

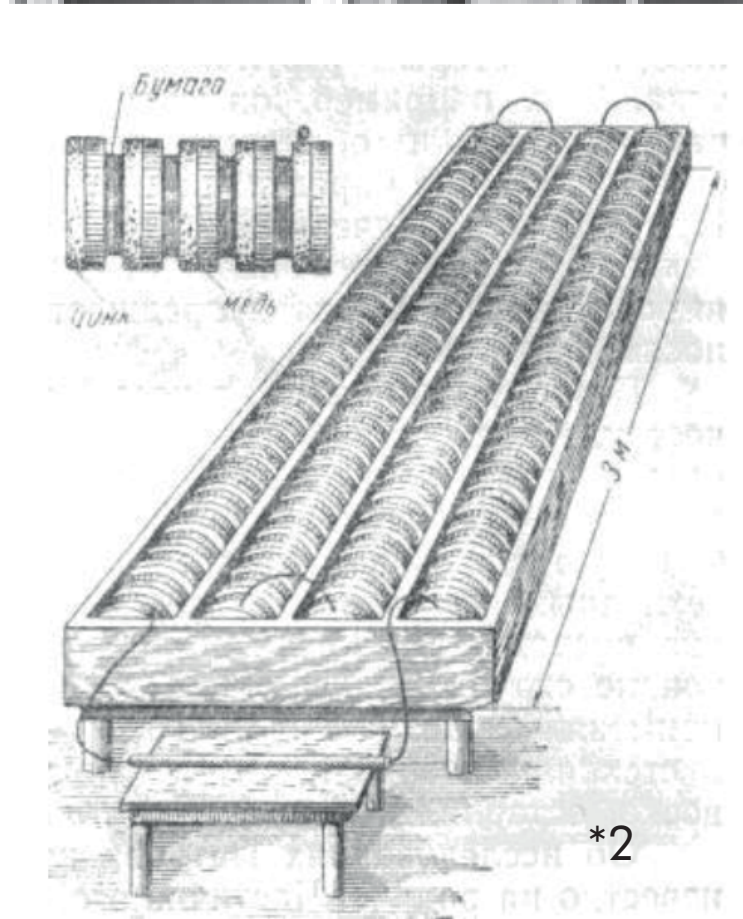
THE GAS DISCHARGE PHYSICS IN THE 19th CENTURY (PART I)

– by Julia Cipo, Holger Kersten –

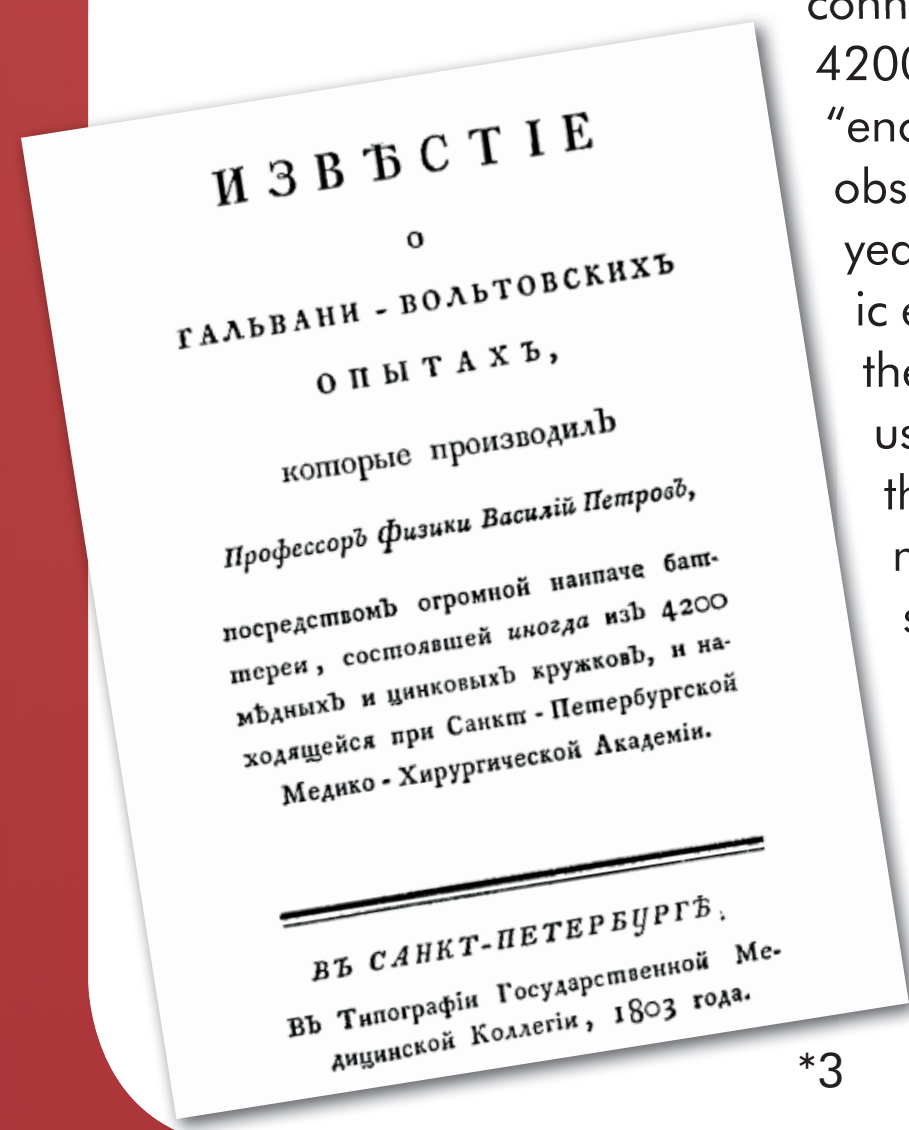
Vasily Petrov

* July 19th, 1761 in Oboyan, Russia
† August 5th, 1834 in Saint Petersburg, Russia

Vasily Vladimirovich Petrov was a russian physicist and member of the Russian Academy of Sciences. After A.Volta introduced his voltaic battery in the year 1800, Petrov began constructing a larger battery by using 4200 copper and zinc discs, stowed in four huge boxes. The boxes were about 3 m long and placed parallel to each other. They alternately ended with zinc and copper, so when connected they could be used as a serial circuit of 4200 electric cells. The motivation of building an “enormous” battery as called by Petrov was the observation of new effects. In his report of the year 1803 “Announcements on Galvano-Voltaic experiments” he describes the observation of the first continuous arc discharge. First Petrov used graphite electrodes and later he replaced them with metal electrodes. Then he noticed melting, burning and erosion of the metal assuming the use of voltaic batteries in smelting, welding and in the producing of pure metallic oxides. Unfortunately he published his works in russian, which is why his publications did not become very popular.



Petrov's battery



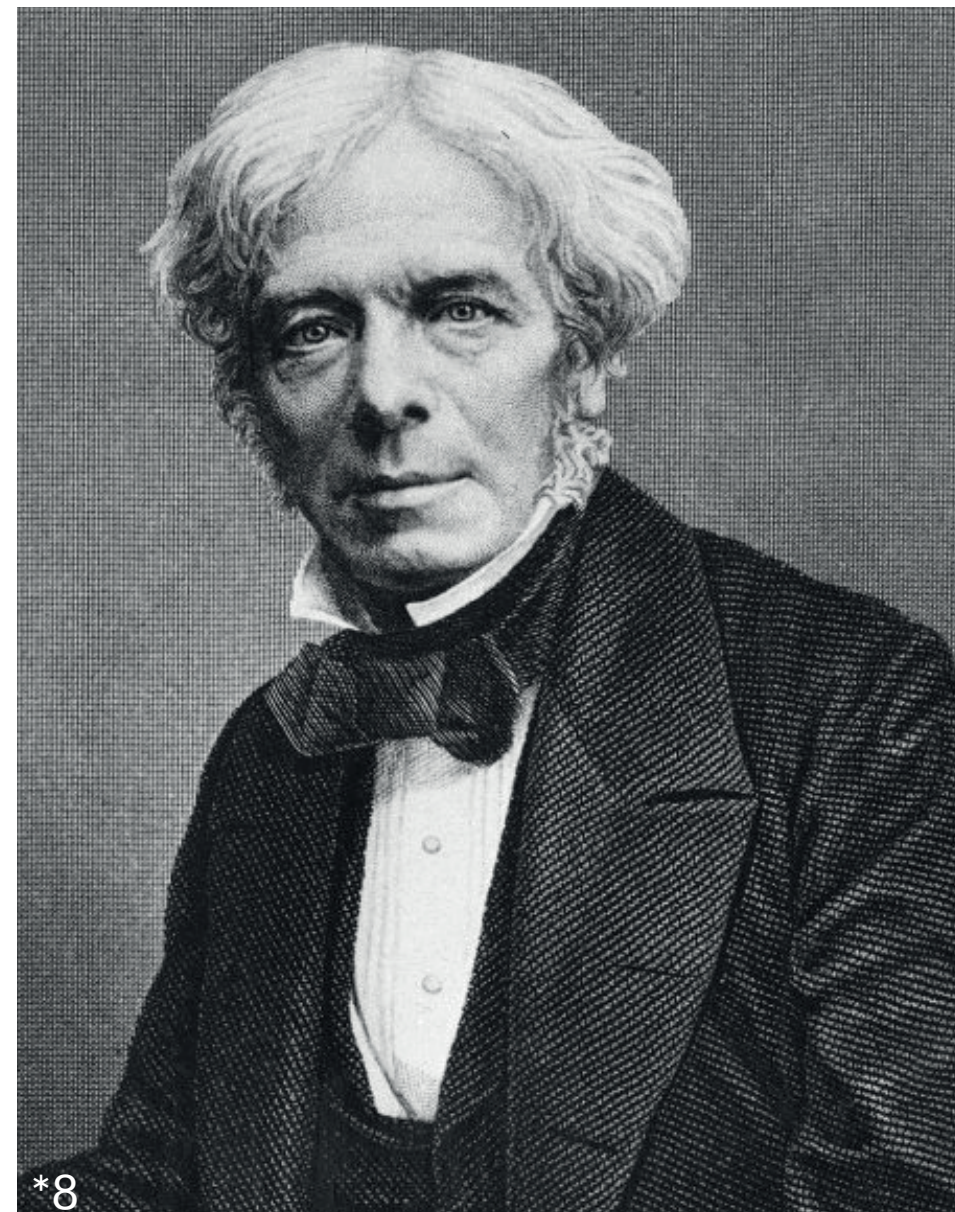
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Cover page of Petrov's report “Announcements on Galvano-Voltaic experiments”, published in 1803

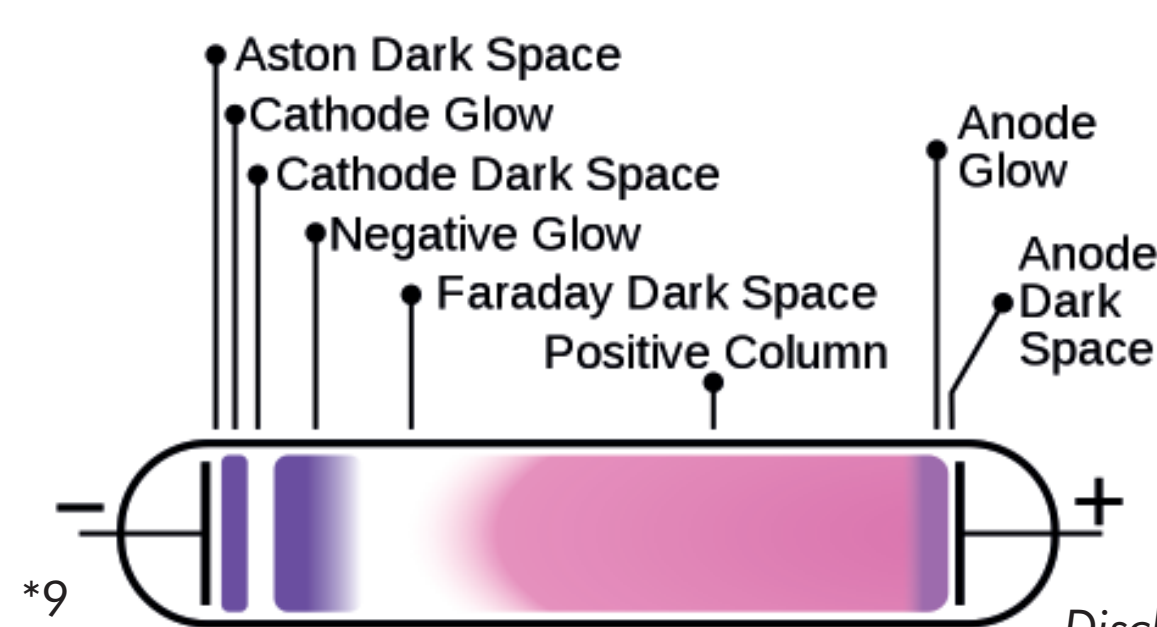
Michael Faraday

* September 22nd, 1791 in Newington Butts, Surrey, England
† August 25th, 1867 in Hampton Court, Surrey, England

Michael Faraday was an english scientist, inventor, assistant of Humphry Davy and member of the Royal Society. Besides his discoveries about the electrolysis, the electromagnetic induction, the diamagnetism as well as inventing the terms ‘anode’ and ‘cathode’, he investigated the electric current in thinned gases during the years 1831-1835. Using different gases like oxygen, hydrogen and a gas mixture as air, he noticed glow discharges with its beginning at the cathode and its end at the anode. As he lowered the gas pressure, he noticed a dark spot between the negative glow and the cathode, also known as the “Faraday dark space”. There the secondary electrons, emitted through the impact of positive ions with the cathode, have been slowed down, making them unable for a collision with other gas particles. In the year 1857 Faraday observed discharge and also deflagration phenomena by using a gold wire in a hydrogen filled glass tube, all connected to a voltaic battery. He predicted that his “deflagrator” could be use for film deposition.



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Discharge tube, Faraday Dark Space

Julius Plücker

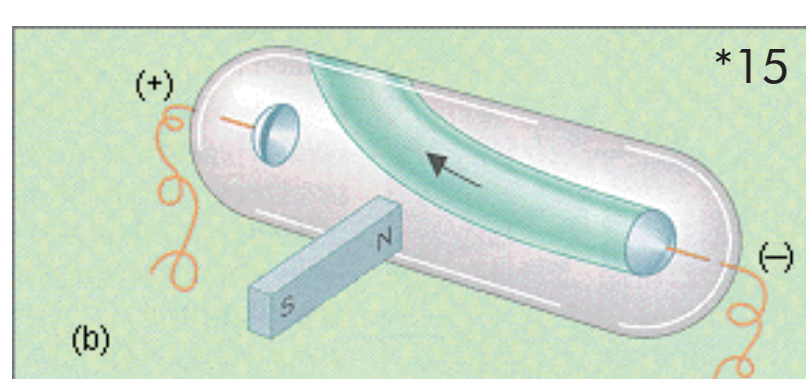
* June 16th, 1801 in Elberfeld by Wuppertal, Germany
† May 22nd, 1868 in Bonn, Germany

Julius Plücker was a german mathematician, physicist and foreign member of the Royal Society. Inspired by the work of Michael Faraday on electromagnetism and after exchanging a lot of letters with the english scientist, he started experimenting with geissler tubes, invented bei Heinrich Geissler, which was the glassblower for Professor Julius Plücker. The advantages of the geissler tubes were the low air pressure within, making the geissler tubes the first ones with a good vacuum inside of it. This way Julius Plücker could use different kind of gases for generating

electrical discharges by applying a high voltage. He wanted to discover more about the magnetic properties of gases and their discharges. So 1858 he placed a magnet close to the glass tube and noticed the shifting of the glowing rays. With this work he approved that the glow discharge has electrical properties. In 1862 he recognized, that the same gas could dispose over different spectra at different temperatures. He was the first to recognize the three lines of the hydrogen spectrum and so he opened the way for the development of spectral analysis and atomic physics.

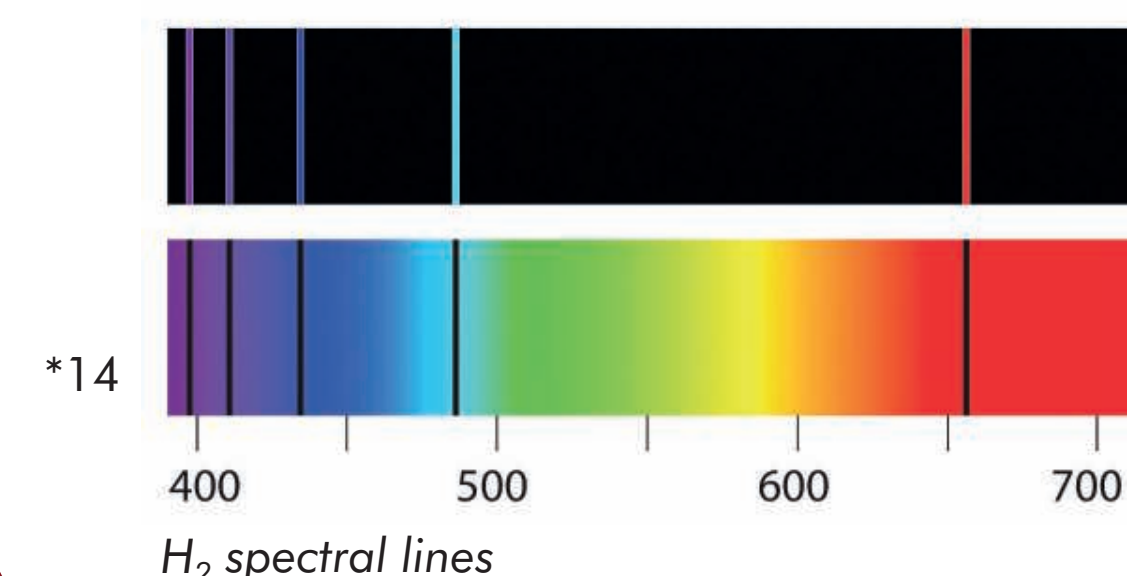


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Magnet close to a Geissler tube

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H₂ spectral lines

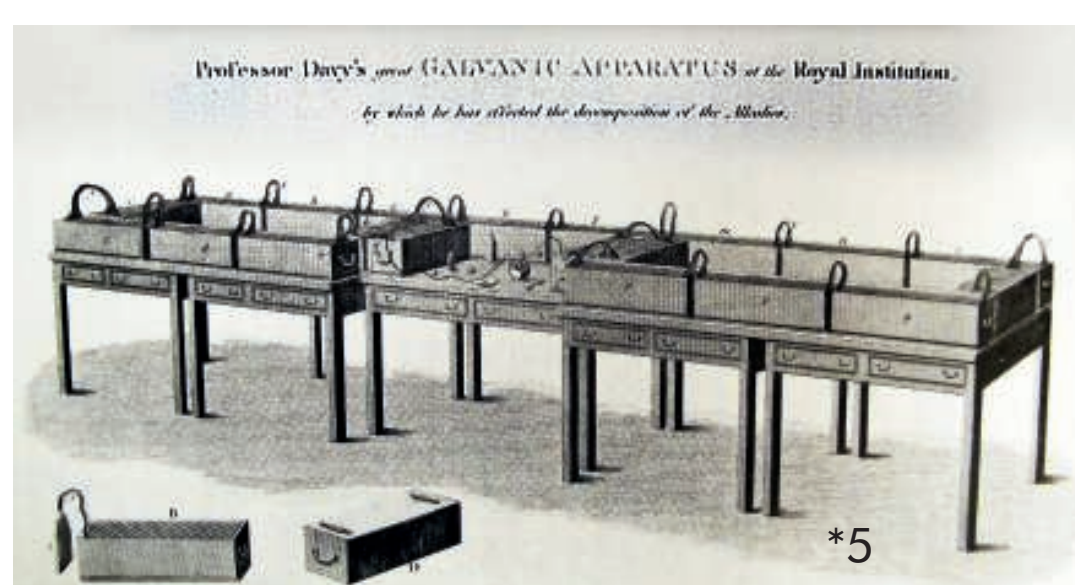
Sir Humphry Davy

* December 17th, 1778 in Penzance, Cornwall in England
† May 29th, 1829 in Genf, Switzerland

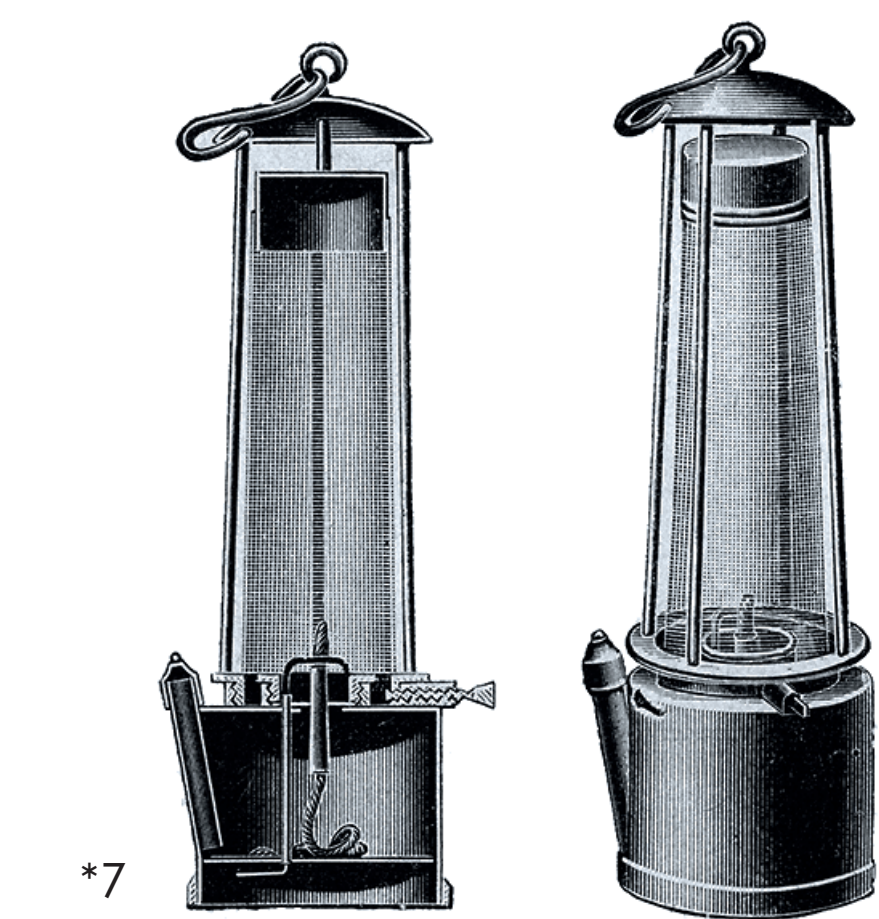


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Sir Humphry Davy was an english chemist, inventor and president of the Royal Society. Unaware of Petrov's work, Davy constructed a larger voltaic battery with an electrode area of 80 m². Using his huge battery in 1807 he could decompose potash and soda by gaining the metals potassium and sodium. Later he could obtain barium, calcium, strontium and magnesium. During these experiments he experienced new gas discharge phenomena such as continuous arcs, which he presented often in front of a large aristocratic audience. In his Bakerian Lecture he writes: “By the arrangement some brilliant phenomena were produced. The potash appeared to be a conductor in a high degree, and as long as the communication was preserved, a most intense light was exhibited at the negative wire, and a column of flame, which seemed to be owing to the development of combustible matter, arose from the point of contact.” Using his results he invented the Davy lamp, a gas discharge lamp with methane, which was used as a safety lamp for the workers in coal mines.



Davy's battery



Davy's lamp

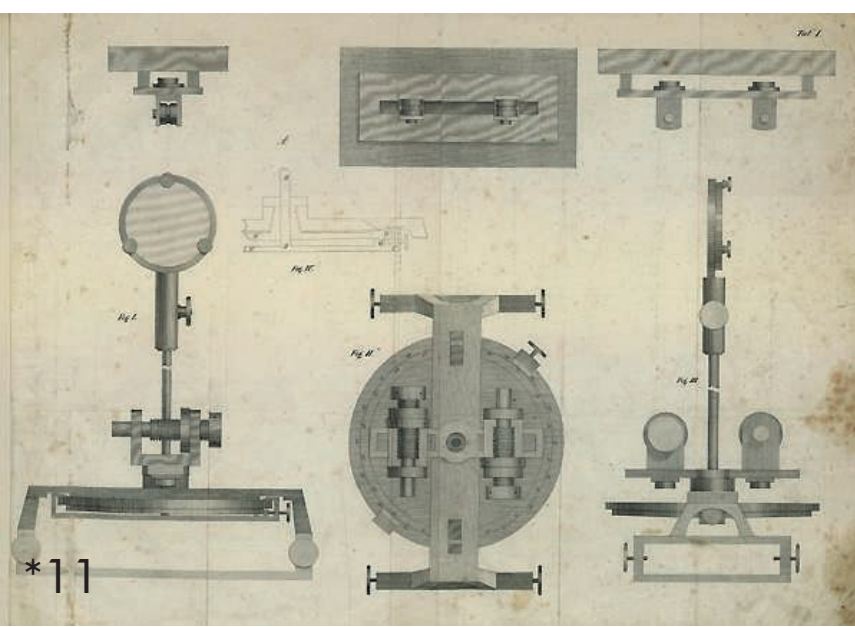


Davy's presentations

Carl Friedrich Gauss

* April 30th, 1777 in Braunschweig, Germany
† February 23th, 1855 in Göttingen, Germany

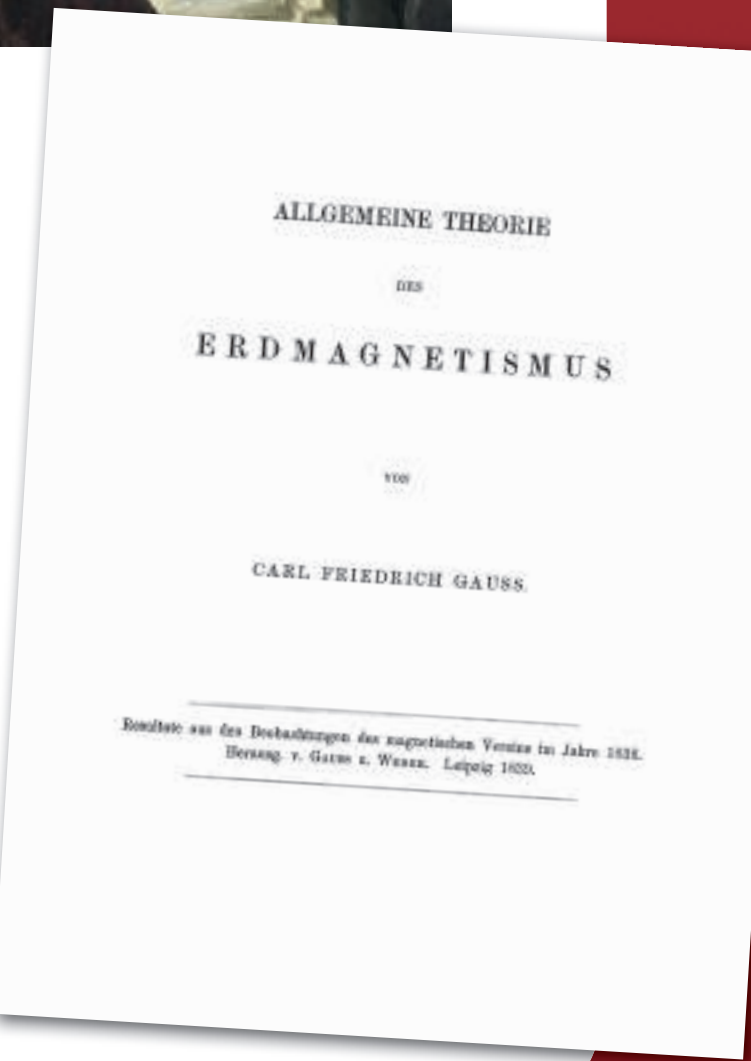
Carl Friedrich Gauss was a german mathematician, astronomer, physicist and a student of Georg Christoph Lichtenberg. Gauss invented a lot of laws, mathematical computational methods and studied the Earth's magnetic field. To measure the daily fluctuations of the magnetic field, he constructed in 1832 a device called the magnetometer. In the observatory of Göttingen Gauss and his assistant Wilhelm Eduard Weber did researches and measurements during the period 1836-1841. Some of the measurements were taken for 44 hours in a row. Because his work fascinated physicists worldwide, he sustained help from over 50 scientists from different continents. The measurements were taken worldwide and sent to Gauss in Göttingen, where he evaluated them. In his works “Resultate aus den Beobachtungen des magnetischen Vereins” (“Results from the observations of the magnetic association”) and “Allgemeine Theorie des Erdmagnetismus” (“The common theory of Earth magnetism”) from the year 1839 he tries to explain the observed daily fluctuations. For Gauss they are a consequence of electrical discharge happening in a conductive layer of the atmosphere. Another side effect of this discharge, which confirms his theory was the existence of Aurora Borealis (Northern lights).



Magnetometer blueprint



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“The common theory of Earth magnetism”, 1839

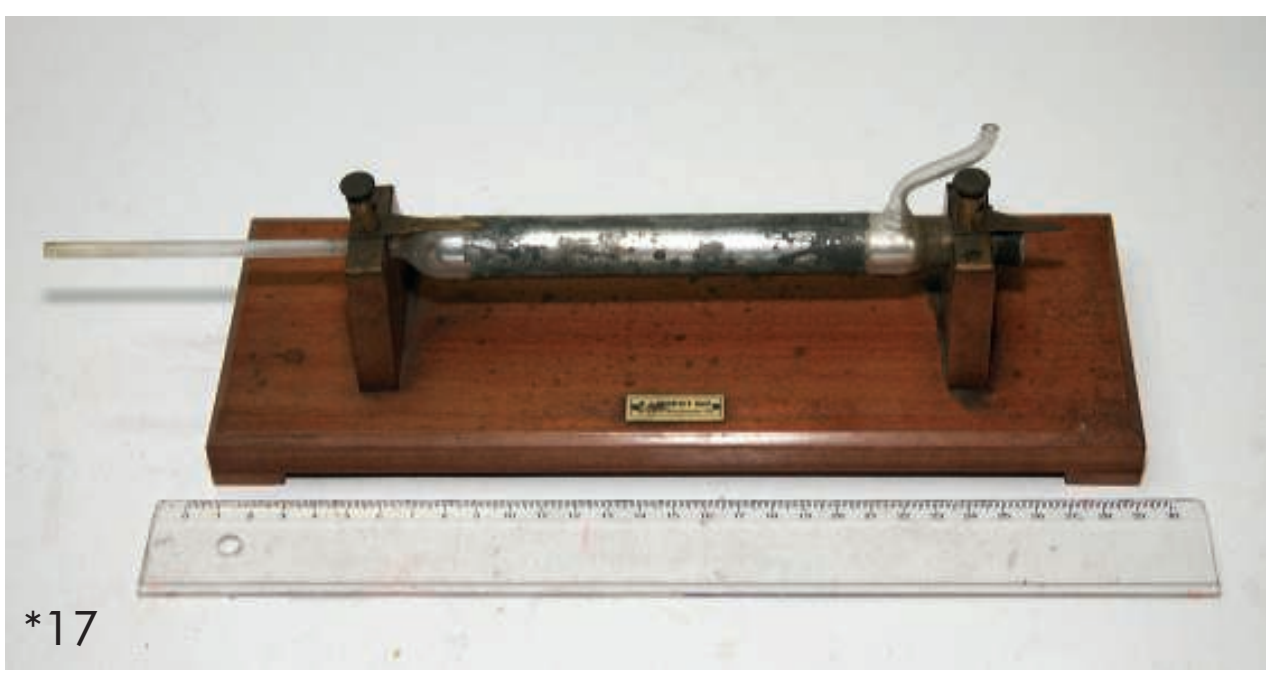
Ernest Werner von Siemens

* December 13th, 1816 in Lenthe by Hannover
† December 6th, 1892 in Berlin

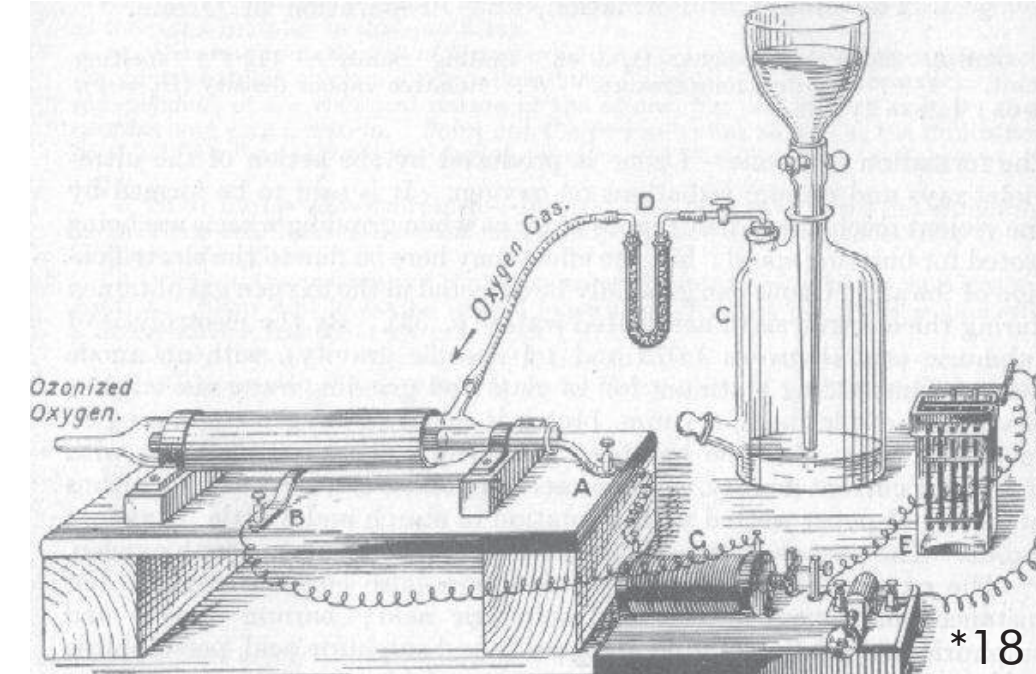
Ernest Werner von Siemens was a german inventor, industrialist and founder of the electrical company Siemens. In the year 1857 Siemens invented the ozone generator as a device for water cleaning. The first ozone generator consists of two with each other connected glass tubes, both of them coated with a metal layer. The inside of the generator can be filled with air or only with oxygen. The metal parts of tubes are connected with an induction apparatus and the whole generator is placed inside of a fluid like water. When Siemens applied a high alternating voltage on this fluid medium, he observed a lightning discharge inside of the gas tube. As he raised the current, he notices that he obtained ozone instead of oxygen.



*16



Ozon generator



The original Siemens ozoniser