THE GAS DISCHARGE PHYSICS IN THE 18th CENTURY

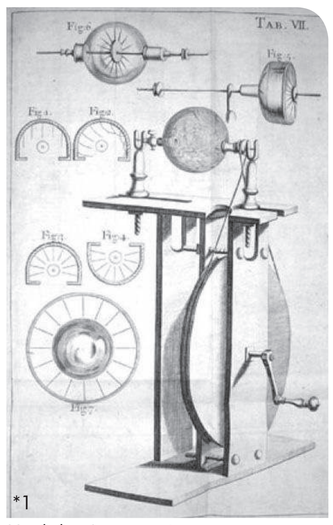
– by Julia Cipo, Holger Kersten –

Francis Hauksbee

* 1666 in Colchester, Great Britain
† April/ May 1713 in London

Francis Hauksbee was a british scientist, lab assistant of Isaac Newton and an elected member of the Royal Society for researches in science.

Inspired by Picard's and Bernoulli's results on the luminosity of mercury in barometric tubes, Hauksbee continued experimenting with mercury with one difference: he examined the probe in a vacuum vessel. In his 1709 publicated work called "Physio-mechanical experiments on various subjects touching light and electricity" he described that after placing mercury in the glass vessel and then evacuating the air, a bright glow could be sighted. Hauksbee also noticed that the generated light could be used to read by. These researches led later to the development of gas-discharge lamps such as neon-lightning lamps.



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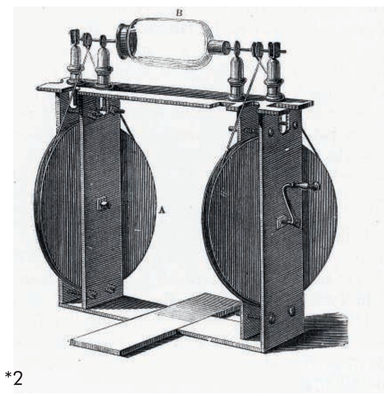
Hauksbee's generator



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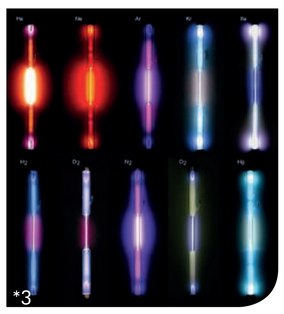
Hauksbee's first electric machine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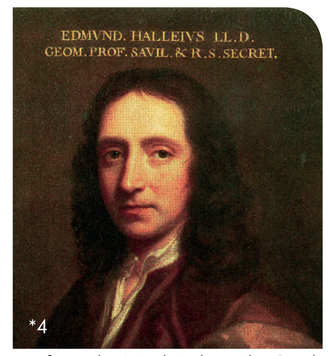
Gas discharge lamps

Edmond Halley

* November 8th, 1656 in Haggerston, London
† January 25th, 1742 in Greenwich



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Edmond Halley was a british astrophysicist, meteorologist, mathematician and member of the Royal Society. As the earth's magnetic field fascinated him, he worked on this topic during the years 1683-1710 and discovered the line profile of the magnetic field as well as the barometric (height) formula. In 1716 a bright Aurora Borealis (Northern Lights) was sighted in Germany, England, France and Holland. Halley began searching for a scientific explanation of this phenomena. He suggested that the aurora was caused by an evaporation of magnetic liquid moving from the North Pole to the South Pole. Even though this wasn't correct, he determined that the aurora's arc did not course along the geographic pole, but along the magnetic pole.

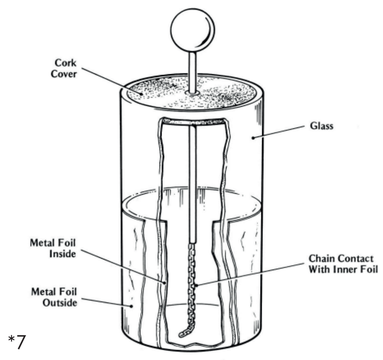

*5
Aurora Borealis

Pieter van Musschenbroek

* March 14th, 1692 in Leiden, Netherlands
† September 19th, 1761 in Leiden, Netherlands


*6

Pieter van Musschenbroek was a dutch scientist, a student of Isaac Newton and a fellow of the Royal Society. In 1746 van Musschenbroek invented the first capacitor, which was named "the Leyden jar" after the city of Leiden. The early Leyden-jars consisted of a glass bottle filled with a small amount of water. A cork with a vertical wire was positioned on the top, so the cork would close the bottle and the metal would dip into water. The exposed end of the wire was connected to a friction device, which generated static electricity. After removing the wire from the electricity source, the leyden jar would save the static electricity. By touching the loose end of the wire with the hand, a discharge would be noticed by receiving a shock. The design of the Leyden jars was being improved. So the water has been replaced by an inner metal foil, which was connected to the metal wire in the inside. The outside of the jar would also be coated by a metal foil, which served as an electrode and is brought into contact with earth. This way it would not be anymore necessary to touch the metal wire to cause a discharge. To prove that the Leyden jar would stock the discharge, the charged bottle was being segmented into the glass part and the two thin metal foils. After the parts are put together a large spark can be received. This also showed, that the actual electricity storage place is the glass part of the jar. The Leyden jars have been used by Benjamin Franklin, Georg C. Lichtenberg and other scientists for their experiments.



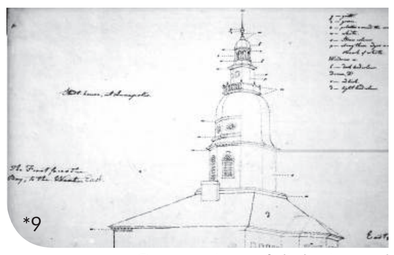
*7
Leyden jar with metal foils

Benjamin Franklin

* January 17th, 1706 on the Governor's Island, Boston
† 17th April, 1790 in Philadelphia, Pennsylvania


*8

Benjamin Franklin was a politician, scientist, printer and author. He played a crucial role in the politics of North America by co-writing the Independence Declaration of America. His requirement of solving problems led him to his most well-known discovery: the lightning rod. In a 1753 edition of his own published almanack "Poor Richard Almanack", where news about the weather and the meteorology were published, he described his kite experiment:
"The method is this: Provide a small iron rod (it may be made of the rod-iron used by the nailers) but of such a length, that one end being three or four feet in the moist ground, the other may be six or eight feet above the highest part of the building... If the house or barn be long, there may be a rod and point at each end, and a middling wire along the ridge from one to the other. A house thus furnished will not be damaged by lightning, it being attracted by the points, and passing thro the metal into the ground without hurting any thing. "
This way he has explained the principle of gas discharges. Franklin also invented the terms 'positive' and 'negative' as well as the Franklin Stove, which is still used nowadays and heated a room more efficiently and safely than a fireplace did.

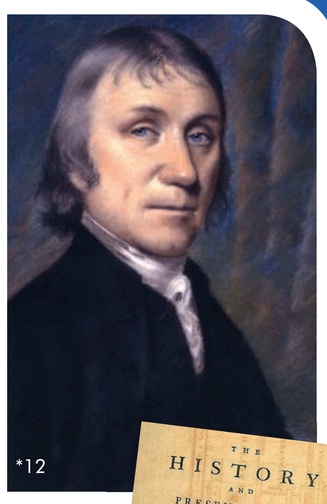

*9
Constructions of lightning rod for the Maryland State House


*10
Franklin's lightning rod


*11
The kite experiment

Joseph Priestley

* March 24th, 1733 in Yorkshire, Great Britain
† February 6th, 1804 in Pennsylvania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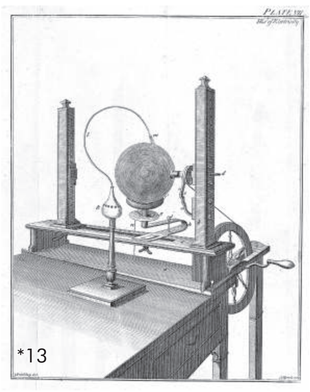
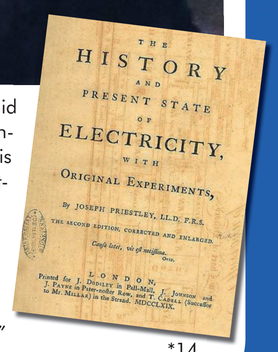


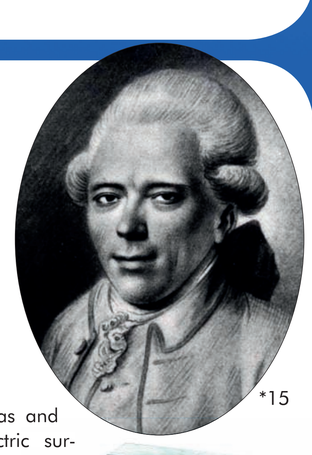
*13
Priestley's electrical machine

Joseph Priestley was an english theologian, chemist, member of the Royal Society and natural philosopher. He had a few meetings with Benjamin Franklin, who encouraged him to summarize his work in the book "The History and Present State of Electricity" published in 1767. There he investigated that the electrical discharge did not acquire a charge, it would be enough if a insulated conductor was near a static electric device. With the help of his brother he constructed an electrical machine and investigated the discharges of electrical charges through iron.


THE
HISTORY
AND
PRESENT STATE
OF
ELECTRICITY,
WITH
ORIGINAL EXPERIMENTS,
By JOSEPH PRIESTLEY, LL.D. F.R.S.
THE SECOND EDITION, CORRECTED AND ENLARGED.
LONDON,
MDCCLXVII.
*14
"The History and Present State of Electricity"

Georg Christoph Lichtenberg

* July 1st, 1742 in Ober-Ramstadt, Germany
† February 24th, 1799 in Göttingen, Germany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Georg Christoph Lichtenberg was a german mathematician, natural scientist, member of the Royal Society and the first german professor for experimental physics.
He was among the first to bring the Franklin's lightning rods to Germany or as he called them "the frightening rods", using several of them on his home. Lichtenberg also constructed the electrophorus, a large electrostatic generator to study the patterns left from the lightnings.
His results were published 1777 in his memoirs "Super Nova Methodo Naturam ac Motum Fluidi Electrici Investigandi". By applying a high voltage charge to an insulating material as glass and then by sprankling its surface with sulfur and lead powder, he noticed some characteristic patterns. The patterns for the positive charge were longer with more branching, while the ones for the negative charge were shorter and more compact. These typical patterns are known as the Lichtenberg Figures. They are a product of interactions between ionized gas and the dielectric surface of the material. The length of the branchings can be varied by changing the applied voltage or the surrounding air pressure.


*16
Lichtenberg figures

Sources: 1- Illustration of the Hauksbee generator "Physico Mechanical Experiments" 1719, 2- Alchetron- Free Social Encyclopedia, 3- Wikimedia, Work of Heinrich Priok, 4- staff.science.uu.nl , 5- suntrek.org, 6- de.academic.ru, 7- Engineering Search Engine http://emadrlc.blogspot.de/, 8- Asia Public Relations, 9- Maryland State Archives, 10- The Pennsylvania Center for the Book, 11- likesuccess.com, 12- Scan of a print found in Wikimedia. Original is housed at the National Portrait Gallery, London., 13- Medical Historical Library of Yale University, 14- taringa.net,m 15- uni-goettingen.de (Georg-August-University of Göttingen, Germany), 16- scientificsonline.com