many of the combinability issues—was the right hand thumb. This is due to its double role in many microtonal fingering patterns. To aid composers in their use and understanding of my microtonal fingering pattern charts I have therefore since added any necessary information about finger position in the Appendices. Videos of the scales have also been added, so that players and composers can hear the pitches, whilst seeing the corresponding fingering patterns (Videos 13, 14, and 15). Finally, to aid other performers, I have also included a short video about the core elements of 31-tone playing on the bass clarinet (Video 16).

Video 16: Summary of the core elements of 31-tone playing on the bass clarinet

CHAPTER 5

The inherent microtonality of the bass clarinet

5.1 Introduction

The inherent microtonality of the bass clarinet refers to the instrument's capability to generate microtonal variants based upon the natural overtone series. As discussed and demonstrated in Chapter 1, all the pitches which can be played on the instrument higher than B♭2 are overtones and are based upon root fingering patterns.

The decision about which root fingering pattern became the standard fingering pattern in semitonal music, particularly from C♯4 upwards, is based upon intonation, reliability, and ease of response. For example, the fingering pattern for C♯4 is based upon A1, the fingering pattern for D4 is based upon B♭1, that for D♯4 upon B1, and so on. However, C♯4 could also be produced using root fingering patterns for D♯1 and F♯2.[70]

The different root fingering patterns with which any pitch above B♭2 can be played each lead to small microtonal variants of the desired pitch. By exploiting the overtone system of the instrument this intrinsic form of microtonality on the bass clarinet can be uncovered. The microtonal possibilities that this approach has to offer will be discussed and detailed in this chapter.

5.2 The root-overtone approach

Root-overtone microtonality is produced by playing different pitches from the harmonic series of the instrument by overblowing root fingering patterns. In *Spectral Immersions*, Watts has detailed the harmonic series of the bass clarinet on root C1 (2015, p.33).

[70] The F♯2 option, often called an 'open' fingering, is regularly used on the bass clarinet as an alternative fingering pattern, whereas on the soprano clarinet this is still rare.

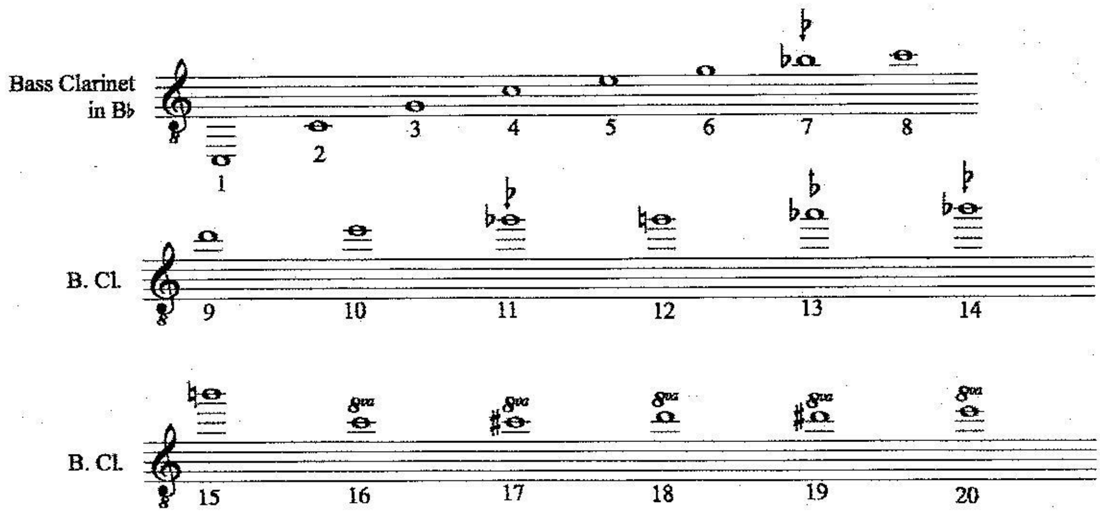

Figure 100: Watts (2015, p.33), the harmonic series of the bass clarinet

Watts states that since the bass clarinet overblows at the twelfth and has a cylindrical tube closed at one end, it “should be able to play only the uneven partials of the harmonic series” but argues that “it is usual to find that in fact most if not all partials will be present other than the lowest partials – certainly all partials from the seventh up should appear” (2015, pp.33-34). Watts has based these conclusions on spectral analyses using *AudioSculpt*,[71] in which the partials are captured in the C1 sound (Figure 101).

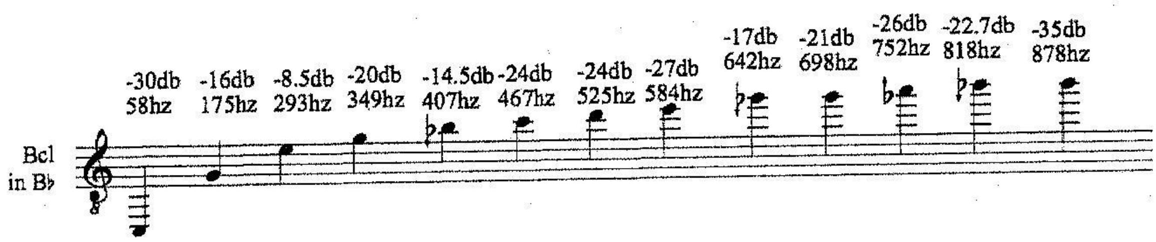

Figure 101: Watts (2015, p.40), the most prominent partials on the bass clarinet’s low C [C1, HB]

[71] AudioSculpt is a software programme for viewing, analysing, and processing sounds, developed by IRCAM.

There is a marked difference, however, between the overtones which can be seen on a spectral analysis of a note using a computer programme and the overtones of the harmonic series which can be separated on the instrument by the player. As British acousticians Murray Campbell, Clive Greated, and Arnold Myers formulate it:

> The reception afforded to odd and even harmonics by the air column is however very different. Each odd harmonic of the exciting air flow is in tune with a natural mode of the air column…The even harmonics, in contrast, find no helpful air column resonances at their frequencies, and therefore make only a weak contribution to the radiated sound. (2006, p.76)

To pick out the right pitch from the cluster of overtones, the technique of overblowing is used. Precise lower lip positions are crucial in allowing the desired overtone from the natural overtone series to sound. Isolating each overtone in a row by changing the position of the lower lip, it is not possible to sound the 2nd (C2), 4th (C3), 6th (G3), 8th (C4), 10th (E4), 12th (G4), and 15th (B4) harmonics.[72] Campbell and Greated remark: "In the upper registers there are only a few harmonics present, but the even ones become more significant, since the resonances of the tube deviate progressively away from the discrete multiples of the fundamental" (1987, p.270). Therefore, after the 13th harmonic, the spectrum changes and starts to favour the even harmonics. This phenomenon can be clearly seen in the measurements shown in Appendix G1.

[72] This is in contrast with the flute, oboe, bassoon, and saxophone, which should be able to play the whole series.

5.2.1 The microtonal effects of using different root fingering patterns

The fourth and fifth octaves of the bass clarinet offer a wealth of overtones, as the same overtone pitches occur in the harmonic series for several different fundamentals (root fingering patterns). For example, C5 can be sounded using the following roots: C1, D1, E1, G1, B♭1, D2, and A2 (Figure 102).
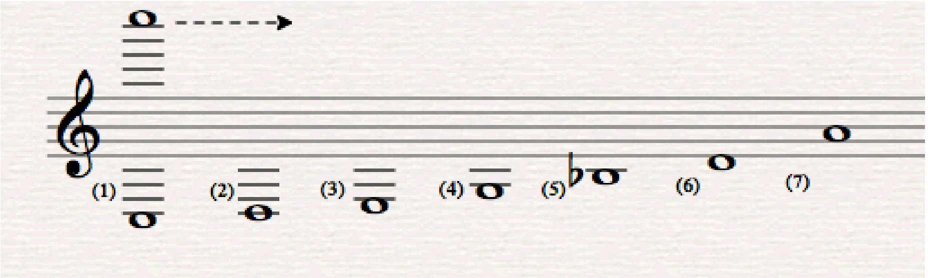
Figure 102: Seven root fingering patterns which can be used to sound overtone C5

Audio example 16: Seven root fingering patterns which can be used to sound overtone C5

When notes are produced following the root-overtone approach, their pitch is expected to follow the rules of the natural harmonic series. This means that, in comparison with twelve-tone equal temperament tuning, some pitches are flat, others sharp, following the mathematical rules of acoustics.[73] Traditionally, the choice of which fingering pattern to use for notes higher than B♭2 on the bass clarinet, has been made for their ease of production, ease of articulation, and good intonation. These intonation choices have, though, typically been based on twelve-tone equal temperament playing.[74]

The chart in Appendix G1 documents the sonic results of the overtone pitches for each root fingering pattern played. This has been done in cents difference from semitone pitches with the instrument tuned to A=442 Hz. Measurements

[73] For example, the 7th harmonic is flat and the 11th harmonic is sharp (Campbell, Greated, & Myers, 2006, p.44).

[74] The so-called 'open' fingerings (see also section 1.3.1.1 and Videos 5 and 6) consist of roots F2-B♭2 and are generally accepted fingering patterns for A♭4-C5.

were done vertically, that is in an accumulative way, starting with the root and playing the overtones from lowest to highest.

As can clearly be seen in this chart, overtones in the fifth octave, from C5 to F♯5, are coupled with the most root options, six alternatives or more. As can be deduced from the measurement results, using different root fingering patterns to play notes leads to microtonal variations of twelve-tone equal temperament pitches. This kind of microtonality is markedly different from the types documented in Chapters 3 and 4: no special fingering patterns are used to generate pitches which are in effect microtonal, just standard root fingering patterns with different lower lip positions.

Although the microtonal differences documented in Appendix G1 show the results of all the vertical measurements, a 'horizontal' test was also completed. This was done by playing D4 using each different root fingering pattern with which it is possible to sound the note: C1, E1, B♭1, and G2 respectively. The outcomes were measured three times in order to obtain average readings.

Root fingering pattern	Position of D4 in the harmonic series	Horizontal	Vertical
C1	9	+17	+15
E1	7	-31	-31
B♭1	5	-19	-11
G2	3	-10	-3

Figure 103: Table comparing the results of using four different root fingering patterns to play the overtone D4

The horizontal and vertical readings for root fingering pattern C1 are almost identical, with a difference of only 2 cents,[75] whilst horizontal and vertical readings for root fingering pattern E1 are exactly the same. The other two root fingering patterns, for B♭1 and G2 respectively, show slightly more discrepancy, with a difference of 7-8 cents. These differences could possibly be explained by

[75] Considering the results for D4/C1 (Figure 103), this microtonal option, which is directly linked to the acoustic architecture of the bass clarinet, could be used in a version of Christopher Fox's *Early one morning* (2014), where deviations from equal temperament of +16/+17 cents occur several times.

the influence of the embouchure. Generally speaking, there is greater flexibility for relaxing the embouchure (as shown by the horizontal reading), than there is for tightening the embouchure (as shown by the vertical reading).

Appendix G2 shows the results of a comparison between the expected frequencies of the harmonic series for root fingering pattern E1 and the obtained results taken on three readings, all in hertz. Tuning to A=442 Hz, the note E1 on the bass clarinet gave a reading of 73 Hz. The supposed pitches of the harmonic series have been calculated, and the equal temperament pitches have also been included. Then three readings of the actual pitch produced have been taken and documented. The average reading for each harmonic has been calculated and has been added to the chart.

As the table shows, the bass clarinet readings were close to either the expected harmonic series pitches or the equal temperament pitches for the 3rd, 5th, 7th, and 9th harmonics.[76] The readings for the 11th and the 13th harmonics both show a lower frequency than the expected pitch in the harmonic series.

Up to the 13th harmonic the readings are generally close to the expected harmonic series pitch. However, the 14th, 16th, and 18th harmonics show much more deviation. For all three of these harmonics the results are much higher than expected from the harmonic series frequency calculations. It is notable that this phenomenon occurs exactly at the changing point between odd and even harmonics.

The 14th, 16th, and 18th harmonics find themselves at the very top of the bass clarinet's (harmonic) range and for that reason are unstable. There is an extremely precise location for the lower lip to be in, in order to generate these altissimo harmonics. That the pitch of harmonics 14, 16, and 18 is higher than expected is due to the lower lip position requirements.

To gain greater insight into the flexibility of pitch control, whilst using the root-overtone system, I studied the extent to which the lower lip position can be manipulated. Root E1 was selected as a paradigm[77] and the results of the measurements, showing the margins with which the pitch of each overtone on this root fingering pattern could be lowered or raised, have been documented in Appendix G3. Measurements have been taken in cents difference from semitone pitches with the instrument tuned to A=442 Hz. Three different

[76] In the case of the 7th harmonic the discrepancy was slightly bigger.

[77] Root E1 was chosen for two reasons: it is a low note available on all bass clarinet models (there still are old models going down to E1 only) and secondly, E1 was used to demonstrate the bass clarinet's harmonic series in Figure 6 and Video 2.

readings have been taken and the measurements for each reading have been done vertically, that is from the root (1st harmonic) up to the 18th harmonic. The average manoeuvrability for each harmonic has been calculated and has been included in the chart.

The readings in Appendix G3 show that there is room for manoeuvre with each and every harmonic. As can clearly be deduced from the measurements, there is more space for manoeuvre lipping down (lowering the pitch), than lipping up (raising the pitch). This did not come as a surprise, because, as discussed in Chapter 1, it is easier to relax the lower lip than to tighten it.

Analysing my results further, it is notable that between the 7th and the 13th harmonic the highest degree of flexibility is found (between one and two semitones). At both ends of the harmonic series (the 3rd and 5th harmonics at the bottom, and the 18th harmonic at the top) the space for manoeuvre is more modest. This is due to the fact that these three harmonics are more difficult to generate or to sustain. The more limited room for pitch manipulation of the 3rd and 5th harmonics is related to their proximity to the root, which will sound together with the overtone as soon as the lip is bent too much or too quickly, especially in the case of a downward movement. The 18th harmonic is at the top of the bass clarinet's ambitus and, when lipped down too much, will turn into the 16th harmonic, as the distance between the two is minute. At the top of the harmonic series the overtones are much denser, much closer together, generally a major second apart. This means that there is little room to adapt the lower lip position for one overtone before the lower lip manipulation leads to a different overtone sounding.

As remarked earlier in this section, the fourth and fifth octaves of the bass clarinet, from C4 upwards, offer a wealth of overtones. Concerning manoeuvrability, Appendix G3 clearly shows that the same area (the 7th to the 13th harmonics) also offers the largest amount of flexibility, thereby contributing even more to the bass clarinet's root-overtone microtonal potential. The data clearly demonstrate that the use of the root-overtone system to create microtonal variants is valid and can be an efficient tool in enlarging microtonal possibilities.

5.2.2 Carter's *Steep Steps*: an analysis to highlight issues with the use of the root-overtone system

Elliott Carter's *Steep Steps* is dedicated to American clarinettist Virgil Blackwell. Carter states in the 'Composer's Note' that the overblowing system inherent to the bass clarinet is the central idea of the piece: "Its title comes from the fact that, unlike the other woodwind instruments, the clarinet overblows at the twelfth, a large interval that forms the basis of much of this composition" (2001).[78] Therefore, some features of the root-overtone system and some of the issues which arise by its use can be illustrated by taking a closer look at *Steep Steps*.

In bar 2 of the piece, the third (E3) and fourth (A1) notes are connected: E3 is an overtone of root fingering pattern A1 (Figure 104). E3 could therefore be played by overblowing the root fingering pattern for A1.

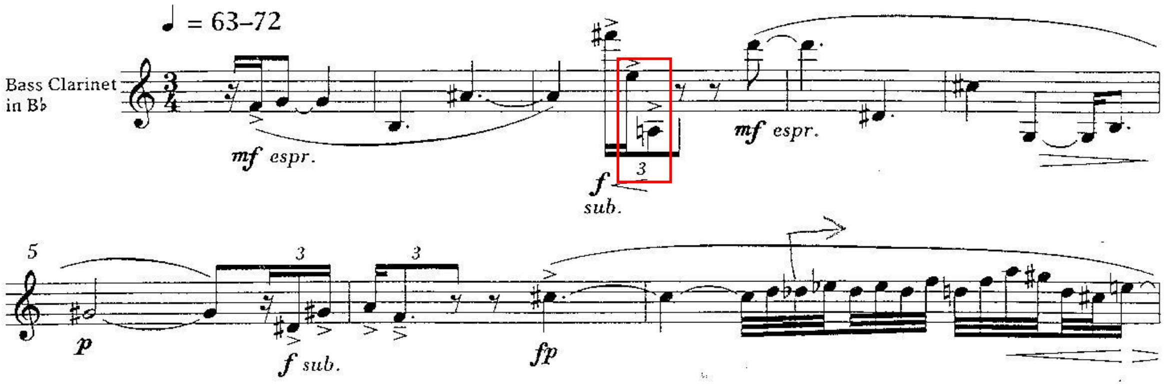

Figure 104: Carter, *Steep Steps*, bars 1-7

Another example of the way in which the root-overtone system can be applied to this work is found in bars 11 and 12 (Figure 105). The first two notes of bar 12, F4 and A♭3, are both overtones of the third note, D♭2 (marked in red in Figure 105). Therefore, it would seem logical to play these three notes using the root fingering pattern for D♭2.

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78 There is a later, revised version of the score (2005), but the original version of the score (2001) has been studied here.

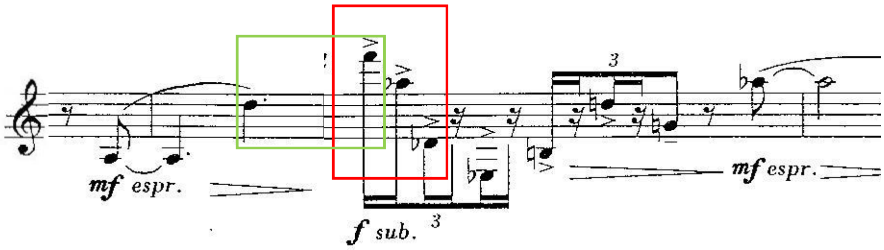

Figure 105: Carter, *Steep Steps*, bars 11-12

However, the note preceding the F4 is a D3 (last note of bar 11). Both F4 and D3 can be played using the root fingering pattern for G1. Therefore, F4 can be played as an overtone of the root fingering pattern for either G1 or D♭2. The F4 in bar 12 can, thus, be considered a 'pivot' note, that is, a note which is in the same overtone series as both the note which precedes it and that which follows it.

The possible dilemma posed by the choice of two root-overtone fingering patterns does not give the entire picture of the decision which must be made by the performer. There is also another aspect which could influence the performer's choice of which fingering pattern to use. Whilst theoretically it would be possible to play all three of the pitches marked in red in Figure 105 using only the root fingering pattern for D♭2, in reality, the tempo is too fast to make this a reliable option. As all three pitches require a different lower lip position, the speed at which they can be played is limited. Therefore, whilst this piece exhibits clear links with the instrument's harmonic series, it is not always practicable to play all the pitches using the root-overtone system.

One possible solution, which would allow the overtones to sound with greater ease, is to add extra keys. For example, if F4, A♭3, and D♭2 are all played using the root fingering pattern for D♭2, then key 18 (the register key) could be added in order to play A♭3, and both key 18 and key 16 could be added to aid the production of F4. Although key 18 and key 16 both help the instrument to produce the prescribed overtone, they do also have an influence on the pitch of the note.[79] Bastardized fingering patterns, using additional keys or leaving keys out, create nano tones, the subject of section 5.3.

The final bar of *Steep Steps* can be seen as a summary of Carter's interest in the roots and overtones of the bass clarinet (Figure 106). The final two notes can be played using just one root fingering pattern. As both C♯3 and G♯4 are overtones of the root fingering pattern for F♯1 and because of the clear connection between the last two notes, I would use the same root fingering pattern, but due to the loud dynamic (***ff***) and the accent, I would half-close LHK1, in order to aid the production of this note.[80]

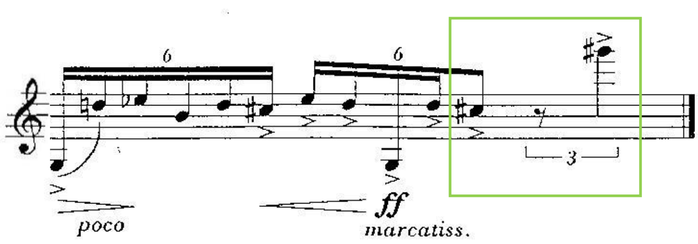

Figure 106: Carter, *Steep Steps*, bars 26-27

Although Carter did not include any fingering patterns in the score, and therefore the choice of fingering patterns is left to the performer, his comment that the overblowing system of the bass clarinet is the central idea of the piece requires the performer to make informed choices about fingering patterns and when the root-overtone system can be used. The issues raised by this piece, the choice of root fingering patterns, and the use of additional keys, are matters which will be covered in more detail in the next section.

[79] It is not stated in the score if Carter wanted the piece to be played using harmonic series tuning, or whether the use of additional keys, to perhaps bring the pitches closer to equal temperament tuning, would have been welcomed by the composer.

[80] If one were to play *Steep Steps* immediately *da capo*, there is a connection between the last note of the piece and the first note: the F2 fingering pattern (first note of the piece) can also be used for G♯4 (last note of the piece).

5.3 Additional microtonal variants of root-overtone sounds

Tiny pitch variations are possible on standard fingering patterns from A♭1 upwards, by using additional keys. This technique is not possible within the lowest fifth, as there are no keys available to make microtonal changes, with the exception of key number 7, F♯1 (see section 1.2.6). As discussed in connection with Carter's *Steep Steps*, single pitches produced using different root fingering patterns, can also be combined with additional keys. This technique generates even more, small microtonal pitch variations. I call these pitch variations of less than an eighth-tone on either standard fingering patterns or root-overtone fingering patterns, nano tones. For example, if key 1, 2, 3, 4, 5, 6, 7, or 8, is added to the (root) fingering pattern for A1, small pitch changes are produced. When the same fingering pattern is used to generate overtone C♯4, the addition of any one of the same keys will also produce small pitch variations. Similar pitch variations can be heard on other overtones higher in the harmonic series, such as G4 and B4.

As a test, measurements were executed on two root fingering patterns, one using keys located on both the upper and lower joints, B♭1, and the other, D2, which uses keys on the upper joint only. The aim of this test was to investigate whether similar pitch variations of the overtones would occur, when different keys were added to each of the root fingering patterns, thus giving an insight into yet another microtonal universe.

Having tuned to A=442 Hz, the root fingering pattern for B♭1 was used to play D4, the 5th harmonic. This pitch was measured to be five cents flatter than equal temperament tuning (D4 -5 cents). The pitch was then measured when each key was added to this root fingering pattern in turn. The following readings were taken:

Key added	Pitch deviation from equal temperament	Pitch deviation from D4 -5 cents
1	-18	-13
2	-12	-7
3	-7	-2
4	-2	+3
5	+8	+13
6	-14	-9
7	-9	-4
8	-2	+3
RHK3	-35	-30

Figure 107: Pitch deviation on D4

The pitch varied with each key used but the pitch variations measured were relatively small, between 2 cents and 13 cents, except for RHK3, which gave the biggest pitch deviation of 30 cents.

I then used the same root fingering pattern, for B♭1, to play the overtone A♭4, the 7th harmonic. The pitch of this overtone, without additional keys, was measured as A♭4 -62 cents (this reading could also be given as A4 +38 cents). Adding keys, the following readings were taken:

Key used	Pitch deviation from equal temperament	Pitch deviation from A♭4 -62 cents
1	-54	+8
2	-50	+12
3	-73	-11
4	-59	+3
5	-43	+19
6	-41	+21
7	-58	+4
8	-38	+24
RHK3	-111 (G4 -11)	-49

Figure 108: Pitch deviation on A♭4

The pitch variations in this case are larger, between 3 cents and 49 cents. The biggest pitch variation is almost a quartertone.

Finally, the root fingering pattern for D2 was put to the test in order to see the extent to which the overtone F♯4, the 5th harmonic, could be modified. As this is a fingering pattern which uses only the upper joint, five more keys were available to test: RHK1, RHK2, RHK3, key 9, and key 14. At the beginning of the test, F♯4, played using the root fingering pattern for D2, sounded a note which measured as F♯4 -28 cents. Adding keys, the following readings were taken:

Key used	Pitch deviation from equal temperament	Pitch deviation from F♯4 -28 cents
1	-27	+1
2	-25	+3
3	-24	+4
4	-25	+3
5	-33	-5
6	-31	-3
7	-31	-3
8	-30	-2
9	-21	+7
14	-22	+6
RHK1	-80	-52
RHK2	-45	-17
RHK3	-33	-5

Figure 109: Pitch deviation on F♯4

The results show that when the root fingering pattern for D2 is used to play the overtone F♯4, the addition of keys 1-9 and key 14 produce the smallest nano tone variants of all three pitches tested here: differences between 1 cent and 7 cents were measured. The key operated by the right hand ring finger (RHK3) also produced similar results. The two keys operated by the right hand index and middle fingers, by contrast, show a very different picture. RHK2 produces a pitch variation of -17 cents, but the key operated by the right hand index finger

(RHK1) really jumps out, with a reading of F♯4 -80 cents. This constitutes a deviation of 52 cents, approximately a quarter of a tone difference with the initial pitch measurement.

To conclude, the addition of available keys to vary the pitch of notes played using root-overtone fingering patterns is a productive method of generating more microtonal options. The test data show that in all three cases the use of keys 1-8 resulted in small microtonal differences, nano tones. Adding the index (RHK1), middle (RHK2), and ring finger (RHK3) keys during the overtone F♯4 test gave a mixed result. Although two of the three variants gave results suitable for inclusion as nano modifiers, the pitch difference resulting from the use of RHK1 makes it unsuitable for my work on microtonal pitch variants of less than an eighth of a tone. The extra options offered by adding different keys to root-overtone fingering patterns creates a myriad of possibilities for nano microtonality.

5.3.1 Type 1 multiphonics

In *New Techniques for the Bass Clarinet* I described type 1 multiphonics as "a stack of harmonics played as one block…by using traditional fingering and by changing the embouchure by means of strong pressure of the lips" (Bok, 2011, p.40). Indeed, a type 1 multiphonic contains several or all of the natural overtones of the root. This means that when playing type 1 multiphonics in a sequence, all overtones in the 'chord' move in the same direction.[81]

As previously mentioned, since writing *New Techniques for the Bass Clarinet*, I have changed my opinion regarding the technique used to sound overtones. I now believe that it is lip placement, not lip pressure, which allows different overtones to sound. It is also lip placement which enables type 1 multiphonics (a combination of harmonics) to be produced.

An interesting aspect of varying the lip placement is the change between monophonic and multiphonic uses of the root-overtone system. It is possible to shift between monophonic and multiphonic sounds, both played using root

[81] I will not consider type 2 multiphonics in this study. Type 2 multiphonics are produced using alternative (special) fingerings. Each type 2 multiphonic gives a specific result, which can vary according to instrument make, and materials used (such as mouthpiece and reed). Type 1 multiphonics, which are characterized by the instrument's natural overtones, can be sounded on any brand or make of bass clarinet, making them 'inherent' components of the bass clarinet's sonic universe.

fingering patterns. This kind of sound manipulation, which can be done smoothly and without interruption, requires skilled finger technique, air management, and control of lower lip positioning. A good ear is also needed to guide these technical skills and push them in the right direction. With the correct technique and the ability to hear what you want to play, different notes of the type 1 multiphonic can also be brought out more prominently.

The same microtonal differences that have been documented when individual pitches from the harmonic series are played using different root fingering patterns, occur when type 1 multiphonics are played, but here the changes affect all the notes sounding in the harmonic series. The application of the root-overtone system within type 1 multiphonics creates the same microtonal variants as with monophonic sounds, where the use of different root fingering patterns to play notes leads to microtonal variations of the twelve-tone equal temperament pitches. Bringing out shared overtones within a sequence of type 1 multiphonics enhances this 'multi-micro' effect.[82]

Figure 110 is an example of a possible sequence, whereby the changes between roots, single sounds, and multisounds result in an uninterrupted line of microtonally varied sonic elements.

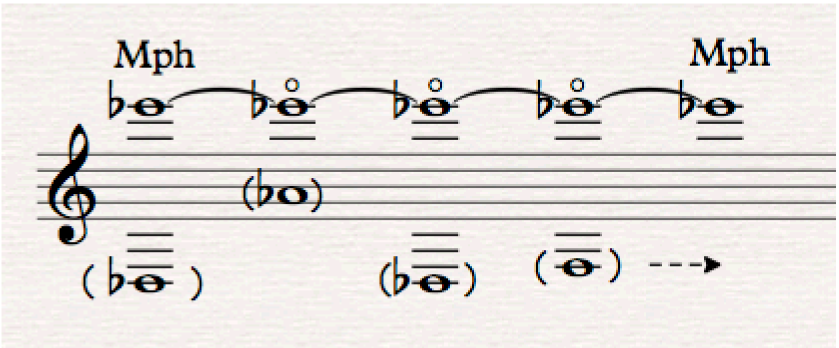

Figure 110: A root-overtone phrase shifting between single sounds and multisounds

Audio example 17: Recording of the root-overtone phrase in Figure 110

[82] *Multi-Micro I* is the title of my composition dealing with this particular aspect of microtonal writing (Audio example 32).

The same process of applying additional keys to root fingering patterns, which has previously been discussed with regard to individual tones, can also be applied to type 1 multiphonics. Adding keys to root fingering patterns when playing type 1 multiphonics changes both the root and all the overtone pitches. The keys used in section 5.3 thus produce nano variants of type 1 multiphonics.

5.4 Applications

5.4.1 Mc Laughlin: *a point on many lines*

Irish composer Scott Mc Laughlin's piece *a point on many lines* has a meditative and intense character. The score is structured in blocks of material, separated by empty space. Each block should be played at a different tempo, between "60-80 bpm" (metronome mark), and the chosen tempo should stay constant within each block (Mc Laughlin, 2013). The central pitch of the composition, D♯, is omnipresent, but occurs in different octaves, either as a root fingering pattern or as an overtone from a root fingering pattern. Mc Laughlin also combines monophonic and multiphonic sounds within this piece. He describes type 1 multiphonics as "multiphonics derived from the harmonic series of the lower note" (Mc Laughlin, 2013). He also prescribes three "special-fingered" multiphonics (type 2), which can be freely chosen by the performer, as long as they "allow the high D♯ [D♯4, HB] to be isolated" (Mc Laughlin, 2013).

The opening four blocks of the piece feature three different ways in which the central pitch should be played (Figure 111). Whereas the choice of fingering pattern for the opening note D♯4 (block 1) is left to the performer,[83] the second appearance of D♯4 (block 2) is based on the root fingering pattern for C♯1. This starts as a split sound, where both C♯1 and D♯4 can be heard, before resolving to only the D♯4. In block 4 Mc Laughlin asks that D♯4 is played as the overtone of the root fingering pattern for B1. At the start of this block only the overtone should be sounded, but, after four quavers, the root should be brought in.

[83] I chose a fingering pattern which is a combination of keys 16 and 18, basically a root-overtone fingering pattern based on G♯2.

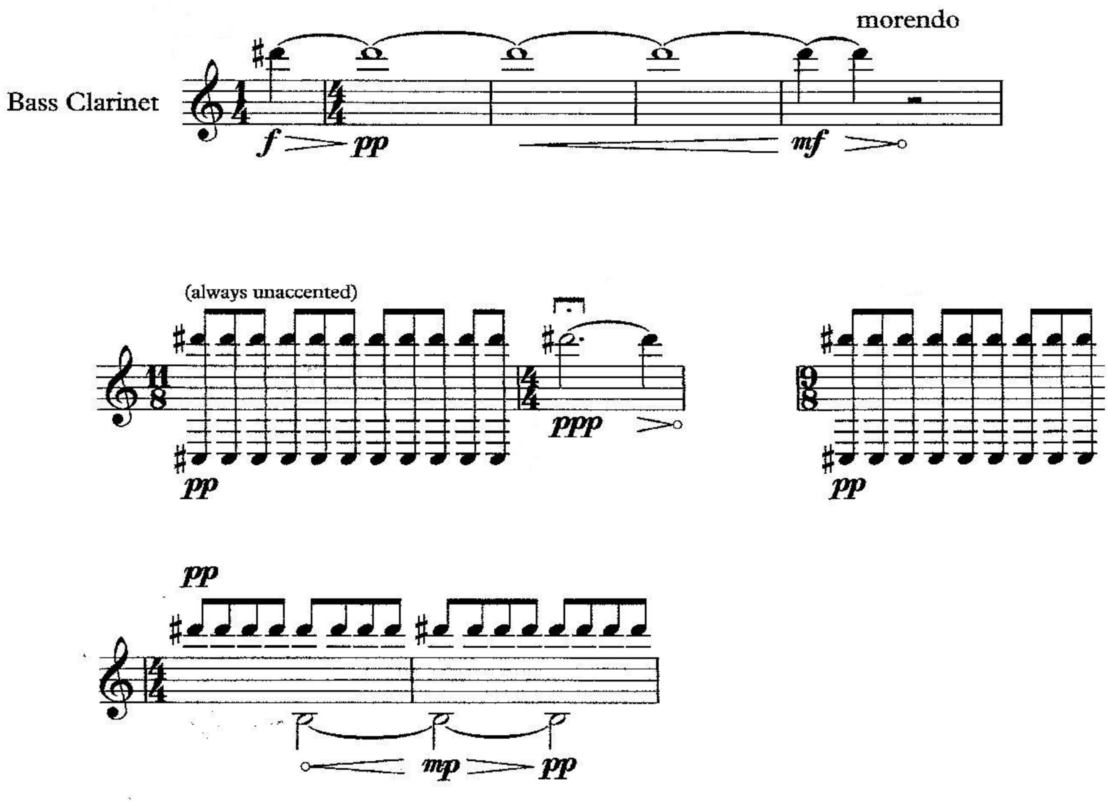

Figure 111: Mc Laughlin, *a point on many lines*, blocks 1-4

[**Audio example 18: Mc Laughlin, *a point on many lines*, blocks 1-4**]

In bar 34 Mc Laughlin introduces another root fingering pattern (F1), which allows the overtone D♯4 to be played (Figure 112), before returning to the root fingering pattern for B1.[84] It is on this root fingering pattern that Mc Laughlin asks the performer to sustain the root, B1, whilst playing D♯4 in a quaver rhythm. These pitches are then transformed into a type 1 multiphonic at the end of the phrase. As the pitches B1 and D♯4 are root and overtone of the same root fingering pattern, technically speaking, B1 cannot be played as a sustained note, whilst D♯4 is played in a repeated quaver rhythm. It is rather the manipulation of the prominence of different pitches within the harmonic series that allows the D♯4 to repeatedly drop away and return.

[84] Bar numbers in the score jump from bar 15 to 21. I here refer to the bars according to the numbering in the score.

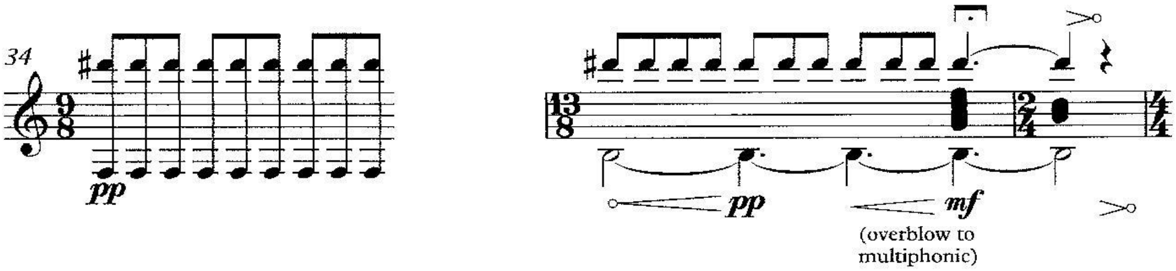

Figure 112: Mc Laughlin, *a point on many lines*, bars 34-37

Audio example 19: Mc Laughlin, *a point on many lines*, bars 34-37

The manipulation of the root-overtone system continues in bars 81-82, where Mc Laughlin writes a tremolo between root fingering patterns for C♯1 and B1 before bringing in the D♯4, which is an overtone common to both these root fingering patterns (Figure 113).

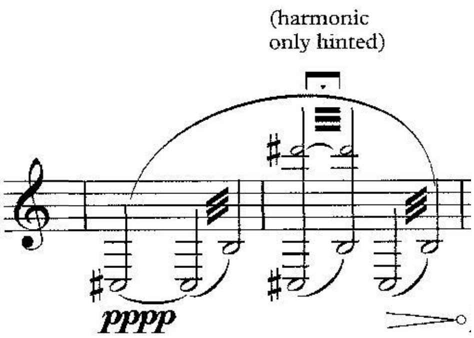

Figure 113: Mc Laughlin, *a point on many lines*, bars 81-82

Audio example 20: Mc Laughlin, *a point on many lines*, bars 81-82

A new element is introduced in bars 92-93 and then repeated: a glissando from the overtone D♯4 to the next playable overtone higher in the harmonic series. This occurs in bars 92-93 based on the root fingering pattern for F1, and in bars

95-97 based on the root fingering pattern for C♯1. Although the notation shows a glissando between these pitches, the composer has said that he does not mean an actual glissando: “gliss here meaning, change harmonics as smoothly as possible, not actual portamento/slide” (Mc Laughlin, 2013, p.4).[85]

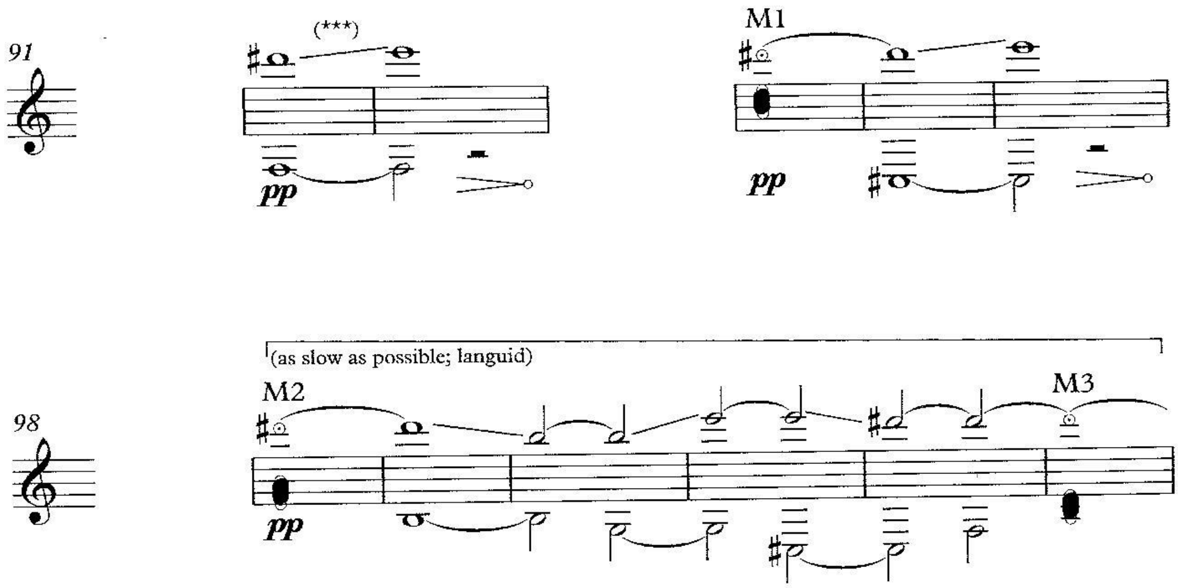

Figure 114: Mc Laughlin, *a point on many lines*, bars 92-104

Mc Laughlin’s remark about the written glissandi in bars 92-104 of *a point on many lines* might resolve what could be considered as inconsistencies in Mc Laughlin’s use of the different overtones in this section, as he chooses pitches which are not in the overtone series of the prescribed root fingering pattern. On the root fingering pattern for F1, the next overtone in the series (above D♯4) is actually G4, not E4. Similarly, on the root fingering pattern for C♯1, the next overtone in the series, above D♯4, sounds as F♯4 (see Appendix G1 for the resultant pitches). Whilst the composer’s choice of pitches does not comply with the overtone series of the bass clarinet, this area of the overtone series, roughly in the fourth octave of the instrument, is rather flexible and there is room for embouchure manipulation. As stated in section 5.2.1, the 7th, 9th, 11th, and 13th harmonics are the most flexible, but, as documented in Appendix G3 I had not previously been able to produce the extreme pitch manipulation that Mc Laughlin had requested here. However, Audio example 21 shows that I was

[85] Maybe an arrow would have conveyed the composer’s intentions in a more succinct manner.

able to push the limits of my pitch manipulation on this occasion, in order to fulfil the composer's request. Therefore, on root fingering pattern F1, the 9th partial could be sufficiently altered in order to sound an E4 and, likewise, on root fingering pattern C♯1, the 11th partial could be sufficiently altered to sound E4 (Audio example 21).

Audio example 21: Mc Laughlin, *a point on many lines*, bars 92-104

Mc Laughlin's work, *a point on many lines*, is a demanding but rewarding solo piece in which the natural overtone series of the bass clarinet comes to fruition through the use of the root-overtone system. Monophonic and multiphonic use of the root-overtone system amply shows the diversity of this inherent form of microtonality on the bass clarinet.

5.4.2 Domínguez: *Cuerpo Negro*

In *Cuerpo Negro* Francisco Domínguez combines quartertone microtonal writing (see section 3.4.1) with root-overtone harmonics. Following the initial slap tongue in bar 1, he makes considerable use of the root-overtone system in order to change the pitches of the notes microtonally. Domínguez prescribes different root fingering patterns from bar 2 onwards for a large part of section A (bars 2-21). The overtone pitches chosen by Domínguez are: B4, B𝄳4, C5, C𝄳5, C𝄲5, D♭5, E♭5, and F5 (Figure 115).

Although Domínguez continues his use of the root-overtone system to explore microtonal variants, in bars 4 and 20 he does it in a manner which does not return for the remainder of the piece: he changes the root fingering pattern used whilst the same overtone pitch should continue to sound (Figure 115).

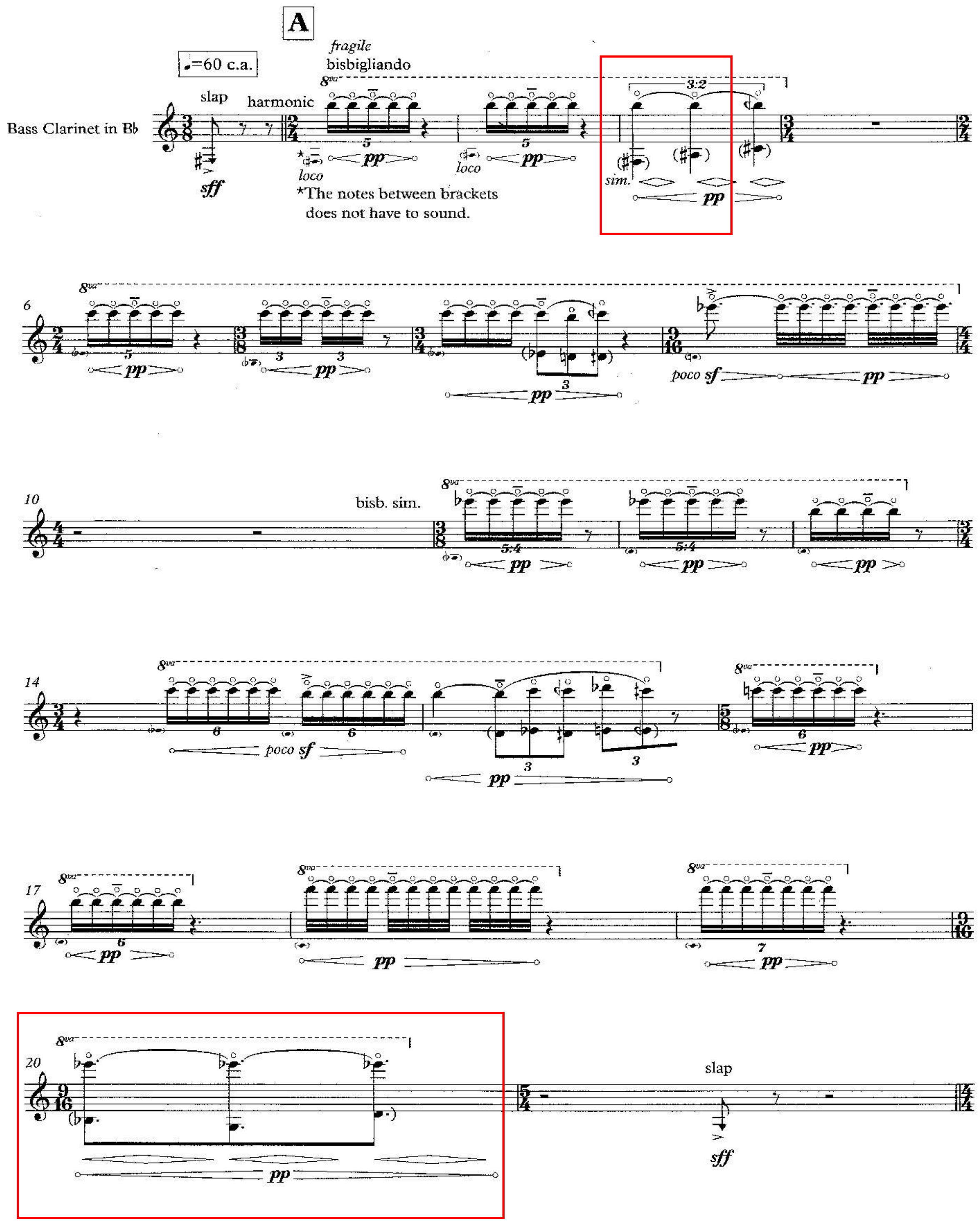

Figure 115: Domínguez, *Cuerpo Negro*, bars 1-21

Changing the roots but keeping the same overtone going (bars 4 and 20) requires a highly controlled change in lower lip position—position 3 for the B4 in bar 4 and position 4 for the E♭5 in bar 20 (see also section 1.3.1.1)—but also the knowledge and ability to instantly find the correct position.

Audio example 22: Domínguez, *Cuerpo Negro*, bars 1-21

From letter B onward Domínguez exploits the bass clarinet's root-overtone resources highlighting the flexibility of this form of microtonality. For example, in bar 22 an overtone produced by a given fingering pattern (B♭1) shifts to the root (Figure 116).

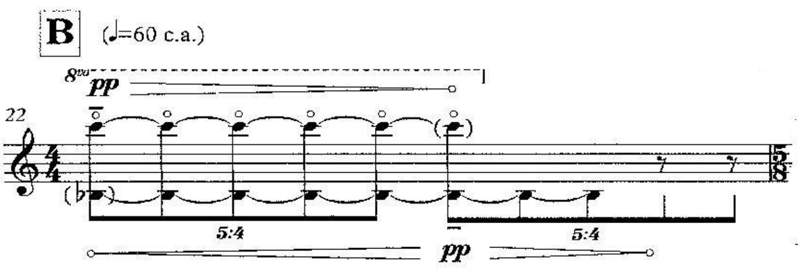

Figure 116: Domínguez, *Cuerpo Negro*, bar 22

Audio example 23: Domínguez, *Cuerpo Negro*, bar 22

In bar 24 there is a combination of quartertone writing and root-overtone writing. The quartertone sequence—E𝄳2, E♭2, D𝄲2—ends on D2, which is used as the root to produce E♭5, three octaves higher than the second note of the bar (E♭2). The D2 fingering pattern specified by the composer will not produce an E♭5 that is an exact octavation of E♭2, but instead, a microtonal variant.

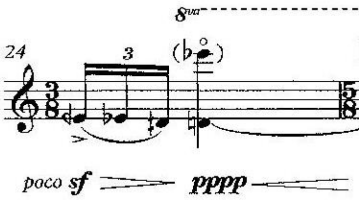

Figure 117: Domínguez, *Cuerpo Negro*, bar 24

Audio example 24: Domínguez, *Cuerpo Negro*, bar 24

In bar 27 the composer again combines quartertone and root-overtone writing. The overtone sequence—B4, C5, C♯5, D♯5—produced by the prescribed roots—A1, B♭1, B1, C♯1—will not produce an exact semitonal sequence. The small microtonal pitch changes, which are inherent to the sequence, have been deliberately chosen by Domínguez (F. Domínguez, personal communication, June 2, 2017).

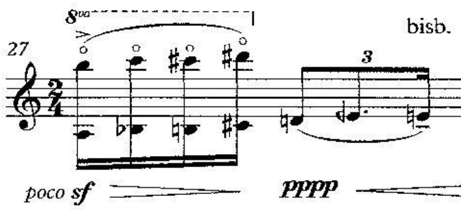

Figure 118: Domínguez, *Cuerpo Negro*, bar 27

Audio example 25: Domínguez, *Cuerpo Negro*, bar 27

The combination of quartertone writing and the microtonality found in the root-overtone system is characteristic of Domínguez's writing in *Cuerpo Negro*. On occasion he uses the same root to produce different overtones, for example, D2 to generate first E♭5 in bar 12, and then to generate B4 in bar 13 (Figure 115). His juxtaposition of different roots to produce the same overtone shows his awareness of the root options available for altissimo harmonic series writing. Two of Domínguez's favourite root-overtone combinations in this composition are the use of D2 for B4 and E♭5, and B♭1 to generate either C5 or E♭5 (Figure 115).

5.4.3 Laufer: *verse & refrain*

Norbert Laufer's work for solo bass clarinet, *verse & refrain*, focuses on two aspects of microtonal playing: 31-tone intonation and root-overtone microtonal variants. Two sections of *verse & refrain* focus particularly on the microtonal possibilities of the root-overtone approach: bars 16-23 and bars 44-51. The central pitch of the first section (bars 16-23) is D (either D4 or D5) and that of the second section (bars 44-51) is G (either G4 or G5).

Laufer couples the D5 in bars 16 and 17 with two different root fingering patterns, D1 and G1 respectively, thus creating a microtonal difference for the overtone. The same happens in the following two bars: overtone D4 is produced by root fingering patterns for E1 and B♭1 respectively. The second D4, based on B♭1, is then turned into a type 1 multiphonic in bar 20. This process is repeated in bar 21 (D4 based on the root fingering pattern for E1) and in bar 22 (D5 based on the root fingering pattern for G1). The section ends with D1 transforming into a type 1 multiphonic, whilst making a decrescendo, and also sounding overtone D5 (Figure 119).

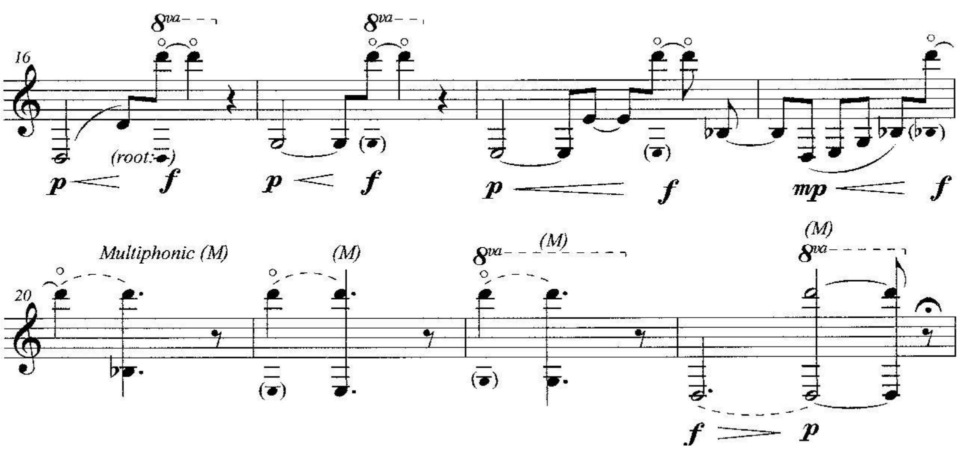

Figure 119: Laufer, *verse & refrain*, bars 16-23

Audio example 26: Laufer, *verse & refrain*, bars 16-23

The structure of the second root-overtone section (bars 44-51) is almost identical, but this time with G4 and G5 as the central pitches. However, in this section, the root fingering pattern used to play the third note in each bar (an overtone), is not that of the first note in each bar. For example, in bar 44 the first note is G1, whilst for the third note (G4), the root fingering pattern for D1 has to be used. Similarly, in bar 45 the first note is C1, but the third note of the bar (G4) should be played by overblowing the root fingering pattern for F1.

In bars 49-50 (Figure 120) Laufer makes similar use of the root-overtone system to Domínguez (see Figure 115): an overtone pitch is held whilst the root fingering pattern changes. Laufer goes one step further than Domínguez though, as the second root fingering pattern used in each bar must also sound a multiphonic.

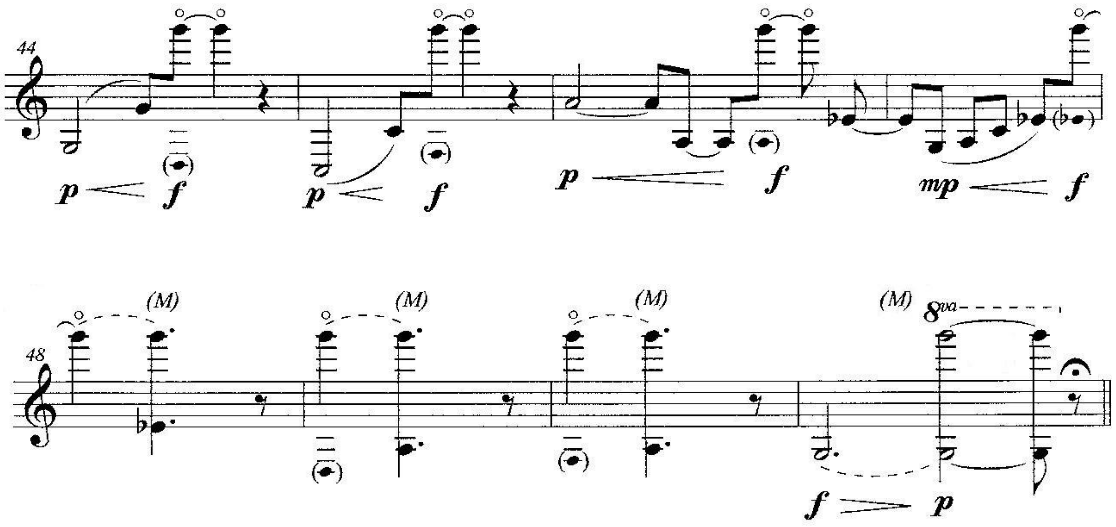

Figure 120: Laufer, *verse & refrain*, bars 44-51

Audio example 27: Laufer, *verse & refrain*, bars 44-51

Like Mc Laughlin, Laufer makes monophonic and multiphonic use of the root-overtone connections. However, whereas for Mc Laughlin root-overtone based microtonality is the principal aesthetic in *a point on many lines*, Laufer combines “traditional intonation” (N. Laufer, personal communication, June 6, 2017), 31-tone microtonal intonation, and root-overtone based microtonality to create his musical language in *verse & refrain*.

5.4.4 Own compositions

5.4.4.1 Bok: *There is a place for multiphonics*

Microtonality as a result of the root-overtone system plays a primary role in my composition *There is a place for multiphonics*. I wrote this composition for solo bass clarinet in the summer of 2012 and premiered it at a concert in Potsdam, New York on September 27, 2012. In June 2013 I revised the piece and premiered the revised (and final) version on June 15, 2013 in Düsseldorf.

One day, when experimenting with different roots and overtones, I discovered that I could play a lot of the opening melody of *There's a place for us* from Leonard Bernstein's *West Side Story*, by manipulating overtones. The start of this line can be played using the overtones of the root fingering pattern for E♭1. As can be seen in Figure 121, root E♭1 provides most of the overtones needed to play the melody. However, C4 and E♭4 do not form part of the natural harmonic series of this root. These pitches have to be produced by using embouchure manipulation to lower the pitch, lipping down the pitches of the natural overtone series, D♭4 and F4 respectively. As discussed in section 5.2.1, there is substantial space for manoeuvre, lipping down, in the fourth and fifth octaves.

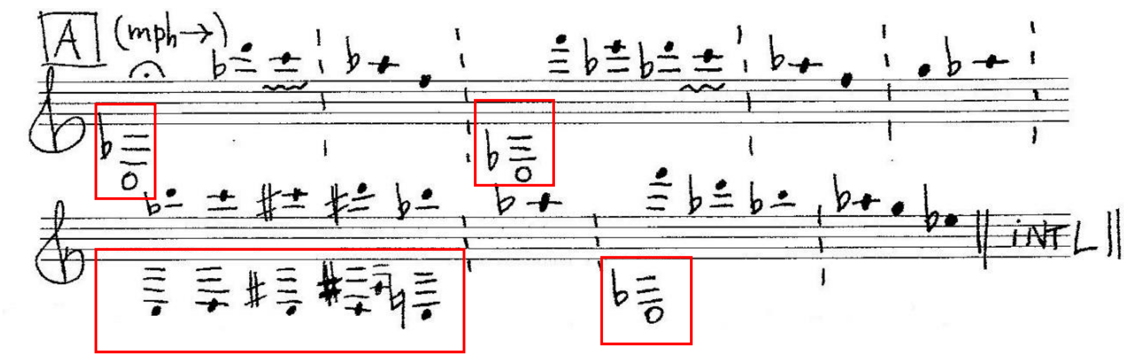

Figure 121: Bok, *There is a place for multiphonics*, section A

Audio example 28: Bok, *There is a place for multiphonics*, section A

The discovery that I could combine overtones based on root E♭1 with extreme manipulation of the lower lip in order to play the melody provided the inspiration for my composition. At the beginning of section B standard fingering patterns are used to play B♭3 and C4, but when the same notes are repeated, root-overtone fingering patterns are used (C1 and D1 respectively). This process of alternating standard fingering patterns with root-overtone fingering patterns continues, culminating in the two last pitches of the section, which are first played as single pitches, using standard fingering patterns, but then repeated an octave higher, utilizing root-overtone fingering patterns to sound a type 1 multiphonic (Figure 122).

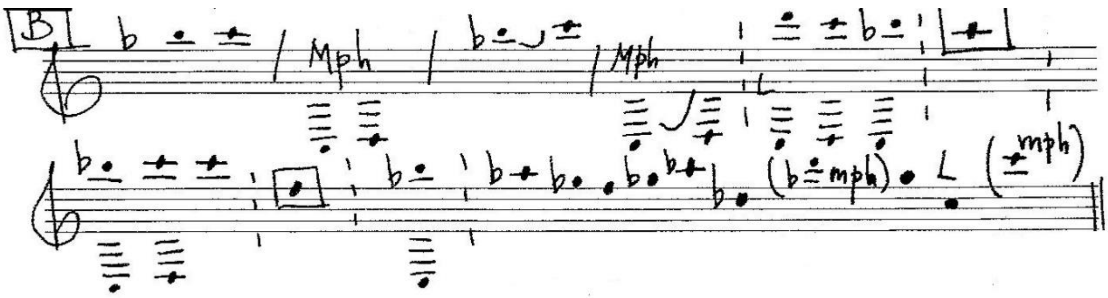

Figure 122: Bok, *There is a place for multiphonics*, section B

Audio example 29: Bok, *There is a place for multiphonics*, section B

The bar before Coda 2 is the last root-overtone occurrence in the piece. The notes of the melody, C4, D4, and E4, are played as type 1 multiphonics, using root-overtone fingering patterns G♯1, B♭1, and C2 respectively (Figure 123).

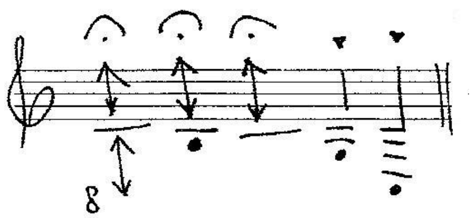

Figure 123: Bok, *There is a place for multiphonics*, penultimate bar

These three notes, notated in the score as fingering patterns, do not produce the original chords, but do provide the chordal ending to the piece that I had in mind.

[Audio example 30: Bok, *There is a place for multiphonics*, penultimate bar]

5.4.4.2 Bok: *Microclimate I*

Microclimate I (2017), for two bass clarinets, also makes use of the microtonal variants resulting from the use of the root-overtone system. A note occupying a central place in this section of the piece is E♭. One bar before section C the melody ends on an E♭, the second bass clarinet plays an E♭1, and the first bass clarinet plays an E♭3. In the first bar of section C the E♭3 is taken up one octave (E♭4, first bass clarinet), whilst the second bass clarinet repeats the E♭1 from the bar before. However, after a grace note (E♭4)—the final note in Figure 124 played using a standard fingering pattern—the fermata semibreve (E♭4) in the first bass clarinet part has to be played using the root-overtone fingering pattern for F1. This allows the single pitch to be transformed into a type 1 multiphonic.
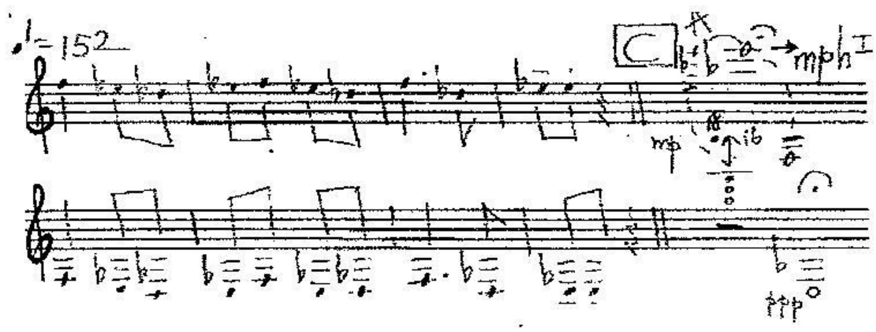
Figure 124: Bok, *Microclimate I*, section C

The final bars of the piece reprise the opening, this time, however, including root-overtone microtonal variations (Figure 125). In the first bass clarinet part the pitch C4 is played using either standard fingering patterns or the root fingering patterns for D1 or A♭1, thus creating microtonal pitch variations.

The piece ends with a C4/C♯4 trill in the first bass clarinet part, which is produced using the root fingering patterns for D1 and E♭1, combined with a microtonal trill C𝄳4/C4 (31-tone) in the second bass clarinet part. The sonic result is a combination of two disparate microtonal systems.

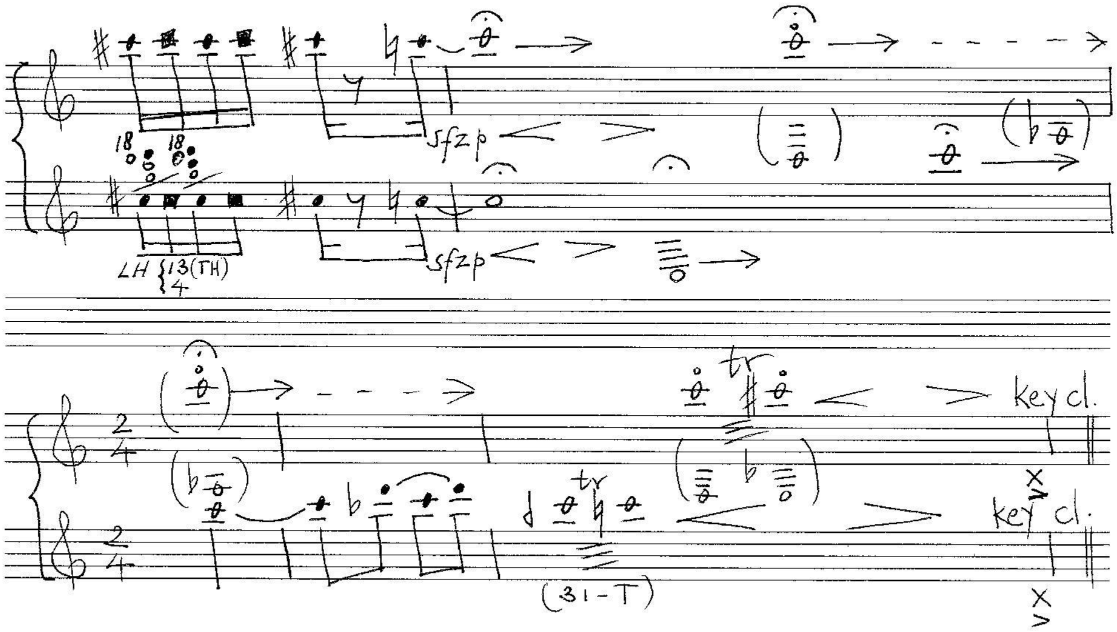

Figure 125: Bok, *Microclimate I*, end of section E

<u>5.4.4.3 Bok*: smaller change*</u>

Another of my compositions, *smaller change* (2017), also uses root-overtone microtonality. In this composition I tried to apply all my microtonal findings (as a performer) to a piece of music (as a composer) in order to show the richness of the microtonal universe of the bass clarinet.

Although it was my original intention to use D4 as the binding factor of the composition, I decided during the process to also include a few D5's, attracted by the fact that D5 is a natural overtone in the harmonic series of D1, the lowest D on the bass clarinet. The piece also features split sounds and type 1 multiphonics, which all include either D4 or D5 as the most prominent pitch.

In Figure 126 four different root fingering patterns are used to produce D4: C1, E1, B♭1, and G2. I also use four nano variants of the fingering pattern for root B♭1, produced by adding key 2, key 5a, key 8, or RHK3. In bar four (Figure 126) there is a microtonal trill created by the movement between the three different root fingering patterns used to play D4 in the three previous bars. The last bar of the root-overtone section reiterates the section’s opening idea (bars 1-4). However, the microtonal trill here is based on only two roots, B♭1 and E1, and develops into a multiphonic trill on the same two root fingering patterns. This produces nano pitch variations throughout the whole multiphonic cluster.
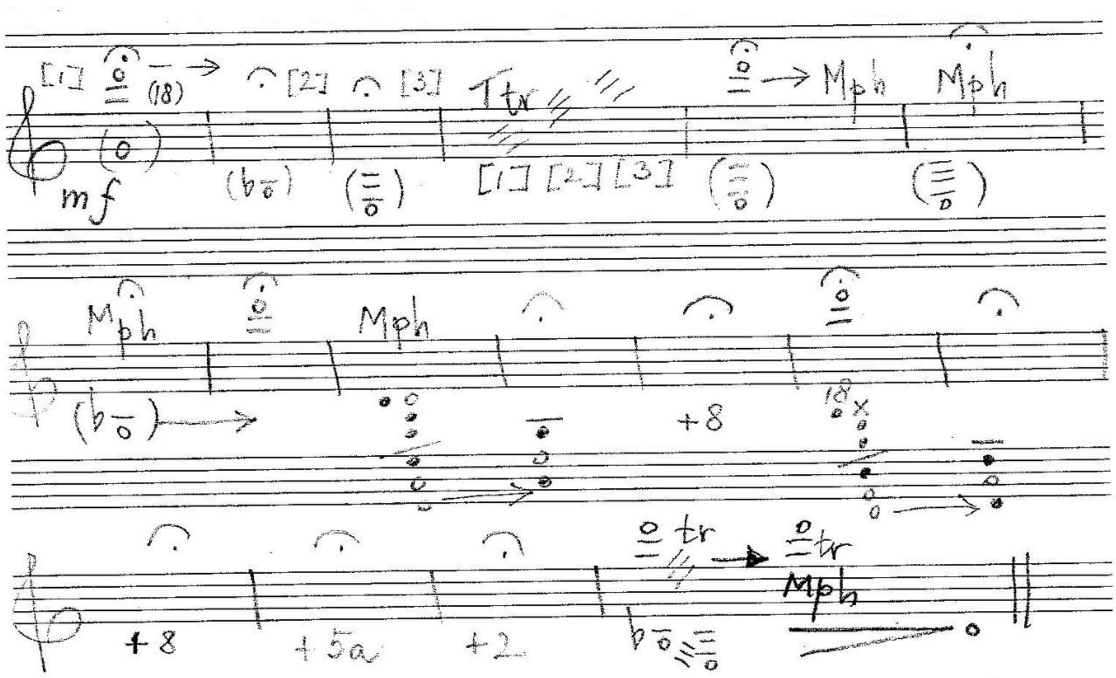
Figure 126: Bok, *smaller change* for solo bass clarinet, root-overtone section

Audio example 31: Bok, *smaller change*, root-overtone section

5.5 Summary and conclusions

I have used the term, the inherent microtonality of the bass clarinet, to refer to the instrument's ability to sound microtonal pitch variations by utilizing the notes of the overtone series based on the root fingering patterns from C1 to B♭2. These microtonal variants can be single, isolated pitches (monophonic), but can also comprise overtones (multiphonic), as type 1 multiphonics are based upon the root-overtone production system. Adding keys to the root fingering patterns produces nano tones (see Glossary), the use of which increases the number of microtonal variants, not only for the roots, but also for any overtone pitch a root can generate.

Root-overtone production clearly demonstrates how bass clarinet acoustics work and how it leads to the 'inner' or intrinsic microtonality of the instrument. Pitch measurements for all the overtones producible by the root pitches of the instrument, from C1 to B♭2, have been documented (Appendix G1). Appendix G2 compares three readings of the harmonic series frequencies for root fingering pattern E1 with the supposed harmonic series pitches and the equal temperament pitches. Appendix G3 shows the overtone manoeuvrability for the same root fingering pattern (E1).

Harnessing the inherent microtonality of the bass clarinet by documenting the root-overtone system in this way, shows that it is a viable form of microtonal practice and adds another dimension to the sound world of the microtonal bass clarinet. This can be further extended through the use of additional keys in order to create nano microtonality. Given the abundance of possibilities, it is no wonder that I have been fascinated by the microtonal variants of the root-overtone system for a very long time, not only as a performer and an improviser, but also as a composer.

Video 17: Summary of the core elements of root-overtone playing on the bass clarinet

CHAPTER 6

Conclusion

The main objective of this research has been to expand the microtonal possibilities of the current unmodified bass clarinet. For me, microtonality has belonged to bass clarinet language from the very first moment I came into contact with the instrument, that is, when I was introduced to this sound world by Eric Dolphy's playing.

My specialised bass clarinet studies and fascination with contemporary music were the driving forces behind my personal search for new sonic possibilities. The results of my findings were first published by Salabert in 1989, as a book entitled *New Techniques for the Bass Clarinet*. There were two microtonal sections in my book, 'Fingerings for variations in timbre' and 'Fingerings for microtones and micro-intervals', but as a performer and a composer, I felt a growing need for preciseness and accuracy when dealing with microtonality.

I wanted to improve upon the accuracy of existing fingering patterns, and to come up with new options where suitable solutions were (still) missing. I also wanted to push boundaries and see to what extent I could find fingering patterns for different divisions of the tone.

Highly motivated to find out as much as I could regarding the microtonal possibilities of the bass clarinet by using adapted fingering patterns, I also wanted to explore another kind of microtonality, one which is inherent to the instrument. The acoustics of the bass clarinet and the way overtones are produced, according to the natural harmonic series, made me aware of the inherent microtonality of the instrument and the additional microtonal options it offers.

My research covered the aforementioned microtonal areas, and discussed and developed the microtonal challenges and opportunities the bass clarinet has to offer, answering the following research questions:

- Which information concerning microtonal possibilities on the bass clarinet is currently available and is this information correct?
- Is it possible to play (more) precise quartertones on the bass clarinet, and if possible, which fingering patterns can be established to do so?

- Is it possible to play (more) precise eighth-tones on the bass clarinet, and if possible, which fingering patterns can be established to do so?
- Is it possible to play 31-tones on the bass clarinet, and if possible, which fingering patterns can be established to do so?
- Is it possible to use the root-overtone system in order to expand the microtonal language of the bass clarinet?
- Is it possible to find microtonal possibilities of less than an eighth-tone on the bass clarinet?[86]

To find the answers to these research questions I started by studying and reviewing the existing literature. All the fingering patterns were checked and (re)measured using the same method and the same set-up (including the reed). The results can be found in Appendices A1, A2, and A3. As the next step I also retested the fingering patterns found in my book *New Techniques for the Bass Clarinet*. Realising that many of the available fingering patterns did not match the strict parameters I had set for the research, I started to search for new fingering patterns. My knowledge of the acoustics and the working of the bass clarinet supported the process of trial and error I used to uncover new possibilities.

The outcomes of this research are:

- My definitive quartertone scale from D2-G5 (Appendix B)
- My definitive eighth-tone scale from D2-G5 (Appendix C)
- A scale of 31-tone fingering patterns from D2-G4, version 1, for use with the Fokker organ (Appendix D)
- A scale of 31-tone fingering patterns from D2-D5, version 2 (Appendix E)
- A scale of 31-tone fingering patterns from D2-D5, definitive version (Appendix F)
- Documents detailing various aspects of the root-overtone system (Appendices G1, G2, and G3)
- Instruction videos covering the technical aspects relevant to microtonal playing
- Videos of my microtonal scales (Appendices B-F)

[86] These small microtonal intervals are referred to as nano tones.

The new fingering pattern charts have already been utilized by a number of composers. The information contained in the Appendices is laid out in a way that other composers and performers will be able to benefit from it. For me, as a performer, my research has led to new, challenging pieces to present to concert audiences. As a composer, I have already profited considerably from the results of my research, writing new solo pieces and compositions for ensemble, a full list of which can be found following my biography. Live recordings of two of my recent compositions, *Multi-Micro I* (2014)[87] and *Fifty shades of Dee* (2017)[88] are included.

Audio example 32: Bok, *Multi-Micro I*

Audio example 33: Bok, *Fifty shades of Dee*

Currently, I am expanding the microtonal polyphony in my ensemble works, as microtonal voicings for two or more instruments are a new artistic challenge for me as a composer. Another project which has occupied me in the final stages of this research is the verification of my microtonal data on a Buffet Crampon Prestige instrument, as I recently switched to this make and model.

Future projects could include the expansion of the information on viable combinations of 31-tone pitches, the possibilities and challenges of combining different forms of microtonality, and the documentation of nano tone variants through the addition of keys to the root-overtone fingering patterns.

[87] Performed by duo Hevans.
[88] With Rainer Klaas on piano.

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Appendix A1 − Review of quartertone fingering patterns

Red has been used to denote keys which are only half-closed

Blue shows the fingering patterns which cannot be played on the instrument used for this research

Green has been used to denote keys bracketed in the original sources when the meaning of this indication is not known

Yellow has been used to highlight other miscellaneous information regarding the fingering patterns

The following abbreviations have been used for the different sources:

JA – Jason Alder

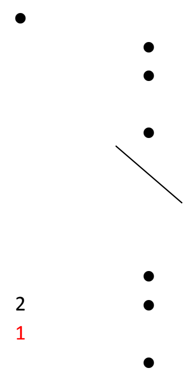
PR – Phillip Rehfeldt

EMR – E. Michael Richards

HS – Harry Sparnaay

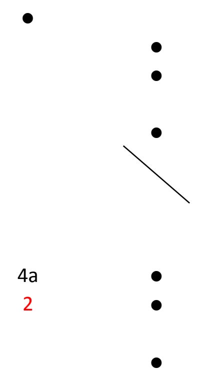
Appendix A1 − Review of quartertone fingering patterns

C𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

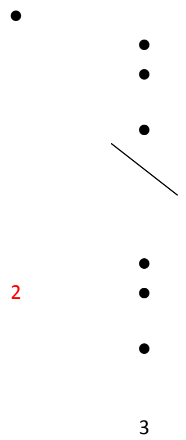
D𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: This fingering pattern could not be tested as key 4a has a different function on Buffet-Crampon instruments

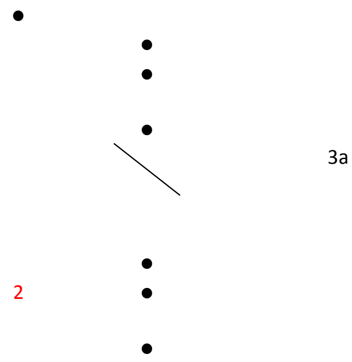
Appendix A1 − Review of quartertone fingering patterns

D𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

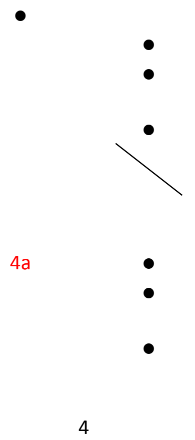
D𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

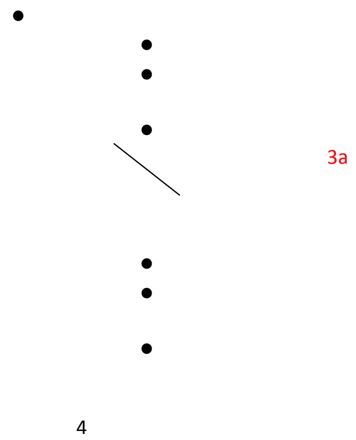
Appendix A1 – Review of quartertone fingering patterns

D𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise
This fingering pattern could not be tested as key 4a has a different function on Buffet-Crampon instruments.

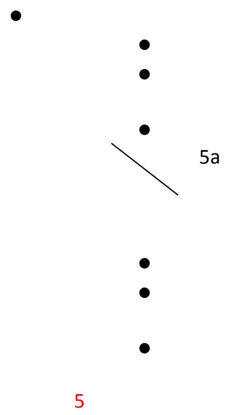
D𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

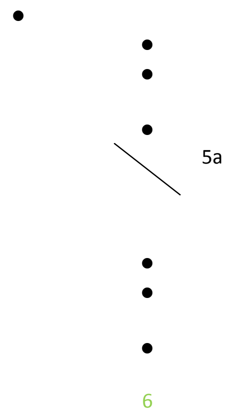
Appendix A1 − Review of quartertone fingering patterns

E𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Keys 5 and 5a both close the same pad. Therefore this fingering pattern is not possible.

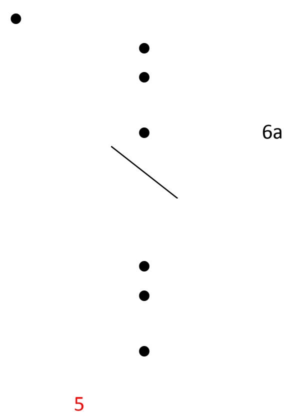
E𝄳1



Source: PR
Source comments: Control the low “e” opening by pressing at a point just above the left calf
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note
Key 6 is bracketed in PR charts. Key 6 changes nothing as the keywork mechanism is closed for pitches E1 to G1

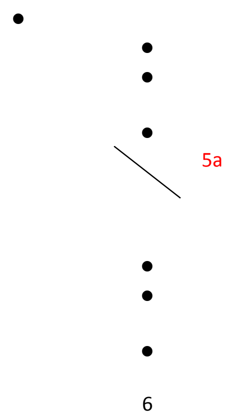
Appendix A1 − Review of quartertone fingering patterns

E𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

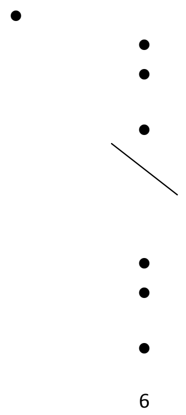
E𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

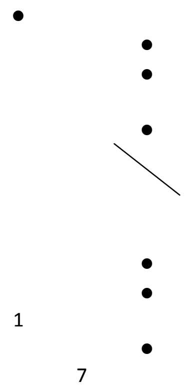
Appendix A1 − Review of quartertone fingering patterns

E𝄲1



Source: PR
Source comments: Control the “f” opening with right calf
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

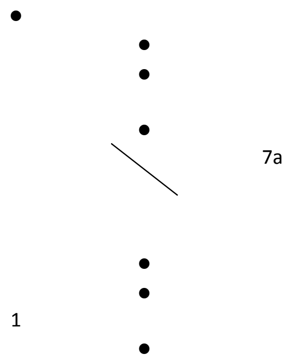
F𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: F♯1 -10 cents
HB comments:

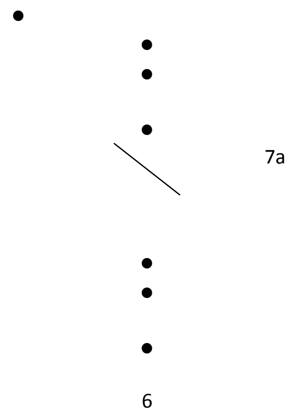
Appendix A1 − Review of quartertone fingering patterns

F𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: F♯1 -10 cents
HB comments:

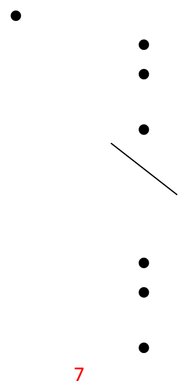
F𝄲1



Source: PR
Source comments: Control the "f♯" opening with left calf
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

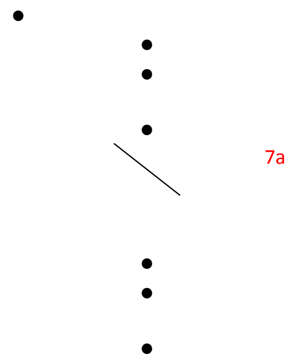
Appendix A1 − Review of quartertone fingering patterns

G𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

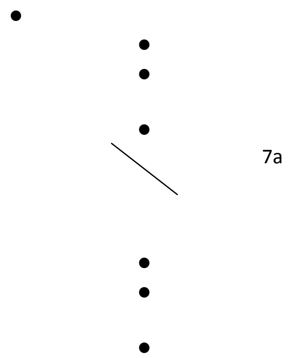
G𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

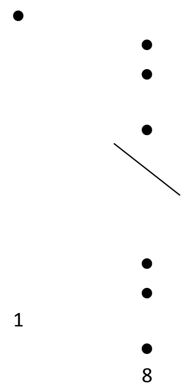
Appendix A1 − Review of quartertone fingering patterns

G𝄳1



Source: PR
Source comments: Control the “f♯” opening with left calf
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

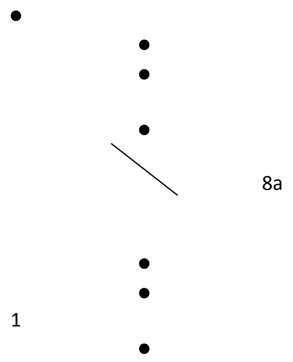
G𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: G𝄲1 -9 cents
HB comments:

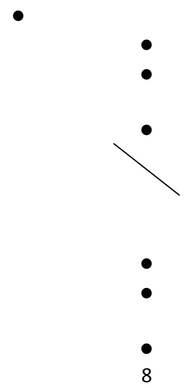
Appendix A1 − Review of quartertone fingering patterns

G𝄲1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: G𝄲1 -9 cents
HB comments:

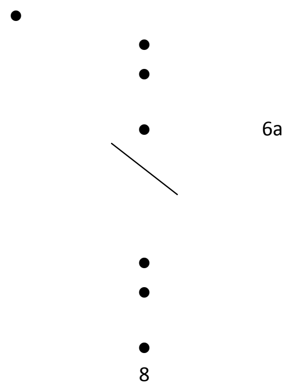
G𝄲1



Source: PR
Source comments: Control the “g𝄲” opening with left knee
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

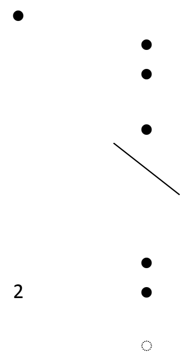
Appendix A1 − Review of quartertone fingering patterns

G𝄲1



Source: HS
Source comments: No quarter tones
Bisbigliando
Pitch: G♯1 -7 cents
HB comments:

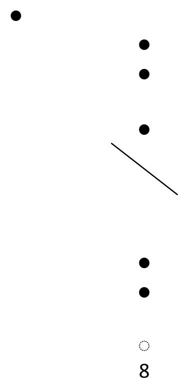
A𝄳1



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: A1 -9 cents
HB comments:

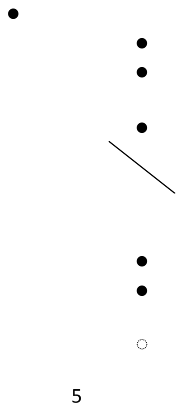
Appendix A1 − Review of quartertone fingering patterns

A𝄳1



Source: PR
Source comments: Control the “a” opening with right knee
Pitch: -
HB comments: PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note
This fingering pattern does not work as key 8 raises the pitch of the fingering pattern for A1 rather than lowers it

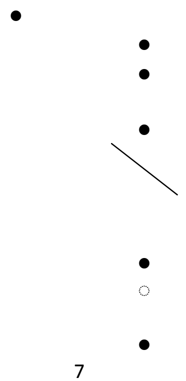
A𝄳1



Source: HS
Source comments: No quarter tones
Bisbigliando
Pitch: A1 -6 cents
HB comments:

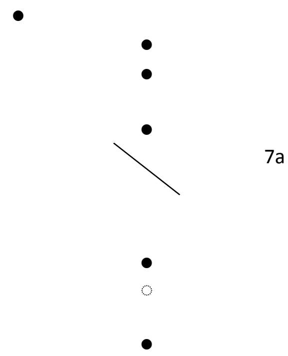
Appendix A1 − Review of quartertone fingering patterns

A𝄲1



Source: JA
Source comments:
Pitch: A♯1 -12 cents
HB comments:

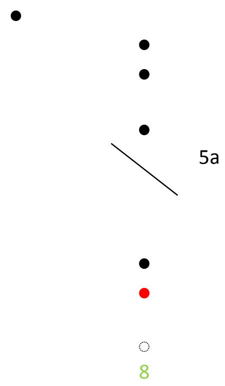
A𝄲1



Source: JA
Source comments:
Pitch: A♯1 -12 cents
HB comments:

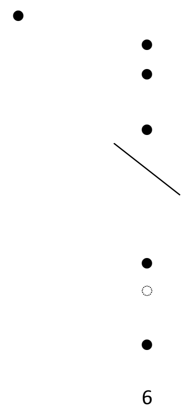
Appendix A1 − Review of quartertone fingering patterns

A𝄲1



Source: PR
Source comments: Control “a” opening with R.H. [right hand] second [middle] finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note
RHK2 does not directly operate a pad: the key moves a pad on the side of the instrument

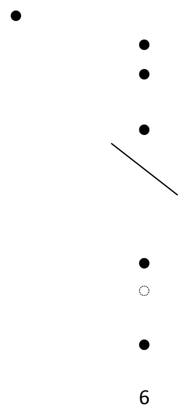
A𝄲1



Source: PR
Source comments:
Pitch: A♯1 -13 cents
HB comments:

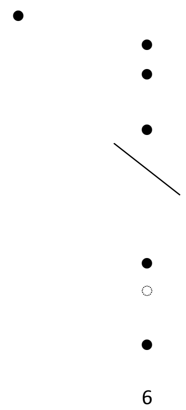
Appendix A1 − Review of quartertone fingering patterns

A𝄲1



Source: EMR
Source comments: Slightly low [in pitch]
Dark timbre
Pitch: A♯1 -13 cents
HB comments:

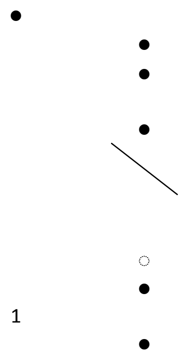
A𝄲1



Source: HS
Source comments: No quarter tones
Bisbigliando
Pitch: A♯1 -13 cents
HB comments:

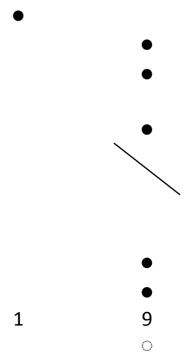
Appendix A1 − Review of quartertone fingering patterns

B𝄳1



Source: JA
Source comments:
Pitch: B1 -5 cents
HB comments:

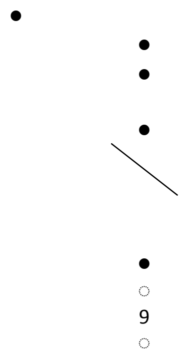
B𝄳1



Source: JA
Source comments:
Pitch: B1 -3 cents
HB comments:

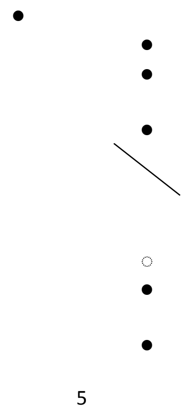
Appendix A1 – Review of quartertone fingering patterns

B𝄳1



Source: PR
Source comments: Control the "b♮" opening by placing R.H. [right hand] thumb on b♮ lever, obtaining leverage between thumb and R.H. third [ring] finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

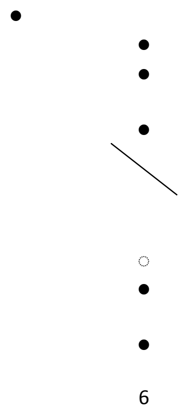
B𝄳1



Source: EMR
Source comments: Slightly high [in pitch]
Slightly dark timbre
Pitch: B1 -3 cents
HB comments:

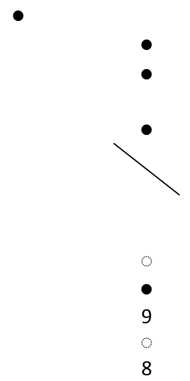
Appendix A1 − Review of quartertone fingering patterns

B𝄳1



Source: HS
Source comments: No quarter tones
Bisbigliando
Pitch: B1 -1 cent
HB comments:

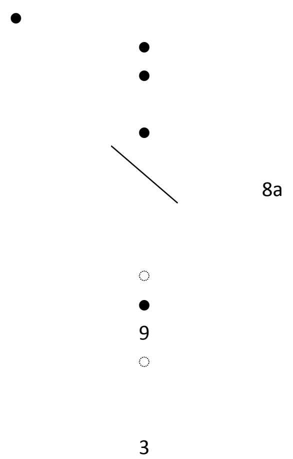
B𝄲1



Source: JA
Source comments:
Pitch: B1 +37 cents
HB comments:

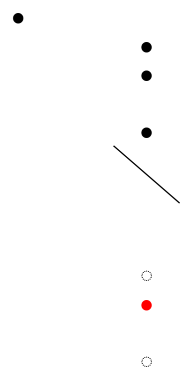
Appendix A1 – Review of quartertone fingering patterns

B𝄲1



Source: JA
Source comments:
Pitch: B1 +37 cents
HB comments: Good sound, open

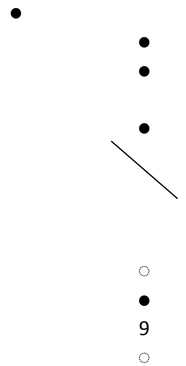
B𝄲1



Source: PR
Source comments: Control the air space below the R.H. [right hand] second [middle] finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

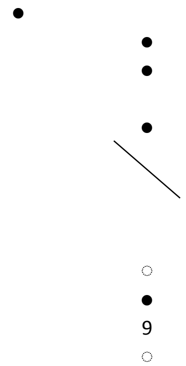
Appendix A1 − Review of quartertone fingering patterns

B𝄲1



Source: PR
Source comments:
Pitch: B1 +39 cents
HB comments:

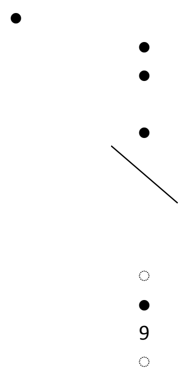
B𝄲1



Source: EMR
Source comments: Slightly bright timbre
Pitch: B1 +39 cents
HB comments:

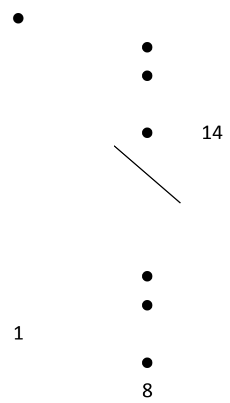
Appendix A1 − Review of quartertone fingering patterns

B𝄲1



Source: HS
Source comments:
Pitch: B1 +39 cents
HB comments:

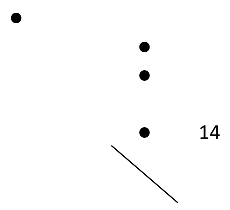
C𝄲2



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

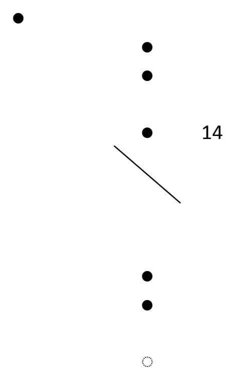
Appendix A1 − Review of quartertone fingering patterns

C𝄲2



Source: PR
Source comments: Control the “c♯” opening with the L.H. [left hand] little finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

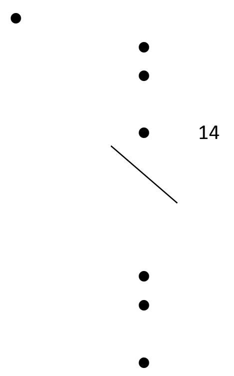
C𝄲2



Source: EMR
Source comments: Dark timbre
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

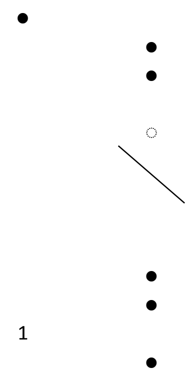
Appendix A1 – Review of quartertone fingering patterns

C𝄲2



Source: HS
Source comments: Very poor tone quality. With the aid of the embouchure
Not possible on the Selmer bass clarinet.
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

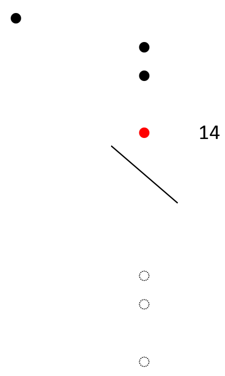
D𝄳2



Source: JA
Source comments:
Pitch: D2 -8 cents
HB comments:

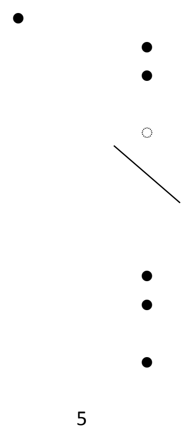
Appendix A1 − Review of quartertone fingering patterns

D𝄳2



Source: PR
Source comments: Control air space with L.H. third [ring] finger
Pitch: -
HB comments: Imprecise

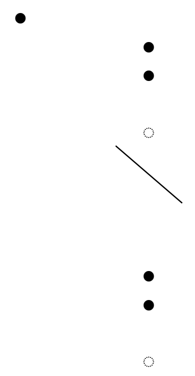
D𝄳2



Source: EMR
Source comments: Slightly high [in pitch]
Dark timbre
Pitch: D2 -4 cents
HB comments:

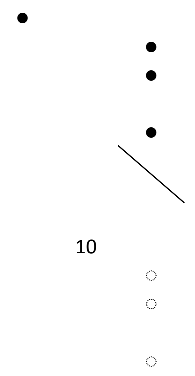
Appendix A1 − Review of quartertone fingering patterns

D𝄳2



Source: HS
Source comments: Very poor tone quality
With the aid of the embouchure
Pitch: D2 +2 cents
HB comments:

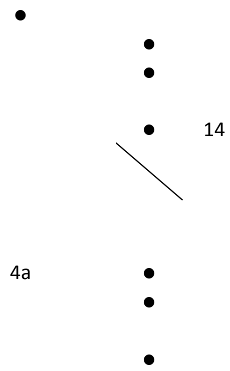
D𝄲2



Source: JA
Source comments:
Pitch: D♯2 -27 cents
HB comments:

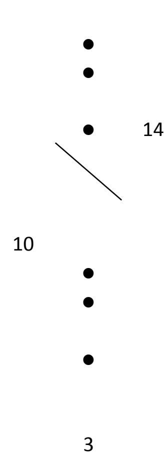
Appendix A1 − Review of quartertone fingering patterns

D𝄲2



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 4a and key 14 have different functions on Buffet-Crampon instruments

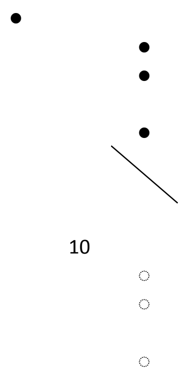
D𝄲2



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments
Without key 14 the pitch was measured as D2 +23 cents

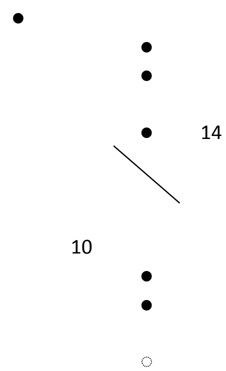
Appendix A1 − Review of quartertone fingering patterns

D𝄲2



Source: PR
Source comments:
Pitch: D♯2 -27 cents
HB comments:

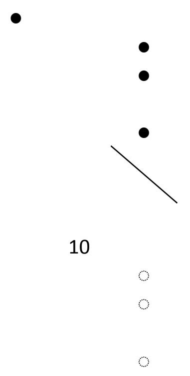
D𝄲2



Source: EMR
Source comments: Slightly high [in pitch]
Slightly dark timbre
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments
Without key 14 the pitch was measured as D♯2 -43 cents

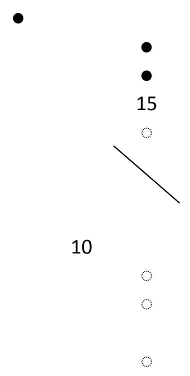
Appendix A1 − Review of quartertone fingering patterns

D𝄲2



Source: HS
Source comments:
Pitch: D♯2 -27 cents
HB comments:

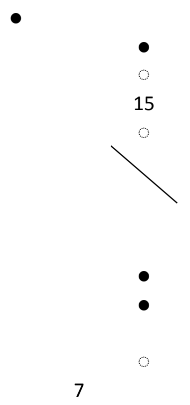
E𝄳2



Source: JA
Source comments:
Pitch: E2 -51 cents
HB comments:

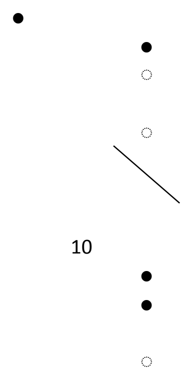
Appendix A1 − Review of quartertone fingering patterns

E𝄳2



Source: JA
Source comments:
Pitch: E♭2 +44 cents
HB comments:

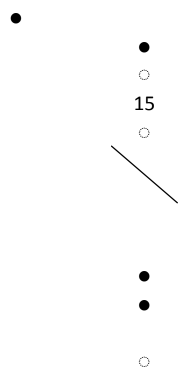
E𝄳2



Source: JA
Source comments:
Pitch: E2 -49 cents
HB comments:

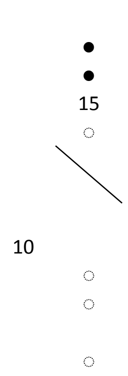
Appendix A1 − Review of quartertone fingering patterns

E𝄳2



Source: PR
Source comments:
Pitch: E2 -49 cents
HB comments:

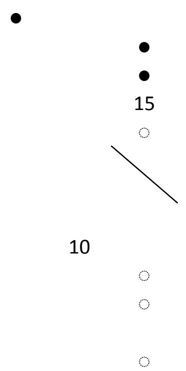
E𝄳2



Source: PR
Source comments:
Pitch: E2 -51 cents
HB comments:

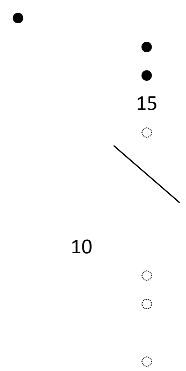
Appendix A1 − Review of quartertone fingering patterns

E𝄳2



Source: EMR
Source comments:
Pitch: E2 -51 cents
HB comments:

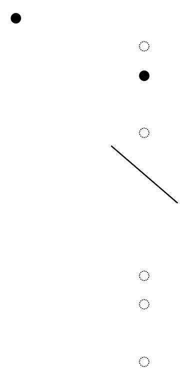
E𝄳2



Source: HS
Source comments:
Pitch: E2 -51 cents
HB comments:

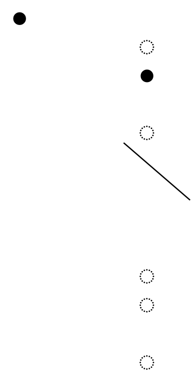
Appendix A1 − Review of quartertone fingering patterns

E𝄲2



Source: JA
Source comments:
Pitch: E2 +31 cents
HB comments:

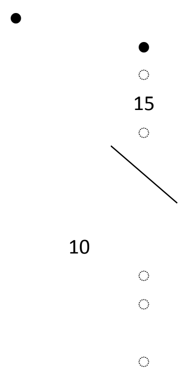
E𝄲2



Source: PR
Source comments:
Pitch: E2 +31 cents
HB comments:

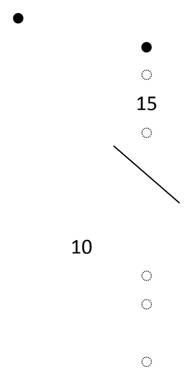
Appendix A1 − Review of quartertone fingering patterns

E𝄲2



Source: PR
Source comments:
Pitch: E2 +23 cents
HB comments:

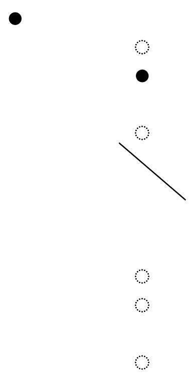
E𝄲2



Source: EMR
Source comments: Slightly bright timbre
Pitch: E2 +23 cents
HB comments:

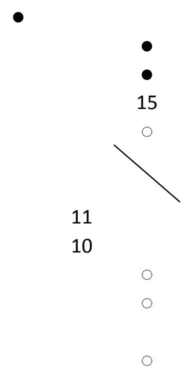
Appendix A1 − Review of quartertone fingering patterns

E𝄲2



Source: HS
Source comments:
Pitch: E2 +31 cents
HB comments:

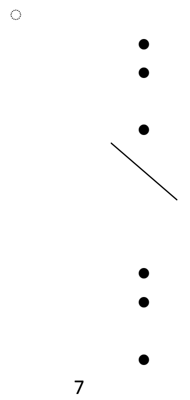
F𝄲2



Source: JA
Source comments:
Pitch: F2 +47 cents
HB comments:

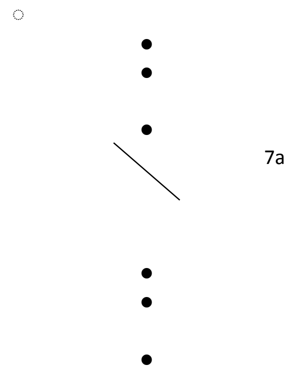
Appendix A1 − Review of quartertone fingering patterns

F𝄲2



Source: JA
Source comments:
Pitch: F♯2 -40 cents
HB comments:

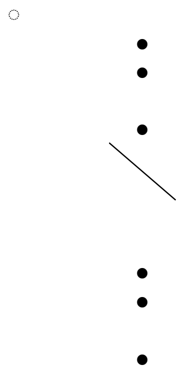
F𝄲2



Source: JA
Source comments:
Pitch: F♯2 -40 cents
HB comments:

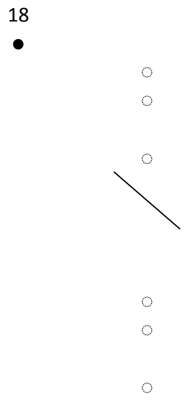
Appendix A1 − Review of quartertone fingering patterns

F𝄲2



Source: PR
Source comments:
Pitch: F♯2 -34 cents
HB comments:

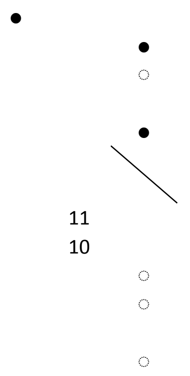
F𝄲2



Source: PR
Source comments:
Pitch: -
HB comments: The given fingering pattern is for C4 and must be underblown. This is not stated in Rehfeldt. It has a very different sound (subtone)

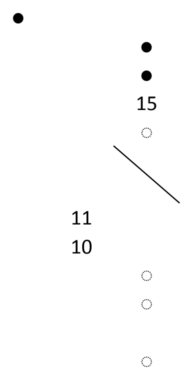
Appendix A1 − Review of quartertone fingering patterns

F𝄲2



Source: EMR
Source comments: Slightly dark timbre
Pitch: F2 +38 cents
HB comments: LHK2 automatically closes when LHK3 is closed

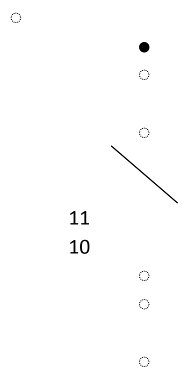
F𝄲2



Source: HS
Source comments:
Pitch: F2 +47 cents
HB comments:

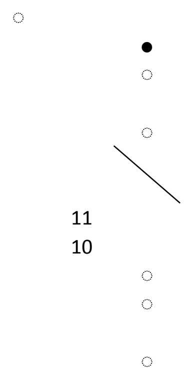
Appendix A1 − Review of quartertone fingering patterns

G𝄳2



Source: JA
Source comments:
Pitch: G♭2 +38 cents
HB comments:

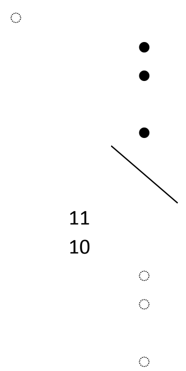
G𝄳2



Source: PR
Source comments:
Pitch: G♭2 +38 cents
HB comments:

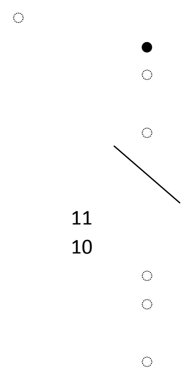
Appendix A1 − Review of quartertone fingering patterns

G𝄳2



Source: PR
Source comments:
Pitch: G♭2 +30 cents
HB comments:

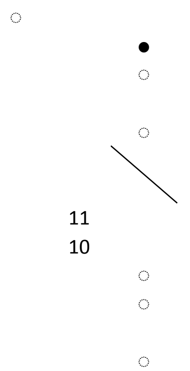
G𝄳2



Source: EMR
Source comments:
Pitch: G♭2 +38 cents
HB comments:

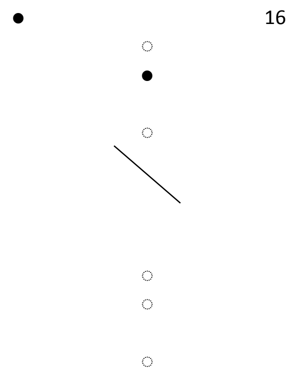
Appendix A1 − Review of quartertone fingering patterns

G𝄳2



Source: HS
Source comments:
Pitch: G♭2 +38 cents
HB comments:

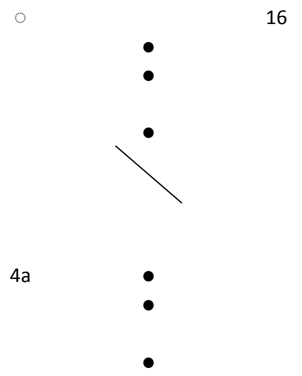
G𝄲2



Source: JA
Source comments:
Pitch: G♯2 -44 cents
HB comments:

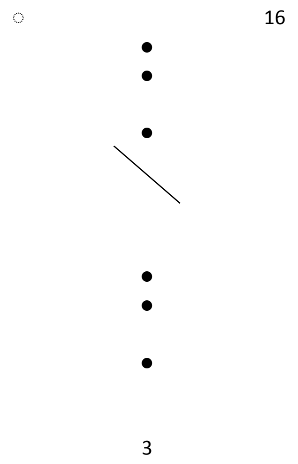
Appendix A1 − Review of quartertone fingering patterns

G𝄲2



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 4a has a different function on Buffet-Crampon instruments

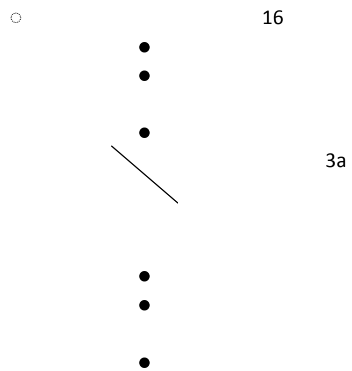
G𝄲2



Source: JA
Source comments:
Pitch: G♯2 -37 cents
HB comments:

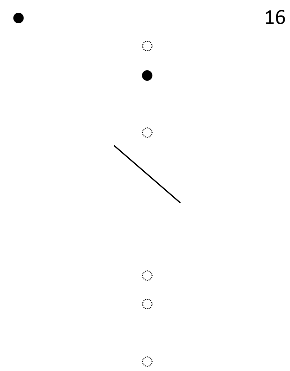
Appendix A1 − Review of quartertone fingering patterns

G𝄲2



Source: JA
Source comments:
Pitch: G♯2 -37 cents
HB comments:

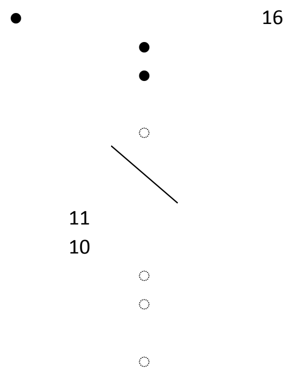
G𝄲2



Source: PR
Source comments:
Pitch: G♯2 -44 cents
HB comments:

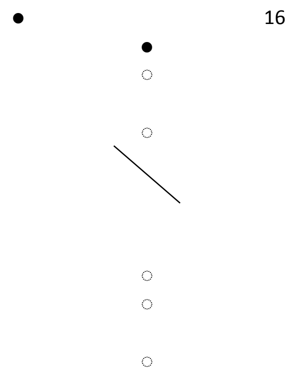
Appendix A1 − Review of quartertone fingering patterns

G𝄲2



Source: EMR
Source comments:
Pitch: G𝄲2 -33 cents
HB comments:

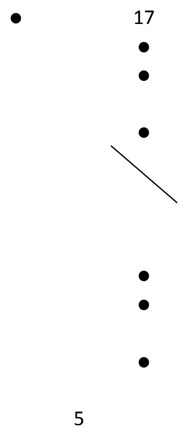
G𝄲2



Source: HS
Source comments:
Pitch: G𝄲2 -47 cents
HB comments:

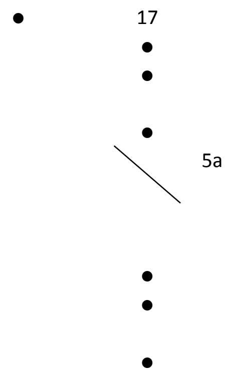
Appendix A1 − Review of quartertone fingering patterns

A𝄳2



Source: JA
Source comments:
Pitch: A2 -35 cents
HB comments: Difficult to open key 17

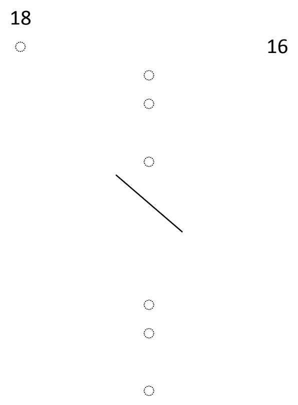
A𝄳2



Source: JA
Source comments:
Pitch: A2 -35 cents
HB comments: Difficult to open key 17

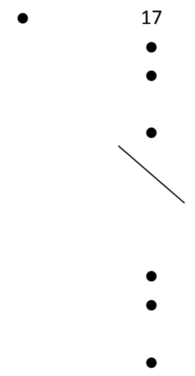
Appendix A1 − Review of quartertone fingering patterns

A𝄳2



Source: PR
Source comments:
Pitch: A2 +13 cents
HB comments: Very bad sound quality

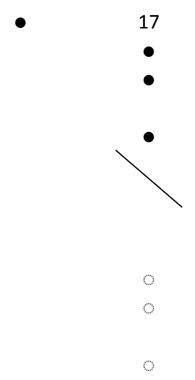
A𝄳2



Source: EMR
Source comments: Slightly dark timbre
Pitch: A2 -27 cents
HB comments: Difficult to open key 17

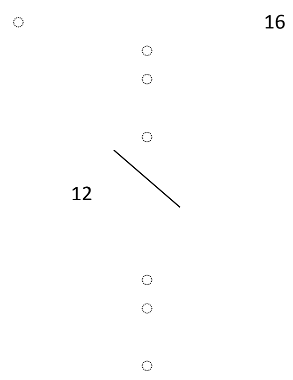
Appendix A1 − Review of quartertone fingering patterns

A𝄳2



Source: HS
Source comments: With the aid of the embouchure
Pitch: A2 -14 cents
HB comments: Difficult to open key 17

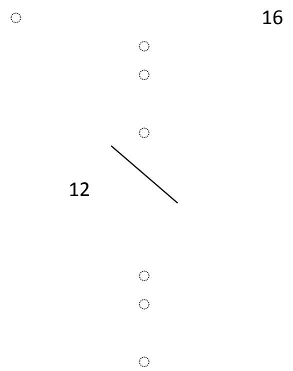
A𝄲2



Source: JA
Source comments:
Pitch: A♯2 -30 cents
HB comments:

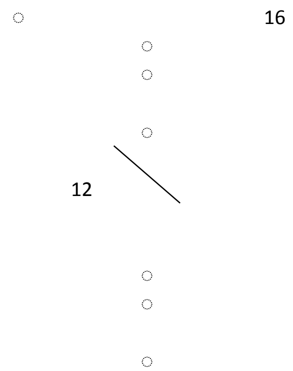
Appendix A1 − Review of quartertone fingering patterns

A𝄲2



Source: PR
Source comments:
Pitch: A♯2 -30 cents
HB comments:

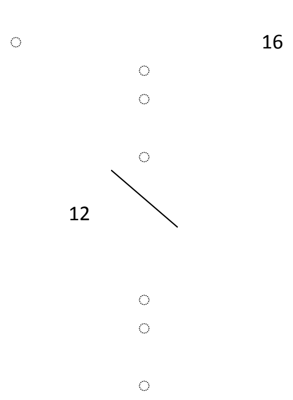
A𝄲2



Source: EMR
Source comments:
Pitch: A♯2 -30 cents
HB comments:

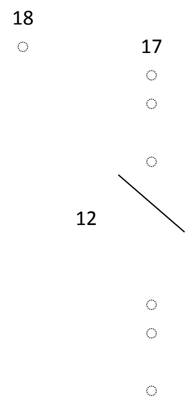
Appendix A1 − Review of quartertone fingering patterns

A𝄲2



Source: HS
Source comments:
Pitch: A♯2 -30 cents
HB comments:

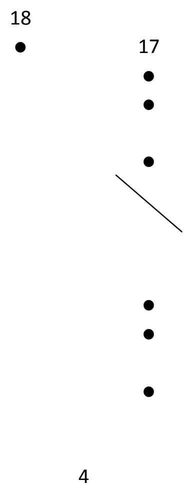
B𝄳2



Source: JA
Source comments:
Pitch: B2 -26 cents
HB comments:

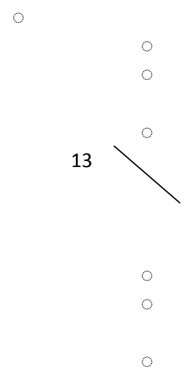
Appendix A1 − Review of quartertone fingering patterns

B𝄳2



Source: JA
Source comments:
Pitch: B2 -47 cents
HB comments:

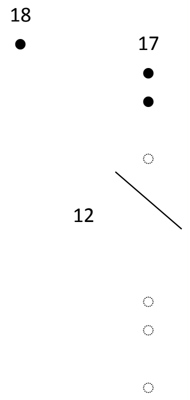
B𝄳2



Source: PR
Source comments:
Pitch: B2 -36 cents
HB comments:

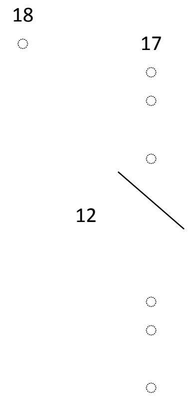
Appendix A1 − Review of quartertone fingering patterns

B𝄳2



Source: EMR
Source comments: Slightly high
Pitch: B2 -24 cents
HB comments:

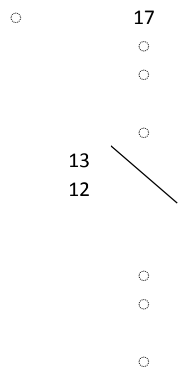
B𝄳2



Source: HS
Source comments:
Pitch: B2 -26 cents
HB comments:

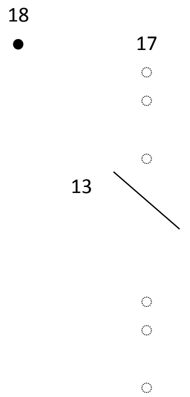
Appendix A1 − Review of quartertone fingering patterns

B𝄲2



Source: JA
Source comments:
Pitch: B2 +46 cents
HB comments:

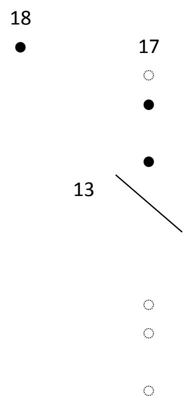
B𝄲2



Source: JA
Source comments:
Pitch: C3 -45 cents
HB comments:

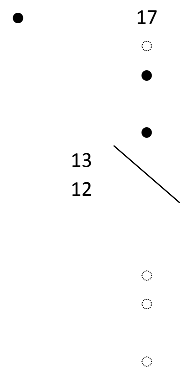
Appendix A1 − Review of quartertone fingering patterns

B𝄲2



Source: PR
Source comments:
Pitch: C3 -49 cents
HB comments:

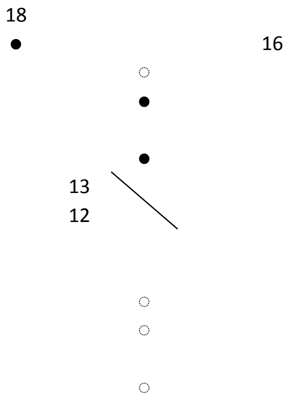
B𝄲2



Source: PR
Source comments:
Pitch: B2 +37 cents
HB comments:

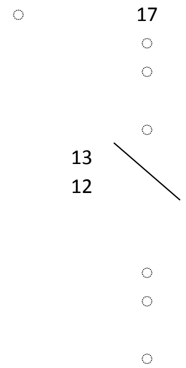
Appendix A1 − Review of quartertone fingering patterns

B𝄲2



Source: PR
Source comments:
Pitch: C3 -15 cents
HB comments:

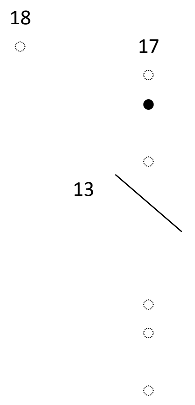
B𝄲2



Source: PR
Source comments:
Pitch: B2 +46 cents
HB comments:

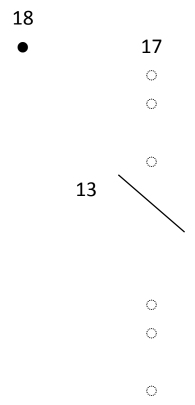
Appendix A1 − Review of quartertone fingering patterns

B𝄲2



Source: PR
Source comments:
Pitch: C3 -48 cents
HB comments:

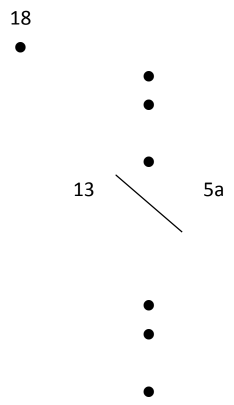
B𝄲2



Source: EMR
Source comments:
Pitch: C3 -45 cents
HB comments:

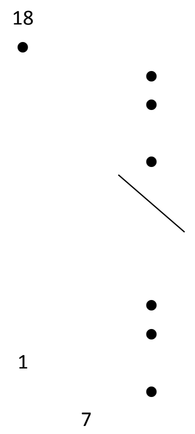
Appendix A1 − Review of quartertone fingering patterns

B𝄲2



Source: HS
Source comments: Key 13 must be played with the right hand thumb (away from under the thumb support)
Pitch: C3 -36 cents
HB comments:

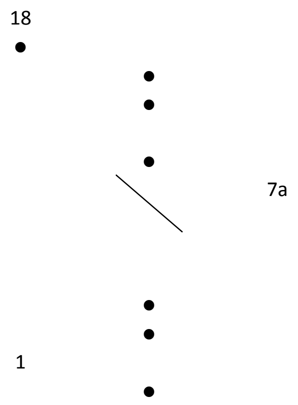
C𝄲3



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: C♯3 -13 cents
HB comments:

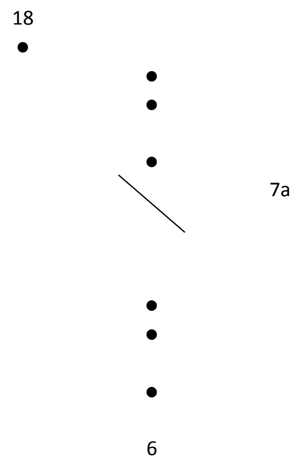
Appendix A1 − Review of quartertone fingering patterns

C𝄲3



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: C♯3 -13 cents
HB comments:

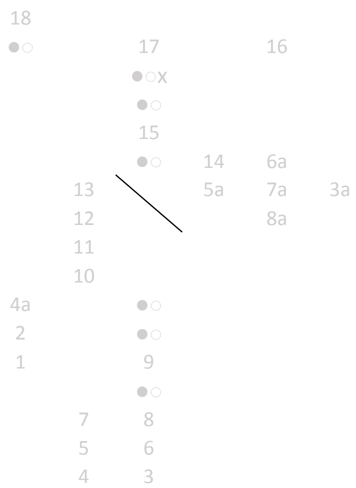
C𝄲3



Source: PR
Source comments: Control the “c♯” opening by obtaining leverage against the left calf
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

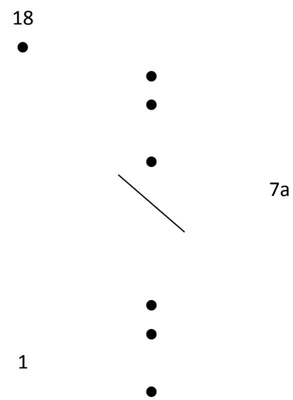
Appendix A1 − Review of quartertone fingering patterns

C𝄲3



Source: EMR
Source comments:
Pitch: -
HB comments: No fingering pattern is given for this pitch

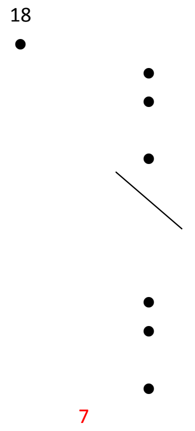
C𝄲3



Source: HS
Source comments: Very poor tone quality
With the aid of the embouchure
Pitch: C♯3 -13 cents
HB comments:

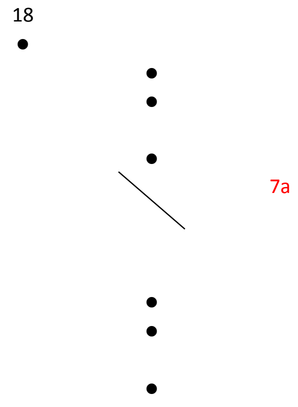
Appendix A1 − Review of quartertone fingering patterns

D𝄳3



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

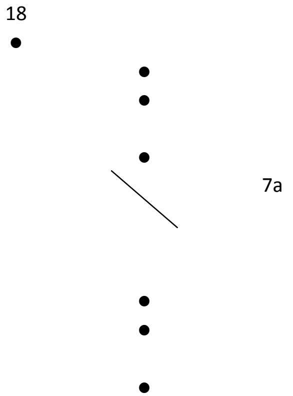
D𝄳3



Source: JA
Source comments: May require extra manipulation with embouchure and/or tongue to lower pitch
Pitch: -
HB comments: Imprecise

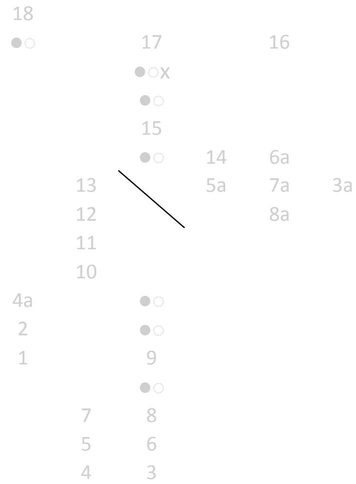
Appendix A1 − Review of quartertone fingering patterns

D𝄳3



Source: PR
Source comments: Control the “c♯” opening by obtaining leverage against the left calf
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

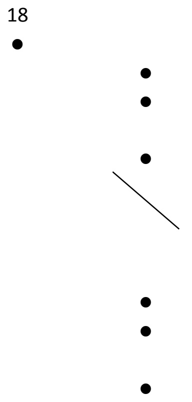
D𝄳3



Source: EMR
Source comments:
Pitch: -
HB comments: No fingering pattern is given for this pitch

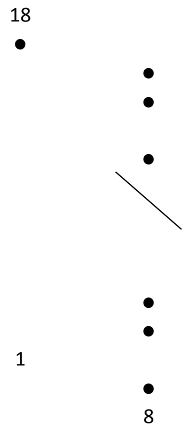
Appendix A1 − Review of quartertone fingering patterns

D𝄳3



Source: HS
Source comments: Very poor tone quality
Only possible with embouchure
Pitch: -
HB comments: D3 fingering pattern manipulated by the embouchure

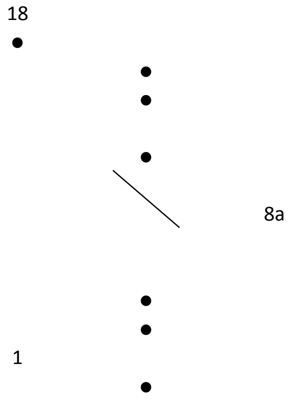
D𝄲3



Source: JA
Source comments:
Pitch: D3 +36 cents
HB comments:

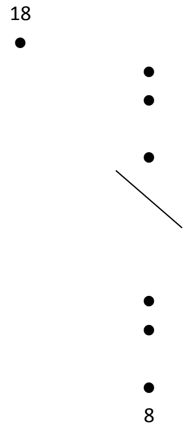
Appendix A1 − Review of quartertone fingering patterns

D𝄲3



Source: JA
Source comments:
Pitch: D3 +36 cents
HB comments:

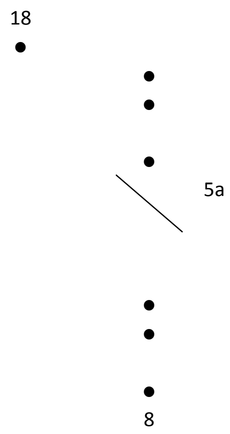
D𝄲3



Source: PR
Source comments: Control the "d♯" opening by obtaining leverage against the left knee
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

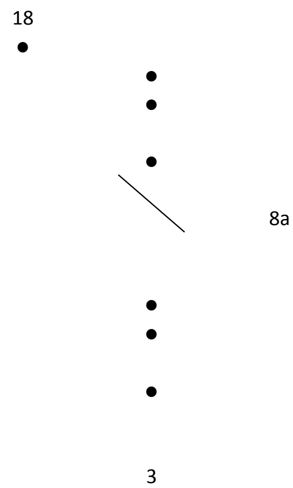
Appendix A1 − Review of quartertone fingering patterns

D𝄲3



Source: EMR
Source comments: Slightly high
Pitch: D𝄲3 -18 cents
HB comments:

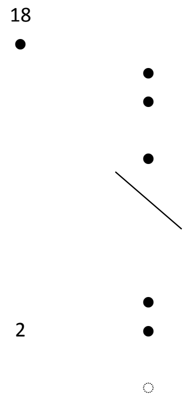
D𝄲3



Source: HS
Source comments: With the aid of the embouchure
Pitch: D𝄲3 -31 cents
HB comments:

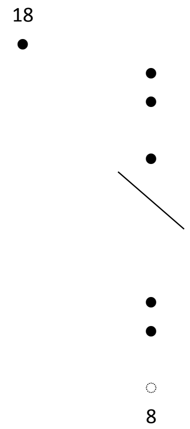
Appendix A1 − Review of quartertone fingering patterns

E𝄳3



Source: JA
Source comments:
Pitch: E3 -44 cents
HB comments:

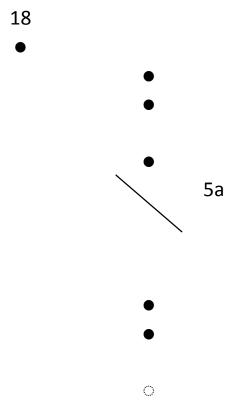
E𝄳3



Source: PR
Source comments: Control "e" opening by pressing against right knee, or with R.H. third finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

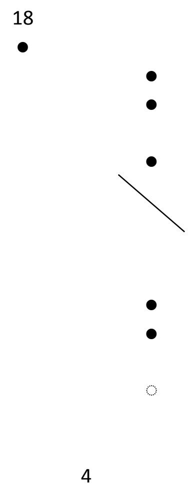
Appendix A1 − Review of quartertone fingering patterns

E𝄳3



Source: EMR
Source comments: Slightly high
Pitch: E3 -15 cents
HB comments:

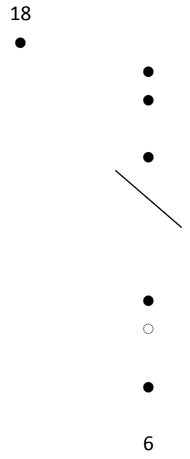
E𝄳3



Source: HS
Source comments: With the aid of the embouchure
Pitch: E3 -18 cents
HB comments:

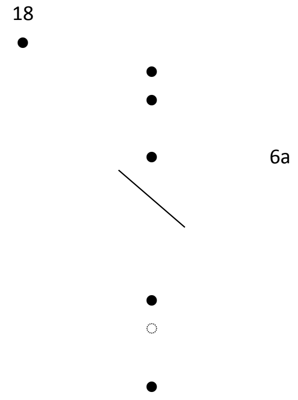
Appendix A1 − Review of quartertone fingering patterns

E𝄲3



Source: JA
Source comments:
Pitch: F3 -44 cents
HB comments:

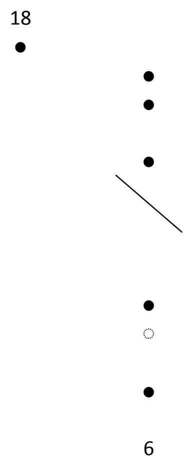
E𝄲3



Source: JA
Source comments:
Pitch: F3 -44 cents
HB comments:

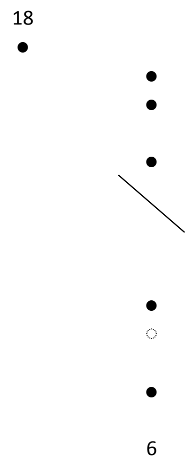
Appendix A1 − Review of quartertone fingering patterns

E𝄲3



Source: PR
Source comments: (lip up)
Pitch: F3 -44 cents
HB comments:

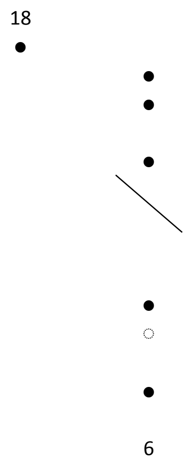
E𝄲3



Source: EMR
Source comments: Dark timbre
Pitch: F3 -44 cents
HB comments:

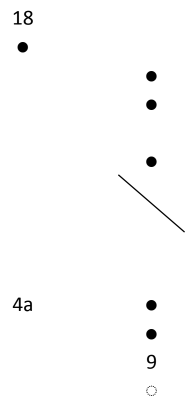
Appendix A1 – Review of quartertone fingering patterns

E𝄲3



Source: HS
Source comments:
Pitch: F3 -44 cents
HB comments:

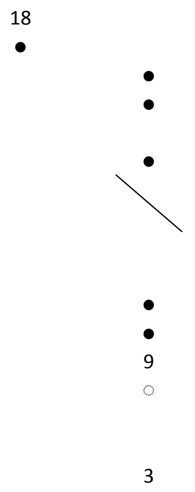
F𝄲3



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 4a has a different function on Buffet-Crampon instruments

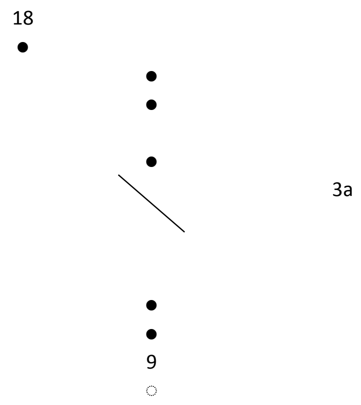
Appendix A1 − Review of quartertone fingering patterns

F𝄲3



Source: JA
Source comments:
Pitch: F♯3 -17 cents
HB comments:

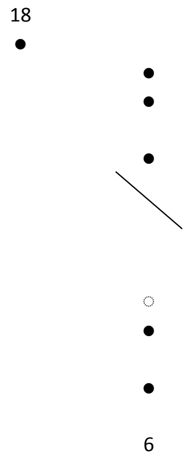
F𝄲3



Source: JA
Source comments:
Pitch: F♯3 -17 cents
HB comments:

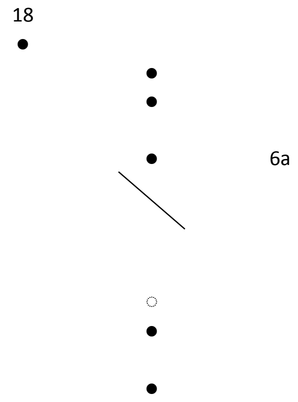
Appendix A1 − Review of quartertone fingering patterns

F𝄲3



Source: JA
Source comments:
Pitch: F♯3 -21 cents
HB comments:

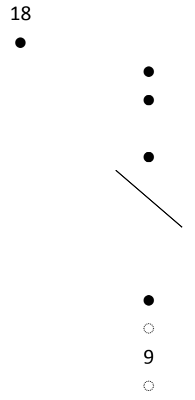
F𝄲3



Source: JA
Source comments:
Pitch: F♯3 -21 cents
HB comments:

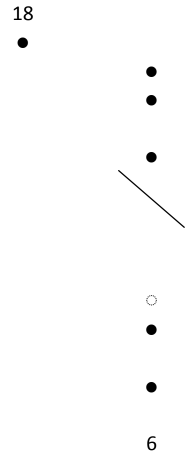
Appendix A1 − Review of quartertone fingering patterns

F𝄲3



Source: PR
Source comments: Control the “b♮” lever with R.H. third finger. Additional accuracy may be obtained by placing the R.H. thumb on the “b♮” pad
Pitch: -
HB comments: Imprecise. F♯3 fingering pattern
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

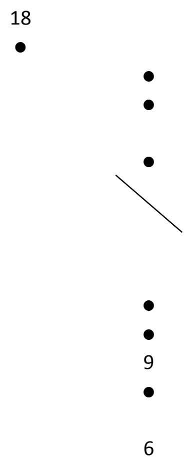
F𝄲3



Source: EMR
Source comments: Dark timbre
Pitch: F♯3 -21 cents
HB comments:

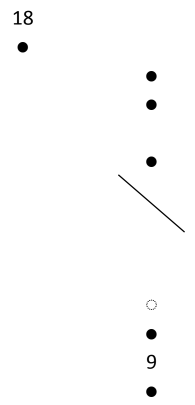
Appendix A1 − Review of quartertone fingering patterns

F𝄲3



Source: HS
Source comments: Very poor tone quality. Key 9 played with the 4th finger [ring finger] of the right hand
Pitch: F♯3 -40 cents
HB comments: Key 6 has to be played by key 6a. The ring finger operates key 9 and the little finger operates the right hand 3 key

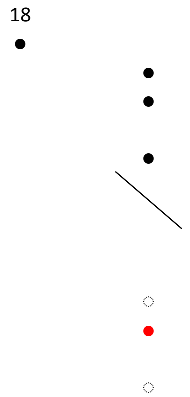
G𝄳3



Source: JA
Source comments:
Pitch: G♭3 +40 cents
HB comments: Two RH fingers will have to change position in order to play this fingering pattern

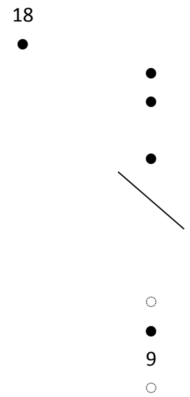
Appendix A1 − Review of quartertone fingering patterns

G𝄳3



Source: PR
Source comments: Control the air space below the R.H. second finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

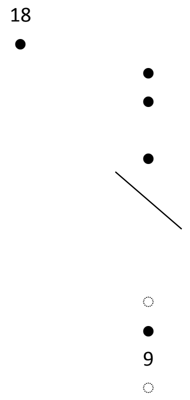
G𝄳3



Source: PR
Source comments:
Pitch: G♭3 +24 cents
HB comments:

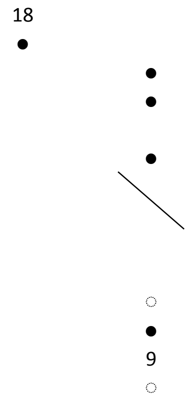
Appendix A1 − Review of quartertone fingering patterns

G𝄳3



Source: EMR
Source comments:
Pitch: G♭3 +24 cents
HB comments:

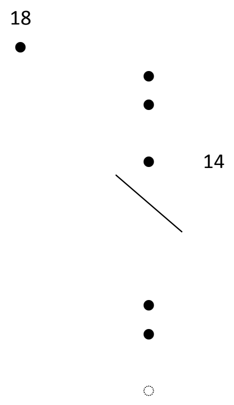
G𝄳3



Source: HS
Source comments:
Pitch: G♭3 +24 cents
HB comments:

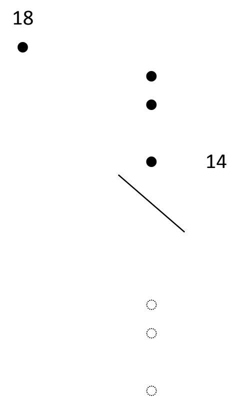
Appendix A1 − Review of quartertone fingering patterns

G𝄲3



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

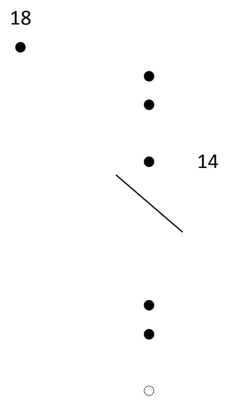
G𝄲3



Source: PR
Source comments: Control the air space above the “g♯” opening with one of the R.H. fingers, or with the L.H. “g♯” lever
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note
G♯3 standard fingering pattern

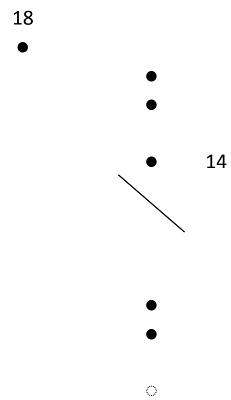
Appendix A1 − Review of quartertone fingering patterns

G𝄲3



Source: EMR
Source comments: Slightly dark timbre
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

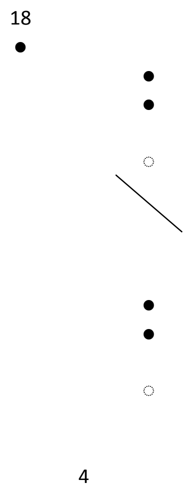
G𝄲3



Source: HS
Source comments: Not possible on the Selmer bass clarinet
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

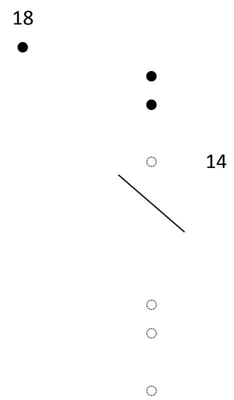
Appendix A1 − Review of quartertone fingering patterns

A𝄳3



Source: JA
Source comments:
Pitch: A3 -33 cents
HB comments:

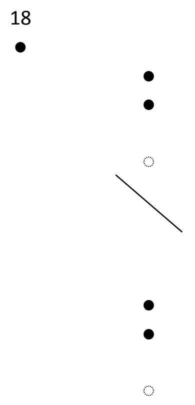
A𝄳3



Source: PR
Source comments: Control air space with L.H. [left hand] third [ring] finger
Pitch: -
HB comments: Imprecise
PR also suggests this fingering pattern for the pitches an 1/8 higher and lower than this note

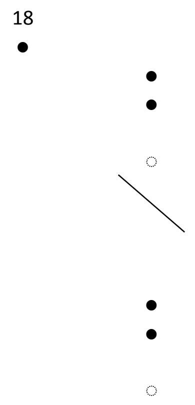
Appendix A1 − Review of quartertone fingering patterns

A𝄳3



Source: EMR
Source comments:
Pitch: A3 -26 cents
HB comments:

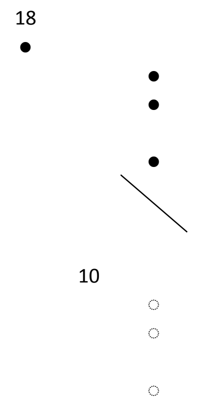
A𝄳3



Source: HS
Source comments: With the aid of the embouchure
Pitch: A3 -26 cents
HB comments:

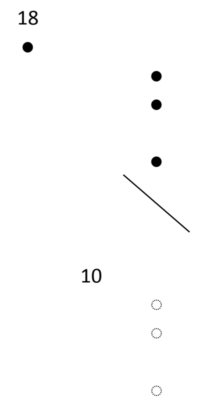
Appendix A1 − Review of quartertone fingering patterns

A𝄲3



Source: JA
Source comments:
Pitch: A3 +44 cents
HB comments:

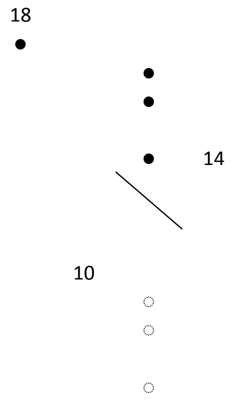
A𝄲3



Source: PR
Source comments:
Pitch: A3 +44 cents
HB comments:

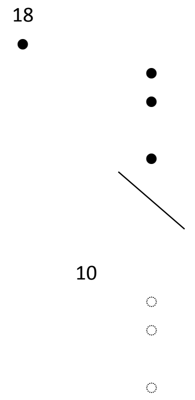
Appendix A1 − Review of quartertone fingering patterns

A𝄲3



Source: EMR
Source comments:
Pitch: A♯3 -29 cents
HB comments:

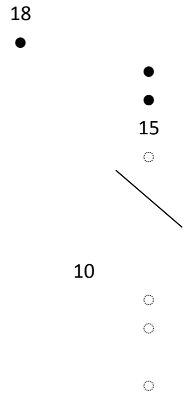
A𝄲3



Source: HS
Source comments:
Pitch: A3 +44 cents
HB comments:

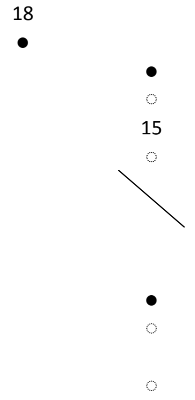
Appendix A1 − Review of quartertone fingering patterns

B𝄳3



Source: JA
Source comments:
Pitch: B♭3 +40 cents
HB comments:

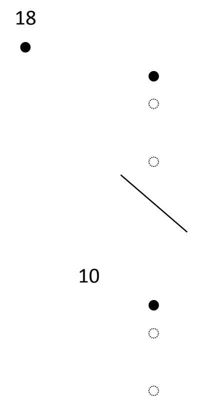
B𝄳3



Source: JA
Source comments:
Pitch: B♭3 +37 cents
HB comments:

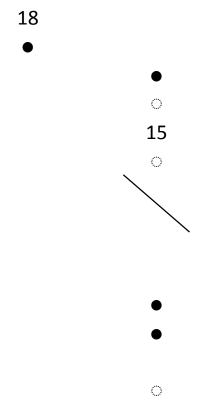
Appendix A1 − Review of quartertone fingering patterns

B𝄳3



Source: JA
Source comments:
Pitch: B♭3 +34 cents
HB comments:

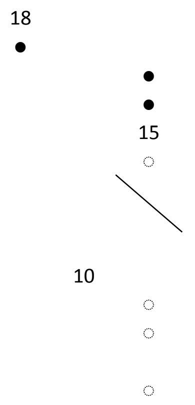
B𝄳3



Source: PR
Source comments:
Pitch: B♭3 +33 cents
HB comments:

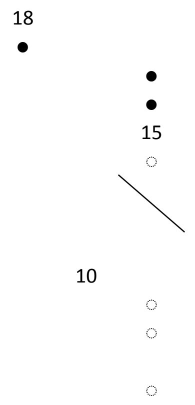
Appendix A1 − Review of quartertone fingering patterns

B𝄳3



Source: PR
Source comments:
Pitch: B♭3 +40 cents
HB comments:

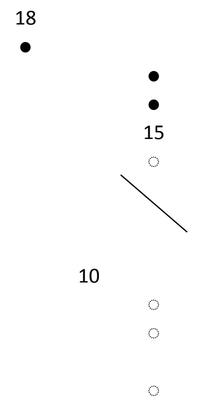
B𝄳3



Source: EMR
Source comments: Slightly bright timbre
Pitch: B♭3 +40 cents
HB comments:

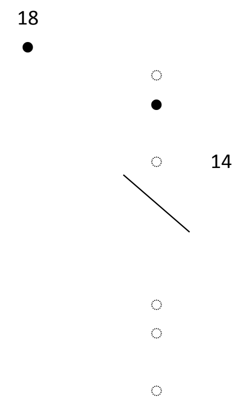
Appendix A1 − Review of quartertone fingering patterns

B𝄳3



Source: HS
Source comments:
Pitch: B♭3 +40 cents
HB comments:

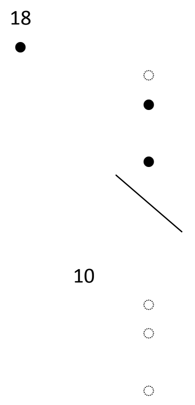
B𝄲3



Source: JA
Source comments:
Pitch: B3 +8 cents
HB comments:

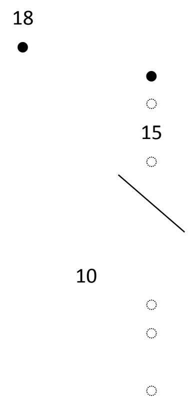
Appendix A1 − Review of quartertone fingering patterns

B𝄲3



Source: JA
Source comments:
Pitch: B3 +23 cents
HB comments:

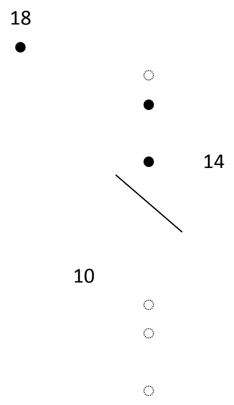
B𝄲3



Source: PR
Source comments:
Pitch: B3 +22 cents
HB comments:

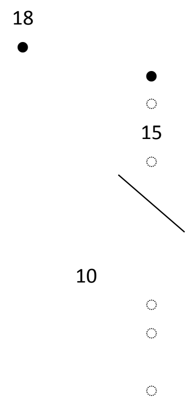
Appendix A1 − Review of quartertone fingering patterns

B𝄲3



Source: PR
Source comments:
Pitch: B3 +34 cents
HB comments:

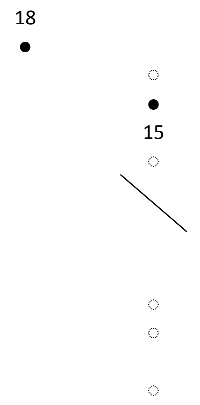
B𝄲3



Source: EMR
Source comments: Slightly bright timbre
Pitch: B3 +22 cents
HB comments:

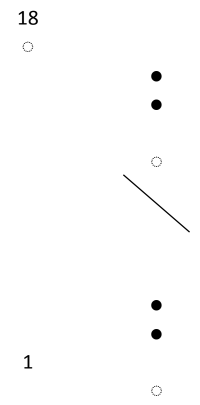
Appendix A1 − Review of quartertone fingering patterns

B𝄲3



Source: HS
Source comments:
Pitch: B3 +49 cents
HB comments:

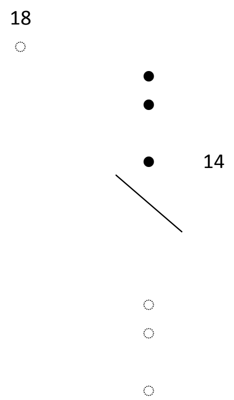
C𝄲4



Source: JA
Source comments:
Pitch: C4 +49 cents
HB comments:

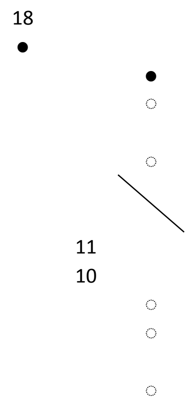
Appendix A1 − Review of quartertone fingering patterns

C𝄲4



Source: JA
Source comments:
Pitch: C4 +43 cents
HB comments:

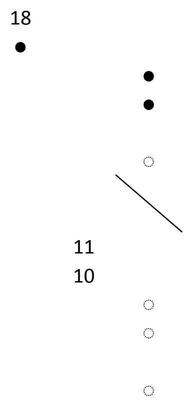
C𝄲4



Source: JA
Source comments:
Pitch: C♯4 -31 cents
HB comments:

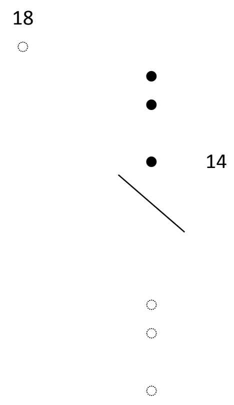
Appendix A1 − Review of quartertone fingering patterns

C𝄲4



Source: PR
Source comments:
Pitch: C4 +29 cents
HB comments:

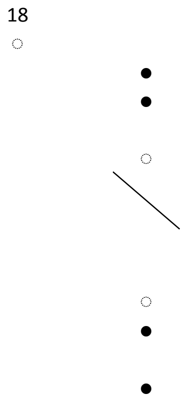
C𝄲4



Source: PR
Source comments:
Pitch: C4 +43 cents
HB comments:

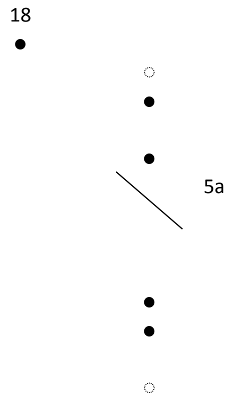
Appendix A1 − Review of quartertone fingering patterns

C𝄲4



Source: PR
Source comments:
Pitch: D4 -45 cents
HB comments: Roughly a semitone too high in pitch

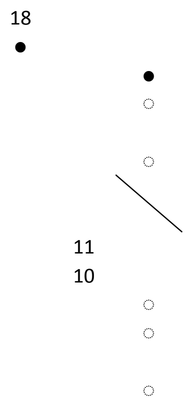
C𝄲4



Source: EMR
Source comments: Slightly dark timbre
Pitch: C4 +34 cents
HB comments: Bad/closed sound

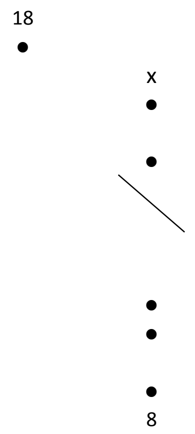
Appendix A1 − Review of quartertone fingering patterns

C𝄲4



Source: HS
Source comments:
Pitch: C♯4 -31 cents
HB comments:

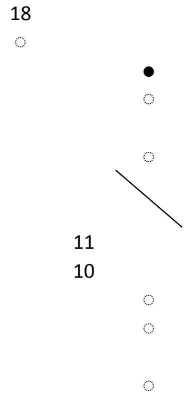
C𝄲4



Source: HS
Source comments:
Pitch: C♯4 -46 cents
HB comments:

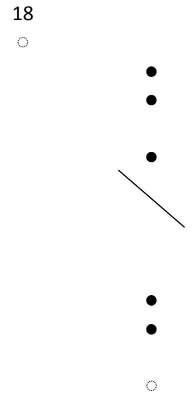
Appendix A1 − Review of quartertone fingering patterns

D𝄳4



Source: JA
Source comments:
Pitch: D♭4 +46 cents
HB comments:

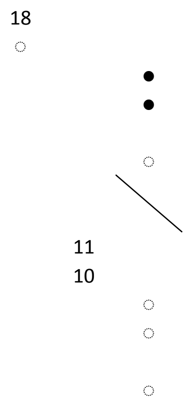
D𝄳4



Source: JA
Source comments:
Pitch: D♭4 +31 cents
HB comments:

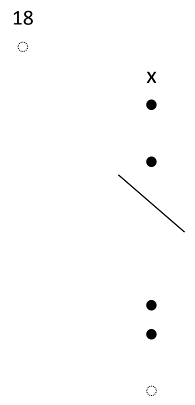
Appendix A1 − Review of quartertone fingering patterns

D𝄳4



Source: PR
Source comments:
Pitch: D♭4 +27 cents
HB comments:

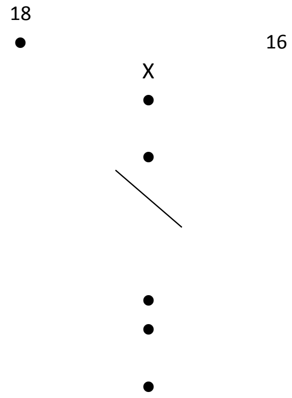
D𝄳4



Source: PR
Source comments:
Pitch: D♭4 +35 cents
HB comments:

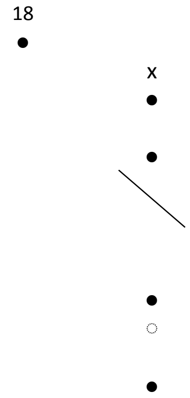
Appendix A1 − Review of quartertone fingering patterns

D𝄳4



Source: PR
Source comments:
Pitch: D4 -5 cents
HB comments:

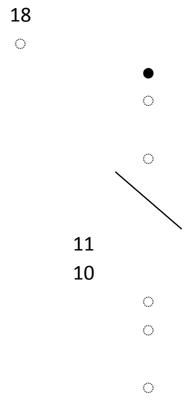
D𝄳4



Source: PR
Source comments:
Pitch: D4 +16 cents
HB comments:

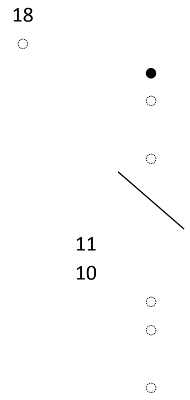
Appendix A1 − Review of quartertone fingering patterns

D𝄳4



Source: EMR
Source comments:
Pitch: D♭4 +46 cents
HB comments:

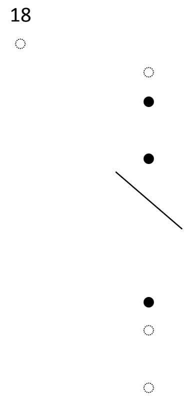
D𝄳4



Source: HS
Source comments:
Pitch: D♭4 +46 cents
HB comments:

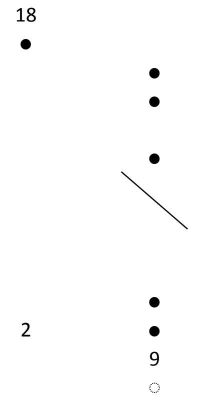
Appendix A1 − Review of quartertone fingering patterns

D𝄲4



Source: JA
Source comments:
Pitch: D4 +35 cents
HB comments:

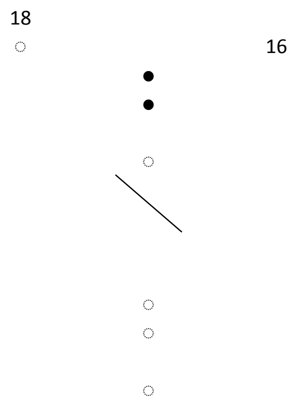
D𝄲4



Source: JA
Source comments:
Pitch: D♯4 -14 cents
HB comments:

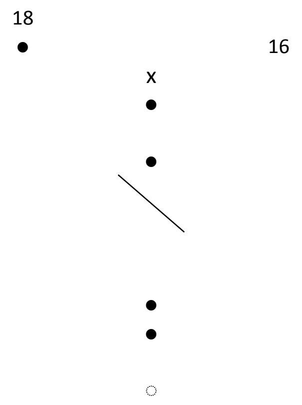
Appendix A1 − Review of quartertone fingering patterns

D𝄲4



Source: JA
Source comments:
Pitch: D♯4 -32 cents
HB comments:

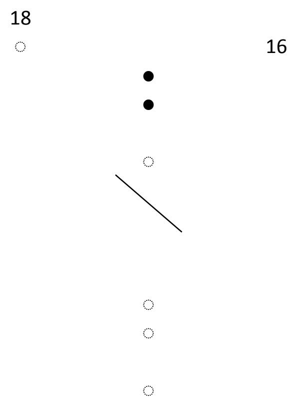
D𝄲4



Source: JA
Source comments:
Pitch: D♯4 -46 cents
HB comments:

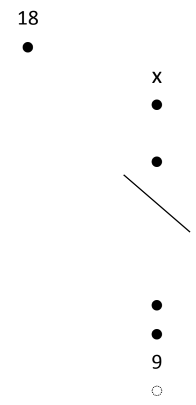
Appendix A1 − Review of quartertone fingering patterns

D𝄲4



Source: PR
Source comments:
Pitch: D♯4 -32 cents
HB comments:

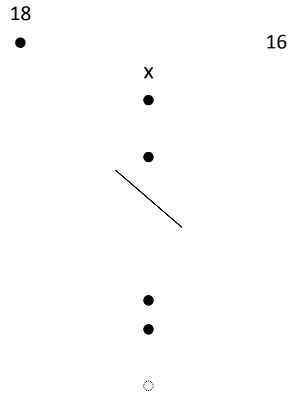
D𝄲4



Source: PR
Source comments:
Pitch: D♯4 -10 cents
HB comments:

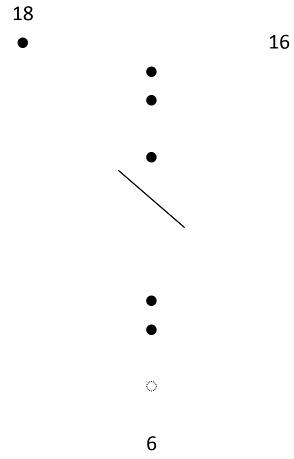
Appendix A1 − Review of quartertone fingering patterns

D𝄲4



Source: PR
Source comments:
Pitch: D♯4 -46 cents
HB comments:

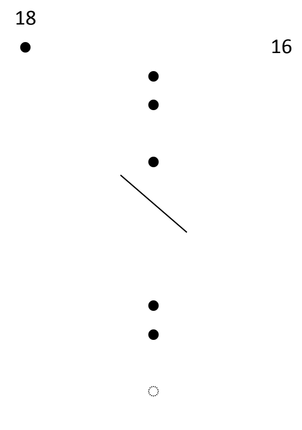
D𝄲4



Source: EMR
Source comments:
Pitch: D4 +44 cents
HB comments:

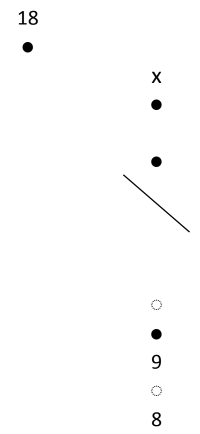
Appendix A1 − Review of quartertone fingering patterns

D𝄲4



Source: HS
Source comments:
Pitch: D♯4 -43 cents
HB comments:

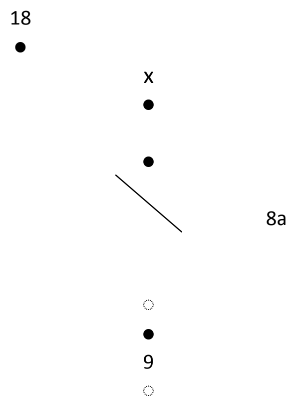
E𝄳4



Source: JA
Source comments:
Pitch: E♭4 +37 cents
HB comments:

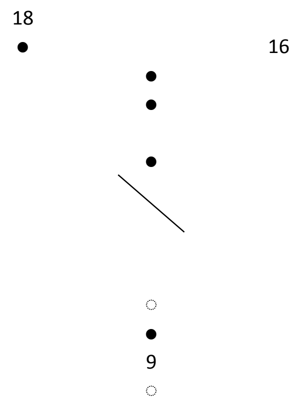
Appendix A1 − Review of quartertone fingering patterns

E𝄳4



Source: JA
Source comments:
Pitch: E♭4 +37 cents
HB comments:

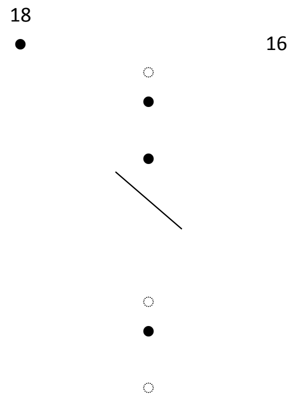
E𝄳4



Source: JA
Source comments:
Pitch: E4 -32 cents
HB comments:

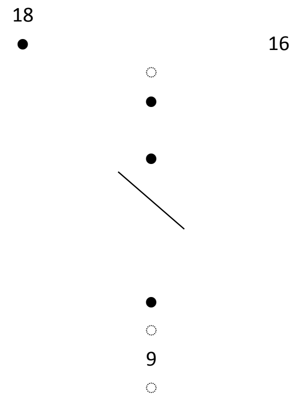
Appendix A1 − Review of quartertone fingering patterns

E𝄳4



Source: JA
Source comments:
Pitch: E4 -46 cents
HB comments:

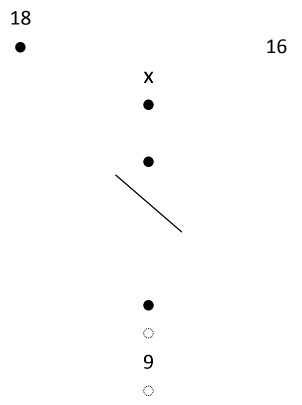
E𝄳4



Source: JA
Source comments:
Pitch: E4 -42 cents
HB comments:

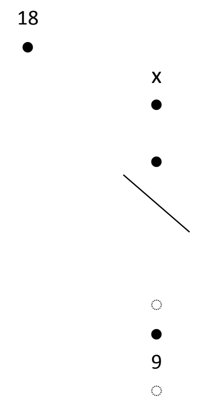
Appendix A1 − Review of quartertone fingering patterns

E𝄳4



Source: PR
Source comments:
Pitch: E♭4 +42 cents
HB comments:

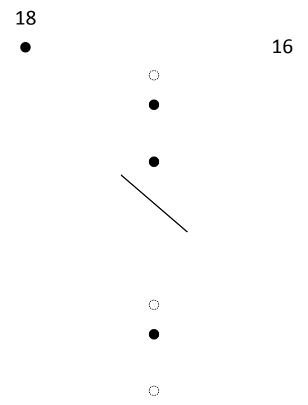
E𝄳4



Source: PR
Source comments:
Pitch: E♭4 +40 cents
HB comments:

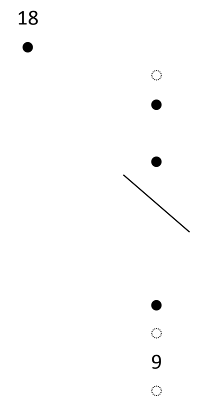
Appendix A1 − Review of quartertone fingering patterns

E𝄳4



Source: PR
Source comments:
Pitch: E4 -46 cents
HB comments:

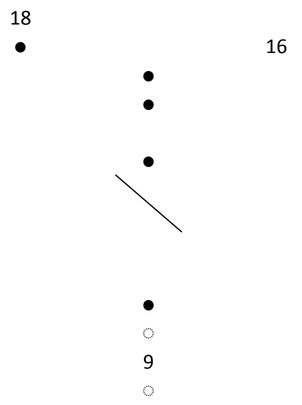
E𝄳4



Source: PR
Source comments:
Pitch: E♭4 +28 cents
HB comments:

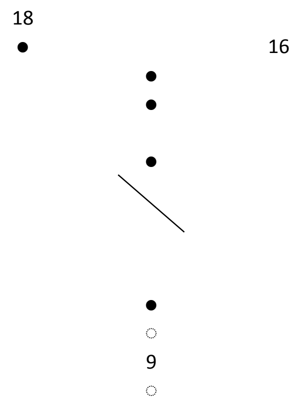
Appendix A1 − Review of quartertone fingering patterns

E𝄳4



Source: EMR
Source comments:
Pitch: E4 -47 cents
HB comments:

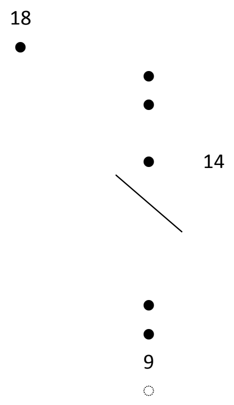
E𝄳4



Source: HS
Source comments:
Pitch: E4 -47 cents
HB comments:

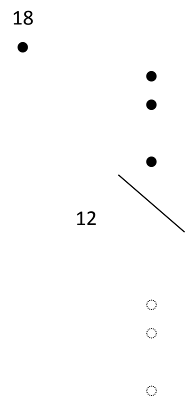
Appendix A1 − Review of quartertone fingering patterns

E𝄲4



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

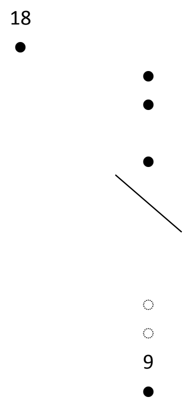
E𝄲4



Source: JA
Source comments:
Pitch: F4 -21 cents
HB comments:

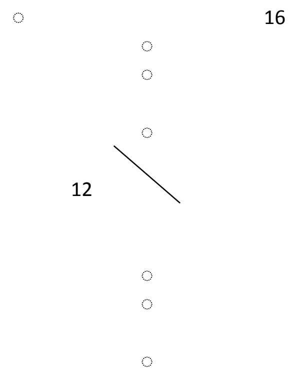
Appendix A1 − Review of quartertone fingering patterns

E𝄲4



Source: JA
Source comments:
Pitch: E4 +43 cents
HB comments:

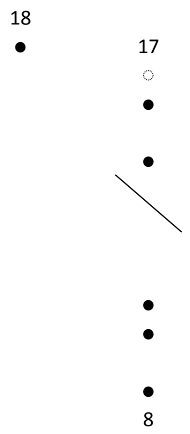
E𝄲4



Source: PR
Source comments:
Pitch: E4 +34 cents
HB comments:

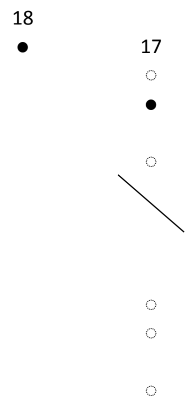
Appendix A1 − Review of quartertone fingering patterns

E𝄲4



Source: PR
Source comments:
Pitch: E4 +41 cents
HB comments:

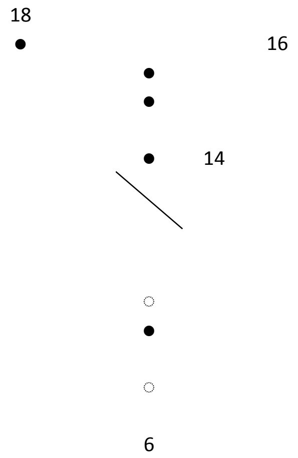
E𝄲4



Source: PR
Source comments:
Pitch: E4 +29 cents
HB comments:

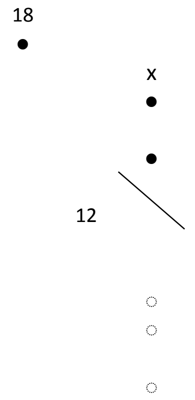
Appendix A1 − Review of quartertone fingering patterns

E𝄲4



Source: EMR
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

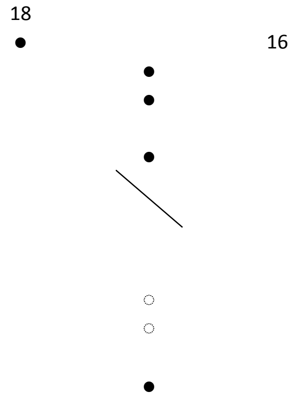
E𝄲4



Source: HS
Source comments:
Pitch: F4 -21 cents
HB comments:

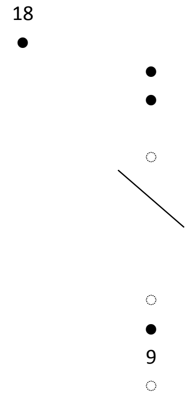
Appendix A1 − Review of quartertone fingering patterns

E𝄲4



Source: HS
Source comments:
Pitch: E4 +44 cents
HB comments:

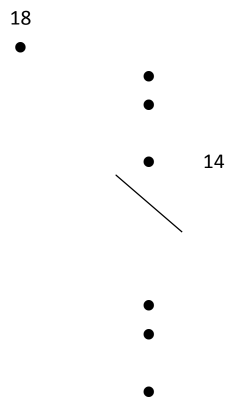
F𝄲4



Source: JA
Source comments:
Pitch: F♯4 -24 cents
HB comments:

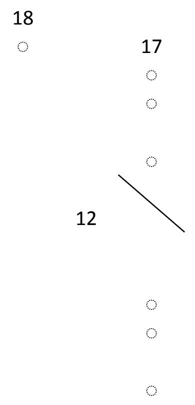
Appendix A1 − Review of quartertone fingering patterns

F𝄲4



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

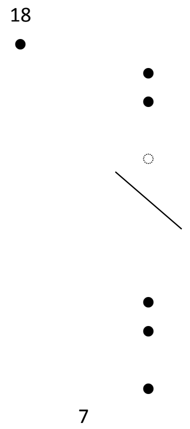
F𝄲4



Source: PR
Source comments:
Pitch: F♯4 -44 cents
HB comments:

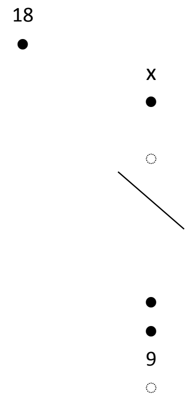
Appendix A1 − Review of quartertone fingering patterns

F𝄲4



Source: PR
Source comments:
Pitch: F♯4 -18 cents
HB comments:

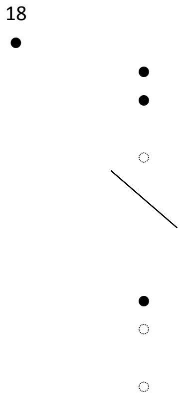
F𝄲4



Source: PR
Source comments:
Pitch: F♯4 -22 cents
HB comments:

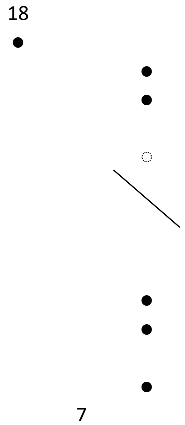
Appendix A1 − Review of quartertone fingering patterns

F𝄲4



Source: EMR
Source comments:
Pitch: F4 +24 cents
HB comments:

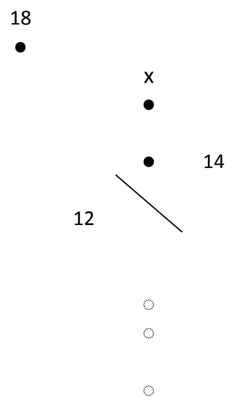
F𝄲4



Source: HS
Source comments:
Pitch: F♯4 -18 cents
HB comments:

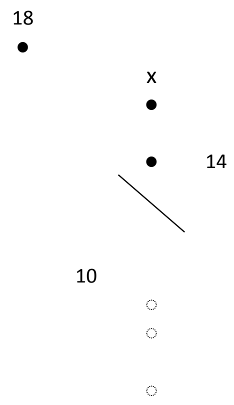
Appendix A1 − Review of quartertone fingering patterns

F𝄲4



Source: HS
Source comments:
Pitch: F4 +34 cents
HB comments:

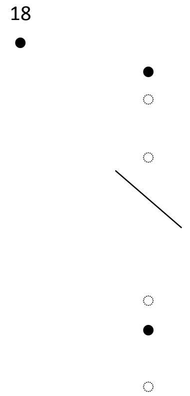
G𝄳4



Source: JA
Source comments:
Pitch: G♭4 +19 cents
HB comments:

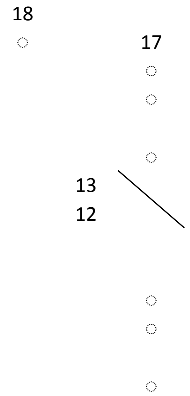
Appendix A1 − Review of quartertone fingering patterns

G𝄳4



Source: JA
Source comments:
Pitch: G4 -33 cents
HB comments:

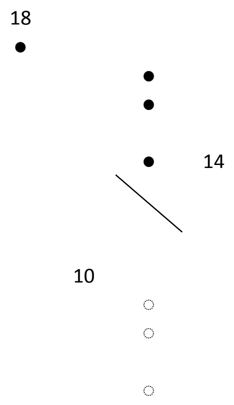
G𝄳4



Source: PR
Source comments:
Pitch: G♭4 +32 cents
HB comments:

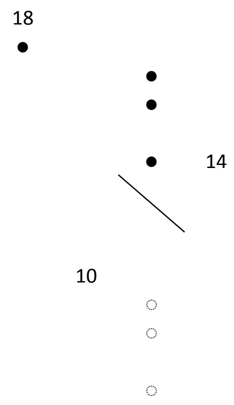
Appendix A1 − Review of quartertone fingering patterns

G𝄳4



Source: PR
Source comments:
Pitch: G♭4 +9 cents
HB comments:

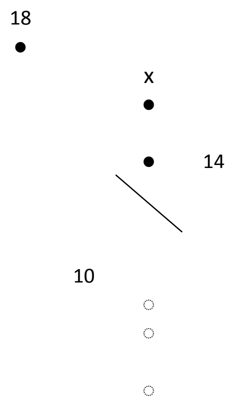
G𝄳4



Source: EMR
Source comments:
Pitch: G♭4 +9 cents
HB comments:

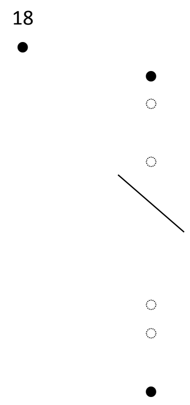
Appendix A1 − Review of quartertone fingering patterns

G𝄳4



Source: HS
Source comments:
Pitch: G♭4 +19 cents
HB comments:

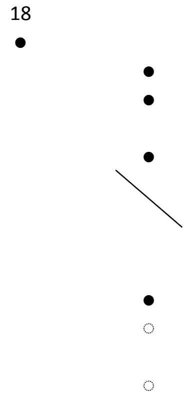
G𝄲4



Source: JA
Source comments:
Pitch: G♯4 -48 cents
HB comments:

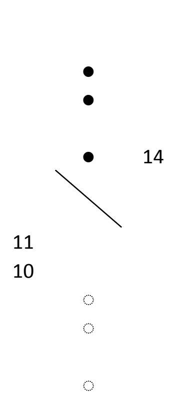
Appendix A1 − Review of quartertone fingering patterns

G𝄲4



Source: JA
Source comments:
Pitch: G♯4 -32 cents
HB comments: Lip position important
Lower lip has to move forward

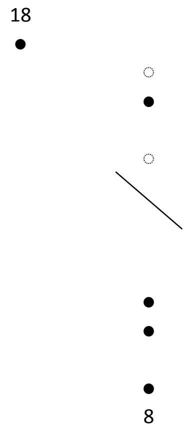
G𝄲4



Source: PR
Source comments:
Pitch: G♯4 -16 cents
HB comments:

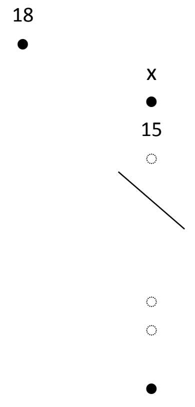
Appendix A1 − Review of quartertone fingering patterns

G𝄲4



Source: EMR
Source comments: Slightly bright timbre
Pitch: G4 +31 cents
HB comments:

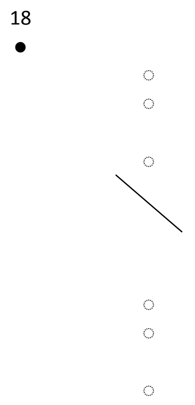
G𝄲4



Source: HS
Source comments:
Pitch: G4 -6 cents
HB comments:

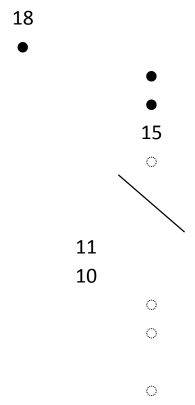
Appendix A1 − Review of quartertone fingering patterns

A𝄳4



Source: JA
Source comments:
Pitch: A♭4 +38 cents
HB comments: Lower lip has to be moved forward

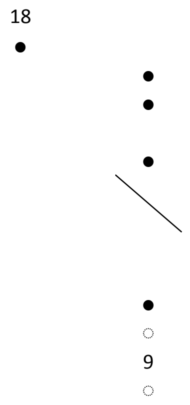
A𝄳4



Source: JA
Source comments:
Pitch: A♭4 +46 cents
HB comments:

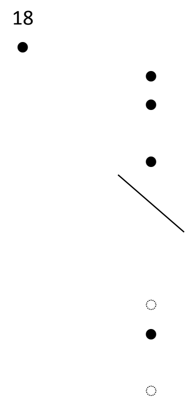
Appendix A1 − Review of quartertone fingering patterns

A𝄳4



Source: JA
Source comments:
Pitch: A4 -42 cents
HB comments: Lower lip has to be moved forward

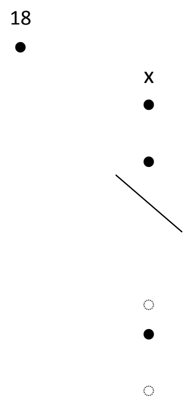
A𝄳4



Source: JA
Source comments:
Pitch: A♭4 +45 cents
HB comments:

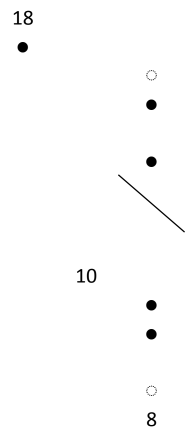
Appendix A1 − Review of quartertone fingering patterns

A𝄳4



Source: PR
Source comments:
Pitch: A4 -45 cents
HB comments:

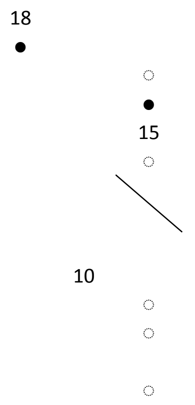
A𝄳4



Source: EMR
Source comments:
Pitch: A♭4 +14 cents
HB comments:

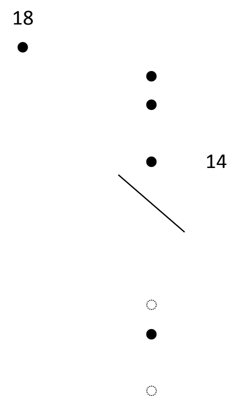
Appendix A1 − Review of quartertone fingering patterns

A𝄳4



Source: HS
Source comments:
Pitch: A♭4 +27 cents
HB comments:

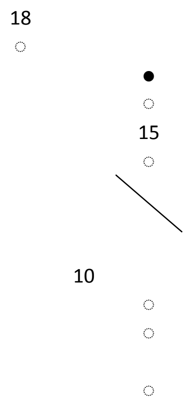
A𝄲4



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

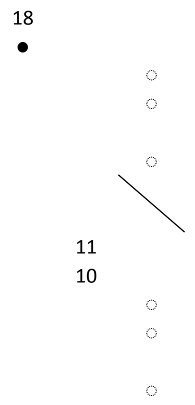
Appendix A1 − Review of quartertone fingering patterns

A𝄲4



Source: JA
Source comments:
Pitch: A4 +43 cents
HB comments:

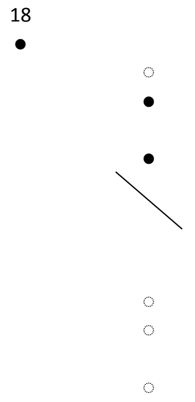
A𝄲4



Source: JA
Source comments:
Pitch: A♯4 -43 cents
HB comments:

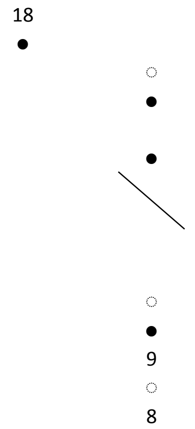
Appendix A1 − Review of quartertone fingering patterns

A𝄲4



Source: PR
Source comments:
Pitch: A♯4 -34 cents
HB comments:

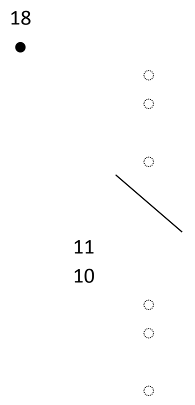
A𝄲4



Source: EMR
Source comments: Slightly low [in pitch]
DAT [a note which is difficult to attack strongly]
Pitch: A4 +13 cents
HB comments: No issues found with strong attack

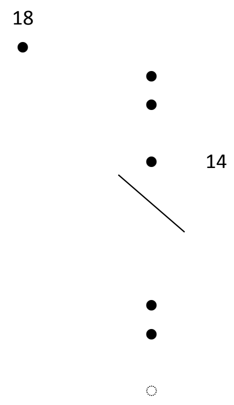
Appendix A1 – Review of quartertone fingering patterns

A𝄲4



Source: HS
Source comments:
Pitch: A♯4 -43 cents
HB comments:

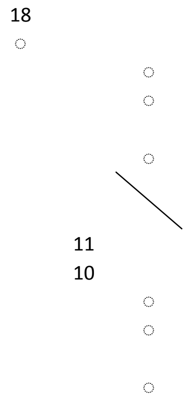
B𝄳4



Source: JA
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments
Without key 14 the pitch was measured as B4 -30 cents

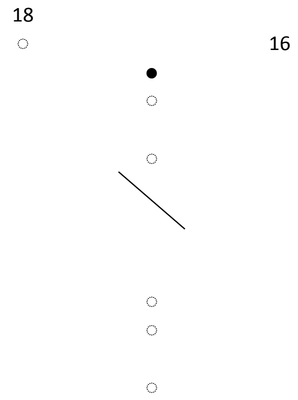
Appendix A1 − Review of quartertone fingering patterns

B𝄳4



Source: JA
Source comments:
Pitch: B♭4 +42 cents
HB comments:

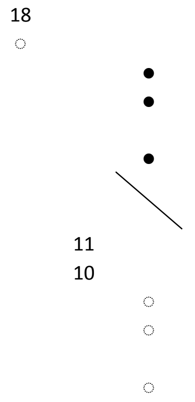
B𝄳4



Source: JA
Source comments:
Pitch: B♭4 +38 cents
HB comments:

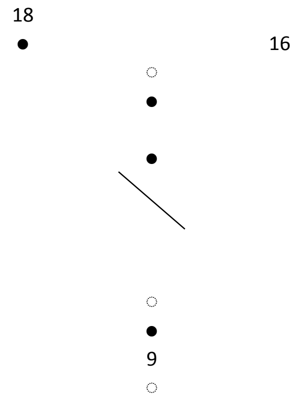
Appendix A1 − Review of quartertone fingering patterns

B𝄳4



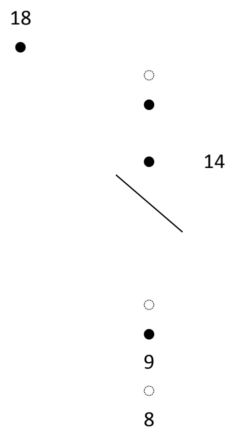
Source: JA
Source comments:
Pitch: B♭4 +31 cents
HB comments:

B𝄳4



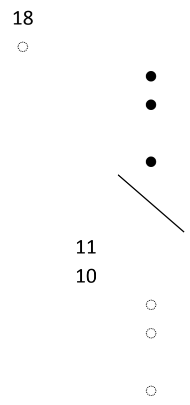
Source: PR
Source comments:
Pitch: B♭4 +27 cents
HB comments:

B𝄳4



Source: EMR
Source comments:
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

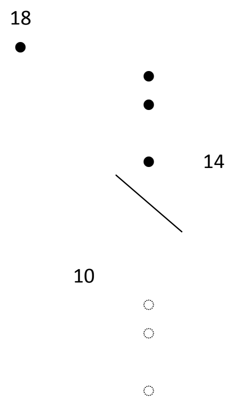
B𝄳4



Source: HS
Source comments:
Pitch: B♭4 +31 cents
HB comments:

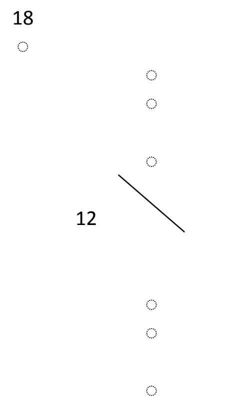
Appendix A1 − Review of quartertone fingering patterns

B𝄲4



Source: JA
Source comments:
Pitch: B4 +44 cents
HB comments:

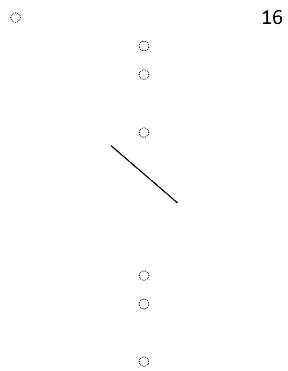
B𝄲4



Source: JA
Source comments:
Pitch: B4 +28 cents
HB comments:

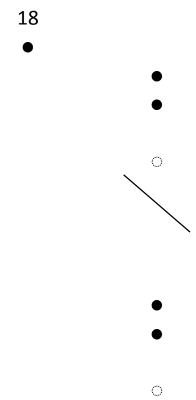
Appendix A1 − Review of quartertone fingering patterns

B𝄲4



Source: PR
Source comments:
Pitch: B4 +30 cents
HB comments:

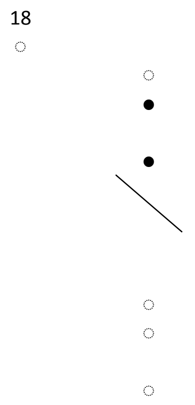
B𝄲4



Source: PR
Source comments:
Pitch: B4 +11 cents
HB comments:

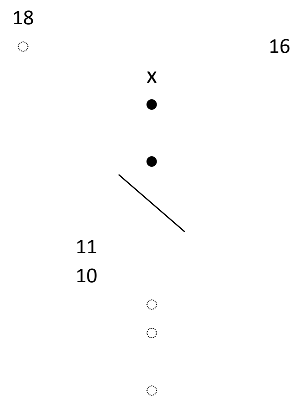
Appendix A1 − Review of quartertone fingering patterns

B𝄲4



Source: PR
Source comments:
Pitch: B4 +41 cents
HB comments:

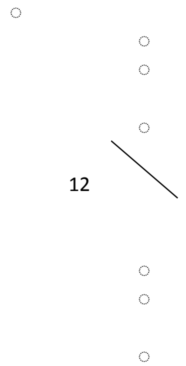
B𝄲4



Source: PR
Source comments:
Pitch: B4 +33 cents
HB comments:

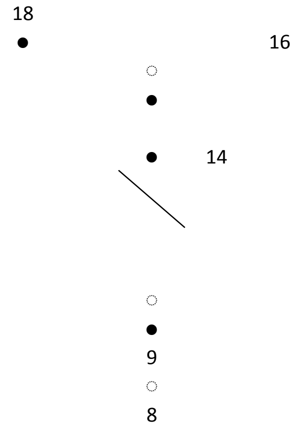
Appendix A1 − Review of quartertone fingering patterns

B𝄲4



Source: PR
Source comments:
Pitch: B4 +39 cents
HB comments:

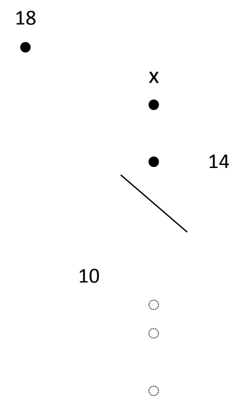
B𝄲4



Source: EMR
Source comments: Slightly low [in pitch]
Pitch: -
HB comments: This fingering pattern could not be tested as key 14 has a different function on Buffet-Crampon instruments

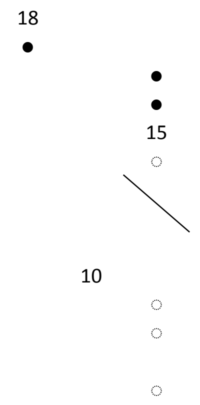
Appendix A1 − Review of quartertone fingering patterns

B𝄲4



Source: HS
Source comments: Overblowing the cuarter (sic, HB) tone f sharp 3
Pitch: B4 +29 cents
HB comments:

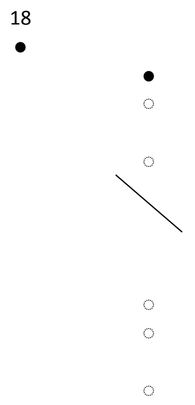
C𝄲5



Source: JA
Source comments:
Pitch: C♯5 -34 cents
HB comments:

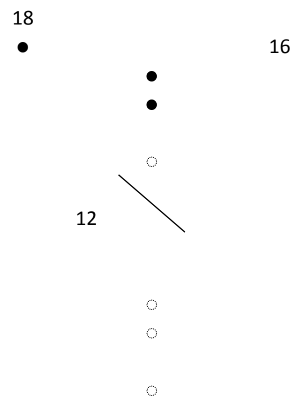
Appendix A1 − Review of quartertone fingering patterns

C𝄲5



Source: JA
Source comments:
Pitch: C5 +18 cents
HB comments:

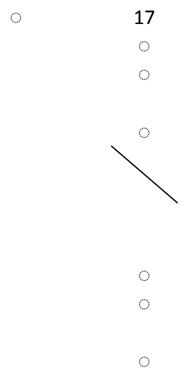
C𝄲5



Source: PR
Source comments:
Pitch: C♯5 -41 cents
HB comments:

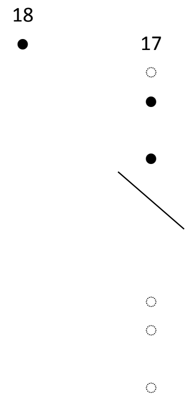
Appendix A1 − Review of quartertone fingering patterns

C𝄲5



Source: PR
Source comments:
Pitch: C5 -17 cents
HB comments: Standard fingering pattern for C𝄲5

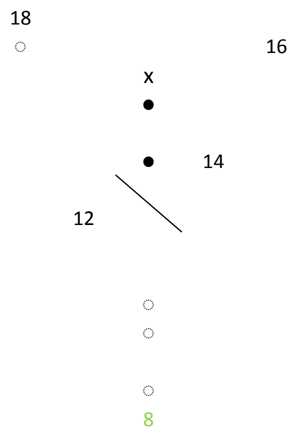
C𝄲5



Source: PR
Source comments:
Pitch: C5 -39 cents
HB comments: This fingering pattern causes the pitch of C𝄲5 to be lowered, not raised

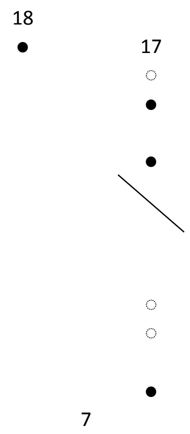
Appendix A1 − Review of quartertone fingering patterns

C𝄲5



Source: PR
Source comments:
Pitch: B5 +25 cents
HB comments: This fingering pattern causes the pitch of C𝄲5 to be lowered, not raised

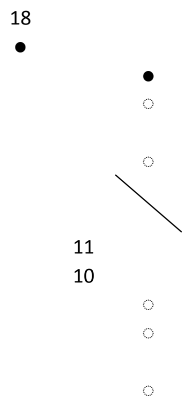
C𝄲5



Source: EMR
Source comments:
Pitch: C5 -28 cents
HB comments: This fingering pattern causes the pitch of C𝄲5 to be lowered, not raised

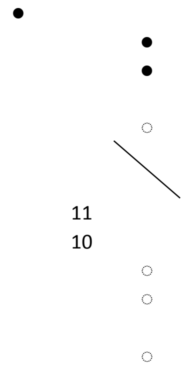
Appendix A1 − Review of quartertone fingering patterns

D𝄳5



Source: JA
Source comments:
Pitch: D5 -26 cents
HB comments:

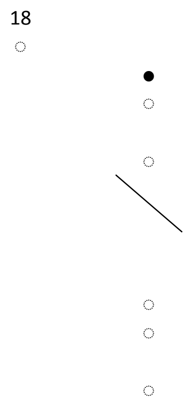
D𝄳5



Source: JA
Source comments:
Pitch: D5 -21 cents
HB comments: Lower lip position crucial

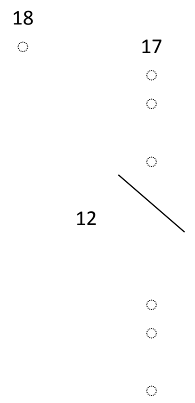
Appendix A1 − Review of quartertone fingering patterns

D𝄳5



Source: JA
Source comments:
Pitch: D5 -20 cents
HB comments:

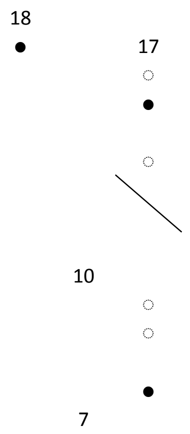
D𝄳5



Source: PR
Source comments:
Pitch: C♯5 +30 cents
HB comments:

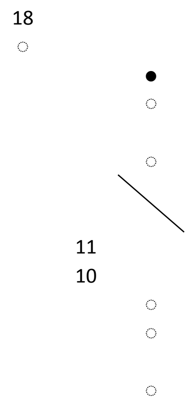
Appendix A1 − Review of quartertone fingering patterns

D𝄳5



Source: EMR
Source comments:
Pitch: D♭5 +13 cents
HB comments:

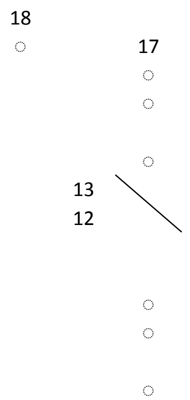
D𝄲5



Source: JA
Source comments:
Pitch: D5 +42 cents
HB comments:

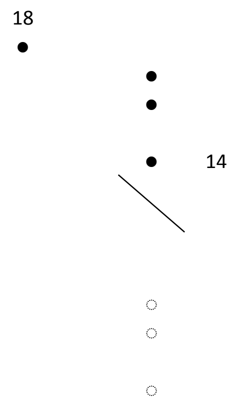
Appendix A1 − Review of quartertone fingering patterns

D𝄲5



Source: PR
Source comments:
Pitch: D5 +19 cents
HB comments:

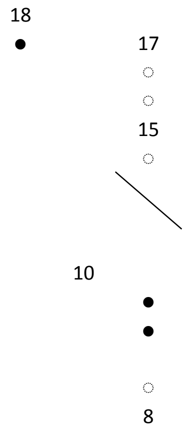
D𝄲5



Source: PR
Source comments:
Pitch: D5 +17 cents
HB comments: Standard fingering pattern for D♮5

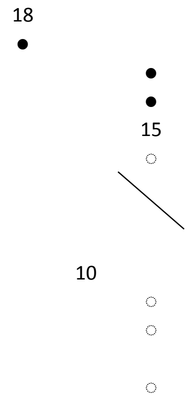
Appendix A1 − Review of quartertone fingering patterns

D𝄲5



Source: EMR
Source comments: Slightly low [in pitch]
Pitch: D5 -11 cents
HB comments: This fingering pattern causes the pitch to be lowered, not raised

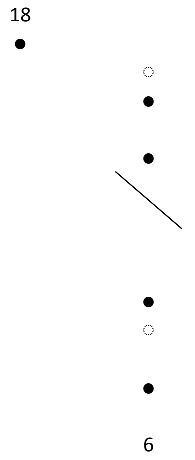
E𝄳5



Source: JA
Source comments:
Pitch: E5 -25 cents
HB comments:

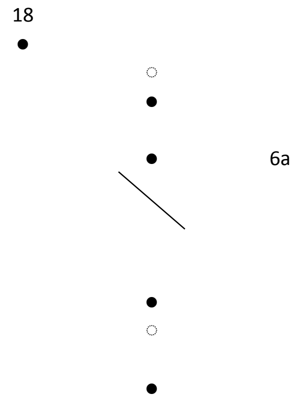
Appendix A1 − Review of quartertone fingering patterns

E𝄳5



Source: JA
Source comments:
Pitch: E♭5 +11 cents
HB comments:

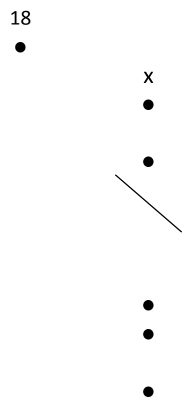
E𝄳5



Source: JA
Source comments:
Pitch: E♭5 +11 cents
HB comments:

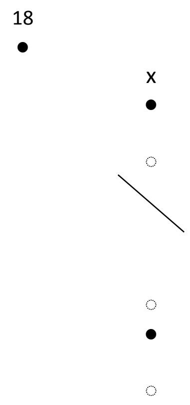
Appendix A1 − Review of quartertone fingering patterns

E𝄳5



Source: PR
Source comments:
Pitch: E♭5 +6 cents
HB comments:

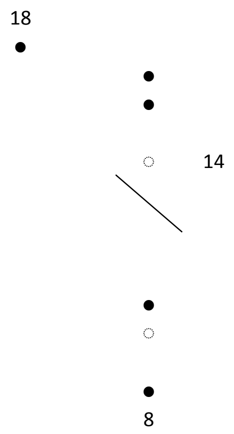
E𝄳5



Source: PR
Source comments:
Pitch: E5 -25 cents
HB comments:

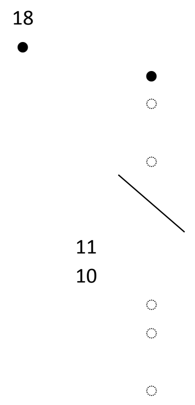
Appendix A1 − Review of quartertone fingering patterns

E𝄳5



Source: EMR
Source comments:
Pitch: E♭5 +14 cents
HB comments:

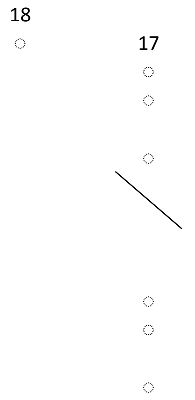
E𝄲5



Source: JA
Source comments:
Pitch: F5 +44 cents
HB comments: This fingering pattern is far closer to producing a F𝄲5 than an E𝄲5

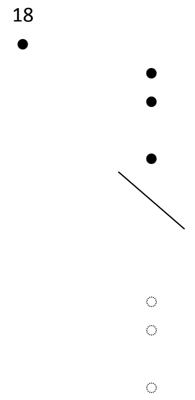
Appendix A1 − Review of quartertone fingering patterns

E𝄲5



Source: JA
Source comments:
Pitch: F5 +10 cents
HB comments: Standard fingering pattern for F♮5

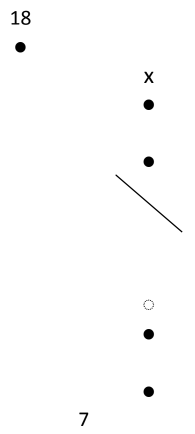
E𝄲5



Source: JA
Source comments:
Pitch: F5 -1 cent
HB comments:

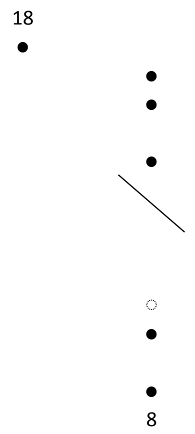
Appendix A1 − Review of quartertone fingering patterns

E𝄲5



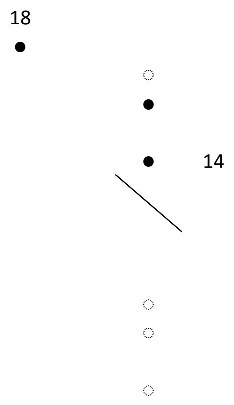
Source: PR
Source comments:
Pitch: E5 +16 cents
HB comments:

E𝄲5



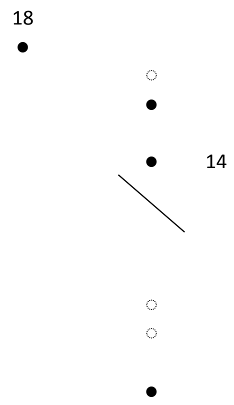
Source: EMR
Source comments:
Pitch: E5 +21 cents
HB comments:

F𝄲5



Source: JA
Source comments:
Pitch: F♯5 -43 cents
HB comments:

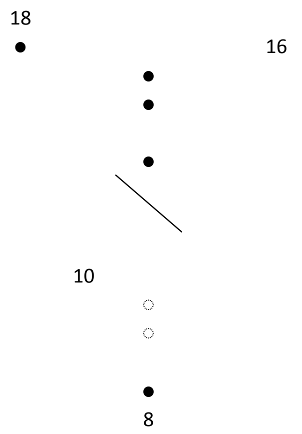
F𝄲5



Source: PR
Source comments:
Pitch: F5 +30 cents
HB comments: RHK3, played using the RH ring finger, does not have an influence on key 14 [on a Selmer bass clarinet]

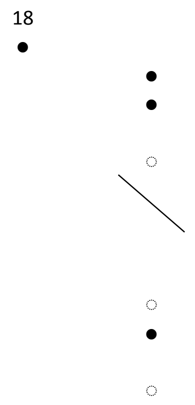
Appendix A1 − Review of quartertone fingering patterns

F𝄲5



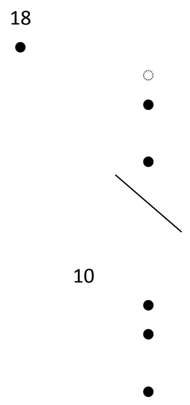
Source: EMR
Source comments: Slightly high [in pitch]
Pitch: F5 +49 cents
HB comments:

G𝄳5



Source: JA
Source comments:
Pitch: G5 -6 cents
HB comments:

G𝄳5



Source: EMR
Source comments: DAT [a note which is difficult to attack strongly]
Pitch: G5 - cents
HB comment

Appendix A2 − Overview of pitch deviations per note

D𝄲2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
							▪		▪▪▪			

E𝄳2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
					▪▪▪▪▪		▪▪					

E𝄲2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪▪	▪▪▪								

F𝄲2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪	▪▪		▪▪	▪				

G𝄳2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪▪▪▪▪								

Appendix A2 − Overview of pitch deviations per note

G𝄲2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
							▪ ▪ ▪	▪ ▪ ▪				

A𝄳2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
								▪ ▪	▪	▪		▪

A𝄲2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
								▪ ▪ ▪ ▪				

B𝄳2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
							▪	▪	▪ ▪ ▪			

B𝄲2

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪	▪ ▪		▪ ▪ ▪ ▪	▪		▪		

C𝄲3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
										▪ ▪ ▪		

Appendix A2 − Overview of pitch deviations per note

D𝄲3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪▪				▪		▪		

E𝄳3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
							▪			▪▪		

E𝄲3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
							▪▪▪▪▪					

F𝄲3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
								▪	▪▪▪	▪▪		

G𝄳3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪▪▪		▪							

A𝄳3

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
								▪	▪▪			

Appendix A2 − Overview of pitch deviations per note

A𝄲3

cents flatter (-)						𝄳/𝄲		cents sharper (+)				
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
					▪▪▪				▪			

B𝄳3

cents flatter (-)						𝄳/𝄲		cents sharper (+)				
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪▪▪	▪▪▪▪							

B𝄲3

cents flatter (-)						𝄳/𝄲		cents sharper (+)				
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
	▪	▪	▪▪	▪	▪							

C𝄲4

cents flatter (-)						𝄳/𝄲		cents sharper (+)				
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪	▪	▪▪▪		▪	▪▪				▪

D𝄳4

cents flatter (-)						𝄳/𝄲		cents sharper (+)				
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪	▪▪	▪▪▪		▪					▪

D𝄲4

cents flatter (-)						𝄳/𝄲		cents sharper (+)				
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
					▪		▪▪▪	▪▪	▪	▪▪		

Appendix A2 − Overview of pitch deviations per note

E𝄳4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪▪	▪▪		▪▪▪▪▪	▪				▪

E𝄲4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪▪	▪	▪▪▪				▪			

F𝄲4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪	▪			▪		▪▪	▪▪		

G𝄳4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
	▪▪	▪▪		▪▪								

G𝄲4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
▪				▪	▪			▪		▪		

A𝄳4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
		▪		▪▪	▪▪		▪▪					

Appendix A2 − Overview of pitch deviations per note

A𝄲4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
		▪		▪▪	▪			▪				

B𝄳4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
			▪	▪▪▪	▪			▪				

B𝄲4

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
		▪	▪▪	▪▪▪	▪▪							

C𝄲5

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
▪▪▪		▪		▪			▪	▪				

D𝄳5

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
		▪					▪		▪▪▪			

D𝄲5

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
		▪▪▪			▪							

Appendix A2 − Overview of pitch deviations per note

E𝄳5

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
	▪	▪ ▪ ▪							▪ ▪			

E𝄲5

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
		▪	▪								▪	▪ ▪

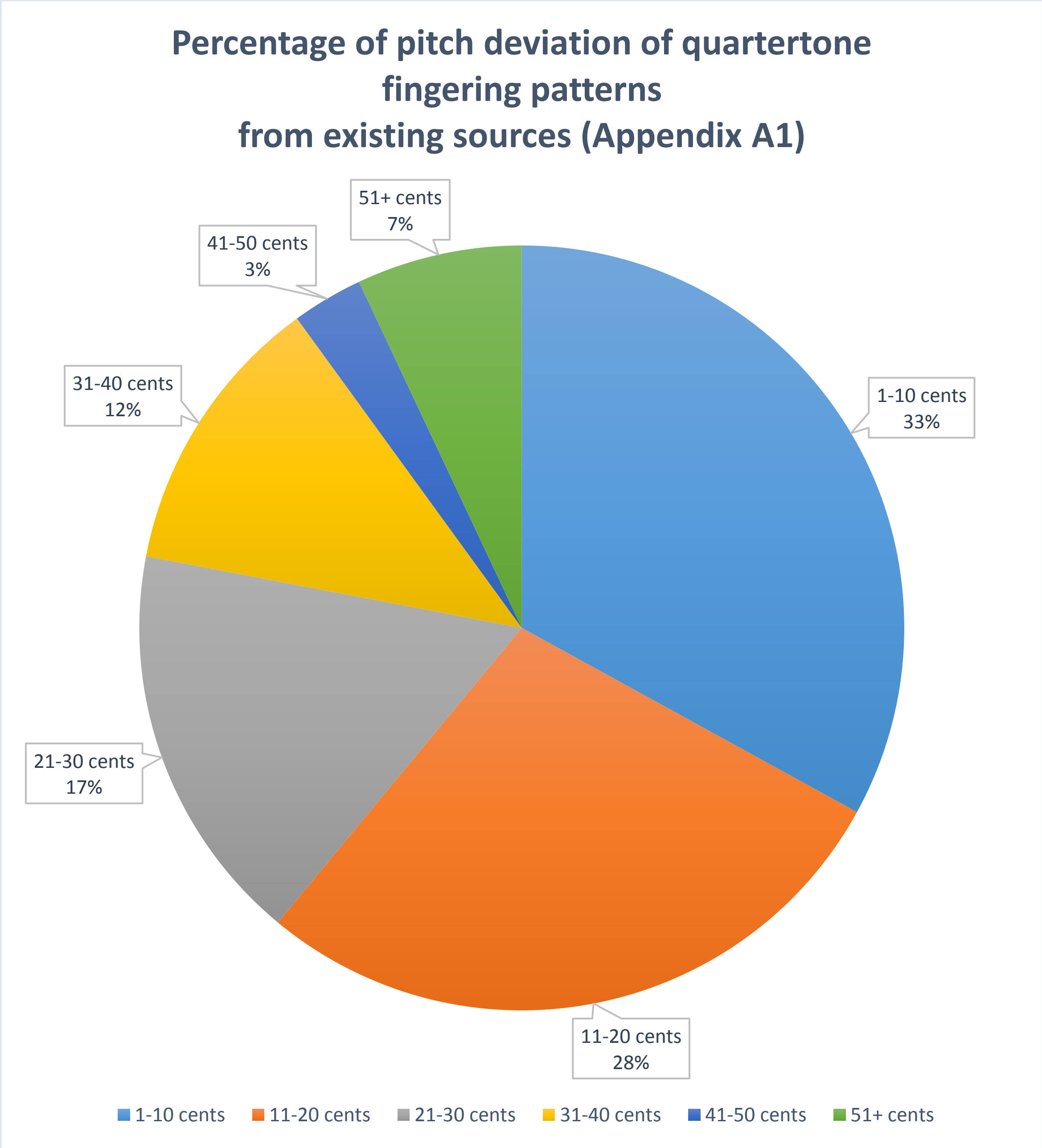
F𝄲5

cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
				▪	▪		▪					

G𝄳5

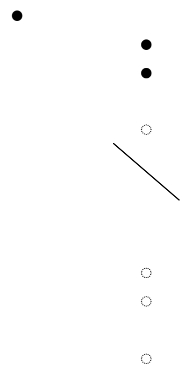
cents flatter (-)						𝄳/𝄲	cents sharper (+)					
51<	41-50	31-40	21-30	11-20	1-10	0	1-10	11-20	21-30	31-40	41-50	51<
											▪	

Appendix A3 − Pitch deviation

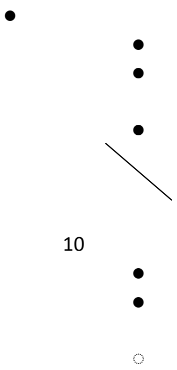


Appendix B − Quartertone scale

D2 No.1



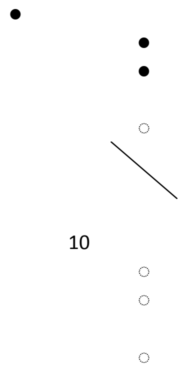
D𝄲2 No.2



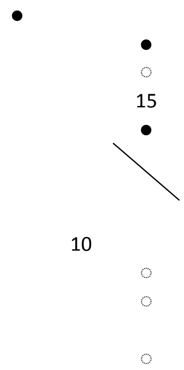
Key 10 is operated by the RH thumb

Tendency to squeak if the embouchure is overly tight

D♯2 No.3

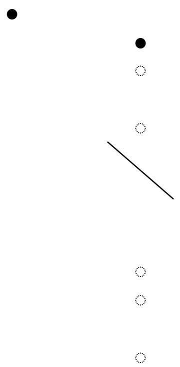


E𝄳2 No.4

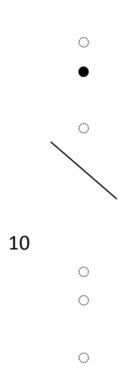


Appendix B − Quartertone scale

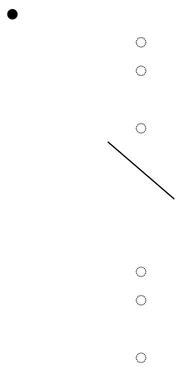
E2 No.5



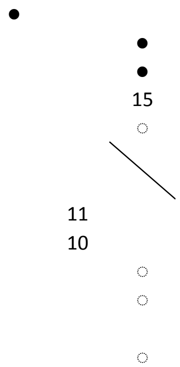
E𝄲2 No.6



F2 No.7

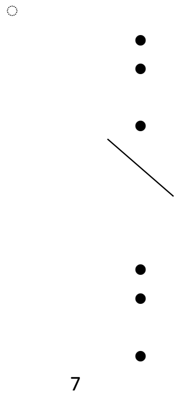


F𝄲2 No.8

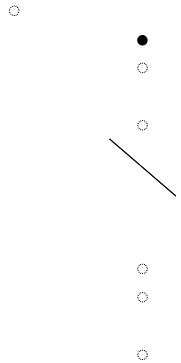


Appendix B − Quartertone scale

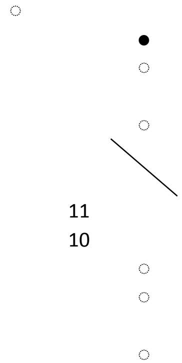
F𝄲2 alt. No.8a



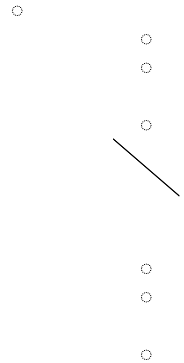
F♯2 No.9



G𝄳2 No.10

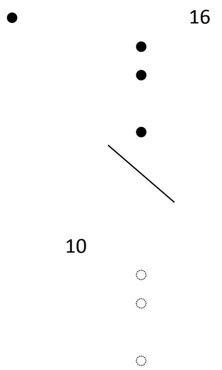


G2 No.11

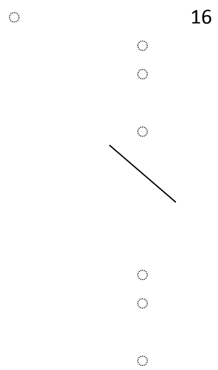


Appendix B − Quartertone scale

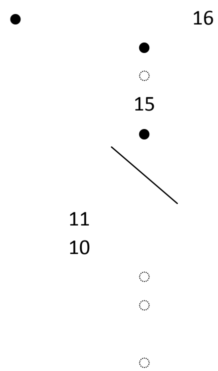
G𝄲2 No.12



G♯2 No.13

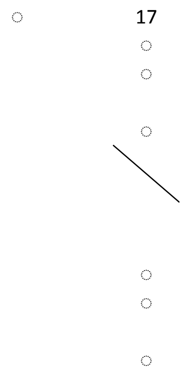


A𝄳2 No.14



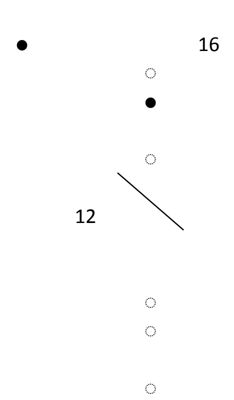
Fingering pattern should be underblown in order to play this pitch

A2 No.15

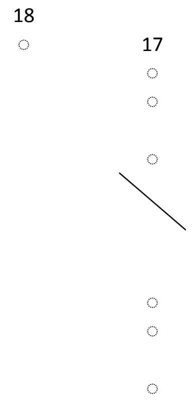


Appendix B − Quartertone scale

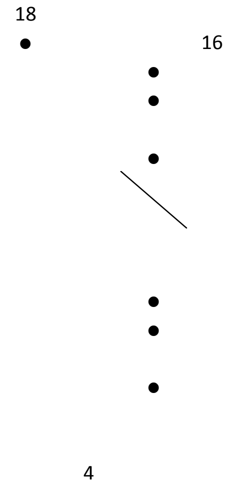
A𝄲2 No.16



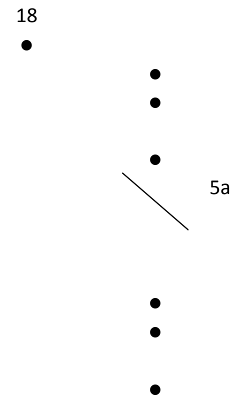
A♯2 No.17



B𝄳2 No.18

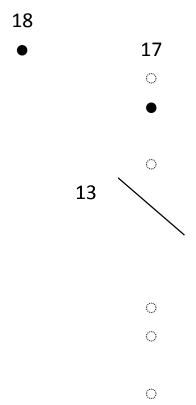


B2 No.19



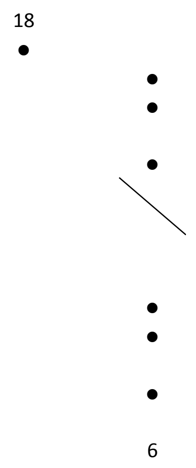
Appendix B − Quartertone scale

B𝄲2 No.20

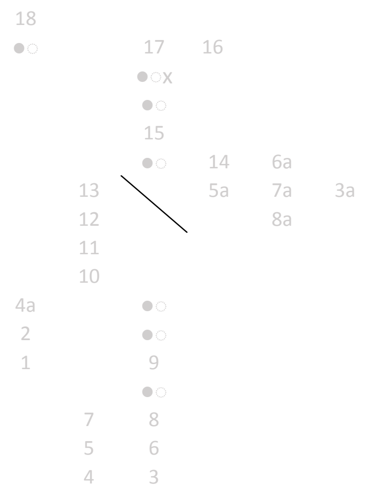


Key 13 is operated by the RH thumb

C3 No.21

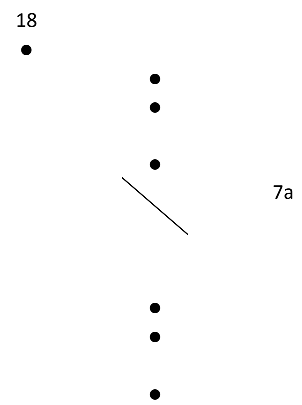


C𝄲3 No.22



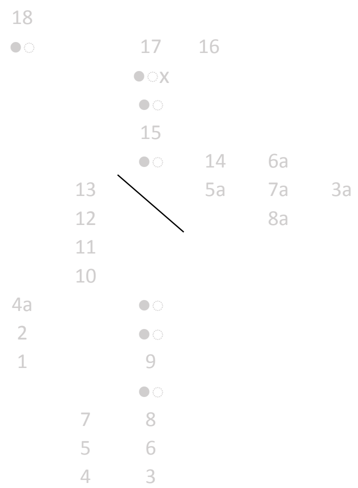
No fingering pattern fulfilled the research criteria

C♯3 No.23



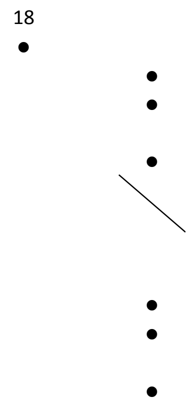
Appendix B − Quartertone scale

D𝄳3 No.24

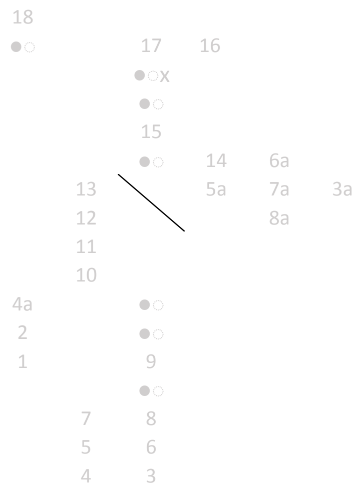


No fingering pattern fulfilled the research criteria

D3 No.25

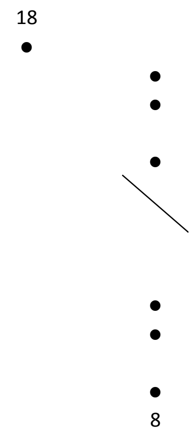


D𝄲3 No.26



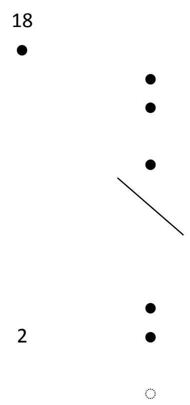
No fingering pattern fulfilled the research criteria

D♯3 No.27

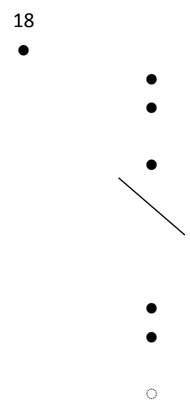


Appendix B − Quartertone scale

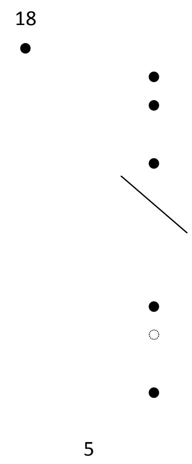
E𝄳3 No.28



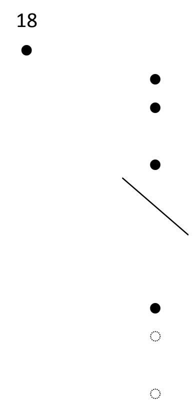
E3 No.29



E𝄲3 No.30

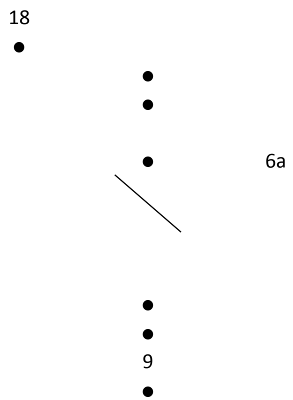


F3 No.31



Appendix B − Quartertone scale

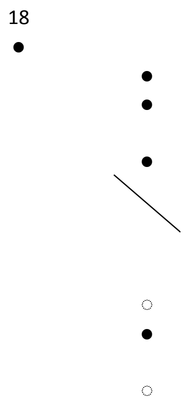
F𝄲3 No.32



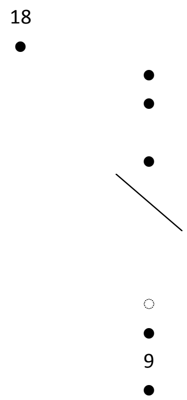
Key 9 is operated by the RH ring finger

RHK3 is operated by the RH little finger

F♯3 No.33



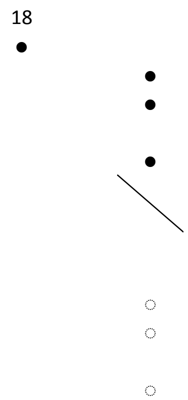
G𝄳3 No.34



Key 9 is operated by the RH ring finger

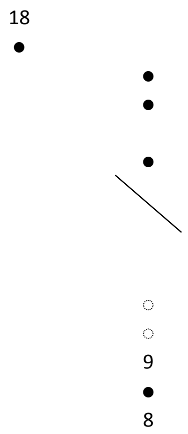
RHK3 is operated by the RH little finger

G3 No.35



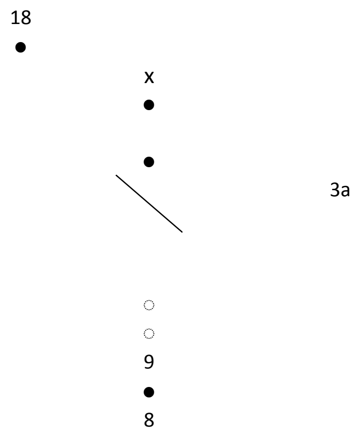
Appendix B − Quartertone scale

G𝄲3 No.36



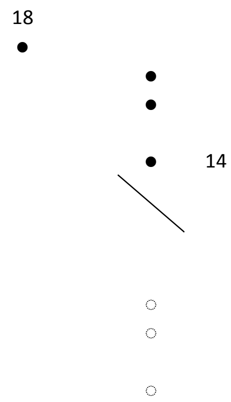
Key 9 is operated by the RH middle finger

G𝄲3 alt. No.36a

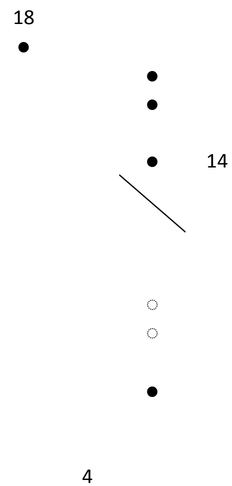


Key 9 is operated by the RH middle finger

G♯3 No.37

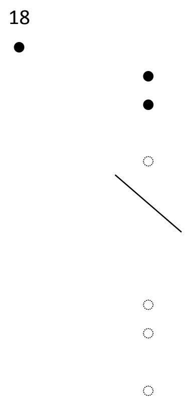


A𝄳3 No.38

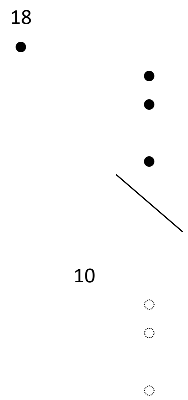


Appendix B − Quartertone scale

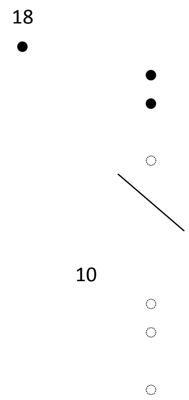
A3 No.39



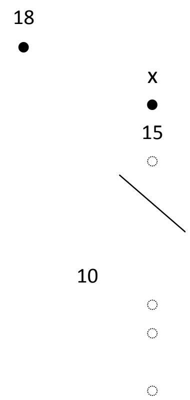
A𝄲3 No.40



A♯3 No.41

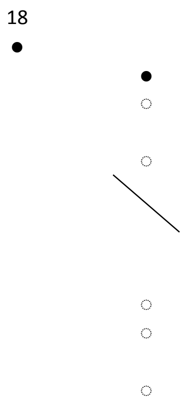


B𝄳3 No.42

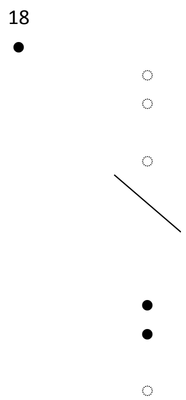


Appendix B − Quartertone scale

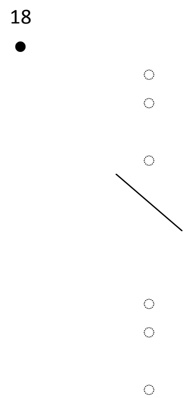
B3 No.43



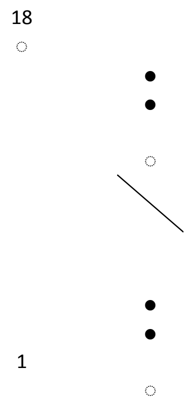
B𝄲3 No.44



C4 No.45

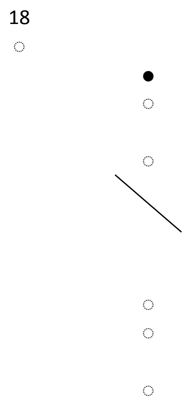


C𝄲4 No.46

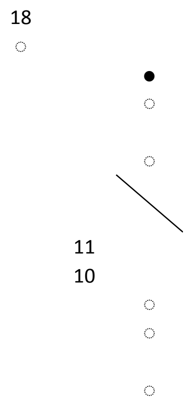


Appendix B − Quartertone scale

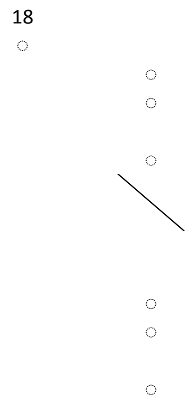
C♯4 No.47



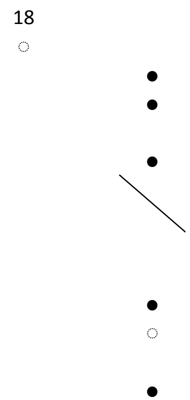
D𝄳4 No.48



D4 No.49

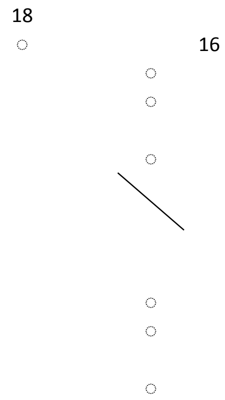


D𝄲4 No.50



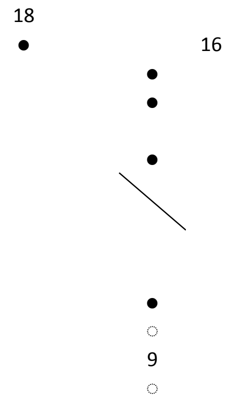
Appendix B − Quartertone scale

D♯4 No.51

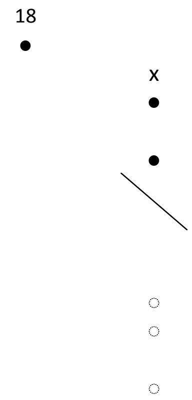


This fingering pattern can be played either with or without key 18

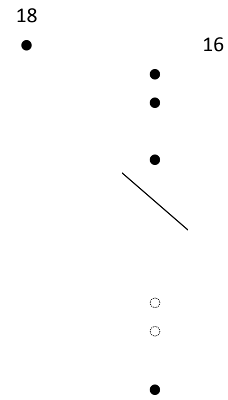
E𝄳4 No.52



E4 No.53

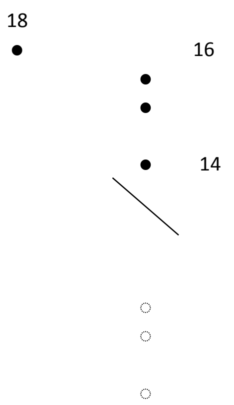


E𝄲4 No.54

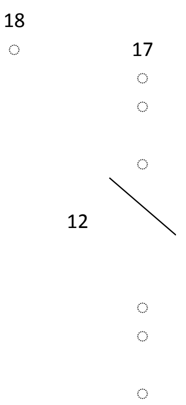


Appendix B − Quartertone scale

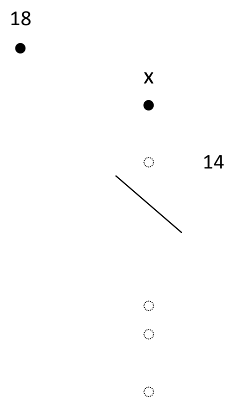
F4 No.55



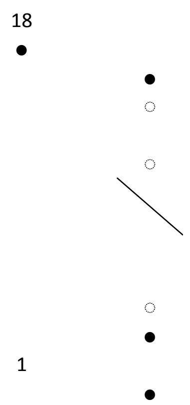
F𝄲4 No.56



F♯4 No.57

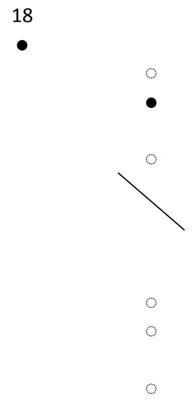


G𝄳4 No.58

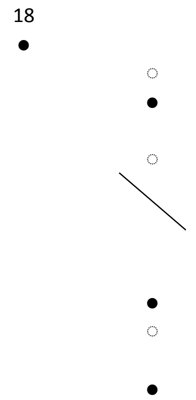


Appendix B − Quartertone scale

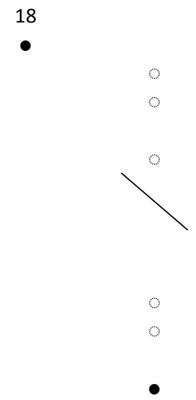
G4 No.59



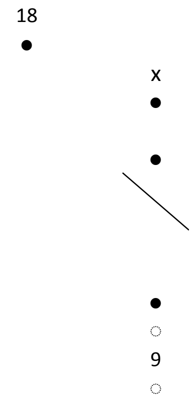
G𝄲4 No.60



G♯4 No.61

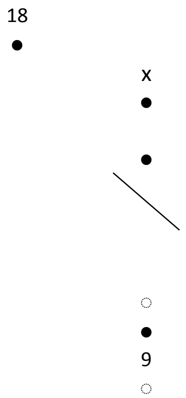


A𝄳4 No.62

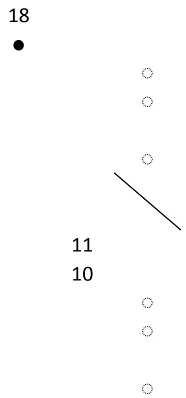


Appendix B − Quartertone scale

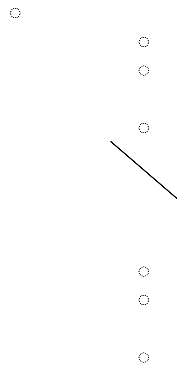
A4 No.63



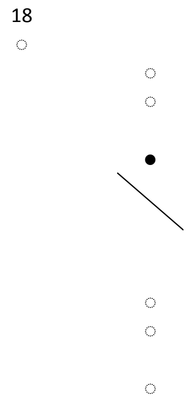
A𝄲4 No.64



A♯4 No.65

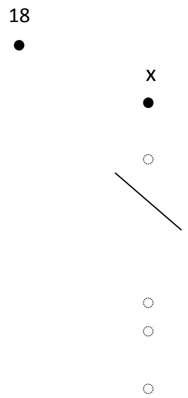


B𝄳4 No.66

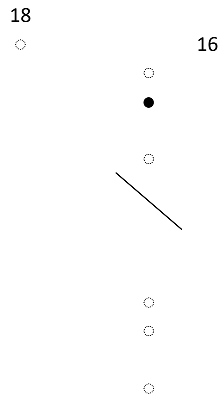


Appendix B − Quartertone scale

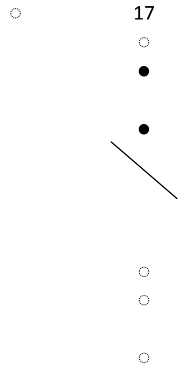
B4 No.67



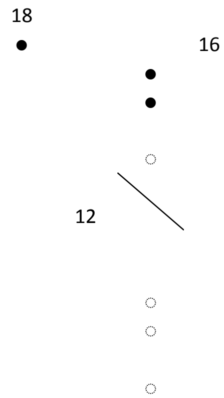
B𝄲4 No.68



C5 No.69

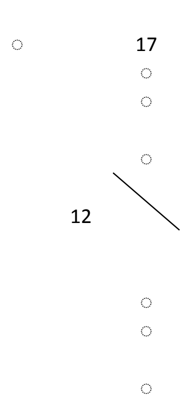


C𝄲5 No.70

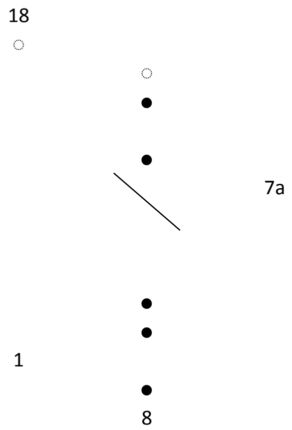


Appendix B − Quartertone scale

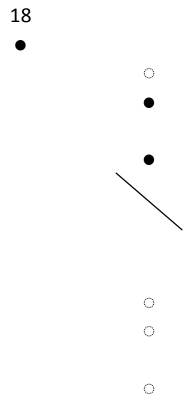
C♯5 No.71



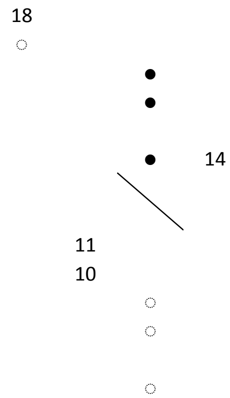
D𝄳5 No.72



D5 No.73

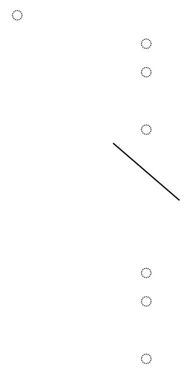


D𝄲5 No.74

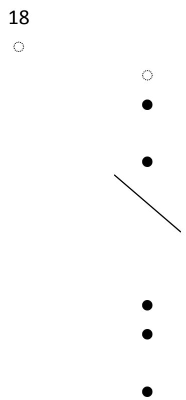


Appendix B − Quartertone scale

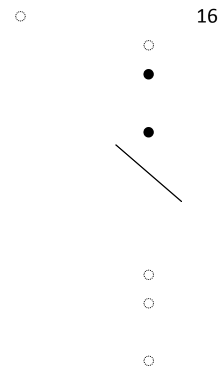
D♯5 No.75



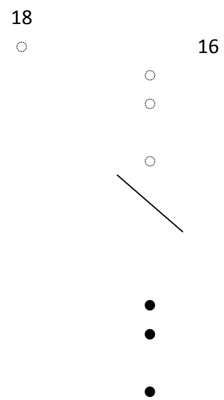
E𝄳5 No.76



E5 No.77

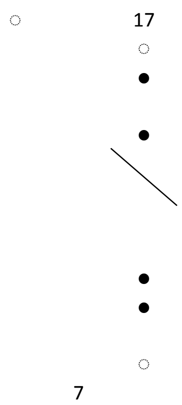


E𝄲5 No.78

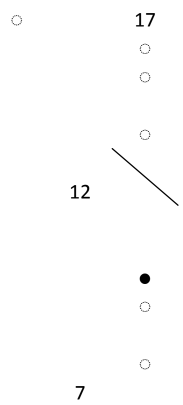


Appendix B − Quartertone scale

F5 No.79

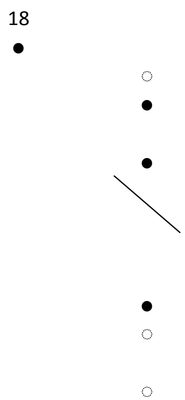


F𝄲5 No.80

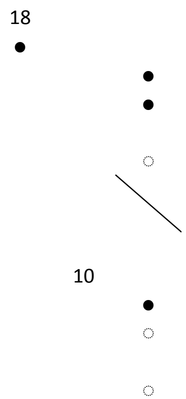


Key 12 is operated by the RH thumb

F♯5 No.81



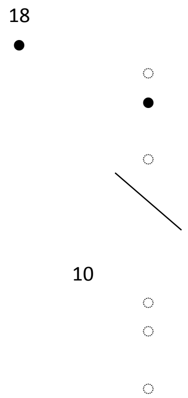
G𝄳5 No.82



Key 10 is operated by the RH thumb

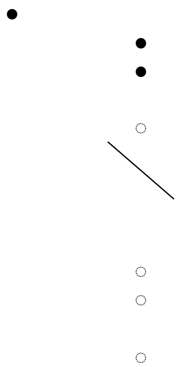
Appendix B − Quartertone scale

G5 No.83

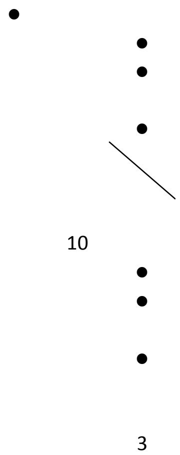


Appendix C − Eighth-tone scale

D2 No.1

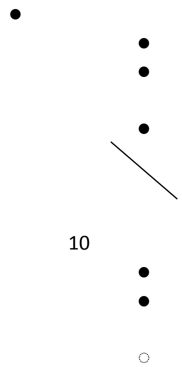


D♮↑2 No.2



Key 10 is operated by the RH thumb

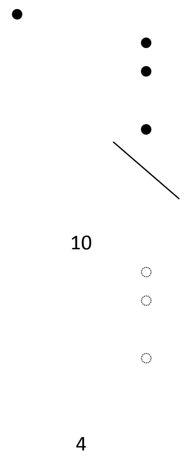
D𝄲2 No.3



Key 10 is operated by the RH thumb

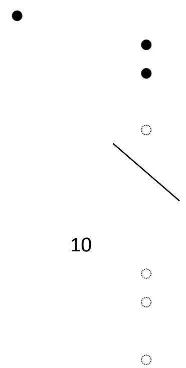
Tendency to squeak if the embouchure is overly tight

D♯↓2 No.4

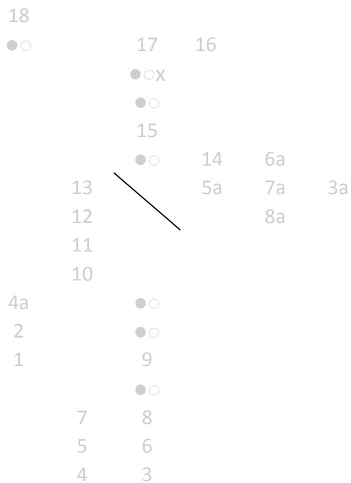


Appendix C – Eighth-tone scale

D♯2 No.5

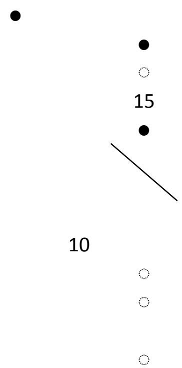


D♯2 No.6

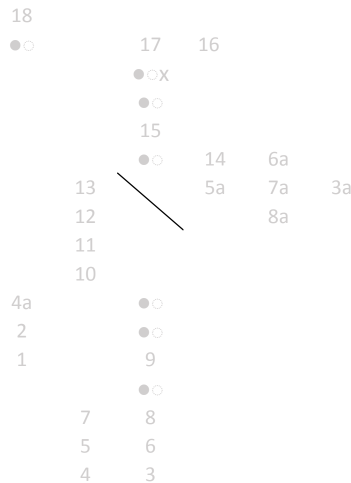


No fingering pattern fulfilled the research criteria

E♭2 No.7



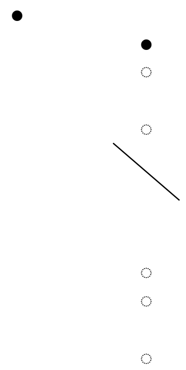
E♮2 No.8



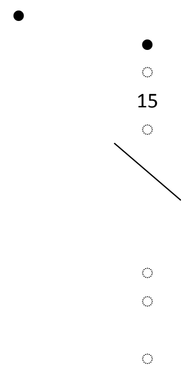
No fingering pattern fulfilled the research criteria

Appendix C – Eighth-tone scale

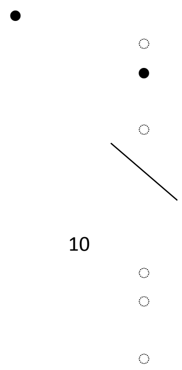
E2 No.9



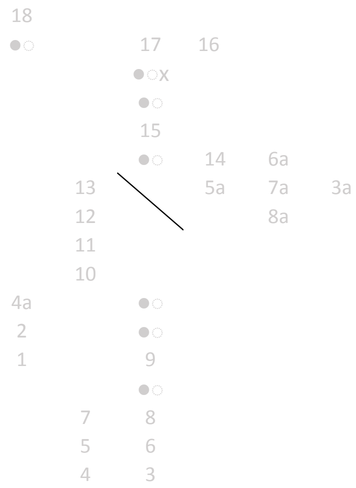
E♮↑2 No.10



E𝄲2 No.11



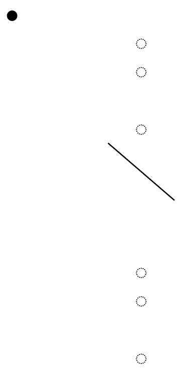
F♮↓2 No.12



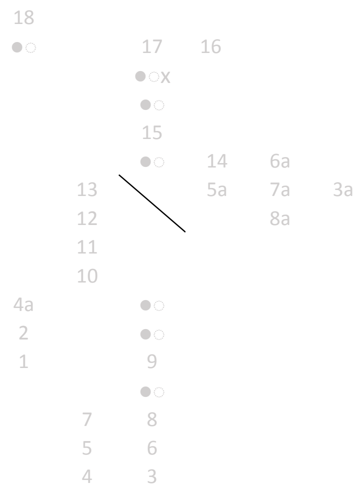
No fingering pattern fulfilled the research criteria

Appendix C – Eighth-tone scale

F2 No.13

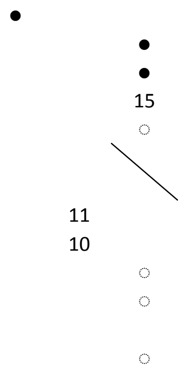


F↑♮2 No.14

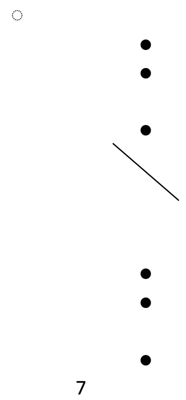


No fingering pattern fulfilled the research criteria

F𝄲2 No.15

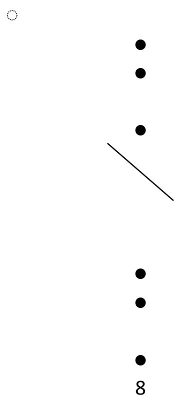


F𝄲2 alt. No.15a

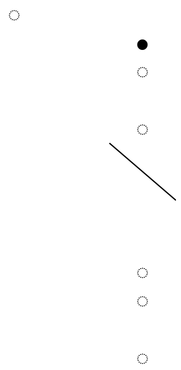


Appendix C – Eighth-tone scale

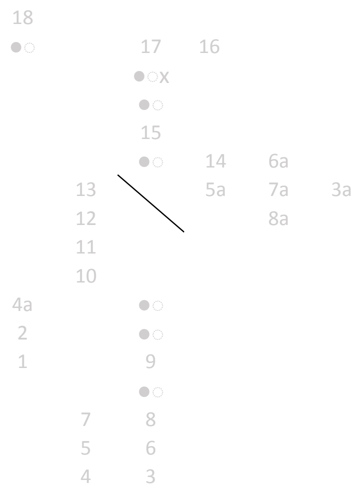
F♯2 No.16



F♯2 No.17

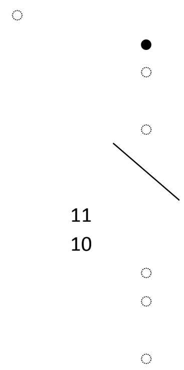


F♯2 No.18



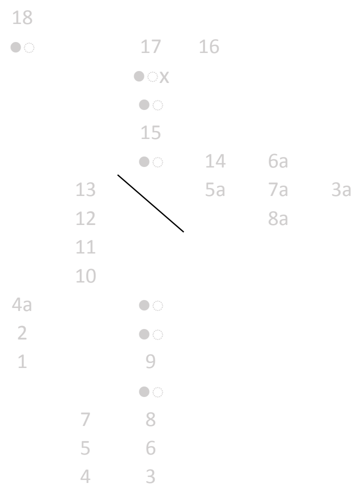
No fingering pattern fulfilled the research criteria

G𝄳2 No.19



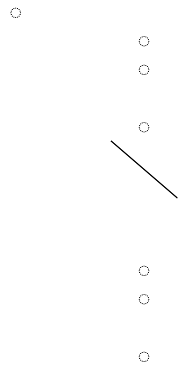
Appendix C – Eighth-tone scale

G♮↓2 No.20

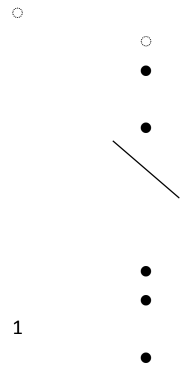


No fingering pattern fulfilled the research criteria

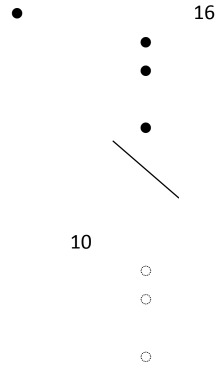
G2 No.21



G♮↑2 No.22

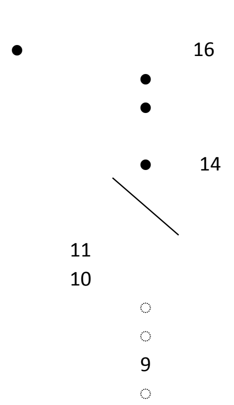


G𝄲2 No.23

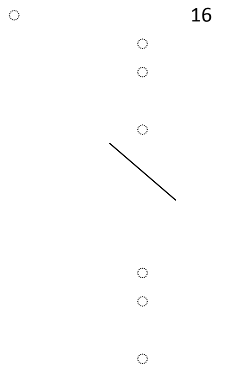


Appendix C – Eighth-tone scale

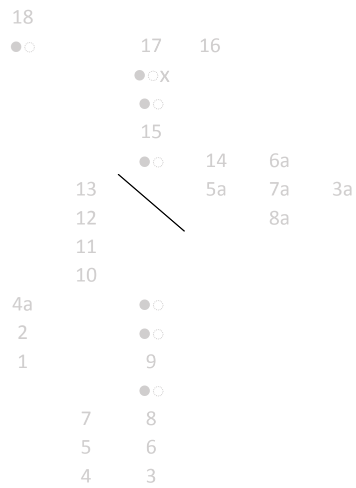
G♯2 No.24



G♯2 No.25

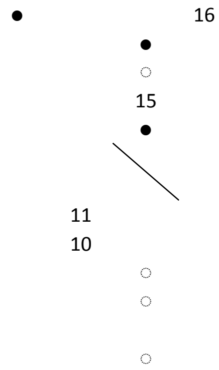


G♯2 No.26



No fingering pattern fulfilled the research criteria

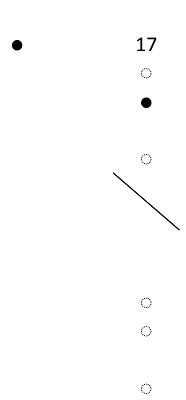
A𝄳2 No.27



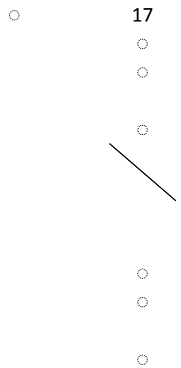
Fingering pattern should be underblown in order to play this pitch

Appendix C – Eighth-tone scale

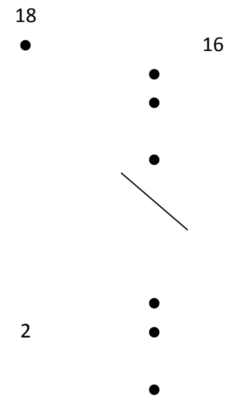
A♮↓2 No.28



A2 No.29

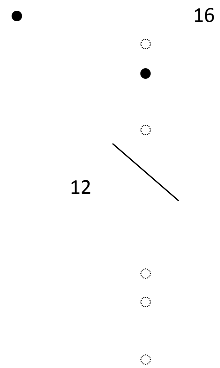


A♮↑2 No.30



A legato sequence to A𝄲2 is not possible

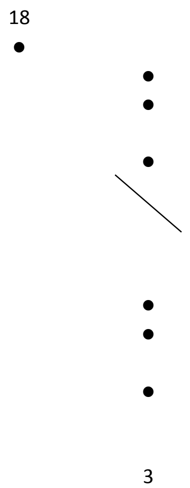
A𝄲2 No.31



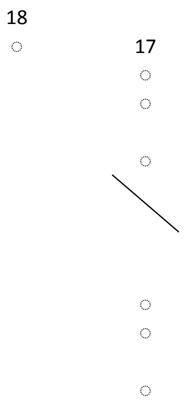
A legato sequence to A♮↑2 is not possible

Appendix C – Eighth-tone scale

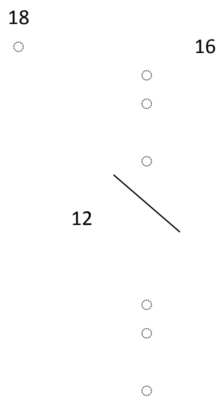
A♯↓2 No.32



A♯2 No.33

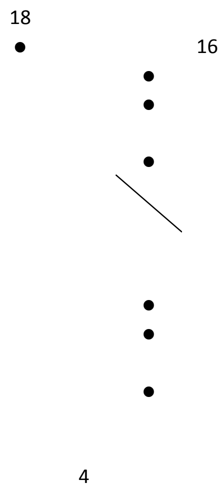


A♯↑2 No.34



For a legato sequence to B𝄳2 key 12 has to be operated by the RH thumb

B𝄳2 No.35

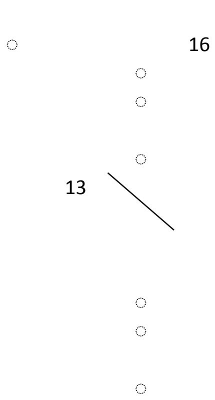


For a legato sequence to A♯↑2 key 12 has to be operated by the RH thumb

For a legato sequence to B♮↓2 key 13 has to be operated by the RH thumb

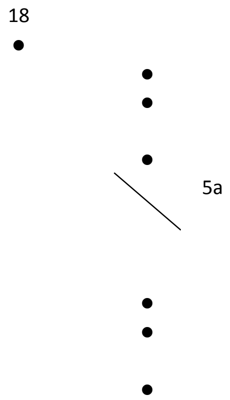
Appendix C – Eighth-tone scale

B♮↓2 No.36



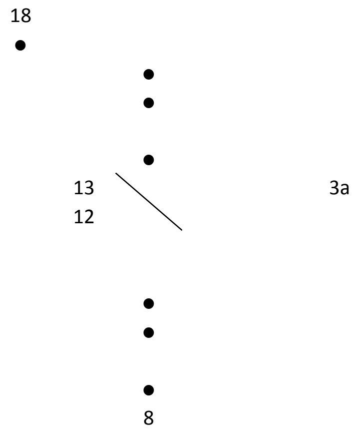
For a legato sequence to B𝄳2 or B2 key 13 has to be operated by the RH thumb

B2 No.37



A legato sequence to B♮↑2 is not possible. Non-legato movement between these pitches is only possible slowly

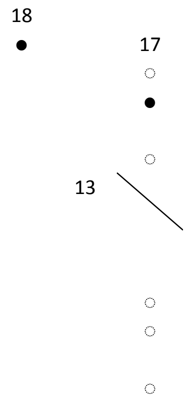
B♮↑2 No.38



Keys 12 and 13 are operated by the RH thumb

A legato sequence to B2 is not possible. Non-legato movement between these pitches is only possible slowly

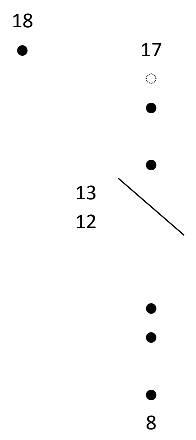
B𝄲2 No.39



Key 13 is operated by the RH thumb

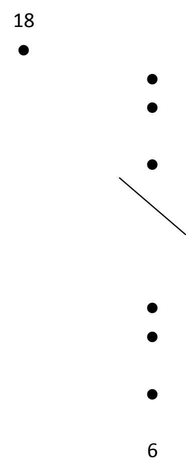
Appendix C – Eighth-tone scale

C♮↓3 No.40

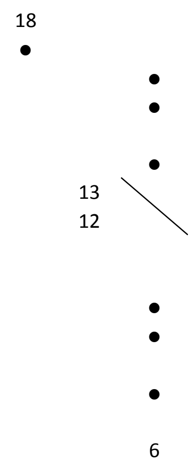


Keys 12 and 13 are operated using the RH thumb

C3 No.41

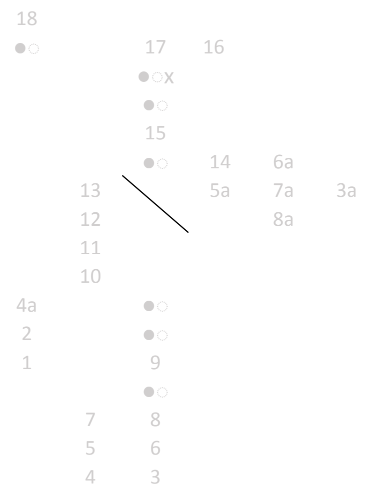


C♮↑3 No.42



Keys 12 and 13 are operated using the RH thumb

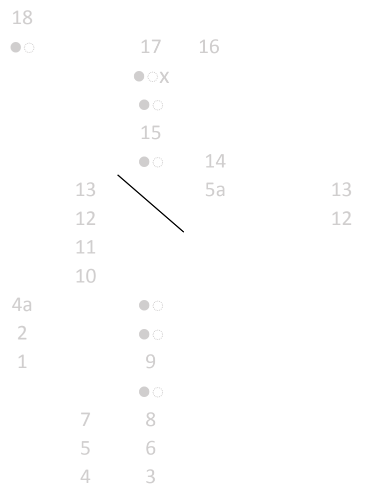
C𝄲3 No.43



No fingering pattern fulfilled the research criteria

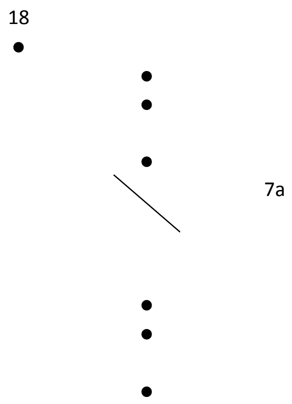
Appendix C – Eighth-tone scale

C♯3 No.44

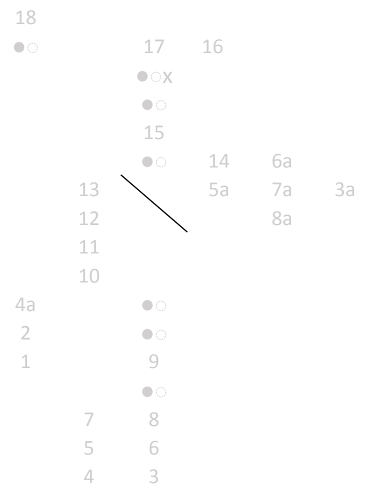


No fingering pattern fulfilled the research criteria

C♯3 No.45

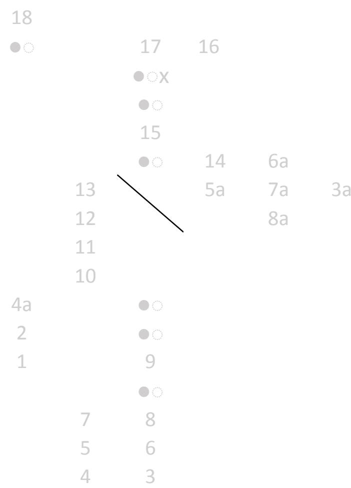


C♯3 No.46



No fingering pattern fulfilled the research criteria

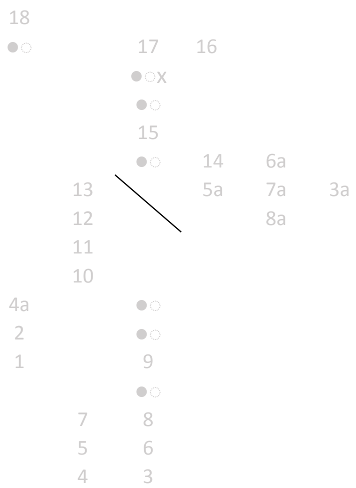
D𝄳3 No.47



No fingering pattern fulfilled the research criteria

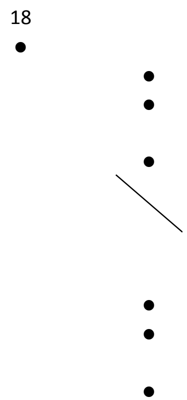
Appendix C – Eighth-tone scale

D♮↓3 No.48

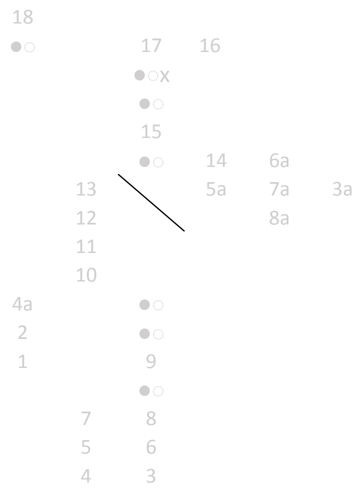


No fingering pattern fulfilled the research criteria

D3 No.49

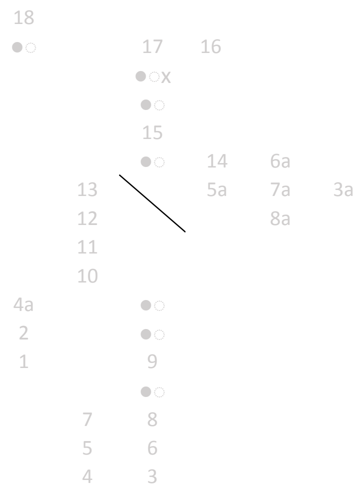


D♮↑3 No.50



No fingering pattern fulfilled the research criteria

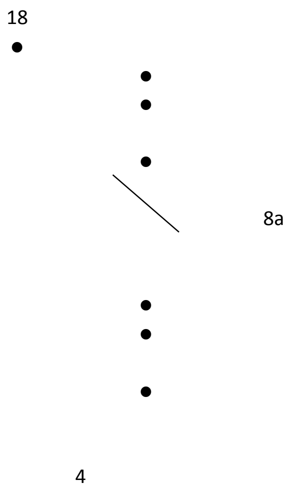
D𝄲3 No.51



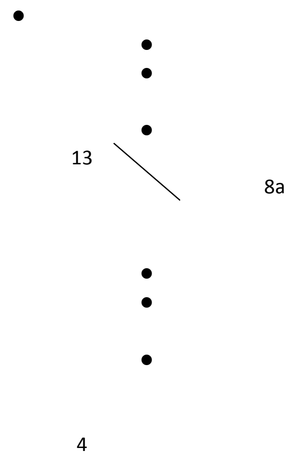
No fingering pattern fulfilled the research criteria

Appendix C – Eighth-tone scale

D♯3 No.52

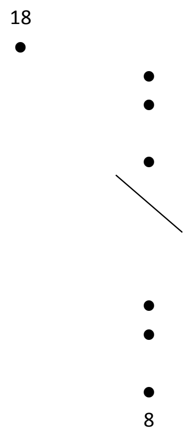


D♯3 alt. No.52a

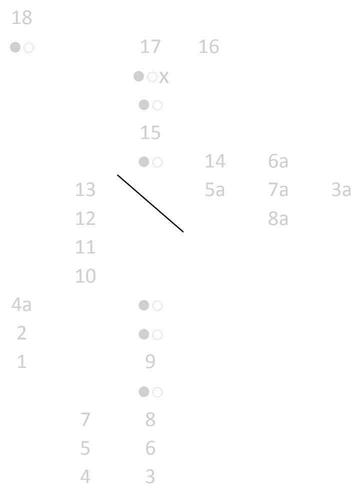


Key 13 is operated by the RH thumb

D♯3 No.53



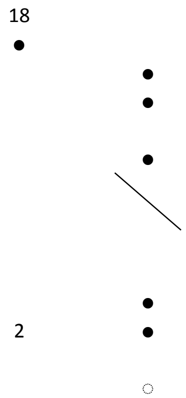
D♯3 No.54



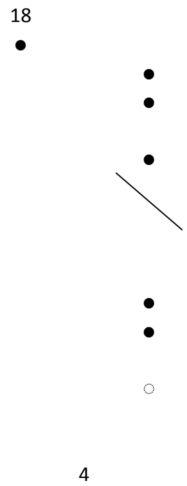
No fingering pattern fulfilled the research criteria

Appendix C – Eighth-tone scale

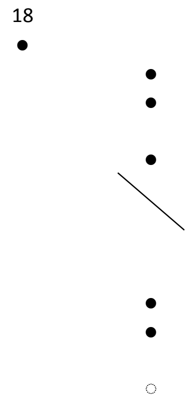
E𝄳3 No.55



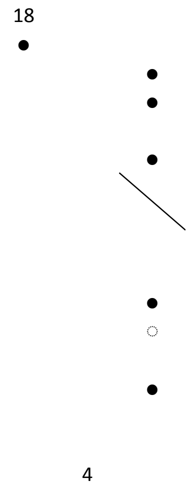
E♮↓3 No.56



E3 No.57

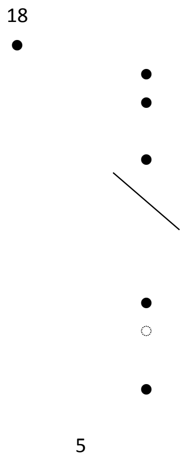


E♮↑3 No.58

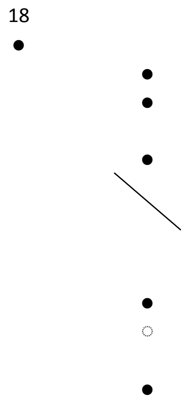


Appendix C – Eighth-tone scale

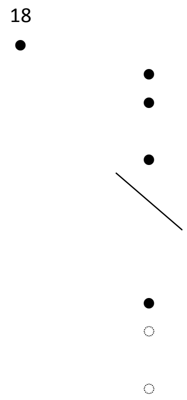
E𝄲3 No.59



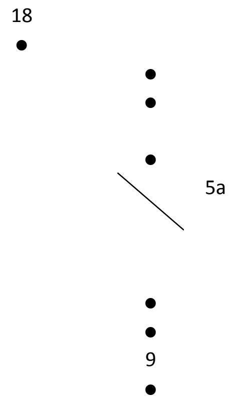
F♮↓3 No.60



F3 No.61



F♮↑3 No.62

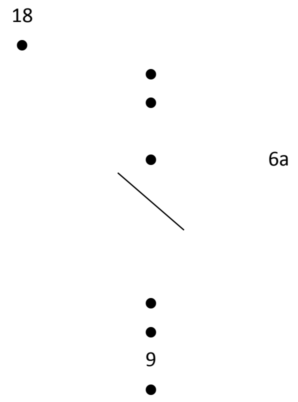


Key 9 is operated by the RH ring finger

RHK3 is operated by the RH little finger

Appendix C – Eighth-tone scale

F𝄲3 No.63

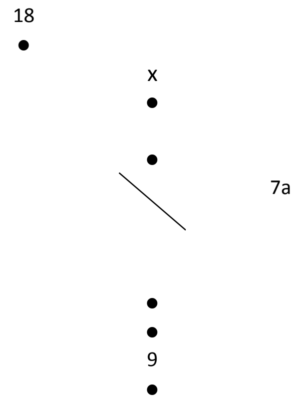


Key 9 is operated by the RH ring finger

RHK3 is operated by the RH little finger

Poor sound quality

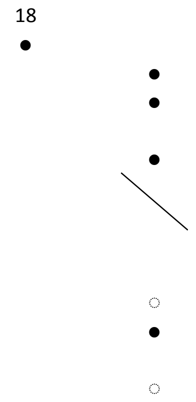
F♯↓3 No.64



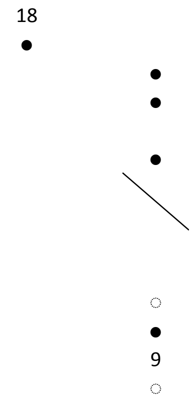
Key 9 is operated by the RH ring finger

RHK3 is operated by the RH little finger

F♯3 No.65

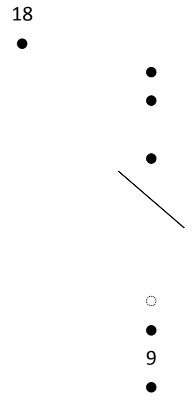


F♯↑3 No.66



Appendix C – Eighth-tone scale

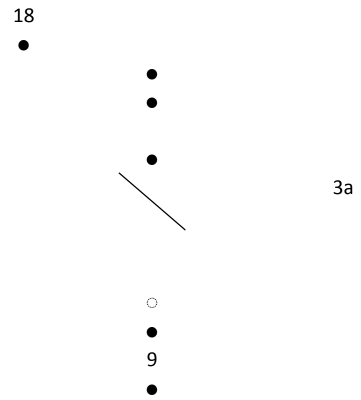
G𝄳3 No.67



Key 9 is operated by the RH ring finger

RHK3 is operated by the RH little finger

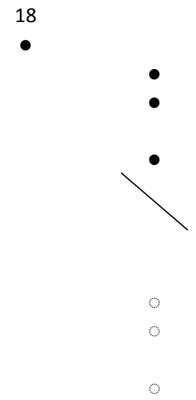
G♮↓3 No.68



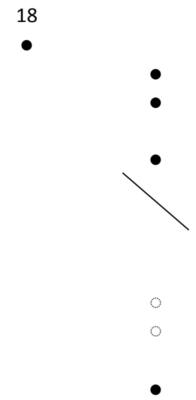
Key 9 is operated by the RH ring finger

RHK3 is operated by the RH little finger

G3 No.69

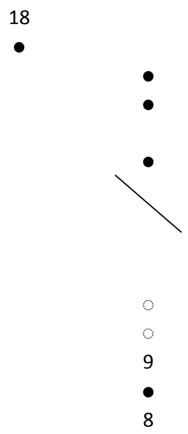


G♮↑3 No.70



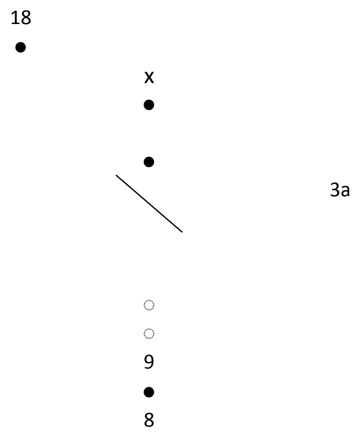
Appendix C – Eighth-tone scale

G♮3 No.71



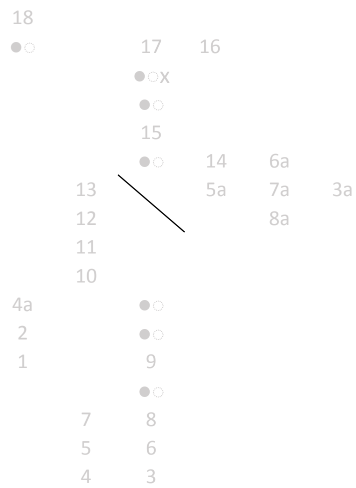
Key 9 is operated by the RH middle finger

G♮3 alt. No.71a



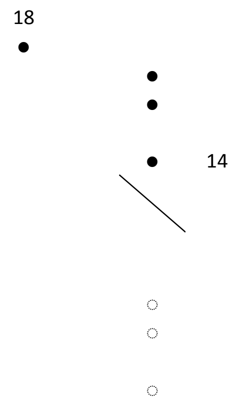
Key 9 is operated by the RH middle finger

G♯3 No.72



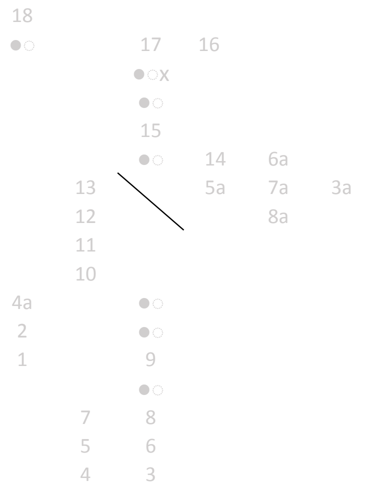
No fingering pattern fulfilled the research criteria

G♯3 No.73



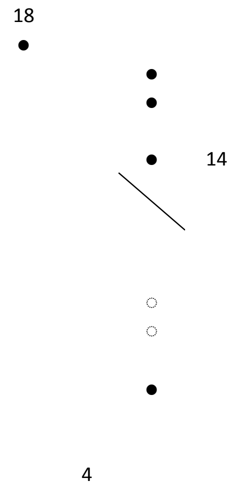
Appendix C – Eighth-tone scale

G♯↑3 No.74

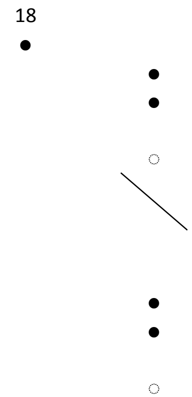


No fingering pattern fulfilled the research criteria

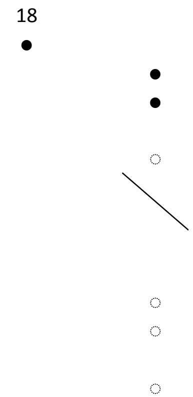
A𝄳3 No.75



A♮↓3 No.76

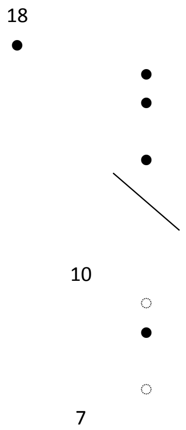


A3 No.77

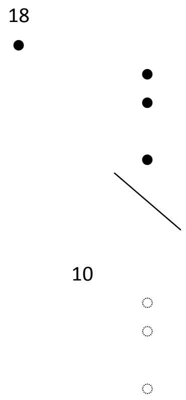


Appendix C – Eighth-tone scale

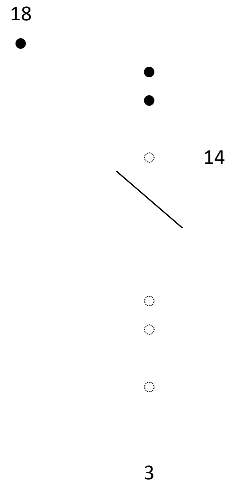
A♮3 No.78



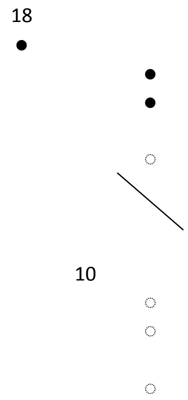
A♯3 No.79



A♯3 No.80

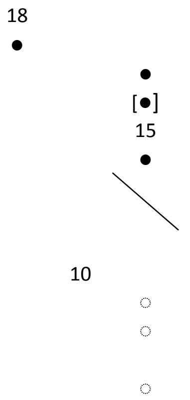


A♯3 No.81

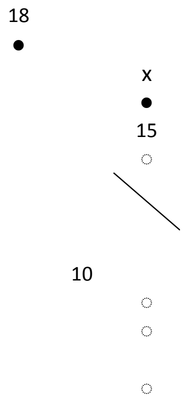


Appendix C – Eighth-tone scale

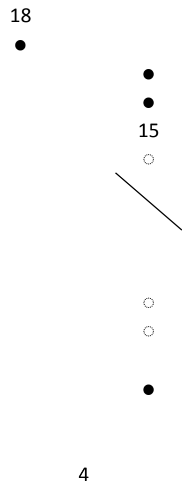
A♯↑3 No.82



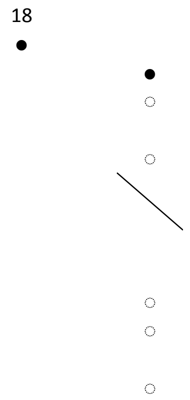
B𝄳3 No.83



B♮↓3 No.84

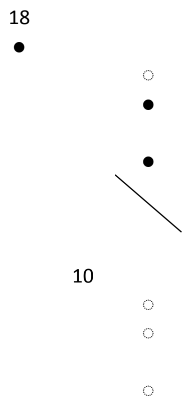


B3 No.85

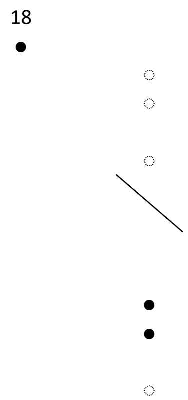


Appendix C – Eighth-tone scale

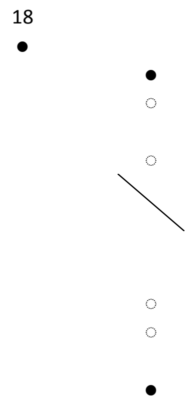
B♮↑3 No.86



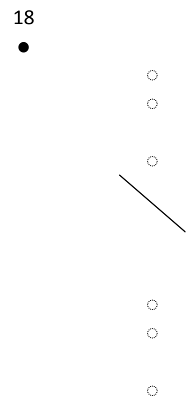
B𝄲3 No.87



C♮↓4 No.88

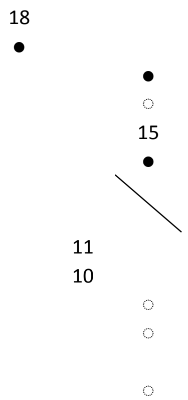


C4 No.89

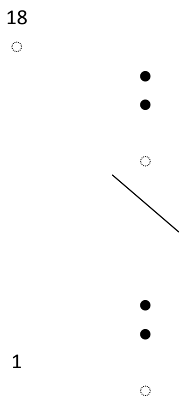


Appendix C – Eighth-tone scale

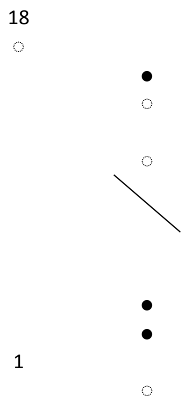
C♮↑4 No.90



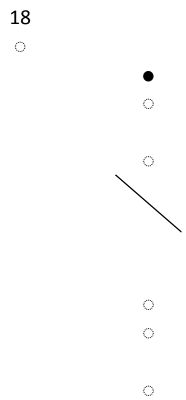
C𝄲4 No.91



C♯↓4 No.92

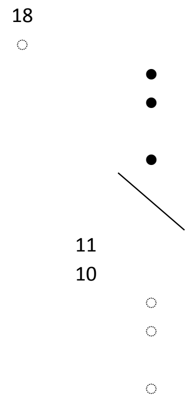


C♯4 No.93

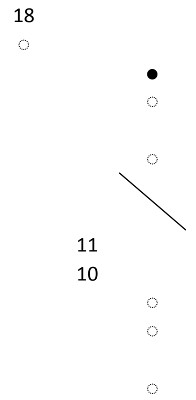


Appendix C – Eighth-tone scale

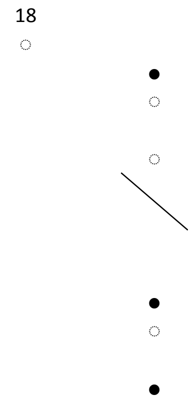
C♯↑4 No.94



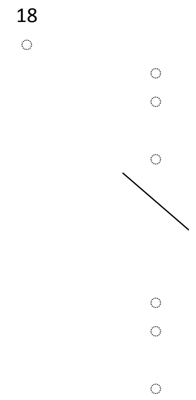
D𝄳4 No.95



D♮↓4 No.96

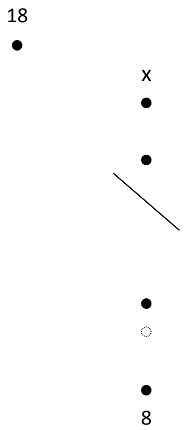


D4 No.97

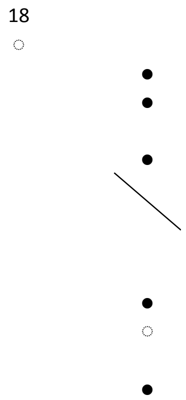


Appendix C – Eighth-tone scale

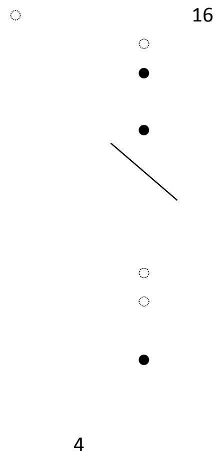
D♮4 No.98



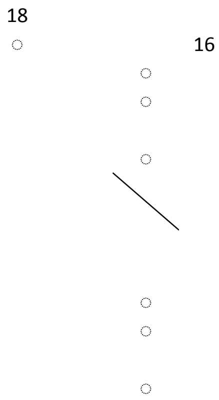
D♯4 No.99



D♯4 No.100



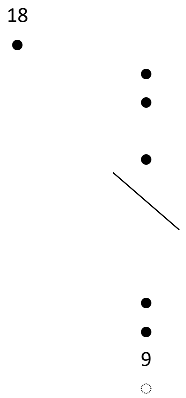
D♯4 No.101



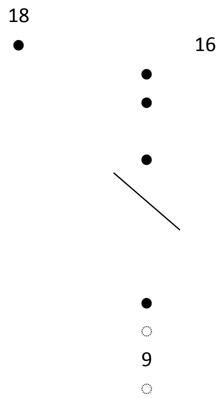
This fingering pattern can be played either with or without key 18

Appendix C – Eighth-tone scale

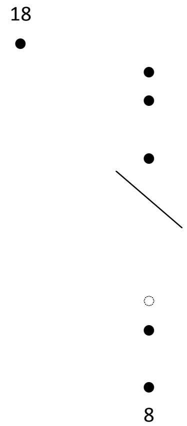
D♯↑4 No.102



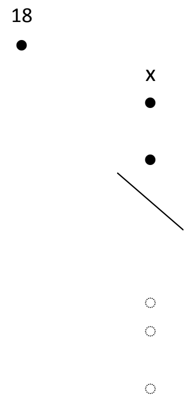
E𝄳4 No.103



E♮↓4 No.104

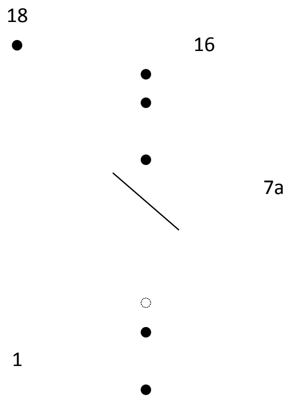


E4 No.105

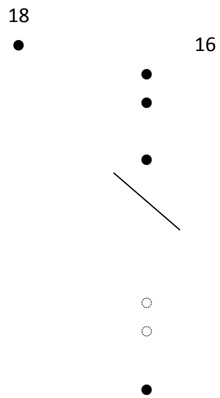


Appendix C – Eighth-tone scale

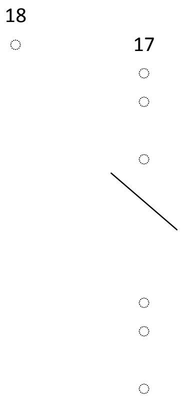
E♮↑4 No.106



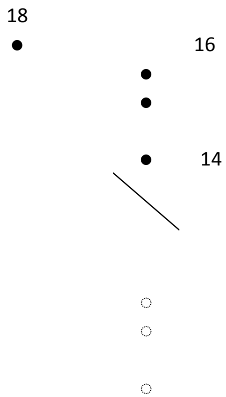
E𝄲4 No.107



F♮↓4 No.108

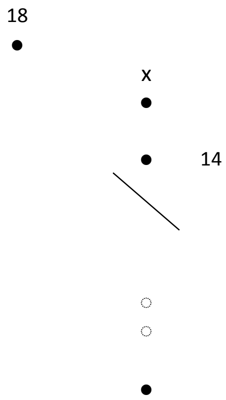


F4 No.109

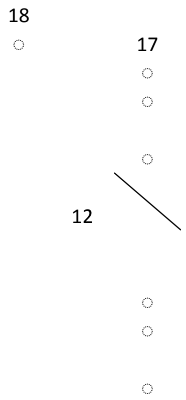


Appendix C – Eighth-tone scale

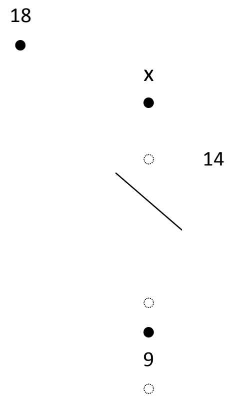
F↑♮4 No.110



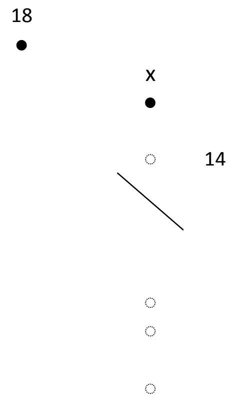
F𝄲4 No.111



F♯↓4 No.112

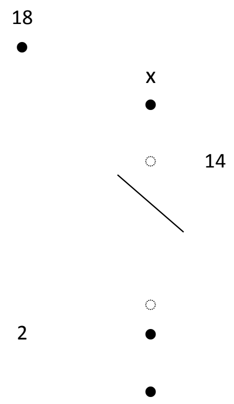


F♯4 No.113

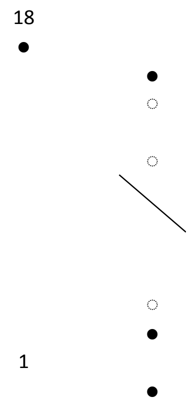


Appendix C – Eighth-tone scale

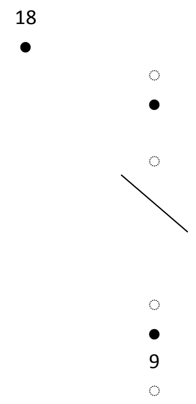
F♯↑4 No.114



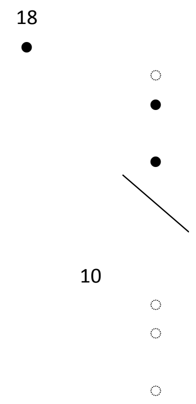
G𝄳4 No.115



G♮↓4 No.116

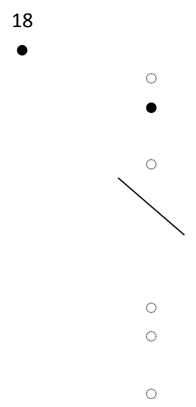


G♮↓4 alt. No.116a

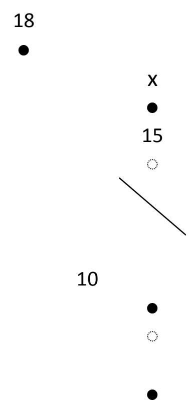


Appendix C – Eighth-tone scale

G4 No.117

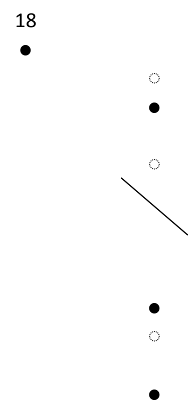


G♮↑4 No.118

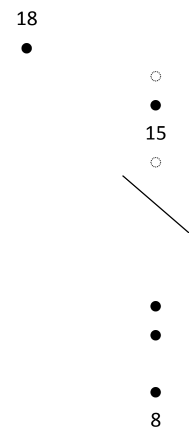


Key 10 is operated by the RH thumb

G𝄲4 No.119

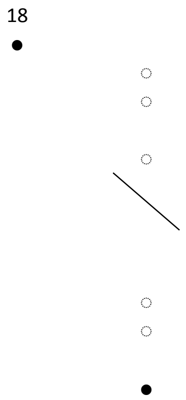


G𝄲↓4 No.120

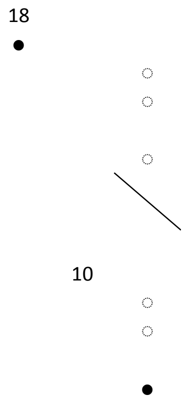


Appendix C – Eighth-tone scale

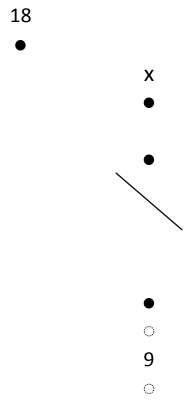
G♯4 No.121



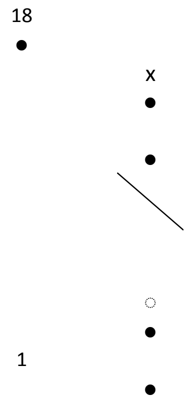
G♯4 No.122



A𝄳4 No.123

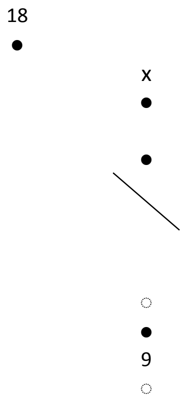


A♮4 No.124

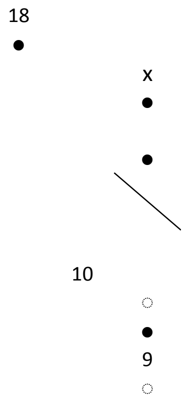


Appendix C – Eighth-tone scale

A4 No.125

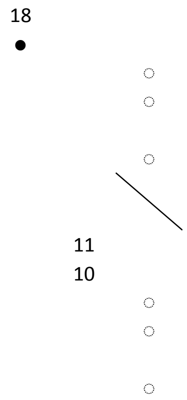


A♮↑4 No.126



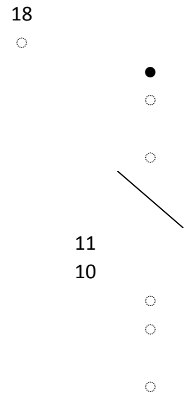
Key 10 should be operated by the RH thumb when a legato sequence to A♯4 is required

A♯4 No.127



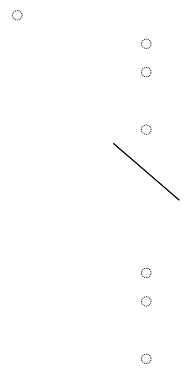
Keys 10 and 11 should be operated by the RH thumb when a legato sequence from A♮↑4 is required

A♯↓4 No.128

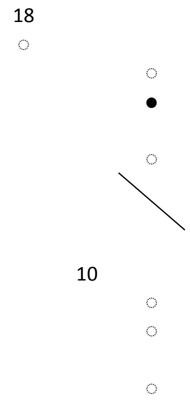


Appendix C – Eighth-tone scale

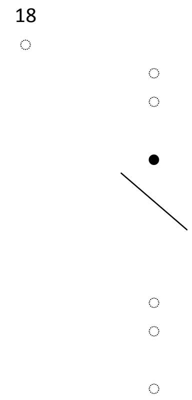
A♯4 No.129



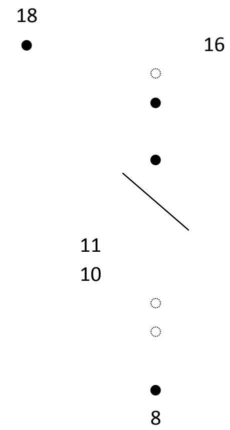
A♯↑4 No.130



B𝄳4 No.131

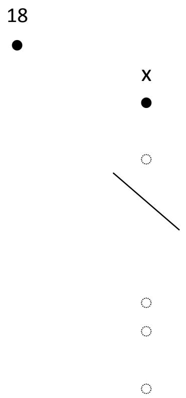


B♮↓4 No.132

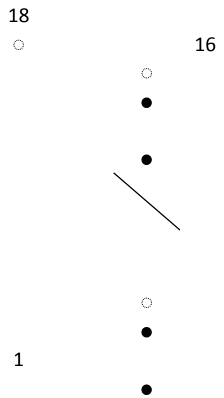


Appendix C – Eighth-tone scale

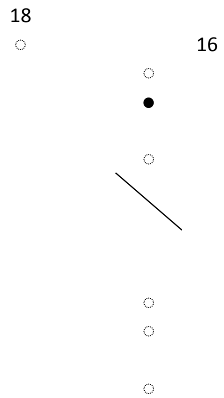
B4 No.133



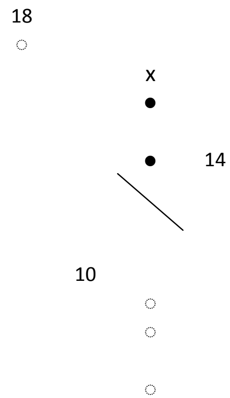
B♮↑4 No.134



B𝄲4 No.135

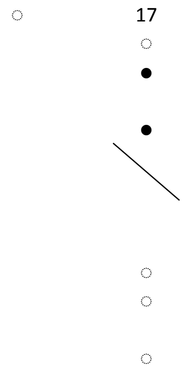


C♮↓5 No.136

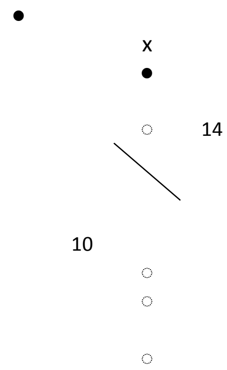


Appendix C – Eighth-tone scale

C5 No.137

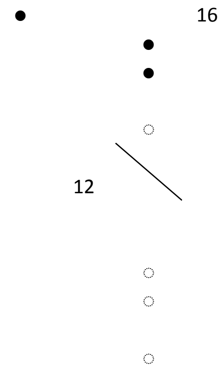


C♮↑5 No.138



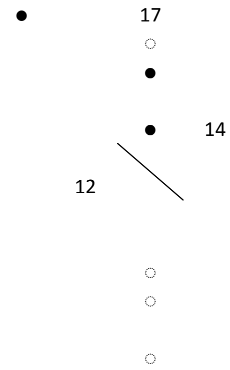
Key 10 should be operated by the RH thumb when a legato sequence to C𝄲5 is required

C𝄲5 No.139



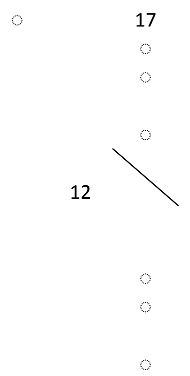
Key 12 should be operated by the RH thumb when a legato sequence from C♮↑5 is required

C♯↓5 No.140

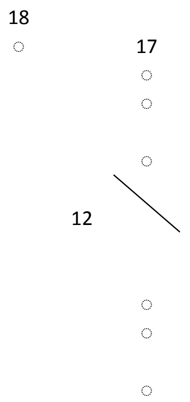


Appendix C – Eighth-tone scale

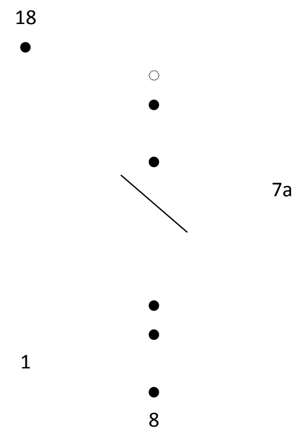
C♯5 No.141



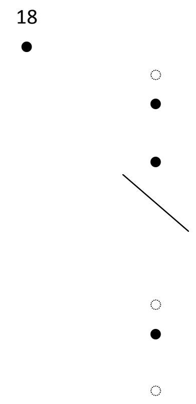
C♯↑5 No.142



D𝄳5 No.143

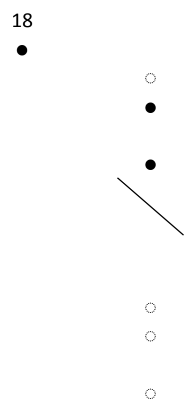


D♮↓5 No.144



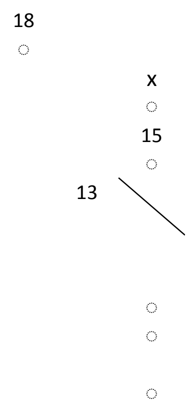
Appendix C – Eighth-tone scale

D5 No.145



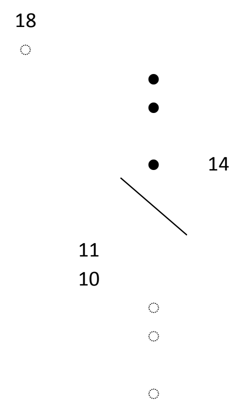
A legato sequence to D♮5 is not possible

D♮5 No.146

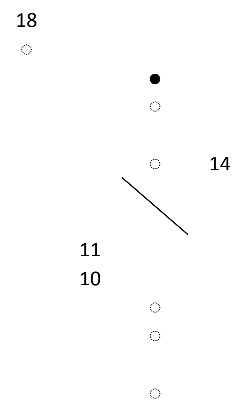


A legato sequence from D5 is not possible

D♯5 No.147

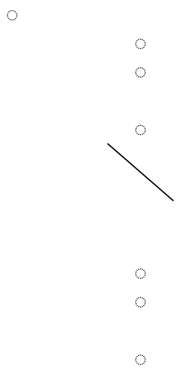


D♯5 No.148

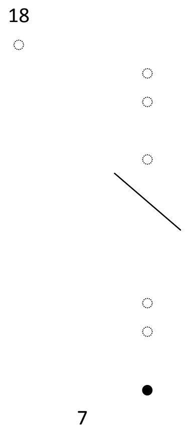


Appendix C – Eighth-tone scale

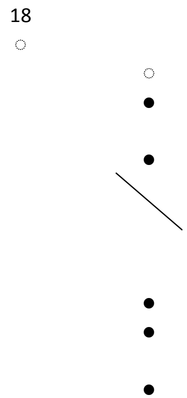
D♯5 No.149



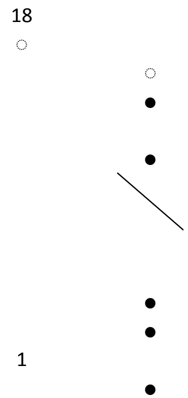
D♯↑5 No.150



E𝄳5 No.151

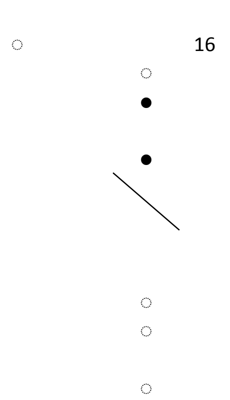


E♮↓5 No.152

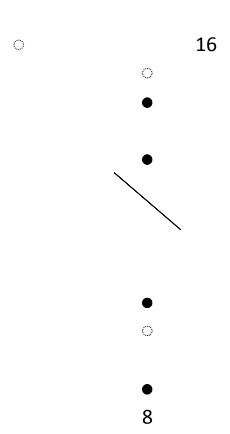


Appendix C – Eighth-tone scale

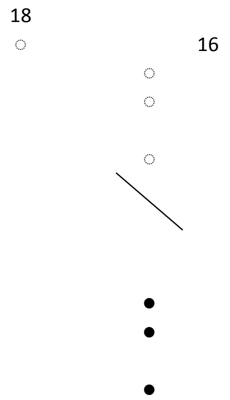
E5 No.153



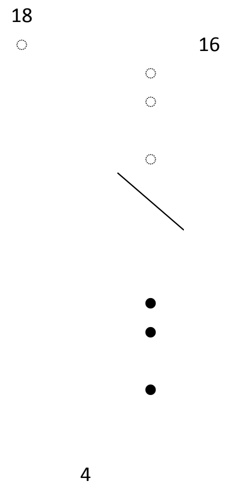
E♮↑5 No.154



E𝄲5 No.155

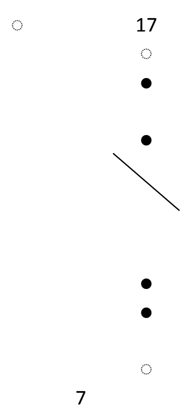


F♮↓5 No.156

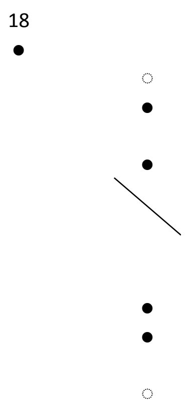


Appendix C – Eighth-tone scale

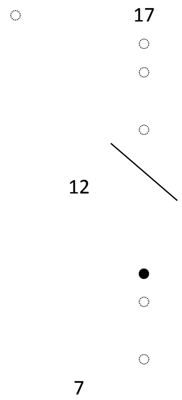
F5 No.157



F♮5 No.158

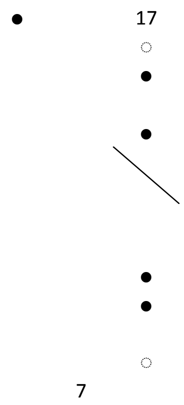


F♯5 No.159



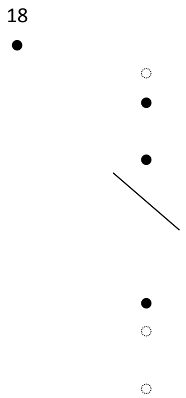
Key 12 is operated by the RH thumb

F♯5 No.160

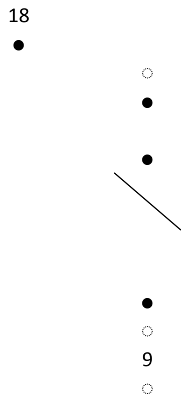


Appendix C – Eighth-tone scale

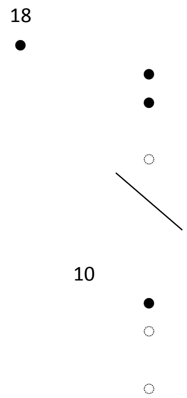
F♯5 No.161



F♯↑5 No.162

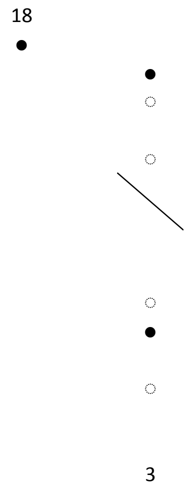


G𝄳5 No.163

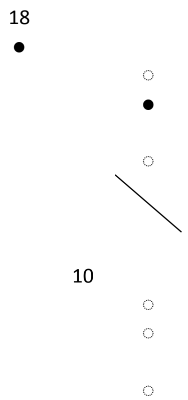


Key 10 is operated by the RH thumb

G♮↓5 No.164

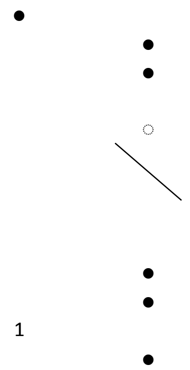


G5 No.165

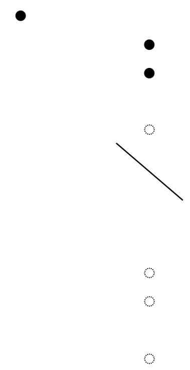


Appendix D − 31-tone scale version 1

D2 No.1

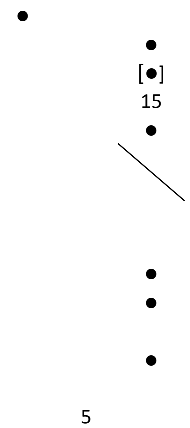


D♮2 No.2



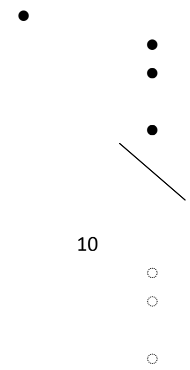
Standard fingering pattern for D2

D♯2 No.3



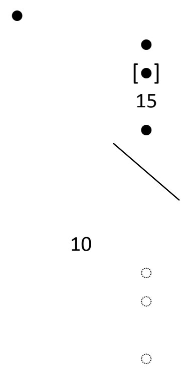
Restrictions to the dynamic level: only playable at dynamics quieter than *piano*

E♭2 No.4

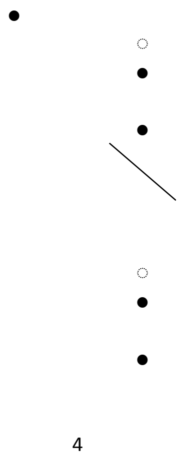


Appendix D − 31-tone scale version 1

E𝄳2 No.5

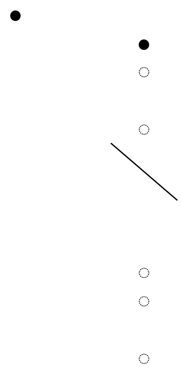


E2 No.6



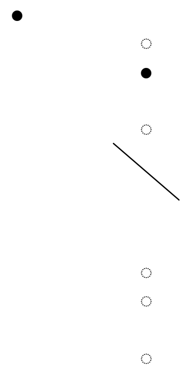
Poor sound quality

E𝄲2 No.7



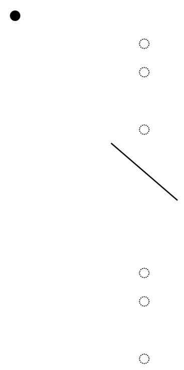
Standard fingering pattern for E2

F𝄳2 No.8



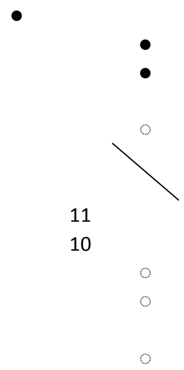
Appendix D − 31-tone scale version 1

F2 No.9

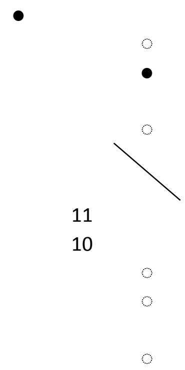


Standard fingering pattern

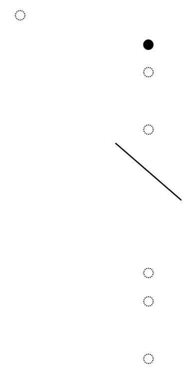
F♮2 No.10



F♯2 No.11



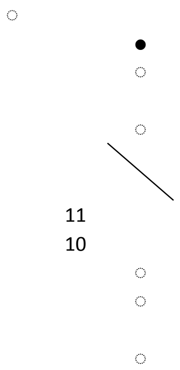
G♭2 No.12



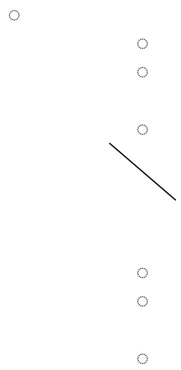
Standard fingering pattern

Appendix D − 31-tone scale version 1

G𝄳2 No.13

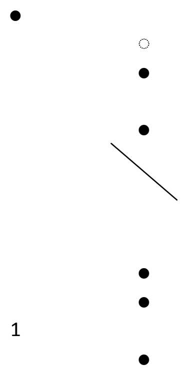


G2 No.14

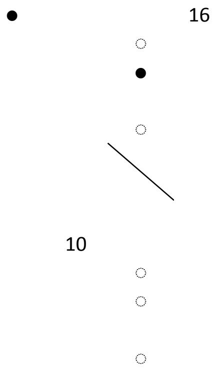


Standard fingering pattern

G𝄲2 No.15

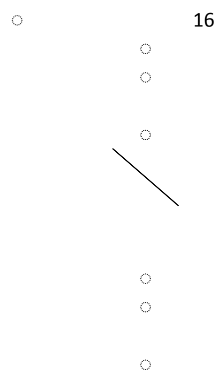


G♯2 No.16



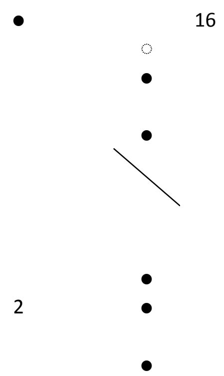
Appendix D − 31-tone scale version 1

A♭2 No.17

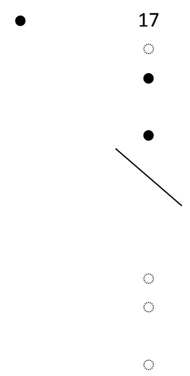


Standard fingering pattern

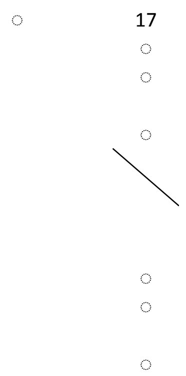
A𝄳2 No.18



A2 No.19



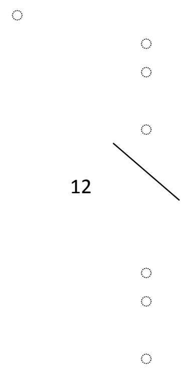
A𝄲2 No.20



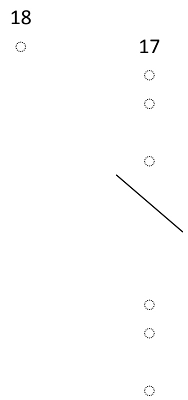
Standard fingering pattern for A2

Appendix D − 31-tone scale version 1

A♯2 No.21

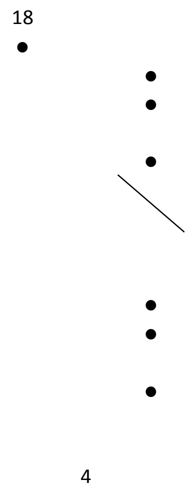


B♭2 No.22

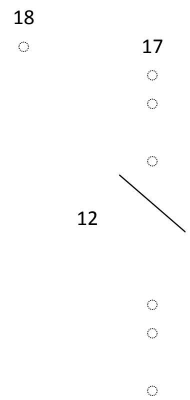


Standard fingering pattern

B𝄳2 No.23

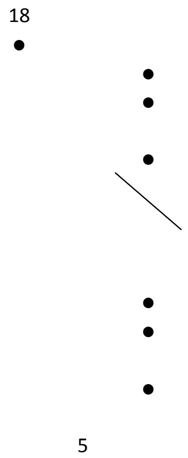


B2 No.24



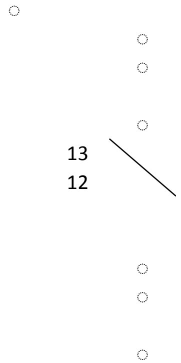
Appendix D − 31-tone scale version 1

B𝄲2 No.25

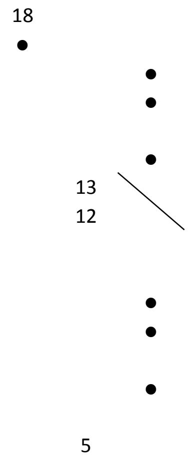


Standard fingering pattern for B𝄲2

C𝄳3 No.26

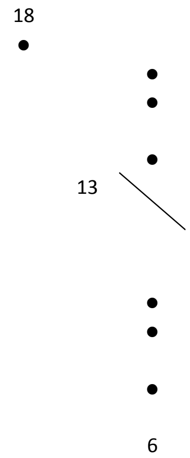


C3 No.27



Keys 12 and 13 are operated by the RH thumb

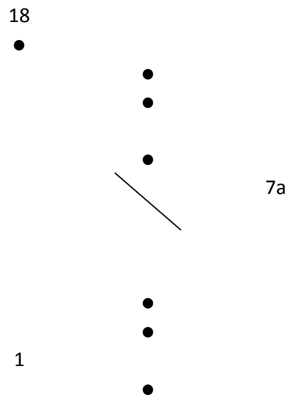
C𝄲3 No.28



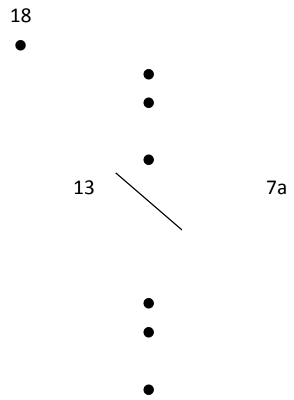
Key 13 is operated by the RH thumb

Appendix D − 31-tone scale version 1

C♯3 No.29

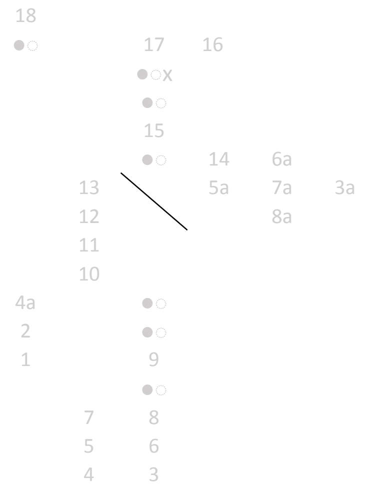


D♭3 No.30



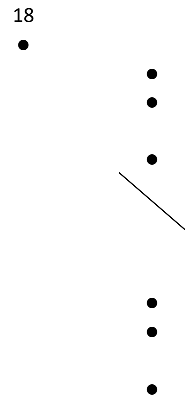
Key 13 is operated by the RH thumb

D𝄳3 No.31



No suitable fingering pattern could be found for this pitch

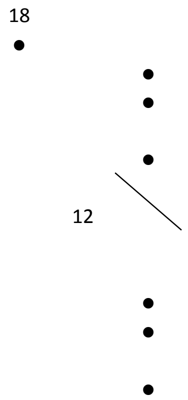
D3 No.32



Standard fingering pattern

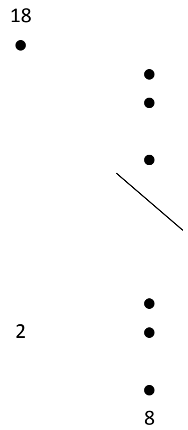
Appendix D − 31-tone scale version 1

D𝄲3 No.33



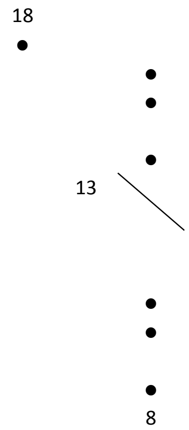
Key 12 is operated by the RH thumb

D♯3 No.34



A legato sequence from D𝄲3 is not possible

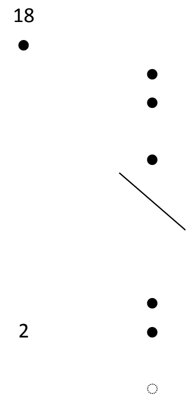
E♭3 No.35



Key 13 is operated by the RH thumb

A legato sequence from D♯3 or to E𝄳3 is not possible

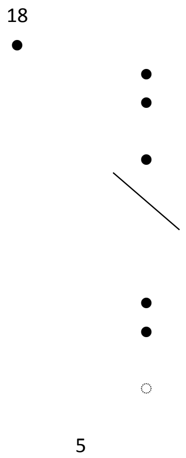
E𝄳3 No.36



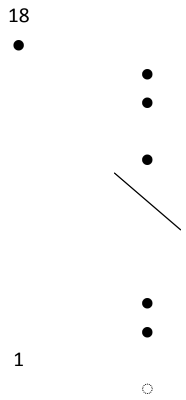
A legato sequence from E♭3 is not possible

Appendix D − 31-tone scale version 1

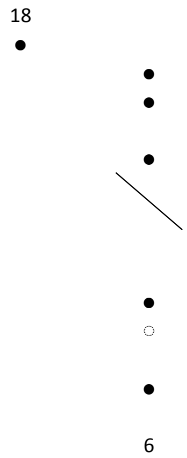
E3 No.37



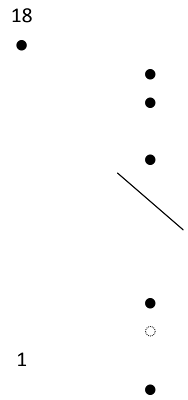
E𝄲3 No.38



F𝄳3 No.39

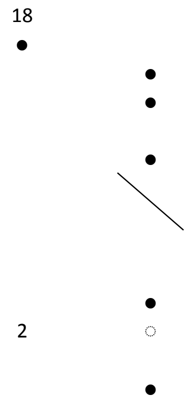


F3 No.40

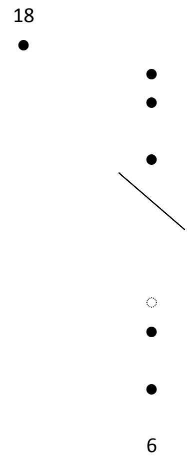


Appendix D − 31-tone scale version 1

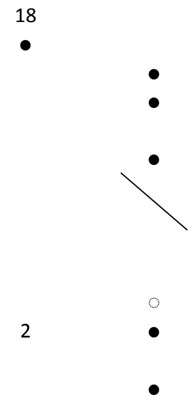
F𝄲3 No.41



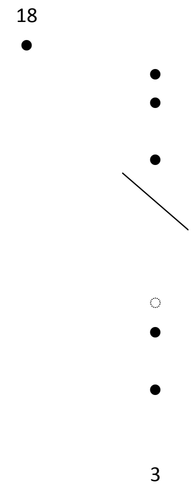
F♯3 No.42



G♭3 No.43

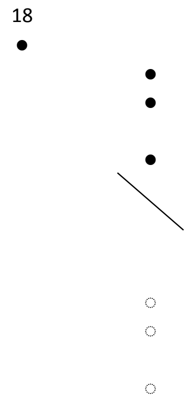


G𝄳3 No.44



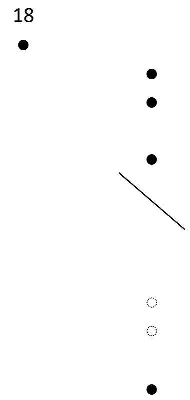
Appendix D − 31-tone scale version 1

G3 No.45

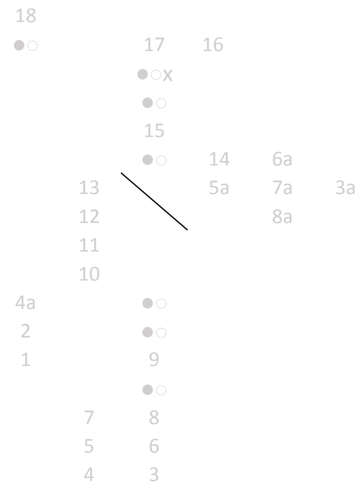


Standard fingering pattern

G𝄲3 No.46

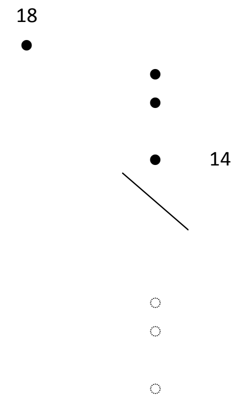


G♯3 No.47



No suitable fingering pattern could be found for this pitch

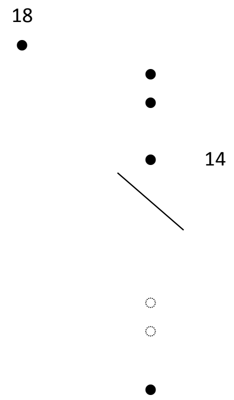
A♭3 No.48



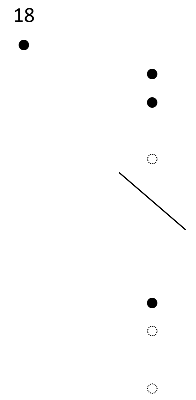
Standard fingering pattern

Appendix D − 31-tone scale version 1

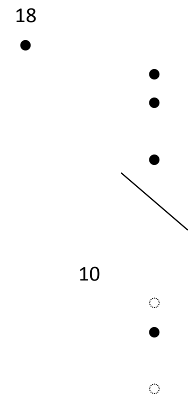
A𝄳3 No.49



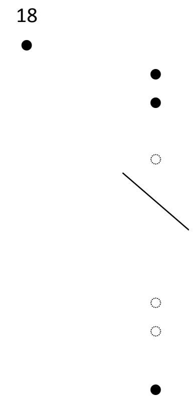
A3 No.50



A𝄲3 No.51

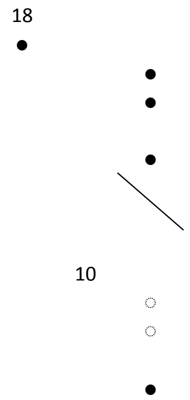


A♯3 No.52

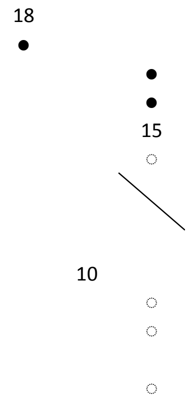


Appendix D − 31-tone scale version 1

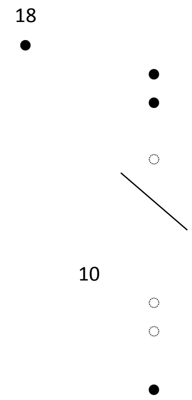
B♭3 No.53



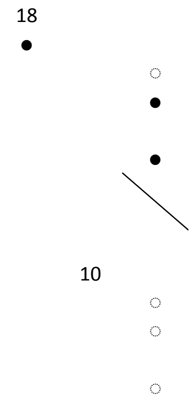
B𝄳3 No.54



B3 No.55

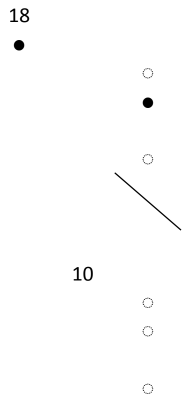


B𝄲3 No.56

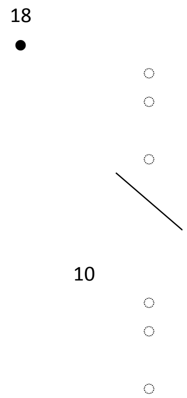


Appendix D − 31-tone scale version 1

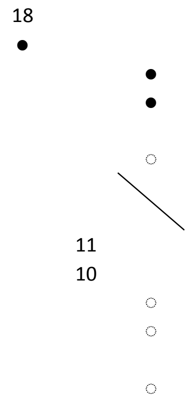
C𝄳4 No.57



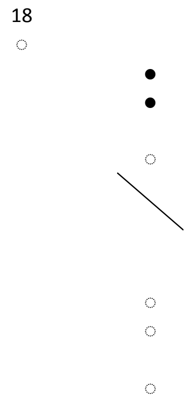
C4 No.58



C𝄲4 No.59

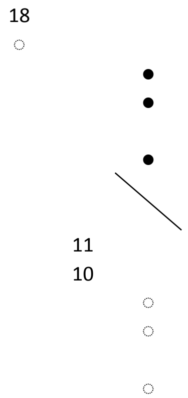


C♯4 No.60

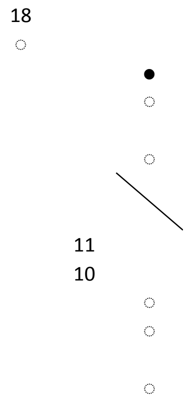


Appendix D − 31-tone scale version 1

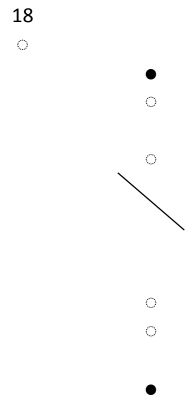
D♭4 No.61



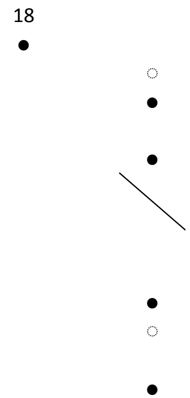
D𝄳4 No.62



D4 No.63

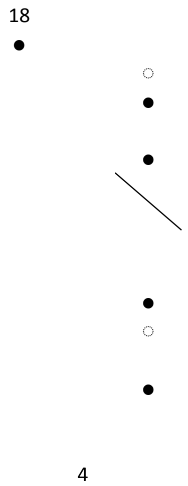


D𝄲4 No.64

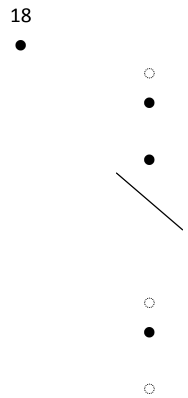


Appendix D − 31-tone scale version 1

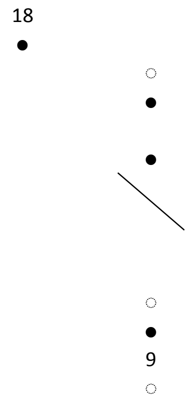
D♯4 No.65



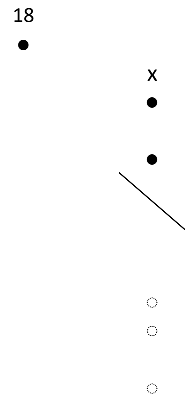
E♭4 No.66



E𝄳4 No.67



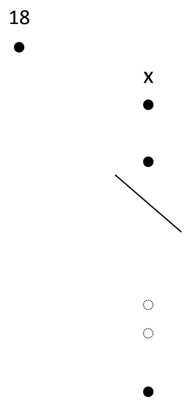
E4 No.68



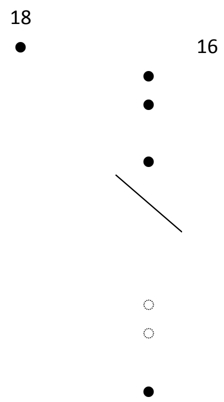
Standard fingering pattern

Appendix D − 31-tone scale version 1

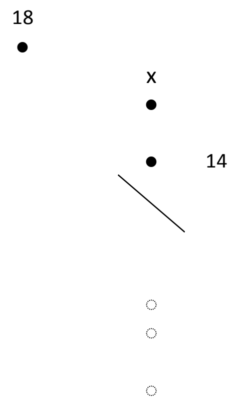
E𝄲4 No.69



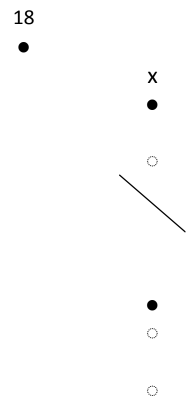
F𝄳4 No.70



F4 No.71

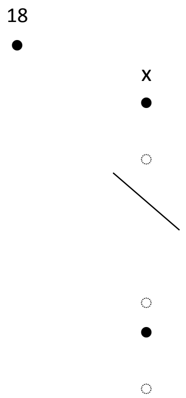


F𝄲4 No.72

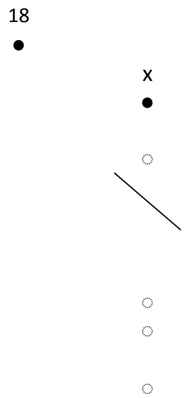


Appendix D − 31-tone scale version 1

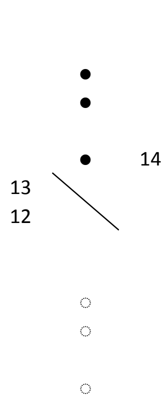
F♯4 No.73



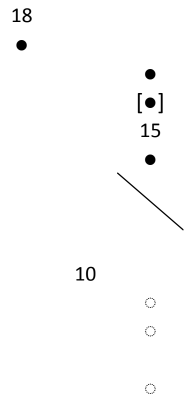
G♭4 No.74



G𝄳4 No.75

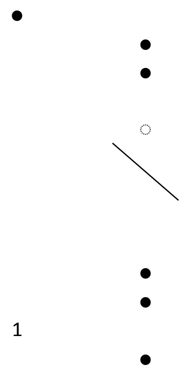


G4 No.76

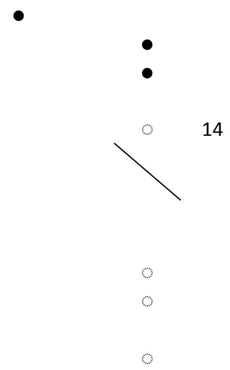


Appendix E − 31-tone scale version 2

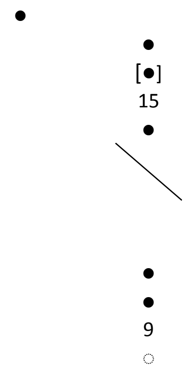
D2 No.1



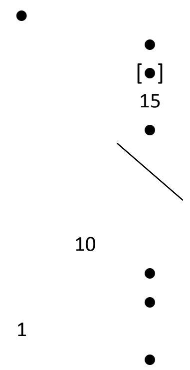
D𝄲2 No.2



D♯2 No.3



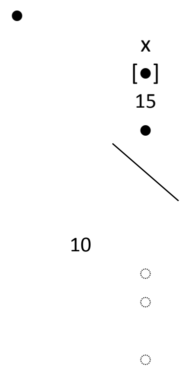
E♭2 No.4



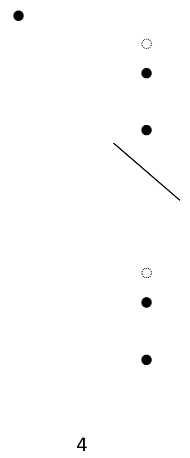
Key 10 is operated by the RH thumb

Appendix E − 31-tone scale version 2

E𝄳2 No.5

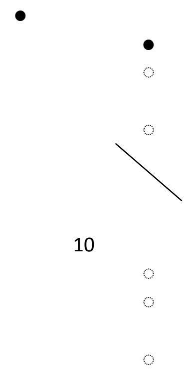


E2 No.6

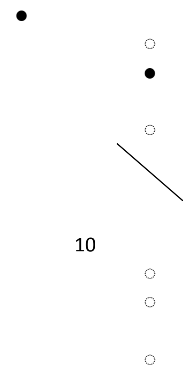


Poor sound quality

E𝄲2 No.7

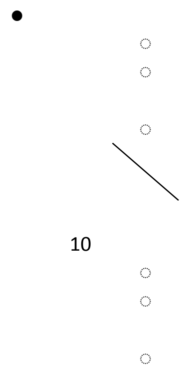


F𝄳2 No.8

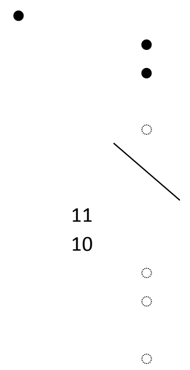


Appendix E − 31-tone scale version 2

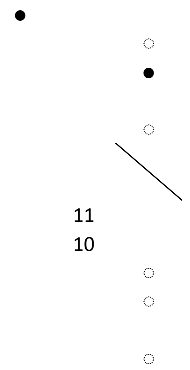
F2 No.9



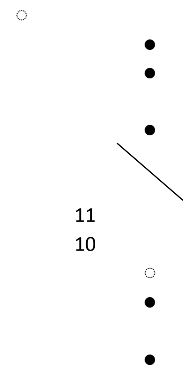
F♮2 No.10



F♯2 No.11

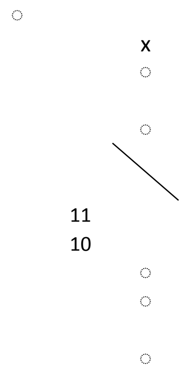


G♭2 No.12

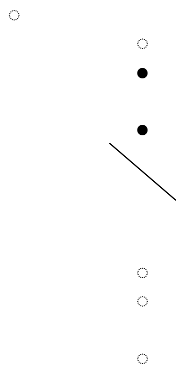


Appendix E − 31-tone scale version 2

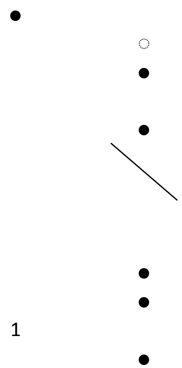
G𝄳2 No.13



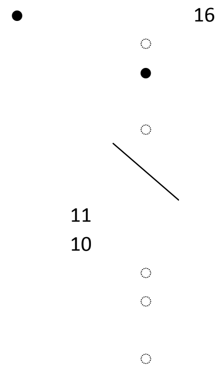
G2 No.14



G𝄲2 No.15

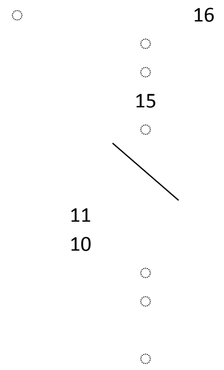


G♯2 No.16

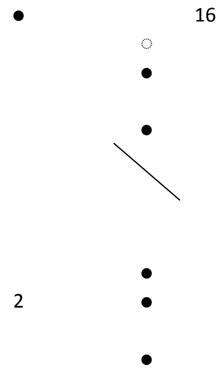


Appendix E − 31-tone scale version 2

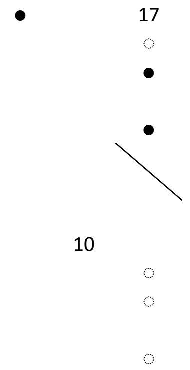
A♭2 No.17



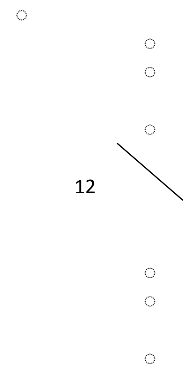
A𝄳2 No.18



A2 No.19

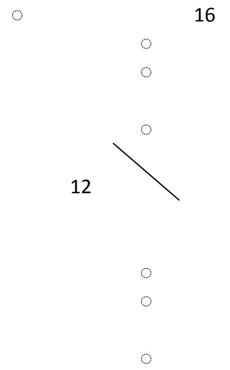


A𝄲2 No.20

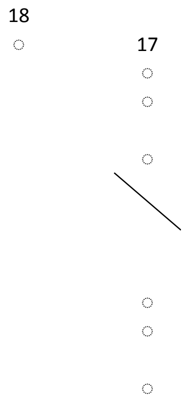


Appendix E − 31-tone scale version 2

A♯2 No.21

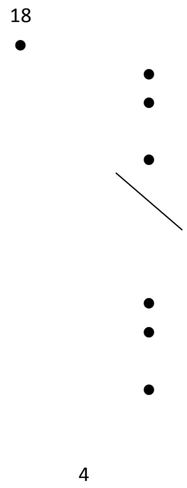


B♭2 No.22

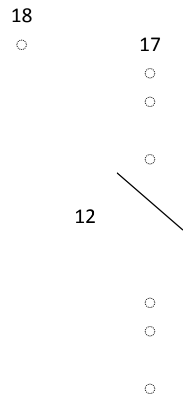


Standard fingering pattern

B𝄳2 No.23

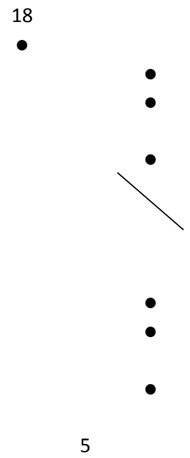


B2 No.24



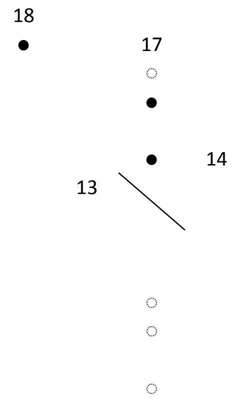
Appendix E − 31-tone scale version 2

B𝄲2 No.25



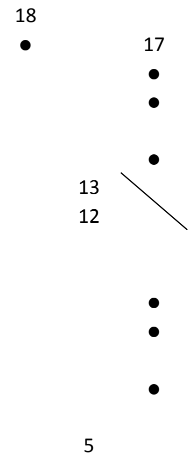
Standard fingering pattern for B𝄲2: B𝄲2 is sharp on most bass clarinets

C𝄳3 No.26



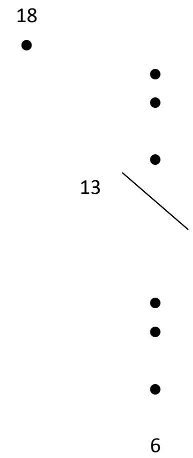
A legato sequence to C3 is not possible

C3 No.27



A legato sequence to C𝄲3 is not possible

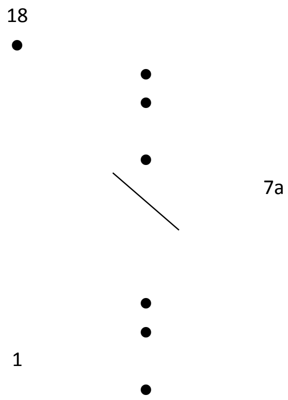
C𝄲3 No.28



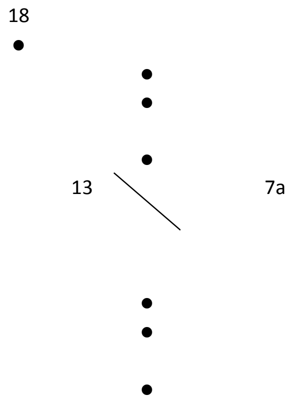
A legato sequence from C3 is not possible

Appendix E − 31-tone scale version 2

C♯3 No.29

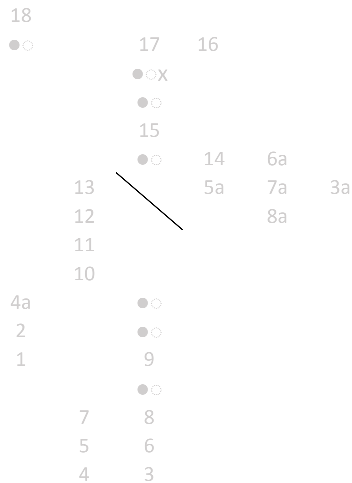


D♭3 No.30



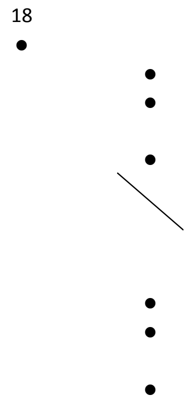
Key 13 is operated by the RH thumb

D𝄳3 No.31



No fingering pattern fulfilled the research criteria

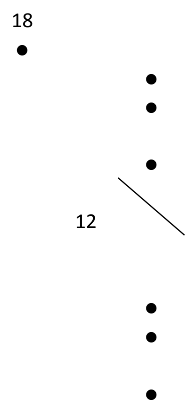
D3 No.32



Standard fingering pattern

Appendix E − 31-tone scale version 2

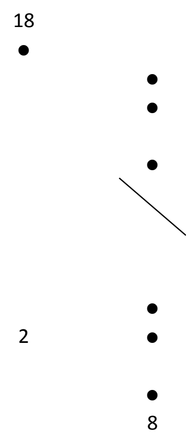
D𝄲3 No.33



Key 12 is operated by the RH thumb

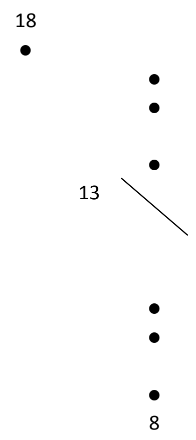
A legato sequence to D♯3 is not possible

D♯3 No.34



A legato sequence from D𝄲3 is not possible

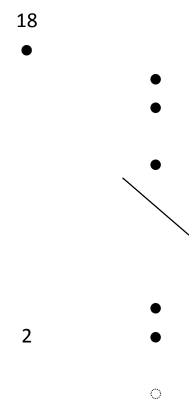
E♭3 No.35



Key 13 is operated by the RH thumb

A legato sequence from D♯3 or to E𝄳3 is not possible

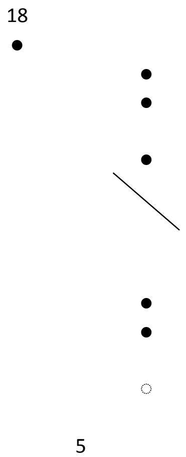
E𝄳3 No.36



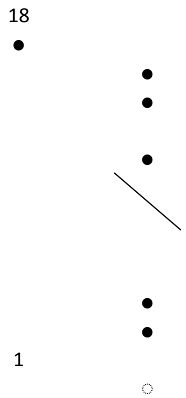
A legato sequence from E♭3 is not possible

Appendix E − 31-tone scale version 2

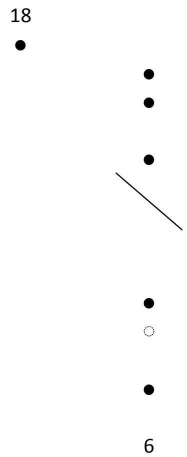
E3 No.37



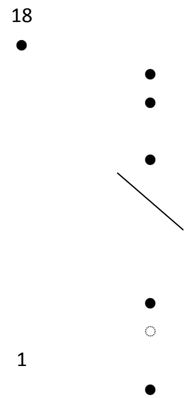
E𝄲3 No.38



F𝄳3 No.39

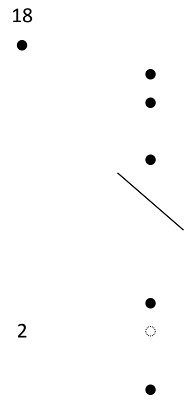


F3 No.40

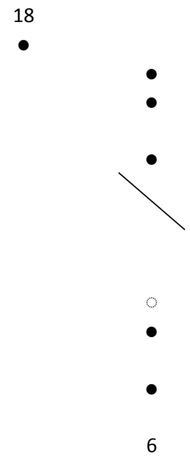


Appendix E − 31-tone scale version 2

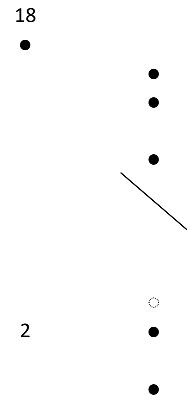
F𝄲3 No.41



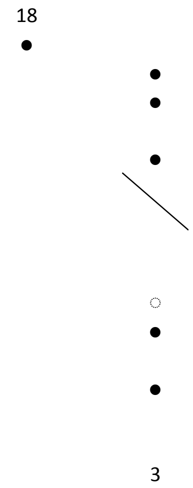
F♯3 No.42



G♭3 No.43

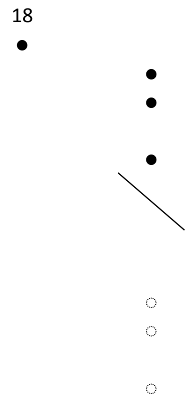


G𝄳3 No.44



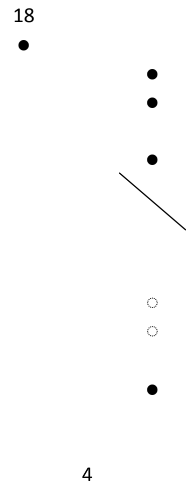
Appendix E − 31-tone scale version 2

G3 No.45

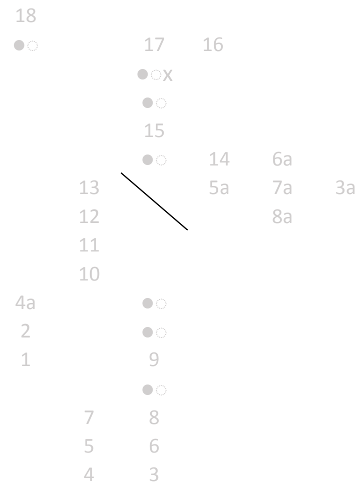


Standard fingering pattern

G𝄲3 No.46

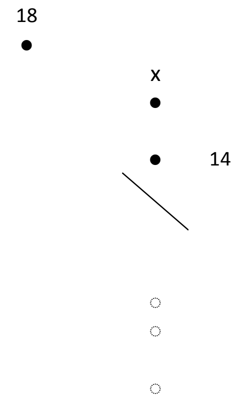


G♯3 No.47



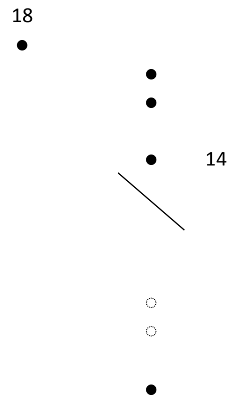
No fingering pattern fulfilled the research criteria

A♭3 No.48

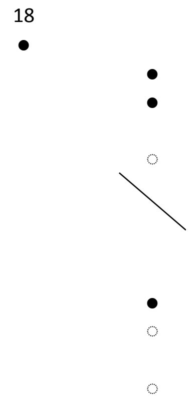


Appendix E − 31-tone scale version 2

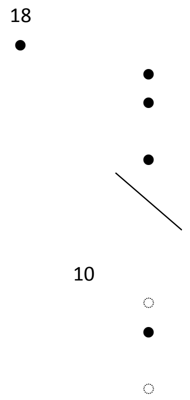
A𝄳3 No.49



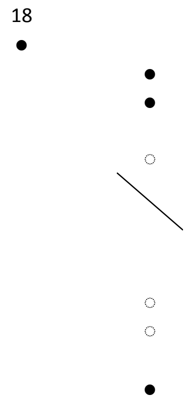
A3 No.50



A𝄲3 No.51

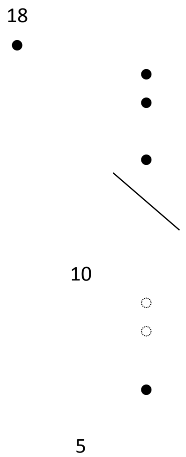


A♯3 No.52

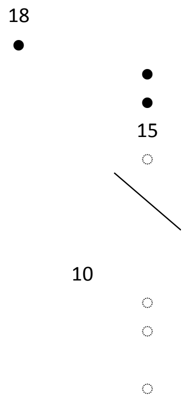


Appendix E − 31-tone scale version 2

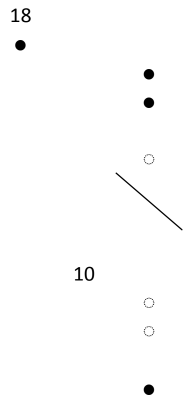
B♭3 No.53



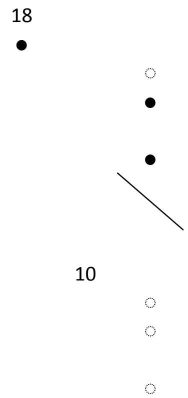
B𝄳3 No.54



B3 No.55

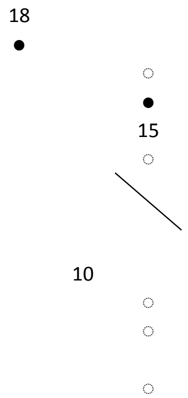


B𝄲3 No.56

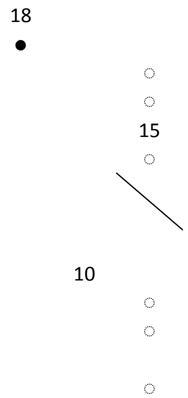


Appendix E − 31-tone scale version 2

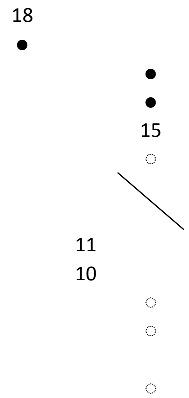
C𝄳4 No.57



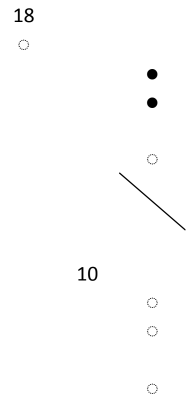
C4 No.58



C𝄲4 No.59

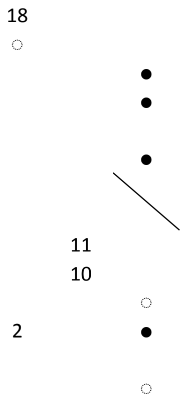


C♯4 No.60

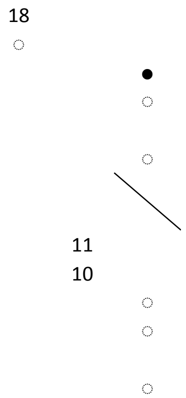


Appendix E − 31-tone scale version 2

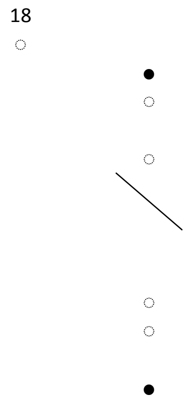
D♭4 No.61



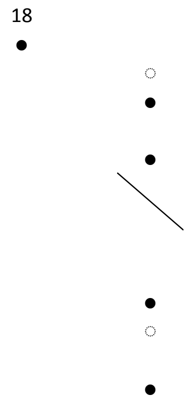
D𝄳4 No.62



D4 No.63

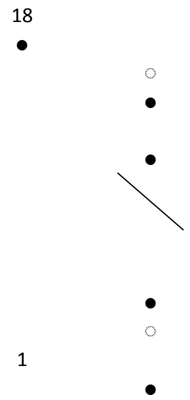


D𝄲4 No.64

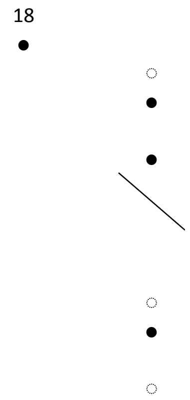


Appendix E − 31-tone scale version 2

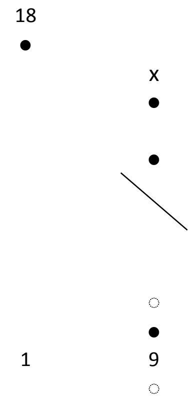
D♯4 No.65



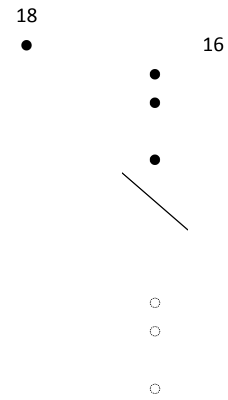
E♭4 No.66



E𝄳4 No.67

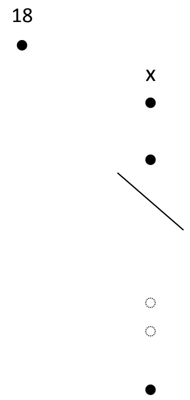


E4 No.68

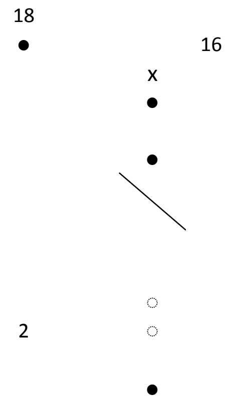


Appendix E − 31-tone scale version 2

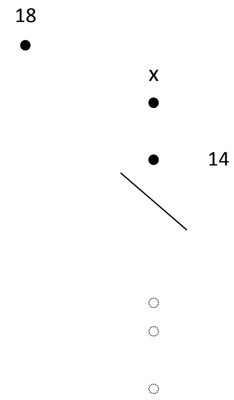
E𝄲4 No.69



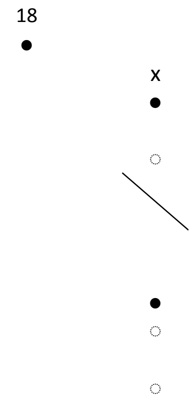
F𝄳4 No.70



F4 No.71

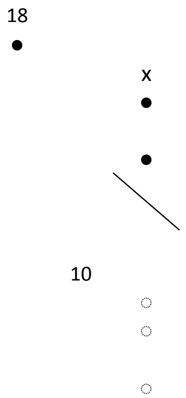


F𝄲4 No.72



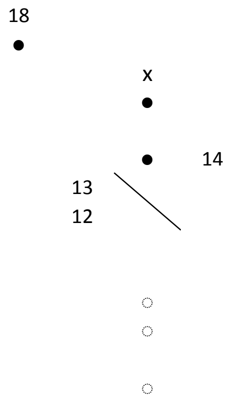
Appendix E − 31-tone scale version 2

F♯4 No.73



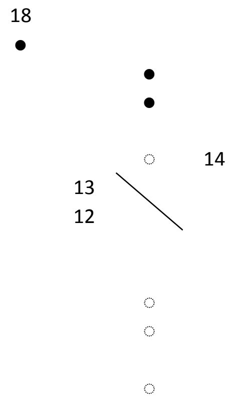
For a legato sequence to G♭4 keys 12 and 13 have to be operated by the RH thumb

G♭4 No.74



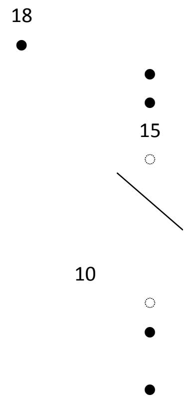
For a legato sequence to F♯4 keys 12 and 13 have to be operated by the RH thumb

G𝄳4 No.75



For a legato sequence to G4 keys 12 and 13 have to be operated by the RH thumb

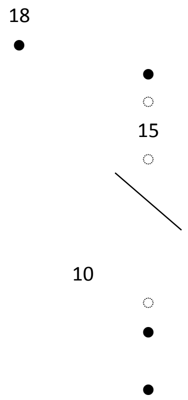
G4 No.76



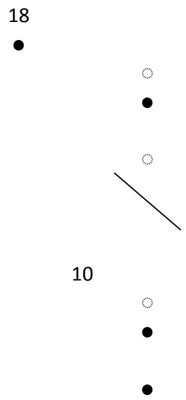
For a legato sequence to G𝄳4 keys 12 and 13 have to be operated by the RH thumb

Appendix E − 31-tone scale version 2

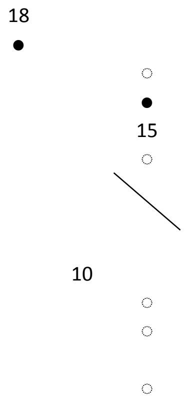
G𝄲4 No.77



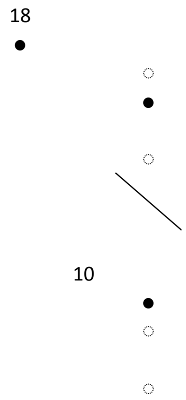
G♯4 No.78



A♭4 No.79



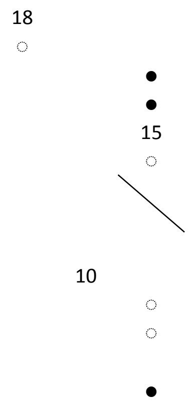
A𝄳4 No.80



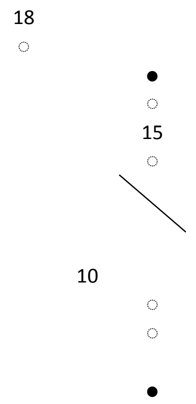
Key 10 can be operated by the RH thumb

Appendix E − 31-tone scale version 2

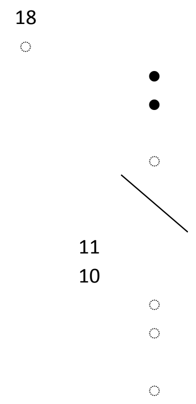
A4 No.81



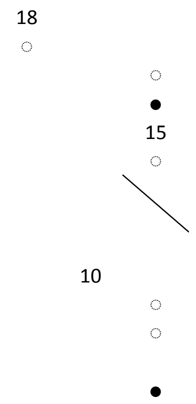
A♯4 No.82



A♯4 No.83

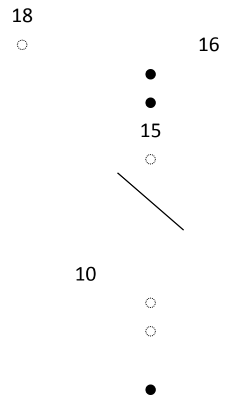


B♭4 No.84

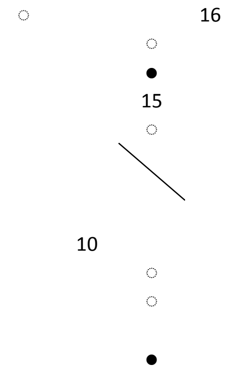


Appendix E − 31-tone scale version 2

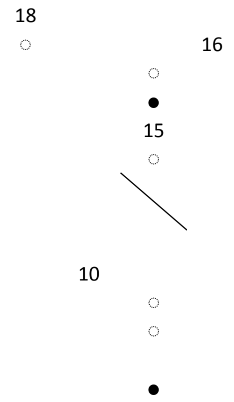
B𝄳4 No.85



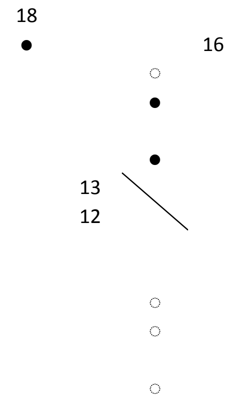
B4 No.86



B𝄲4 No.87

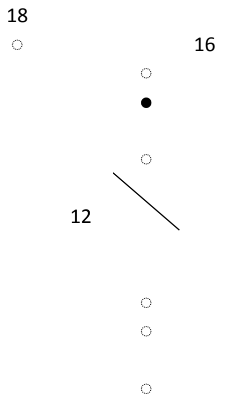


C𝄳5 No.88

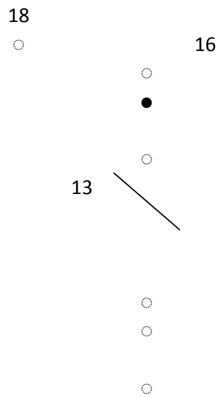


Appendix E − 31-tone scale version 2

C5 No.89

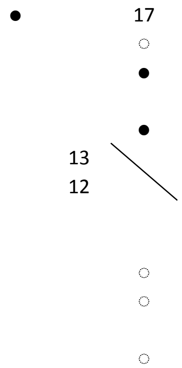


C♮5 No.90

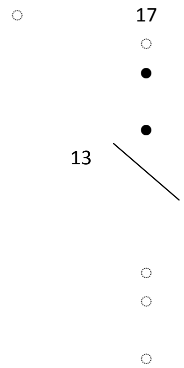


Key 13 should be operated by the RH thumb when a legato sequence from C5 is required

C♯5 No.91

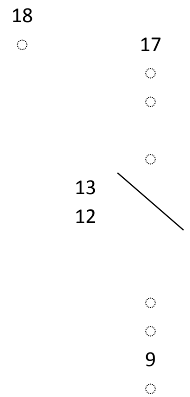


D♭5 No.92

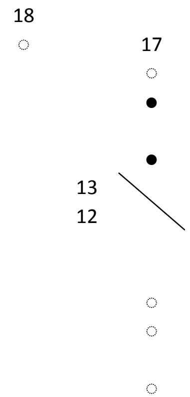


Appendix E − 31-tone scale version 2

D𝄳5 No.93

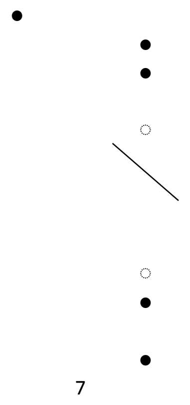


D5 No.94

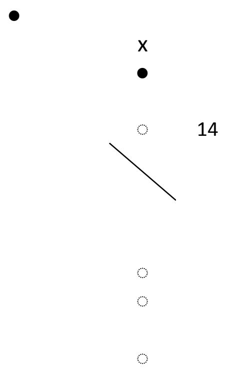


Appendix F − 31-tone scale definitive version

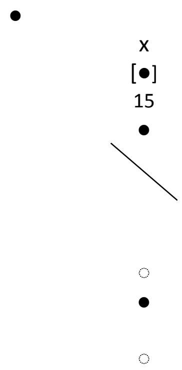
D2 No.1



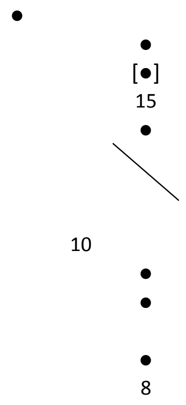
D𝄲2 No.2



D♯2 No.3



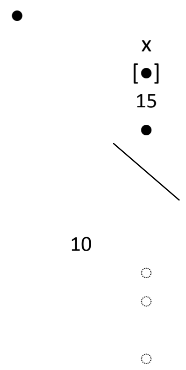
E♭2 No.4



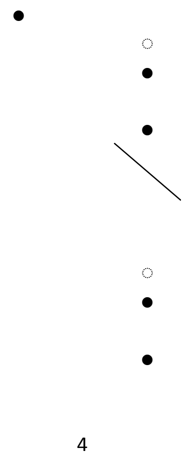
Key 10 can be operated by the RH thumb

Appendix F − 31-tone scale definitive version

E𝄳2 No.5

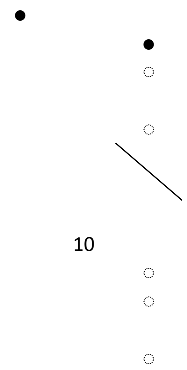


E2 No.6

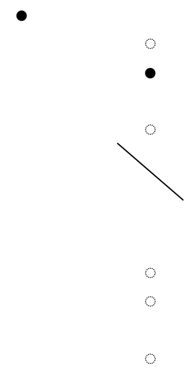


Poor sound quality

E𝄲2 No.7

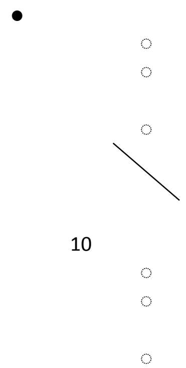


F𝄳2 No.8

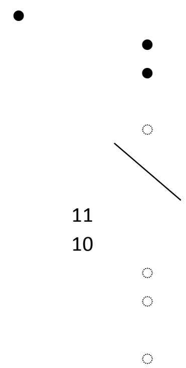


Appendix F − 31-tone scale definitive version

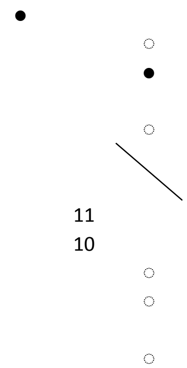
F2 No.9



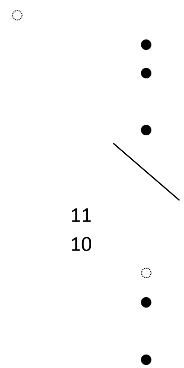
F♯2 No.10



F♯2 No.11

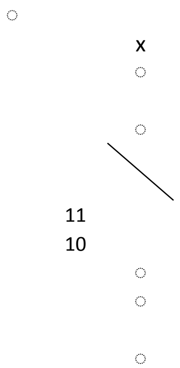


G♭2 No.12

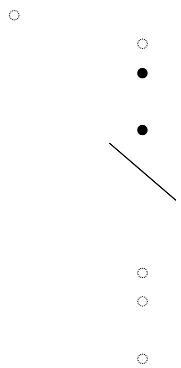


Appendix F − 31-tone scale definitive version

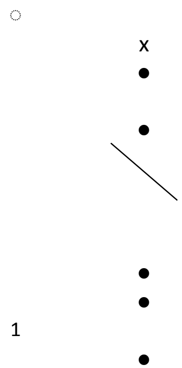
G𝄳2 No.13



G2 No.14

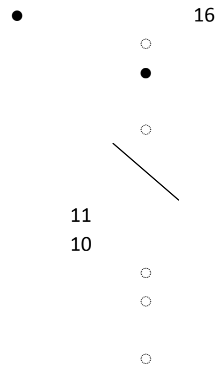


G𝄲2 No.15



LHK1 can be either half-open (x) or closed

G♯2 No.16



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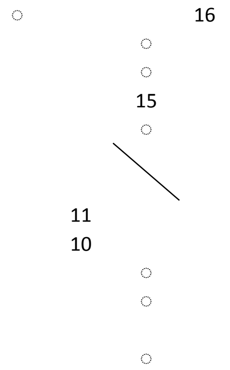
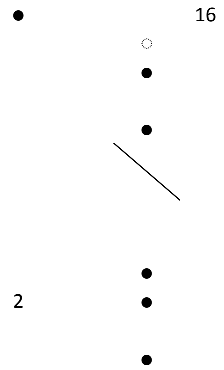
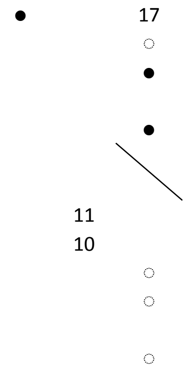
A♭2 No.17



A𝄳2 No.18

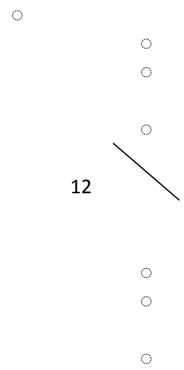


A2 No.19



For a legato sequence to A𝄲2 key 12 has to be operated by the RH thumb

A𝄲2 No.20



For a legato sequence to A2 key 12 has to be operated by the RH thumb

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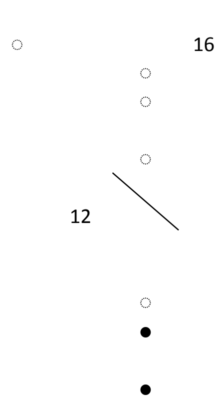
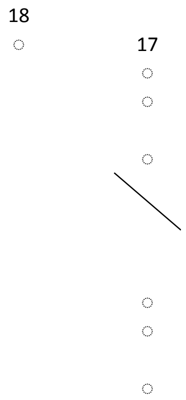
A♯2 No.21

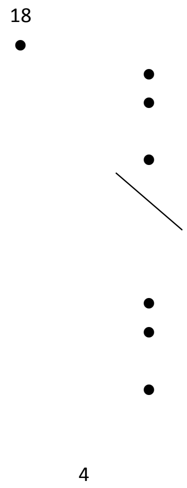


B♭2 No.22



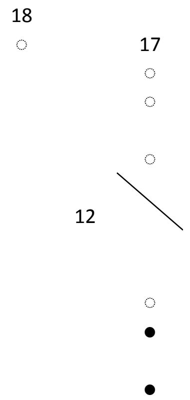
Standard fingering pattern

B𝄳2 No.23



For a legato sequence to B2 key 12 has to be operated by the RH thumb

B2 No.24



For a legato sequence to B𝄳2 key 12 has to be operated by the RH thumb

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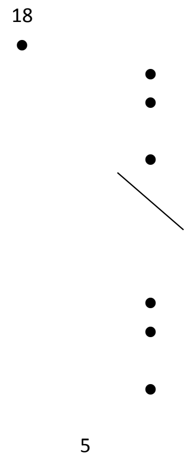
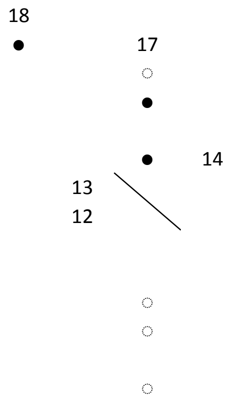
B𝄲2 No.25



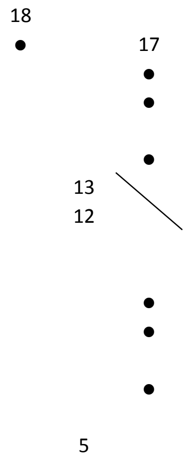
Standard fingering pattern for B♮2

C𝄳3 No.26



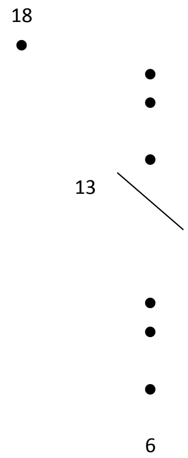
A legato sequence to C3 is only possible when keys 12 and 13 are operated by the RH thumb

C3 No.27



A legato sequence to C𝄲3 is not possible

C𝄲3 No.28



A legato sequence from C3 is not possible

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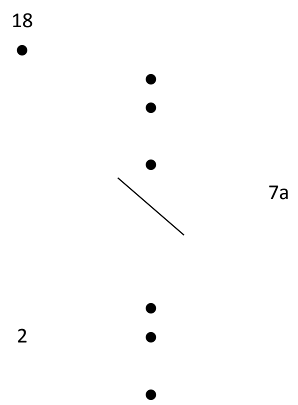
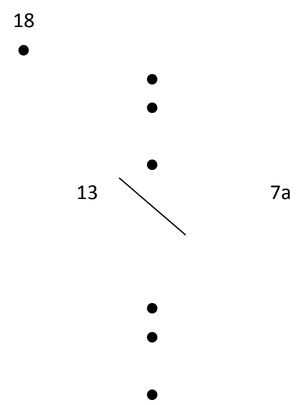
C♯3 No.29



A legato sequence to D♭3 is not possible

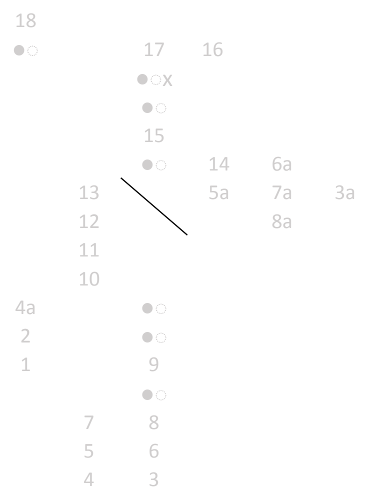
D♭3 No.30



Key 13 is operated by the RH thumb

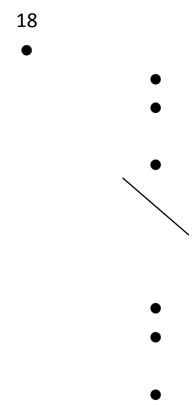
A legato sequence to C♯3 is not possible

D𝄳3 No.31



No fingering pattern fulfilled the research criteria

D3 No.32



Standard fingering pattern

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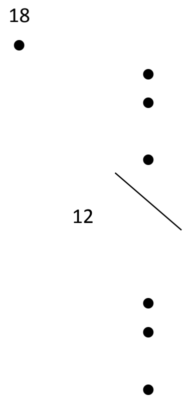
D𝄲3 No.33

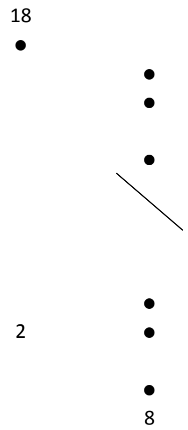


Key 12 is operated by the RH thumb

A legato sequence to D♯3 is not possible

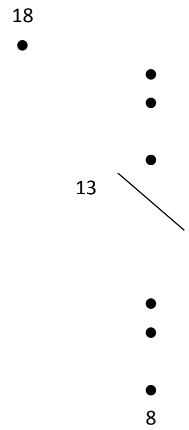
Very unstable

D♯3 No.34



A legato sequence from D𝄲3 is not possible

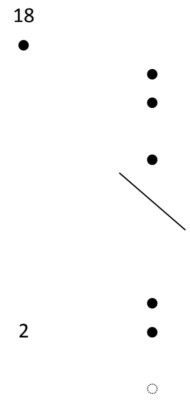
E♭3 No.35



Key 13 is operated by the RH thumb

A legato sequence from D♯3 or to E𝄳3 is not possible

E𝄳3 No.36



A legato sequence from E♭3 is not possible

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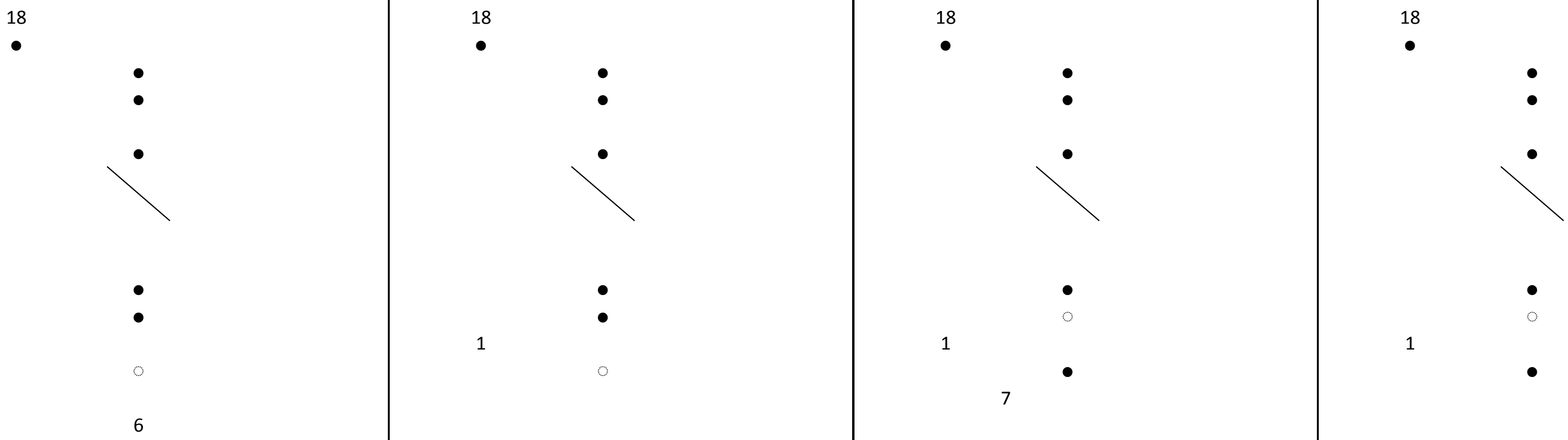
E3 No.37

E𝄲3 No.38

F𝄳3 No.39

F3 No.40



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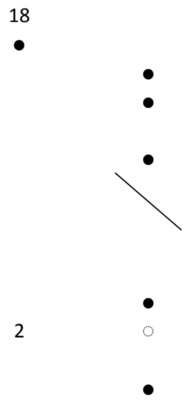
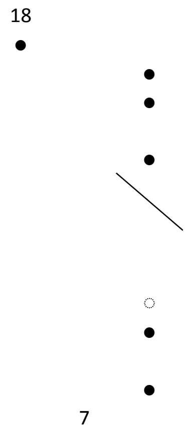
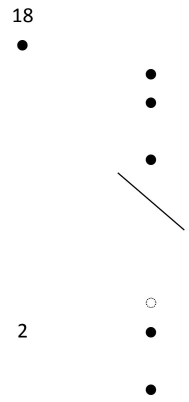
F𝄲3 No.41



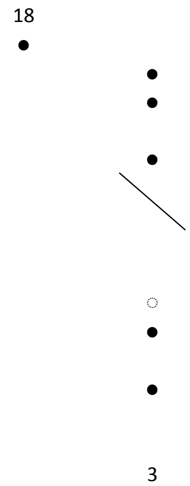
F♯3 No.42



G♭3 No.43



G𝄳3 No.44



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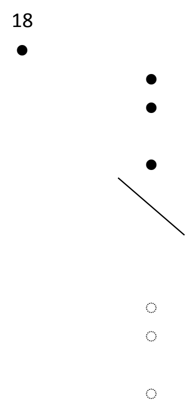
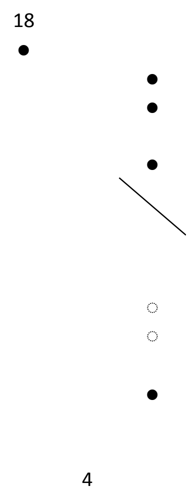
G3 No.45

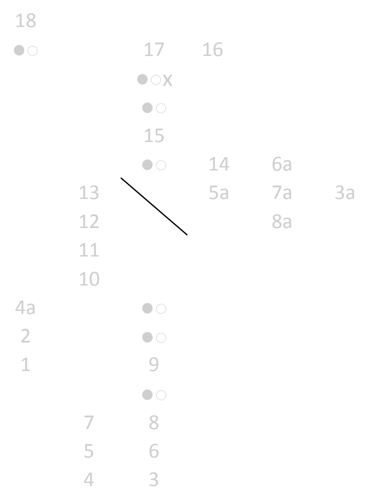


Standard fingering pattern

G𝄲3 No.46

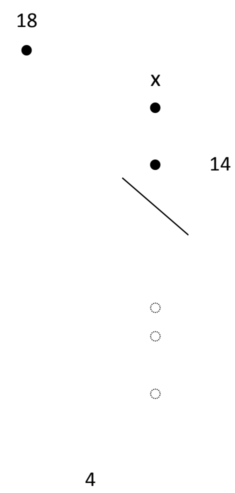


G♯3 No.47



No fingering pattern fulfilled the research criteria

A♭3 No.48



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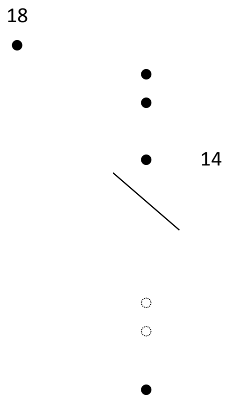
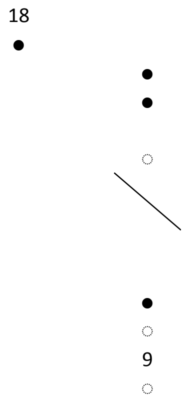
A𝄳3 No.49

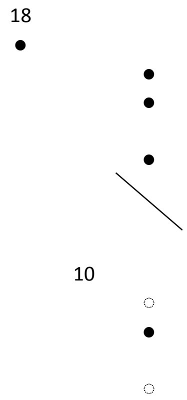


For a legato sequence to A3 RHK3 has to be operated by the RH little finger

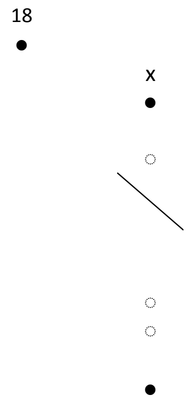
A3 No.50



A𝄲3 No.51



A♯3 No.52



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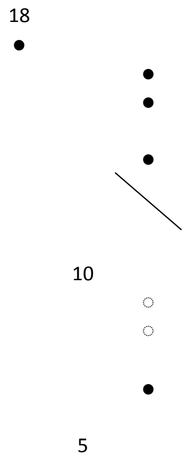
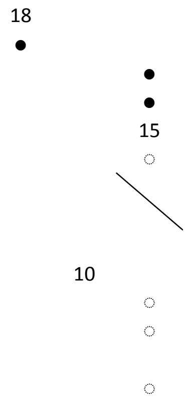
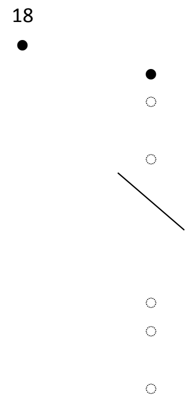
B♭3 No.53



B𝄳3 No.54

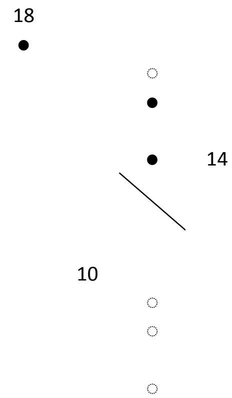


B3 No.55



Standard fingering pattern

B𝄲3 No.56



For a legato sequence to C𝄳4 LHK2 has to be operated by the LH index finger

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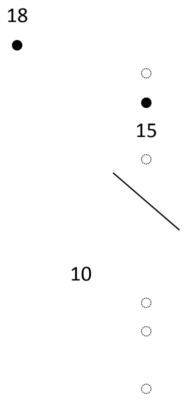
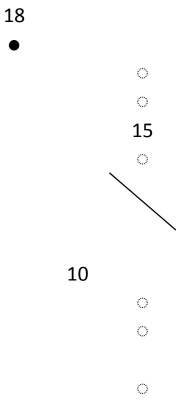
C𝄳4 No.57



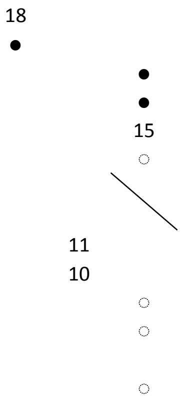
For a legato sequence to B𝄲3 LHK2 has to be operated by the LH index finger

C4 No.58



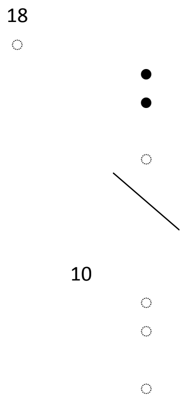
For a legato sequence to C𝄲4 key 11 has to be operated by the RH thumb

C𝄲4 No.59



For a legato sequence to C4 key 11 has to be operated by the RH thumb

C♯4 No.60



A legato sequence to D♭4 is not possible

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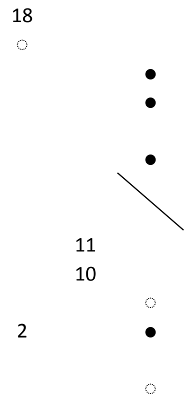
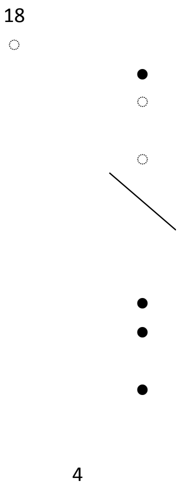
D♭4 No.61



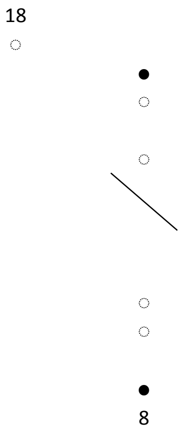
A legato sequence to C♯4 or to D𝄳4 is not possible

D𝄳4 No.62

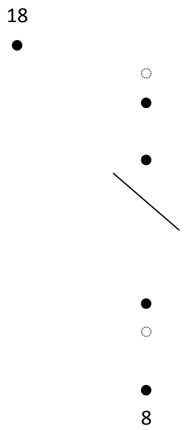


A legato sequence to D♭4 is not possible

D4 No.63



D𝄲4 No.64



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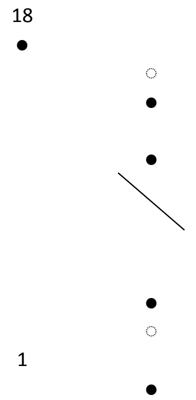
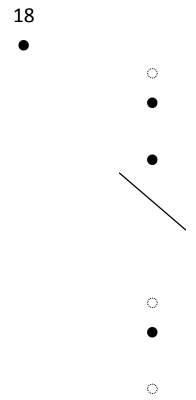
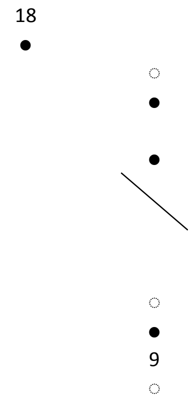
D♯4 No.65



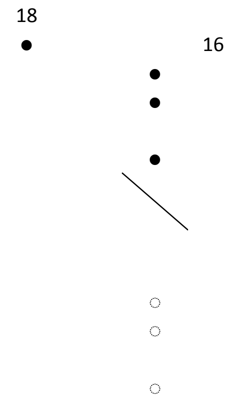
E♭4 No.66



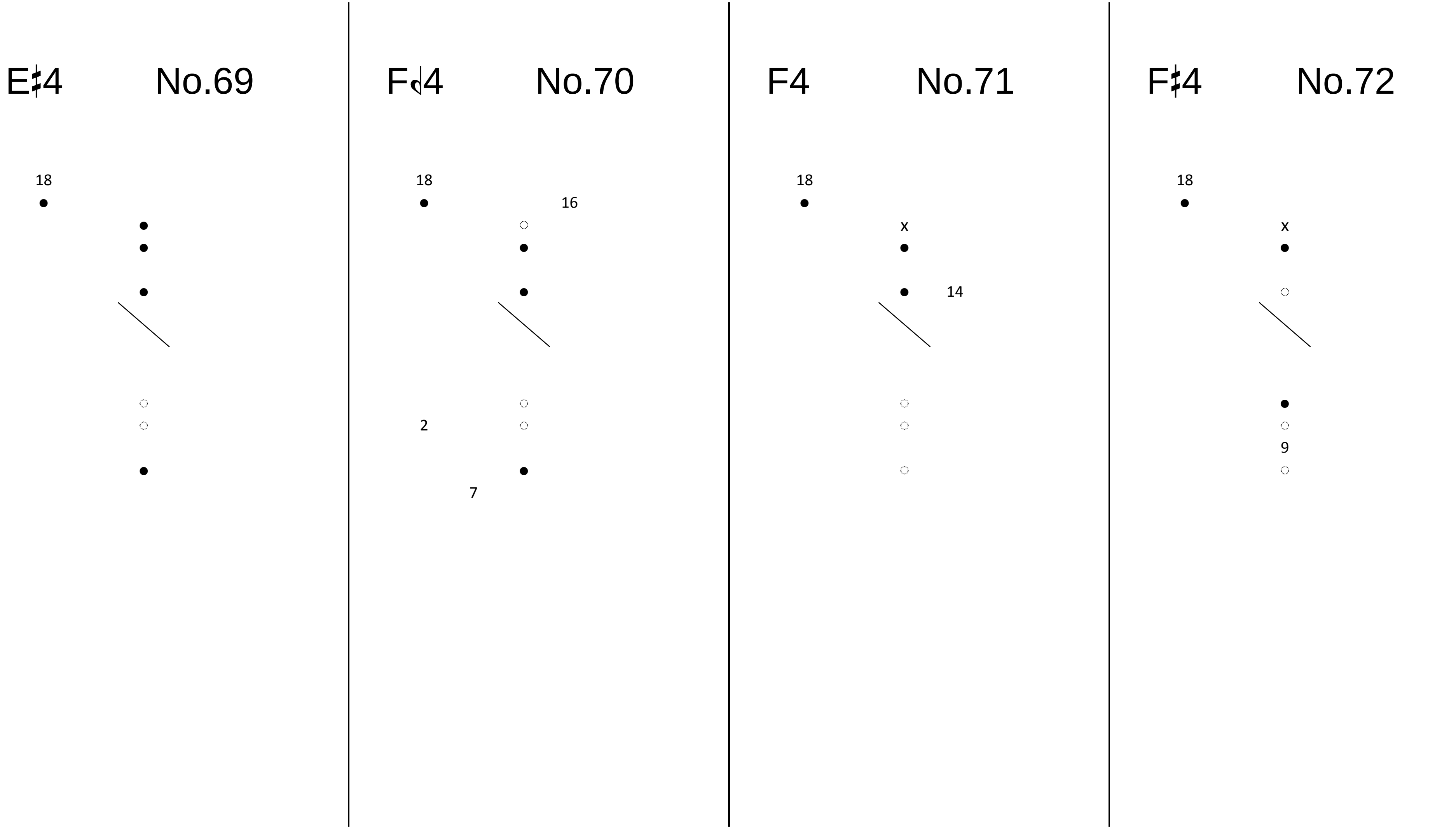
E𝄳4 No.67



E4 No.68



Appendix F − 31-tone scale definitive version



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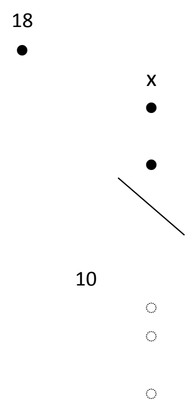
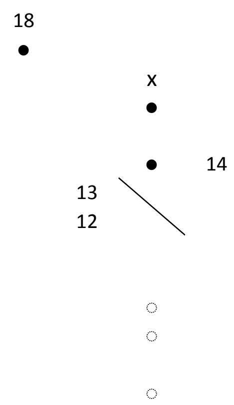
F♯4 No.73



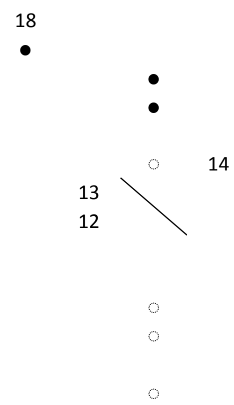
For a legato sequence to G♭4 keys 12 and 13 have to be operated by the RH thumb

G♭4 No.74



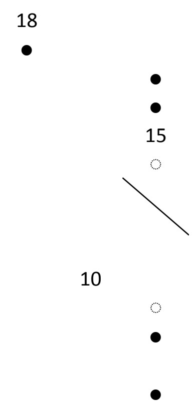
For a legato sequence to F♯4 keys 12 and 13 have to be operated by the RH thumb

G𝄳4 No.75



For a legato sequence to G4 keys 12 and 13 have to be operated by the RH thumb

G4 No.76



For a legato sequence to G𝄳4 keys 12 and 13 have to be operated by the RH thumb

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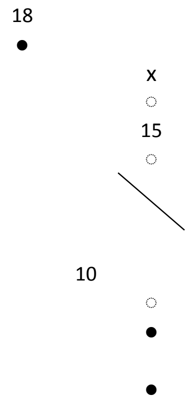
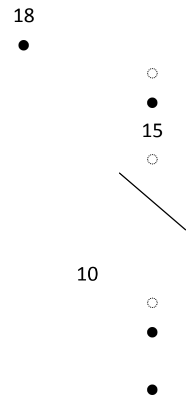
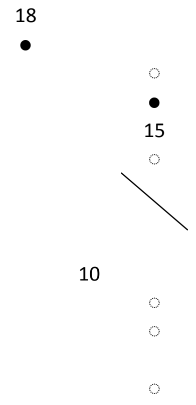
G𝄲4 No.77



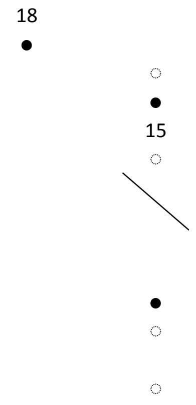
G♯4 No.78



A♭4 No.79



A𝄳4 No.80



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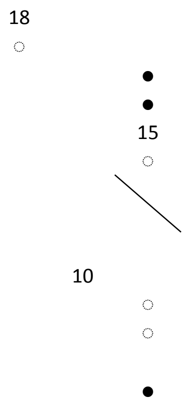
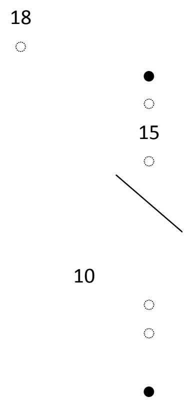
A4 No.81

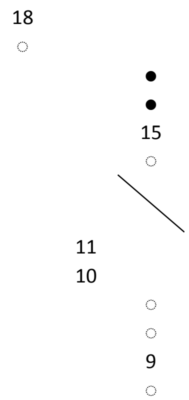


A♯4 No.82



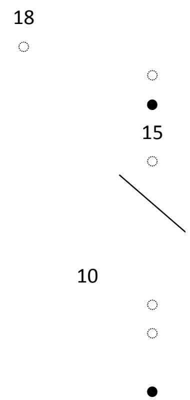
For a legato sequence to A♯4 key 11 has to be operated by the RH thumb and key 9 by the RH middle finger

A♯4 No.83



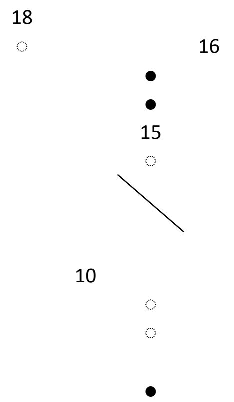
For a legato sequence to A♯4 key 11 has to be operated by the RH thumb and key 9 by the RH middle finger

B♭4 No.84

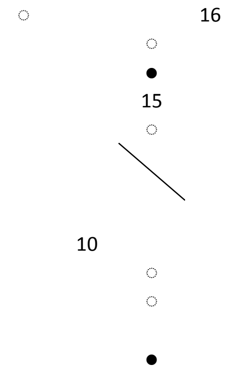


Appendix F − 31-tone scale definitive version

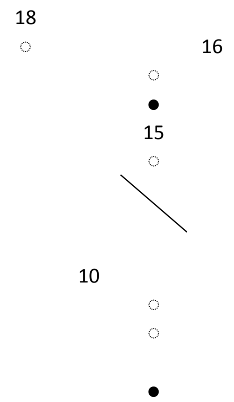
B𝄳4 No.85



B4 No.86

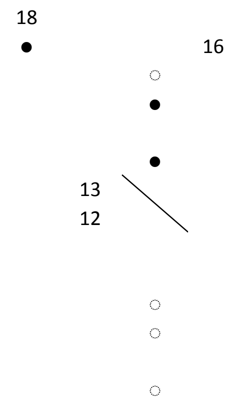


B𝄲4 No.87



A legato sequence to C𝄳5 is not possible

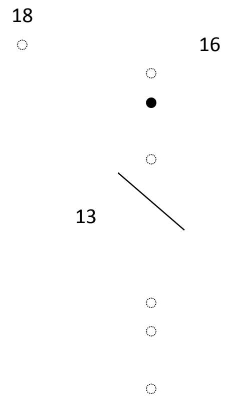
C𝄳5 No.88



A legato sequence to B𝄲4 is not possible

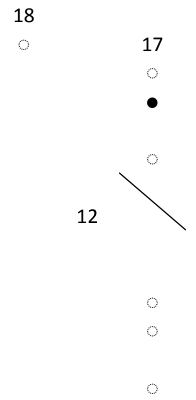
Appendix F − 31-tone scale definitive version

C5 No.89



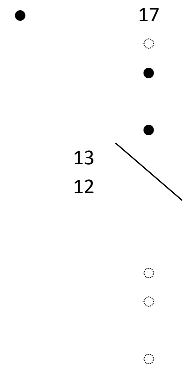
For a legato sequence to C𝄲5 or C♯5, key 12 has to be operated by the RH index finger and key 13 by the RH thumb

C𝄲5 No.90



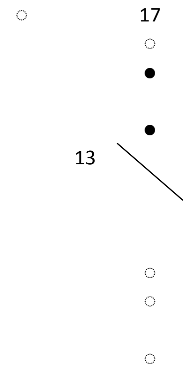
For a legato sequence to C5, C♯5, or D♭5, key 12 has to be operated by the RH index finger and key 13 by the RH thumb

C♯5 No.91



For a legato sequence to C5, C𝄲5, or D♭5, key 12 has to be operated by the RH index finger and key 13 by the RH thumb

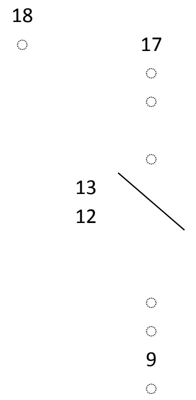
D♭5 No.92



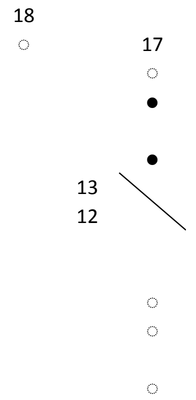
For a legato sequence to C𝄲5, C♯5, key 12 has to be operated by the RH index finger and key 13 by the RH thumb

Appendix F − 31-tone scale definitive version

D𝄳5 No.93



D5 No.94



Appendix G1 − Overtone series pitch measurements

Overtone					
G♮5		-		-	
F♯5	+3		-	-34	+9
F♮5		+28	+14		-47
E♮5	+47			-39	
E♭5		+46	-43		
D♮5	+21			-49	+45
C♯5	-42	+17	-47		
C♮5					-17
B♮4	-49	-6		+37	
B♭4			+36		
A♮4	-47	+20			+10
G♯4				+49	
G♮4			+48		
F♯4		-9			-11
F♮4	+28			+12	
E♮4			+20		
E♭4		+4			
D♮4	+15				-31
C♯4				-9	
C♮4			-12		
B♮3		-23			
B♭3	-7				
A♮3					
G♯3					-13
G♮3				+12	
F♯3			+24		
F♮3		-16			
E♮3	+4				
E♭3					
D♮3					
C♯3					
C♮3					
B♮2					-3
B♭2				+23	
A♮2			+36		
G♯2		0			
G♮2	+16				
Root	C♮1	C♯1	D♮1	E♭1	E♮1

Appendix G1 − Overtone series pitch measurements

Overtone					
G♮5	-		-		-
F♯5		+39		+8	
F♮5	-16		+3		
E♮5		-4		-26	+40
E♭5	+10		-9		
D♮5		-12			-38
C♯5	+1			+13	
C♮5			+5		
B♮4		-10			-40
B♭4	+12			-17	
A♮4			-3		
G♯4		-7			
G♮4	-28				-49
F♯4				-24	
F♮4			-26		
E♮4		-21			
E♭4	-17				
D♮4					
C♯4					-6
C♮4				+2	
B♮3			+1		
B♭3		0			
A♮3	-11				
G♯3					
G♮3					
F♯3					
F♮3					
E♮3					-7
E♭3				-1	
D♮3			+6		
C♯3		+7			
C♮3	+4				
B♮2					
B♭2					
A♮2					
G♯2					
G♮2					
Root	F♮1	F♯1	G♮1	G♯1	A♮1

Appendix G1 − Overtone series pitch measurements

Overtone					
G♮5					
F♯5	-31	-18			
F♮5			-41	-19	
E♮5					
E♭5	-37	+43			-27
D♮5				+17	
C♯5			+18		
C♮5		+6			
B♮4	+47				+26
B♭4				+42	
A♮4			+47		
G♯4	-45	+38			
G♮4					
F♯4					-33
F♮4				-18	
E♮4			-14		
E♭4		-8			
D♮4	-11				
C♯4					
C♮4					
B♮3					
B♭3					
A♮3					-7
G♯3				0	
G♮3			+1		
F♯3		+2			
F♮3	-4				
E♮3					
E♭3					
D♮3					
C♯3					
C♮3					
B♮2					
B♭2					
A♮2					
G♯2					
G♮2					
Root	B♭1	B♮1	C♮2	C♯2	D♮2

Appendix G1 − Overtone series pitch measurements

Overtone					
G♮5					
F♯5					
F♮5	-10	-27			
E♮5					
E♭5					+24
D♮5				-44	
C♯5			-43		
C♮5	-34	+38			
B♮4					
B♭4					+22
A♮4				+10	
G♯4			+21		
G♮4	-47	+33			
F♯4					
F♮4					
E♮4					
E♭4					
D♮4					-3
C♯4				-14	
C♮4			-21		
B♮3		-7			
B♭3	+1				
A♮3					
G♯3					
G♮3					
F♯3					
F♮3					
E♮3					
E♭3					
D♮3					
C♯3					
C♮3					
B♮2					
B♭2					
A♮2					
G♯2					
G♮2					
Root	E♭2	E♮2	F♮2	F♯2	G♮2

Appendix G1 − Overtone series pitch measurements

Overtone			
G♮5			
F♯5			
F♮5		-27	
E♮5	+27		
E♭5			
D♮5			
C♯5			-48
C♮5		-5	
B♮4	+30		
B♭4			
A♮4			
G♯4			
G♮4			
F♯4			
F♮4			-35
E♮4		-9	
E♭4	-4		
D♮4			
C♯4			
C♮4			
B♮3			
B♭3			
A♮3			
G♯3			
G♮3			
F♯3			
F♮3			
E♮3			
E♭3			
D♮3			
C♯3			
C♮3			
B♮2			
B♭2			
A♮2			
G♯2			
G♮2			
Root	G♯2	A♮2	B♭2

Appendix G2 – Comparison of harmonic series frequencies

This table is a comparison between the expected frequencies of the harmonic series for the **root fingering pattern for E1** and the obtained results taken on three readings, all in hertz.

Tuning to A=442 Hz, the note E1 on the bass clarinet gave a reading of 73 Hz. The supposed pitches of the harmonic series have been calculated and then three readings of the actual pitch produced have been taken.

Harmonic	Note name	Harmonic series pitch	Equal temperament pitch	Reading 1	Reading 2	Reading 3	Average reading
18	F♯5	1314	1324	1331	1336	1337	1335
16	E5	1168	1180	1219	1217	1207	1214
14	D5	1022	1051	1079	1073	1062	1071
13	C5	949	936	925	943	942	937
11	A♯4	803	834	792	800	799	797
9	F♯4	657	662	659	660	660	660
7	D4	511	525	516	515	517	516
5	G♯3	365	371	368	368	369	368
3	B2	219	221	220	220	220	220
1	E1	73	73	73	73	73	73

Appendix G3 − Overtone manoeuvrability

The table is a comparison of the manoeuvrability between the different overtones for the **root fingering pattern E1**.

Tuning to A=442 Hz, the lowest and the highest possible manipulation of each overtone has been measured on three readings. The pitch deviation reading for each harmonic has been given (in cents) from the nearest pitch. The range of pitch deviation has been ascertained for each overtone, on each reading, and from that the average manoeuvrability has been determined (in cents).

Harmonic	Overtone pitch	Reading 1			Reading 2			Reading 3			Average manoeuvrability
		Lowest	Highest	Range	Lowest	Highest	Range	Lowest	Highest	Range	
18	F♯5	F♯ +9	G5 +23	96	F♯ -19	F♯ +31	50	F♯ -9	F♯ +28	37	61
16	E5	E -5	F5 -29	76	E -14	F -14	100	E -37	F -15	122	99
14	D5	D -23	D♯5 -47	76	D -41	D♯ -47	103	D -42	D♯ -31	111	97
13	C5	B4 -43	C5 +37	130	B +8	C +38	130	B +3	C +35	132	131
11	A♯4	G♯4 +7	A♯ +46	239	G♯ +10	A♯ -47	143	A -49	A♯ +49	198	193
9	F♯4	E4 +16	F♯ +8	192	F♮ -36	F♯ +11	147	F -47	F♯ +8	155	165
7	D4	C4 +16	D -18	166	C♯ -47	D -22	125	C +31	D -19	150	147
5	G♯3	G♯ -41	G♯ -6	35	G♯ -32	G♯ -1	31	G♯ -33	G♯ +4	37	34
3	B2	B -13	B +9	22	B -39	B +4	43	B -41	B +9	50	38

Acknowledgements

First of all, I would like to thank my supervisors, Prof. Dr Marcel Cobussen, Prof. Frans de Ruiter, and Dr Peter Nijssen.

Prof. Frans de Ruiter accepted me and supported me throughout my long and complicated PhD journey, always nudging me and encouraging me at the right moment.

Prof. Dr Marcel Cobussen proved an eminent ‘sparring partner’ who pushed me to expand my boundaries and inspired me to document my research not only through written text, but also – and foremost – through demonstration videos.

Dr Peter Nijssen has sharpened my mind with his scientific knowledge and has been of great importance as my bass clarinet ‘conscience’, testing and double-checking my fingering patterns.

I am greatly indebted to Harry Sparnaay, my teacher and mentor, who sadly passed away in the course of this research. He has helped me realize my dream to become a bass clarinet specialist and let me witness, as a second pair of eyes, the genesis of core repertoire such as the works by Kunst and Ferneyhough.

I am very grateful to pianist Emma Kovárnová for taking the time to talk with me and share her intimate knowledge of Josef Horák’s microtonal experiences.

My special thanks go to all the composers I have had the privilege to work with during my long career, more specifically the composers who agreed to participate in my microtonal projects: Francisco Domínguez, Christopher Fox, Norbert Laufer, Scott Mc Laughlin, Roger Redgate, Fabien Téhéricsen, and René Uijlenhoet.

I am also very grateful to the Huygens-Fokker Foundation, to its director Sander Germanus, organist Ere Lievonen, and guitarist Melle Weijters, who challenged duo Hevans to come up with solutions for 31-tone fingering patterns and thus paved the way for my 31-tone microtonal journey.

I would also like to thank family and friends, especially my parents-in-law, not only for supporting me, but also for accepting my lack of availability during the research process.

Last, but not least, I wish to thank my duo partner and wife, Dr Eleri Ann Evans, without whose encouragement I could not have conducted this study. She has

challenged my artistic and academic conscience and has been of great help, assisting me with audio and video recordings.

Summary - *The deep-rooted microtonality of the bass clarinet*

The main objective of this research has been to expand the microtonal possibilities of the current unmodified bass clarinet. This study is systematic, practice-led research into the microtonal fingering patterns possible on my closed-key single reed instrument. It is research in, and through, musical practice.

During my career I have, on occasion, been asked by composers to find solutions for microtonal passages in their music. My book, *New Techniques for the Bass Clarinet* (1989), also contained information relating to microtonality. Through the years, my interest in this subject has grown and I felt the need to thoroughly explore this exhilarating subject.

My aims were to research and document bass clarinet fingering patterns for both equal and unequal divisions of the tone. Precision was an important asset during the course of this research: all the fingering patterns have been double-checked to make sure they fall within the set criteria. The fingering patterns have been documented in Appendices B-F. Additional information, regarding any restrictions for their use and the combinability of fingering patterns, has also been included. Demonstration videos have been made of each microtonal scale.

Highly motivated to find out as much as I could regarding the microtonal possibilities of the bass clarinet, I also wanted to explore another kind of microtonality, one which is 'rooted' in the instrument. The harmonic series of the bass clarinet, the way overtones are produced on top of roots, made me aware of the 'inherent' microtonality of the instrument and the additional microtonal options it offers which have been documented in Appendices G1, G2, and G3.

Ample information has been included about playing-parameters, such as embouchure, lower lip position, and air management. These parameters are essential for successful microtonal performance. Several instruction videos were made to illustrate these subjects.

In Chapter 1 all parameters and guidelines relevant to playing the bass clarinet microtonally are discussed and illustrated. Such matters have been included, because a relaxed and flexible embouchure, the control of lower lip positions and articulation, and a proper breathing technique and breath support, all aid successful microtonal playing. An understanding of the root-overtone system of

the bass clarinet and the way the instrument overblows, producing the partials which constitute its harmonic series, is crucial for the creation and production of a different form of microtonality.

Chapter 2 details the development of the bass clarinet from a multiform low clarinet to its current shape and keywork, for which Adolphe Sax is mainly responsible. Sax's technical improvements, such as the addition of a second register key, paved the way, in the long term, for microtonality. Early bass clarinet repertoire is discussed, orchestral, as well as solo and chamber music. These latter categories were scarce until the 1960s, when a revolutionary change took place due to the pioneering work of Eric Dolphy, Josef Horák, and Harry Sparnaay. These three musicians each had a role in the development of microtonality on the bass clarinet.

In Chapter 3 equal divisions of the tone are scrutinized, starting with a review of the existing literature. Most of the information found in the existing sources concerns the quartertone scale. An eighth-tone fingering pattern chart appears in only one source. The reliability and the accuracy of existing fingering patterns is called into question by the results documented in Appendices A1-A3. However, my research demonstrates that it is possible to play many precise quartertone pitches on the bass clarinet, and also to play steps smaller than a quartertone. This research has resulted in both a quartertone and an eighth-tone scale of more than three octaves, determined following strict criteria (Appendices B and C).

Initially inspired by the possibility of duo Hevans performing with the 31-tone Fokker organ in Amsterdam, my duo partner tenor saxophonist Eleri Ann Evans and I were challenged with finding 31-tone fingering patterns for our respective instruments (Chapter 4). At the end of our research we were able to document more than two octaves of 31-tone fingering patterns (Appendix D). The next step in developing my fingering patterns was to try to expand the ambitus of the 31-tone area on the bass clarinet, so that composers would have more possibilities to choose from when writing 31-tone music. As the data shows, the goals I set myself for this development could be met, as both a more precise (Appendix E), and a definitive (Appendix F) 31-tone fingering pattern chart could be established. The ambitus was extended to three octaves, from D2-D5.

The term 'the inherent microtonality of the bass clarinet' refers to the instrument's ability to sound microtonal pitch variations by utilizing the notes of the overtone series based on the root fingering patterns from C1 to B♭2

(Chapter 5). These microtonal variants can be either single, isolated pitches (monophonic), or a cluster of overtones (multiphonic). Root-overtone production clearly demonstrates how bass clarinet harmonics work and is the most direct path to the ‘inner’ or intrinsic microtonality of the instrument. All the overtones contained in the root pitches of the instrument—from C1 to B♭2—have been listed, and vertical and horizontal measurements have been documented (Appendices G1, G2, and G3). Adding keys to the root-overtone pitches further increases the number of microtonal options by producing nano tones (tones with a very small pitch difference of 1-15 cents). Harnessing nano microtonality shows that the root-overtone system is a viable form of microtonal practice and adds another dimension to the sound world of the microtonal bass clarinet.

My practice-based research was undertaken from the joint perspectives of performer, composer, and improviser. Through sharing my data about the microtonal possibilities of the bass clarinet, collaborations with composers have led to new solo and chamber works. The findings also enabled me to strengthen the microtonal elements in my own compositions, as well as in my improvisations.

I hope and expect that the extension of the bass clarinet’s microtonal possibilities will enrich the creative processes of bass clarinettists, composers, and other instrumentalists.

Samenvatting - *De diepgewortelde microtonaliteit van de basklarinet*

Het belangrijkste doel van dit onderzoek was om de microtonale mogelijkheden van de huidige, ongemodificeerde basklarinet uit te breiden. Deze studie is een systematisch, door de muziekpraktijk geleid onderzoek naar microtonale grepen, die mogelijk zijn op mijn enkelriet instrument met gesloten kleppen.

Gedurende mijn carrière hebben componisten mij, bij tijd en wijle, gevraagd om oplossingen te vinden voor microtonale passages in hun muziek. Mijn boek *New Techniques for the Bass Clarinet* (1989) bevatte ook informatie over microtonaliteit. Naarmate ik meer interesse kreeg in deze materie, voelde ik de behoefte groeien om dit fascinerende onderwerp tot op de bodem uit te zoeken.

Mijn doelstellingen waren om basklarinetgrepen te onderzoeken en te documenteren voor zowel gelijke als ongelijke verdelingen van de toon. Precisie was een belangrijk oogmerk tijdens dit onderzoek en alle grepen zijn gedubbelcheckt om er zeker van te zijn dat ze binnen de gestelde criteria vallen. Deze grepen zijn gedocumenteerd in Appendices B tot en met F. Aanvullende informatie met betrekking tot de gebruiksbeperkingen en de combinatiemogelijkheden van reeksen grepentabellen is ook toegevoegd. Om elke greep aanschouwelijk te maken zijn er demonstratievideo's gemaakt van elke microtonale toonladder.

Uiterst gemotiveerd om zoveel mogelijk uit te vinden met betrekking tot de microtonale mogelijkheden van de basklarinet, wilde ik ook een ander soort microtonaliteit exploreren, die welke is 'geworteld' in het instrument. De boventonenreeks van de basklarinet, de manier waarop boventonen worden geproduceerd vanaf de grondtoon, maakten me bewust van de 'inherente' microtonaliteit van het instrument en de extra microtonale opties die daardoor ter beschikking komen (gedocumenteerd in Appendices G1, G2, en G3).

Een ander belangrijk doel was het verschaffen van gedetailleerde informatie over relevante parameters zoals embouchure, de positie van de onderlip en adembeheersing. Deze parameters zijn essentieel als het gaat om een succesvolle microtonale uitvoeringspraktijk. Met het oog hierop werden diverse instructievideo's opgenomen.

In hoofdstuk 1 worden alle parameters en richtlijnen die relevant zijn bij het spelen van microtonaliteit op de basklarinet, besproken en geïllustreerd. Dergelijke zaken zijn vermeld, aangezien een ontspannen en flexibele embouchure, de beheersing van onderlipposities, articulatie, een juiste ademtechniek en ademsteun, succesvol microtonaal spel bevorderen. Inzicht in het ‘root-overtone’ (‘grondtoon-boventoon’) systeem van de basklarinet en de manier waarop het instrument overblaast is eveneens cruciaal voor de creatie en productie van een andere vorm van microtonaliteit.

Hoofdstuk 2 schetst de ontwikkeling van de basklarinet, van een veelvormige lage klarinet tot zijn actuele vorm en kleppenmechaniek, waarvoor met name Adolphe Sax verantwoordelijk is. De technische verbeteringen van Sax, zoals de toevoeging van een tweede registerklep, baanden, op de lange termijn, de weg naar microtonaliteit. Vroeg basklarinetrepertoire wordt besproken, zowel symfonisch als solo- en kamermuziek. Deze laatste categorieën behelsden weinig stukken tot de jaren zestig van de vorige eeuw, toen er een revolutionaire verandering plaatsvond, dankzij het pionierswerk van Eric Dolphy, Josef Horák, en Harry Sparnaay. Deze drie musici hebben ieder een rol gespeeld in de ontwikkeling van microtonaliteit op de basklarinet.

In hoofdstuk 3 worden gelijke verdelingen van de toon aan een nader onderzoek onderworpen, te beginnen met een overzicht van de bestaande literatuur. De meeste informatie gevonden in de bestaande bronnen betreft de kwarttoonladder. Een grepentabel voor achtste tonen komt slechts in één bron voor. Ik zet vraagtekens bij de betrouwbaarheid en de accuratesse van bestaande grepen, zoals gedocumenteerd in Appendices A1 tot en met A3. Mijn onderzoek toont echter aan dat het niet alleen mogelijk is om een grote hoeveelheid nauwkeurige kwarttonen te spelen op de basklarinet, maar ook om tonen kleiner dan een kwarttoon te spelen: het onderzoek heeft geresulteerd in zowel een kwarttoonreeks als een achtstetoonreeks van meer dan drie octaven die binnen strikte marges vallen (Appendices B en C).

Aanvankelijk geïnspireerd door de mogelijkheid om met duo Hevans op te treden met het Fokker 31-toonsorgel in Amsterdam, werden mijn duo-partner, tenorsaxofoniste Eleri Ann Evans, en ik uitgedaagd om 31-toon grepen te vinden voor onze instrumenten (hoofdstuk 4). Aan het eind van ons onderzoek waren we in staat om meer dan twee octaven aan 31-toon grepen te documenteren (Appendix D). De volgende stap in de ontwikkeling van mijn grepen was te trachten de omvang van het 31-toongebied op de basklarinet uit te breiden, zodat componisten meer keuzemogelijkheden zouden hebben bij het schrijven van 31-toonsmuziek. Zoals de uitkomsten laten zien, konden de doelen die ik mezelf voor deze ontwikkeling had gesteld, worden gehaald: een nauwkeuriger (Appendix E) en een definitieve (Appendix F) 31-toon grepentabel konden worden opgesteld. De omvang werd uitgebreid tot drie octaven, van D2 tot en met D5.

‘De inherente microtonaliteit van de basklarinet’ verwijst naar het feit dat het instrument in staat is om microtonale toonhoogtevariaties te laten horen door gebruikmaking van de noten van de boventoonserie, gebaseerd op de grondtoongrepen van C1 tot B♭2 (hoofdstuk 5). Deze microtonale varianten kunnen ofwel enkele, geïsoleerde tonen zijn (monophonic), ofwel een cluster van boventonen (multiphonic). Root-overtone productie laat duidelijk zien hoe basklarinetboventonen werken en is de meest directe weg naar de ‘innerlijke’ of intrinsieke microtonaliteit van het instrument. Alle boventonen die zijn vervat in de grondtonen van het instrument, van C1 tot B♭2, zijn op een rij gezet en verticale en horizontale metingen zijn gedocumenteerd (Appendices G1, G2, en G3). De toevoeging van kleppen aan de root-overtone toonhoogten breidt het aantal microtonale opties verder uit, doordat nanotonen (tonen met een heel klein toonhoogteverschil van 1-15 cent) worden geproduceerd. Het gebruik van nanomicrotonaliteit laat zien dat het root-overtone systeem een levensvatbare vorm van microtonale uitvoeringspraktijk is: het voegt nóg een dimensie toe aan de klankwereld van de (microtonale) basklarinet.

Mijn op de muziekpraktijk gebaseerd onderzoek is gedaan vanuit de gecombineerde perspectieven van uitvoerend musicus, componist en improvisator. Het delen van mijn bevindingen betreffende de microtonale mogelijkheden van de basklarinet heeft geleid tot samenwerkingen met componisten en heeft nieuwe solo- en kamermuziekwerken opgeleverd. De gevonden resultaten hebben mij ook in staat gesteld om de microtonale elementen in mijn eigen composities en in mijn improvisaties sterker te maken.

Ik hoop en verwacht dat de uitbreiding van de microtonale mogelijkheden van de basklarinet de creatieve processen van basklarinettisten, componisten en andere instrumentalisten zal verrijken.

Curriculum vitae

Henri Bok was born in 1950 in Rotterdam, the Netherlands. After finishing Grammar School, he went to Leiden University to study French Literature and Linguistics, specializing in Linguistics after his ‘Kandidaats’ exam.

Concurrent with preparing his ‘Doctoraal’ exam in French linguistics (which he completed in 1976), Henri Bok started music studies at Rotterdam Conservatoire, studying saxophone with Leo van Oostrom and bass clarinet with Harry Sparnaay. In 1980 he finished his musical studies cum laude, obtaining DM, UM and Chamber Music diplomas (considered to be equivalent to the current Master of Music diploma).

He has collaborated with musicians of many styles and genres, including Gustavo Beytelmann, José Luis Estellés, Mike Garson, Josef Horák, Bennie Maupin, Justo Sanz, Louis Sclavis, Willem Tanke, Henri Tournier, Dawn Upshaw, and Eric Vloeimans.

Henri Bok’s interest in new sound combinations has led him to initiate unusual instrumental groups: Duo Contemporain (with marimba/vibraphone), Duo Novair (with accordion), Bass Instincts (with bass oboe), Duo Clarones (bass clarinet duo with Luis Afonso 'Montanha'), Duo HeRo (with jazz pianist Rob van Bavel) and duo Hevans (with Eleri Ann Evans, tenor saxophone).

From 1981 until 2015 Henri Bok was professor of bass clarinet and free improvisation at Rotterdam Conservatoire (later called Codarts), preparing a great many international bass clarinet students for their specialist career.

Henri Bok is currently professor of bass clarinet at Fontys University of the Arts (Tilburg, the Netherlands) and Musikene (San Sebastian, Spain), as well as guest professor at Robert Schumann Hochschule für Musik (Düsseldorf, Germany). Between 2000 and 2017, he also taught the bass clarinet class during the annual Julian Menéndez clarinet summer course in Ávila (Spain).

Henri Bok was the initiator and artistic director of the first World Bass Clarinet Convention. This was held in Rotterdam, in 2005, and was attended by more than five hundred bass clarinettists from all over the world.

His book, *New Techniques for the Bass Clarinet*, written in 1989 (revised in 2011), is widely considered to be the standard work for instrumentalists and composers interested in extended techniques. Collaborations with composers from all over the world have resulted in hundreds of pieces written for and dedicated to him.

Following his first composition, *Vinho do Porto Brasileiro* (1997), Henri Bok has written numerous solo and chamber music works, many of which include microtonality. His compositions are published by Shoepair Music.

In recognition of his exceptional contributions to music, Henri was made a Knight in the Order of the Netherlands Lion by King Willem Alexander in 2014.

List of microtonal compositions

2012

ANNalogy for tenor saxophone and bass clarinet

DOLPHYNS for bass clarinet solo

Fluctuations I for tenor saxophone and bass clarinet

2013

There is a place for multiphonics for bass clarinet solo

2014

Multi-Micro I for tenor saxophone and bass clarinet

2015

E-A-E for bass clarinet solo

TuTu Soft for bass clarinet solo

2016

Duettino I for clarinet and bass clarinet or two bass clarinets

Duettino II for clarinet and bass clarinet or two bass clarinets

GIANT nano Steps for bass clarinet solo

HOMAGE for bass clarinet solo

Late Viola for bass clarinet solo

Small change for tenor saxophone and bass clarinet

2017

Fifty shades of Dee for bass clarinet and piano

Microclimate I for two bass clarinets

Smaller change for bass clarinet solo

Smaller change for tenor saxophone and bass clarinet

2018

3-4-5 for single reed duo or single reed groups

Bat-Kolu-Song for tenor saxophone and bass clarinet

Bh-Dee for bass clarinet soloist and bass clarinet quartet

HS-HB for bass clarinet solo