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Research project: "Out of the Bass Register. Uncovering the Organology, Pedagogy, and Performance Practice of Small-Sized Bassoons from the 18th and 19th Centuries"

# Collection and comparisons of measurement data of historical small-sized bassoons

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## Abstract

Two SNSF research projects hosted at the Schola Cantorum Basiliensis catalogued small-sized bassoons from the 18<sup>th</sup> and 19<sup>th</sup> centuries and investigated their musical and pedagogical roles. Additionally, reconstructions of four selected models combining 3D-CT technologies with conventional methods were undertaken. The detailed datasets, containing descriptions and measurements of the more than 60 small-sized bassoons examined, have been published in the open-access repository Zenodo and may be used to compare instrument types and aid in future reconstructions. In this article, manual methods and tools used to compile data are described, as well as various points of comparison.

## Keywords

Fagottino, tenoroon, small-sized bassoons, manual measurements

## Introduction

In the scope of two SNSF research projects "Fagottini and tenoroons – Small forgotten giants" and "Out of the bass register", an instrument catalogue listing approximately 130 extant small-sized bassoons has been created, augmented by more than 60 datasets containing detailed measurements, inner bore dimensions, descriptions, photographic/video material, and information of particular interest to instrument builders. Critical points also include tone hole dimensions and angles. The compiled

datasets enable numerous comparisons of the different sizes of fagottino and tenoroons examined.

While manual measuring procedures are still the norm for most historical woodwind makers, data collection using sophisticated 3D-CT technology is increasingly preferred by many museums as outlined by the MUSICES project carried out by the Germanisches Nationalmuseum and the EZRT (Development Center for X-ray Technology) of the Fraunhofer Institute.<sup>1</sup>

3D-CT scanning of an instrument is, however, not always a viable option. A special climate-controlled transportation case is required and removing the instrument from its regulated environment is a costly and time-consuming undertaking; some curators, however, permit a careful investigation on site.

Four models (two from private Swiss collections and two from museums in Zürich and Berlin) were procured for scanning, printing, and subsequent reconstructions of four selected models for trials carried out within the second SNF project. It was additionally possible to collect a substantial amount of measurement data of many more small bassoons using the manual procedures described in this article. This data, in turn, can serve as a preliminary basis for future reconstructions of models built in a conventional manner. Please see our website www.historical-bassoon.ch for further details.

## **Description of manual measurements for small-sized bassoons**

The following diagrams depict primary external and internal measurements collected from small-sized bassoons found in each instrument's dataset ("Basic and complete measurements"), located in the Zenodo repository via our website: <u>www.historical-bassoon.ch/datasets-links-to-zenodo/</u>.

External measurements such as bore diameters and lengths, are represented in blue, and those taken internally, in red. Bocal dimensions include length and diameters at regular intervals north/south and east/west, as well as diameters at both ends.

Total internal bore lengths are calculated using the internal bore length of the wing joint (including the bocal well), butt joint (big and small bores), long joint and bell – minus the socket length of the big and small bores in the butt joint, as well as the bell socket. A calculated allowance of septum space for fagottino (25 mm) and tenoroon (35 mm) has been added.

<sup>&</sup>lt;sup>1</sup> Baer 2018. The MUSICES project at the Germanisches Nationalmuseum developed scientific standards and guidelines recommending "optimized technical parameters of 3D-scanning, best practice recommendations for handling and scanning musical instruments, and outlines of a dedicated metadata model to stock and retrieve the accumulated information."



Figure 1: Standing Instrument.



Figure 2: Bocal.



43 44 45 46 Wing - tone hole 1 distance from south Wing - tone hole 2 distance from south Wing - tone hole 3 distance from south Bocal well length 29 30 31 Bocal well thickness with ferrule Bocal well ferrule thickness Wing - tenon thickness Wing - tenon northern extern. Ø Wing - tenon southern extern. Ø 
 Wing - tone hole 2 angle
 31

 Wing - tone hole 3 angle
 32

 Wing - tone hole 1 approx. Ø
 33

 Wing - tone hole 2 approx. Ø
 34
 Wing - tone hole A distance from south Wing - tone hole C distance from south 47

Figure 3: Wing Joint.

17

19 20 21

18

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Figure 4: Butt Joint.



Figure 5: Long Joint.



Figure 6: Bell.

## Methods and tools

#### List of tools required for measuring external lengths, bocals, and internal bores

- Ruler
- Masking tape
- Everts' fixed diameter caliper set, with ruled stick
- Tilting caliper, with ruled stick
- Digital calipers (plastic)
- Cylinders
- Protractor
- Framework to hold joint, with padded wooden sticks

**External measurements** of the joint lengths and standing lengths are taken with a ruler, while the bocal can be measured by creating a scale (0.0–2.5–5.0–7.5 mm) on a piece of masking tape and attaching this to the top (north) from end to end. External diameter measurements can be taken at the marked points in directions north/south and east/west. Using calipers, the ends of the bocal (external/internal) and thickness of the walls are also measured.

#### Methods and tools for measuring internal bores

#### Everts' caliper set

The set consists of a series of calipers ranging from 4.7 mm to 34 mm (the so-called fixed diameters) which can be perpendicularly screwed onto a ruler stick.<sup>2</sup> From 4.7 to 7.3 the calipers increase by 0.1 mm; from 7.4 mm to 25 mm, by 0.2 mm; from 25 mm to 34 mm, by 0.5 mm. The ruled stick with a fixed (preset) diameter is inserted into the instrument until it touches the wall of the bore, then L, which is the depth at that point, is measured.



Figure 7: Everts' caliper set, with ruled stick.

<sup>&</sup>lt;sup>2</sup> This type of calipers is described in Bouterse 2015, Comm. 2032.

Each measured value consists of two components: L, the depth (or distance) measured between the reference point R (end of instrument where measuring tool is inserted); and D, the diameter ( $\emptyset$ ) at that point. L and D are perpendicular (Figure 8).

L minimum (Depth min.) and L maximum (Depth max.) are recorded for each fixeddiameter interval. (Woodwind bores tend to shrink over the years, resulting in cross sections having some degree of ovality.)<sup>3</sup> It is not required to find the maximum and minimum diameter at each point, but it is necessary to turn the instrument bore with extreme care while inserting the tool.

Ø (D)	
<b>&gt;</b>	L
	L

Figure 8: Components of depth and diameters, diagram from Bouterse 2015, Comm. 2032.

The diameter progression inside the bore reflects these diameters steps as shown in Table 1.

Long joint, 7-key fagottino, BONACCORSI,							
Barga, ca.1815							
-							
Ømm	Depth max. in mm	Depth min. in mm					
13.6	302.5	287					
13.8	277	273					
14	275.5	264					
14.2	258	249					
14.4	248	238					
14.6	238	228					
14.8	229	219					
15	215	203					

 Table 1: Example of value progressions.

The wing, long and butt big bore joints are measured from the smallest to largest diameter. Everts' measuring tool is inserted into the bore from its largest diameter. Values display an increasing series of diameters corresponding to a decreasing series of depths (see Table 1).

*If it is not possible to uncork butt joint,* the small bore cannot be measured with this tool; the series of rods cannot pass through the beginning of the bore, as the bore starts with its smallest diameter and expands down to the septum and cork space.

## How can one measure the small bore in the butt joint?

In case uncorking is not possible, a tool inspired by David Rachor (Figure 9) has been made which enables measurements of the small bore of the butt joint to be taken. This tool is very similar to Everts', the difference being that a *tilted* caliper can enter the

<sup>&</sup>lt;sup>3</sup> Ibid.

bore, attached to the ruled stick with a flexible wire. When the bottom of the bore in the butt joint is reached, the wire is pulled so that the caliper leaves its tilted position and takes a perpendicular position on the ruler stick. Depths of diameter can thus be recorded. Using this tool, values will display in a decreasing series of diameters and a corresponding decreasing series of depths.



Figure 9: Tilting ruled caliper stick.

If it is possible to remove the butt joint cork, then Everts' measuring tool can be used to measure the small bore and data collected by inserting the tool through the cork space (south). Values will display the usual series of increasing diameters corresponding to a decreasing series of depths.

The bell is measured with Everts' tool, starting from the southern part. The bell's smallest diameter is usually found at the end of the northern part. If bells having an almost or very cylindrical bore are measured, two series of value sets can be offered: one measured from south to north and one measured from north to south, often with an irregular series of depths with big steps. Shrinking and/or ovality are more evident in these cases.

Some bells have an internal bell chamber right before its northern end. To measure this, the tilting caliper stick is employed by inserting it from north into the bell; value collection goes from south to north, that is: from the beginning of bell chamber to its end; values will display a decreasing series of depths and an irregular series of diameters (first increasing, then decreasing).

#### Diameters of tone holes

A set of cylinders are used to record the approximate diameter of tone holes. Cylinders are inserted into tone holes and the one fitting "snugly" is recorded as the approximate diameter. On the long joint, a digital caliper is often used instead of cylinders, especially for the D, C, and Bb tone holes.

#### Angles of tone holes

A special tool was designed for this purpose, as shown in Figure 10.



Figure 10: Framework with padded sticks to hold joint horizontally.

Each tone hole angle is measured using a protractor while the joint is attached to this framework. Each joint has an imaginary line passing through the center of its bore, aligned with the device and parallel to the surface of working surface. Joints are rotated to have an imaginary surface cutting the tone hole in two (theoretically equal) parts along its own axis. This imaginary surface must be perpendicular to the working surface. A padded stick centered in the axis of each tone hole is used to determine the angle and the angle of incidence between two imaginary lines is measured. The first imaginary line, coinciding with the stick going into the tone hole, extends down to the working surface; the second (perpendicular to the working surface at the point of incidence) is measured. (This last perpendicular line is called 'normal' in geometry, and it is at zero on the protractor.) Angle directions are indicated by "north" and "south", according to the chimney direction into the bore.



Figure 11: Protractor.

#### Approximate lengths of tone holes

The approximate length of the axis of each tone hole, the segment starting in the center of the beginning of the tone hole and connecting to its end, is given. The small sliding measuring stick on digital calipers is used to measure these values, when possible. Alternatively, a wooden stick imaginarily connecting the centers of beginning and end of a tone hole is used: once aligned to the tone hole axis, this stick is positioned just before the beginning of the bore, and the start of the hole is marked by pencil, considering the instrument surface; the length between the pencil mark and the beginning of the stick gives the approximate length of the tone hole.

## **Measurement comparisons**

The following tables offer an overall picture of some of the most important measurements of the examined instruments. This data can be compared on different levels, for example according to a chronological order and/or a geographical scheme. Some sizes of instruments can thus easily be compared to instruments made by the same builder, or to instruments made by their contemporaries.

#### Standing lengths, chronologically ordered and smallest to largest

A chronological display of instrument types, standing lengths, total external lengths and inner bore lengths is an important guideline to compare how many of these major measurements differ over the decades (Table 2). The list shows the popularity of instrument types from ca. 1700–1900. The last two columns offer an overview of the total bore lengths, from the smallest to the largest. It is therefore evident that there is a constant measurement range in which the category of fagottini can be found, and the same can be said for tenoroons in G and F.

#### Details

- *Fagottini* have a total internal bore length between ca. 971 mm (FT12 Castlas) and ca. 1227.3 mm (FT39 Scherer). The range of the external length is ca. 972 mm–1220 mm. The "fagottino median" calculated within all available bore total lengths (without any geographical or chronological ranking) is ca. 1098.7 mm. This value corresponds to the total bore length of FT28 Scherer 1.
- **Tenoroons in G** have a total **internal bore length** range between ca. 1294.5 mm (FT22 Proff) and ca. 1476.6 mm (FT11 Cahusac). The range of the **external length** is ca. 1279 mm–1478 mm. The "tenoroon median in G" calculated using all the available bore total lengths (without any geographical or chronological ranking) is ca. 1359.6 mm.
- **Tenoroons in F** are those instruments with a total **internal bore length** within a range between ca. 1506.9 mm (FT9 Blockley) and ca. 1682.1 (FT34 Tuerlinckx). The **external length** range is ca. 1467 mm–1658 mm. The "tenoroon median in F" calculated using all the available bore total lengths (without any geographical or chronological ranking) is ca. 1602.2 mm. This value corresponds the total bore length of FT45 Stehle.

According to studies made by Giovanni Battista Graziadio, total bore lengths in fagottini generally correspond to roughly half of the total bore length of the full-size bassoon made by the same maker; tenoroons in G generally have slightly less than 3/4 of the total bore length of the full-size bassoon made by the same maker; tenoroons in F, generally slightly more than 3/4 of the total bore length of the full-size bassoon made by the same maker.

DescriptionDescriptionDescriptionDescriptionSector	SMALL-SIZE BASSOONS - CHRONOLOGIAL LIST				LEGEND	SMALL-S	IZE BASSOONS, SM	MALLEST TO LARGEST			
FindSingening Bis lange (Singening Bis sector)Singening Bis lange (Singening Bis	ID NR	INSTRUMENT TYPE, MAKER, PLACE, DATE	Transposition	Length: butt joint to bell / mm	Length: butt joint to wing joint / mm	TOTAL external length / mm	TOTAL inner bore length / mm		ID NR	ASCENDING TOTAL inner bore length / mm	PLACE
Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob<Prob< <t< td=""><td>FT14</td><td>3-key fagottino, Johann C. Denner, Nuremberg ca.1700</td><td>Octave</td><td>636</td><td>447.7</td><td>1083.7</td><td>×</td><td>PINK = fagottino</td><td>FT12</td><td>967/992</td><td>Turin (I)</td></t<>	FT14	3-key fagottino, Johann C. Denner, Nuremberg ca.1700	Octave	636	447.7	1083.7	×	PINK = fagottino	FT12	967/992	Turin (I)
PrintArrigenet 	FT7	3-key fagottino, Anonymous (8), Unknown (Germany), ca 1730–1780	Octave	646.5	473.5	1120	1129	BLUE - teneroon in G	FT13	1050	Paris (F)
1110Adv synchen11 and synch Anomyson (1) lubranes a corr Sector (1) and a c	FT39	4-key fagottino, Johannes & Georg H. Scherer (5), Butzbach, cs 1750–78	Octave	694	526	1220	1227.3	GREEN = tenorson in F	FT25	1068.5	Paris (F)
T23ferry flyadia, Soldinka & Rateshaugh, Brazenis, ex.1749Octore647448116rFIT1107.2Jan (17)Jan Jan (17)	FT40	4-key fagottino, Anonymous (11), Unknown, ca.1750–1790	Octave	666	487	1153	1169.45	YELLOW = tenaroon in Eb	FT10	1070.4	Barga (I)
T23Free partine, Johannes Sourg Storen (I) Modulo, 10.1%Citew6.106.106.1010.10511.10 <t< td=""><td>FT23</td><td>4-key fagottino, Godfridus A. Rottenburgh, Brussels, ca.1760</td><td>Octave</td><td>667</td><td>448</td><td>1115</td><td>x</td><td></td><td>FT17</td><td>1077.9</td><td>Auch (F)</td></t<>	FT23	4-key fagottino, Godfridus A. Rottenburgh, Brussels, ca.1760	Octave	667	448	1115	x		FT17	1077.9	Auch (F)
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Time       4 key spacino, Mulier, Germany, ca. 1773       O thuw       647       1114       112.53         Time       4 key margani, Johanna & Gaorg Schware (I), Subtach,       O thuw       641       440       1111       110.25         Time       4 key margan, Jahn Suks, (1) Germany, ca. 1775       G       G       740       643       1133       1332       1332         Time       4 key margan, Jahn Suks, (1) Germany, ca. 1778       O thuw       641       443       1144       5         Time       4 key margan, Jahn Suks, (1) Germany, ca. 1778       O thuw       647       Mail       1162       1110.25       Butbach (60)         Time       4 key gadinin, Jacony min, Huinch, Chike (1) Bananshung (a. 1778)       O thuw       647       440       1076       1077         12       4 key gadinin, Jacony Time, schike (1) Ladoo, 178       O thuw       658       441       1478       1372       178       110.45       (Eermany)         111       4 key gadinin, Jacony mone (1), Jacon (n. 1880       O thuw       658       441       1478       1372       1784       1104.4       (Eermany)         112       2 key gadinin, Jacony mone (1), Jacon (n. 1880       O thuw       658       441       1416       11052       11014.2       Germ	FT29	1760-70 4-key fagottino, Johannes & Georg Scherer (2), Butzbach, ca.1764	Octave	642	464	1106	1108.75		FT15	1106.6	Dresden (G)
PPC Production. Johannes & Georg Scherr (48, Bodilach.)         Ocione         44         46         110         1110.25           F19         44ay Banerean, Lifoux, Lifo Banar, Cast 775         G         74         499         1353         1382           F19         44ay Banerean, Johan Bickky, Lifeesbarkher, Gar 775         G         74         499         1365         1166         1         1365           F12         44ay Banerean, Johan Bickky, Lifeesbarkher, Gar 775         G         74         499         1367         1467         1366.3           F12         4ay Banerean, Johann, Schrift, Gar 7780         Octore         641         415         1676         1076.4           F13         4ay Banerean, Contradue Datases, Paris, ca. 7183         Octore         643         4164         1167         1166.4           F13         4ay Banerean, Contradue Datases, Apris, ca. 1789         Octore         653         411         1161.4         1166.4           F14         F44 Banerean, Contradue Datases, Apris, ca. 1800         Octore         653         411.1         1162.4         6emany           F15         Saray Banerian, Network Datases, Calino         O         772         1534.4         1164.1         1164.1           F14         Saray Banerean, Saray Pan	FT20	4-key fagottino. Müller, Germany, ca.1770	Octave	647	467	1114	1124.9		FT3	1108.6	Austria
Cont         Cont <thcont< th="">         Cont         Cont         <thc< td=""><td>FT30</td><td>5-key fagottino, Johannes &amp; Georg Scherer (4), Butzbach,</td><td>Octave</td><td>641</td><td>460</td><td>1101</td><td>1110.25</td><td></td><td>FT29</td><td>1108.75</td><td>Butzbach (G)</td></thc<></thcont<>	FT30	5-key fagottino, Johannes & Georg Scherer (4), Butzbach,	Octave	641	460	1101	1110.25		FT29	1108.75	Butzbach (G)
No.         Number of the Back Process status is a 1780         P </td <td>FT18</td> <td>ca.1760-78 A-key teoroon 1 Kraus (1) Germany ca.1775</td> <td>G</td> <td>764</td> <td>589</td> <td>1353</td> <td>1362</td> <td></td> <td>FT30</td> <td>1110.25</td> <td>Butzbach (G)</td>	FT18	ca.1760-78 A-key teoroon 1 Kraus (1) Germany ca.1775	G	764	589	1353	1362		FT30	1110.25	Butzbach (G)
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1         1	ETA	A key function, John Blockley, Chevanishire, Ca. 1760	Octown	630	463	1104	1300.5		FT30	1124.0	Germany
Γ12         Γ13         Γ13 <thγ13< th=""> <thγ13< th=""> <thγ13< th=""></thγ13<></thγ13<></thγ13<>		A her fraction deleter for Title (4) Beneratively of 1760	Octave	647	463		-		1120	1124.5	Germany
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P171       Skar pagetino, Jacobian, Castina (J. London, T379)       G       B37       6440       1076       1077.3         P111       Karp pagetino, Jacobian, Castina Castina, Castina Castin	F113	7-key fagottino, Christophe Delusse, Paris, ca.1783	Octave	625	418.5	1044.5	1050		F143	1145.5	Kobienz G
P111       C4xy Incoreon, Theoma, Cahusa Ch), Leadon, 1780       G       837       641       1472       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       1475       110       110       110       110       110       110       110       11111       111	FT17	5-key fagottino, Jacoby Fils, Auch, ca.1785	Octave	636	440	1076	1077.9		FT40	1169.45	(Germany?)
F133       4-key fagettim, Jan A. Turritincks (1), Machalian Empire, ez.1190       Octure       643       446       1110       1121.7         F13       4-key fagettim, Jan A. Turritincks (1), Machalian Empire, ez.1190       Octure       635       471       1166       1100.4         F111       F-key fagettim, Jan Marine Empire, ez.1190       Octure       603       472.4       142.1       x         F122       F-key fagettim, Jann Stainer, Fund, ez.1180       Octure       640       472.4       142.1       x         F124       F-key fagettim, Jann Stainer, Paris, ez.1880       G       716       543       1279       1224.5         F124       F-key fagettim, Jann Marine, Empire, ez.1815       G       642       157       157.4         F126       F-key fagettimo, Jann Marine, Empire, ez.1815       G       712       151.2       151.2         F13       F-key fagettimo, Jann Marine, Empire, ez.1815       G       640       1302       1312         F16       F-key fagettimo, Jann Marine, Empire, ez.1815       G       640       1302       137.4         F11       F-key fagettimo, Jann Marine, Empire, ez.1815       G       715       534       1421       Key fagettimo, Jann Marine, Empire, ez.1815       G       717       151.5       157.4<	FT11	6-key tenoroon, Thomas Cahusac (1), London, 1789	G	837	641	1478	1476.6		FT39	1227.3	Butzbach (G)
FT3       4-key fagettim, Anonymou (1), Austrian Empire, ca. 1800       Octure       635       471       1106       1108.5         FT12       A-key fagettim, Castlas, Turin, ca. 1800       Octure       999       400 / 370       997       997/992       977       979       977<	FT33	4-key fagottino, Jean A. Tuerlinckx (1), Mechelen, ca.1795	Octave	644	466	1110	1121.7		FT22	1294.5	Tours (F)
F112       7-key kgottino, Listan, Turin, ca. 1800       Octave       99       400 / 373 $\frac{177}{12}$ 95/1992         F116       5-key kgottino, Heinrich Grenser, (1), Dreaden, ca. 1800       Octave       660 3       472.8       1142.1       x         F127       5-key kgottino, Heinrich Grenser, (1), Dreaden, ca. 1800       Octave       660 3       472.8       1142.1       x         F12       5-key kgottino, Dominique A, Porthaux, Paris, ca. 1800       F       937       642       1579       1574.4         F16       6-key kgottino, Savary pere, Paris, ca. 1810       G       044       663       1403       1402.9         F18       6-key kgottino, Savary pere, Paris, ca. 1815       G       464       563       1403       1402.9         F176       7-key kgottino, Savary pere, Arris, ca. 1815       G       464       563       1463       1402.9         F176       7-key kgottino, Kapaz ratuler (1), Vienna, ca. 1815       G7       755       516.4       124       1295.5         F174       5-key kgottino, Jean A, Turklinak, (2), Machelen, ca. 1820       F       977       641       1641       x         F174       5-key kgottino, Jean A, Turklinak, (2), Machelen, ca. 1820       F       977       6414       1685       1662.1	FT3	4-key fagottino, Anonymous (1), Austrian Empire, ca.1800	Octave	635	471	1106	1108.6		FT46	1299.5	(Germany?)
FT16       Servy Agentino, Heinrich Gresser, (I), Dreadon, ca. 1800       Octawe       669.3       472.8       1142.1       x         FT22       S-key Manoroon, Drangius Axier Prof. Jours, ca. 1800       G       714       503       129       1294.5         FT21       S-key Manoroon, Drangius A. Porthaux, Paris, ca. 1800       G       72       157       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.1       157.2       157.1       157.1       157.2       157.1       157.1       157.2       157.1       157.1       157.2       157.1       157.1       157.2       157.1       157.1       157.2       157.1       157.1       157.2       157.2       157.1       157.1       157.2       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       157.1       157.2       176.1       157.2       177.1       157.4       177.1       157.4       177.1       157.2       177.1       157.4       177.1       157.2       177.1       157.2       177.1       157.2       177.1       157.2<	FT12	7-key fagottino, Castlas, Turin, ca.1800	Octave	599	400/373	972	967/992		FT24	1322	Paris (F)
F122       54ey Improven, François-Xavier Profi, Tours, ca. 1800       G       716       542       1279       1294.5         F71       64ey Improven, Damingue A. Perfhaux, Paris, ca. 1800       G       937       642       1579       1574.4         F724       54ey Improven, Savary peris, Paris, ca. 1800       G       937       642       1579       1374.4         F714       54ey Improven, Gorg Aator & Horwood, Loudon, ca. 1815       G       640       630       1403       1222         F716       64ey Improven, Gorg Aator & Horwood, London, ca. 1815       G       630.5       435.5       1662.9       10704.         F716       74ey Improven, Kasper Tauber (1), Vienna, ca. 1815       G7       675       536       1461       X         F741       124ey Improven, Jean A. Turelinckx (2), Mechalen, ca. 1825       G7       759       534       1284       1299.5         F741       124ey Improven, Jean A. Turelinckx (2), Mechalen, ca. 1820       F7       677       681       1682.1       F74       158.4       Vienna (A)         F714       54ey Improven, Jean A. Turelinckx (2), Mechalen, ca. 1820       Octuve       677       449.5       1169.5       1168.1         F725       164ey Importen, Jean-M. Turelinckx (2), Mechalen, ca. 1820       Octuve	FT16	5-key fagottino, Heinrich Grenser, (1), Dresden, ca.1800	Octave	669.3	472.8	1142.1	×		FT18	1362	Germany
FT21       94-ey Isnoroon, Dominique A. Porthaux, Paris, ca. 1808       F       937       642       1579       1574.4         FT2       54-ey Isnoroon, Savary pere, Paris, ca. 1809       G       762       551       1313       1322         FT6       64-ey Isnoroon, Savary pere, Paris, ca. 1815       G       640       563       1403       1402-9         FT8       64-ey Isnoroon, Gorg Astor & Horwood, London, ca. 1815       G       640       563       1070       X         FT10       74-ey Bognino, Bonscors, Kapar Laber(J), Vienna, ca. 1815       G       640       563       1070       X         FT44       64-ey Isnoroon, Kapar Tauber (J), Vienna, ca. 1815       G7       750       634       1264       1295-5         FT41       124-ey Isnoroon, Kapar Tauber (J), Vienna, ca. 1815       G7       750       634       1264       1295-5         FT41       124-ey Isnoroon, Anonymous (12, (Germany, ca. 1815       G7       750       634       1264       1295-5         FT45       54-ey Isnoroon, Jean Atonicholes Savary Jeure (D), Paris, R27       Colave       670       440.5       1105.5       1106.6         FT45       74-ey Isgontino, Jonan Pelar Laberz, Koblerz, 182-5       Golave       670       472.5       1164.5       1452.5	FT22	5-key tenoroon, François-Xavier Proff, Tours, ca.1800	G	716	563	1279	1294.5		FT6	1402.9	Austria
FT24       54ey Imoreon, Savary pere, Paris, ca.1810       G       762       511       1313       1322         FT6       8-key Imoreon, Anonymous (7), Austrian Empire, ca.1815       G       840       660       1402       1402.9         FT8       6-key Imoreon, Georg Aster & Horwood, Lendon, ca.1815       F7       890       680       1570       X         FT61       7-key fignatific, Benaccorsi, Barga, ca.1815       Octave       630.5       435.5       1062.9       1070.4         FT64       6-key Imoreon, Anonymous (12), (Germany, ca.1815       G7       750       534       1284       1299.5         FT64       12-key Imoreon, Hambrunner (Gebrüchr) (1), Sumisvald, 1815-47       ED7       1064       772       1785       1828.8         FT35       6-key fignatific, H. Gremar, K. 2.8120       F       1064       772       1785       1828.8         FT36       6-key fignatific, H. Gremar, K. 2.8120       F       1064       1155       11666.5       1167.5       1166.6         FT37       14-key fignatific, Jean-M. Tuerlinkx (2), Machelen, ca.1820       F       70       414.5       1155.5       1160.6         FT34       14-key fignatific, Jean-M. Tuerlinkx (2), Machelen, ca.1820       F       70       414.5       1165.5	FT21	9-key tenoroon, Dominique A. Porthaux, Paris, ca.1808	F	937	642	1579	1574.4		FT11	1476.6	London (UK)
FT6       84ey Isnoroon, Anonymous (7), Austrian Empire, ca. 1815       G       460       563       1403       1402.9         FT8       64ey Isnoroon, Georg Astor & Horwood, Landon, ca. 1815       F7       900       680       1570       x         FT8       64ey Isnoroon, Kaspar Tauber (1), Vienna, ca. 1815       F7       970       546       1962       1070.4         FT4       64ey Isnoroon, Kaspar Tauber (1), Vienna, ca. 1815       F7       675       514       1284       1295.5         FT4       24ey Isnoroon, Kaspar Tauber (1), Vienna, ca. 1815       G7       750       514       1284       1295.5         FT4       24ey Isnoroon, Handmark (1), Sumiswald, 1815-07       ED7       1064       725       1789       1282.8         FT3       54ey Isnoroon, Jean Aluerinck 2(2), Mechalen, ca. 1820       F8       977       4681       1195.5       1160.5       1602.5         FT3       54ey Isnoroon, Jean Nicholas Savary Jeune (2), Paris, (6.17)       Octuve       645       1195.5       1162.5       1602.5         FT4       14ey Spottino, Joahan Peter Laiberz, Koblenz, 152.5       Octuve       647       442.5       1145.5       1142.5         FT3       14ey Isnoroon, Jaan Nicholas Savary Jeune (1), Paris, ca. 1835       F       940       662.5	FT24	5-key tenoroon, Savary pere, Paris, ca.1810	G	762	551	1313	1322		FT9	1506.9	Leicestershire (UK)
FTB       64sy knoroon, Georg Astor & Horwood, London, ca. 1815       F7       890       680       1570       X         FT10       74sy fagottino, Bonaccorsi, Barga, ca. 1815       Octave       630.5       435.5       1062.9       1070.4         FT31       64sy knoroon, Kaspar Tauber (1), Vienna, ca. 1815       F7       875       586       1461       X         FT46       54sy knoroon, Anonymous (12), (Germany), ca. 1815       G7       750       534       1284       1295.5         FT41       124sy knoroon, Anonymous (12), (Germany), ca. 1815       G7       750       634       1284       1295.5         FT35       64sy knoroon, Jean A. Tuerlinckx (2), Mechelen, ca. 1820       F       977       641       1565       1562.1         FT35       64sy fagottino, Jaan-Nicholas Savary Joune (2), Paris, 1827       Octave       670       449.5       119.5       1106.6         FT34       04sy fagottino, Jaan-Nicholas Savary Joune (2), Paris, 1827       Octave       670       447       1084.5       X         FT43       04sy fagottino, Johan Peter Leiberz, Koblenz, 1825-35       Octave       670       4472       1142       1145.5         FT16       14sey knoroon, Jaan-Nicholas Savary Joune (4), Paris, ca.1835       F       960       662.5       16	FT6	8-key tenoroon, Anonymous (7), Austrian Empire, ca.1815	G	840	563	1403	1402.9		FT2	1535.9	Paris (F)
FT10X-ex fagottino, Bonaccarsi, Barga, ca.1815Octave630.5435.51062.91070.4FT316-key tenoroon, Kaspar Tauber (1), Vienna, ca.1815F78755861461XFT445-key tenoroon, Kaspar Tauber (1), Vienna, ca.1815G775053412041295.5FT4112-key tenoroon, Kirsbarumer (Gebrücher) (1), Sumiswaid, 1815-47Eb7106472517891828.8FT356-key fagottino, H.Grenser & S. Wiesner, Dresden, ca.1820F97764116821682.1FT356-key fagottino, Jean-Aluerlinckx (2), Mechelen, ca.1820F9776411064.51662.5FT356-key fagottino, Jean-Aluerlinckx (2), Mechelen, ca.1820F9776411064.51662.5FT356-key fagottino, Jean-Aluerlinckx (2), Mechelen, ca.1820Cuture64542510701066.5FT356-key fagottino, Jean-Micholas Savary Jeune (2), Paris, 1827Octave64542510701066.5FT457-key fagottino, Jean-Micholas Savary Jeune (2), Paris, ca.1835F9406621602xFT414-key tenoroon, Fielderic-Guillaume Adler (1), Paris, ca.1835F9406621622xFT414-key tenoroon, Jean-Micholas Savary Jeune (1), Paris, ca.1836F94066216221657.3FT414-key tenoroon, Jean-Micholas Savary Jeune (1), Paris, ca.1840F94763015771533.5FT414-key tenoroon, Jean-Micholas Savary Jeune (1), Paris,	FT8	6-key tenoroon, Georg Astor & Horwood, London, ca.1815	F?	890	680	1570	×		FT37	1559.4	Paris (F)
FT31       δ-key kenoroon, Kaspar Tauber (1), Vienna, ca. 1815       F?       875       586       1461       x         FT46       S-key kenoroon, Anonymous (12), (Germany), ca. 1815       G?       750       534       1284       12995         FT41       12-key tenoroon, Hirsbrumer (Gebrüder) (1), Sumiswald, 1815-47       Ebr       1064       725       1780       1828.8         FT33       S-key kenoroon, Jean A. Tuerlinckx (2), Mechelen, ca. 1820       F       977       681       1669       1682.1         FT35       6-key fagottino, Jean A. Tuerlinckx (2), Mechelen, ca. 1820       F       977       681       1658       1682.1         FT35       6-key fagottino, Jean A. Tuerlinckx (2), Mechelen, ca. 1820       F       977       681       1658       1662.5         FT35       6-key fagottino, Jean Nicholas Savary Jeune (2), Paris, 1827       Octave       670       472       1142       1145.5         FT4       7-key fagottino, Johann Petr Leiberz, Koblenz, 1825-35       Octave       670       472       1142       1145.5         FT1       11-key tenoroon, Jean Nicholas Savary Jeune (4), Paris, ca. 1835       F       940       662       1662       x         FT24       12-key tenoroon, Jean Nicholas Savary Jeune (4), Paris, ca. 1835       F       952	FT10	7-key fagottino, Bonaccorsi, Barga, ca.1815	Octave	630.5	435.5	1062.9	1070.4		FT5	1572.9	Paris (F)
FT46       5-key tenoroon, Anonymous (12), (Germany), ca.1815       G7       750       534       1244       1299.5         FT41       12-key tenoroon, Hirsbrunner (Gebrüder) (1), Sumiswald, 1815–47       Eb7       1064       725       1789       1828.8         FT35       5-key tenoroon, Jean A. Tuerlinckx (2), Machelen, ca.1820       F       977       681       1688       1682.1         FT35       6-key fagottino, Jean-Nicholas Savary Jeune (2), Paris, 1827       Octave       670       449.5       1119.5       1106.6         FT36       0-key unfinished fagottino, Joseph Dupré, Tournal, ca.1830       Octave       637.5       447       1084.5       x         FT47       7-key fagottino, Johann Peter Leiberz, Koblenz, 1825–35       Octave       670       472       1142       1145.5         FT19       8-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835       F       940       662       1662       x         FT19       8-key tenoroon, Jaan-Nicholas Savary Jeune (4), Paris, ca.1835       F       940       662       1662       x         FT2       12-key tenoroon, Jaan-Nicholas Savary Jeune (4), Paris, ca.1840       F       952       665       1662       167.3         FT2       12-key tenoroon, Jaan-Nicholas Savary Jeune (1), Paris, ca.1840       F	FT31	6-key tenoroon, Kaspar Tauber (1), Vienna, ca.1815	F7	875	586	1461	×		FT21	1574.4	Paris (F)
FT41       124ey tenoroon, Hirsbrunner (Gebrüder) (1), Sumiswald, 1815–47       Eb?       1064       725       1789       1828.8         FT34       5-key tenoroon, Jean A. Tuerlinckx (2), Mechelen, ca.1820       F       977       681       1658       1662.1         FT35       6-key fagattino, H. Grenser & S. Wiesner, Dresden, ca.1824       Octave       670       449.5       1119.5       1106.6         FT35       0-key unfinished fagottino, Joseph Dupré, Tournal, ca.1830       Octave       637.5       447       1084.5       x         FT41       17.4ey fagottino, Johann Peter Leiberz, Koblenz, 1825       Octave       667       447       1142       1145.5         FT41       17.4ey fagottino, Johann Peter Leiberz, Koblenz, 1825       Octave       670       447       1084.5       x         FT41       17.4ey fagottino, Johann Peter Leiberz, Koblenz, 1825       F       940       662       1602       x         FT55       164.ey fenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1835       F       952       660       1642       1657.3         FT2       134ey fenoroon, Jean-Nicholas Savary Jeune (14), Paris, ca.1836       F       963       665.1       1642       1657.3         FT2       134ey fenoroon, Jean-Nicholas Savary Jeune (14), Paris, ca.1840       F	FT46	5-key tenoroon, Anonymous (12), (Germany), ca.1815	G?	750	534	1284	1299.5		FT19	1584.8	Vienna (A)
FT34       5-key tenoroon, Jean A. Tuerlinckx (2), Mechelen, ca. 1820       F       977       681       168       1682.1         FT15       6-key fagottino, H. Grenser & S. Wiesner, Dresden, ca. 1824       Octave       670       449.5       1119.5       1106.6         FT35       6-key fagottino, Jean-Nicholas Savary Jeune (2), Paris, 1827       Octave       637.5       447       1084.5       x         FT43       7-key fagottino, Joseph Dupér, Tournal, ca. 1830       Octave       637.5       447       1084.5       x         FT41       7-key fagottino, Joseph Dupér, Tournal, ca. 1830       Octave       637.5       447       1084.5       x         FT41       7-key fagottino, Joseph Dupér, Tournal, ca. 1830       Octave       637.5       447       1084.5       x         FT14       11-key tenoroon, I. Merklein, Vienna, ca. 1835       F       940       662       1602       x         FT26       12-key tenoroon, J. Merklein, Vienna, ca. 1835       F       952       660       1642       1657.3         FT21       13-key tenoroon, Fiedéric-Guillaume Adler (2), Paris, ca.1840       F       947       630       157.7       1535.9         FT22       14-key tenoroon, Jean-Nicholas Savary Jeune (11), Paris, ca.1840       F       983       665.1	FT41	12-key tenoroon, Hirsbrunner (Gebrüder) (1), Sumiswald, 1815–47	Eb?	1064	725	1789	1828.8		FT47	1587	Ferrera (I)
FT15       6-key fagottino, H. Grenser & S. Wiesner, Dresden, ca.1824       Octave       670       449.5       1119.5       1106.5         FT25       14-key fagottino, Jean-Nicholas Savary Jeune (2), Paris, 1827       Octave       645       425       1070       1068.5         FT35       0-key unfinished fagottino, Joseph Dupré, Tournal, ca.1830       Octave       637.5       447       1084.5       x         FT43       7-key fagottino, Johann Peter Leiberz, Koblenz, 1825–35       Octave       670       472       1142       1145.5         FT1       11-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835       F       940       662       1602       x         FT26       12-key tenoroon, I. Merklein, Vienna, ca.1835       F       952       663       1615       1558.8         FT26       12-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1840       F       982       660       1642       1657.3         FT21       11-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       983       665.1       1648.1       1651.2         FT32       12-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       980       658.5       1638.5       1644.9         FT33       12-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840	FT34	5-key tenoroon, Jean A. Tuerlinckx (2), Mechelen, ca.1820	F	977	681	1658	1682.1		FT45	1602.5	Vienna (A)
FT25       14-key fagottino, Jean-Nicholas Savary Jeune (2), Paris, 1827       Octave       645       425       1070       1068.5         FT35       0-key unfinished fagottino, Joseph Dupré, Tournal, ca.1830       Octave       637.5       447       1084.5       x         FT43       7-key fagottino, Johann Peter Leiberz, Koblenz, 1825–35       Octave       670       472       1142       1145.5         FT1       11-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835       F       940       662       1602       x         FT26       12-key tenoroon, I. Merklein, Vienna, ca.1835       F       952       663       1615       1584.8         FT26       12-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1836       F       952       660       1642       1657.3         FT27       15-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1836       F       952       660       1642       1657.3         FT2       13-key tenoroon, Jean-Nicholas Savary Jeune (1), Paris, ca.1840       F       983       665.1       1636.5       1651.2         FT31       15-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, 184.1       F       980       658.5       1638.5       1644.9         FT32       12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842       F<	FT15	6-key fagottino, H. Grenser & S. Wiesner, Dresden, ca.1824	Octave	670	449.5	1119.5	1106.6		FT36	1608.9	Paris (F)
FT35       0-key unfinished figottino, Joseph Dupré, Tournal, ca.1830       Octave       637.5       447       1084.5       x         FT43       7-key fagottino, Johann Peter Leiberz, Koblenz, 1825–35       Octave       670       472       1142       1145.5         FT1       11-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835       F       940       662       1602       x         FT19       8-key tenoroon, I. Merklein, Vienna, ca.1835       F       952       663       1615       1584.8         FT26       12-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1836       F       982       660       1642       1657.3         FT2       13-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1840       F       983       665.1       1648.1       1651.2         FT2       15-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       983       665.1       1648.1       1651.2         FT38       12-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1842       F       999       661       1660       1663.3         FT45       12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842       F       999       661       1602.5       1602.5         FT41       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860–70       F       <	FT25	14-key fagottino, Jean-Nicholas Savary Jeune (2), Paris, 1827	Octave	645	425	1070	1068.5		FT27	1644.9	Paris (F)
FT43       7.4ey fagotfino, Johann Peter Leiberz, Koblenz, 1825–35       Octave       670       472       1142       1145.5         FT1       11.4ey tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835       F       940       662       1602       x         FT19       8.4ey tenoroon, I. Merklein, Vienna, ca.1835       F       952       663       1615       1584.8         FT26       12.4ey tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1836       F       982       660       1642       1657.3         FT2       13.4ey tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1840       F       983       665.1       1646.4       1651.2         FT2       11.4ey tenoroon, Jean-Nicholas Savary Jeune (11), Paris, ca.1840       F       983       665.1       1646.4       1651.2         FT31       12.key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       980       655.5       1638.5       1644.9         FT32       15.4ey tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842       F       999       661       1660       1663.3         FT45       12.key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842       F       999       661       1660.5       1602.5         FT45       12.key tenoroon, Giacinto Riva, Ferrera, ca.1860–70       F	FT35	0-key unfinished fagottino, Joseph Dupré, Tournai, ca.1830	Octave	637.5	447	1084.5	×		FT42	1651.2	Paris (F)
FT1       11-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835       F       940       662       1602       x         FT19       8-key tenoroon, I. Merklein, Vienna, ca.1835       F       952       663       1615       1584.8         FT26       12-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1838       F       982       660       1642       1657.3         FT2       13-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       983       665.1       1644.1       1651.2         FT27       16-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       980       655.5       1636.5       1644.9         FT38       12-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1840       F       980       655.5       1636.5       1644.9         FT38       12-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, ca.1842       F       999       661       1660       1663.3         FT45       12-key tenoroon, Johann Stehle, Vienna, ca.1850-60       F       950       658.8       1605.5       1602.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860-70       F       940       642       1582       1587         FT5       13-key tenoroon, Anonymous (6), Paris, ca.1660       F       948.5	FT43	7-key fagottino, Johann Peter Leiberz, Koblenz, 1825–35	Octave	670	472	1142	1145.5		FT26	1657.3	Paris (F)
FT19       8-key tenoroon, I. Merklein, Vienna, ca. 1835       F       952       663       1615       1584.8         FT26       12-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca. 1838       F       982       660       1642       1657.3         FT2       13-key tenoroon, Frédéric-Guillaume Adler (2), Paris, ca. 1848       F       947       630       1577       1535.9         FT42       11-key tenoroon, Frédéric-Guillaume Adler (2), Paris, ca. 1840       F       983       665.1       1648.1       1651.2         FT27       16-key tenoroon, Jean-Nicholas Savary Jeune (11), Paris, ca. 1840       F       980       655.5       1636.5       1644.9         FT34       12-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, 1841       F       980       651.5       1636.5       1644.9         FT34       12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca. 1842       F       999       661       1660       1663.3         FT45       12-key tenoroon, Johann Stehle, Vienna, ca. 1850-60       F       950       658.8       1608.5       1567.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860-70       F       940       642       1582       1587.9         FT5       13-key tenoroon, Anonymous (6), Paris, ca.1660       F       948.5 <td>FT1</td> <td>11-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835</td> <td>F</td> <td>940</td> <td>662</td> <td>1602</td> <td>x</td> <td></td> <td>FT38</td> <td>1663.3</td> <td>Paris (F)</td>	FT1	11-key tenoroon, Frédéric-Guillaume Adler (1), Paris, ca.1835	F	940	662	1602	x		FT38	1663.3	Paris (F)
FT26       12-key tenoroon, Jean-Nicholas Savary Jeume (4), Paris, ca. 1838       F       982       660       1642       1657.3         FT2       13-key tenoroon, Frédéric-Guillaume Adler (2), Paris, ca. 1840       F       947       630       1577       1535.9         FT42       11-key tenoroon, Jean-Nicholas Savary Jeume (11), Paris, ca. 1840       F       983       665.1       1648.1       1651.2         FT27       16-key tenoroon, Jean-Nicholas Savary Jeume (12), Paris, 1841       F       980       658.5       1648.9         FT38       12-key tenoroon, Jean-Nicholas Savary Jeume (8), Paris, ca. 1842       F       999       661       1660       1663.3         FT45       12-key tenoroon, Johann Stehle, Vienna, ca. 1850-60       F       950       658.8       1608.5       1602.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860-70       F       940       642       1582       1587.9         FT5       13-key tenoroon, Anonymous (6), Paris, ca.1860       F       940.6       651.8       1605.5       1562.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860-70       F       948.5       631       1579.5       1572.9	FT19	8-key tenoroon, I. Merklein, Vienna, ca. 1835	F	952	663	1615	1584.8		FT34	1682.1	Mechelen (B)
FT2       13-key tenoroon, Frédéric-Guillaume Adler (2), Paris, ca.1840       F       947       630       1577       1535.9         FT42       11-key tenoroon, Jean-Nicholas Savary Jeume (11), Paris, ca.1840       F       983       665.1       1648.1       1651.2         FT27       16-key tenoroon, Jean-Nicholas Savary Jeume (12), Paris, 1841       F       980       658.5       1638.5       1644.9         FT38       12-key tenoroon, Jean-Nicholas Savary Jeume (8), Paris, ca.1842       F       999       661       1660       1663.3         FT45       12-key tenoroon, Johann Stehle, Vienna, ca.1850-60       F       950       658.8       1608.5       1602.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860-70       F       940       642       1582       1587         FT5       13-key tenoroon, Anonymous (6), Paris, ca.1660       F       948.5       631       1572.9	FT26	12-key tenoroon, Jean-Nicholas Savary Jeune (4), Paris, ca.1838	F	982	660	1642	1657.3		FT41	1828.8	Sumiswald (CH)
FT42       11-key tenoroon, Jean-Nicholas Savary Jeune (11), Paris, ca.1840       F       983       665.1       1648.1       1651.2         FT27       16-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, 1841       F       980       658.5       1638.5       1644.9         FT38       12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842       F       999       661       1660       1663.3         FT45       12-key tenoroon, Johann Stable, Vienna, ca.1850–660       F       950       658.8       1602.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860–70       F       940.       642       1582         FT5       13-key tenoroon, Anonymous (6), Paris, ca.1660       F       948.5       631       1572.9	FT2	13-key tenoroon, Frédéric-Guillaume Adler (2), Paris, ca.1840	F	947	630	1577	1535.9				
FT27       16-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, 1841       F       980       658.5       1638.5       1644.9         FT38       12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842       F       999       661       1660       1653.3         FT45       12-key tenoroon, Johann Stehle, Vienna, ca.1850–60       F       950       658.8       1608.5       1602.5         FT47       13-key tenoroon, Giacinto Riva, Ferrera, ca.1860–70       F       940       642       1582         FT5       13-key tenoroon, Anonymous (6), Paris, ca.1860       F       948.5       631       1572.9	FT42	11-key tenoroon, Jean-Nicholas Savary Jeune (11), Paris, ca.1840	F	983	665.1	1648.1	1651.2				
FT38         12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris, ca.1842         F         999         661         1660         1663.3           FT45         12-key tenoroon, Johann Stehle, Vienna, ca.1850–60         F         950         658.8         1608.5         1602.5           FT47         13-key tenoroon, Giacinto Riva, Ferrera, ca.1860–70         F         940         642         1582         1587           FT5         13-key tenoroon, Anonymous (6), Paris, ca.1860         F         948.5         631         1572.9	FT27	16-key tenoroon, Jean-Nicholas Savary Jeune (12), Paris, 1841	F	980	658.5	1638.5	1644.9				
FT45         12-key tenoroon, Johann Stehle, Vienna, ca.1850–60         F         950         658.8         1608.5         1602.5           FT47         13-key tenoroon, Giacinto Riva, Ferrera, ca.1860–70         F         940         642         1582         1587           FT5         13-key tenoroon, Anonymous (6), Paris, ca.1860         F         948.5         631         1572.9	FT38	12-key tenoroon, Jean-Nicholas Savary Jeune (8), Paris ca 1842	F	999	661	1660	1663.3				
FT47         13-key tenoroon, Giacinto Riva, Ferrera, ca.1860–70         F         940         642         1582         1587           FT5         13-key tenoroon, Anonymous (6), Paris, ca.1860         F         948.5         631         1579.5         1572.9	FT45	12-key tenoroon, Johann Stable Vienna os 1850-50	F	950	658.8	1608.5	1602 5				
FT5         13-key tenoroon, Anonymous (6), Paris, ca.1860         F         948.5         631         1579.5         1572.9	ETAT	12-key tenoroon Giacinto Riva Ferrera on 1860.70		940	642	1583	1597				
r 240.0 031 13/3.3 23/2.3	ETE	12.key tenorona Annaumous (E) Davis as 1950	F	949.5	634	1570.5	1572.0				
	FT33	15 key landrow, AC Bhilings Mercell Barls of 1865		940.0	601	10/9.5	1550.4				
ET36         #5 minutes         Control (Control (Contro) (Control (Contro) (Control (Control (Contro) (Co	ETTE	16 kau kananan Gautat Alak Boda an 1877 at		0.57	630	1000	1609.0				

Table 2: Standing lengths.

#### Comparison of bore diameters of single joints (smallest and largest diameters)

Table 3 gives rough information about how conicity is different or similar when considering bore diameters of joints of different instruments having similar lengths, approximating bores to regular conic sections and ignoring how the diameter progressions along the bores can vary. Using the values given in Table 3, more conjectures can be made if the instruments come from same region and/or period.

The volume of air put into vibration is what is significant for pitch/tone with instruments having similar bore lengths. This volume of each joint (and of the whole instrument) is directly proportional to the length of each joint, but it is even more proportional to the diameters of beginnings and ends of each bore. In any case, for more profound information of the design of bores, please consult our bore measurement collection in the instrument datasets on our project website.

		WING	BUTT	LONG	
ID	INSTRUMENT TYPE MAKER	JOINT	JOINT	JOINT	BELL
NR		north/south	north/north	south/north	south/north
		mm	mm	mm	mm
FT14	3-key fagottino, Johann C. Denner	x	x	x	x
FT7	3-key fagottino, Anonymous (8)	x	x	x	x
FT39	4-key fagottino, Johannes & Georg H. Scherer (5)	x/12.3	12.8/20.2	21.3/25.8	25/23.1
FT40	4-key fagottino, Anonymous (11)	8.6/13.4	14.6/18	17.7/22.7	22.8/21
FT23	4-key fagottino, Godfridus A. Rottenburgh	x/11.7	x/x	16.3/21.6	x/21
<b>FT28</b>	4-key fagottino, Johannes & Georg Scherer (1)	10.4/12.7	13.2/18.4	16/22.4	23.3/21.8
<b>FT44</b>	4-key fagottino, Johannes & Georg H. Scherer (3)	7.7/12.7	14.2/18	17.3/22.5	27.6/21.7
FT29	4-key fagottino, Johannes & Georg Scherer (2)	9.4/13.4	13.6/18.9	15.67/21.8	23.8/21.9
<b>FT20</b>	4-key fagottino, Müller	10.6/11.3	12.4/17	16.5/20.4	20.1/20.4
FT30	5-key fagottino, Johannes & Georg Scherer (4)	8.3/13	14.2/18.8	16.5/21	23.4/22
<b>FT18</b>	4-kev tenoroon in G. I. Kraus (1)	8.4/13.8	15/21.6	20.4/25	26.6/23
FT9	4-key tenoroon in G. John Blockley	x	x	x	x
FT4	4-key fagottino Anonymous (4)	x	x	x	x
FT32	4-key fagottino, Heinrich C. Tölke (1)	x	x	x	x
ET13	7-key fagottino, fileminen C. Toike (1)	7 3/12 7	15/18 6	16 1/22	23 4/22 6
ET17	5 key fagetting, lapphy file	6 4/10 8	12 2/17 4	16 8/22 8	23 3/22
FT17	5-key lagolullo, Jacoby Ilis	v/12 7	12.2/17.4	20 2/24 2	23.5/22
FTTT	6-key tenoroon in G7, momas Canusac (1)	A/12.7	12.0/20.7	47 2/20 2	23.0/21.4
F133	4-key fagottino, Jean A. Tuerlinckx (1)	0.9/12.5	13.0/17.0	17.3/20.2	23/22.3
F13	4-key fagottino, Anonymous (1)	8.9/11.4	10.8/21.0	16/19.5	20.5/21.0
F112	7-key fagottino, Castlas	8.2/11.5	12.7/19.4	19/24.8	24.8/26.1
FT16	5-key fagottino, Heinrich Grenser (1)	X	x	X	x
FT22	5-key tenoroon in G, François-Xavier Proff	8.7/13.7	13.8/16.3	15.8/18.8	19.2/18.6
FT21	9-key tenoroon in F, Dominique A. Porthaux	7.5/13.8	14/22.8	19.6/27.6	27.5/26.4
FT24	5-key tenoroon in G, Savary pere	6.7/11.9	12.4/17.2	16.6/22.4	22.6/22.1
FT6	8-key tenoroon in G, Anonymous (7)	x	x	x	x
FT8	6-key tenoroon in F?, Georg Astor & Horwood	x	x	x	x
FT10	7-key fagottino, Bonaccorsi	6/9.5	9.6/13.7	13.7/19.5	20/19.2
FT31	6-key tenoroon in G?, Kaspar Tauber (1)	x	x	x	x
FT46	5-key tenoroon in G, Anonymous (12)	x	x	x	x
FT41	12-key tenoroon in F, Hirsbrunner (Gebrüder) 1	x/13.6	13.4/22.2	21.5/28.5	27.5/20.7
FT34	5-key tenoroon in F, Jean A. Tuerlinckx (2)	x/13.6	13.6/19.3	19.6/22.8	25.9/23.6
<b>FT15</b>	6-key fagottino, H. Grenser & S. Wiesner	5.8/10.5	11.4/18.8	18.2/26.4	27.3/23.3
FT25	14-key fagottino, Jean-Nicholas Savary Jeune (2)	6.7/12.7	12.9/19	19/25.5	24.4/27.5
FT35	0-key unfinished fagottino. Joseph Dupré	x	x	x	x/18.2
FT43	7-key fagottino, Johann Peter Leiberz	x	x	x	x
FT1	11-key tenoroon in F. Frédéric-Guillaume Adler (1)	x	x	x	x
FT19	8-key tenoroon in F. I. Merklein	10.4/12.6	21.8/20.6	21.5/28.1	34.3/25
FT26	12-key tenoroon in F. Jean-Nicholas Savary Jeune (4)	x	x	x	x
FT2	12-key tenoroon in F. Erédéric-Guillaume Adler (2)	9 8/12 6	12 7/19 8	19 4/25 2	26/26 7
ET42	11-key tenoroon in F. Jean-Nicholas Savary Jours (11)	7 4/13 9	13 5/21 8	22 3/30 5	30 3/34 7
ET27	16 key teneroon in F. Jean Nicholas Savary Jeune (11)	8 1/13 9	14 2/22 9	21 2/30	20 2/20 5
F12/	12-key tenoroon in F. Jean-Nicholas Savary Jeune (12)	v/12 7	13 9/22 4	21.2/30	20/29 7
FT45	12-key tenoroon in F. Johann Stohlo	x/13./	13.0/22.4	21.7/20.0	30/30.7 V
FT45	13-key tenoroon in F. Giacinto Riva	x	x	x	x
FT5	13-key tenoroon in F. Anonymous (6)	8.2/12.8	14.2/19.8	19/25	27/26.2
FT37	15-key tenoroon in F. A.G Philippe Marzoli	x/12.6	13.2/21.6	21.8/28	27/27.7
FT36	16-key tenoroon, Gautrot ainé	x/12.8	15.4/21	20.6/27.6	28/28.7

Table 3: Comparison of bore diameters.

#### Bocal lengths and diameters (shortest to longest)

A large range of bocal dimensions is displayed of those located with the examined small-sized bassoons in Table 4. It is impossible to confirm if all bocals have remained with the instruments they were built for (the only real test would be by playing), but of the three bocals located with Scherer fagottini, two are similar: FT44 (244 mm) and FT30 (258.3 mm). These kinds of comparisons can also be made with Savary Jeune bocals and others. An interesting investigation can be done by calculating the median of bocals located with different types of instruments.

Bocal and reed dimensions are complementary, influencing overall pitch, tuning, response, and tone quality. Reeds are generally chosen according to the individual player's requirements and can therefore vary substantially. We have not located any original reeds for small-sized bassoons.

*Fagottino:* The shortest fagottino bocal belongs to FT29 Scherer (130 mm); the longest, to FT30 Scherer (258.3 mm). The "fagottino bocal median" calculated from all available fagottino bocal lengths (without any geographical or chronological ranking) is ca. 198 mm.

*G tenoroon:* There are only three bocals listed for G tenoroons: FT11 (182 mm), FT18 (203 mm), FT6 (225 mm). The "G tenoroon bocal median" calculated from all the available G tenoroon bocal lengths (without any geographical or chronological ranking) is ca. 203.333... mm, which can be approximated to the FT18 bocal length.

*F tenoroon:* The shortest F tenoroon bocal belongs to FT45 Stehle (173 mm); the longest, to FT27 Savary Jeune (339 mm). The "F tenoroon bocal median" calculated from all the available F tenoroon bocal lengths (without any geographical or chronological ranking) is ca. 252 mm.

#### **Bocal Diameters**

*Fagottino:* The median of the diameters at the beginning is 3.57 mm; the smallest diameter is 3 mm in FT30 Scherer, and largest is 4.35 mm in FT7. The median of the diameters at the tenon is 7.4 mm; the smallest is 6.95 mm (FT43 Leiberz) and largest is 7.95 mm (FT44 Scherer).

*G tenoroon:* The median of the diameters at the beginning 3.7 mm; the smallest diameter is 3.45 mm (FT18 Kraus) and largest is 3.9 mm (FT6 Anonymous). The median of the diameters at the tenon is 8.3 mm and is the same value (8.35 mm) for FT18 Kraus and FT11 Cahusac.

*F tenoroon:* The median of the diameters at the beginning is 3.93 mm; the smallest is 3.6 mm (FT2 Adler) and largest is 4.55 mm (FT47 Riva). The median of the diameters at the tenon is 8 mm; the smallest is 6.8 mm (FT2 Adler) and the largest is 10.4 mm (FT27 Savary Jeune).

ID Nr	Instrument, maker	Length mm	Internal Ø at beginning mm	Internal Ø at tenon mm	External Ø at beginning mm	External Ø at tenon mm
FT29	4-key fagottino, Johannes & Georg Scherer (2)	130	3./3.4	6.8/7.9	4./4.2	8.3/8.4
FT13	7-key fagottino, Christophe Delusse	153	4	7.2/7.5	4.4/4.8	8.2/8.7
FT25	14-key fagottino, Jean-Nicholas Savary Jeune (2)	171	3.3/3.9	6.5/8.	3.75/3.9	7.8/7.9
FT45	12-key tenoroon, Johann Stehle	173	3.7/3.8	7.6/7.8	x	x
FT33	4-key fagottino, Jean A. Tuerlinckx (1)	178	3./3.6	6.8/7.5	x	x
FT11	6-key tenoroon, Thomas Cahusac (1)	182	3.7/3.8	8.2/8.5	4.5	10.7
FT20	4-key fagottino, Müller	182.5	3.2/3.5	7./7.7	4.1/4.3	8.5/8.8
FT12	7-key fagottino, Castlas	185.6	x	x	3.8/4.5	8.3/8.6
FT9	4-key tenoroon, John Blockley	199	x	x	3.4/3.47	9.7/9.64
FT18	4-key tenoroon, I. Kraus (1)	203	3.3/3.6	8./8.7	3.9/4.1	9.3/9.4
FT6	8-key tenoroon, Anonymous (7)	225	3.9	8.2	x	x
FT26	12-key tenoroon, Jean-Nicholas Savary Jeune (4)	229	3.7	7.3	x	x
FT7	3-key fagottino, Anonymous (8)	235	x	x	4.6/4.7	8./8.4
FT42	11-key tenoroon, Jean-Nicholas Savary Jeune (11)	235	3.55/3.9	8./8.2	4.2/4.3	9.1/9.2
FT43	7-key fagottino, Johann Peter Leiberz	242.5	3.9/4.	6.8/7.1	x	x
FT44	4-key fagottino, Johannes & Georg H. Scherer (3)	244	x	x	4./4.2	8.2/8.4
FT38	12-key tenoroon, Jean-Nicholas Savary Jeune (8)	245	3.8	7.7	x	x
FT34	5-key tenoroon, Jean A. Tuerlinckx (2)	254	3.8	8.5	x	x
FT37	15-key tenoroon, A.G Philippe Marzoli	257.5	3.9	7.4	4.2	8./8.2
FT30	5-key fagottino, Johannes & Georg Scherer (4)	258.3	3	7.3	3.8	8.7
FT21	9-key tenoroon, Dominique A. Porthaux	267	3.4/3.9	7.2/8.3	4.1	8.4/8.9
FT2	13-key tenoroon, Frédéric-Guillaume Adler (2)	271	3.6	6.8	4.1	8.3/8.6
FT47	13-key tenoroon, Giacinto Riva	281.6	4.4/4.7	8.3/8.5	x	x
FT41	12-key tenoroon, Hirsbrunner (Gebrüder) 1	319	4.8	9.3	5.5	10.7/10.8
FT27	16-key tenoroon, Jean-Nicholas Savary Jeune (12)	339	4.2/4.80	10.4	x	x

Table 4. Bocal lengths and diameters

## Conclusion

The preferred non-invasive 3D-CT technologies enable exhaustive investigations and data-gathering of historical woodwind instruments, but these are costly and not always practical. Granted, technologies are evolving very quickly, and these procedures may eventually become the norm. If such an investigation is however not possible, a careful manual examination may be allowed.

There has never been a consensus about the measurement points needed while collecting reference data for wind instruments. Even when similar tools are used for manual measuring among builders and researchers of wind instruments, the key points chosen to be measured might vary according to needs and goals. For instance, an exact reconstruction of a certain instrument will require a different set of measurements than a collection of data used as an inspiration to make a new, but historically inspired instrument.

This article focuses on instrument comparisons using the methods and key points developed in the scope of two research projects and described above. Using these methods, we were able to make comparisons and propose theories, drawing some conclusions about the construction of fagottini and tenoroons; for example, how the transposition pitch of the instruments is reflected in the length of the instruments.

Further analyses of the data collected may also throw some light onto many other characteristics and unique features about the history and construction of small-sized bassoons.

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