

“FRAGMENTS OF SCIENCE”



A sign that cautions not to start a specific type of electric light with a match. Unknown author, circa 1900 – 1915.

The Nernst Electric Lamp – Walter Nernst, of the University of Göttingen, has recently devised an electric lamp which promises to be an important addition to our present methods of lighting. The part of the lamp which emits the light consists of a small rod of highly refractory material, said to be chiefly thoria, which is supported between two platinum electrodes. The rod is practically a nonconductor when cold, but by heating it (in the smaller sizes a match is sufficient) its conductivity is so raised that a current will pass through it; after the current is once started, the heat produced by the resistance of the rod is sufficient to keep up the conductivity, and the latter is raised to a state of intense incandescence, and gives out a brilliant white light. As the preliminary heating by means of a match or other flame would in some cases be an inconvenience, Nernst has devised a lamp which, by means of platinum resistance attachment, can be started by simply turning a switch. The life of the rods is about five hundred hours. The lamps are said to work equally well with either alternating or direct

and there is no vacuum necessary. If this lamp proves a success as a commercial apparatus, it will be another example of how slight a matter may make all the difference between success and failure. There have been numerous experimenters trying for the last ten years, and in fact ever since the appearance of the arc lamp, to utilize in an electric lamp the great light-giving power of the refractory earths in a state of incandescence; but owing to their high resistance at ordinary temperatures, no results were obtained until Nernst thought of heating this thoria rod, and this simple procedure seems to have solved the whole difficulty. It is claimed that the Nernst lamp is a much more economical transformer of electricity into light than the present incandescent electric lamps. An apparatus called a kaolin candle had been suggested by Paul Jablochhoff in 1877 or 1878. It consisted of a strip of kaolin, along which ran a "match" of some conducting material. The current was passed through this "match" until the kaolin strip became heated sufficiently to become a conductor itself. The lamp did not, however, prove a commercial success. *Fragments of Science*. Appletons' Popular Science Monthly, April 1899.



An automatically starting incandescent light fixture made by the Nernst Lamp Company, in 1902. There would have been a frosted glass globe diffuser covering the rods at the left. The glow rods in this example were made from thin rods of iron that had been coated with thoria. Credit: National Museum of American History / Smithsonian.

Today, we take it for granted that turning on an electric light is as simple as merely flipping a switch. Before the widespread adoption of electric lights there were gas lamps. A valve would first be turned to start the flow of natural gas, and then a match would be used to ignite it. Once lit, the lamp would continue to generate light by burning the gas.



A replica of Edison's 1879 carbon filament light bulb. Made in 1929 by General Electric Co. for the 50th anniversary.

The first Edison incandescent light bulb used a glowing filament of carbonized yarn thread. It lasted for less than 40 hours of continuous operation before burning out. He then tried many other cellulose sources of carbon. He settled on singed bamboo fibers as the ideal material. The bamboo was imported from Kyoto Prefecture in Japan. The bamboo fibers grown there are highly durable and flexible, with thick and sturdy fibers. These filaments lasted about 1,200 hours. These types of lamp would start to illuminate as soon as the switch was turned on. The earliest lamps were not very efficient. Twenty years later, the Nernst lamp invention was significantly brighter, and had a whiter color closer to daylight. The carbon filament lamps had a warmer yellow to amber color. The glowing rod was twice as efficient as the carbon type; it used half the electricity to produce the same amount of light. Two or more rods could be placed in the same light fixture to provide an even brighter illumination.

The materials mentioned are antiquated terms. Thoria was the name used for a chemical compound that is also known as thorium dioxide. Kaolin referred to an alumina silicate. These materials were formed into thin rods. It was often less than 1/10th of an inch in diameter, and an inch or two long. A refractory material is one that is strong and resistant to decomposition that can be caused by chemical reactions or very high temperatures. Unlike a carbon filament lamp, the rod does not need to be enclosed in a sealed glass envelope from which the air has been evacuated. The lack of a glass envelope allows access to the filament to heat it with a match and start it glowing. The rod must be heated to about 1,300 °F – the temperature of a match or oil lamp flame. The reason for preheating the filament is because the ceramic has a very high resistance at room temperature. When it is turned on it would get hot and possibly glow dull red. It wouldn't give a significant amount of illumination. When the filament is hot, the resistance is much lower. This allows the flow of a strong current of electricity. This current generates enough heat to maintain the low resistance and keep it incandescent for as long as the power remains on.

The Nernst invention was started using a “platinum resistance attachment” instead of a flame. This was a small electric heating coil with a thermostat to turn it off after the filament was heated enough. The Nernst lamp was more complicated and more expensive to manufacture. The initial cost to purchase it was higher. This was somewhat offset by the cost savings from using less electricity. The Nernst design was the first successful automatically starting ceramic filament lamp. Inventors had been trying to make a reliable coil started lamp that was inexpensive to manufacture for more than a decade. Before Nernst's invention, the flame started filaments were sometimes used. The ceramic filaments and heating coils in the Nernst lamp would periodically need to be replaced. The cost of replacing these parts in a Nernst lamp was reasonable. The platinum in a broken heating coil would be sent back to the manufacturer. The customer would get a discount on the cost of the replacement coil.



An early carbon filament light bulb. It was likely made before 1915. It uses about 30 watts.

An arc lamp is another early type of electric light that has two electrodes with a gap between them instead of a filament, with the electricity “jumping” across the gap to create a bright “arc” of light. These arc lights were very bright. They were usually only used outdoors, for example, in streetlights. They were also sometimes used to illuminate factory floors for the third shift workers.

Before the widespread availability of gas or electric lights, there were other methods of producing light. One involved a rod of quicklime, or calcium oxide, that was burned in a stream of hydrogen and pure oxygen gases. These were used in the mid-19th century for stage lighting in theaters. An actor was said to be standing on the stage in the intense “limelight” of the brightly burning quicklime.



The zigzag shaped metal filament in this lamp is about 3 feet long. This style is referred to as a “squirrel cage” arrangement. It is likely made of tantalum, instead of tungsten, was probably manufactured in the 1910s or early 1920s. It uses about 240 watts and is very bright. (A very short exposure was used to take this photo to make it easier to see the filament.)

Other materials were also tried for lamp filaments before the 1910s – transition metal elements such as osmium, tantalum, molybdenum, and tungsten. They are very conductive, and can withstand high temperatures. These metals were very difficult to work with a century ago. It took more than a decade for inventors to devise a method to economically produce filaments from one of these metals in quantity. By the early to mid-1910s manufacturers, like Thomas Edison's General Electric Company, solved these problems. The Brian Marsh Mill, a subsidiary of General Electric, manufactured tantalum filament light bulbs in Central Falls, RI. Later, tungsten became the most commonly used filament material. A low wattage light bulb would have cost 40 cents then, equivalent to 13 dollars today. These prices were after mass production greatly lowered the cost. Tungsten incandescent bulbs are currently being replaced today by more efficient LED lamps.



An advertisement for the new, more efficient, tungsten lamp. Credit: Providence Journal, Jan. 18, 1910.



A modern LED lamp that is designed to look like it has an early incandescent style filament. It uses about 4 watts.

Edison's company had the exclusive rights to sell the patented Nernst lamp invention in America. A sign like the one shown here would have been found in places like hotel rooms. It would alert the guests, who might be from out of town, that the lamps had been upgraded from the type that is started with a match to one that automatically starts. The switch was shaped like the valve on the early gas lamps. Turning the key shaped switch starts the electric light. Someone would literally "turn" the key on. After turning on a Nernst lamp, it would take about a half of a minute to get hot enough to reach full brightness. It was more convenient, but no less time-consuming, to start than holding a match to the rod.

– Michael L. Umbricht

(Except where otherwise noted, photographs are by the author.)