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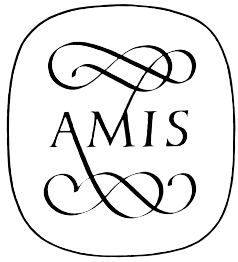

Gautrot and His Sarrusophone Revisited: A Multidisciplinary Approach

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This article offers an in-depth and multidisciplinary approach to the study of the sarrusophone.[1] We will focus specifically on the technology needed to produce it (procedures, machines, and tools) and its relative price in the market. After all, the sarrusophone was just one of the thousands of commodities available to nineteenth-century bourgeois society. We also discuss a dispute arising with the litigious Adolphe Sax concerning the sarrusophone's legitimacy under patent law.

The sarrusophone is a conical double-reed brasswind instrument fitted with a key system, invented in the middle of the nineteenth century.[2] It failed to establish itself as a common instrument, but once found a place in amateur groups (and bands)[3] and professional military ensembles.[4]

1. The author acknowledges and appreciates the corrections and suggestions from Ignace de Keyser, Albert Rice, Jerry L. Voorhees, Emanuelle Marconi, and Bruno Kampmann. He would also like to express his gratitude to the Institut national de la propriété industrielle (INPI) archivists, especially Steeve Gallizia and Amandine Gabriac; and to his colleagues Viçent Giménez Pons (oboe) and Arnau Coma Cunill (bassoon).

2. That paradigm, a brass tube fitted with keys and a double-reed mouthpiece, was not new. The sarrusophone was preceded by the *Tritonikon* (1854) by the Czech Václav František Červený, a sort of metal contrabassoon. This name and idea had been protected in 1836 by the Viennese builder Johann Stehle and developed by Schöllnast und Sohn in Bratislava. Other early brass examples are the *Contrabass* (ca.1840) by another Austrian, Léopold Uhlmann; and the *Contrafagotto in ottone* by Giuseppe Pelitti (after 1845). Bohuslav Cizek, *Instruments de Musique* (Paris: Gründ, 2003), 142–43; Günter Dullat, *Fast vergessene Blasinstrumente aus zwei Jahrhunderten* (Nauheim: the author, 1997), 132–33; Lyndesay G. Langwill, "The Double-Bassoon: Its Origin and Evolution," in *Proceedings of the Musical Association*, 69th Sess. (Leeds: Taylor & Francis, on behalf of the Royal Musical Association, 1942–43), 13–18, 23–25, and 28; Ignace de Keyser, "The Keyed Ophicleide as a Paradigm in the Development of New Wind Instruments in the 1830s and 1840s," in *Vom Serpent zur Tuba: Entwicklung und Einsatz der tiefen Polsterzungeninstrumente mit Grifflöchern und Ventilen*, XLI. Wissenschaftliche Arbeitstagung und 33. Musikinstrumentenbau-Symposium Michaelstein, 7. bis 9. November 2014 (Augsburg and Michaelstein: Wißner and Kloster, 2019), 83–84.

3. The first documented American amateur ensemble to make use of the sarrusophone in its formation was the Lyceum Concert Club (1883), which sought, with its unusual instrumentation, to differentiate itself from other ensembles and to be hired for more performances. James Russell Noyes, "Edward A. Lefebre (1835–1911): Preeminent Saxophonist of the Nineteenth Century" (PhD diss., Manhattan School of Music, 2000), 57.

4. The famous American bands of Gilmore and Sousa also used sarrusophones from

It has also had forays into jazz,[5] light music, and even the circus. In the opera and symphony, it was used by renowned composers such as Saint-Säens (*Noces de Prométhée*, 1867),[6] Dukas (*L'Apprenti sorcier*, 1897), Massenet (*Esclarmonde*, 1889; *Visions*, 1891; *Suite parnassienne*, 1912), Ravel (*Schéherazade*, 1898; *Rapsodie espagnole*, 1907; *L'heure espagnole*, 1907–09), Georges Sporck (*Boabdil*, 1902), Paderewski (Symphony in B minor (*Polonie*),1903), Debussy (*Le Martyre de Saint Sébastien*, 1911; *Jeux*, 1913), Lili Boulanger (*Psaume 130: Du fond de l'abîme*, 1917), Arrigo Boito (*Nerone*, 1924), and Stravinsky (*Threni*, 1957–58), among others.[7] These composers specified a sarrusophone in the named orchestral works or allowed it as a replacement, at least, of another instrument, usually the contrabassoon.

Its inventor was Pierre-Louis Gautrot, a compelling entrepreneur who patented the sarrusophone family for the first time on June 9, 1856. The name was an eponym combining the Greek suffix with the surname of a distinguished French military musician, conductor, and decorated officer (Chevalier de la Légion d'honneur), Pierre-Auguste Sarrus (1813–1876), who allegedly helped Gautrot to develop this invention. Although the name may have been motivated by gratitude, there was also a commercial intention behind it, since Sarrus was a publicly regarded figure. The naming convention, a custom already in use,[8] was to become more and

time to time to attract more audiences. A famous photograph of Gilmore's Band on the steps of the St. Louis Exposition (1889) included unusual instruments, including a contrabass sarrusophone easily visible. https://tubapastor.blogspot.com/2016/06/conrad-with-gilmores-band-1889.html. See also James B. Kopp, *The Bassoon* (New Haven and London: Yale University Press, 2012), 220 and 263. Perhaps the most important band of the time was *Garde Républicaine* from Paris, which also used the sarrusophone. E. Guilbaut, *Guide pratique des sociétés musicales et des chefs de musique* (Paris: Collective Ed., [1894]), 111–12. Italian and Spanish bands also sporadically used low sarrusophones. Anthony Baines, *Woodwind instruments and Their History* (New York: Dover, 1991), 167; a photo of the Alabarderos band appears in *Ilustración Musical Hispano-Americana*, December 8, 1889, 184.

5. The best-known recorded performance is Sydney Bechet's *Mandy, Make Up Your Mind* with Clarence Williams' Blue Five, a one-time band created by this American composer. Okeh S-73026B, December 17, 1924.

6. Fabien Guilloux and Emanuele Marconi, eds., *Un souffle de modernité! Camille Saint-Saëns et les instruments à vent* (La Couture-Boussey: Éditions du Musée des instruments à vent, 2021), 101.

7. Constant Pierre, *La facture instrumentale à l'Exposition Universelle de 1889* (Paris: Librairie de l'Art Indépendant, 1890), 40–47; and Bruno Kampmann, "Le sarrusophone dans l'orchestre symphonique," *Larigot* 23 (August 1999): 13. Some of these early scores can be found in the IMSLP repository.

8. Ignace de Keyser, "The Creation of Genius in 19th Century Music: The Case of Adolphe Sax," in *Romantic Brass. Das Saxhorn. Adolphe Sax' Blechblasinstrumente im Kontext ihrer Zeit.* Romantic Brass Symposium 3 (Schliengen: Argus, 2020): 113–47.

more frequent in the competitive bourgeois society, not only to achieve more sales but also recognition and longevity. One such entrepreneur, and Gautrot's counterpart, was Adolphe Sax, who argued that the sarrusophone was nothing more than a disguised copy of the saxophone, a controversy to be addressed below.

A review of its origins demonstrates how this instrument was valued by connoisseurs and critics of the time. The first important opinion we owe to Adolphe de Pontécoulant, in his report on the London International Exhibition of 1862, where the sarrusophone was featured in Gautrot's showcase.[9] Pontécoulant was rather negative and inclined to think that this upstart "might have had a future had it not been preceded by the saxophone, which is preferable to it in timbre and sonority."[10] He clarified that the sarrusophone family consisted of three members (tenor in B♭, baritone in E♭, and bass in B♭), corresponding to saxophones of the same pitch. However, Pontécoulant played down the importance of a possible kinship, judging that the sarrusophone and saxophone could be confused "in the eyes of the general public (*vulgaire*), but not in the ears of the musicians." Finally, he confessed that he was "not yet convinced of the usefulness of the sarrusophone in bands," where new timbres were welcome "and [in this respect] the sarrusophone offered nothing new."

Nicolas Boquillon's report of the event is more objective. According to this chronicler and librarian at the Conservatoire des Arts et Métiers, Gautrot "was probably the most important [firm] in the world for the manufacture of almost all types of musical instruments." When mentioning the sarrusophone, he did not describe it in contrast to the saxophone, but noted its similarities with the bassoon, noting that "new and extraordinarily loud sounds were obtained, especially in the low [register]."[11] However, due a paucity of evidence, "no statement could be made about the future of this artistic tool."[12]

Five years later, at the French International Exhibition of 1867,

9. No sarrusophones can be clearly identified in an engraving of Gautrot's stand of 1862. *Catalogue des instruments de musique de la manufacture générale de Gautrot Ainé* (Paris, 1878), xiii.

10. Adolphe de Pontécoulant, *Douze jours à Londres. Voyage d'un mélomane à travers l'Exposition Universelle* (Paris: Frédéric Henry, 1862), 221. The friendship that this melomaniacal count shared with Adolphe Sax was widely known.

11. Charles Pierre Lefebvre Laboulaye (dir.), *Annales du Conservatoire Impérial des Arts et Métiers*, tome 3 (Paris: Ed. Lacroix, 1862), 221–26.

12. *Études sur l'exposition universelle de Londres en 1862* (Paris: Ed. Lacroix, 1863), 224.

Pontécoulant provided additional information: that Gautrot was able to afford two stands full of instruments and, significantly, several sarrusophones, "a family of ten individuals, from soprano to contrabass, to cover an extension of six octaves."[13] According to Pontécoulant, these specimens were designed for the transformation of oboes, bassoons, and contrabassoons into brass instruments producing a more considerable volume, in order to restore the timbre of double-reed woodwinds to military music.[14]

Gautrot

Pierre-Louis Gautrot (1812–1882) is frequently mentioned in connection with the sarrusophone. The literature on woodwind and brasswind instruments includes an engaging article about his life and work,[15] and his name appears frequently in another article that provides substantial data.[16] However, Gautrot still lacks a rigorous and complete study, as does one of his countrymen, Gustave Besson. Both were overshadowed by Adolphe Sax during the peak of brass innovation and technologic fever of the nineteenth century.[17] There is more information to be studied in

13. A side view of Gautrot's double display case is in a photograph by P. Petit, Bisson *jeune* and Ch.-L.-L. Michelez in *Exposition universelle* (Paris, 1867) [*planche* 38: Palais central. France. Galerie II. Matériel des arts libéraux]. Although none of these ten specimens can be precisely identified in an engraving of the same in Adolphe de Pontécoulant, *La musique à l'Exposition Universelle de 1867* (Paris: Au Bureau du Journal l'Art Musical, 1868), 100 [bis], some information is provided in *Le Monde Illustré*, September 7, 1867, 155–56.

14. Pontécoulant, *La musique à l'Exposition*, 35–36, 70–71, 95, and 103. The English reporter, Mr. Clay, noted that "the sarrusophone is intended to take the place of wooden clarinets and bassoons in brass bands. And, inasmuch as its carrying power is much superior to that of the instruments now in use . . . its employment could clearly be advantageous in those ensembles." *Reports on the Paris Universal Exhibition, 1867*, vol. 1 (London: George E. Eyre and William Spottiswoode, 1868), 215–16.

15. William Waterhouse, "Gautrot-Aîné, First of the Moderns," in *Brass Scholarship in Review. Proceedings of the Historic Brass Society Conference, Cité de la Musique, Paris, 1999*. Bucina: The Historic Brass Society Series 6 (2006): 121–32.

16. Cyrille Grenot, "La facture instrumentale des cuivres dans la seconde moitié du XIXe siècle en France," in *Romantic Brass. Französische Hornpraxis und historisch informierter Blechblasinstrumentenbau. Symposium 2* (Schliengen: Argus, 2016), 11–97. See also Thomas Le Roux, "Le patrimoine industriel à Paris entre artisanat et industrie: le facteur d'instruments de musique Couesnon dans la Maison des Métallos (1881–1936)," *Le Mouvement Social* 199/2 [sic] (2002): 11–36.

17. Sax's "official genius," notoriety, and praise were frequently reported in the press, in exhibition reports, and supported by Louis-Philippe's and Napoleon III's governments and armies.

Gautrot's patents; his work with his predecessor Guichard, who began the *bon marché* (cheap production) of brass instruments;[18] his procedures and business relocations; and sociological aspects involving his employees. Besson is equally interesting, not only because of his inventiveness but also because he designed ad hoc machinery[19] that brought maturity, fluidity, and competitiveness to the market. He was possibly the most thoroughly documented maker in his manufacturing procedures.

In 1845, Gautrot inherited from Auguste-Charles Guichard, his brother-in-law, control of workshops located at the foot of the Notre-Dame Cathedral in Paris. The sizable company moved to the rue Saint-Louis, in the Marais district.[20] The new factory employed 200 workers and served as an official store. In addition, Gautrot in 1855 opened a second production plant with another 320 employees at Chateau-Thierry, a village ninety-five kilometers to the east of Paris where, no doubt, both workers' salaries and land prices were lower than in the capital city. That factory by the Marne River, a tributary of the Seine, was directly connected to Paris by boat for transport of products.

Two iconographic resources published at that time offer a detailed view of Gautrot's impressive use of technology and machinery one year before he patented the sarrusophone. In the magazine *L'Illustration*, an 1855 article begins with a friendly description of this huge establishment, stating that Gautrot "made all the instruments used to make music with the help of very clever processes which he set in motion [with] a steam

18. Gautrot was also known because he manufactured "shoddy" instruments (*de pacotille*), made quickly and carelessly. Many critics recognized the business advantages of that model, by which makers could reach into every pocket. But Gautrot also offered other instruments of a much higher quality. Bruno Kampmann, "French Makers' Improvements on Brass Instruments in the Mid-19th Century, Compared with Those by Adolphe Sax," in *Romantic Brass. Das Saxhorn. Adolphe Sax' Blechblasinstrumente im Kontext ihrer Zeit. Romantic Brass Symposium 3* (Schliengen: Argus, 2020), 175.

19. See, for example, Certificate of Addition of Gustave-Auguste Besson on 12 July 1856 concerning invention patent no. 22072 for "improvements of any kind of brass instruments (*pour des perfectionnements aux instruments de musique de tous genres en cuivre*)" from 18 January 1855 [for 15 years], 52–54 and 59 (Institut national de la propriété industrielle). His friend De la Fage promoted these new manufacturing methods (*Revue et gazette musicale de Paris*, August 3, 1856: 251), ensuring that his reviewing could distinguish the "centième de millimètre" in the diameter of tubes, and emphasizing the precision of the solid metal cores used. *Revue et gazette musicale de Paris* (November 4, 1855): 343. Hereafter *RGMP*.

20. Haine estimates that Gautrot amassed 600,000 francs per year. Malou Haine, *Les facteurs d'instruments de musique à Paris au 19e siècle* (Brussels: Université de Bruxelles, 1985), 73.

engine of sixteen horsepower."[21] Also noted was an "economy of labor that made it possible to produce cheap products with an excellent finish, which was important at a time when musical studies were so highly developed." Moreover, the French builder applied "a more rational system of division, form, and proportions" to his instruments, but was not allowed to exhibit some examples at the Universal Exhibition of 1855. Unmentioned was that Adolphe Sax had recently reported him for plagiarism and provoked two raids by bailiffs on his factory and the fairground. The report went on to list most of this merchandise, as well as the main improvements on some items, namely his valve system for the horn, cornet (or bugle), etc., which aimed at ease of playing, avoiding crook changes (*corps de rechange*); an improved ophicleide with new fingerings and proportions; the implementation of a gear, called *système Bréguet*, to improve note changes on instruments with valves;[22] and, finally, a sort of mobile mouthpiece for playing still or in motion.[23]

A glance at the first illustration (fig. 1) shows in the lower right foreground brass sheets, the starting point for all brass musical instruments. These (and perhaps some premade tubes) were supplied by external metalworking factories.[24] Next to the sheets of brass, the huge scissors that would have been used to quickly cut the material are depicted. Adolphe Sax seems to have used a guillotine for the same purpose.[25] Moving to the left, we can see various tools, such as hammers, sharp objects, an anvil, and the clamping jacks, also known as vises.[26] In addition, at least two mandrels

21. *L'Illustration*, July 21, 1855, 43–45.

22. The name Bréguet is linked to one of the most important watchmaking firms of all time. This suggests how crucial technology was transferred between products of the time, especially from clockmaking (*horlogerie*, requiring much mechanical precision) to the building of brass and woodwind instruments. In another example, Claude Laurent, the flute maker, was also a watch maker.

23. Gautrot also wrote an article promoting himself and his products in *RGMP*, December 6, 1857: 400, mentioning the meticulous care (*soin minutieux*) he applied in their manufacture and testing.

24. The 1847–48 survey provides several professions that may match with this type of supplier, specifically the *fondeurs* (founders), with a total of 77 employers and 1,979 workers, or the laminators (*lamineurs*) and metal-sheeters (*planeurs de métaux*), 13 employers and 90 workers. *Statistique de l'industrie de Paris résultant de l'enquête faite par la Chambre de Commerce pour les années 1847–1848* (Paris: Guillaumin, 1851), 157–58.

25. This is based on iconographic sources in a 3D recreation of Sax's factory and equipment in *Sax Revolutions: Adolphe Sax's life* (Documentary in DVD; José-Modesto Diago, dir. and prod.) Exp. no. CA-217-14. Cádiz, 2014, 64 min: son. col., from 8:40 to 13:24.

26. Using Sax as a reference and primary source in the inventory of his first bankruptcy, other minor tools used by this type of maker were "periwinkles" (or winkles), a kind

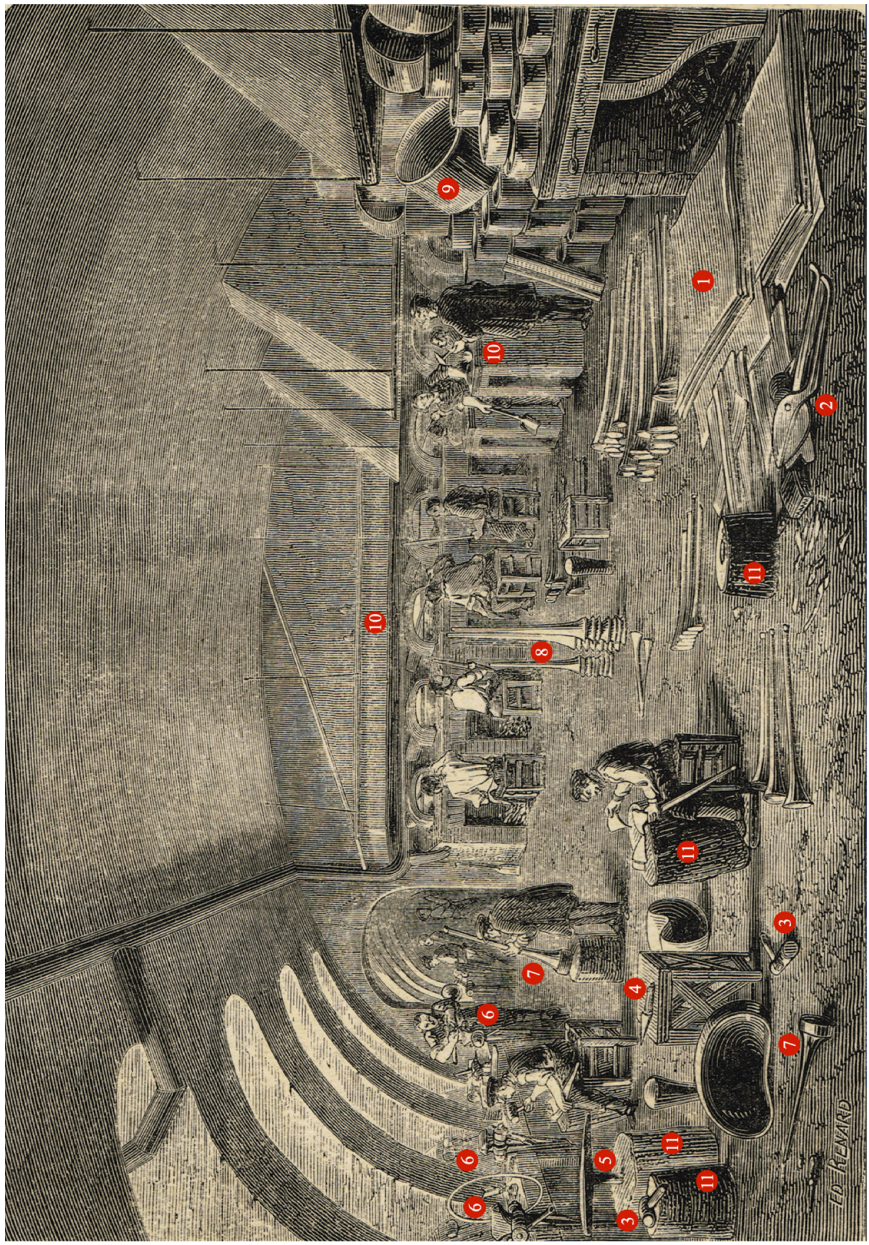


FIGURE 1. View of a part of the workshops of the Gautrot aîné factory in the Marais district, Paris (1855) and its most significant elements: brass sheets or plates (1), shears (2), hammers (3), perforator (4), anvil (5), leg vise (6), mandrels (7), bells or *pavillons* (8), kettles or drum shells (9), furnaces (10) and tree stumps (11). *L'Illustration*, July 21, 1855: 44.

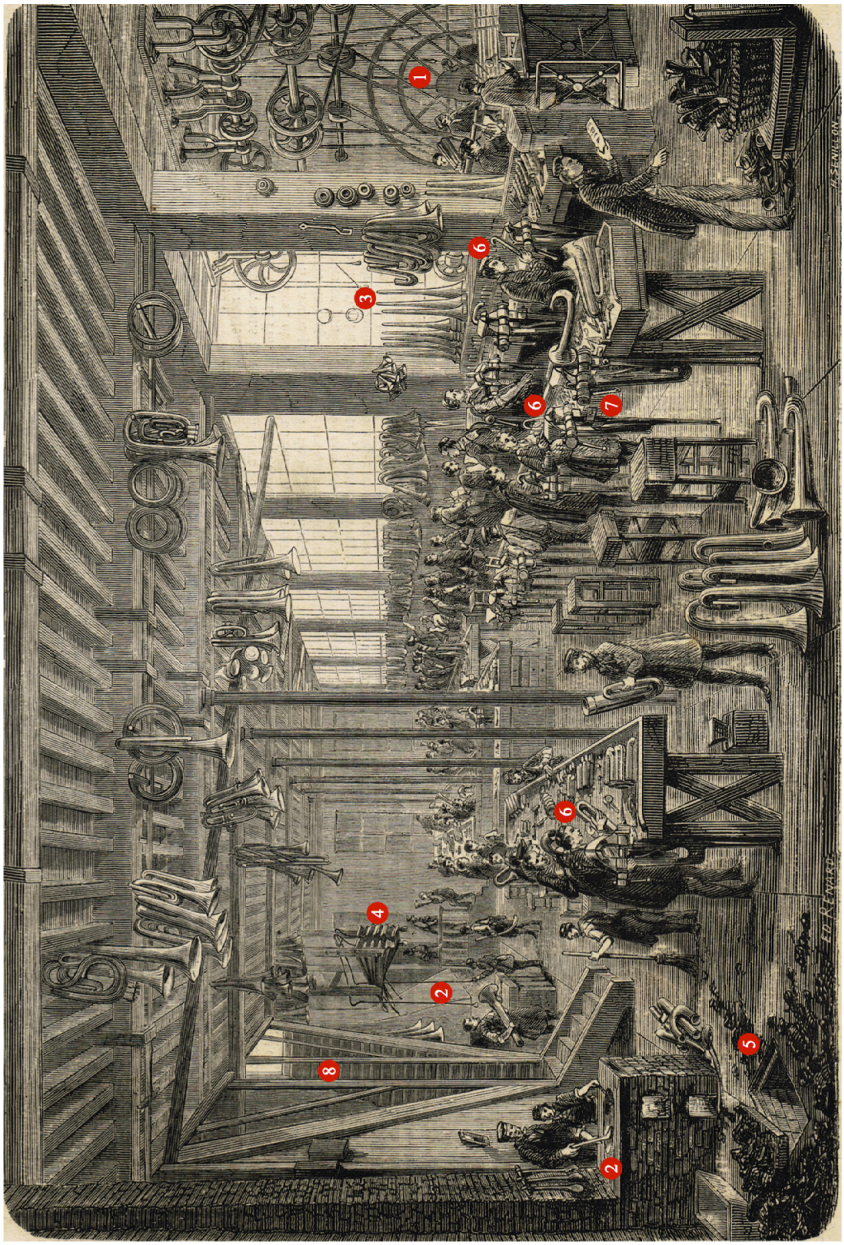


FIGURE 2. Details of the ground floor of the Gautrot aîné factory in the Marais district, Paris (1855) include: steam engine and belts (1), crucibles, forges, or furnaces (2), mandrels? (3), bellows (4), coal bunker (5), assembly sections (6), leg vises (7), and stairs (8). *L'Illustration*, July 21, 1855: 44.

and several instrument bells piled in the center of the image can be seen. To the right, also piled up, are numerous cauldrons or shells, probably intended to become the outlines of the bodies of percussion instruments. However, the most noteworthy parts of the image are people working in the small furnaces or forges, from which it can be deduced that this is the welding room, where the bells or sound reflectors were made.[27]

Briefly describing the other design from Gautrot's workshop (fig. 2): to the right is a steam engine, enclosed by a gate, used to drive numerous belts. Unfortunately, neither its composition nor its cogwheel teeth, which seem rather blunt, can be seen. On this floor, there are also at least two forges, one of them with a bellows on top, and a coal bunker in the floor. Judging by the equipment, this is the area where the instruments were assembled, composed, or finished.

The point to emphasize is that Gautrot's factory was equipped with specific machinery and tools for cutting and working brass with precision, assembling pieces, and, preeminently, assembling keys and complicated mechanisms. Below we have a first-hand look at what that technology was like, and how he captured it in two patents for the sarrusophone.

Two Patents

Gaturot obtained two patents for his sarrusophones. A document of this type reserved the owner's right to manufacture and to sell the product exclusively in France for five, ten, or fifteen years, and to grant licenses to other makers, who were then free to produce the instruments. In addition,

of hook twisted on itself (*bigorneaux*), blowtorches (*chalumeaux*), draw bench (*banc à étirer*), anvils (*enclumes*), shears (*cisailles*), tongs (*tenailles*), elbows (*tasseaux*), mandrels (*bouterolles*), reamers (*fraises*), bits (*forets*), hand drills (*vilebrequins*), tacks (*pointes*), burins (*poinçons*), pincers (*pinces*), etc., among many others. Malou Haine, "Les faillites des facteurs d'instruments de musique: La cas Adolphe Sax en 1852," *Musique-Images-Instruments* 13 (2012): 148–50.

27. Pontécoulant mentioned a characteristic of some of nineteenth-century brass makers. The maker Jacques-Charles Labbaye "still combined in 1834 the trade of coppersmith (*chaudronnier*) with that of brass-instrument maker." Adolphe de Pontécoulant, *Organographie. Essai sur la facture instrumentale. Art, industrie et commerce* 2 (Paris: Castel, 1861), 376. As is well known, in the *ancien régime*, not only *luthiers* but also some carpenters and cabinetmakers made bowed or plucked string instruments. Before there was a definitive specialization in making brass instruments, those who could earn extra money by making signal or percussion instruments included forge operators, blacksmiths, goldsmiths or, as in the case of the Labbayes, manufacturers of metal cooking vessels. Adrien de la Fage, *Quinze visites musicales à l'Exposition Universelle de 1855* (Paris: Tardif, 1856), 140.

the patent was a legal tool to be used as protection or to attack violators of the patent in courts of law, possibly receiving economic compensation and the right to confiscate the conflicting goods and machinery.[28]

The First Patent

The first patent (no. 28034, filed on June 9, 1856) claimed a fifteen-year protection "pour un instrument de musique dit: Sarrusophone." The description and specifications (*mémoire descriptive*) occupied barely three handwritten pages, in which Gautrot confessed that instrument makers "of all times" always had the desire to build a single family of instruments that would accommodate the entire register of the orchestra. According to him, such an initiative had not been satisfactory for the brass family, especially when these instruments were built in larger sizes and there was a physical limitation for the player to produce such frequencies. Moreover, the other bass instruments he mentioned—ophicleides with keys or valves, the bassoon, the contrabassoon *allemand*, the batyphone, and the saxophone—did not reach the bass notes of the string bass, and some (those using reeds) did not even tune well (*manque de justesse*).

To alleviate these problems, Gautrot built the family of sarrusophones, whose members completed the full range of pitch and maintained a desirable sonority and tuning. The author added that the tube was conical and that he had drilled seventeen holes along its length, all of which were keyed. He also commented that the sarrusohone's reed was similar to that of the bassoon, and that the family extended from the B♭ soprano to B♭ contrabass. Gautrot remarked that the sarrusophone's timbre was completely new and that its fingering was very easy and similar to that of the clarinet.

He then went on to briefly describe the design that accompanied the patent (fig. 3) featuring a baritone sarrusophone in B♭, seen from the front and back. It is accompanied by a sketch of the bell (center), and three pairs of reeds of different sizes for different members of the family, placed below. No further information was added, except that the design of the

28. The law ruling patents of invention in France at the time the sarrusophone was protected was passed in 1844. For more information, see Jean-Baptiste Duvergier, *Lois, décrets, ordonnances, règlements et avis du conseil d'état*, tome 44, Année 1844 (Paris: Guyot et Scribe, 1845), 553–621.

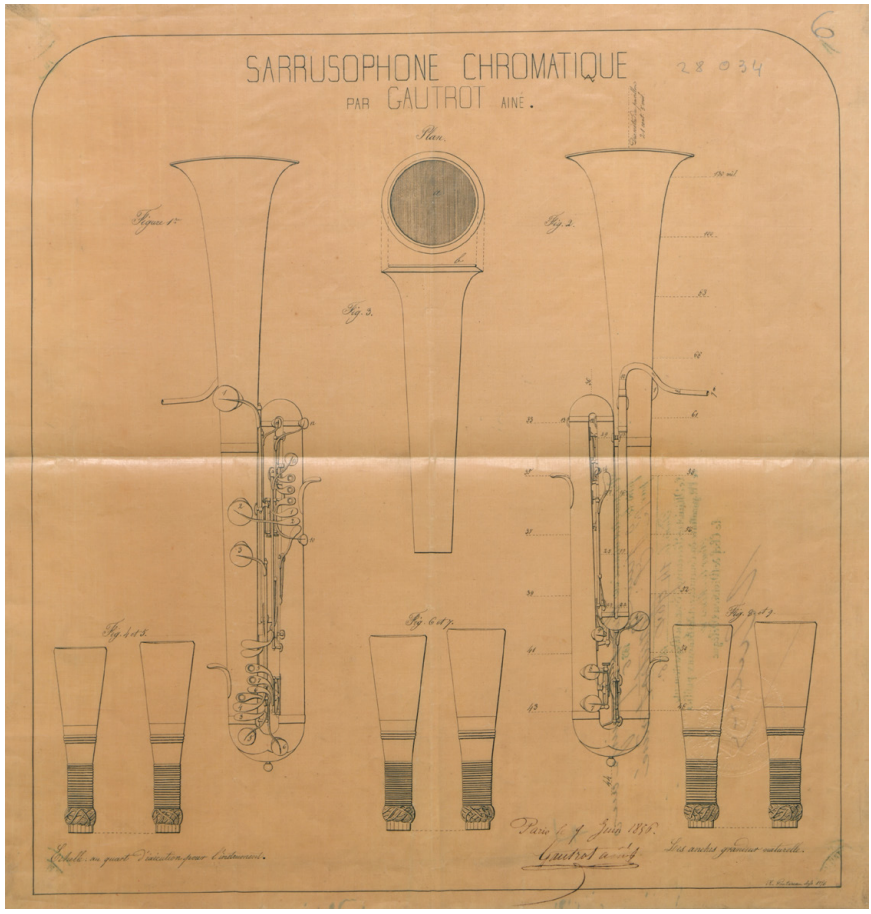


FIGURE 3. Main sketch of Pierre-Louis Gautrot's first sarrusophone patent, no. 28034, for "un instrument de musique dit: Sarrusophone," 9 June 1856, 6. Institut national de la propriété industrielle.

instrument on the left incorporated additional drawn circles on some key touches to indicate open-standing keys, and on the instrument on the right there are numbers representing the cross-sectional measurements of the tube in millimeters. The last three paragraphs were devoted to justifying the attachment of a table representing the scope of five members of the family,[29] the motivation for the name of the instrument,[30] and the right to explain the resources of this new family in further detail in the future.

Perhaps some partial conclusions could already be drawn, such as the presumed search for a wider tonal range, the ease of execution, or its "familiarity" with the bassoon. But the document reveals a certain immaturity in the explanation and designs, possibly motivated by the rush to bring out a new product that was not yet truly finished.

The Second Patent

Gautrot confirms this assumption in the introduction to the second patent, no. 67433, for improvements made to the family of sarrusophones (*pour perfectionnements apportés à la famille des sarrusophones (instruments de musique en cuivre)*), filed on May 20, 1865, and valid for fifteen years. This document is more extensive than the previous one, having eight handwritten pages and fourteen detailed sketches (*planches*) with designs of all family members. In addition, the document had an appendix with a Certificate of Addition, deposited on 8 February 1867, comprising three more pages and a double plate.

The *mémoire descriptif* in the original document quoted his patent of nine years earlier and regretted not having better explained the construction details of the family members on that occasion. Indeed, he said that he had completely reorganized the family and carried out numerous tests to determine the location of the twenty holes, no longer seventeen; the place they occupied on the body of the instrument, and the diameter they required. He also performed tests to determine the proportions, that is,

29. These are: soprano in B♭, mezzo soprano in E♭, tenor B♭, bass in B♭ and double bass in B♭. Following the pitch index according to Scientific Pitch Notation, the range from the highest note of the soprano in B♭ to the lowest note of the double bass in B♭ comprised from $G♭^{6}$ to A^{0}.

30. "I have given the name Sarrusophones to these instruments because I wanted to show a public recognition of gratitude to my friend Sarrus, the band conductor [of music] of the 13th Line Regiment, for his support provided with my new invention."

the gradual taper of the tube for each member of the family. Moreover, he claimed that the sarrusophones he was now proposing had practically nothing to do with those he had presented in 1856, except for the original concept and the double-reed.

According to him, the family he recreated was the most complete of all the families of wind instruments. He observed seven types: soprano in B♭, alto in E♭, tenor in B♭, baritone in E♭, bass in B♭, contrabass in E♭, and, finally, the contrabass in C, which could reach two tones below the lowest note of the stringed contrabass. However, he intended to develop two more models in the future: a sopranino in E♭ and a contrabass in B♭.[31]

He used the following paragraphs to describe the reed, noting its similarity to those of the oboe and bassoon, but producing a somewhat louder sound; the fingering, which he related to that of the oboe or clarinet; and the timbre, which resembled that of the oboe or bassoon, depending on whether one used treble or bass sarrusophones. He also said that the deep models had the advantage of being louder than the bassoon, but that their intensity could be easily controlled.

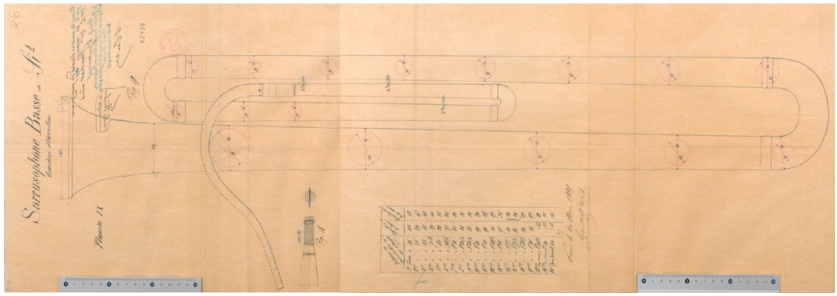
Gautrot included a description of the "sounding body" (*corps sonore*), the most important part of the document, as he acknowledged ("J'arrive à un point important et qui en grande partie a motivé cette demande de Brevet.") He listed four parameters that gave substance to his invention and that helped to explain its design:

1. The length of the tube, which determines the pitch and tonality of the instrument.
2. The diameters of the holes, which provide the correct or fine quality of tuning, as well as the sonority (*la justesse et la sonorité*).
3. The distance from the center of each hole to the end of the bell.
4. The diameters of the tube along its length, called proportions (*les proportions*), that is, how wide the tube was the diameters at places where a hole was drilled.

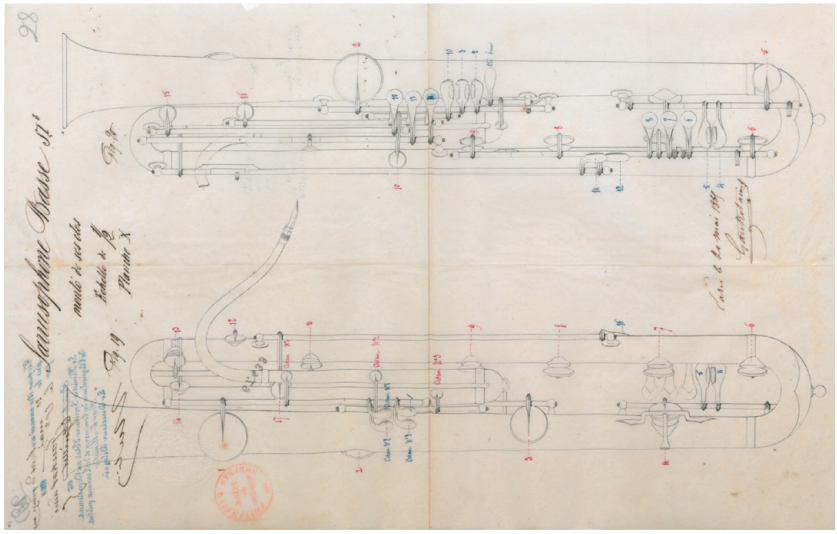
31. Bruno Kampmann indicates that Gautrot made a tenth type, the C bass, equivalent to the bassoon in pitch (number 131 of his collection), although he never saw any mention of this pitch in catalogs or articles. In addition to Kampmann's and according to the information of one of the reviewers of the article, there are two other specimens in that pitch.

The B♭ contrabass sarrusophone was the deepest woodwind ever in commercial production, reaching A♭^{0}, a tone below the contrabassoon. Robert Howe, "On the Dating of Instruments Marked 'Triebert,'" *Journal of the American Musical Instrument Society* 45 (2019): 244–46.

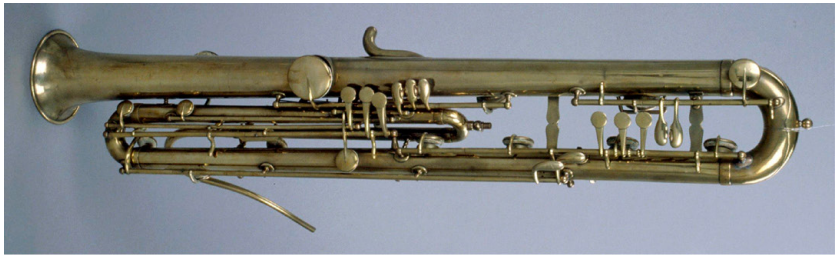
(a)



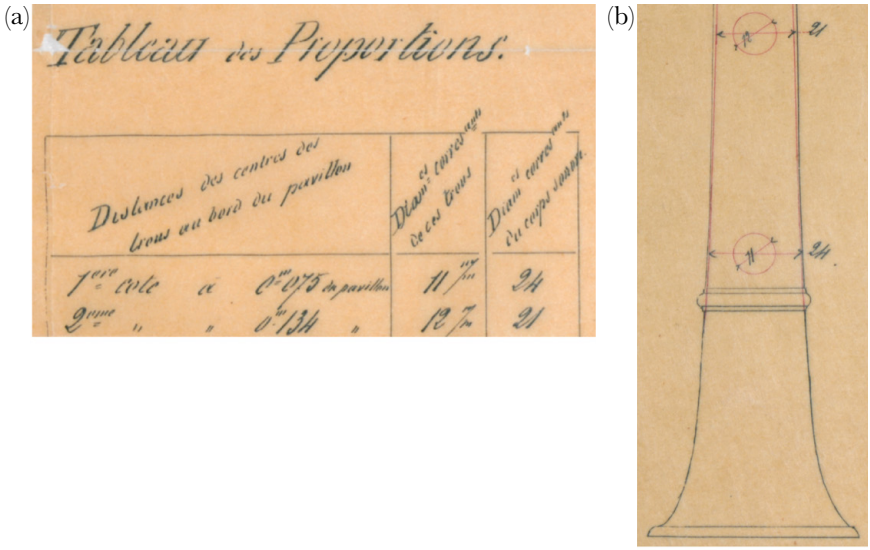
(b)



(c)



FIGURES 4 a–c. Sketches (a, b) of the B♭ bass sarrusophone from Gautrot's second patent, no. 67433, for "perfectionnements apportés à la famille des sarrusophones," 20 May 1865, planches IX and XX. Institut national de la propriété industrielle. (c) B♭ bass sarrusophone by Gautrot-Marquet, Musée de la Musique de Paris, E.1168. Photo by Thierry Olivier.



FIGURES 5 a–b. Parameters (a) of the soprano sarrusophone according to Gautrot's second patent and their correspondence (b) with the body of the instrument. Patent no. 67433 for "perfectionnements apportés à la famille des sarrusophones," 20 May 1865, *planche I*. Institut national de la propriété industrielle.

Afterward, he mentioned once again those fourteen sketches organized in three groups, one without keys, and the other two with them. This pair below is seen from the front and the back, for each member of the seven sarrusophones specified by Gautrot. Besides a figure of a reed corresponding to each member, all had an annexed table in which he had included the detailed data with which he had constructed the family and which obeyed the previous four parameters (*quatre conditions*) (fig. 4).[32] To be better understood, Gautrot provided data about the sketch of the soprano model[33] which, he assured the reader, could be extrapolated to the whole family. For example, it had two octave keys, but these were extended to three in bass members. There are two colors for keys that have a similarity with the fingering of the flute, clarinet, or oboe; blue for the buttons (touches) and red for the plates that act as plateau keys. He also instructed the learner how to play a chromatic scale and noted which

32. There were in fact only parameters 2, 3 and 4, because this list of measurements lacked the total length of the tube (the first parameter), which was calculated from the scale size for each of the sarrusophones. For example, the contralto is represented at "grandeur naturelle" scale, i.e., 1:1; and the bass at "1/2 grandeur," i.e. 1:2.

33. However, this model had a strangely drawn double tube, actually a tube within a tube, because, he claimed, it was too narrow and created problems.

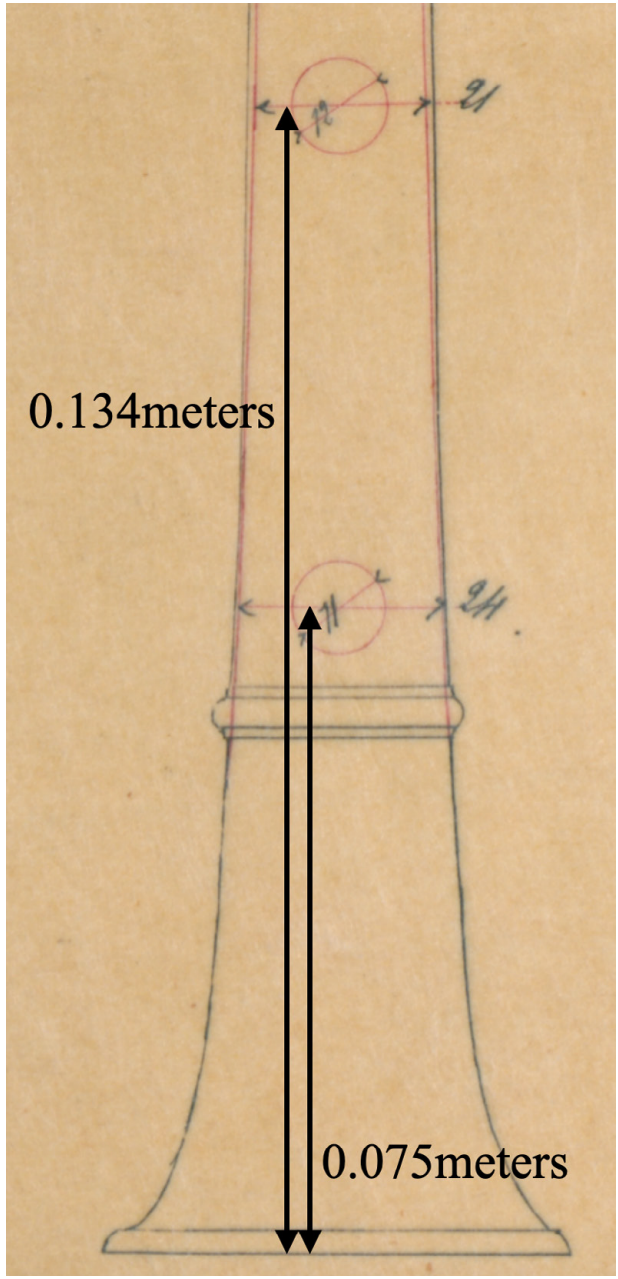


FIGURE 6. Representation (vertical arrows and measurements added) of the third parameter (taking two values as references) for the soprano sarrusophone according to Gautrot's second patent. Patent no. 67433 for "perfectionnements apportés à la famille des sarrusophones," 20 May 1865, *planche I*. Institut national de la propriété industrielle.

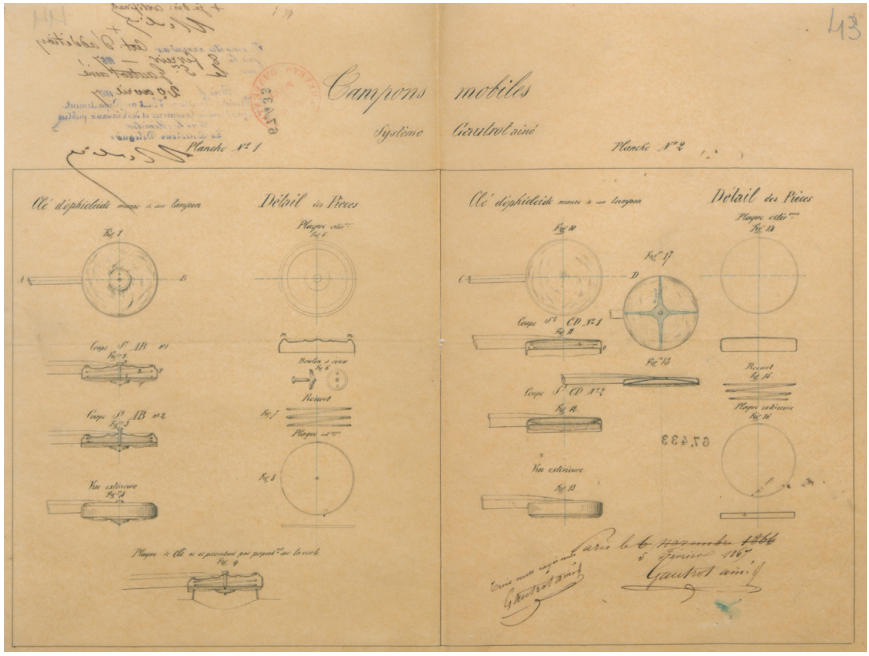


FIGURE 7. Main sketch of Gautrot's Certificate of Addition for adaptable pads. Certificate of Addition, 8 February 1867, to Patent no. 67433 for "perfectionnements apportés à la famille des sarrusophones," 20 May 1865, 43 [in pencil]. Institut national de la propriété industrielle.

keys were closed or open when at rest.

In the last two paragraphs of the document, he again disavowed the first patent of 1856 ("il est difficile de reconnaître le même instrument") claiming the importance of the second patent since a number of its refinements produced a "nouvel instrument," a distinction that, in the event of conflict, would be determined by a judge. The most interesting aspect of this patent is the use of the four parameters, which were actually three. In fig. 5a, the upper portion of the two first rows in the table of proportions for the soprano sarrusophone is reproduced. The right column expresses the diameter of the tube walls (fourth parameter) as the width in millimeters, 24 and 21; these labels also appear on the right side of the instrument's tube (fig. 5b). The central column of fig. 5a shows the diameter of the tone holes (second parameter) in millimeters (11 and 12), also indicated within circles in fig. 5b. The column on the left shows the longitudinal distance from the center of these openings to the edge of the bell (third parameter): 0.075 meters and 0.134 meters. However, these two

numbers are not replicated in the drawing, but measured from the center of the tone holes (second parameter), indicated by horizontal stripes, to the edge of the bell (fig. 6).

The patent did not end there, since Gautrot annexed a Certificate of Addition on February 8, 1867.[34] However, the improvement was not exactly aimed at the structure of the instrument, but at its pads, which he called "tampons mobiles," that is, movable or adaptable pads. The problem he wanted to alleviate was an unsure closure of some pads (air leaks) on their respective tone holes, which generated sound problems ("la note se produit sourde, fausse et quelquefois même pas du tout") not only on the sarrusophone, but also on the saxophone "and in general in all instruments with keys." His idea was to embed a spring inside the pad so that it would sit better and be completely airtight. In the attached design, he proposed two versions, with and without a sort of central screw or bolt (*boulon*) (fig. 7).

Controversy

It is clear that the sarrusophone had legitimacy to exist and that its patentee had adequately protected it in the two patents he filed. However, some entrepreneurs would do everything possible to undermine their rivals, even take them before the courts.[35] In fact, the unofficial perception of the sarrusophone was tense, and certain intellectuals were opposed to it. For example, Pontécoulant (1861) commented that Gautrot wanted to "counterbalance the acceptance and vogue of the saxophone with a gross copy which he called the sarrusophone."[36]

What triggered the legal battle for the sarrusophone occurred on the exact day before the patent for the saxophone expired (March 20, 1866).

34. These *certificats d'addition* were regulated by the third section of the law, articles 16 to 19. Their fundamental characteristic was an absolute dependence on the main patent and they had the advantage of being cheap, only twenty francs. This encouraged many makers to obtain more to protect their product from being easily copied. However, they were also used irregularly, since many makers used them to create a new invention with little or no link to the original document.

35. Jeremy Montagu, in *The Industrial Revolution and Music* (Oxford: Hataf Segol Publications, 2018), 115, held that Gautrot "conspired with other enemies of Sax to have them [the sarrusophones] adopted in the French military bands instead of the saxophones."

36. Pontécoulant, *Organographie*, 513.

With judicial backing, Adolphe Sax spurred a raid by bailiffs on the establishments of his professional rivals, namely Gautrot, Halary, Millereau, Leroy and Goumas, Buffet *jeune*, Jules Martin, M[me] Besson, Barbu father and son, Massabo, Kroll, the Martin brothers, Couturier, Gaubert, and Bohem.[37] Sax charged all these dealers with the infringement of his saxophone patent because he believed it was unfair that they could trade in those minor items which made it possible for the instrument to sound (mouthpieces, clamps, reeds, and pads). He also accused certain firms of having repaired saxophones, a right which Sax also considered exclusively his own. In addition, he reported Buffet *jeune* for selling saxophones, noting that he previously had "purchased them at a lower price from regimental bands."[38]

A little over five months after the raid, the *Tribunal Correctionnel de la Seine*, under President Vivien, found Sax's accusations capricious and dismissed all charges against the defendants in the sentence of August 23, 1866. The seized material was returned to the makers and they were compensated for minimal damage to their shops, with sums of between 100 and 150 francs.[39] However, the judge retained a sarrusophone by Gautrot, which was seized from an entrepreneur and inventor named Cordier, and requested the help of an expert, Monsieur Surville, to investigate how closely this instrument resembled the saxophone. Vivien subsequently credited Sax, who maintained that the sarrusophone "was nothing more than a disguised copy of the saxophone, obtained by narrowing the dimensions of the former and applying to it, instead of a single-reed mouthpiece,

37. Interestingly, five of these firms had been licensees of Sax for saxotrombas (Gautrot, Halary, Millereau, Jules Martin, and Couturier) and one might assume that there was some deference or warning before proceeding with this aggressive seizure. However, the opposite was the case.

38. *Annales de la propriété industrielle, artistique et littéraire*, tome 15 (Paris, 1869), 304 and 308. The defendant was Auguste Buffet (1816–1884), who inherited his nickname from his father, Louis-Auguste Buffet (1789–1864), deceased two years before. Albert Rice, "The Early History of the Nineteenth Century Boehm-System Clarinet," *Musique-Images-Instruments* 13 (2012): 132.

39. The court rejected Sax's request to reconsider the seizure of mouthpieces and other related items as legitimate. His desperate argument was that, as the saxophone was a completely new and unchallenged instrument, its component parts were, by extension, also exclusive. *Note sur le brevet du saxophone. Réponse aux conclusions de Monsieur l'Avocat général. M. Sax contre MM. Gautrot, Leroy et Goumas, Jules Martin, Martin frères, Lecomte et Cie, Millereau, Buffet jeune, Halary, femme Besson, Barbu père, Barbu fils, Massabo, Kroll, Couturier, Bohem et Gaubert. Chambre des appels de Police Correctionnelle. M. Saillard Président. M. le conseiller Falconnet, Rapporteur. M. Ducreux, Avocat général* (Paris, [1867]), 4–24.

a double-reed mouthpiece similar to that of the bassoon."[40]

All the businessmen mentioned above appealed, some to obtain higher financial compensation, fifty times higher in some cases, and also Sax, because he did not agree with the outcome. However, the remainder of the story is the battle for the sarrusophone between Gautrot and Sax.

While the case escalated to the Court of Appeal, Gautrot paid Victor Bois, a civil engineer, for a private report at the end of 1866 that subsequently was published as a *factum*,[41] to provide more credibility to his invention. According to this report, the expert compared an Adolphe Sax alto saxophone (serial number 5891) and an E♭ alto sarrusophone, concluding that they were different instruments. He observed that the latter was less conical than the former and, using measurements precise within half a millimeter, provided tables of the distances of each hole from the mouthpiece and each other, as well as hole diameters and the tapering at that point. Bois correctly concluded that these data did not follow any arithmetic or geometric progression, nor were they made according to an established acoustical rule. Rather, he concluded, the builders had based their work on established facts (*données générales qui sont prises sur des constatations de faits*) and their own background, study, and experiences (*ou plutôt sur l'expérience*). This process allowed them to arrive at these instruments almost blindly but with much effort (*peine*) and expense (*beaucoup de dépenses*).[42]

The sarrusophone battle continued in the Court of Appeal where arguments were heard on January 4, 11, and 18, 1867. However, the judge and president of the court, Saillard, who had previously heard the conclusions of the advocate general Ducreux, was clear in his judgment of February 15 and ruled against Adolphe Sax, who was ordered to pay the costs of

40. *Annales de la propriété industrielle*, tome 15, 302–05.

41. A *factum* is a pamphlet published by those interested in a legal action in order to defend themselves, or to refute or attack their opponent. These pleadings usually contained, among other things, a statement of the facts (according, obviously, to self-interest), alleged fragments of original sentences, and a (pseudo-)legal reasoning that sought not only to influence the judges, but also adjacent agents involved in the process. These were not the official minutes of a trial, nor did they emanate from the presiding authority, but from the individuals themselves or their lawyers.

42. *Affaire Sax contre Gautrot. Attaque du sarrusophone en contrefaçon du saxophone. Consultation de Monsieur Victor Bois, Ingénieur, sur la différence existant entre ces deux instruments* (Paris, 1866), 1866, 1–8. Sax complained about the work of this specialist and pointed out that his review lacked any legal value. *Note sur le brevet du saxophone*, 31–35.

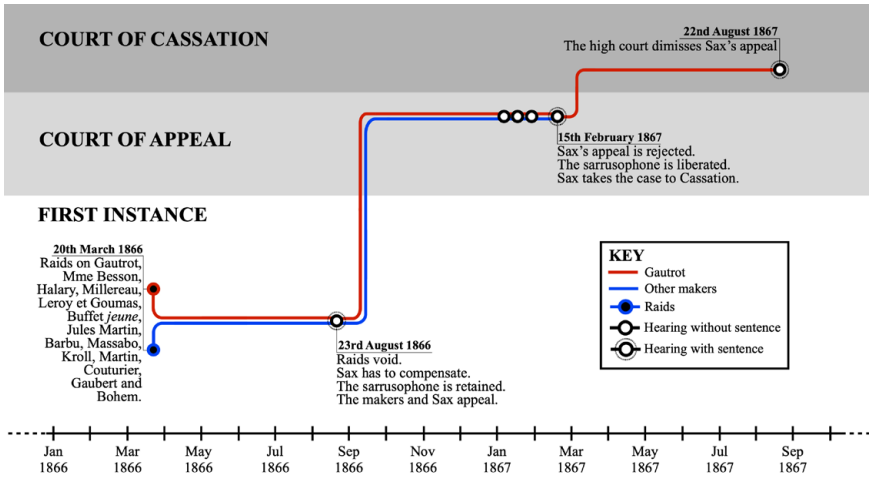


FIGURE 8. Timeline of the Sax vs. Gautrot legal confrontation concerning the sarrusophone. Compiled by the author.

the trial.[43] Saillard also ruled the order of the previous chamber, which had requested the supervision of an expert (Surville),[44] as a "useless assignment," since "the instrument called sarrusophone, made by Gautrot, is not a forgery of the saxophone." In addition, Gautrot was to receive a compensation of 1,000 francs for all the inconvenience that Sax had caused him.

But there was still an opportunity to reverse this situation in the Court of Cassation, an option that Sax did not hesitate to use, basing his complaint on three reasons. The first, which took as legal support articles from the law of 1844, claimed that the mouthpiece, clamps, reeds, and pads were

43. *Annales de la propriété industrielle*, tome 15, 306–08.

44. Eugène Surville, born in 1790, died in August 1866 or at the beginning of 1867. He was a veteran engineer of bridges and roads, having retired in 1841. He also worked on the construction of canals and railway lines. He had studied at the *École polytechnique* (1808) and at a university (1810). We have not found any other academic training, neither musical nor acoustic. Surville was one of the thirty-seven engineers who worked for the Paris Court of First Instance. *Almanach Impérial pour 1866* (Paris: Guyot et Scribe, 1866), 1027–28.

It is questionable why Surville was working as an expert for a case removed from his field of expertise. The answer may be ambition. Édith Marois describes him as "un ingénieur riche d'ambitions." Édith Marois, "Les relations entre Laure Surville et son frère Honoré . . . de Balzac," in *Mémoires de l'Académie des Sciences, Arts et Belles-Lettres de Touraine*, tome 24 (Touraine: Académie de Touraine, 2011), 80. Surville also left an enormous bequest of 111,918 francs at his death. This fact makes us think that the debts that he left were probably greater than his bequest. Pierre Laszlo, "Deux polytechniciens et la chimie," *Bulletin de la Sabix* 50 (2012): 5–13.

inherent elements of the saxophone patent and therefore protected by it. However, the higher legal forum took a different view, arguing that they were already widely known components of other instruments, such as the clarinet, and therefore commercial use did not alienate their legal status. The second reason relied on the general regulations and insisted that Gautrot's invention was actually Sax's in disguise. His statement was: "the characteristics of the saxophone are not found in the sarrusophone, and these two instruments differ from each other by their shape, by the name, by the size of the holes, by the number of notes produced, by the shape of the reed and the mouthpiece, by the manner of emission of air, and by the results and sound obtained." The third and last argument sought to demonstrate procedural flaws based on articles 190, 210, 408, and 413 of the Code of Criminal Instruction and was immediately rejected.

Not unexpectedly, Maître Vaïsse, president of the Chamber Criminelle, who dealt with Sax's legal challenges for the tenth time,[45] dismissed Sax's appeal to the high court on August 22, 1867 (fig. 8), after hearing the preliminary report of Legagneur, the arguments of the parties, and the conclusions of Bédarrides, the advocate general.[46] Sax was left without legal arguments to raise a complaint[47] and the sarrusophone received all the support of the law, if it was ever needed.

Coexistence, Competition, and Prices

However, this legal support would be of no use without the fundamental support of the market. The sarrusophone was just one of thousands of products offered to the bourgeois consumer society, so the inventor had to implement convincing strategies to make it attractive and reach as many customers as possible. One of the most important maneuvers, of course, was to make it competitively priced. Another was to oust a competitor and take over his market share.

45. The author is preparing a publication that will deal with those judicial trials with the tentative title of *The Brass Instrument Business at the Heart of the French Industrial Revolution.*

46. *Annales de la propriété industrielle*, tome 15, 308–10.

47. However, a year earlier Sax also tried to undermine his adversary by filing a fifteen-year patent on 19 March 1866 (no. 70895) for a "Perfectionnement apporté à l'instrument de musique dit sarrusophone, pour lequel le sieur Gautrot aîné a pris un brevet de 15 ans le 9 juin," which consisted of attaching a saxophone mouthpiece to replace the original double reed. (Sax did not even make the effort to include a sketch.)

TABLE 1. Comparison of the prices of saxophones and sarrusophones produced by Adolphe Sax and Pierre-Louis Gautrot between 1864 and 1867.

	Saxophone (Sax 1864)	Sarrusophone Gautrot 1865	Saxophone Gautrot 1867	Sarrusophone Gautrot 1867
Sopranino E♭				150fr
Soprano B♭	200fr	160fr	160fr	160fr
Contralto E♭	225fr	170fr	180fr	170fr
Tenor B♭	225fr	180fr	190fr	180fr
Baritone E♭	250fr	190fr	210fr	190fr
Bass B♭		210fr		210fr
Contrabass E♭		260fr		260fr
Subcontrabass (*contre-basson*) C or B♭				300fr

Sources for this table: *RGMP*, March 27, 1864, 104; *Catalogue Gautrot* 1865, 8, 10 and 12; *Catalogue des instruments de musique de la Manufacture Générale de Gautrot aîné & C^ie* (Rennes, 1867), *R Larigot* 10 spécial (April 1999), 4, 6, 8, and 10.

However, we do not know how much the instrument cost in those first years of existence, and whether it was sold at a low price, which is doubtful. The first catalog that Gautrot printed after he registered the first sarrusophone patent is dated ca. 1858–59 (Bibliothèque Nationale de France) and does not include prices, only engravings similar to those appearing in *L'Illustration* of July 21, 1855. Another commercial brochure (dated to 1859 or 1860, although the title page reads 1858; Bibliothèque Historique de la Ville de Paris), has several captivating figures of brass instruments, but no sarrusophones. Finally in 1865, when the second patent was in force, a published catalog (Biblioteca Nacional de España) provides evidence that Gautrot achieved a competitive product. The soprano sarrusophone or highest-pitched member cost forty francs less than a saxophone of the same size,[48] which entailed significant savings.

48. *Catalogue des instruments de musique de la Manufacture Générale de Gautrot aîné. À Paris,*

TABLE 2. Price ranges of Gautrot's sarrusophones, bassoons, and oboes in 1867.

	Price range in the 1867 catalog
Sarrusophones Gautrot (standard)	150-300fr
Bassoons Gautrot (high-end)	300-350fr
Oboes Gautrot (high-end)	300-400fr

Source: *Catalogue Gautrot aîné & Cie* (1867), *R Larigot* 10 spécial (April 1999), 4, 6, 8, 130 and 132.

Nevertheless, it seems that Gautrot did not intend to replace the saxophone, but rather to replace the oboes and bassoons that left the military bands. This notion was expressed by the inventor himself in his 1865 catalog,[49] an idea that was not asserted in either of his two patents. Rather, it was his professional desire to replace these woodwinds, as French military bands were officially regulated.[50]

Gautrot's complete commercial brochure of 1867 had sarrusophones too, as well as several saxophones since they were already deregulated. When comparing Gautrot's with Sax's instruments in Table 1, interesting price data are evident.

The first and most evident fact is that sarrusophones were cheaper than their single-reed counterparts, enjoying a decent discount starting at forty francs for a soprano up to sixty francs for a baritone. Such a significant saving per instrument was sufficiently appealing for any amateur or for the average worker, who barely earned 100 francs a month.[51] Moreover, these

rue Saint-Louis (Marais, 60) et À Château-Thierry (Aisne) (Paris,1865), 8; and *RGMP*, March 27, 1864, 104.

49. *Catalogue Gautrot* 1865, 7. This same desire to replace oboes and bassoons was stated in one of only two methods for sarrusophone published by Gautrot, which emphasized the sarrusophones' volume of tone. Emile Coyon, *Méthode élémentaire de Sarrusophones* (Paris: Gautrot, [1867?]), 1. The second handbook (L. Girard's *Petite Méthode de Sarrusophone*) is quite basic and does not even include a sketch or a fingering chart.

50. Although there were no bassoons in French military bands at the time, the official *Décret impérial* of 26 March 1860 contained a pair of oboes in infantry ensembles. *Journal militaire officiel* [no exact date, first half of] 1860 [no. 14], 261–63.

51. Providing the average worker in Paris earned 4.5fr a day in ca.1867 and worked six days a week, this would give a salary of 108fr a month. The income for employees in the provinces was much lower, at an average of 2.8fr a day, hardly 67fr per month. *Statistique de l'industrie à Paris résultant de l'enquête faite par la Chambre de Commerce pour l'Année 1860* (Paris: Chambre de Commerce, 1864), xxxvii–xxxviii; and Émile Chevalier, *Les salaires au*

instruments were affordable enough not to undermine the budget of civilian bands and military ensembles adding new and attractive instruments.

As for saxophones, Gautrot's clients saved between thirty-five francs and forty-five francs compared to those of Sax, quite a significant amount. With that money in 1867–8, one could hire a coach (*voiture de grande remise*) for almost two days, send more than 100 letters to Spain from France, send eighty telegram dispatches within Paris, finance two funerals, obtain a gun license for almost two years, rent a student room for a month, eat more than twenty-six days in an affordable restaurant (*établissement de boillon*), pay four fines for not having a valid passport, drink 100 shots of liquor, or smoke 200 small cigars.[52]

Table 2 compares the prices of these double-reed instruments. In particular, amateurs interested in studying oboe or bassoon had a more budget-friendly possibility if they chose Gautrot's sarrusophone.[53] In addition, those civilian and military bandleaders who did not want to give up double-reed instruments could acquire players who would play the more modest sarrusophones, avoiding the expenditure of a small fortune.[54]

XIXe siècle (Paris: Rousseau, 1887), 42.

52. *Galignani's New Paris Guide* (Paris: Galignani, 1868), 4, 10, 11, 39 and 86; Adolphe Joanne, *The Diamond Guide for the Stranger in Paris* (Paris and London: Hachette and Sampson Low, Son and Marston, 1867), 18, 23–25, 27, 30, and 223.

53. So far, no researcher has been able to find potential licenses, if they in fact existed, that Gautrot may have granted for the manufacture of sarrusophones before 1871, when his invention would enter the public domain. In a catalog (ca.1870) by the English dealer and publisher Lafleur, sarrusophones were offered for a hefty £17 (425fr approx.). Baines, *Woodwinds*, 336–37.

54. Some makers of the time offered very cheap oboes and bassoons; for example, Gautrot himself had oboes from 90fr and bassoons from 180fr. *Catalogue Gautrot aîné & Cie* (1867), *R Larigot* 10 spécial (April 1999), 130 and 134. Also, Triebert (ca. 1863) offered these products from 100fr and 200fr respectively. Robert Howe, "Nineteenth-Century French Oboe Making Revealed: A Translation and Analysis of the Triebert et Cie '1855' *Nouveau Prix-Courant*," *Galpin Society Journal* 64 (March 2011): 79–109. The point here is that people who wanted to get closer to music by playing a double-reed instrument could acquire a comfortable, lasting, and affordable sarrusophone. Thus, they could avoid a harder learning curve on an oboe or bassoon, especially if their budget did not allow them to purchase a reliable instrument or they had to settle for a cheap one with dubious performance.

Conclusions

The invention of the sarrusophone was made possible by the proliferation of new technologies related to brass, and most significantly, those concerning procedures and machines that provided speed and precision. Focusing on speed, we need only remember the ten or more assembly lines on workbenches present in the engravings of Gautrot's factory, which ensured not only specialization in a specific part of the brass instrument but also careful and diligent work.[55] The data of the government survey of 1847–48, nine years before the first sarrusophone patent, specifying the occupations of metalworkers, is proof of this.[56] More significant are the machines and tools listed in the inventories of bankrupt manufacturers, a resource underused by organologists and technology historians. They provide a clear outline of the production stages of any instrument during the beginning of industrialization. Detailed inventories also testify to the presence of specific materials for cutting and working brass with precision, assembling pieces, and, very importantly, assembling keys and complicated mechanisms, connecting these items to their precise assembly. Of course, that rigorous organization and work ethic was not exclusive to Gautrot or brass manufacturers. Woodwind manufacturers also made efforts to assure that their keys and key systems worked correctly. To cite two examples, Louis-Auguste Buffet and Hyacinthe Klosé's 1843 clarinet, with its precise assembly of tone holes, rings, and double keys; and the extraordinary engineering of Theobald Boehm's 1847 brass flute both represented evolutionary achievements for wind instruments. It is also fitting that Boehm serves to close this paragraph, as the "genetics"

55. To achieve more cost savings, a proprietor could outsource the manufacturing of a piece, like keys or pistons. Let us cite Drouelle, "fab[ricant] de pistons, clefs [keys] et garnitures [cases or accessories] d'instruments de musique en cuivre," with whom Sax was in dispute for several years, or Belorgey (also a specialist sued by Sax), who manufactured valves for Sax. (With respect specifically to woodwinds, the more the systems evolve, the more the keywork is outsourced to key makers).

56. The *Statistique de l'industrie à Paris (1847–1848)*, 818, reported 499 workers among 60 manufacturers (*facteurs*), including 56 assemblers or fitters (*monteurs, ajusteurs et poseurs*), 32 polishers (*polisseurs*), 31 lathe operators (*tourneurs*), 30 cabinet makers (*menuisiers*), 27 bell makers (*pavillonniers*), 26 valve makers (*pistonniers*), 12 polishers (*ponceurs*), 11 key makers (*cleftiers*), 10 finishers (*finisseurs*), 9 workshop managers (*chefs d'atelier*), 7 people in charge of heavy duties (*hommes de peine*), 2 coppersmiths (*cuivristes*), 2 painter-decorators (*peintres décorateurs*), and 129 without specific jobs (*sans dénomination spéciale*). Others (17) worked at home for an employer (*travaillant en chambre*), and 1 woman and 37 children were reported.

of his 1832 key system are also present in the sarrusophone,[57] another example of the progression of technology necessary to improve existing instruments and to create new ones.

The fever for brass instruments had its reflection in the number of patents registered halfway into the nineteenth century,[58] and the sarrusophone was a good example, as it was registered twice. However, the first patent (1856) seems to be that of an instrument that was not finished. While certain important details were explained, such as the taper of the tube, the description of the key system is extremely confusing. Other explanations, including comparing the fingering to that of the clarinet, do not seem very credible, given that the sarrusophone's conical properties make it overblow to the octave and not to the twelfth.[59] In any case, we know of no surviving physical specimen of sarrusophone in public or private collections that corresponds to the 1856 patent. Rather, we would argue that Gautrot allowed himself to be swept up in the surge of technological agitation and innovation for manufacturing brass instruments, during their golden age,[60] and at this time patented an immature product.

Although he did not discuss reeds or fingering in detail, Gautrot's second patent (1865) is a fine effort, giving exhaustive details of the construction of the instrument, with precise figures and details. Moreover, the designs look like carbon copies of original physical instruments. It is striking that Sax wanted to argue such an obvious matter, because Gautrot's document was very well constructed from both formal and content sides. Although the judge of the First Instance, perhaps as a precaution, asked for more information, the person in charge of the appeal (Saillard) was absolutely clear in his understanding. Although Sax took the case to the Court of Cassation, it was to no avail. Moreover, the appeal underlined one of Sax's darkest aspects: excessive ambition and perhaps greed, as well

57. Jerry L. Voorhees, *The Development of Woodwind Fingering Systems in the 19th and 20th Centuries* (Hammond: Voorhees Publishing, 2000), 215.

58. José-Modesto Diago, "Music as a Legitimizing Element of Bourgeois Revolutions: A Historic, Economic, and Organological Study of the Saxophone" (PhD diss, University of Cádiz, 2020), 955–67.

59. Needless to say, the fingering of the sarrusophone is logically very close to that of the saxophone, except for some alternative fingerings that are exclusive to the sarrusophone, the third octave key of low sarrusophones that is not necessary in low saxophones, and the position of the low B♭ key, reached by the right thumb in sarrusophones instead of the left little finger. Gautrot surely avoided this analogy likelihood to not fuel the domineering personality of Adolphe Sax.

60. Malou Haine, *Les facteurs d'instruments*, 100–62.

as an intention to undermine his competitors by any means possible.

Regarding the issues of economy and production, it must be concluded that most brass manufacturers did not invest in the instrument because there was hardly any military, civilian, or professional demand for it. If the sarrusophone was to compete for a market share of the sale of double-reed woodwind instruments, it had little chance to succeed. Oboes and bassoons, solidly established as chamber, band,[61] and orchestral instruments, enjoyed an interesting repertoire,[62] historical importance, and previously established industrial and business interests. On the other hand, Gautrot's invention shared similarities with the saxophone, including their novelty, brass construction, similar octave register mechanisms, same range, lack of orchestral repertoire, absence of support from composers, and a dual conception of families made in B♭ and E♭. But the saxophone had certain competitive advantages: for example, a different timbre from that of the double-reed family and the use of a less-fragile single reed, which resulted in ease of playing. Its fundamental favorable condition was that of being a permanent fixture (in soprano, alto, tenor, and baritone versions) in French military ensembles since 1845. At intervals, the saxophone lost its protection during the Second French Republic, but regained it in the regulations of 1854, 1855, 1860, 1861, and 1873, which contributed to an important standardization of the sound preferences of wind instruments.[63] The amateur bands of the middle of the Second Empire and the beginning of the Third Republic imitated this model, which had saxophones and, on rare occasions, sarrusophones.[64]

61. There were no bassoons in the regimental bands at the midpoint of the Second French Empire, nor at the beginning of the Third Republic (*Journal militaire official* 67 (1873): 544), although bassoons survived in the military bands and civilian bands of other countries.

62. We have hardly found any nineteenth-century chamber repertoire for the sarrusophone and what has appeared is shared with other wind instruments. For example, Edouard Sabon's *Invocation à Ste Cécile, offertoire pour hautbois ou violon avec acc. d'orgue ou d'harmonium* is originally for oboe or violin, although the solo part was *arrangé* (transposed) in 1883 for clarinet, saxophone, or sarrusophone. Of course, the publisher allowed these arrangements to add to his profits.

63. The taste for and enjoyment of open-air music was encouraged and publicly promoted. For example: listening to a band playing from park and promenade bandstands, or enlivening an evening in the surrounding cafés and restaurants, participating in military protocols, religious ceremonies, or civil festivals, where the band's sound was effective outdoors.

64. A photograph (1870s) of one of these civilian ensembles with sarrusophones appears in *Larigot* 32 (October 2003): 9.

It was precisely amateur bands and a few military bands (those with some autonomy and a bit more budget) that bought sarrusophones during the nineteenth century.[65] Meanwhile, the visual effect of Gautrot's invention should not be underestimated. The physical forms of his sarrusophones are striking and visually appealing in parades, especially that of the bass models. They are, one might say, exotic instruments, and thus can add extra value to the sound and visual experience, and, of course, to the ensemble fortunate enough to own sarusophones.

65. In his catalog of 1867, Gautrot advised readers to subscribe to the collection (*Journal*) of military music, bands and fanfares he founded on 1 January 1864 under the name of *L'Instrumental*. (*Catalogue Gautrot aîné & Cie* (1867), *R. Larigot* 10 spécial (April 1999), iv.) According to Gautrot, this publication included 300 scores, most of them inspired by opera themes and arranged by "eminent artists." The Bibliothèque nationale de France holds many of these waltzes, marches, melodies, fantasies, etc., dated from 1865 to 1872, which sometimes specified sarrusophones and saxophones, usually interchangeably.