The Electrostatic Clock – the first Electrical Clock

Introduction

The first battery operated Electrostatic clocks were produced around 1815 – 25 years before Alexander Bain developed and Patented his electromagnetic clock in 1840. The electrostatic clock was simultaneously developed in three countries around 1815 – Italy, England and Bavaria

Prior to 1799 only static electricity, generated by rubbing insulating materials together was able to be generated. Storage was limited to Leyden Jars – a form of capacitor. Quite a few experiments were carried out in the 1700's on static electricity. However very little was known about the nature of electricity and nothing about electromagnetism.

In 1800 Alessandro Volta discovered the battery and produced continuous electric currents. His battery cells were constructed of dissimilar metals with a porous separator with an electrolyte eg salt water soaked in the separator. Volta stacked 20 to 40 of these cells together to form a battery or "Pile" Each cell produced about 1 volt. He published his results to the world and this started a huge amount of experimentation and discovery on the nature and uses of electricity throughout the world.

Electrolysis was discovered in 1800 by Nicholson and Carlisle.

Electromagnetism was discovered in 1820 by Oersted and Ampere

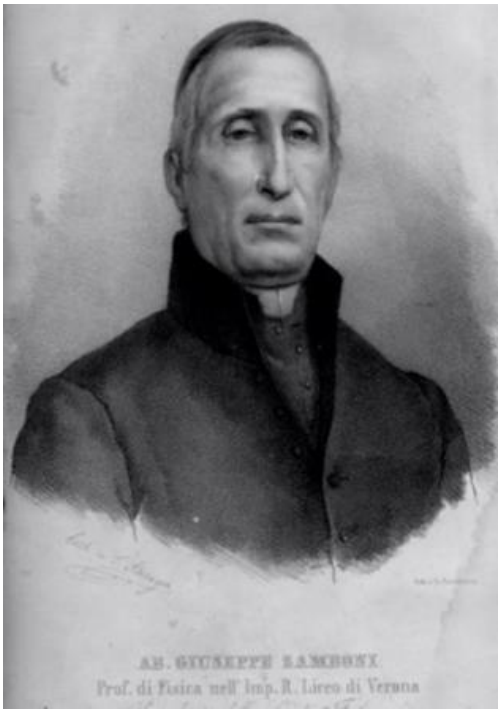
The homopolar electric generator was discovered by Faraday around 1831 and the first dynamo by Pixii in 1832. The first industrial generator was built in 1844 in the UK.

Dry Pile Batteries

Electrostatic clocks depended on the Dry Pile Battery for their operation. The dry pile was a development of the Volta wet Pile invented by Volta in 1800. A dry pile battery was a large number (several thousand) of alternating layers of dissimilar metals (eg Zinc and copper) discs separated by paper or similar impregnated with a slightly moist electrolyte.

Bishop Giuseppe Zamboni produced the best dry pile batteries and developed his dry pile batteries over a long period from 1810 to 1840. (ref 1) In the initial stages of development he communicated in detail with Volta so improvements could be made.

Zamboni Dry Piles were used initially to power a perpetual electromotor made for Zamboni by Streizig. This Electromotor was demonstrated at various places around Europe by Assalini and so it became well known to the scientific community. Ref 4.



the abbot Giuseppe Zamboni (1776 – 1846

On the left, a 'Pila di Volta' and on the right the 'Pila di Zamboni'. In principle they are similar, but in those of Zamboni the 'electrolytic solution' was formed naturally, thanks to the absorption of atmospheric humidity by the discs that insulated the numerous metal sheets and there were many more cells in the pile.

The perpetual electromotor of Zamboni by Streizig C 1814. The dry pile batteries are in the columns and the pivoted pendulum top ring rocks between the upper round plates on the piles. One of the circular top plates is positive and the other is negative. When the pendulum rocks and the ring touches the left positive round plate it picks up a positive charge. It then is repelled by the plate and attracted to the right hand negative plate. It then moves to the negative plate and touches it and picks up a negative charge which is then repelled by the negative plate and attract ted to the positive plate. This device would operate for many years without the battery being exhausted due to the exceptionally long durability of the battery and very low current draw of the device. A similar in principle dry pile device has been in Operation for 176 years ringing a pair of small bells known as the “Oxford Electric Bell”

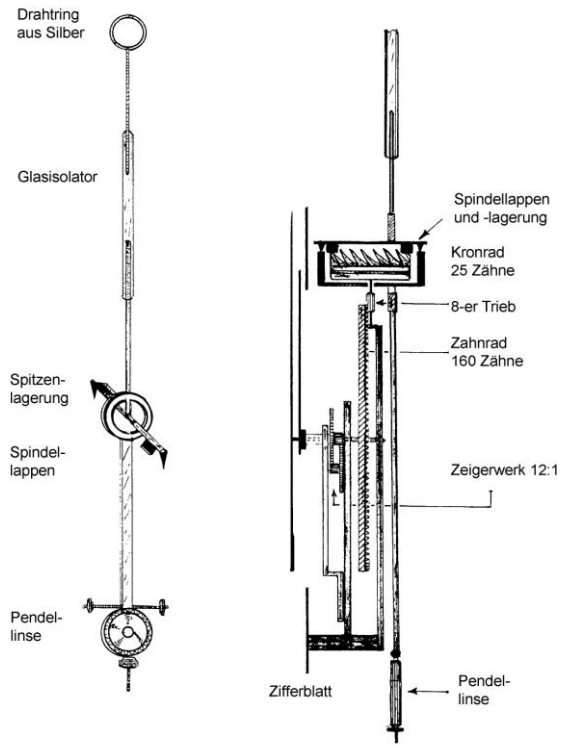
The First Electric Clocks

Interestingly electrostatic clocks were developed simultaneously in Italy, Bavaria and England in 1815. They have a similar appearance to the Perpetual Electromotor and they were probably inspired by the perpetual Electromotor of Zamboni and Streizig.

Zamboni and Streizig 1815 - Italian

This clock is believed to be the first electrostatic clock and was built in 1815 by Carlo Streizig who had a shop in Verona. Ref 2. It was based on the perpetual electromotor by Streizig from 1814. It utilised a compound pendulum and ring electrostatic element.

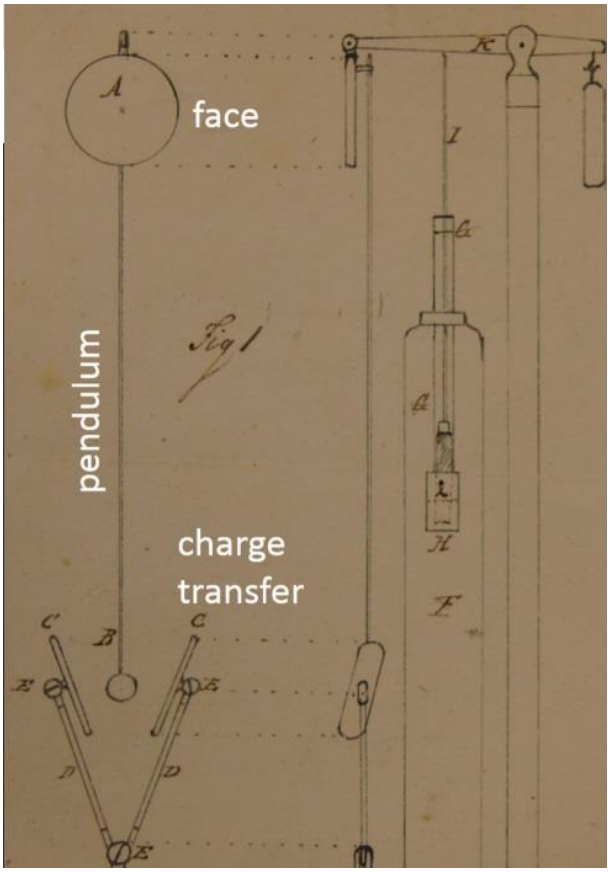
Clock by Streizig C 1816 – improved version of 1815 clock. Ref 2



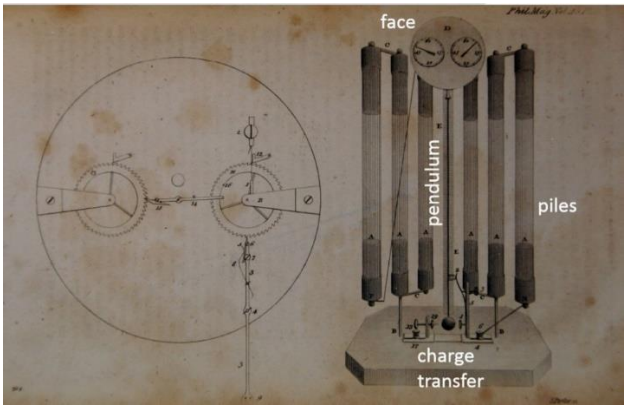
aus: Aked/Rizzardi 1975

Francis Ronalds 1788 to 1873- English

Ronalds made several clocks in from 1815 and onwards using DuLuc Piles and Zamboni Piles. Ronalds was a prolific inventor and experimenter working on many other things as well including the Telegraph. Ref 3



The clocks are not in existence but based on his drawings and are not believed to be very “commercial” The small electrostatic element size would not impart much energy for driving the clock mechanism. The clock used a simple pendulum but had accuracy problems mainly due to varying electrostatic voltage. Ref2. This is the first example of a simple pendulum being used.



Alois Ramis 1815- Bavarian

Ramis also built an electric clock and presented it in 1815. The clock was a commercial in that it could be purchased. Ref 4. The clock looked very nice but appears to lack a lot of driving power due to the small electrostatic force surface and the compound pendulum design. Ramis probably saw the Streizig perpetual Electromotor demonstrated in Munich and Zamboni strongly contested the originality of Ramis's clock.

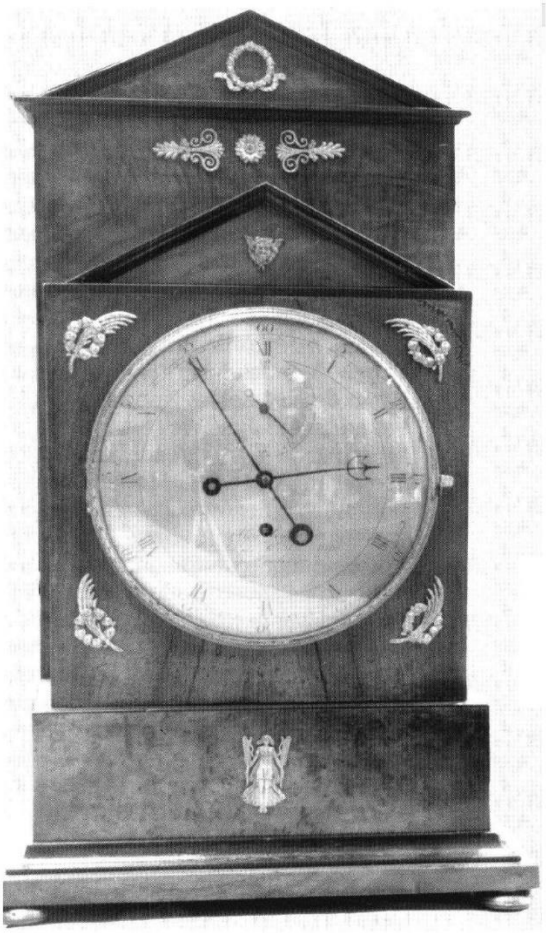
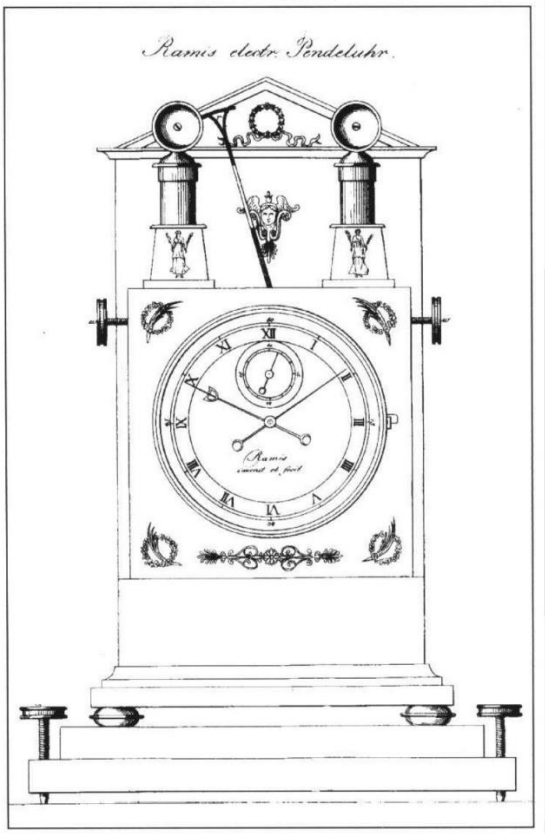


Photo of Ramis Clock in the Munich City Museum. The original electrostatic mechanism has been removed/modified and a spring wound mechanism inserted.

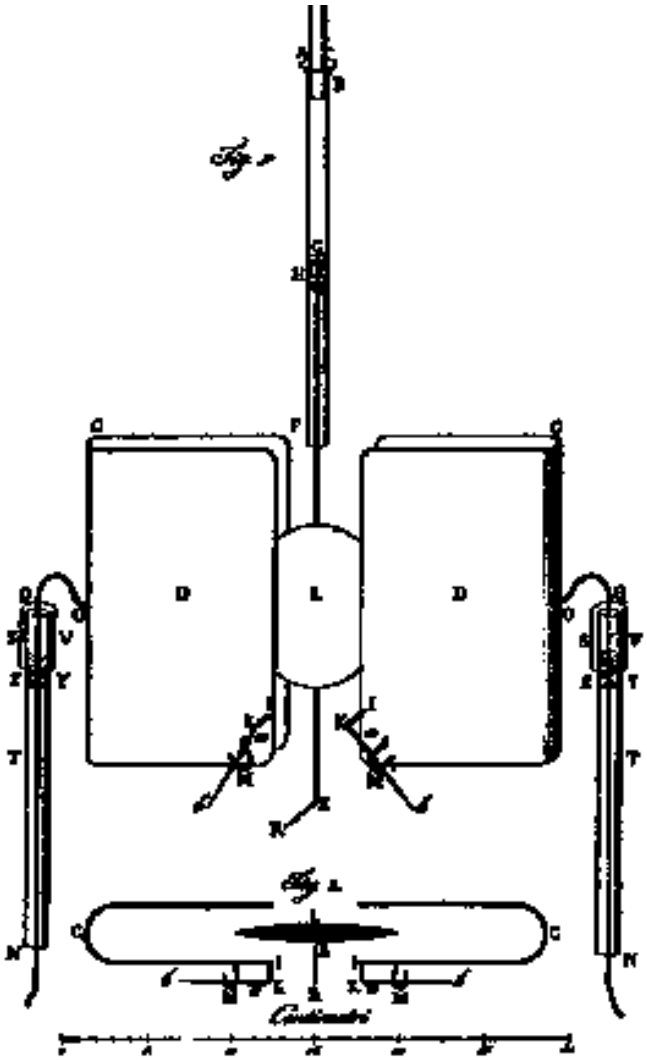


Drawing of Ramis Electrostatic clock showing original piles and ring electrostatic element on top of compound pendulum. Photo and drawing courtesy of Richard Knerr.

Antonio Camerlengo 1827 Italian

From 1820 onwards Camerlengo stood out in the improvements in the electric clock. He incorporated a one second gridiron pendulum, improved gear work and the increase in size of the electrostatic elements with the introduction of Lanterns and a large pendulum bob. Ref 2.

Zamboni 1 second Clock by Antonio Camerlengo C 1827



Control system of pendulum with the use of plates of great dimension, from "Lettera all'Accademia Reale delle Scienze di Parigi", Poligrafo, March 1831 Ref 3

Other Italian Electrostatic Clocks

A number of other clocks are still in existance – the two below are in the Liceo Maffei in Verona (museum)

Clock signed Giovanni Bianchi

Unknown Clock in Verona

Conclusion

The electrostatic clock was invented around 1815 by inventors in 3 countries at about the same time. Probably the most successful and highly developed were in Verona Italy using Zamboni Piles. However the clocks were never particularly commercially successful due to problems with the Dry Cell Piles varying voltage and low generated electrostatic power. However they were undisputedly the first electric clocks and preceded by some 25 years the invention of the electromagnetic clock by Alexander Bain in 1840. Bain's clocks were powered by an Earth Battery made with two large plates of copper and zinc buried in the soil.

Recent Developments

Dry piles have been researched in the 20th Century. Ref 5, 6. They have not achieved any great application.

Recently Brian Scott has been revisiting the application of electrostatic principles for clock construction. A 1 to 2kV voltage source is used rather than dry pile batteries. Below is a clock he constructed in 2020. It has a 24 hour dial. The pendulum is driven solely by electrostatic forces and the coupling from the pendulum to the clock hands is purely mechanical. The best result in 2021 was over a 76 day period where the variation in the daily error was 2.3 seconds with a standard deviation of 3.3 seconds. No adjustments were made to the clock during this period. Development is continuing.

References

1 Massimo Tinazzi "PERPETUAL ELECTROMOTIVE OF GIUSEPPE ZAMBONI. MANUFACTURE"

http://www.sisfa.org/wp-content/uploads/2013/03/xviTinazzi.pdf

2 Roberto Mantovani "Clockmakers, makers and collectors of scientific instruments in Verona in the first half of the 19th Century"

3 Beverley Ronalds "Remembering the first battery-operated clock" Antiquarian Horological Society" 2015

4 Richard Knerr "Pioniere der Entwicklung elektrischer Uhren in München"

5 Paul F Howard "A High Voltage Pile of the Zamboni Type" 1953

6 P. Bristeau. Pile haute tension de faible volume. J. Phys. Phys. Appl., 1951, 12 (S8), pp.74-78.

Acknowledgements

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