Volta's electric lighter and its improvements: The birth, life and death of a peculiar scientific apparatus which became the first electric household appliance

Paolo Brenni

From the itinerant lecturers of the 18th century to popularizing physics in the 21st century – exploring the relationship between learning and entertainment
Proceedings of a conference held in Pognana sul Lario / Italy, June 1-6, 2003.
Eds.: Jürgen Teichmann, Arthur Stinner, Falk Rieß,
Munich, Winnipeg, Oldenburg 2004
www.deutsches-museum.de, www.hsse.uwinnipeg.ca, www.uni-oldenburg.de/histodid

Deutsches Museum

Introduction

Today it is so common to produce light just by turning a knob or pulling a switch and it is so easy to produce a flame with a very cheap box of matches or a disposable plastic gas lighter that we can hardly imagine how problematic it was in the past to obtain the same effects. The history of fire-making appliances dates back to prehistory and is marked by a large number of artefacts (tinder, flint and steel, quartzite and iron, matches, etc.) and methods (friction, chemical, pneumatic, etc.), which were often unreliable, inconvenient or dangerous.

In this article I would like to retrace the evolution of a very peculiar fire producing apparatus which was invented in the late 1770s and remained in use up to the middle of the 19th century: the hydrogen electric lighter. The first lighter of this kind was conceived by the famous Italian physicist Alessandro Volta (1745-1827) but subsequently it was essentially in Germany that this useful device was largely improved and modified. This lighter became the first electric household appliance, one of the very first "push-button" (or at least "turn-key") apparatus.

Volta, the electric lamp and the electric lighter[1]

The name of Alessandro Volta is immediately and always connected with the invention of the electric cell, which was announced in the famous letter of the 20th of March 1800 to Sir Joseph Banks. However the Italian physicist conceived several other instruments such as the electrophorus, the electric pistol, the eudiometer, the comparable electroscope, the condenser electroscope, the electrostatic balance, just to mention some of the most important ones. All these instruments made their mark on the history of electricity and the evolution of measurement and laboratory practices. However, another Volta's invention of the late 1770s, the electric lighter[2], even if from a purely scientific point of view it could be considered as a cabinet curiosity, nevertheless became very popular.

---

[1] All the references to Volta's writings are taken from: *Le Opere di Alessandro Volta Edizione Nazionale*, Ulrico Hoepli, Milano, Ulrico Hoepli, 1918-1929 (volumes I-VII), *Epistolario di Alessandro Volta*, *Edizione Nazionale*, Bologna, Nicola Zanichelli, 1949-1955, (volumes I-V), *Aggiunte alle opere e all'epistolario di Alessandro Volta, Edizione Nazionale*, Bologna, Nicola Zanichelli, 1966, (volume I); *Indici delle opere e dell'epistolario di Alessandro Volta, Edizione Nazionale*, , Milano, Rusconi Editore, 1974 (volumes I-II). For Volta's instruments see also: Fabio Bevilacqua, Giuliano Bellodi, Gianni Bonera, Lidia Falomo (editors), *Gli strumenti di Alessandro Volta: il gabinetto di Fisica dell'Università di Pavia*, Milano Heopli, 2002 and *Il Tempio Voltiano in Como*, Como, E.Cavalleri, 1939 (reprinted in 1973).

[2] There is some confusion about the terminology. Volta as well as some of the inventors mentioned in this article also proposed various gas lamps, which were supposed to produce light for quite a long time. However, these lamps were not really successful due to the difficulty of storing the important quantities of gas they needed. Volta called his first unsuccessful apparatus "lucerna" (lamp), which was intended to be used as a long lasting night lamp, while he used the term "accendilume" (lighter) for what was called in English an "electric lamp", "Volta's lamp", "electro-pneumatic lamp" or "hydropneumatic lamp", in German "Brennluftlampe" or "elektrische Lampe" and in French "lampe à air inflammable" or "lampe à hydrogène". In fact a more precise name for the apparatus would be "lighter" instead of "lamp" because it was not used to produce a constant light but a temporary flame used for lighting a candle. I will use here the term lighter.

In Autumn 1776, while still professor of physics in Como, Volta collected a gas the so-called "aria inffiammabile delle paludi" (methane) bubbling from the water of the Verbano Lake and soon he discovered this gas was flammable and could be ignited by an electric spark.[3] At the same time Volta was also experimenting with another gas: the "flammable air" (hydrogen), which he ignited in his famous electric pistols (with all the possible variations of this quite innocuous laboratory weapon: electric cannons, electric guns, electric mortars etc.).[4] In May 1777, in letter to the Marquis Francesco Castelli, he mentioned for the first time that he was elaborating a new invention: a methane gas lamp.[5]. Almost a year later, in April and May 1778 he wrote a series of letters to the Geneva naturalist Jean Senebier (1742-1809), in which he mentioned that he had perfected two kinds of lamp. The first one was burning methane and could produce light for one hour with a "jar" of gas, while the second one was in fact a hydrogen lighter (briquet) which could be used for igniting a candle or a waxed wick. The latter was portable and could be ignited with the spark of a pocket electrophorus (invented by Volta himself in 1775). For the lamp Volta also proposed a simple pneumatic gasometer (or gas holder) for producing a steady flow of gas and noted that the flame of the methane was larger than that of hydrogen.[6] In July and in September of the same year George Nassau Clavering 3d Earl of Cowper (1738-1789) a wealthy amateur scientist, who was living in Florence and had a large physics cabinet, asked Volta for some information concerning the construction of the lamp and the lighter.[7] Volta sent an improved lighter to Lord Cowper in July 1779.[8] Meanwhile at the beginning of this year, Jean Jacques Théodore Barbier de Tinan (?-1791) an amateur physicist of Strasburg communicated to Volta that, after having seen a lamp made following Volta's instructions, he had improved the apparatus: "*C'est un instrument si joli et si commode pour bien d'expériences*… And a few months later Barbier again wrote about it: « *je suis très content de la mienne* [the lighter] *dont je fais un usage journalier pour allumer la lumière*…"[9]. At the same time Volta wrote again to Senebier saying that he had perfected his lighter and several similar machines. He experimented also with a mixture of gases.[10] Around 1780 Volta sent one of his lighters to Carlo of Austria Archduke of Lorena (1771-1847). But Volta apologized because, due to the lack of skill of the local instrument makers, the apparatus was not very elegant.[11] In October 1780 Volta in a letter to Carlo Count of Firmian (1716-1782)[12] announced that his lighter was a great success and proudly added that it

[3]Alessandro Volta, *Opere*, vol. VI, pp. 15-102.

[4]H.L. Blackmore., "English Instrument Makers: Airguns and electric guns", *Arms Collecting*, 31, 2, 1993, pp. 39-47.

[5] Alessandro Volta, *Opere*, vol. VI, p. 150.

[6] Alessandro Volta, *Epistolario*, vol I, p. 235; *Opere*, vol. VI, pp. 258-259 and pp. 274-275.

[7] Alessandro Volta, *Epistolario*, vol. I, p. 261 and p. 281.

[8] Alessandro Volta, *Epistolario*, vol. I, pp. 354 –356.This lamp had been made by Giuseppe Re (?-1820) one of the makers, who for many years worked for Volta.

[9] Alessandro Volta, *Epistolario*, vol. I, p. 328 and 344.

[10] Alessandro Volta, *Epistolario*, vol. I, pp. 355-356.

[11] Alessandro Volta, *Epistolario*, vol. I, p. 393

[12] Firmian was at the time the plenipotentiary Austrian governor in Lombardy.

was manufactured by the famous instrument maker Edward Nairne (1726-1806), who had presented it to the Royal Society.[13]

In fact, since about 1780 after various experiments Volta had abandoned the idea of a gas lamp burning for several hours (the device was very impractical due to the necessity of producing and storing large quantities of gas)[14] the lighter began to acquire a certain popularity. But what exactly was this apparatus? Volta wrote a description which he illustrated with a drawing (Fig.1.A), but unfortunately the manuscript is not dated.[15] The instrument was composed by two superimposed glass vessels, connected by a couple of tubes and a double cock, which formed a pneumatic gasometer. The apparatus was very similar to Hero's fountain, a very popular device in every physics cabinet of the 18th century. The lower vessel was mounted on a copper base with an opening and a plug. The upper vase was filled with water while the lower one stored the hydrogen, which had been introduced through the opening. On the top of the apparatus there were two electrodes forming a spark gap. By opening the cock the water flowed into the lower vessel and pushed the hydrogen through the pipe whose nozzle was between the electrodes. By touching one of them[16] with the plate of the electrophorus (or with the conductor of a small Leyden jar) it was possible to produce a spark, which ignited the gas. The flame was then used for lighting a candle or a wick and after a few seconds the cock could be closed. On the other hand, the apparatus could also be used for filling with hydrogen the electric pistols. At the beginning of the 1780s the design of this type of Volta's lighter was well established and the instrument began to be copied and improved.

Even though Volta never considered his lighter to be one of his major inventions (even before the invention of the electric cell), nevertheless he was quite proud of it, considering that it was not only an amusing curiosity but also useful and practical device.[17]

---

[13] Alessandro Volta, *Epistolario*, vol. II, p. 10.

[14] Alessandro Volta, *Opere*, vol. VI, p. 409. The historian Giambattista Giovio (1748-1814) in a short biography of Volta written in 1784 made some playful jests about Volta's lamp. Not only, he said, it would have been necessary to have lamps "larger than houses" because of the large amount of gas consumed (which was not compressed!). Giovio also added that the faint light produced by of the gas was similar to a "will-o'-the-wisp" and would have been just ideal for lugubrious tombstone. See Alessandro Volta, *Epistolario*, vol. II, p. 512. Less ironic but more caustic was the biologist Lazzaro Spallanzani (1729-1799). In a series of polemic letters written under the pseudonym of Francesco Lombardini, he harshly criticised Volta's method of teaching physics at the University of Pavia, and did not miss the opportunity to define his electric pistols and lamps as "little toys of physics": "Non avendo egli toccato i principii della Geometria,dell'Algebra, della Meccanica e delle altre facoltà affini, è condannato a dover sempre parlare di arie, di calore, di elettricità, senza potere mai dare un compiuto corso di Fisica; e per conseguenza lasciando polverose ed inutili le macchine di Ottica, di Statica, d'Idrostatica ec. esercita eternamente la gioventù in quelle, che concernono lo scaricare la sua pistola e l'accendere il moccolino coll'aria infiammabile, che non sono in fine che due giocolini della Fisica…" See: Alessandro Volta, *Epistolario*, vol. II, p. 541.

[15] Alessandro Volta, *Opere*, vol. VII, pp. 153-157.

[16] The other electrode was normally grounded.

[17] "Di queste la più singolare è a mio credere una specie di lucernetta ossia accendi-lume ad aria inf. Nella quale macchinetta, se troppo non mi lusingo, va unita al diletto qualche utilità o comodo". Alessandro Volta, *Epistolario*, vol. I, p. 393.

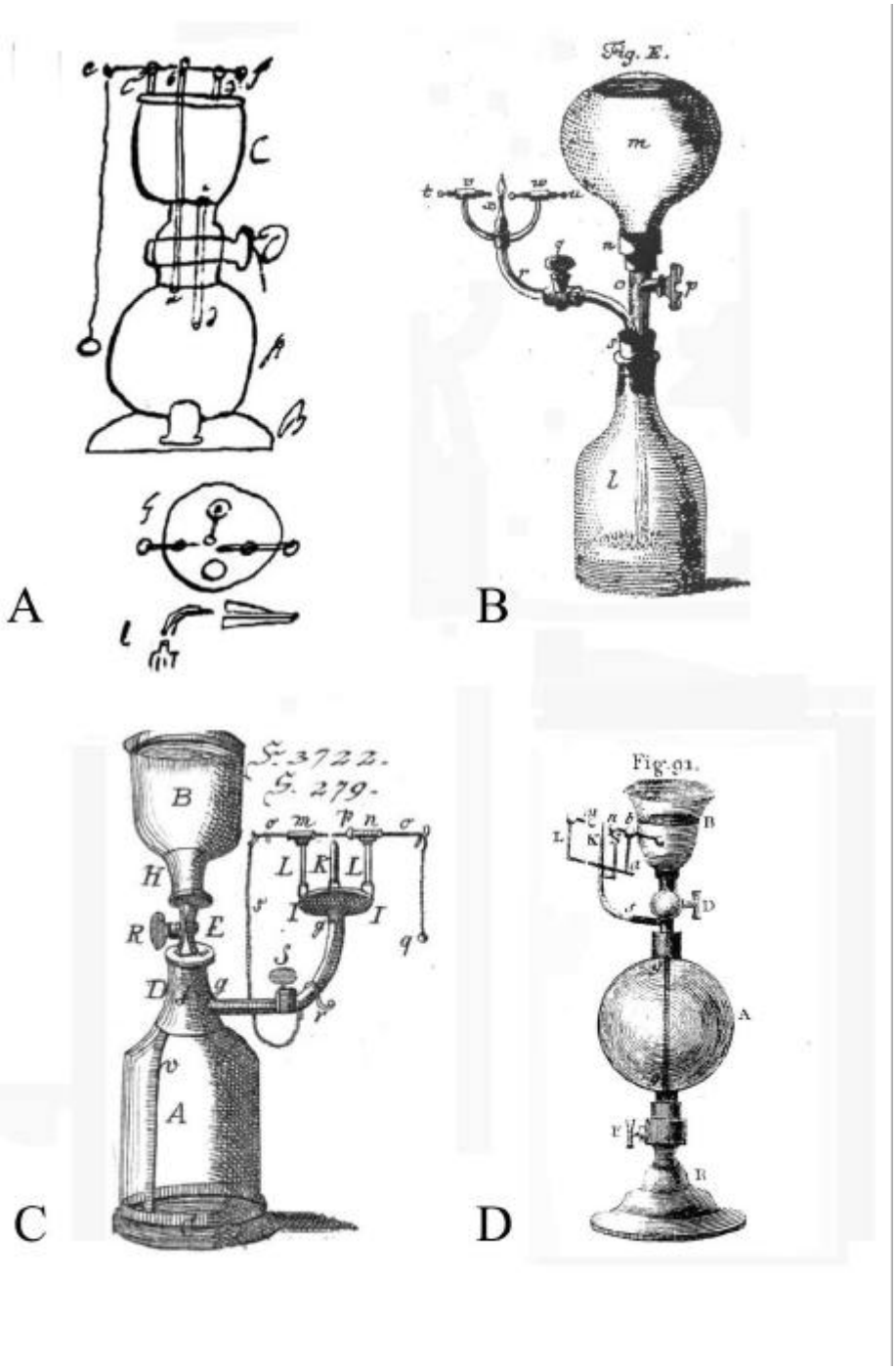

Fig. 1: Early lighters A) Volta's sketch of lighter, B) Brander's lighter of the first type described by Weber, C) Fürstemberger's lighter, D) Adams's lighter.

Improvements and modifications[18]

From the end of the 1770s onward, several apparatus based on Volta's appeared in various treatises and articles. In 1779 the German physicist Joseph Weber (1753-1831) in the second edition of his book dedicated to the electrophorus[19] gave the first detailed and illustrated description of a hydrogen lighter (Fig. 1.B) which was manufactured by the famous instrument maker Georg Friedrich Brander (1713-1783). The apparatus had two vessels (the upper one for the water and the lower one for the gas. A pipe with a cock allowed the water to penetrate into the lower vessel, while curved pipe (with a second cock) and a nozzle supported an insulated spark gap with two electrodes.

In 1780 Frédéric Louis Ehrmann (1741-1800), professor of physics in Strasbourg published the booklet *Description et usage de quelque lampes à air inflammable,* in which he illustrated various types of hydrogen lighters without mentioning the name of Volta.[20] When the Italian physicist heard of this publication he claimed his priority for the invention, which he said he had conceived in 1777. Volta also pointed out that during his trip to Switzerland in Autumn 1777 not only had he visited Barbier de Tinan in Strasburg and described the lighter to him: "*Je ne manquais pas non plus de la* [the lighter] *communiquer à Strasbourg, en particulier à M.Barbier de Tinan…. Il fut le premier qui, d'après mon example, construisit une lampe à air inflammable faisant l'office d' accendilume, et il eut la bonté de m'en faire passer la description dans une de ces lettres intéressantes*.» but also that in Basel he had met Fürstenberger an amateur physicist.[21] And the latter was indicated as the inventor of the hydrogen lighter in Ehrmann's book. Volta did not accuse explicitly anybody of having stolen his idea but he presented a series of evidences, which could easily convince the readers that he had conceived and made the very first hydrogen lighter.

Ehrmann described four different apparatus. The first one (Fig 1.C) presented as the original invention of Fürstemberger was very similar to Brander's lighter described by Weber. In 1784 a very similar lamp (only with a spherical gas container) was also described by George Adams, who attributed it to Volta (Fig. 1.D) [22]

---

[18] Apart from the specific articles and books mentioned in these notes, there are three fundamental encyclopaedic works reporting several information concerning the history of hydrogen lighter. The most important one is probably: Johann Georg Kruenitz, *Oeconomische-technologische Encyclopädie : oder allgemeines System der Staats-, Stadt- Haus und Landwirtschaft und der Kunst-Geschichte,* Berlin, Buchhandlung Pauli, 1801, Zweite Auflage, vol. LIX , pp. 247-343. The other ones are: Johann Carl Fischer, *Physikalisches Wörterbuch*, , Göttingen, bei J.Christian Dietrich, 1800, vol. III, pp. 215-220 and Johann Samuel Traugott Gehler, *Physikalisches Wörterbuch neu bearbeitet von Brandes, Gmelin, Horner, Mucke, Pfaff* , Leipzig, E.B. Schweickert, 1831, vol. VI, Erste Abtheilung, pp. 75-86.

[19] Joseph Weber, *Beschreibung des Luftelektrophors. Neueste mit der Beschreibung der elektrischen Lampe vehmehrte Auflage*, Augsburg, bei E.Kleist gel. Wittwe und Franck, 1779, pp. 82-86.

[20] Fréderic Louis Ehrmann, *Description et usage de quelques lampes à air inflammable*, Strasbourg, J.H.Heitz, 1780.

[21] Volta was in Basel the 25th and the 26th September and in Strasburg between the 28th and the 30th September. Alessandro Volta, *Epistolario*, vol. I, p. 196 e 494.; *Opere*, vol. III, p. 349; *Opere*, vol. IV, p. 118; *Opere*, vol. VII, p. 118.

[22] George Adams, *An Essay on Electricity*, London, by the author, 1784, pp. 286-288. It seems that this particular type of lamp remained quite popular in France and in Italy for several years. It was also described in Claude Veau Delaunay, *Manuel d'électricité*, Paris, chez l'auteur, 1809 and again in the

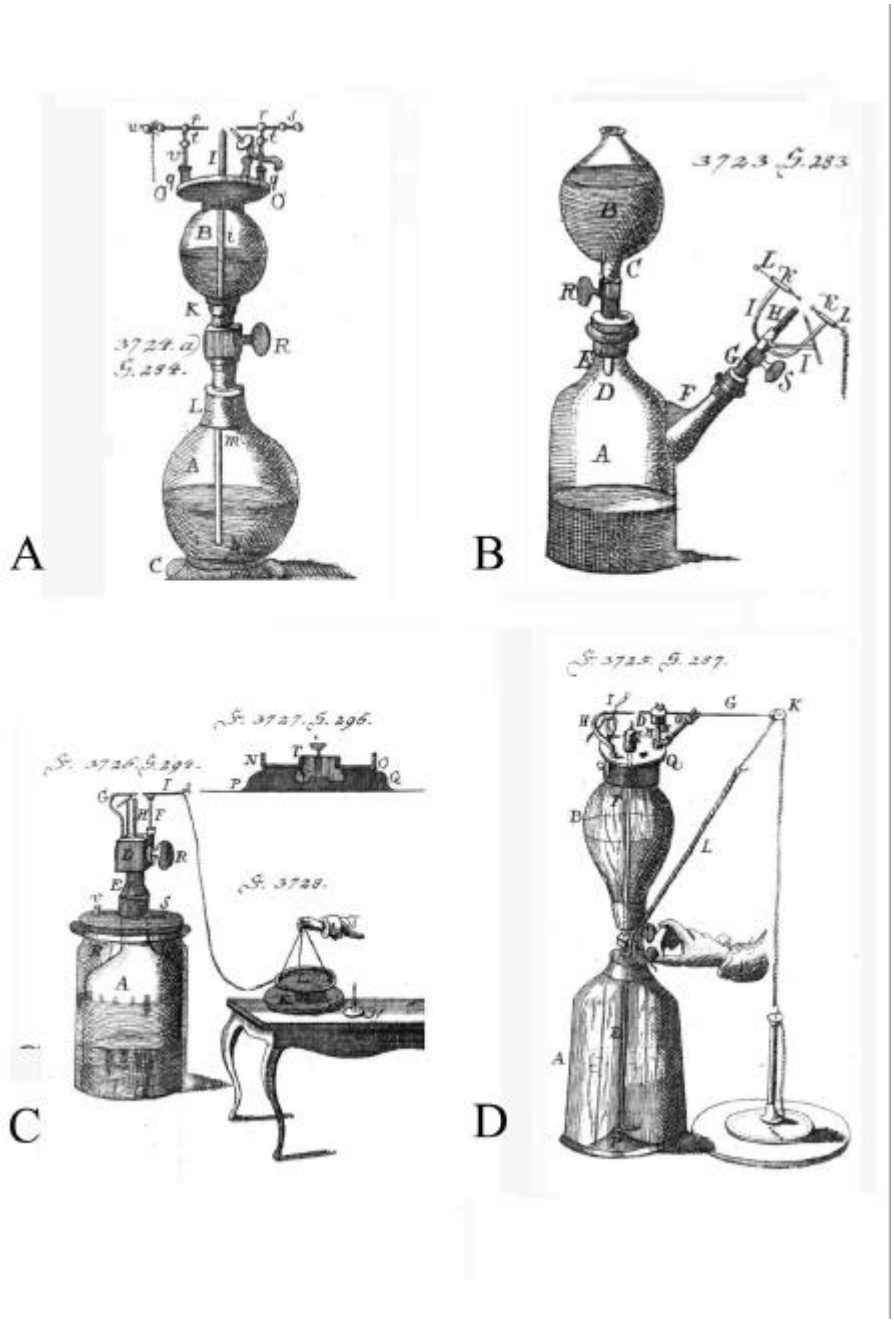

Fig. 2: A) De Gabriel's lighter, B) Brander' lighter of second type described by Ehrmann, C) Ehrmann's lighter, D) Ingenhousz-Pickel lighter with automatized action of the electrophorus.

Encyclopédie Méthodique, *Physique*, Tome III, Paris, chez Mme veuve Agasse, 1819, p. 635. The famous French instrument makers Dumotiez, whose catalogue of electrical instruments was bound with Veau Delaunay's book, proposed a similar lamp for 80 francs, while in 1805 the English maker Accum advertised "Volta's inflammable air lamp" for 4 guineas. See Frederick Accum, *Catalogue of the Chemical Preparations, Apparatus and Instruments for Philosophical Chemistry*, London, 1805.

The second lighter (Fig. 2.A), which was attributed to a certain De Gabriel (or Degabriel) closely resembled the one from Volta's sketch (Fig. 1.A) and had at the top of the upper bottle a plate with the gas nozzle and the couple of electrodes forming the spark gap. A brass joint with a cock (for the water and for the gas) connected the two bottles while a small candle on a moveable stand could be lit by the hydrogen flame.

The third apparatus (Fig. 2.B) was an improved lighter made again by Brander who had modified his first model. He sealed to it an oblique efflux tube in order to allow the water to expel all the hydrogen stored from the lower bottle.[23]

The fourth lighter (Fig. 2.C) was described by Erhmann as his own invention (conceived together with his brother) and represented a real improvement because the apparatus was more compact. An inverted glass bell containing the gas was inserted in a larger cylindrical vessel for the water.[24] When the bell was filled with gas the water was displaced in the space between the two vessels. This design became the standard one in several later electric lighters as well as in the Döbereiner lighters (see below).

At the beginning of the 1780's also the Dutch physicist Ian Ingenhousz (1730-1799), also became interested in the electric lighter.[25] Ingenhousz (who knew the book of Ehrmann and also attributed the invention of the device to Fürstemberger) stated that he saw it for the first time in 1780 during a visit to Barbier de Tinan's house, when he stopped in Strasburg during a trip from Paris to Vienna.[26] In Strasburg, he bought a lighter of the Furstemberger type and when he arrived in Vienna he ordered a second lighter (similar to the Gabriel's) to which he made some minor improvements (Fig. 2.D). For example, he added a second cock near the gas nozzle so that the hydrogen which remained in the pipe after having closed the main cock, could not escape into the atmosphere and be replace by the air. This fact often obliged the operator to produce several sparks before the gas could be ignited. But Ingenhousz also illustrated an interesting modification, which he attributed to Johann Georg Pickel (1751-1838).[27] A light metallic chain attached to the plate of the electrophorus passed on a small pulley inserted in one of the electrodes of the spark gap and was fixed (thanks to an insulating silk thread) to a second pulley on the gas cock.[28] With this system, the opening of the

---

[23] I was not able to find any electric lighter signed (or supposedly made) by Brander. Brander and Höschels trade catalogue of 1783 does not specifically mention the electric lighter but the items N. 90 indicates: *Verschidene Instrumente die zu den Versuchen mit der inflammablen Luft gehören.* The electric lighter could have been included in this group of instruments. See: Alto Brachner, *G.F.Brander 1713-1783 Wissenschaftliche Instrumente aus seiner Werkstatt*, München, Deutsches Museum, 1983.

[24] The bottom of the bell was closed by a metallic disk with a valve. This valve was always open when the bell was inserted in the larger vessel, while it was closed when it was necessary to transfer the bell filled of gas.

[25] Ian Ingenhousz, "Description d'une lampe à air inflammable", in *Nouvelles expériences et observations sur divers objets de la physique,* Paris, chez T. Barrois, 1785, Vol. I, pp. 136-149.

[26] Ingenhousz stopped in Strasburg in Summer 1780 during a trip between Paris and Vienna. Alessandro Volta, *Epistolario*, vol. I, p. 417.

[27] Pickel was professor of chemistry and pharmacy in Würzburg.

[28] The other electrode of the spark gap was connected to the earth through the lighter itself or thanks to a little metallic chain.

cock automatically lifted the plate of the electrophorus and produced the spark. With one hand and a single movement it was possible to produce the flame.

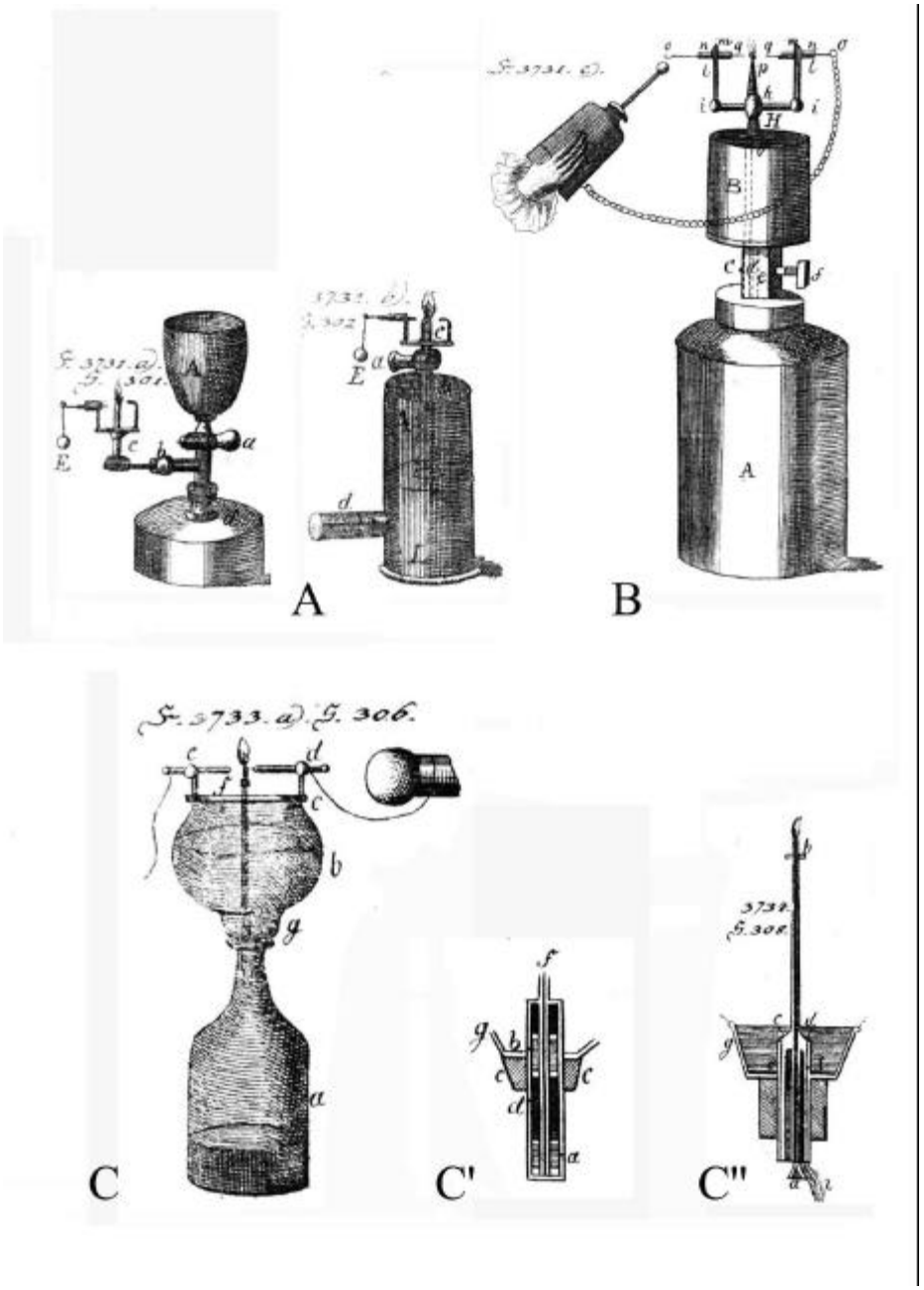

Fig. 3: A) The two types of Langenbucher's lighter, B) Donndorff's lighter C) Schmidt's lighter, C') Schmidt's piston valve, C") Schmidt's rotating valve

In 1780 the silversmith Jacob Langenbucher (?-1791) from Augsburg proposed a couple of quite compact modified lighters[29] (Fig. 3.A) while in 1785 the advocate and electrician Johann August Donndorff (1754-1837) of Quedlinburg, illustrated a large apparatus all made of brass which could be used both as a lighter and as a lamp (Fig. 3.B).[30] Far more interesting but probably not very popular were the modifications introduced in the lighter (Fig. 3.C) by the mechanic of Jena Georg Christoph Schmidt (1740-1811 circa). Schmidt proposed two different kinds of valve, which allowed one to eliminate the gas and water cock. The first valve proposed by Schmid (Fig. 3.C'), was a kind of double piston connected to the gas tube and sliding in a cylinder with three holes. By pulling up the tubes the position of the pistons allowed the water to fall in the gas container and the gas to flow in the vertical tube, whose nozzle was between the electrodes of the usual spark gap. When the tube was pushed down the flame was extinguished. The second system had a rotating valve. (Fig. 3.C") By turning the vertical pipe for the hydrogen, the valve allowed the water to enter into the gas vessel thus displacing the gas. When the lighter was not used a small wooden peg had to be inserted at the top of the tube. The Schmidt's lighters did not need a special container for the hydrogen, but thanks to a cork the valve (together with the water vessel) could be inserted into the neck of any bottle filled of gas. In this way it was possible to store several bottles of hydrogen which could be easily replaced when empty.

All the above-mentioned lighters had in common two major characteristics. First, the apparatus were not producing but only storing the flammable gas and secondly the igniting spark was generated thanks to a separate electrophorus (or a small Leyden jar), which were not part of the lighter itself. In the 1790s a major improvement was introduced. Not only was the action of the electrophorus automatized (like in the instrument proposed by Pickel) but the electrophorus itself was included in the apparatus. In 1791 the mathematics teacher and mechanic Johann Conrad Gütle (1747-?) of Nürnberg described a lighter (Fig. 4.A) having an electrophorus concealed in a wooden box with sliding sides, which formed the base of the apparatus. The resin cake of the electrophorus was covered by its metallic plate, which was attached to a moveable arm.[31] A thread passed on a pulley and connected the plate with the gas cock. A conducting wire whose lower end terminated just a few millimetres above the plate of the electrophorus was fixed to the isolated electrode of the spark gap.[32] For lighting the gas it was first necessary to open the cock controlling the admission of the water in the gas vessel and to open the gas cock connected with the metallic plate. The latter was immediately lifted and touching the metallic wire above it produced the spark, which lit the hydrogen. The flame ignited a small waxed wick and the two cocks could be closed.

---

[29] Jacob Langenbucher, Beschreibung einer beträchtlich verbesserte Elektrisiermaschine, Augsburg, Rieger 1781.

[30] Johann August Donndorff, *Die Lehre von der Elektricität theoretisch und praktisch aus einander gesetzt*, Erfurt, Keyser, 1784, Vol. II, p. 867. Donndorff got his lamp from a certain Stegmann from Kassel.

[31] Generally a small piece of tinfoil connected with the metallic container of the cake of the electrophorus touched the plate, when the latter was resting on the cake itself. In this way it was possible to ground the plate (and charging it) without touching it with a finger.

[32] The spark sprang between the nozzle of the lamp (all made of brass) and the electrode isolated in a glass tube.

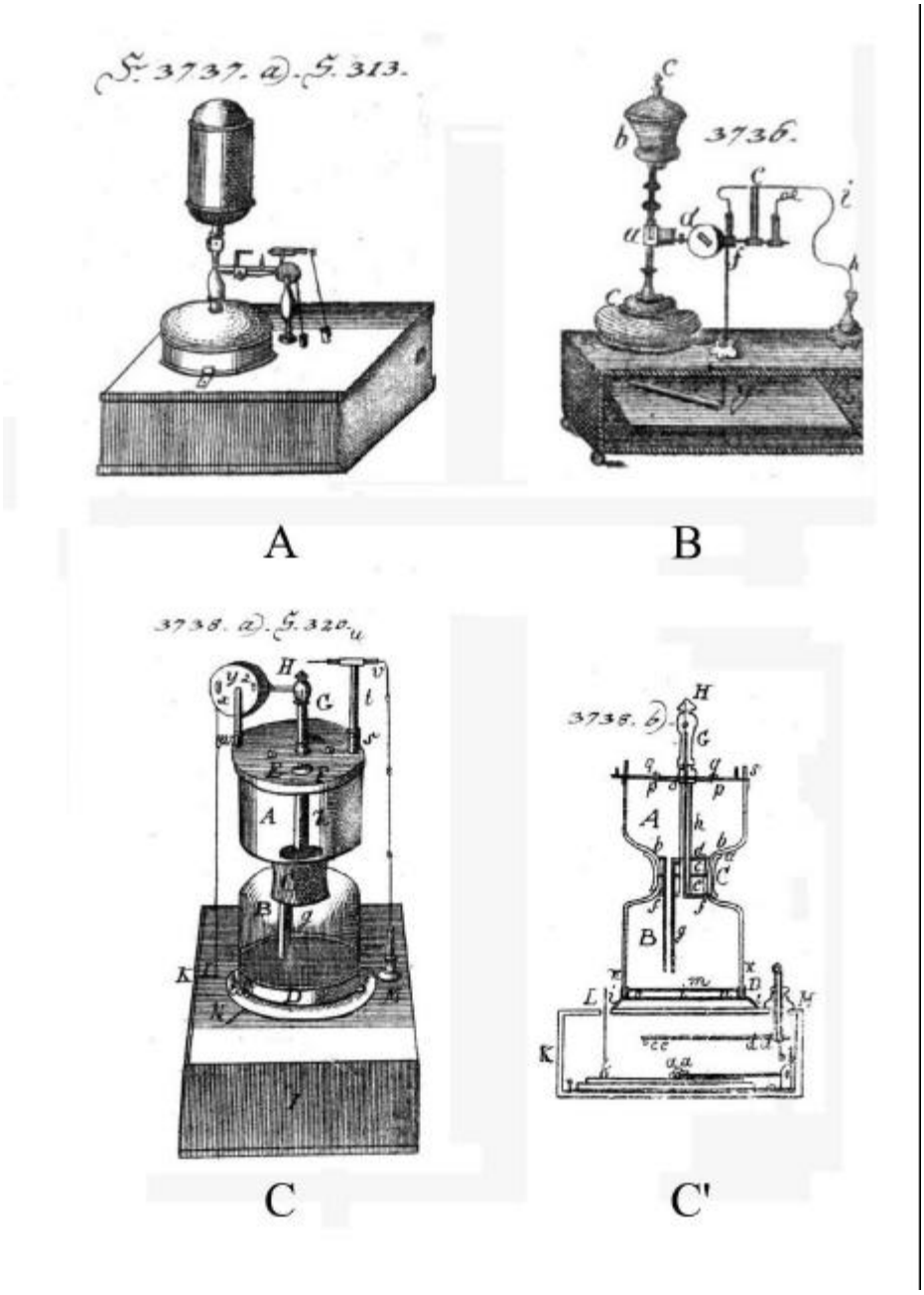

Fig. 4: A) Gütle's lighter, B) Lütgendorf's lighter, C) Bohnenberger's lighter and its scheme C')

Around the same time a very similar lighter (Fig. 4.B) was also proposed by baron von Lütgendorf,[33] while the jurist and experimenter of Nürnberg Karl Alexander Faulwetter (1745-1801) proposed a simplified version of Gütle's lighter. Faulwetter, who used glass instead of brass vessels, eliminated the water cock by introducing a double connection cock, which allowed one to open with a single movement both the pipe for the water as well as the one for the gas. The rest of the apparatus did not present any peculiar difference with Gurle's lighter. Another German, the minister Gottlieb Christian Bohnenberger (1732-1807) [34] also described a lighter of different design (Fig. 4.C) but also with a single cock which controlled the pneumatic system for the gas and water flow as well as the action of the electrophorus. But Bonenberger's lighter was different from the other ones as far as the filling of the hydrogen was concerned. The water was poured as usually into the upper vessel and flew directly in the lower one (Fig. 4.C'). Than the brass cock connected with a bladder full of hydrogen was screwed onto the nozzle of the gas pipe. By squeezing the bladder the gas was forced into the lower vessel and displaced the water in the upper one. The empty bladder was removed and the lighter was ready to be used.

At the beginning of the 19th century, in spite of several clever improvements the electric lighter still presented a major disadvantage: it did not produce, but just stored the hydrogen. In fact, almost all the inventors carefully described how to prepare hydrogen and how to fill the apparatus. It is true that a gas bottle could be used for several dozens of ignitions but nevertheless the operation of preparing the hydrogen and filling the lighter with it was a relatively complicated and tedious operation which required various apparatus. The gas was generated in a kind of retort where diluted sulphuric (or hydrochloric) acid reacted with some zinc (or iron filing) and was introduced in the gas vessel thanks to a pneumatic trough or thanks to a bladder, which like in the Bohnenberger apparatus, had been previously filled. A great care had to be displayed for avoiding a mixture of air and hydrogen. The latter together with the oxygen could produce the explosive mixture known as "detonating gas".

It is difficult to know exactly when the first lighter with a built-in gas generator was introduced, however in 1807 a certain Richard Lorentz from Hammersmith applied for a British Patent describing a "Machine for Producing Light and Fire Instantaneously" (Fig. 5.A) [35] The design of Lorentz lighter was quite different than the one of the German apparatus. The lighter was fully enclosed in an elegant wooden box. In the upper part of it there was a rectangular tin vessel divided into two compartments: the upper one for the water and the lower one for the gas. A bottle placed in a corner of the upper compartment was used as a gas generator and a removable pipe connected it to the lower compartment, which was filled with water. When hydrogen was produced in the bottle

---

[33] Krueniz (op. cit. note 18) reported as Litgendorf, but he probably was Joseph Max Freiherr von Lütgendorf (or Lüttgendorf, 1750-1829) a German pioneer of ballooning and electrical experimenter. I would like to thank Christoph Meinel for this information.

[34] Kruenitz (op. cit. note 18), pp. 320-335. Gottlieb Christian Bohnenberger was the father of Johann Gottlieb Friedrich von Bohnenberger (1765-1831), the famous astronomer, mathematician and physicist whose name is associated with a well-known electroscope and an induction electrostatic machine.

[35] See British Patent 3007 of the year 1807. One of this lighters is preserved at the Science Museum and is illustrated in: Alan Q. Morton, Jane A. Wess , *Public and Private Science, The King George III Collection*, , Oxford, Oxford University Press, 1993, pp. 628-629.

by the usual mixture of acid and zinc, it was introduced in the lower compartment by the pipe and displaced the water in the upper one. As usual, an electrophorus which was hidden in the lower part of the box was directly operated by the gas cock and produced the spark for the ignition. The hydrogen flame lit a candle fixed in a brass chandelier on the front face of the apparatus. In 1811 Matthew James Mayer, an instrument maker in the parish of Saint James (Middlesex) applied for a patent where he described an improved Lorentz's lighter.[36] Mayer changed the design of the connection pipe between the gas vessel and the cock by introducing a kind of siphon and by adding a few modifications which allowed his lighter to be operational even if it was submitted to *"..any kind of motion to which the machine may be exposed on board of ships, or in carriages.*." The gas generating system as well as the disposition of the electrophorus were almost identical to the one introduced by Lorentz.

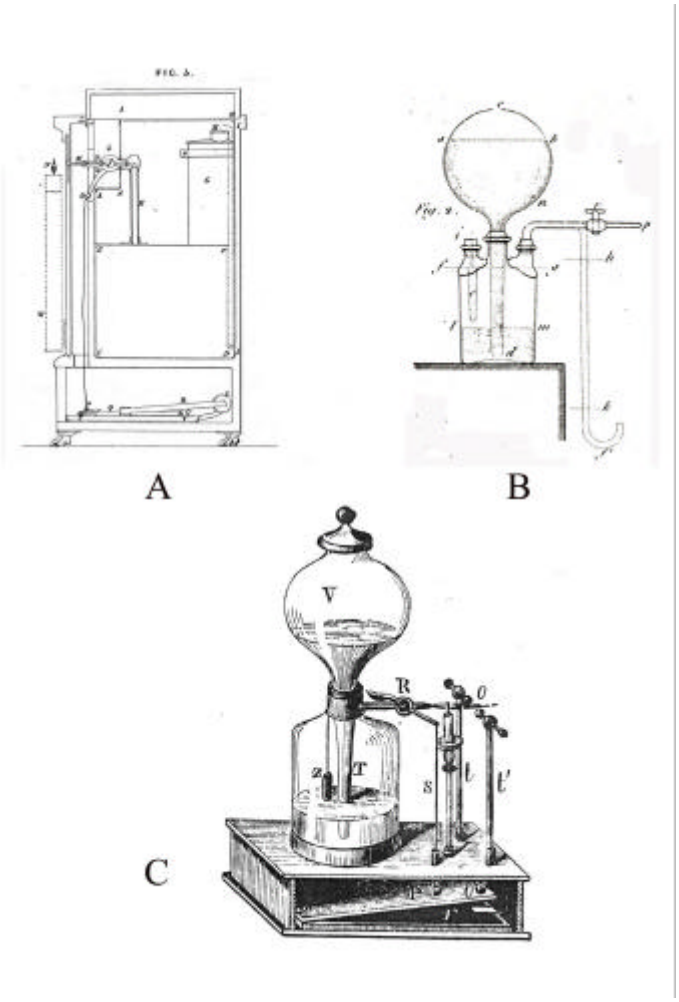

Fig. 5: A) Lorentz's lighter, B) Gay-Lussac's gas generator, C) Definitive form of the hydrogen lighter.

[36] See British Patent 3470 of the year 1811. One of this lighters is preserved in the Playfair Collection in Edinburgh and is described in Robert G.W. Anderson, *The Playfair Collection and the Teaching of Chemistry at the University of Edinburgh 1713-1858*, Edinburgh, The Royal Scottish Museum, 1978, pp. 148-149.

If hydrogen was produced in the lighter itself, the production was not yet automatized and every time that the gas vessel was empty, it was necessary to refill the generating bottle and to repeat a series of operations. The cleverest solution for definitively simplifying the gas generation was proposed in an article of 1817 by the famous French chemist Joseph Louis Gay-Lussac (1778-1850). [37] (I have to point out that it is possible that the same idea had been applied a few years before without being published). Gay-Lussac's gas generator was again composed by two superimposed bottles (Fig. 5.B) The upper one was an inverted glass flask whose long neck penetrated into the lower one and almost touched its bottom. A cylindrical piece of zinc (or iron) was suspended in the lower bottle, which also had an efflux pipe with a cock. When the cock was open and this bottle was partially filled with sulphuric acid, the reaction with the zinc produced hydrogen which flew out. By closing the cock the pressure of the gas pushed all the acid in the upper bottle through its neck. So, when the zinc did not dip in the acid anymore, the production of gas automatically stopped. The lighter, whose lower vessel remained full of hydrogen, was ready for a new ignition. As Gay-Lussac pointed out, the instrument could be used not only as a lighter but also in the laboratories as gas generator. In fact his apparatus represented a first step toward the very popular Kipp's apparatus, which is still used today. This was a major step in the evolution of the electric lighter, because the apparatus became absolutely self-sufficient and all the fastidious tasks of filling the gas container thanks to a separate system could be forgotten. Even with frequent use it was not necessary to replace the zinc and the acid more than once a year. In France the improvement of Gay-Lussac was immediately adopted by Dumotiez and other instrument makers and was illustrated in several important treatises.[38] In Germany this type of lighter was probably introduced about the same time. Sometimes the gas generator was also built following the design of the original Ehrmann's lighter with a glass bell for the gas and a surrounding cylindrical vessel for the acid. The key difference with Ehrmann's apparatus was that a piece of zinc was suspended in the bell. By opening the cock at the top of the latter the acid could reach the zinc and produce the gas.

Finally, by the late 1810s the hydrogen lighter found its definitive design (Fig. 5.C) and the introduction of the gas self generating apparatus largely contributed to increasing its diffusion into households. However, it is necessary to mention a major modification which, if not very popular, was nevertheless interesting. When the cake[39] of the electrophorus was not properly prepared, it had the tendency, especially in moist weather, to lose its charge and thus become unable to produce a spark. Therefore, one imagined that substituting the electrophorus with a small electrostatic machine would

---

[37] Joseph Louis Gay-Lussac, "Perfectionnement de la Lampe à air inflammable, et appareil pour se procurer instantanément du gaz hydrogène dans un laboratoire", *Annales de physique et de chimie*, Tome 5, 1817, pp. 301-304.

[38] In 1818 also Lerebours proposed the "Nouvelle lampe ou briquet électrique à gaz hydrogène" for 80 francs. See : Lerebours*, Notice d'instruments d'optique, physique et mathématique*, Paris, Didot, 1818, p. 16. Again in 1835 Pixii, who was successor of Dumotiez, listed for the same price the "Lampe ou briquet électrique, à gaz hydrogène, perfectionné par M. Gay-Lussac". Pixii père et fils*, Catalogue des principaux instruments de physique, chimie, optique, mathématique*, Paris, chez l'auteur, 1835, p. 14. See also : Despretz C., *Traité élementaire de physique*, Paris, chez Méquignon-Marvis, 1827 (II edition), pp. 379-380.

[39] The cake was formed by melting together various resins and substances such as turpentine, shellac, sulphur, sealing wax, mastic, pitch, colophony, etc.

have avoided the problems. One of these lighters was proposed by C.H. Hübschmann (?-1846) in 1821.[40] The device was exceedingly complicated (Fig. 6.A). A miniature cylinder machine was hidden in the base of the apparatus and its collector was connected with the spark gap. On the axle of the machine there was a pulley with a spring and ratchet mechanism. A string that was rolled on the pulley was connected with a moveable arm of the gas cock. By pulling the string the machine was operated, and at the same time the cock was opened and the spark ignited the flowing hydrogen. When the string was released the action of the spring automatically rewound it on the pulley while, thanks to the ratchet, the cylinder did not counter rotate. By pulling a second string it was also possible to move a small arm with a metallic cup, which extinguished the flame of a small oil lamp lit by the hydrogen flame.[41] Hübschmann's lighter did not generate the hydrogen, which was simply stored in the usual two-compartments gasometer.

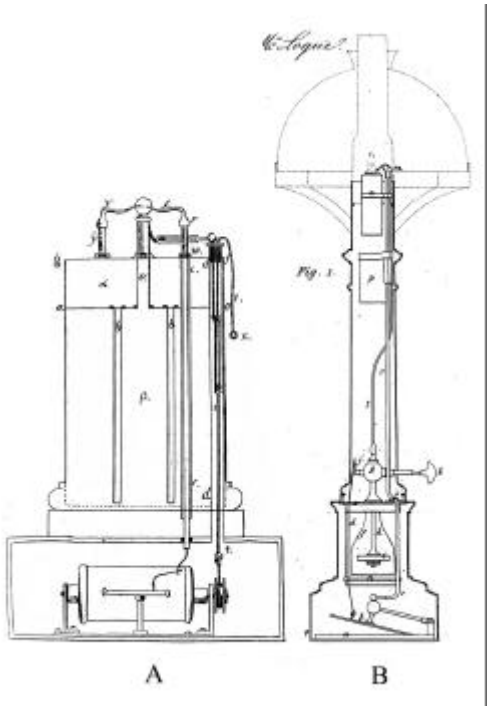

Fig. 6: A) Hübschmann's lighter with cylinder electrostatic machine, B) Loque's oil lamp with hydrogen lighter

In another model of lighter by an unknown maker, a crank driven cylinder machine charged a small Leyden jar. (Fig. 7) The addition of the jar certainly allowed one to

[40] C.F. Hübschmann, *Beschreibung einer neuen, vorzüglich bequem eingerichteten elektrischen Lampe*, Reutlingen, F.W.G. Stahl, 1821.

[41] Hübschmann suggested that with long strings and a couple of pulleys fixed to the ceiling it was possible to use his lamp without moving from the bed, even if the former was distant from the latter. He also added to his device a lampshade and a cup which could be used as a perfume-burner. Furthermore, he also tried to realise a gasometer which did not need any water, which could easily freeze during the winter. From this comment we can understand how poor could have been the domestic heating at the beginning of the early 19th Century!

produced a stronger spark. By opening the gas cock the electrode of the jar came into contact with the wire connected with the spark gap. Around at the same time, lighters with disk machines (enclosed in a separate box) were also produced in Munich. But, as it was pointed out, in moist weather also the electrostatic machines could fail and finally they were not more efficient than a well made electrophorus which could easily retain its charge for several months.[42] Furthermore, these apparatus were also more complicated and thus more expensive and therefore they were less popular.[43] Another peculiar device, which probably did not have a great success, is worth mentioning here. In 1818 a certain Loque, a French jeweller, patented an unusual lamp "ignifère" (Fig. 6.B) which also had a hydrogen generator (with the vessel containing the bell with a piece of zinc) and an electrophorus. In fact Loque's apparatus was an hydrogen applied to an oil lamp and the hydrogen flame just used for igniting the wick.[44]

Fig. 7: A hydrogen lighter with a cylinder electrostatic machine and a Lyden jar. (Private collection).

[42] But the use of electrostatic machines in gas lighters did not disappear with the hydrogen lamp. With the introduction of gas lighting and domestic gas distribution several types of portable lighters were introduced and some of them concealed in their handle a small Voss-type influence machine. Generally the latter had a hard-rubber drum with metallic sectors, which could be rotated by pressing a button with the thumb. A fine example of such a late 19th century lighter is preserved in the collection of the Fondazione Scienza e Tecnica in Florence.

[43] Gehler, op. cit, p. 85.

[44] French Patent 893 of the 25 May 1818. Christinan (editor), *Description des machines et procédés spécifiés dans les brevets d'inventions, de perfectionnement et d'importation*, Tome X, Chez Mme Huzard, Paris, 1825, pp. 215-217. In a very unusual hydrogen generating oil lamp (French Patent 4110 of the 9th of February 1836 by Milan and Franchot in Paris) the gas was just used to lift the oil to the wick with a constant pressure. Description des machines et procédés spécifiés dans les brevets d'inventions, de perfectionnement et d'importation, Tome XL, chez L.Bouchard- Huzard, Paris, (no date), pp. 240-242.

Finally, in 1838 the Italian instrument maker Corrado Wolf proposed a peculiar magneto-electric hydrogen lighter.[45] Wolf was one of the preferred makers of the Italian physicist Leopoldo Nobili (1784-1835), whose name is associated with a famous astatic galvanometer. In the 1830s Nobili conceived a magneto-electric machine called "sparkling magnet" (*calamita scintillante*). It was composed of a coil fixed to a moveable lever and wounded around an iron bar and a permanent horseshoe magnet. The terminals of the coil, which were made of flexible metallic springs, touched the poles of the magnet. Thanks to the action of the lever the coil could be suddenly detached from the magnet, the circuit would be interrupted and a spark jumped between the springs and the poles of the magnet. The latter was produced by the induced extra current generated by breaking the circuit. (A similar effect could be observed by closing the circuit).[46] Wolf applied the "sparking magnet" to the hydrogen lighter in an elegant apparatus enclosed in a wooden box which contained the hydrogen generator (with the glass vessel containing the bell for the gas) as well as a vertical horseshoe magnet. The coil (resting on the pole of the magnet) and its lever were placed on the top of the apparatus. (Fig. 8) By rapidly pushing the lever, it was possible to open the cock of the gas as well as to produce the spark. As usual, the hydrogen flame ignited a small oil lamp.[47]

Fig. 8: Magneto-electric hydrogen lighter with Nobili's sparking magnet. (Liceo Classico N.Machiavelli, Lucca)

[45] Paolo Brenni, Willem Hackmann, "Gli strumenti scientifici" in *L'eredità di Leopoldo Nobili*, Reggio Emilia, Comune di R.Emilia, 1984, pp.28-97.

[46] Leopoldo Nobili, *Memorie e osservazioni edite ed inedite del cavaliere Leopoldo Nobili: colla descrizione ed analisi de'suoi apparati e strumenti*, Firenze, David Passigli e soc., 1834, vol. 1, pp. 219-231 and vol. II, pp. 51-52. Nobili also proposed a more sophisticated sparking magnet with two horseshoe magnets and a coil moving between them.

[47] Probably the only existing magneto-electric hydrogen lighter of this type is preserved in the scientific collection of the Liceo Classico N.Machiavelli in Lucca. It is not signed, but it could well be the one presented by Wolf at the exhibition held in 1838 at the Accademia dei Gerogofili in Florence. Another magneto-electric lighter was proposed in the late 1840s by the American instrument maker Benjamin Pike.

The hydrogen lighter as household apparatus

Probably, until the introduction of an easy method of producing hydrogen in a single self contained apparatus the lighter essentially remained a laboratory device or it was used at home by amateurs who had a certain practice of chemical and physical manipulations. The great Swedish chemist Jöns Jacob Berzelius (1779-1848) wrote: "*Une lampe* [à hydrogène]…, *me sert depuis plus de trente ans dans mon laboratoire, pour allumer d'autres lampes, sans qu'elle ait eu besoin une seule fois d'être raccommodée pendant ce long espace de temps."* [48]

When the hydrogen lighter became a popular household apparatus (especially in Germany) it also acquired a much more elaborate design. The scientific instrument was transformed into a fashionable and elegant piece of furniture, which could be proudly displayed in a drawing room or in a salon.

Fig. 9: A richly decorated lighter (Private collection).

Fig. 10: An elegant lighter in form of an urn. (Museo Civico, Modena).

The glass vessels were often made with faceted Boemia glass or with coloured glass. The wooden box containing the electrophorus was executed using precious wood and elaborated inlays. (Fig. 9) Often the box was decorated with gilded bronze ornaments and zoomorphic feet. Sometimes the lighter assumed a more "theatrical" form. For example, at the Museo Civico di Modena there is a lighter hidden in an elegant wooden urn on a base containing the electrophorus. (Fig. 10) The flame was automatically ignited by opening the top of the urn. The Bryant and May collection[49] of fire making appliances

[48] Jöns Jacob Berzelius, *Traité de chimie, Opérations et appareils chimiques*, Tome VIII, Paris, Firmin Didot, 1833, pp. 265-267.

[49] This collection of fire appliances is today preserved in the Science Museum.

preserved a photograph of a lighter whose description was: " *..the whole surmounted and protected by a handsome removable cover of Berlin porcelain, in the form of the temple of Vesta, at Rome, the dome and the pillar white, the plinth, base, doors and windows black, the dome crowned by a statue of Vesta, goddess of hearth and home, with a representation of a Vestal Virgin standing in the doorway…"* This instrument was made by a certain Schulz in Pomerania.[50] Another elaborated lighter which had been made by an unknown Parisian maker: "*...eine Art von philosophischer Lampe erfunden, die eine Vestalin vorstellt, welche vor einem Altare sitzt, und eine Wachs-Kackel in der Hand hält. Bey den Füssen der Vestalin ist ein Hahn angebracht, den man nach Belieben drehen kann. Wenn man dreht, bricht aus der Mitte des Altares ein Feuer-Strahl hervor, die die Fackel der Vestalin anzündet.*" In the Roman mythology Vesta (corresponding to the Greek Hestia) was the goddess of hearth and home and her cult was celebrated by Vestal virgins. Therefore all the symbols and representations of Vesta were particularly appropriate for decorating a domestic fire producing device (Fig. 11).

Fig. 11: The temple of Vesta (Private collection).

The electric lighter was a curious and useful apparatus, and certainly represented an attractive conversation piece. The learned gentlemen could discuss and examine its parts and its operating system, while for simpler people its sudden and almost magical action caused marvel and stupefaction. It is impossible to estimate the number of lamps produced in the few decades of its popularity but, especially in Germany, it certainly was quite common and in several regions it could be found in almost all the well-off houses.[51]

---

[50] Christy Miller, *The Bryant and May Museum of Fire-Making appliances, Catalogue of the Exhibits, Supplement*, Bow, Bryant & May, 1928, p. 267.

[51] See: Gehler, (op.cit. note 18), p. 85. The physicist Erst Gottrified Fischer (1754-1831) wrote: "*Ces briquets sont très répendus à Berlin, et les meilleures sont fabriqué par M.Elckner.*" See : Erst Gottrified Fischer, *Physique mécanique*, Paris, Veuve Courcier, 1819, p. 246.

But was the lighter dangerous? Today in an era of overly-rigid safety rules, when a droplet of mercury from a broken thermometer appears as dangerous as a plutonium bar, it would be unimaginable to keep in the drawing room an apparatus filled with hydrogen and sulphuric acid. As it was pointed out before, the greatest danger, was represented by the possibility of having a mixture of air and hydrogen in the lamp forming the detonating gas, which could have been ignited by the spark. Since 1782, Ingenhousz warned of the possible danger of the lighter: "*Ceux qui veulent se servir de ces sortes de lampes sans être un peu verse dans cette belle branche de la physique, doivent être sur leur gardes. On ne doit surtout pas permettre que les gens peu au fait du maniement d'un tel instrument, comme des femmes et des domestiques, se mêlent de le remplir d'air, crainte d'accident. On doit surtout empêcher que les enfants ne manient cet instrument. L'imprudence pourroit causer cette explosion avec d'autres sortes de lampes à air inflammable, plutôt qu'avec celle-ci. Je sais que de tels cas sont déjà arrivé, mais par pure inattention; car, lorsqu'on connoît exactement la nature de ces lampes, & qu'on les manie toujours soi-même, il n y a rien à en appréhender.*" [52]

We have to remember that Ingenhousz was speaking of a lighter which required to be periodically refilled with hydrogen and not of the self generating ones. Furthermore he pointed out that, also in the presence of detonating gas if the diameter of the nozzle was small enough and the length of the pipe connecting it to the vessel was long enough, no backfire was possible.

Conclusion

In 1823 the German chemist Johann Wolfgang Döbereiner (1760-1849) introduced a new kind of hydrogen lighter, which did not need any electrical device. Döbereiner had discovered that a particular form of finely subdivided platinum, the so-called "platinum sponge", had a very strong catalytic action on hydrogen. When a jet of hydrogen (mixed with a bit of air) was directed on a small mass of platinum sponge, the latter became hot and then incandescent and subsequently ignited the gas.[53] The Döbereiner's lamp based on this phenomenon still had a hydrogen generating apparatus (which was very similar to the one of the electric lighter) but the gas was not ignited by a spark. This invention as well as the introduction of better and more efficient friction matches marked the decline of the electric lighter. [54] However this instrument did not suddenly disappear and it was manufactured at least for another couple of decades.[55] If in the second half of the 19th century the electric lighter was old fashioned and was abandoned as a domestic

[52] See: Ingenhousz, (op. cit note 25), pp. 146-147.

[53] Johann W. Döbereiner, „Neu entdeckte merkwürdige Eigenschaften des Suboxyds des Platins, des oxydirten Schwefel-Platins und des metallischen Platin-Staubes", *Annalen der Physik und der physikalischen Chemie*, vol. LXXIV, 1823, pp. 269-273. See also, „Beschreibung einiger hydropneumatischen Lampen", *Annalen der Physik und Chemie*, vol. II, 1824, pp. 329-333.

[54] But it has to be remembered that, even the Döbereiner lighter could fail. In fact, after a certain time platinum sponge tends to loose its catalytic proprieties and it has to be reheated to a high temperature in order to reacquire it.

[55] For example, in 1832 the Londoner instrument maker firm Warkins and Hill advertised: "Electrophorus mounted in various forms, with apparatus for generating and retaining hydrogen gas: the whole combined presents an elegant machine for obtaining instantaneous light 4l. 4s." Watkins and Hill, *Descriptive catalogue of optical mathematical philosophical and chemical Instruments and Apparatus*, London, 1832, p. 42.

appliance, it was still illustrated in several physical treatises. In 1853 Charles Chevalier in his famous « Manuel du physicien préparateur » admitted : *« Cet instruments est plus curieux qu'utile et ne saurait remplacer le briquet à mousse de platine ».*[56] Nevertheless the electric lighter was again described in various technological books and treatises until the late 1870s.[57] In fact, like many other obsolete apparatus, even though it was not practically used anymore, it remained a "classical" demonstration piece.

The electric lighter is one of the very first examples of a scientific instrument which became a fashionable and useful domestic apparatus.[58] A few decades later several other artefacts born in the laboratory such as the phonograph, the telephone or the wireless receiver, found an extremely important place outside it.

But an intriguing question remains unanswered. The electric lighter was born in Italy, but it was essentially modified and improved by German scientists and inventors. Furthermore, it was in Germany where it became a very popular device. Why? Certainly, thanks to Volta's connections and to his trip of 1777, the new apparatus was known very early in the German learned community. On the other hand, one could perhaps argue that the electric lighter was so successful also because of its emblematic character. Combining chemical (the production of hydrogen and its ignition) as well as electrical effects (the action of the electrophorus) the promethean lighter represented the new discoveries of chemistry and electricity, two fields of research which fascinated the German Romantics.[59] However, this explanation is probably too vague and could certainly be better applied to other instruments, (which like the electrophorus or the electric cell were much more problematic from a theoretical point of view) and I think that this intriguing aspect of the history of the electric hydrogen lighter needs further investigation.

I would like to thank Ferdinando Abbri, Lucio Fregonese Christoph Meinel, David Pantalony, and Jane Wess for their help and their useful comments.

First published in "Musa Musaei Studies on Scientific Instruments and Collections in Honour of Mara Miniati", a cura di Marco Beretta, Paolo Galluzzi, Carlo Triarico, Leo Olschki, Firenze, 2003, pp. 371-394.

---

[56] Charles Chevalier, Fau*, Nouveau Manuel du physicien préparateur*, Paris, Librairie Roret, 1853, Vol I, pp. 240-241. See also : Auguste De La Rive, *Traité d'électricité théorique et appliquée*, Paris, chez Baillière, 1854, Vol I, pp. 87-88.

[57] See for example : Daguin Adolphe, *Traité élementaire de physique théorique et expérimentale*, Paris, Delagrave, Toulouse, Privat, 1878, IV ed., Tome III, p. 222.

[58] Many lighters survive in several European museums as well as in various private and public collections. Certainly one the largest collections in the world (more than two dozen of pieces) can be found in the Deutsches Museum in Munich. In Italy hydrogen lighters can be seen for example at the University collections of Pavia and Padua, in the Liceo Volta and in the Tempio Voltiano in Como, at the Liceo Foscarini of Venice and at the Istituto e Museo di Storia della Scienza in Florence.

[59] See for example: Walter D. Wetzels, "Johann Wilhelm Ritter: Romantic physics in Germany" in Andrei Cunningham, Nicholas Jardine (editors), *Romanticism and the Sciences*, Cambridge, Cambridge University Press, 1990 and Francesco Moiso, "L'influsso di Alessandro Volta sulla filosofia della natura del romanticismo tedesco" in Corrado Sinigaglia (editor), *Correnti elettriche e illuminismo scientifico*, Milano, Franco Angeli, 2002, pp. 162-180.