A Temple in a Science Museum: Object Biography of Gerzabeck's Zündmaschine

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The Zündmaschine developed and manufactured by Johannes Gerzabeck in 1817, at first glance, does not look much more than a decorative object with its temple-like appearance. However, after a more careful examination, it reveals to be a perfect combination of nineteenth century technology and of early '800s culture and social expectations. This machine is part of the permanent exhibition of the "Academy Collection" at the Deutsches Museum in Munich (inventory no. 1271). The starting point for the object analysis is the Fleming's model (1974) characterized by the following steps: identification, evaluation, cultural analysis, interpretation. However, this protocol lacks "a confrontation with the object's materiality". Therefore, sensory and physical inspection and technical evaluation are performed in order to include a scientific point of view and shed light on all the tacit knowledge that is not generally found in written records but that can only be obtained through an active interaction with the object. Thanks to this "corrected" and "adjusted" model, the Zündmaschine is discovered to be a table lighter that exploits an electric spark to ignite hydrogen produced inside the lighter itself. This proves the innovative nature of this object that, differently for the previous lighters, does not require an external source of hydrogen since this is produced inside the object itself through the reaction between sulphuric acid and zinc. Another advantage of the process of writing the object biography is that of discovering information about the "users" of the machine. The Zündmaschine reveals its nature as a status symbol of wealth, comfort and elegance. It represents the advancements of technology that allow few elected to take control of the power of electricity, "the purest celestial fire", and "guide it" at one's own convenience.

Keywords: material culture, object biography, Deutsches Museum, Johannes Gerzabeck, Zündmaschine, Fleming's protocol, Winterthur model

Introduction

The object that will be analysed is a Zündmaschine from the Deutsches Museum in Munich, where it is part of the Founding Collection (Gründungssammlung des Deutschen Museums) and it is identified by the inventory number 1271. This machine is displayed among other scientific instruments in the permanent exhibition of the "Academy Collection". In the digital archives of the Museum, the device is also identified by the name *Elektrisches Tischfeuerzeug;* this name suggests that it is an electric table lighter, an ignition machine, a device used to ignite gas with

a spark. However, its design seems to tell a different story as it looks like some sort of lamp or an unusual decorative object.
The starting point for the analysis is the artifact study model presented in 1974 by E. McClung Fleming. Developed in his seminar “The Artifact in American History” as part of the Winterthur Museum-University of Delaware Program in Early American Culture, it is also known as the Winterthur Protocol (Hamilton, 2006). In his work, Fleming proposes this model as a tool to “identify many of the possible approaches to the artifact study, provide a framework relating them to each other, and thus suggest the outlines of a program of collaborative research for all who are engaged in study of the artifact” (Fleming, 1974). Anderson (2013), in her work, summarizes the steps that, according to Fleming, are fundamental in providing a guide for the analysis of material artefacts. The model consists in four analytical operations that have to be performed on five basic properties of an artifact: history (including provenance and maker), materials, construction (including techniques of manufacture), design (structure, form, iconography, ornament) and function (intended and unintended uses). The analytical operations are, in sequence: identification, evaluation, cultural analysis, interpretation. Their aim is that of guiding the study of the artifact and each one has a particular purpose (Fleming, 1974):

- identification (which includes classification, authentication, and description), results in a body of distinctive facts about the artifact that can be obtained from the object itself or from documentary evidence (Anderson, 2013);
- evaluation, results in a set of judgments about the artifact, usually based on comparisons with other examples of its kind;
- cultural analysis, examines the various interrelationships of an artifact and its contemporary culture and users;
- interpretation, suggests the meaning and significance of the artifact in relation to aspects of the culture of whom analyses the object and to his contemporary time.

This model has been developed in the context of the study of decorative arts, therefore, it is oriented towards this field and favours artifacts coming from that same area of interest. As Anderson (2013) underlines, the model provides a “pedagogical tool” that helps focusing the “attention on aspects of the object that might otherwise escape recognition”. However, when trying to apply this methodology to artifacts that do not pertain the decorative arts, such as scientific and technological instruments, the model is no longer adequate to grasp their richness and fails in capturing their significant and characteristic aspects. Therefore, it is necessary to improve the Winterthur model and recognize the importance of interacting with the object itself or, as Anderson (2013) defines it, of confronting with “the object’s materiality”. This, as described by Fors, Principe and Sibum (2016), “can help bridge the unavoidable gap that exists between the actions and ideas of historical actors and the textual descriptions or artefactual residues of those actions and ideas”. It helps to uncover what they define as “tacit knowledge” and allows to interwove sensory experience and evidence, with knowledge emerging from records and documents (Anderson, 2013). Fors, Principe and Sibum (2016) also add that the experience emerging from the handling of the object and the active engagement with it can also help “resolve ambiguities or clarify uncertain meanings in textual records”.
The Zündmaschine is not a scientific object in the strictest sense of the word, but can be considered as such since it is more than a tool or a decoration, it has a scientific value and it is a symbol of the passage from science laboratories to general public fruition. It will be studied using the presented and extended version of the Winterthur protocol. The analysis will start by looking at the object without previous knowledge and without any information about its provenience, name and manufacturer. The aim is that of obtaining an unbiased description of the device in all its details. After this first phase, the analysis will continue with the help of textual records in order to understand who the maker of the object was and how the Zündmaschine ended up in the Deutsches Museum. Then, the function and mode of operation of the machine will be investigated in order to understand how the different parts described at the beginning

interact with one another. Next, the design will be evaluated and a possible explanation for the peculiar choice of a temple will be researched. Lastly, the object will be analysed in relation to its own time and its intended specific users, in order to uncover more and more layers of information about this artifact.

Looking at the object: visual analysis of the Zündmaschine

At first glance, the object under investigation appears as a temple-like decorative object positioned over a wood pedestal and with columns enclosing three glass vessels, as can be seen in Fig. 1. The overall dimensions are 260mm (width) x 260mm (depth) x 480mm (height). The round Tuscan columns, unfluted and tapered, and the base of the dome are made of varnished wood, while the dome itself and the decorative elements are in lacquered brass; in particular, the dome presents a gold star pattern design (see Fig. 2) while the decorative band is characterized by a palmette and flower motif (as in Fig. 3). The base is covered in root wood veneer.

Fig. 1 On the left, a photo of the object from Gründungssammlung des Deutschen Museums. Edited by Julia Bloemer und Benjamin Mirwald, Version of 08.08.2020: © CC BY-SA 4.0
On the right, a photo of how the object appears nowadays where it is possible to see paper used to protect the glass vessels. Source: Deutsches Museum Munich, © Celeste Ottaviani.

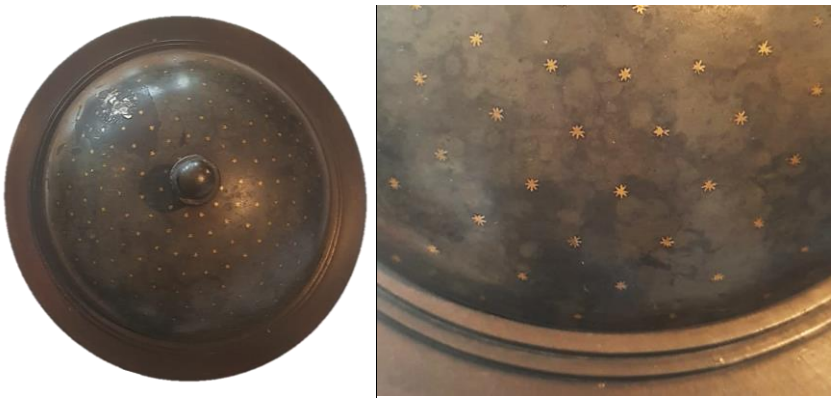

Fig. 2 Close-up of the dome from above and detail of the decoration. Source: Deutsches Museum Munich, © Celeste Ottaviani.

Fig. 3 Detail of the golden painted decoration with palmettes and a flower motif that can be seen at the base of the dome. Source: Deutsches Museum Munich, © Celeste Ottaviani.

Looking at the object more carefully, it is possible to see several hints of its usage. Starting from the dome, one can see the degradation of the lacquer, then, focusing on the glass vessels, it is possible to notice that they are connected to the base of the dome through a passage of some sort where there is the presence of a greenish residue, as Fig. 4 clearly shows. Another sign of usage can be found below the wooden base that, once the object is lifted, reveals several spots and marks (see Fig. 5).

Fig. 4 Close-up of the passage connecting the glass vessels to the dome. Source: Deutsches Museum Munich, © Celeste Ottaviani.

Fig. 5 Bottom of the wooden base. Source: Deutsches Museum Munich.

The passage between the glass and the dome suggests the presence of something inside the upper part of the temple. The dome, in fact, is a lid that, once opened, surprisingly reveals a hidden brass mechanism with a lever and some copper wires, as Fig. 6 shows.

Fig. 6 On the left, a photo of the opened apparatus, from Gründungssammlung des Deutschen Museums. Edited by Julia Bloemer und Benjamin Mirwald, Version of 08.08.2020: © CC BY-SA 4.0
On the right, how the mechanism appears from behind, Source: Deutsches Museum Munich, © Celeste Ottaviani.

At the base of the mechanism it is possible to find an engraving in the brass plaque that reveals the name of the maker of this object. The inscription, which can be seen in Fig. 7, reads: *Joh. Gerzabeck inv. et fecit Monachii*. This allows not only to understand who produced and, in particular, "invented", this object, but also where it was manufactured, allowing to locate the possible area of provenance.

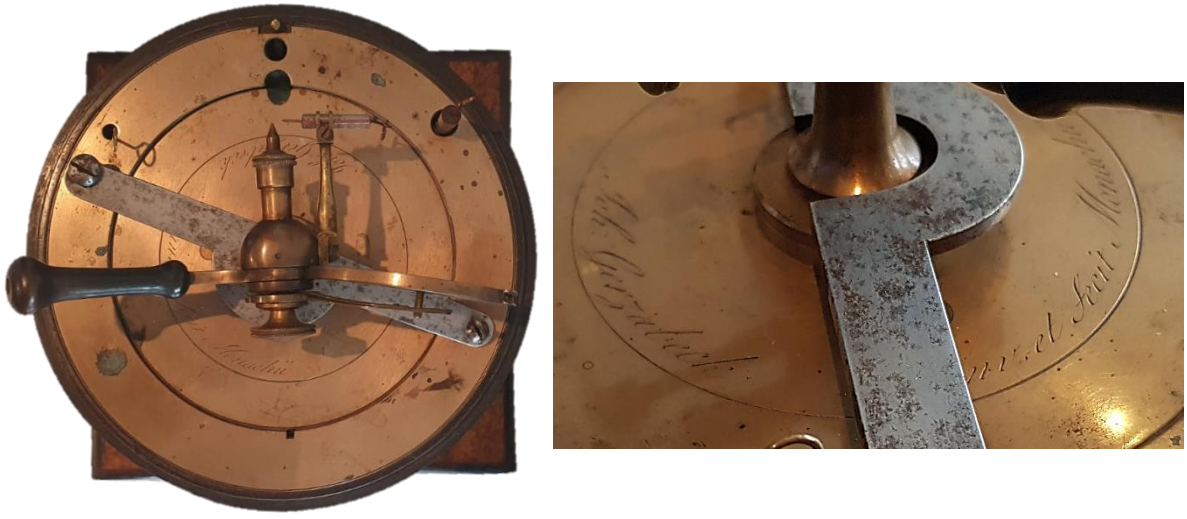

Fig. 7 On the left, how the mechanism appears from above; on the right, close-up of the engraving. Source: Deutsches Museum Munich, © Celeste Ottaviani.

In the mechanism (Fig. 8), different parts can be identified. From the middle of the lever two small arms extend: one, pointier, presents a nozzle at the extremity (too small to be seen in the photo), while the other has the function of supporting a wire encased in glass. This wire is then connected through a loop to another hanging metal thread. Around the lever there are also

different holes in the brass with wires coming out. It is important to notice that the holes are positioned in correspondence of the columns and that the wire inside the one on the bottom right corner of Fig. 8 can be extended as shown in Fig. 9. Moreover, in the same figure, it is also possible to see that the lever has a peculiar shape with a groove directly above one of the holes.

Fig. 8 Close-up of the mechanism from the front. Source: Deutsches Museum Munich, © Celeste Ottaviani.

Fig. 9 On the left, it is possible to see the wire completely extended out. Source: Deutsches Museum Munich, © Celeste Ottaviani.
On the right, detail of the lever from a different angle. Source: Deutsches Museum Munich.

The presence of the wires inside the columns suggests the possibility that the wooden base may also hide a surprise. In fact, the base of the temple reveals to be a secret drawer that, unfortunately, could not be opened at the time of the analysis of the object, due to the fragility of the wood.

This analysis is only the starting point in trying to understand the story and the function of this curious object. A lot of questions arise from looking at this peculiar temple: what is its function? And its utility? Who may have used it? Where did it come from? Why is this object now held at the Deutsches Museum?

The instrument maker

The first hint in the analysis, which can be used as a starting point for the biography of the object, is the engraving where the name *Joh.* [Johannes] *Gerzabeck* appears. The same name can be found at the end of the preface of the manual for the Zündmaschine, entitled "Anleitung zum Gebrauch der Zündmaschine des Mechanikus Joh. Gerzabeck" (Gerzabeck, 1820), where it is possible to read: "Joh. Gerzabeck, Mechanikus, Hausmeister bey der Königl. Akad. der Wissenschaften". From this it is possible to learn that Gerzabek was a *hausmeister*, hence, a custodian at the Bavarian Academy of Sciences[1]. This institution was founded in 1759 by Maximilian III Joseph, Elector of Bavaria, who, led by the spirit of enlightenment that pervaded the 18th century, wanted to create a place where sciences and humanities could be studied and investigated. The aim was that of emphasizing the benefits of science through education and public experimental lectures, therefore, numerous instruments were created for this purpose (Deutsches Museum, 2020(a)). It is estimated that between 1759 and 1903, at the Bavarian Academy of Sciences were assembled more than a thousand instruments ranging from air pumps to polarizers and circular dividing machines (Deutsches Museum, 2020(b)). This confirms a culture of instrument making that was thriving in the 19th century Munich and in which Gerzabeck's figure can be surely included.
Gerzabeck's name appears also in "Kunst - und Gewerbeblatt des Polytechnischen Vereins für das Königreich Bayern" (Author unknown, 1818: 10, 1830: 6, 1840: 7), in the section "Verzeichnisz der Mitglieder des polytechnischen Vereins für Bayern", where he is listed as one the members and is also described as a mechanic residing in Munich, in the Isar district.
The name appears also in the address book of Munich and the suburb area for the year 1842 (Author unknown, 1842: 117), as working or living in Neuhauser Straße, under the section "Instrumentenmacher, phisicalische", hence, confirming that this record is referring to the same person as all the other documents. Unfortunately, there is no further information on his life, however, all these documents help reconstruct a general picture of this instrument maker that worked in Munich in the first half of the 19th century.

The Zündmaschine at the Deutsches Museum

From the previous documents it is clear that Gerzabeck worked for the Bavarian Academy of Sciences, so it is not strange that the Academy may have had one of the instruments he produced. Proof of this can be found in "Denkschriften der Bayerischen Akademie der Wissenschaften" (Author unknown, 1820: XXXIII), where it is possible to read: "des Hausmeisters Gerzabek verbesserte Zündmaschine". The document mentions that this improved ignition machine manufactured by Gerzabeck was discussed in one of the meetings of the Academy.
But, how did the Zündmaschine end up on the shelves of the Deutsches Museum? One possible explanation is that when in 1903 the Bavarian Academy of Sciences donated its extensive collection of instruments to the newly founded Deutsches Museum, it also donated that device (Deutsches Museum, 2016). From the 1860s/70s onwards, in fact, scientific research lost importance for the Bavarian Academy of Sciences due to the decision of the monarch, King Ludwig I (1786-1868), to move the state university from Landshut to Munich[2], thus separating teaching from the Academy (Deutsches Museum, 2020(c), (d)). The Academy collection contained thousands of valuable objects, reflecting the various scientific disciplines that characterized the institution: apparatuses for research, for educational and teaching purposes, but also for entertainment (Deutsches Museum, 2020(b)).

[1] The Academy is also referred to as *Königlich Bayerischen Akademie der Wissenschaften* or as *Kurbayerische Akademie der Wissenschaften*.
[2] Originally established in Ingolstadt, in 1472, it is now known as the Ludwig Maximilian University of Munich.

How does the Zündmaschine work?

In the analysis of the Zündmaschine, other questions arise: how does this object work? What is it? The visual analysis is not enough to understand the function of this temple. The presence of metal wires may, in fact, suggest that it has something to do with electricity, while the glass vessels recall the equipment used in Chemistry experiments, therefore, it is necessary to seek help from documents and textual records. An important document that clarifies the purpose of the Zündmaschine is its manual: “Anleitung zum Gebrauch der Zündmaschine des Mechanikus Joh. Gerzabeck” (Gerzabeck, 1820), that was found while searching for the identity of Johannes Gerzabeck. This document helps also in the dating of the machine; it was published in 1820, therefore, the manufacture of the Zündmaschine dates back to that period.

The manual starts with a brief preface in which Gerzabeck states that his machines are durable and reliable and that there are several testimonies that confirm his impeccable work. He also adds that he will be forever liable for every fault in these machines and that he feels “obliged, especially because of the many imitations”, to declare that he designates each of his machines with his name. This is additional proof of the fact the Gerzabeck produced the device in question.

After the preface, follows an extract from “Wöchentlicher Anzeiger für Kunst - und Gewerb-Fleiß im Königreiche Bayern” (Author unknown, 1817: 74-78) that, in addition to bringing the dating of the machines produced by Gerzabeck to 1817, starts by saying that among the great number of physical discoveries of the previous century, there was that of the electric lighter, named “Fürstenberger lighter” after its inventor. More details on this first electro-chemical ignition machine can be found in “Handbuch der technischen Chemie” where it is possible to read that it was invented around 1770, in Basel, and that it was a “flammable air” lighter that used hydrogen gas ignited thanks to the spark induced by an electrophorus[3] (Schubarth, 1839: 101). However, studies as the one carried out by Brenni in 2003 shed light on the invention of the electric hydrogen lighter that was originally conceived by Alessandro Volta in 1777 and not by Fürstenberger. Moreover, Brenni indicates that in 1780, a booklet was published in which Frédéric Louis Ehrmann, professor of Physics in Strasbourg, attributed the invention to Fürstenberger, an amateur physicist, without even mentioning the name of the Italian scientist. This probably started a series of misunderstandings about the rightful inventor.

At the beginning, the electric hydrogen lighter was composed of two glass vessels, one over the other, that had to be filled with water (upper one) and hydrogen (lower one). The hydrogen had to be produced outside and, only in a second moment, could be stored in the vessel. The gas release occurred by allowing the water to flow into the lower vessel and push the hydrogen out of a nozzle placed on top of the device. This nozzle was placed between two electrodes that could be charged by touching one of them with the plate of an external electrophorus, not part of the lighter itself. This would induce the production of a spark and, consequently, the ignition of the gas (Brenni, 2003).

In the 1790s, a major improvement was introduced by including the electrophorus itself in the apparatus, concealed in a wooden box which formed the base of the device, and by automatizing

[3] The electrophorus is an instrument that allows the production of a considerable amount of electric charge through triboelectrification and induction. The online catalogue of Museo Galilei (2015) provides a clear description of this instrument that consists of an insulated plate called "cake", typically made of a dielectric material such as pitch, wax or resin, on which is placed a metal disk with an insulated handle. The resin acquires negative charge when rubbed with fur; this induces a separation of charges when the metal disk is placed on the cake. As a consequence, positive charges will aggregate on the bottom side of the disk, while negative ones on the top side. If a conductor is connected with the top of the metal disk, the negative electric charge can be used to create a current.

its action (Brenni, 2003). With further improvements was then possible to start producing hydrogen inside the device itself instead of only storing it. Later, was also possible to simplify the gas generation and devise a way to have an apparatus that was self-sufficient and did not require all the fastidious tasks of filling the gas container thanks (Brenni, 2003)[4].

The ease with which the flame could be obtained, as often as desired, made this kind of device very popular and a lot of these ignition machines started to be manufactured in great number. However, all these machines had their imperfections, which were due to the manufacturing process, to the materials used in the electrophorus that were very sensitive to the influence of humid air, but also due to the cumbersome process required to produce the flame and generate the spark. Gerzabeck, who for a long time produced and repaired many ignition machines, was able to improve the device and remove some imperfections.

Comparing the visual analysis of the object with the textual records from the manual, it is now clear what the Zündmaschine is and how it worked. It is a table lighter in the shape of a temple, with the ignition mechanism located under the removable dome and a friction electric machine inside the base of the device, in the wood box shown in the initial analysis. In the centre, enclosed by the columns, there are glass vessels in which hydrogen gas can be produced by a reaction between water, zinc and a little (sulphuric or hydrochloric) acid. When the lever, on the top of the device (Fig. 6), is lowered, the hydrogen starts flowing out of the nozzle located at the extremity of one of the arms extending from the base of the lever (Fig. 8). At the same time, the electric machine in the base starts working; this consists of a round glass plate which rotates between two leather cushions coated with amalgam (Fig. 10). This electric machine is connected, thanks to a wire encased in glass[5] and running inside one of the columns, to an electrode placed on the other arm extending from the base of the lever. This second arm is located directly in front of the opening for the outflowing hydrogen, that acts also as the second electrode to form the spark gap. The spark discharge leads to the ignition of the hydrogen-oxygen gas mixture. As soon as the pressure of the outflowing gas decreases, the lever closes automatically and thus stops the combustion process (Gründungssammlung, 2020).

Fig. 10 Photo of how the electric machine appears once the wood base is opened. This particular example is from another Zündmaschine manufactured by Gerzabeck in 1830 and kept in the Deutsches Museum depot. © Deutsches Museum. Available at: http://www.deutsches-museum.de/blog/blog-post/2015/06/18/tischfeuerzeug-von-johann-gerzabeck/ (23/08/2020)

[4] For further details on the automatism, Brenni (2003) describes carefully how it worked.
[5] In order to be isolated from the rest of the machine and not disperse the electric charge (Fig. 8).

To clarify how the Zündmaschine is structured inside, the photo of a similar machine produced by Gerzabeck and disassembled into the three main parts (Fig. 11) comes to help. The glass vessels enclosed in the columns of the temple can be accessed by lifting the base of the mechanism (already presented in the analysis in the previous pages and shown in Fig. 6 to 9)[6]. This is coherent with the presentation of the machine in the manual that states that all the machines manufactured by Gerzabeck were characterized by a gas release device made of a single part. Hence, all screws, insulation pads and additional sealing of the gas containers were removed and his apparatus could, therefore, be assembled and disassembled easily by hand without the need for an assistant. This facilitated the filling of the glass vessels and enabled every owner to do it by himself.

Fig. 11 Another Zündmaschine manufactured by Gerzabeck where it is possible to see how the device appears once it is opened and disassembled (Rehfus [n.d.]).

The manual of the Zündmaschine contains also the composition of the mixture required for the device to work correctly; it consists of 2 Pf [7] of pure water and 15 Loths [8] of Vitriol oil, which has to be mixed carefully and drop by drop with the water in the glass vessels. Then, once put the vessels in place and closed, few grains of zinc (8 to 9) have to be thrown into the liquid in order to start the production of the hydrogen gas. Vitriol with no further qualifications, often means sulphuric acid (H_2SO_4), a colourless, odourless, and viscous liquid that is soluble in water where it can be diluted. Zinc reacts with dilute sulphuric acid to form zinc sulphate ($ZnSO_4$) and hydrogen (H_2) gas:

$$Zn(s)+H_2SO_4(aq)\rightarrow ZnSO_4(aq)+H_2(g)$$

[6] The device shown in Fig. 11 presents a base for the mechanism in ceramic, while the previously analysed Zündmaschine has a brass base; the lifted section includes the lever.
[7] It corresponds to the measuring unit Pfund; in 1820, time in which the manual was published, it had a value equal to 560 g in the Bayern state (Meyer-Stoll, 2005). Until the middle of the 19th century, in fact, regionally different measures of weight were in use (Mozhnik, 1848).
[8] This is a measure of weight formerly used in Germany, the Netherlands and some other parts of Europe, equivalent to 17.5 g (Meyer-Stoll, 2005).

At the beginning, the H_2 produced is contaminated with the atmospheric air remained inside the vessels, therefore, it is necessary to let this atmospheric air out by opening the nozzle. Once enough Hydrogen develops (which is evident from the rising of the liquid in the glass containers), the device is ready to be used. The hydrogen which gradually escapes during the continued use of the machine is replaced by the reaction of the zinc as long as the liquid still dissolves it; if this does not happen anymore, the filling must be renewed[9].

From the manual, it is clear that the machines manufactured by Gerzabeck have two advantages, with respect to previous lighters: the internal production of hydrogen and the removal of the usual electrophorus that is replaced with a small electric machine with the necessary friction equipment. As already said, this electric machine allows to avoid using an electrophorus. With a motion of the lever[10], in fact, a glass plate inside the bottom box is turned at the required speed and through friction induces a separation of charges; consequently, an electric current is produced and used to ignite the gas. This new kind of apparatus is described as being able to serve its purpose as a lighter even under very unfavourable conditions.

The manual continues praising the Zündmaschine by saying that apart from the normal use as igniters, these machines could also be employed for many other purposes: for example, to carry on small electrical experiments or charge a Leyden jar[11]. Moreover, they could be used to obtain combustible air (i.e. hydrogen-oxygen mixture) for various purposes and experiments. Therefore, the Zündmaschine, was not only a lighter, but a device that could be used by teachers or science enthusiasts, that often were not able to buy complete apparatuses.

The peculiar design

Gerzabeck was very mindful of the technical details of his Zündmaschine, but, at the same time he was also very keen on and meticulous with the external look.
The device is characterized by its peculiar temple shape that mimics a monopteros, a circular temple that in Baroque and Neoclassical architecture was a popular motif in European gardens and parks. One example is the monopteros in the English Garden in Munich that is said to have been of inspiration to Gerzabeck (Gründungssammlung, 2020). However, the temple was built between 1832 and 1837 meaning that probably Gerzabeck used the same design before the completion of its construction. This peculiar design recalls also similar temples and classical architectures used in scientific illustrations, as in the case of the frontispiece of the *Rudolphine Tables* published by Johannes Kepler in 1627, evidence of the fact that the Zündmaschine was not only a beautifully crafted lighter, but also an instrument of scientific value.
In Ancient Rome, the monopteros design was associated with the worship of Vesta, the goddess of the hearth, home, and family and one of the main deities of the Roman religion. Her sanctuary was traditionally a circular building, in imitation of the early settlements with round huts, and was symbolic of the public hearth where a perpetual fire burned (Encyclopaedia Britannica, 2019). The symbolism associated with Vesta is therefore particularly appropriate for decorating a fire producing device (Brenni, 2003). It is not strange that Gerzabeck chose a similar design to contain its perfected mechanism: the Zündmaschine was a symbolic hearth, the central fire of the house, an instrument with which obtain “perpetual” fire with only a simple motion of a lever.

[9] The manual states that, in case of multiple daily uses, this can only happen every two years at most.
[10] Probably the motion of the lever is transferred to the plates in the electric machine thanks to some sort of string (not present in the machine analysed), as suggested by the peculiar shape of the lever (Fig. 9). The groove already described could have been used to connect the string, probably coming out from one of the holes, with the lever.
[11] A Leyden jar is a device used for storing static electricity.

Cultural analysis: the users of the Zündmaschine

The electric lighter is one of the very first examples of a scientific instrument that became popular enough to turn into a fashionable and useful domestic apparatus; in particular, it can be considered the first electric household appliance (Brenni, 2003). A testimony of this can be found in the "Journal des Luxus und der Moden" of the year 1800 (Author unknown), where the electric lighter is celebrated as a device that not only makes a comfortable and beautiful furniture in an elegant room, but also as a practical machine that is really easy to fill with flammable air. The Journal underlines the scientific nature of this lighter, saying that it is really astonishing to think that the discoveries made in the field of electricity and the results of the experiments carried out by Franklin with lightning would be used one day for pure convenience and that electric and spark machines would find a place among other home appliances in everyone's living rooms. At the start of the 19th century, the elegance and the curiosity surrounding these new electric lighters, made them very popular among science-loving men and women and these devices were romanticized, as bearers of the "purest celestial fire" (Author unknown, 1800).

The Zündmaschine manufactured by Gerzabeck, did not require the level of ability and knowledge required by apparatuses where the hydrogen was not produced inside. This was an important factor in the diffusion of similar devices outside of laboratories and the homes of who had a certain practice manipulating scientific instruments (Brenni, 2003). The electric lighter mechanism allowed to have fire and light whenever necessary, more comfortably than by means of steel, stone, tinder and sulphur candles, especially at night, where it could be used to get light when in bed, without having to inhale the smell of sulphur (Ehrmann, 1780).
Around the beginning of the 19th century, these electric lighters were only affordable for the wealthy and rich people. Lighters were, in fact, luxury items and it is remarkable to highlight that several detonating machines manufactured by Gerzabeck were sold to the Wittelsbach, the Royal Family, who used them in the Munich Residence (Deutsches Museum, 2016).

Conclusions

The analysis of Zündmaschine allowed to understand that this object, which, at first, draws attention for its design, hides a far more interesting apparatus and biography. It is an instrument of great value, it represents a perfect combination and synthesis of the physical and chemical knowledge of the beginning of the 19th century. With this device, the ease of production of the flame by means of an electric spark exceeded that of previous apparatuses thanks to the automatized process of production of the Hydrogen and the internal electric machine. These improvements where already implemented in other lighters, even before the ones manufactured by Gerzabeck, however, they often presented several imperfections, were very complicated to use, and did not have both the internal production of Hydrogen and the integrated electric mechanism. At the same time, with Gerzabeck, the decorative design of the electric lighters reached its peak to the point of transforming a device that was for few expert users, in something that could be used by anyone. The perfected and refined lighters became a representative status symbol of wealth and elegance.

Acknowledgements

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References

Anderson, Katharine, Mélanie Frappier, Elizabeth Neswald, Henry Trim 2013. Reading Instruments: Objects, Texts and Museums. *Science & Education* (22): 1167–1189.

Author unknown 1800. Die electrische Licht-Maschine. *Journal des Luxus und der Moden*. (15(3)): 159-161. Available online at: https://zs.thulb.uni-jena.de/rsc/viewer/jportal_derivate_00116022/JLM_1800_H003_0026_b.tif (26.08.2020)

Author unknown 1817. *Wöchentlicher Anzeiger für Kunst- und Gewerb-Fleiß im Königreiche Bayern* (vol.5). München: Zeller.

Author unknown 1818. *Kunst- und Gewerbeblatt des Polytechnischen Vereins für das Königreich Bayern* (vol.4). München: Fleischmann.

Author unknown 1820.*Denkschriften der Bayerischen Akademie der Wissenschaften* (vol.6). München: Bayerische Akademie der Wissenschaften.

Author unknown 1830. *Kunst- und Gewerbeblatt des Polytechnischen Vereins für das Königreich Bayern* (vol.16). München: Fleischmann.

Author unknown 1840. *Kunst- und Gewerbeblatt des Polytechnischen Vereins für das Königreich Bayern* (vol.26). München: Fleischmann.

Author unknown 1842, *Adreßbuch von München und der Vorstadt Au*. München: Litterarisch-Artistische Anst.

Brenni, Paolo 2003. *Volta's electric lighter and its improvements: The birth, life and death of a peculiar scientific apparatus which became the first electric household appliance*. URL: https://www.academia.edu/29169181/Voltas_electric_lighter_and_its_improvements_The_birth_life_and_death_of_a_peculiar_scientific_apparatus_which_became_the_first_electric_household_appliance (26.08.2020)

Deutsches Museum 2015. *Depotfund des Monats: Tischfeuerzeug*. URL: http://www.deutsches-museum.de/blog/blog-post/2015/06/18/tischfeuerzeug-von-johann-gerzabeck/ (11.08.2020)

Deutsches Museum 2016. *Spurensuche in der Gründungssammlung*. URL: https://www.deutsches-museum.de/blog/blog-post/2016/09/02/spurensuche-in-der-gruendungssammlung/ (11.08.2020)

Deutsches Museum 2020 (a). *Akademiegründung*. URL: https://www.deutsches-museum.de/ausstellungen/naturwissenschaft/akademiesammlung/akademiegruendung/ (11.08.2020)

Deutsches Museum 2020 (b). *Gründungssammlung*. URL: https://digital.deutsches-museum.de/projekte/gruendungssammlung/geschichte/ (11.08.2020)

Deutsches Museum 2020 (c). *Vorläufer zur Uni*. URL: https://www.deutsches-museum.de/de/ausstellungen/ naturwissenschaft/akademiesammlung/vorlaeufer-zur-uni/ (11.08.2020)

Deutsches Museum 2020 (d). *1827–1903: General–Conservatorium*. URL: https://www.deutsches-museum.de/ausstellungen/naturwissenschaft/akademiesammlung/1827-1903-general-conservatorium/ (11.08.2020)

Encyclopaedia Britannica 2019. *Vesta.* URL: https://www.britannica.com/topic/Vesta-Roman-goddess (16.08.2020)

Ehrmann, Friedrich Ludwig 1780. *Déscription Et Usage De Quelques Lampes Á Air Inflammable*. Strasbourg: De l'Imprimerie de J.H. Heitz, Imprimeur de l'Univ. Permalink: http://mdz-nbn-resolving.de/urn:nbn:de:bvb:12-bsb10133683-2 (26.08.2020)

Fleming, E. M. 1974. Artifact Study: A proposed model, *Winthertur Portfolio* (9): 153-173.

Fors, Hjalmar, Lawrence M. Principe and H. Otto Sibum 2016. From the Library to the Laboratory and Back Again: Experiment as a Tool for Historians of Science. *Ambix*, (63(2)): 85-97.

Gerzabeck, Johannes 1820. *Anleitung zum Gebrauch der Zündmaschine des Mechanikus Joh. Gerzabeck*. München: Lentner.

Gründungssammlung des Deutschen Museums 2020. *Elektrisches Tischfeuerzeug*.URL: https://digital.deutsches-museum.de/projekte/gruendungssammlung/detail/1271 (15.08.2020)

Hamilton, Michelle A. and Shelley McKellar 2006. Learning through Objects: Development of the UWO Medical Artifact Collection as a Teaching and Research Resource. *Canadian Bulletin of Medical History* (23): 219-240.

Schubarth, Ernst Ludwig 1839. *Handbuch der technischen Chemie* (vol.3). [s.l.]: Rücker.

Meyer-Stoll, Cornelia 2005. Die Regulierung der bayerischen Landesmaße. *Akademie Aktuell* (03(15)): 20-25. Available online at: https://badw.de/fileadmin/pub/akademieAktuell/2005/15/00_aa2005-3_gesamt.pdf (26.08.2020)

Mozhnik, Franz 1848. *Lehrbuch des gesammten Rechnens für die vierte Classe der Hauptschulen in den k.k. Staaten*. Wien: Im Verlage der k.k. Schulbücher Verschleiß-Administration bey St. Anna in der Johannisgasse. Available online at: https://commons.wikimedia.org/wiki/File:Gewichtma%C3%9Fe1.jpg (26.08.2020)

Museo Galilei 2015. *Virtual Museum. In-depth:Electrophorus*. URL: https://catalogue.museogalileo.it/indepth/Electrophorus.html (26.08.2020)

Rehfus, Birgit [n.d.]. *Von Stahl und Stein zum Streichholz. Aus der Geschichte des Feuerzeugs*. URL: http://www.deutsches-museum.de/fileadmin/Content/data/Insel/Information/KT/heftarchiv/1981/5-1-1.pdf (14.08.2020)